NATIONAL BANK OF THE REPUBLIC OF MACEDONIA

5th Research Conference "Economic and Financial Cycle Spillovers: Reconsidering Domestic and Cross-Border Channels and Policy Responses"

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Foreword

On April 7-8, 2016, the National Bank of the Republic of Macedonia organized the 5-th Annual Research Conference entitled: "Economic and Financial Cycle Spillovers: Reconsidering Domestic and Cross-Border Channels and Policy Responses". This conference is traditionally organized on the occasion of the anniversary of the monetary independence of the Republic of Macedonia. The 5-th Annual conference started with a keynote lecture and a panel of the distinguished speakers of the Central Banks and academic institutions from the region on the main conference topic. In addition, high quality papers were presented, received upon Call for papers sent to the central banks in the region. This booklet incorporates the papers presented at the conference, as well as the opening speech of the Governor of the National Bank of the Republic of Macedonia and the speech of the keynote lecturer.

Launching this booklet, we would like to express our gratitude to the esteemed Governors, all presenters, the discussants, the moderators of the conference sessions, as well as to all other participants, all of them adding value to the success of the conference.

National Bank of the Republic of Macedonia

Dear Governors, Your Excellences,

Ladies and Gentlemen, Dear guests,

Let me wish you a warm welcome to our fifth Annual Research Conference that we usually host to mark the anniversary of the country's monetary independence. This year's Conference is a kind of a small jubilee considering the fact that for five consecutive years we have been inviting policy makers and researchers from the region and wider to discuss main policy issues and research questions, creating useful interaction and mutual knowledge increment, on which we are very proud. In addition, this year's Conference coincides with yet another great anniversary – celebration of 70 years of central banking activities in the Republic of Macedonia and the conference is among the events that mark this immense anniversary throughout the year.

As you probably noticed, this year we have chosen quite comprehensive and challenging Conference topic: *Economic and Financial Cycle Spillovers: Reconsidering Domestic and Cross Border Channels and Policy Responses.* Although not a new issue, it has been fully indorsed in the last global crisis and considered to be one of its main lessons that is still widely explored in the central banking and academic community.

In dealing with global and domestic economic and financial cycle spillovers in the last years of turbulent global environment, central banks have broadened their objectives by including the financial stability goal, as well as many creative innovations in their toolkit. In a low or zero interest rate environment, the monetary authorities across the world turn to the use of unconventional monetary policy measures and obviously now, several years after the outburst of the crisis, it is still an ongoing practice for most central banks. While still examining their usefulness, it is difficult to discuss their exit dynamics, even in the case of the FED, although its monetary policy normalization started at the end of the last year. Anyway, it is still debated whether the unconventional instruments and tools created during the crisis will become an integral part of the conventional monetary policy framework. Probably this will depend on country specific circumstances and individual contribution of these newly created instruments and measures in fulfilling policy objectives on price and financial stability. Macro-prudential tools have also been widely used for dealing with specific features of the financial cycles in the last period, aiming to boost financial soundness or provide positive feedback to the economic recovery that has certainly expanded the horizon of their expected impacts compared to the past. Policy measures aimed to support lending, especially in the economies with strong negative loop between private sector leverage and banks' credit risk, will probably stay effective for a reasonable time span. The capacity of economies to cope with these headwinds related to the financial cycle recovery will rely upon providing resilient policy framework and keeping sufficient policy buffers in all segments of the economy.

Obviously, many aspects on the economic and financial cycles have already been observed, with even more still awaiting to be explored. Our latest experience is mainly related to the bust of the cycles, however we need to know if the size of spillovers or effectiveness of our instruments will be the same in the boom stage of the cycle. The seminal work by Borio from 2012, has already provided some stylized facts regarding frequency, duration and leading indicators of the cycles, incorporating the period of the last global crisis. However, we need to disentangle country's specific features of the cycles as a basis for the policy mix design. In analyzing financial cycle, it is necessary to go deeper into bank's balance sheet, and therewith to head towards data granularity as an important platform to better assess banks' risk attitude as well as to appropriately link banks' specifics and their market behavior. Consequently, increasing knowledge of economic and financial cycles requires stronger modeling abilities, enlargement of the analytical base and combining information of both domestic and cross border spillover channels, as a floor for adequate policy responses.

Touching upon the issue of economic and financial cycle spillovers in the case of Macedonian economy, I could refer to the following points. Namely, during the last global crisis, our economy followed relatively quick and steady recovery from the trough at the beginning of the crisis that was supported by the financial cycle pick up. The banking sector has proven to be sound and stable all these turbulent years, with slowdown of lending relative to the pre-crisis period, yet with moderate credit growth rates supportive to the economic rebound. A related point to consider is the solid ground of the banking system taking into account not only the high capital adequacy and liquidity, but also the relatively moderate level of non-performing loans, especially compared to the peer countries of the region. Besides the high foreign capital in the banking system, cross border effects have remained contained, mainly due to the simple framework of banking operations and strict banking regulations. Last but not least, sound economic recovery also transmits positive spillovers to the financial sector developments. Regarding the economic cycle upward movements, we should underline the strong fundamentals of the Macedonian economy that have been obviously fighting off challenges from the trembling global environment as well as domestic political instability since the beginning of the previous year. The main reasons behind these economic performances were the structural changes in the economy in recent years, which supported export diversification and reduction of unemployment. Improved country's economic fundamentals are expected to continue providing support to the financial cycle picking up, although both domestic and external risks are still being present. Regarding policy implementation, besides monetary policy measures, we have also used non-standard monetary policy measures that are still in place, and additionally in several occasions we have modified some of the prudential measures for further strengthening of financial stability.

Managing economic and financial cycle spillovers and putting them on the right track, go beyond monetary policy scope of operation and refer to the overall macroeconomic policy mix. Additionally, international developments and regulation could also affect domestic cyclical movements. Nowadays, we live in a world of ongoing recovery of the advanced economies from the long-lasting crisis, rising vulnerabilities of emerging economies, increasing and unpredictable volatility of the international financial markets and, on top of that, quite persisting geo-political risks. In this complex environment, we need to continue with internal policy coordination and international cooperation.

Therefore, we have been discussing here today quite comprehensive economic phenomena that require multiple angles of observation and profound analysis. Although I believe that the research papers that are going to be presented today will shed light on some of the issues that I have mentioned, this will definitely be a challenge for the researchers in the period ahead, too. As policy makers, speaking today, many years after the onset of the global crisis, we can probably say that many policy challenges are already behind us, but still there are more to come. Therefore, we need to keep on building our institutional capacity and research skills and I believe that today's conference, as a continuation of our previous conferences, will additionally contribute to this goal, not only for us, but also for the participating central banks and other institutions.

I look forward to yet another successful conference, interesting discussions and useful policy messages!

Dimitar Bogov, Governor of the National Bank of the Republic of Macedonia

Skopje, 7 April 2016

Challenges for policy responses within the European Union in the context of post-crisis reconstruction

Keynote speech by Boris Vujčić, the Governor of the Croatian National Bank, at the international conference "Economic and Financial Cycle Spillovers: Reconsidering Domestic and Cross Border Channels and Policy Responses", organized by the National Bank of the Republic of Macedonia in Skopje from 7 to 8 April 2016[I]

Dear Ladies and Gentlemen,

I am truly honoured to be invited as a keynote speaker at this conference that gathers central bankers and policy makers in the region to discuss issues raised by the heightened levels of distress and volatility in financial markets. With two episodes of severe distress behind us, the global financial crisis, followed by the euro-area crisis, many observers share a conviction that today we might be observing the seeds of a new similar incident waiting to happen. Some point to possible bubbles in asset markets, some to distorted business models in (parts of) the financial industry, and quite a few of them see a new crisis lurking behind emerging market developments, which may start the latest episode of a " crisis trilogy", as recently pointed out by Andrew Haldane from the Bank of England[II]. To circumvent the reoccurrence of a lengthy and costly crisis, we need to improve our understanding of the processes underlying crisis episodes and adjust our policies accordingly. This is a great challenge for our trade, even more so amid the current deconstruction of overarching paradigms and a slow, if any, emergence of new central banking principles. Such principles need fundamental research as a foundation to help redesign the policy frameworks of central banks and to guide our corrective actions.

This is an exceptional opportunity to address the challenges of shaping policy responses in an increasingly integrated and changing world, particularly from a perspective of countries that are or aspire to become members of the European Union and the euro area. I hope I can raise a few relevant issues with the potential to provoke a constructive discussion and obtain much needed research insights.

Allow me to briefly summarize the main points for my discussion, structured here in three interrelated topics. First, real and financial cycles exhibit some regular patterns relevant for designing policy responses in open economies exposed to frequent shocks. Second, it is of major importance for the future of the euro area to advance the institutional design in order to make all of the envisaged protective mechanisms operational and enhance setting the right policy mix, which encompasses both EU and national policies. Finally, such a policy mix should pay a particular attention to careful coordination, given the interdependences among different national and supranational policies and immense potential for cross border policy leakages. I will elaborate briefly on each of the mentioned topics.

1. Economic and financial cycles: five important patterns

The financial crisis in 2007-08 has induced a change in the hierarchy of central bank goals. The concern of central banks for business cycles and economic growth has moved far beyond the extent to which those did, or did not, generate inflationary (or deflationary) pressures. Price stability has proven insufficient to deliver financial stability and the lack of the latter has *once again* disclosed the overwhelming economic and social costs generated by the episodes of financial instability[III]. This has altered our view of financial stability issues, inaugurated the notion of systemic risks, and subsequently led to the broadening of our policy mandate. The establishment of the dual mandate for central banks implied that the traditional monetary policy function was "supplemented" by macroprudential policy as a response to the interplay of financial cycles and systemic risk.

[I] I would like to thank Saša Cerovac and Ivana Herceg for their help in preparing these remarks.

[II] Haldane, A. (2015): How low can you go? – speech given at the Portadown Chamber of Commerce, Northern Ireland, 18 September 2015 (http://www.bankofengland.co.uk/publications/Pages/speeches/2015/840.aspx).

[III] D. Miles, Monetary Policy and Forward Guidance in the UK, speech given at the Northumbria University, Newcastle, 2013, D. Kapp, M. Vega, Real Output Costs of Financial Crises: A Loss Distribution Approach, MPRA Paper No. 38988., 2012, A. G. Haldane, The $100 Billion Question, comment by Andrew G. Haldane, Financial Stability, Bank of England, Institute of Regulation & Risk, Hong Kong, BIS Review 40/2010

The broadening of the central bank mandate and the need to add new measures and instruments to the policy toolkit have opened several avenues for central banks to expand on their knowledge. We need to re-examine the phenomena of regular disturbances, or cyclical processes taking place with different frequencies, as well as their inherent structures. While the nature of shocks and propagation mechanisms still largely remain on the battlefield of economic theory, empirically observed patterns and the consequences of the materialisation of risks necessitate our reaction, which should be based on our best knowledge and abilities. Allow me to get into more detail here.

Optimal policy responses in a multi-country setting require a careful examination of real and financial cycles, both domestic and international. For that purpose, let us look at five important patterns that seem to characterise them. First, *financial cycles seem to have a lower frequency and higher amplitudes compared to standard business (real) cycles.* Credit and asset price cycles may take long to develop their potential to destabilize the financial system. Further on, such a potential may emerge regardless of watchful micro-prudential supervision or stable inflation. The resulting notion of systemic risk may be identified as the interplay of macroeconomic shocks that make financial sector vulnerable, the contagion resulting from financial interconnectedness and endogenous financial imbalances associated with credit booms, credit leverage and risk taking behaviour of financial institutions[IV].

Second, there are still no mechanisms in place to engineer sustainable synchronisation of cyclical movements across Europe. The question of cyclical synchronisation arises as particularly important within the international setting. This is the factor that makes policy responses even more complex, especially within a currency union such as the euro area, where the damage of suboptimal policy responses might exceed mere fiscal costs and output losses – they may threaten the future of the euro itself. Due to the recent events, therefore, researchers have focused their attention on testing for the endogeneity of optimal currency areas, further enriching the vast literature on the synchronisation of business cycles[V]. This literature substantiates the conclusion of diverging real and financial cycles across member states, both during the pre-EMU and post-EMU regimes. The single monetary policy has not brought cycles together, although a few efficient and credible shock absorbers were devised at the eve of the euro.

Further on, there is some evidence on the increasing correlation between real cycles and financial cycles across different groups of EU member states, as provided by Meller and Metiu (2015)[VI]. Such a pattern emerges regardless of different sources and well-documented differences in frequencies and amplitudes between real and financial cycles. Moreover, researchers from the Bank for International Settlements have shown that the correlation between real and financial cycles gets stronger over time as the duration and amplitude of financial cycles increases. The main explanation for the increasing correlation between the real and financial cycle is the so-called "unfinished recession" phenomenon, according to which globalization and a more activist monetary policy, which fails to take into account the state of the financial cycle, eventually cause a bigger recession down the road[VII].

We are left with two more interesting features of cyclical (co)movements. *The degree to which real and financial cycles converge across groups of member states is neither constant, nor does it increase in linear fashion over time.* All the previously described processes might deliver the periods of high synchronisation, followed by rapidly collapsing convergence.

[IV] Constâncio, V. (2015): Financial stability risks, monetary policy and the need for macro-prudential policy; speech at the Warwick Economics Summit, 13 February 2015 (https://www.ecb.europa.eu/press/key/date/2015/html/sp150213.en.html).

[V] Grigora, V., Stanciu, I.E. (2015): New Evidence on the Synchronization of Business Cycles: Is there an European Business Cycle?, National Bank of Romania, Macroeconomic Modelling and Forecasting Department, Bucharest University of Economic Studies;
Basten, C. (2006): Business cycle synchronisation in the euro area: Developments, determinants and implications, Working Paper Series, Research Notes 22, Deutsche Bank research;
Stremmel, H. (2015): Capturing the financial cycle in Europe, Working Paper Series, No.1811/June 2015, European Central Bank;
Sybille, L. (2012): Has the Euro Changed Business Cycle Synchronization? Evidence from the Core and the Periphery, Ifo Working Paper No. 122 (www.cesifo-group.de)
Gouveia, S. and Correia, L. (***):Some facts about business cycles synchronisation across the euro area countries: the case of small countries, Centre for Transdisciplinary Development Studies (CETRAD), Department of Economics, Sociology and Management (DESG), University of Trás-os-Montes and Alto Douro (UTAD), Portugal.

[VI] Meller, B., Metiu, N. (2015): The synchronisation of European credit cycles, Discussion Paper No. 20/2015, Deutsche Bundesbank.

[VII] Drehmann, M., Borio, C., Tsatsaronis, K. (2012): Characterising the financial cycle: don't lose sight of the medium term!, BIS Working Papers No 380, Monetary and Economic Department.

Finally, the (in)famous *duality between the core and the peripheral countries emerges as a theme here as well, as country groups tend to cluster in terms of real and financial cycles*. All of these notions call for further research and better understanding, but they are nevertheless useful information for shaping policy responses.

The expectations of convergence in real and financial cycles due to increased trade and financial integration, pursued strongly within Europe (the euro zone) during the last few decades, have far from materialized. In addition to some old suspects, theoretical and empirical literature have identified some new channels at work to explain for such a phenomenon[VIII]. The traditional view that increasing trade integration may, or may not be, supportive for the synchronisation of business cycles, depending on the specific trade pattern, has certainly been warranted (Krugman vs. Frankel-Rose hypothesis). Further on, stronger financial linkages have also proven to be an elusive channel for engineering sustainable convergence of real and financial cycles. While debt flows remain a theoretical channel that might increase the extent of international risk sharing, the actual effect depends on what happens during the crises. For example, an increased risk premium and depressed collateral prices in a country hit by an asymmetric shock may reverse capital flows exactly during the period when higher inflows are most needed. Such effect is usually known as a sudden-stop in capital inflows and the mechanics of the process is not too different from the disrupting effect of the financial accelerator on the credit channel of monetary policy in developed countries.[IX]

Finally, even an analysis of trade and financial integration, while improving our understanding of complex open economic systems, may fall short of explaining the synchronisation of real and financial cycles. Since cyclical patterns are largely attributable to different cost structures and profitability profiles that affect investment decisions and output volatilities, another potential explanation should be sought on the production side, which operates in conjunction with trade and finance. What is often left out of the euro area storyline is the fact that the monetary union came on top of diverging trends in total factor productivity (TFP) as the catching-up process in the EU came to a stall during the early 1990s[X]. A reversal in the catching-up process came regardless of high investments in some peripheral countries and high capital output ratios – rather than a sign of success, high investments were an indication of deeper-rooted problems.[XI] Many peripheral countries did not need more investments *per se* to restart convergence – what they needed was a more efficient allocation of investments. The efficiency of investments fell victim to poor economic governance, rigid labour and product markets, low investments in information and communication technologies, defunct educational systems and the poor quality of corporate management. What the monetary union accomplished against such a background was to create an illusion of continuing convergence on the back of increasing foreign borrowing and investment in non-tradables, rather than to enact discipline in the economic governance of peripheral countries. The adoption of the single currency, followed by the consistent private sector interest spread, elimination of exchange rate risk and implied fiscal bail-out clause, cemented the duality in the quality of economic governance and boosted the suboptimal reallocation of resources in the periphery. So, we have observed financing low-productivity sectors (via real estate or government spending) with debt inflows, instead of capital flows fuelling further "catching-up". This has produced asset bubbles and large exposures of banks from core euro area countries, as well as world-wide creditors, towards the euro area periphery, and created strong contagion channels that have increased the amplitude of swings in comparison to historical business cycles. Such a phenomenon has in quite a few instances also been observed outside of the euro-area, regardless of the exchange rate regime implemented, which brings me to the discussion of challenges in finding an optimal policy mix in a small open economy.

[VIII] Duval, R., Cheng, K., Hwa Oh, K., Saraf, R., Seneviratne, D. (2014): Trade Integration and Business Cycle Synchronization: A Reappraisal with Focus on Asia, IMF Working Paper 14/52; Davis, S. (2011): Financial Integration and International Business Cycle Co-Movement: The Role of Balance Sheets, Federal Reserve Bank of Dallas, Globalization and Monetary Policy Institute, Working Paper No. 89.

[IX] Bernanke B.S., speech at the Credit Channel of Monetary Policy in the Twenty-first Century Conference, Federal Reserve Bank of Atlanta, Atlanta, Georgia, June 15, 2007.

[X] Gros, Daniel. (2011) What is holding Italy back?, CEPS Commentary, 8 November 2011.

[XI] Hassan F., G. I. P. Ottaviano (2013), Productivity in Italy: the great unlearning, VoxEU.org, 30 November.

2. Mutations of the traditional monetary trilemma: policy responses in open economies or "Ray in European clothing"

According to the newly emerging set of principles, this dual central banks' mandate is supposed to function via two independent sets of policies. As real and financial cycles diverge, central banks need a set of two independent policies.[XII] Monetary policy should target the real cycle in order to stabilize inflation, while macroprudential policy should be used to tame the financial cycle. The task of maintaining price stability and financial stability should be even easier if central banks adopt a flexible approach to inflation targeting, the one that allows for temporary deviations and the gradual convergence towards the inflation target, as pointed out by Stanley Fischer (2010)[XIII].

Such a simple story of two independent policies – monetary and macroprudential – aiming at two separate goals, has some weaknesses. Such a framework is underlined by the traditional monetary trilemma theorem launched by the Mundell-Fleming model. The traditional monetary trilemma limits policy choice to only two among the three dimensions: independent monetary policy, free capital mobility and exchange rate stability. However, the usefulness of exchange rate flexibility as the shock absorber has been increasingly questioned over time. A more sceptical view on the usefulness of flexible exchange rates has changed the trilemma into an "irreconcilable duo: independent monetary policies are possible if and only if the capital account is managed" (Ray, 2013)[XIV]. Those who believe that exchange rate flexibility should not be abandoned, even in the cases of small open economies, have largely deflated their expectations of flexible exchange rates to act as shock absorbers[XV]. Therefore, the notion that "the global financial cycle constrains national monetary policies regardless of the exchange rate regime" has now become part of common knowledge.

With supranational "one-size-fits-all" monetary policy, the role of national fiscal policy in stabilizing real activity and inflation has, accordingly, increased in euro-area member states. However, the configuration of single monetary policy, coupled with national fiscal sovereignty and the no bail-out clause, has generated suboptimal policies and frictions that threaten the monetary union. With single monetary policy, commitment not to bail-out heavily indebted member states is necessary to eliminate potential for moral hazard. However, the actual euro-area experience demonstrates strong incentives for sovereign fiscal policies to "trespass" on the prudent fiscal stance, either in the expectations of non-enforcement of the no bail-out clause, with the implicit assumption that sovereign default will be politically unacceptable, or through a direct support of common monetary authority through special monetary operations. This uneasy triangle is usually referred to as the fiscal trilemma of the monetary union. Such a "holy trinity" makes impossible the cohabitation of the independent monetary policy of a supranational central bank, national fiscal sovereignty and the no bail-out clause[XVI]. In order to ease the frictions stemming from national fiscal policies, the monetary framework of the euro area was reconstructed by implementing the elements of the banking union (the Single Supervisory Mechanism and the Single Resolution Mechanism), setting up the European Stability Mechanism (ESM, previously the European Financial Stability Fund (EFSF)) as well as by starting the ECB's quantitative easing program (QE). All these mechanisms should help to decouple bank distress and sovereign debt pressures.[XVII]

The described trilemmas in the European economic and monetary framework, with the still absent synchronisation of real and financial cycles, have given birth to a specific quadrilemma that demonstrates difficulties faced by policy makers in the euro area. With supranational monetary policy concerned primarily with the overall price stability objective, symmetric (global) shocks transmitted through financial linkages and domestic (national) divergent cycles, the burden of adjustment has to be borne by national macroprudential policy. The absence of other adjustments mechanisms, such as a perfect labour mobility

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[XII] Constâncio, 2015. *ibid.*

[XIII] Stanley Fischer (2010): Myths of Monetary Policy, Israel Economic Review, 2010.

[XIV] Ray, H. (2013): Dilemma Not Trilemma: The Global Financial Cycle And Monetary Policy Independence, Working Paper 21162, NBER Working Paper Series.

[XV] Couré, B. (2015): Paradigm lost: Rethinking international adjustments, speech atEgon and Joan von Kashnitz Lecture, Clausen Center for International Business and Policy, Berkeley, 21 November 2015.

[XVI] Beck, H., Prinz, A. (2012): The trilemma of a Monetary Union: Another Impossible Trinity, Leibniz Information Centre for Economics.

[XVII] Pisani-Ferry, J. (2012): The Euro Crisis and the New Impossible Trinity.

or a transfer mechanism in the form of unemployment insurance[XVIII], adds to the burden on fiscal policy, which is already suffering from moral hazard issues. The Vice-President of the ECB, Vitor Constancio, is right to emphasize that "macroprudential policy is therefore essential in any economy as the business and financial cycles are not synchronised. Even more so in a monetary union where vulnerabilities identified in each country can be addressed with macroprudential policy, allowing for the appropriate heterogeneity, while countries remain subject to a single monetary policy"[XIX].

There are a couple of other difficulties related to the use of national policies. The shock absorbing capacity of fiscal policy is in too many instances limited by the narrow fiscal space existing before the crises. The recession has further eroded fiscal positions and fiscal rules have failed to tame unsustainable fiscal paths so that the ability of fiscal policies in the EU to deal with another blow of crises is quite limited. Also, a need for national macroprudential policy immediately opens the issues of harmonisation and coordination on the international level in order to avoid unintended consequences, which I will comment in more detail later on. Additionally, for macroprudential policy to be effective it must be intrusive, affecting the "normal behaviour" of agents and markets[XX], yielding benefits in reducing long-term costs generated by the systemic risk that makes it hard to attenuate public interest thus creating a central bank's legitimacy paradox[XXI].

Unconventional expansionary monetary policy, which was pursued after reaching the zero lower bound, and out of the fear of "the risk of doing nothing"[XXII], may be risk-inducing by fuelling search for yield behaviour. Abundant liquidity and low borrowing costs have the capacity to generate bubbles, confirming a notion that rational individual decisions may lead to irrational social outcomes – albeit as a reaction to highly non-conventional policies. When inflationary impulses eventually pick up, the present monetary support will dry up and trigger a renewed divergence of national real and financial cycles, the phenomenon termed "unfinished recession".

The reconstruction of the euro area is clearly the work in progress. We need to get the policy framework right in order to pursue optimal policies. But given the magnitude of challenges, a good policy framework will not be enough to set the right policies – a lot of talent and ingenuity will be needed as well, making our job an art much more than before.

3. Critical moments in the post-crisis reconstruction of the European Union and specificities of macroprudential policy

The experience of the global financial crisis and more recent euro area debt crisis has motivated the reconstruction of the European economic and monetary framework along the pillars presented in the Fiscal Compact and Five President's Report[XXIII] on completing the monetary union. These issues need to be put into the described perspective in order to value the potential of the new framework to reduce the chance of catastrophic scenarios and provide us with adequate instruments should such a scenario take place.

First, the rebalancing of the euro area has often been associated with reducing labour costs in order to improve competitiveness. Coeuré (2016)[XXIV] vocally reinforces the view that productivity growth is central to competitiveness and to growing out of debt, as opposed to benefits of wage moderation. Seeing rebalancing as being all about cutting costs is misguided as benefits diminish with more countries engaging in such activities. However, pursuing structural reforms to raise productivity, in contrast to wage

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XVIII Bernoth, K., Engler, P. (2013): A Transfer Mechanism as a Stabilization Tool in the EMU, DIW Economic Bulletin, 1.2013.

XIX Constâncio, V. *ibid.*

XX Constâncio, V. *ibid.*

XXI Baker, A. (2013): The bankers' Paradox: The Political Economy of Macroprudential Regulation, School of Politics, International Studies and Philosophy, Queen's University of Belfast.

XXII Draghi, M. (2016): How domestic economic strength can prevail over global weakness, keynote speech at the Deutsche Börse Group New Year's reception 2016, Eschborn, 25 January 2016.

XXIII European Commission (2015): Completing Europe's Economic and Monetary Union, Report by: Jean-Claude Juncker in close cooperation with Donald Tusk, Jeroen Dijsselbloem, Mario Draghi and Martin Schulz.

XXIV Coeuré, B. (2016): Rebalancing in the euro area: are we nearly there yet?, speech at the Danish Economic Society, Kolding, 15 January 2016, (https://www.ecb.europa.eu/press/key/date/2016/html/sp160115.en.html) moderation, benefits substantially and uniformly all countries. "We do not need all euro area countries to adopt identical structural reforms. What we need is a framework that takes into account both how countries differ based on their national conditions, and how they are similar by virtue of being in a monetary union. Within those parameters there are various combinations of country-specific institutions that can produce smooth adjustment." (Praet, 2015)[XXV].

These notions should, of course, be the key ingredients of the Macroeconomic Imbalance Procedure and the Structural Reform Support Programme (as of 2017). If these conditions are met through institutional reform plans (until 2025), relying on deeper convergence, entailing, for example, Competitiveness Authorities and further financial and fiscal reforms, including the Deposit Insurance Scheme, Capital Markets Union and European Fiscal Board, should help resolve the quadrilemma. In the words of the Report: "...the Macroeconomic Imbalance procedure (MIP) could be utilised as a tool not only to prevent and correct imbalances but also to foster reforms and monitor progress in each euro area Member State towards these common standards. Significant and sustained convergence towards similarly resilient economies should be a condition for access to a shock absorption mechanism to be set up...".

As central bankers we need to be aware of the role and importance of structural reforms. And we also need to communicate this to the general public. However, even if convergence in TFP as a source of sustainable catching up gets kick-started and risks arising from it eventually get ironed-out, fiscal and macroprudential policies will still be needed to take care of residual idiosyncratic shocks. Moreover, we are directly responsible for getting macroprudential policy right, and in order to be able to do that, we need a profound understanding of all the issues relevant for its smooth and efficient implementation. Some of the critical issues for macroprudential policy at this point in time encompass (i) cross-border spillovers, (ii) the coordination of macroprudential and monetary policy and (iii) devising an internally consistent structure of macroprudential instruments.

International policy coordination, harmonisation and the consistent application of implemented instruments are vital to ensure effectiveness and limit the possibility and impact of adverse cross-border spillover effects[XXVI]. The potential spillover of nationally implemented macroprudential policies largely depend on the degree of financial cycle synchronisation, especially within the highly integrated (economically and financially) states, as in the case of the European Union, or even more so within the currency union members with a single monetary policy. Several aspects of the potential spillover should be considered when formulating the policy stance in a highly integrated environment that challenges us in pursuing financial stability. *Outward cross-border spillovers* of systemic risk create a need for countervailing macroprudential measures, clearly emphasising the need for policy coordination and measure reciprocation. In contrast, *inward spillover effect* is a direct consequence of the regulatory arbitrage that motivates internationally operating financial institutions to seek organisational restructuring that minimizes regulatory costs. The issue of converting subsidiaries into branches has recently attracted a lot of attention, as some member states are actively trying to reduce this risk,[XXVII] alongside international efforts directed towards formulating a framework for voluntary cross-border reciprocity[XXVIII]. Some countries, for example, try to internalize the costs of registering subsidiaries as branches by increasing depositor and retail consumer legal protection through an option for retail clients to cancel liability/ claim without penalty, extraordinary contributions to deposit guarantee systems, etc. The potential for intra-banking-group arbitrage could also be diminished if a macroprudential measure is applied at the appropriate level of consolidation and/or exposure location, making reciprocity arrangements a necessary condition for mitigating these effects.

Since it may be difficult to simultaneously hit macroprudential and monetary objectives due to the general low degree of synchronisation between real and financial cycles, the policy coordination of the two

[XXV] Praet, P. (2015): Structural reforms and long-run growth in the euro area, intervention on the panel "Long-run growth, monetary policy and financing of the economy" at 43rd Economics Conference of Oesterreichische Nationalbank, Vienna, 15 June 2015.

[XXVI] European Central Bank (2015): A framework for analysing and assessing cross-border spillovers from macroprudential policies, Financial Stability Review, Special features, May 2015.

[XXVII] Czech National Bank (2014): Box 7: Fragmentation, Ring-fencing of Local Activities and Foreign Bank Branches, Financial Stability Report, 2013/2014.

[XXVIII] Recommendation ESRB/2015/2 on the assessment of cross-border effects of and voluntary reciprocity for macro-prudential policy measures.

is an essential prerequisite for simultaneously stabilizing the general price level and financial movements as there are "important synergies and interactions between the two policy functions" (Constancio, 2015). This is especially evident today in the environment of the anaemic growth and low inflation that require pursuing the expansionary stance of monetary policy, yet at a price of jeopardizing financial stability through the search for yield behaviour that might create new asset bubbles. To tame these risks, the tight stance of macroprudential policy is needed. Still, it remains to be seen how effective macroprudential policy can be in taming the risks that emanate from a long period of ultra-loose monetary policy.

The macroprudential ammunition at the disposal of central banks is another potential source of concern. The CRR/CRDIV has provided us with various tools: supply-side (such as capital and liquidity buffers) and demand-side instruments (such as LTV, LTI or DSTI ratios). However, one should be very careful not to err in calibration of those instrument, whether on the side that leaves insufficient coverage (effectively producing policy inaction) or on the side that creates too much of a burden (exceeding the net benefit of macroprudential policy in the medium term).

Conclusion

I hope this overview comes as a stimulus for further theoretical ad empirical research, regardless of the degree of agreement on the specific issues outlined in this speech. Therefore, I am looking forward to this conference. Hopefully, we will leave with answers to at least some of the questions raised and with a strengthened sense of obligation to continue with demanding work.

Thank you.

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FINANCIAL AND REAL CYCLE SYNCHRONIZATION IN CENTRAL, EASTERN AND SOUTHEASTERN EUROPEAN COUNTRIES

Mite Miteski[1] and Ljupka Georgievska[2]

Abstract

This paper analyzes the interactions between the real and financial cycles in the CESEE region and also between the financial and real cycles of these countries with the respective cycles of the euro area. The properties of the business and financial cycles are also extensively analyzed, both on a country and region-level basis. The analysis is done using the BBQ algorithm covering 16 CESEE countries – Czech Republic, Slovakia, Hungary, Poland, Slovenia, Macedonia, Serbia, Bulgaria, Albania, Bosnia & Herzegovina, Croatia, Romania, Estonia, Latvia, Lithuania and Turkey. Our findings indicate that observed on a country-level, real and financial cycles are significantly synchronized only in the minority of CESEE countries (Macedonia, Bulgaria, Croatia, Estonia, Lithuania and Turkey). Analyzed on a regional level, concordance between the real and financial cycle is found only in some of the SEE and Baltic countries, whereas the two cycles appear independent of each other in the CEE region. We have also found that there are a few CESEE countries which have a synchronous real business cycle with the euro area as opposed to the financial cycles which were found to be significantly concordant with the euro area in far larger number of the CESEE countries.

Keywords: real business cycles, financial cycles, turning points, synchronization, Concordance index, BBQ algorithm.

JEL Classification: C14, C26, E32

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1. INTRODUCTION

The role of the financial markets in driving real business cycles is a long debated topic in the literature. The interest in the subject is supported by anecdotal evidence that recognizes the interrelations between the financial and real cycles. The cases of Japan and its "Lost Decade" and the Asian crisis, form some prominent examples from the 1990s where economic downturns were preceded by financial busts that came after a prolonged booming phase at some particular segment of the financial market. More recent example is the global economic crisis from 2008-2009, that was to a large extent shaped by the overturn in the financial cycle. These developments have brought the debate about the linkages between the real economy and the financial sector to the fore and renewed the interest of researchers in studying the finance-growth nexus.

We study this question by analyzing the interactions between the real and financial cycles in the CESEE region and also between the financial and real cycles of these countries with the respective cycles of the Euro Area. The motive is to examine the role of the credit market developments in shaping the real business cycles in CESEE. In addition to the financial and real cycles synchronization, our study provides an extensive analysis of the main characteristics of the real and financial cycles, which is done both, on a country-level and on a region-level basis. In order to measure the cycle characteristics and synchronization we use a variation of the Bry-Boschan procedure developed by Harding and Pagan (2002) which is applicable to quarterly data and henceforth is referred to as BBQ algorithm. The analysis is done for 16 CESEE countries – Czech Republic, Slovakia, Hungary, Poland, Slovenia, Macedonia, Serbia, Bulgaria, Albania, Bosnia and Herzegovina, Croatia, Romania, Estonia, Latvia, Lithuania and Turkey. For analysis purposes the countries are then grouped in four sub-regions consisting of: Central and Eastern Europe – CEE (Czech Republic, Slovakia, Hungary, Poland and Slovenia); Southeastern Europe – SEE (Macedonia, Serbia, Bulgaria, Albania, Bosnia and Herzegovina, Croatia and Romania); the Baltic region (Estonia, Latvia, Lithuania) and Turkey. We use GDP to study the real cycle, while credit to the private sector is used as proxy to measure the financial cycle. The analysis covers the period from 1995-2015 conditional to data availability when it comes to separate countries. We use quarterly data.

Our findings indicate that observed on a country-level, real and financial cycles are significantly synchronized only in the minority of CESEE countries (Macedonia, Bulgaria, Croatia, Estonia, Lithuania and Turkey). Analyzed on a regional level, concordance between the real and financial cycle is found only in some of the SEE and Baltic countries, whereas the two cycles appear independent of each other in the CEE region. We have also found that there are a few CESEE countries which have a synchronous real business cycle with the euro area as opposed to the financial cycles which were found to be significantly concordant with the euro area in far larger number of the CESEE countries.

The paper is organized as follows. Section 2 covers the literature review. Section 3 provides some stylized facts on credit and real GDP developments in CESEE countries. Section 4 discusses the data and methodology. Section 5 documents the empirical results. Section 6 concludes.

2. LITERATURE REVIEW

The interactions between the financial sector and the real economy are broadly studied in the literature. The interest in the finance-growth nexus dates back to Fisher (1933) and Keynes (1936) in their studies of Great Depression where they acknowledged the financial and real sector interconnections. The more recent research in the field includes Bernanke and Gertler (1989), Bernanke et al. (1999) and Kiyotaki and Moore (1997) who study the role of the financial variables in shaping the macroeconomic developments. According to Cochrane (2006), macroeconomic and financial developments are closely linked to each other interacting through the wealth and substitution effects. Reinhart and Rogoff (2009) focus on financial crises examining the real and financial variables reactions to shocks. Helbing et al. (2010) find that credit shocks play important role in driving global business cycles, while Adrian et al. (2010) go one step further, including the monetary cycles in the analysis. Borio (2012) analyzes the characteristics of the financial cycle. He concludes that the best way to capture the financial cycle is by studying the movements in credit and property prices. His findings further suggest that financial cycles have larger amplitude and last longer as compared to the traditional business cycles. Similar findings can be found in Claessens et al. (2011) who report that financial cycles are severe and long in duration and highly synchronized across countries. Avouyi-Dovi and Matheron (2003) examine the interconnections of the business and stock market cycles. Their findings suggest that movements in the real sector activity and the stock prices are shaped by the same determinants in the long term. Still, strong dependence link between the two is not evidenced in their research, except for the United States.

The literature provides many methods for studying cycles. Most of them rely on detecting the turning points in the series to isolate the boom and bust phases in the cycle. One of the frequently used methods was set by Bry and Boschan (1971) who developed a procedure that was able to successfully replicate the business cycle reference dates determined by a committee of renowned economists from the USA-based National Bureau of Economic Research (NBER). Harding and Pagan (2002) introduced a quarterly version of this method that became broadly recognized as BBQ algorithm and widely used in the literature. IMF extensively uses the BBQ algorithm and its variants when studying the financial and real sector interactions. One prominent study is from Claessens et al. (2011) employing extensive database of over 200 business and 700 financial cycles in 44 countries for the period 1960-2007. Their findings point to strong linkages between business and financial cycles suggesting that financial disruptions tend to amplify the severity of the recessions, while rapid growth in credit and house prices tends to support stronger recoveries from recessions. Kannan et al. (2009) examine recessions and recoveries in advanced economies and the role of countercyclical macroeconomic policies. Their findings support the role of financial developments in determining real sector dynamics. What they find is that when associated with financial crisis recessions tend to last longer and are more severe as compared to episodes with properly functioning financial sector. Egert and Sutherland (2012) study the nature of financial and real cycles in OECD countries. They provide evidence on the main characteristics of the cycle, including the length, amplitude and asymmetry of the cycle, as well as the degree of economic and financial cycle synchronization between OECD countries by using BBQ algorithm. They report changing nature of the cycles between 1950 and 2009 with growing asymmetries in the length of the phases in favor of extended expansionary phases. Though not fully conclusive, their findings suggest strengthening synchronization of business cycles among countries over time and unprecedented synchronization of the real and financial cycles during the global economic crisis, that holds for both, across countries and within countries.

Our paper also relates to the literature that employs the BBQ algorithm in analyzing financial and real cycles. It adds to the literature by analyzing the CESEE countries, given that the literature in the field is mainly focused on advanced and OECD countries while relevant research dedicated to this region is rather scarce.

3. REAL AND FINANCIAL SECTOR RELATIONS IN CESEE: SOME STYLIZED FACTS

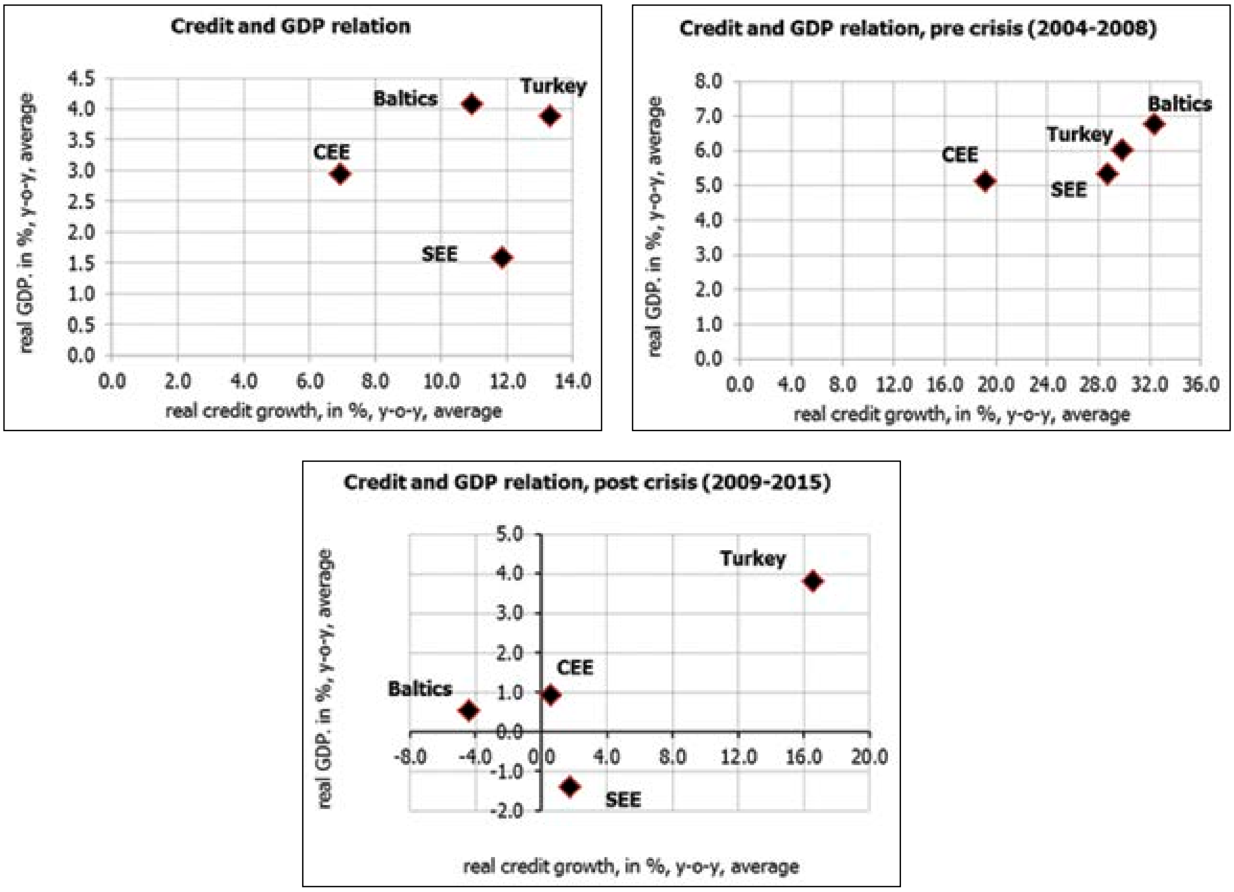
As noted in the previous section, there is a vast literature dealing with financial and real sector relations, but it is mainly focused on advanced economies. Research covering emerging markets is rather poor that, despite the data availability, to a large extent can be related to the specifics of these countries. Given the massive transformations of their economies and multiple shocks and crises they have faced, the claims from theory may not fully apply in emerging economies leading to disruptions in the main macroeconomic links. So, the state of the financial and real sector linkages in emerging economies may be quite different and heterogonous as compared to advanced economies.

The countries from CESEE region went through a massive restructuring of their economies as they moved from centrally-planed to market economies in the beginning of the 1990s. Turkey is an exemption, but it on the other hand, has faced many shocks and crises that urged for equal quantity of reforms and restructuring of the economy. So, what links these economies together is that starting the 1990s they have all been on a convergence path, still, achieving progress at different pace and reaching at different stages of development. Czech Republic, Slovakia, Hungary, Poland, Slovenia, Bulgaria, Romania, Estonia, Latvia and Lithuania are EU member states with Croatia joining recently. On the other hand, Serbia, Bosnia & Herzegovina, Macedonia, Albania and Turkey are acceding and candidate countries.

They further differ with respect to the monetary and exchange rate policies. Slovenia, and more recently Slovakia, Estonia, Latvia and Lithuania are part of the Eurozone. Bulgaria and Bosnia & Herzegovina maintain a currency board. Macedonia and Croatia apply the strategy of exchange rate peg, while Poland, Czech Republic, Hungary, Romania, Serbia, Albania and Turkey exhibit a free or managed float regime. The CESEE region has differed widely and with respect to their vulnerability to external shocks, internal disputes and conflicts and capital flow reversals.

However, when it comes to financial sector structure and development, CESEE countries share many similarities. Their financial systems are predominantly bank-based with credit to the private sector representing a main channel of financing. Similar patterns are noticed and when analyzing credit dynamics. The pre-crisis period 2004-2008 was marked with dynamic growth of credit, with nominal credit growth averaging around 33%, y-o-y, on average. Looking at sub-regions, the Baltics and Turkey were the fastest growing countries (at around 45-46% on average), followed by SEE (37% on average) and CEE (23% on average). The conclusions are similar and when credit is analyzed in real terms. Such dynamics in credit to some extent relates to the catching-up process given the low level of financial intermediation also boosted by foreign banks entrance, benign external environment and abundant capital inflows from abroad. High capital inflows were particularly typical for the Baltics who experienced the fastest credit growth.

Figure 1: Stylized facts



Buoyant credit has surely boosted economic activity with all of the sub-groups growing at around 5% or more. In line with the dynamics in credit, Baltics and Turkey were countries with fastest expanding GDP (at 6 to 7% on average) followed by SEE and CEE at around 5%. This suggests to positive relationship between credit and real economy growth in CESEE in the period prior to the crisis.

The global economic crisis from late 2008-early 2009 brought the credit boom in CESEE to a halt, even moving to a negative territory in some countries. Analyzed at sub-regional level, largest correction was observed in the Baltics, who witnessed considerable credit deleveraging following the crisis. The adjustment was quite significant in SEE and CEE region as well, where credit growth was downsized to low single-digit numbers and remained negative for some time in most of the countries. Turkey was an outlier as it experienced a sort of a "mini credit boom" following the acute phase of the crisis on the back of the recovering economic activity and abundant capital inflows from abroad. The real credit growth in Turkey averaged around 16% in the post-crisis period, accompanied by robust GDP growth at nearly 4% on average. Despite the significantly subdued credit activity, most of the CESEE countries have recovered quite strongly from the crisis. The credit market revival lagged far behind the rebound in the economic activity, which holds for most of the countries. In the Baltics for instance, the economic recovery has started around 2010, while the recovery in credit markets came much later at around 2013/2014. Analyzed on a country-level, Poland performed quite well managing to deliver solid economic growth with private credit continuing to increase. Croatia on the other hand, went through a prolonged economic downturn coupled with significant credit rationing.

Macedonia, Slovakia, and Czech Republic were among the few that exhibited continuous positive growth in credit following the crisis, though at a much lower level as compared to the pre-crisis booming phase. Here also, some divergent trends were visible, with economic recovery leading the rebound in the credit markets. Such developments suggest to certain decoupling between the real and financial cycle in the period following the crisis. In the reminder of the paper we tend to evaluate the financial and real sector interrelations in CESEE, thus providing some useful stylized facts of the cycle behavior in the region which should prove valuable to policy makers in these countries.

4. EMPIRICAL ANALYSIS

4.1. Methodology for describing a cycle

4.1.1. Determining turning points

In the literature, a cycle is defined as "a process that moves sequentially between a series of clearly identifiable phases in a recurrent or periodic fashion" (Hamilton 2005, p.435). In order to identify the phases of the cycle a necessary condition is to determine the cyclical turning points. Then, on the basis of these points, the time period between a high point (peak) and a low point (trough) can be associated with the contractionary phase, whereas a trough-to-peak will represent the expansionary phase of the cycle. In their seminal work, Bry and Boschan (1971) developed a procedure that was able to successfully replicate the business cycle reference dates determined by a committee of renowned economists from the USA-based National Bureau of Economic Research (NBER). Since then, their procedure became widely used in academic research and is described by Harding and Pagan (2002) as "the best known algorithm for performing these tasks" (p.10). Consequently, for the purpose of identification of the turning points in our paper, we use a variation of the BB procedure developed by Harding and Pagan (2002) which is applicable to quarterly data[3] and henceforth is referred to as BBQ. Similar to the Bry and Boschan procedure for monthly observations, the BBQ algorithm is able to detect peaks and troughs for a single time series subject to certain censoring rules. We conduct our research with the following default rules of the algorithm:

- Local maxima and minima are identified in a symmetric window of t+/-2 quarters. A peak/trough is reached at t if the value of the series at date t is higher/lower than the value of the surrounding observations within the window. Technically, a peak is an observation for which $(y_{t-2},\ldots, y_{t-1}) < y_t > (y_{t+1},\ldots,y_{t+2})$ and a trough is an observation for which $(y_{t-2},\ldots, y_{t-1}) > y_t < (y_{t+1},\ldots,y_{t+2})$.

- The procedure ensures that peaks and troughs alternate, so that no two consecutive local maxima/minima occur. In case of multiple consecutive maxima/minima, the highest/lowest maximum/minimum is chosen.

- Censoring rules stating that every peak-to-trough and trough-to-peak phases should be at least p quarters long and every peak-to-peak and trough-to-trough cycles should be at least c quarters

[3] The original Bry and Boschan procedure was applied only to monthly data.

long. Harding and Pagan (2002) impose that the minimum length of the phases equal two quarters and the length of completed cycles equal at least five quarters as default in the algorithm for quarterly data.

4.1.2. Measuring cycle characteristics

Once the dates of the turning points have been identified, they can be used in conjunction with the original series to analyze various features of classical cycles. Commonly, the characteristics that are of main interest are the duration and amplitude of the cycle and phases, cumulative movements within phases and asymmetries between the phases (Harding and Pagan, 2002). Duration measures the length, whereas amplitude refers to the depth of expansions and contractions (average rise or decline of activity). Cumulation refers to cumulated gains or losses and represents the sum of the amplitudes for each period of the phase. As a way to analyze asymmetries, the excess movements metrics captures the divergences from a triangle which is used as an approximation of a typical phase with the height being the amplitude and the base being the duration. Given that the triangle approximation measures the cumulative change in the level of the variable, if it changed at a constant rate over a phase, the excess metrics is able to capture the shape of the cycle compared to this triangle approximation. In order to calculate the measures of these characteristics, one should first transform the original series containing the turning points into binary variables. We follow Harding and Pagan (2002) in defining binary variables St that take values of 1 when the series is in expansionary phase and 0 when the series is in contractionary phase. Then, for example the average duration (1) and amplitude (2) of expansions can be calculated as:

$$(1)\ D = \frac{\sum_{t=1}^{T} S_t}{\sum_{t=1}^{T-1}(1-S_{t+1})S_t} \qquad (2)\ A = \frac{\sum_{t=1}^{T} S_t \Delta y_t}{\sum_{t=1}^{T-1}(1-S_{t+1})S_t}$$

where the denominator in (1) and (2) represents number of peaks, the numerator in (1) represents the total time spent in expansions and the numerator in (2) represents sum of the changes in the level of the variable in the expansionary phases.

Cumulative movements and excess movements[4], respectively, are given by:

$$(3)\ C = \sum_{t=1}^{T} r_t - \frac{1}{2}A \qquad (4)\ E = \frac{1}{D}\left(\frac{1}{2}DA - \sum_{t=1}^{T} r_t + \frac{1}{2}A\right)$$

where $\sum_{t=1}^{T} r_t$ is the sum of the areas of t rectangles, with each rectangle referring to the log difference between the level of the variable in each quarter during the phase and the level of the variable at the beginning of the phase. Other metrics of the cycle are also available, such as the coefficients of variation of durations and amplitudes[5].

4.1.3 Measuring cycle synchronization

In order to analyze the degree of synchronization between classical business and financial cycles we use the concordance index established by Harding and Pagan (2002). The concordance index is a descriptive statistic which specifies the average amount of time in which two variables, in our case GDP and credit, are found to be in the same phase of their cycles. It can take any number between 0 and 1, with 1 representing perfect overlap of the two cycles and 0 indicating that the series are always in opposite phases of the cycle. The index has the advantage in that it does not require the two variables to be stationary. In order to compute the index, Harding and Pagan (2002) apply the following formula:

$$\hat{I} = \frac{1}{T}\left\{\sum_{t=1}^{T} S_{xt} S_{yt} + \sum_{t=1}^{T}(1 - S_{xt})(1 - S_{yt})\right\}$$

4 Excess movements are usually calculated for both phases, although this metrics might not be very reliable for contractions, given that they are short-lived (Engel, Haugh and Pagan, 2005).

5 More details can be found in Engel, Haugh and Pagan, 2005.

Given the two series x_t and y_t, S_{xt} and S_{yt} are the binary variables obtained from the non-parametric BBQ algorithm which, as mentioned previous, are defined as:

S_{xt} = {1 if x is in expansionary phase at time t, 0 otherwise}

S_{yt} = {1 if y is in expansionary phase at time t, 0 otherwise}

T is the number of time periods in the sample.

Once the concordance index is calculated, the next step is to test whether the degree of synchronization of the two cycles is statistically significant or not. To this end, and by previously showing that the concordance index is monotonic in the correlation between the two series S_{xt} and S_{yt}, Harding and Pagan (2006) suggest estimating the following linear relationship:

$$\frac{S_{yt}}{\hat{\sigma}_{Sx}\hat{\sigma}_{Sy}} = \alpha_1 + \rho\frac{S_{xt}}{\hat{\sigma}_{Sx}\hat{\sigma}_{Sy}} + u_t$$

where $\hat{\sigma}_{Sx}$ and $\hat{\sigma}_{Sy}$ are the estimated standard deviations of S_{xt} and S_{yt}, respectively, α_1 is a constant, ρ is the correlation coefficient and u_t is an i.i.d. error term. Then, the t-statistic on ρ can be used for testing the null hypothesis of no synchronization. However, since the S_{yt} series exhibits extensive serial correlation, one must take account of this fact and use autocorrelation (and heteroscedasticity) consistent method to obtain the correct t-ratios and draw inference about the statistical significance of the concordance indicator. To this end, following Harding and Pagan (2006) we use the Generalized Method of Moments (GMM) estimator with a HAC estimation weighing matrix, Bartlett kernel and Newey-West fixed bandwidth method to test whether there exists significant cycle synchronization between the real economic and credit activity in the countries of interest. The same method is used to pin down the European countries that exhibit a common real and financial cycle with the euro area.

4.2 Data Description

Our sample consists of sixteen countries of the CESEE region, which are classified in the following sub-regions:

- Central and Eastern Europe (CEE), consisting of the Czech Republic, Slovakia, Hungary, Poland and Slovenia;

- Southeastern Europe (SEE), consisting of Macedonia, Serbia, Bulgaria, Albania, Bosnia & Herzegovina, Croatia and Romania;

- the Baltic region, consisting of Estonia, Latvia and Lithuania

- and Turkey as both a country and a separate sub-region.

In addition, the Economic and Monetary Union, i.e. the euro area, is included to serve as benchmark for comparison of the results.

Following Harding and Pagan (2002) we focus on cycles in the levels of the variables, which are generally referred to as classical cycles. Hence, to study the business cycle we use real GDP volumes[6], since this is the best available measure of the aggregate economic activity typically used in the literature. As a measure of the financial cycle, credit to the private sector[7] deflated by the consumer price index is used, as it represents the most important link between savings and investment. Same as Harding and Pagan, we work with the natural logarithm rather than the nominal value of the variables, because this is a commonly adopted transformation used in the applied work. Moreover, this transformation has no effect on the determination of the dates of turning points. Given the availability of data, and taking into account the requirements of the technique for identification of turning points, data are with a quarterly frequency and are also adjusted for the seasonal effects. The sample period is different for each country

[6] Gross domestic product at market prices, chain linked volumes in national currency, seasonally adjusted.

[7] Outstanding amounts at the end of the period (stocks) of loans of MFIs excluding central bank (total maturity, all currencies combined) to non-MFIs excluding general government sector, denominated in national currency, seasonally adjusted.

depending on the time span of officially published data by national authorities, however for nearly all of countries there are data of more than ten years, which should ensure coverage for at least one complete cycle. Data are acquired from Eurostat, ECB, national statistical offices and national central banks of the analyzed countries. The BBQ analysis[8] was performed in MATLAB[9], whereas the GMM estimation was done in eViews.

5. MAIN RESULTS

We start our analysis first with a description of the main features of business and financial cycles, since we consider this as a necessary step before going into investigation about the relations between them. Thus, Sections 5.1 and 5.2 discuss about the estimates of the average duration of the cyclical phases, amplitude, average cumulative movement and excess for the business and financial cycles. All of these measures are in terms of percentages, with the exception of duration which is in quarters. The results of the concordance analysis are presented in Section 5.3.

5.1. Business cycle characteristics

In Table 1 we present the main features and descriptive statistics of the different phases of the business cycle. The results indicate that in the CESEE region contractions last for about five quarters on average, whereas expansions last significantly longer (17 quarters or more than four years), which is to be expected of classical cycles in growing economies. Interestingly, these results are relatively close to those observed in the euro area, where the length of contractions and expansions is estimated to be 6.5 and 23 quarters, respectively. Analyzed by sub-regions, it was found that the CEE countries have experienced the shortest contractions (around 4 quarters), whereas the SEE and Baltic countries, as well as Turkey have spent somewhat larger number of quarters in recession (close to 5 quarters). However, there are clear differences among different countries. Namely, the shortest recessions are recorded in Poland and Albania[10] (between 1 and 2 quarters), and Macedonia and Slovakia (3 quarters), whereas Romania (9.5 quarters), Croatia (7 quarters) and Slovenia (6.5 quarters) have been the longest in contractionary phase. A general finding is that in all countries in the sample the average expansion length is greater than the average contraction length, but also there is a greater variation in the length of expansions compared to contractions between countries. The expansion length varies between around 8 quarters (Albania) and around 24 quarters (Lithuania). Three of the sub-regions have recorded above average duration of the expansionary phase, with the Baltic region being an outperformer, spending almost two years in expansion. On the other hand, the duration of expansions in the SEE region is the lowest of all and is also the only one below the CESEE average. Turning to the measure of change in output in the cyclical phases, it is estimated that the amplitude of contractions for the full sample is -6%, whereas the average cumulative output loss is 22%. By sub-regions, the deepness of recessions is particularly large in the Baltic region and Turkey (-9.3% and -9.8%), whereas it is the smallest in the CEE region (-4%). The highest amplitude is recorded in Lithuania (-10.7%), whereas the lowest amplitude is observed in Poland (-0.6%). On the other hand, the average amplitude of expansions in the CESEE region is 20.9% and the average cumulative gain is 298.6%. Specifically, the Baltic countries and Turkey experience the highest growth in output during expansions (of more than 30%), unlike the SEE region which registers twice as lower amplitude. By countries, Latvia has seen the largest expansion amplitude (36.7%), whereas the lowest is registered in Albania (6.5%). In addition, the "excess" metrics shows that there are significant asymmetries in the shapes of the contractionary and expansionary phase. In half of the countries, the excess index is negative in recessions implying concave shape of the phase, whereas in the other half the excess index is positive, implying convex shape of the phase. Regarding the expansions phases, in

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[8] Although we decided to use the default censoring rules, the algorithm was not able to detect any turning points in the case of Poland, Croatia and Albania. That is why for these countries only, we impose that the phase and turnphase last for at least one instead of two quarters. This is found to be very suitable and realistic in describing their cycles when the results are presented graphically.

[9] We use the code of the BBQ program in MATLAB written by James Engel that we have accordingly adjusted to our needs.

[10] It should be noted however that the data time span for Albania is relatively short and thus might not be entirely representative for the longer history as well as comparative with the other countries. However, since there is coverage for at least one complete cycle, we do not exclude this country from the analysis.

the majority of the countries the excess index is positive, implying that the cumulative gain is smaller than that of the triangle approximation, i.e. that the shape of the phase is convex. In the CESEE region as whole, cumulative losses during contractions are higher by 3.4% than the triangle approximation, while cumulative gains during expansions are lower by 4.5%, on average. It is also worth noting that in all countries the decreases in output recorded during contractions are more than compensated by the increases during expansions. The results show that expansions are more variable in terms of duration and amplitude than contractions. In addition, the amplitude of the contraction and especially the expansion phase in all of the CESEE sub-regions is noticeably greater compared to the euro area.

Overall, it seems that the SEE region is having the worst combination of characteristics of the cyclical phases, given that it spends more time in recessions and less time in expansions compared to other regions and experiences larger declines in output from peak to trough and smaller output gains from trough to peak. This might be an explanation of their poor economic performance over the sample period. On the other hand, the CEE region appears to be performing better than others, with the shortest duration and lowest amplitude of contractions and longest duration and reasonably large amplitude of expansions. The Baltic countries and Turkey experience both lengthy durations and large amplitudes of recessions and expansions which can explain the unsmooth growth pattern that they have been following in the analyzed period.

Table 1: Characteristics of business cycles, by country

Region	Country	Period	Mean duration (quarters)		Amplitude		Avg. cum. movement		Excess movements		CV of duration		CV of amplitude	
			Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions
	Euro area	1995q1:2015q3	6.5	23.0	-3.5	13.2	-10.1	290.7	-18.2	-13.9	0.33	1.09	-0.73	1.23
SEE	Macedonia	1997q1:2015q3	3.0	12.4	-6.2	16.5	-10.8	121.1	-1.7	5.2	0.27	0.66	-1.16	0.32
	Bulgaria	2000q1:2015q3	3.8	18.3	-4.7	20.6	-16.4	313.2	19.3	66.1	0.61	0.79	-1.34	1.27
	Croatia	2000q1:2015q3	7.0	13.7	-5.2	13.2	-31.6	191.1	18.9	7.2	0.76	1.10	-1.09	1.51
	Serbia	1995q1:2015q3	5.2	11.2	-7.8	17.9	-19.0	267.9	-7.0	1.6	0.32	1.21	-1.34	1.44
	Albania	2009q1:2015q3	1.5	7.7	-1.9	6.5	-2.4	60.9	-12.1	22.9	0.47	1.39	-1.15	0.98
	BIH	2006q2:2015q3	4.5	9.3	-1.7	7.0	-4.7	40.7	-15.4	-48.3	0.79	0.27	-0.17	0.64
	Romania	1995q1:2015q3	9.5	21.0	-9.6	24.5	-71.3	336.6	46.9	-15.0	0.22	0.74	-0.05	1.07
CEE	Slovenia	1995q1:2015q3	6.5	23.0	-7.4	21.6	-31.0	475.4	12.4	12.6	0.11	1.13	-0.50	1.37
	Czech Republic	1996q1:2015q3	4.3	16.3	-3.5	13.6	8.2	203.6	-6.7	-1.2	0.27	1.12	-0.63	1.35
	Slovakia	1997q1:2015q3	3.0	21.7	-5.5	27.2	-6.4	386.8	-34.4	4.1	0.33	0.74	-0.51	0.86
	Hungary	1995q1:2015q3	4.0	16.5	-3.1	13.7	-13.1	234.9	37.9	-2.5	0.61	1.06	-1.09	1.34
	Poland	2002q1:2015q3	1.3	12.5	-0.6	13.3	-0.7	177.2	5.2	12.6	0.43	1.07	-0.44	1.02
Baltics	Estonia	1995q1:2015q3	4.0	23.3	-8.7	35.4	-29.9	521.9	6.8	7.8	0.66	0.46	-1.40	0.67
	Latvia	1995q1:2015q3	5.7	21.7	-9.9	36.7	-62.1	481.1	-11.2	-9.8	0.97	0.58	-1.37	0.81
	Lithuania	1995q1:2015q4	5.0	24.3	-10.7	35.8	-38.9	526.3	-5.3	-2.8	0.28	0.43	-1.03	0.65
	Turkey	1998q1:2015q3	4.7	18.7	-9.3	30.7	-22.0	438.7	1.3	10.9	0.25	0.63	-0.56	0.61
CESEE	mean		4.6	17.0	-6.0	20.9	-22.0	298.6	3.4	4.5				
	min		1.3	7.7	-10.7	6.5	-71.3	40.7	-34.4	-48.3				
	max		9.5	24.3	-0.6	36.7	8.2	526.3	46.9	66.1				
	st.dev.		2.0	5.3	3.2	9.9	21.7	161.3	20.4	22.9				

Source: Authors' calculation. Cumulative movements combine information about duration, amplitude and the shape of cyclical phases and are represented as a percent of GDP in first quarter of phase. Excess movements show the percentage gain or loss of output per quarter during an expansion or contraction in comparison with the constant growth scenario. CV is the coefficient of variation calculated as a ratio of the standard deviation of durations and amplitudes to their means.

Table 2: Characteristics of business cycles, by regions

Region	Mean duration (quarters)		Amplitude		Avg. cum. movement		Excess movements	
	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions
Euro area	6.5	23.0	-3.5	13.2	-10.1	290.7	-18.2	-13.9
SEE	4.9	13.4	-5.3	15.2	-22.3	190.2	7.0	5.7
CEE	3.8	18.0	-4.0	17.9	-8.6	295.6	2.9	5.1
Baltics	4.9	23.1	-9.8	36.0	-43.6	509.8	-3.2	-1.6
Turkey	4.7	18.7	-9.3	30.7	-22.0	438.7	1.3	10.9
CESEE	4.6	17.0	-6.0	20.9	-22.0	298.6	3.4	4.5

Source: Authors' calculation.

5.2. Financial cycle characteristics

Turning to the financial cycle features, Table 3 shows that downturns of the credit cycle last longer than economic recessions on average, unlike credit upturns which tend to be shorter than economic expansions. Moreover, financial upturns persist for about 14 quarters on average, which is twice longer than the duration of downturns (about 7 quarters). In only three of the countries (Romania, Latvia and

Lithuania) the contractionary phase is longer-lived than the expansionary phase. The findings are similar compared to the euro area, where the length of financial upturns and downturns is found to be 18 and 6 quarters, respectively. By sub-regions, downturns are with the shortest duration in the SEE countries and Turkey (around 5 quarters), whereas the Baltic countries have experienced the longest lasting credit downturns (around 13 quarters). By countries, the shortest duration of financial downturns is observed in Macedonia (2 quarters), whereas the longest duration is registered in Latvia and Lithuania (13 quarters). On the other hand, the length of the financial upturn phase in the CESEE countries varies between 6 quarters in Romania, and 27 quarters in the Czech Republic. An interesting finding is that in the SEE countries and Turkey, the length of credit cycles is very comparable to the length of business cycles. Furthermore, it was found that the amplitude of financial downturns and upturns in the CESEE region is significantly higher than the amplitude of business cycle phases. On average, these countries experience 13.6% fall in credit activity during downturn phases and 57.2% increase in credit activity during upturn phase. These amplitudes are also significantly higher than the ones observed in the euro area. The SEE countries have the lowest amplitude of credit downturns and second lowest amplitude of upturns, which combined with the low duration of the two phases might only point towards shallow integration of their financial markets. The largest amplitudes of financial downturns and upturns are registered in Turkey and the Baltic region. Average cumulation is rather smaller compared to the business cycle measure, amounting -1.1% on average in contractions and 8.4% in expansions. The indicator of excess movements shows that as in the case of business cycles, there are asymmetries in the shapes of the downturn and upturn phase. Similarly to the business cycle, half of the countries have negative excess metrics in contractions, implying concavity of the phase, whereas the other half experience convex recessions, given their positive excess metrics. Contrary, in expansions the majority of the countries have negative excesses, indicating larger cumulative gains than the triangle approximation and hence concave shape of the expansion phases. In the CESEE region as a whole, cumulative losses during contractions are higher by 2.6%, whereas cumulative gains during expansions are higher by 5.9% on average than the triangle approximation. The reported coefficients of variation of duration and amplitude indicate that, in general, expansions are more variable than contractions, which was also the case with real business cycles.

Table 3: Characteristics of financial cycles, by country

Region	Country	Period	Mean duration (quarters)		Amplitude		Avg. cum. movement		Excess movements		CV of duration		CV of amplitude	
			Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions
	Euro area	1997q3:2015q4	6.0	18.3	-4.1	21.8	-23.5	508.8	3.08	26.54	0.73	1.31	-1.35	1.63
SEE	Macedonia	1997q1:2015q4	2.0	13.4	-3.3	46.8	-6.0	482.5	29.40	-10.94	0.00	0.55	-0.92	1.10
	Bulgaria	2004q1:2015q3	5.3	10.0	-4.4	43.7	-17.7	470.5	82.43	2.28	0.43	0.87	-1.05	1.61
	Croatia	1998q1:2015q3	4.6	9.4	-6.7	28.5	-33.2	478.3	1.60	13.82	0.82	1.52	-0.93	1.83
	Serbia	2004q1:2015q4	5.5	18.0	-7.7	67.6	-35.4	1332.6	-6.80	8.96	0.64	1.10	-1.66	1.32
	Albania	2002q4:2015q3	5.5	20.0	-5.0	119.9	-13.6	2780.8	-29.38	-5.16	0.64	1.20	-0.09	1.39
	BIH	2005q1:2015q3	4.0	11.3	-3.1	27.6	-6.4	219.0	-36.32	-26.36	0.35	0.72	-1.05	1.31
	Romania	2004q4:2015q4	7.0	5.8	-12.0	36.3	-58.5	294.8	26.28	-12.84	0.62	1.08	-0.42	1.79
CEE	Slovenia	2004q1:2015q4	11.5	12.0	-28.3	45.7	-262.0	439.9	-48.85	19.13	1.17	0.83	-1.35	1.34
	Czech Republic	1996q1:2015q3	12.0	27.0	-35.4	57.6	-319.1	1763.6	-18.18	44.77	1.06	1.31	-1.39	1.12
	Slovakia	2005q1:2015q4	3.0	12.3	-1.1	39.7	-1.8	323.3	-20.14	-20.29	0.00	0.38	-0.78	1.14
	Hungary	1996q1:2015q3	6.0	13.5	-16.3	42.0	-105.8	613.7	10.46	-31.00	1.11	1.42	-0.89	1.35
	Poland	1996q1:2015q3	2.5	13.6	-1.8	41.1	-3.6	390.1	21.65	-2.07	0.23	0.46	-0.47	0.93
Baltics	Estonia	1997q1:2015q4	11.5	17.3	-16.7	92.3	-158.1	1313.5	-2.94	-2.22	1.05	0.94	-1.14	1.01
	Latvia	2004q1:2015q3	13.0	10.0	-27.7	69.6	-319.7	742.3	-4.54	-44.37	1.09	1.13	-1.42	1.13
	Lithuania	2004q1:2015q4	13.0	10.5	-18.8	70.1	-306.8	737.1	26.86	-26.25	1.31	1.01	-1.41	1.32
	Turkey	1994q1:2015q4	4.8	16.5	-29.5	86.8	-99.9	996.0	9.88	-1.40	0.43	0.62	-0.73	0.60
CESEE	mean		6.9	13.8	-13.6	57.2	-109.2	836.1	2.6	-5.9				
	min		2.0	5.8	-35.4	27.6	-319.7	219.0	-48.9	-44.4				
	max		13.0	27.0	-1.1	119.9	-1.8	2780.8	82.4	44.8				
	st.dev.		3.9	5.1	11.4	25.6	123.4	677.7	31.6	21.8				

Source: Authors' calculation. Cumulative movements combine information about duration, amplitude and the shape of cyclical phases and are represented as a percent of GDP in first quarter of phase. Excess movements show the extra gain or loss during an expansion or contraction of the credit activity in comparison with the constant growth scenario. CV is the coefficient of variation calculated as a ratio of the standard deviation of durations and amplitudes to their means.

Table 4: Characteristics of financial cycles, by regions

Region	Mean duration (quarters)		Amplitude		Avg. cum. movement		Excess movements	
	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions	Contractions	Expansions
Euro area	6.0	18.3	-4.1	21.8	-23.5	508.8	3.08	26.54
SEE	4.8	12.6	-6.0	52.9	-24.4	865.5	9.6	-4.3
CEE	7.0	15.7	-16.6	45.2	-138.4	706.1	-11.0	2.1
Baltics	12.5	12.6	-21.1	77.3	-261.5	931.0	6.5	-24.3
Turkey	4.8	16.5	-29.5	86.8	-99.9	996.0	9.88	-1.40
CESEE	6.9	13.8	-13.6	57.2	-109.2	836.1	2.6	-5.9

Source: Authors' calculation.

5.3. Synchronization of classical cycles

5.3.1 Business cycle dating

Before we move to the main analysis of the co-movements of business and financial cycles, it is useful first to examine the timing of their peaks and troughs in order to get a visual impression about the relationship between them. In summary, by using the BBQ dating algorithm we have identified 44 contractions and 41 expansions of the economic activity in the CESEE region as a whole. Of these, 14 contractions and 14 expansions are in the CEE region, 20 contractions and 18 expansions are in the SEE region, 7 contractions and 7 expansions are in the Baltic region and 3 contractions and 2 expansions are in Turkey. On the other hand, we have found 37 downturns and 44 upturns regarding the financial cycle. More precisely, 12 downturns and 13 upturns are in the CEE region, 17 downturns and 21 upturns are in the SEE region, 4 downturns and 6 upturns are in the Baltic region and 4 downturns and 4 upturns are in Turkey. When we systemize the identified cyclical phases by date (Tables 5 and 6), one might come to a conclusion that there is a certain clustering in turning points of the two cycles, which is especially evident in some of the SEE and Baltic countries as well as Turkey. A clear example is Macedonia, where it appears that the business and financial cycles are almost all the time in the same state. Moreover, the long phase of expansion of the economic and credit activity in the 2000's is clearly noticeable in almost all of the CESEE countries.

Table 5: Business cycle dates

	Euro area	Macedonia	Bulgaria	Croatia	Serbia	Albania	BIH	Romania	Slovenia	Czech Rep.	Slovakia	Hungary	Poland	Estonia	Latvia	Lithuania	Turkey
P		2001Q1															
T		2001Q3															
P		2002Q2															
T		2003Q1			1995Q4						1997Q4				1995Q4		1999Q3
P		2006Q1			1997Q4			1996Q3		1996Q3	1998Q4	1996Q2	2002Q4	1998Q3	1998Q2	1998Q3	2000Q4
T		2006Q4		2000Q2	1999Q2			1999Q2		1997Q4	1999Q4	2006Q4	2003Q1	1999Q1	1998Q4	1999Q3	2001Q4
P	2008Q1	2008Q3	2008Q4	2008Q1	2008Q1	2009Q2	2008Q3	2008Q3	2008Q2	2008Q3	2008Q3	2007Q2	2004Q2	2007Q4	2007Q3	2008Q2	2008Q1
T	2009Q2	2009Q3	2010Q1	2010Q2	2009Q4	2009Q4	2009Q1	2010Q3	2009Q4	2009Q2	2009Q1	2008Q2	2004Q3	2009Q3	2010Q3	2009Q4	2009Q1
P	2011Q1		2012Q2	2011Q2	2011Q4	2014Q4	2010Q4		2011Q2	2011Q4		2010Q1	2012Q3	2014Q4			
T	2013Q1		2012Q4	2014Q1	2012Q4	2015Q1	2012Q3		2013Q1	2013Q1		2011Q4	2013Q1				
P					2013Q3							2012Q2					
T					2015Q1												

Source: Authors' calculations.

Notes: "P" denotes a peak, "T" denotes a trough. The economy is in expansion in the time between a trough and peak, whereas it is in contraction in the time between a peak and trough.

Table 6: Financial cycle dates

	Euro area	Macedonia	Bulgaria	Croatia	Serbia	Albania	BIH	Romania	Slovenia	Czech Rep.	Slovakia	Hungary	Poland	Estonia	Latvia	Lithuania	Turkey
P													2001Q3				
T										1996Q4			2002Q1				
P		2001Q1		1998Q4						1997Q2		2006Q3	2004Q1	1998Q3			
T		2001Q3		2000Q1						2002Q3		2007Q1	2004Q3	1999Q2			1994Q4
P		2002Q3		2008Q4				2008Q3	2008Q4		2009Q1	2009Q1	2009Q1	2008Q2	2008Q3	2008Q3	1998Q2
T		2003Q1		2009Q3				2009Q3	2009Q2		2009Q4	2009Q4	2009Q4	2013Q2	2014Q2	2014Q4	1999Q4
P	2009Q1	2009Q1	2009Q1	2010Q3			2008Q4	2010Q1	2010Q3		2011Q3	2010Q2	2011Q4		2014Q4	2015Q3	2000Q3
T	2010Q1	2009Q3	2011Q1	2011Q1			2010Q1	2011Q2			2012Q2	2011Q1	2012Q3				2002Q2
P	2011Q3	2012Q2	2012Q2	2011Q4	2012Q1	2012Q1	2014Q2	2011Q4				2011Q3					2008Q3
T	2014Q2	2012Q4	2013Q2	2014Q3	2014Q1	2014Q1	2015Q1	2014Q4									2009Q2
P	2015Q1		2014Q3	2015Q1	2015Q1	2014Q4											2015Q2

Source: Authors' calculations.

Notes: "P" denotes a peak, "T" denotes a trough. The time between a trough and peak represents financial upturn, whereas the time between a peak and trough represents a financial downturn.

5.3.2. Synchronization between real business and financial cycles

In this section we formally investigate the synchronization of business and financial cycles by the means of the concordance statistic proposed by Harding and Pagan (2002). We calculate the concordance index between business and financial cycles first on an individual country basis, and then we present a summary statistics for the CESEE region as a whole and the separate sub-regions (Tables 7 and 8). In the tables that follow $\hat{\rho}$ represents the estimated correlation coefficient, whereas CI stands for the computed concordance indices.

The results suggest that output and credit tend to be pro-cyclical in all of the analyzed countries, with concordance above 0.5 for all cycle pairs. However, the results are statistically significant only in six of the CESEE countries: Macedonia, Bulgaria, Croatia, Estonia, Lithuania and Turkey. In all of these countries output and credit cycles appear to be most highly synchronized, with the highest concordance registered in Macedonia (0.89). This means that in the case of Macedonia both output and credit are concurrently in the same phase of the cycle about 90% of the time. This result suggests that fluctuations in credit are very important for the Macedonian real economy, i.e. expansion in real credit goes together with expansion in real GDP and vice versa. Taking into account the underdeveloped financial market in the country and the practical non-existence of other forms of financing of the investment projects of firms[11], this appears to be a reasonable finding. Moreover, the concordance that Macedonia displays is found to be higher even than the statistic for the euro area (0.78). Turkey displays second highest concordance index of 0.86, followed by Bulgaria (0.77), Croatia (0.76), Estonia (0.72) and Lithuania (0.56). It is interesting that very high concordance indices are also observed in two other countries (Slovakia and Poland), but they are not found to be statistically significant. This is in contrast with the lower but statistically significant concordance statistic for Lithuania. Harding and Pagan (2006) offer an explanation according to which "what might appear to be a high degree of association between cycles can be misleading, as it is simply an artifact of expansions lasting for long periods of time relative to the sample" (p.11)[12]. Hence, the high concordance in Slovakia and Poland is most likely to be a result of the high mean value of the states of the cycles, rather than of a strong correlation between phases. In fact, as it can be seen from the table below, the estimated correlation between the output and credit cycles is actually negative in these countries.

Table 7: Concordance and correlation statistics of output and credit cycles, by country

Country	$\widehat{\rho}$	CI
Euro area	0.61	0.78***
Macedonia	0.59	0.89***
Bulgaria	0.93	0.77***
Croatia	0.62	0.76***
Serbia	0.25	0.64
Albania	-0.06	0.56
BIH	-0.02	0.61
Romania	0.30	0.61
Slovenia	0.29	0.64
Czech Republic	-0.21	0.59
Slovakia	-0.18	0.81
Hungary	0.08	0.68
Poland	-0.19	0.80
Estonia	0.54	0.72**
Latvia	0.31	0.57
Lithuania	0.54	0.56**
Turkey	0.85	0.86***

Source: Authors' calculation.

** and *** indicate significance at the 5% and 1% level, respectively.

[11] In spite of the underdeveloped domestic capital market, it should be noted that intercompany lending is an alternative source of firms' financing in Macedonia.

[12] Hardin and Pagan (2006) show that in the case of independent random walk processes, ρ_S=0 so that the concordance index equals 0.5 when the empirical average of the states of the two series also equal 0.5. However, if the two random variables are with drifts so that the empirical average of the states of the two series equal 0.9, in that case the concordance index equals 0.82. However, since the variables have been sampled independently, there should be no relation between them. Thus, a high value of the concordance index relative to 0.5 should not imply a high degree of synchronization. That is why Harding and Pagan argue that it is necessary for the concordance statistic to be mean corrected, which is what happens if one estimates the correlation coefficients and uses them for inference.

Table 8 presents the synchronization of real business and credit cycles by sub-regions. It is evident that output and credit are pro-cyclical in all sub-regions, with the two series being 69% of the time on average in the same state of contraction or expansion in the CESEE region as a whole. The concordance indices are very similar for the CEE and SEE sub-regions, with only the Baltic region lagging somewhat behind the average CESEE statistic. However, as it can be seen from Table 7, none of the CEE countries exhibit significant concordance, as opposed to the SEE region where around 40% of the countries have highly statistically significant cycle synchronization. In fact, in most of the CEE countries there is a negative correlation between the output and credit cycles. Although below the average, in two out of the three Baltic countries there is statistically significant concordance evidenced. With concordance statistic of 0.86, Turkey is characterized with the most synchronized real and financial cycles when compared to the other CESEE regions and also when compared to the euro area. In all other sub-regions the mean synchronization of cycles is found to be below the one observed in the euro area.

Table 8: Concordance of output and credit cycles, by regions

	CESEE	CEE	SEE	Baltics
mean	0.69	0.70	0.69	0.62
max	0.89	0.81	0.89	0.72
min	0.56	0.59	0.56	0.56
standard deviation	0.11	0.10	0.12	0.09

Source: Authors' calculation.

5.3.3. Synchronization of real business cycles

In this section the analysis is extended to examine the degree of synchronization between the real business cycles of the CESEE countries and the euro area. Ex ante, one might expect that the CESEE business cycles will be synchronized with the euro area business cycle, given that the euro area is their important trading partner[13]. Table 9 contains concordance statistics and correlations for all countries versus the euro area. Surprisingly, concordance is found to be statistically significant only for the minority of the CESEE countries, suggesting a high risk of asymmetric shock transmission. The strongest link with the euro area business cycle is found in Slovenia, with the two outputs coinciding in the same phase of the cycle about 95% of the time. The other member-countries of the euro area display non-concordance, even though in the literature it is argued that joining a currency union should increase business cycle synchronization[14]. However, Slovenia has been the longest of all other respective countries in our sample a member of the Economic and Monetary Union, so this might lend support to the significant coincidence of their cycles. Of the other non-euro area CEE countries, a strong degree of business cycle synchronization is observed also in the Czech Republic (0.87) and Poland (0.78), which suggests that they appear ready to join the Eurozone according to this criterion[15]. Turning to the SEE region, it is evidenced that output cycles with the euro area have overlapped to a significant extent in Bosnia and Herzegovina (0.84), Croatia (0.83), Bulgaria (0.81) and Serbia (0.73). The concordance index for Macedonia is relatively high (0.75), but it is not statistically significant given the low correlation coefficient. Furthermore, the Baltic countries and Turkey are also found not to be significantly concordant with the euro area business cycle.

[13] See European Commission (1990) for more about the expected influence of trade on cycle co-movement.

[14] Formal models supporting this claim are presented in Corsetti and Pesenti (2002) and Ricci (2006). Engel and Rose (2002) for example, show empirically that there is a positive effect of currency unions on the correlation of business cycles.

[15] Business cycle similarity is among the criteria defined within the theory of optimum currency areas.

Table 9: Concordance and correlation statistics of real business cycles, by country

Country	Euro area	
	$\hat{\rho}$	CI
Macedonia	0.12	0.75
Bulgaria	0.76	0.81***
Croatia	0.57	0.83**
Serbia	0.34	0.73*
Albania	-0.31	0.52
BIH	0.99	0.84***
Romania	-0.12	0.69
Slovenia	0.90	0.95***
Czech Republic	0.56	0.87**
Slovakia	0.04	0.75
Hungary	0.29	0.78
Poland	0.70	0.78**
Estonia	0.40	0.82
Latvia	0.14	0.75
Lithuania	0.19	0.82
Turkey	0.25	0.72

Source: Authors' calculation.

*, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

Summary of the concordance statistic between the real cycles of the CESEE sub-regions and the euro area is given in Table 10. It is evident that the CEE countries are characterized by the most concordant business cycles with the euro area, followed by the Baltic countries. However, as it was said previously, although high, none of the Baltic countries concordance indices are statistically significant. SEE countries have the second lowest concordance indices on average, and exhibit highest variation in the statistic. Apart from it being not statistically significant, Turkey's cycle is the least concordant on a regional level with the euro area.

Table 10: Concordance of real business cycles with the euro area, by regions

	CESEE	CEE	SEE	Baltics
mean	0.78	0.83	0.74	0.80
max	0.95	0.95	0.84	0.82
min	0.52	0.75	0.52	0.75
standard deviation	0.09	0.08	0.11	0.04

Source: Authors' calculation.

5.3.4. Synchronization of financial cycles

Analogous to the previous section, here we proceed with the analysis by examining the co-movement of the financial cycles between the CESEE countries and the euro area. In this regard, one should expect concordance between the two financial cycles, given that most of the CESEE countries are either part of the euro area, or their monetary policies are very closely linked to that of the euro area[16]. The calculated concordance indices and estimated correlations are given in Table 11. As expected, we find concordance in 75% of the CESEE countries, which is much higher than in the case of business cycle

[16] Slovenia, Slovakia and the Baltic countries are part of the euro area; Macedonia has a euro peg whereas Bulgaria and Bosnia & Herzegovina have euro-based currency boards. Croatia, Serbia and Albania operate under flexible exchange rate regimes but are subject to practical constraints in the monetary policy conduct given the high euroization in the countries.

synchronization. Interestingly, the highest significant concordance is observed in Hungary, a country with independent monetary policy, where the two cycles overlap for 88% of the time. It should be however noted that for the most of the period under observation, Hungary has been operating under some form of a peg regime. Significant concordance is evidenced in all of the Baltic countries and in all CEE countries with the exception of Poland. However, there is one peculiar finding when it comes to the CEE countries. Namely, a low and statistically significant concordance index is obtained for the Czech Republic, which indicates that the relationship between this country's credit cycle and the euro area credit cycle is significantly countercyclical. Specifically, the concordance value for the Czech Republic is 0.48, which implies that 52% of the time the Czech financial cycle is in different phase compared to the euro area. The negative correlation between the two cycles further supports this countercyclical behavior. When it comes to the SEE region, a strong positive co-movement of the financial cycles is evidenced in all countries, with the exception of Macedonia and Bosnia and Herzegovina. Not surprisingly, we do not detect a significant synchronization between the financial cycles of Turkey and the euro area.

Table 11: Concordance and correlation statistics of financial cycles, by country

Country	Euro area	
	$\hat{\rho}$	CI
Macedonia	0.11	0.77
Bulgaria	0.39	0.72*
Croatia	0.63	0.83***
Serbia	0.92	0.85***
Albania	0.93	0.85***
BIH	0.36	0.60
Romania	0.69	0.68***
Slovenia	0.77	0.77***
Czech Republic	-0.32	0.48**
Slovakia	0.98	0.74***
Hungary	0.75	0.88***
Poland	0.44	0.79
Estonia	0.43	0.75**
Latvia	0.75	0.81***
Lithuania	0.62	0.74***
Turkey	-0.08	0.58

Source: Authors' calculation.

As it can be seen from Table 12, real credit cycles on a regional level are found to be highly synchronized with the euro area cycle. Compared to the CESEE average, the concordance statistic for the Baltic and SEE countries is highest, whereas it is lowest for the CEE countries and Turkey. As mentioned above, the low concordance value for the Czech Republic is the main culprit for the low CEE average. Excluding the Czech Republic changes substantially our previous conclusion, since in this case cycle synchronization appears to be strongest precisely in the CEE region.

Table 12: Concordance of financial cycles with the euro area, by regions

	CESEE	CEE	SEE	Baltics
mean	0.74	0.73	0.76	0.77
max	0.88	0.88	0.85	0.81
min	0.48	0.48	0.60	0.74
standard deviation	0.11	0.15	0.10	0.04

Source: Authors' calculation.

5.4. Main findings on Macedonia: short summary

In this section we summarize the main findings on Macedonia regarding the properties of the business and financial cycle and their synchronization. To the best of our knowledge, we believe this is the first such analysis of its kind. Our study detects three complete cycles in Macedonia for the period 1997q1:2015q3, apart from the one that is currently ongoing. Namely, according to our estimates, the Macedonian economy currently is in expansion phase starting from the fourth quarter of 2009, following the short recession provoked by the global economic crisis. We find that the general business cycle characteristics in the Macedonian economy are similar to those in developing economies with expansionary phases demonstrating much longer duration as compared to the contractionary phases of the cycle. Our estimations suggest that over the last 18 years the economy was predominantly in a booming phase with the expansionary cycle lasting for 12.4 quarters on average. The bust cycle was much shorter extending over 3 quarters on average. During recessions the activity declined by 6.2% on average which resulted in total loss in output of 10.8% for all of the bust phases. This output waste was fully replenished during the booming phases with the average rise of activity being 16.5% that has ensured total output gain of 121.1%. Such findings are in line with the convergence and catching-up processes associated with emerging and developing economies. Our findings further suggest that the financial cycle in Macedonia shares similar characteristics with the business cycle. The duration of the bust phases is estimated to last for 2 quarters on average while the booming phase expands over 13.4 quarters. As in the case of the business cycle the amplitude of the expansionary phase is much higher amounting 47% on average, which considerably outweighs the downsizing in credit during the bust phases of 3% on average. Given the similar properties, the real and credit cycle in Macedonia are found to be highly synchronized moving concordantly in 90% of the time. Such findings are intuitive given the structure of the financial sector which is predominantly bank-based, that along with the rather underdeveloped capital markets makes bank credit a leading source of financing in the country. The synchronization level of 0.89 is the highest within the sample suggesting that credit dynamics is highly procyclical in Macedonia and represents important determinant of the business cycle.

6. CONCLUSION

The main goal of this paper was to quantitatively evaluate whether there is a co-movement between financial and real cycles in the CESEE region, and also between the financial and real cycles of these countries with the respective cycles of the euro area. In addition, we have provided a comprehensive description of the main characteristics of real and financial cycles. The analysis was performed by using the non-parametric BBQ dating algorithm, introduced by Harding and Pagan (2002). The key empirical findings indicate that real and financial cycles are significantly synchronized only in the minority of CESEE countries (Macedonia, Bulgaria, Croatia, Estonia, Lithuania and Turkey). Analyzed on a regional level, this result suggests that concordance between the real and financial cycle exists only in some of the SEE and Baltic countries, whereas the two cycles appear independent of each other in the CEE region. We have also found that there are a few CESEE countries which have synchronous real business cycles with the euro area. Bulgaria, Croatia, Serbia and BIH of the SEE region, and Slovenia, Czech Republic and Poland of the CEE region are significantly concordant with the euro area business cycle, which for the countries that are already EU members might signify their preparedness for joining the monetary union, judging solely by this criterion. On the other hand, there appears to be no clear pattern of clustering of peaks and troughs in the Baltic countries and Turkey. Contrary, financial cycles are found to be significantly concordant with the euro area in far larger number of the CESEE countries. Only in Macedonia, BIH, Poland and Turkey there is no clear relationship between the timing of their financial cycles with the one of the euro area. In addition, it should be also noted that when looking at the comparison of the cycle synchronization with the euro area, our study shows that in many of the analyzed countries there is no discrepancy between the synchronization of their real and their financial cycles with the respective cycles of the euro area. All in all, the obtained results provide useful stylized facts of the CESEE countries cycle behavior which should prove valuable to policy makers in these countries. However, it should be noted that concordance here was examined only in terms of the classical cycle definition, so a natural way of expanding the analysis is by studying the properties of the growth and/or deviation cycle. Additionally, it would be also interesting to investigate the potential determinants underlying the synchronization of business and financial cycles.

REFERENCES

1. Adrian T., Estrella A. and Shin H. S. (2010). Monetary Cycles, Financial Cycles, and the Business Cycle. *Federal Reserve Bank of New York Staff Reports*, No.421.

2. Avouyi-Dovi S. and Matheron J. (2003). Interactions Between Business Cycles, Financial Cycles And Monetary Policy: Stylised Facts. *BIS Working Papers*, No. 22, pp. 273-298.

3. Bernanke, B. and Gertler, M. (1989). Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review*, 79(1), pp. 14-31.

4. Bernanke, B., Gertler, M. and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. *Handbook of Macroeconomics*, in: Taylor J. B. and Woodford M. (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 21, pp. 1341-1393 Elsevier.

5. Borio, C. (2012). The Financial Cycle And Macroeconomics: What Have We Learnt? *BIS Working Papers*, No. 395.

6. Bracke P. (2011). How Long Do Housing Cycles Last? A Duration Analysis for 19 OECD Countries. *IMF Working Paper*, No.11/231.

7. Bry, G. and Boschan C. (1971). Cyclical Analysis Of Time Series: Selected Procedures And Computer Programs. *Technical Papers*, No. 20, NBER.

8. Claessens, S., Kose, M. A. and Terrones M. E. (2011). Financial Cycles: What? How? When? *IMF Working Paper*, No.11/76.

9. Claessens, S., Kose, M. A. and Terrones M. E. (2011). How Do Business and Financial Cycles Interact? *IMF Working Paper*, No.11/88.

10. Cochrane J. H. (ed.). (2006). Financial Markets and the Real Economy, *Edward Elgar Publishing*, No. 2923.

11. Corsetti, G. and Pesenti, P. (2002). Self-validating optimum currency areas. *CEPR Discussion Paper* 3220.

12. Égert, B. and Sutherland, D. (2012). The Nature of Financial and Real Business Cycles: The Great Moderation and Banking Sector Pro-Cyclicality. *OECD Economics Department Working Papers*, No. 938, OECD Publishing.

13. Engel, C. and Rose, A. (2002). Currency unions and international integration. *Journal of Money, Credit, and Banking*, 34(4), pp.1067-1089.

14. Engel, J., Haugh, D. and Pagan, A. (2005). Some Methods for Assessing the Need for Non-Linear Business Cycle Models in Business Cycle Analysis. *International Journal of Forecasting*, 21, pp. 651-662.

15. European Commission (1990). One market, one money. *European Economy Special Report* 44.

16. Fisher, I. (1933). Stamp Scrip. New York: Adelphi Company.

17. Hamilton, J. D. (2005). What's Real About the Business Cycle? *Federal Reserve Bank of St. Louis Review*, 87(4), pp. 435-52.

18. Harding, D. and Pagan, A. (2006). Synchronisation of Cycles. *Journal of Econometrics*, 132.

19. Helbling T., Huidrom R., Kose, M. A. and Otrok C. (2010). Do Credit Shocks Matter? A Global Perspective. *IMF Working Paper*, No. 10/261.

20. Keynes, J. M. (1936). The General Theory of Employment, Interest, and Money. London: Macmillan.

21. Kiyotaki, N. and Moore, J. (1997). Credit Cycles. *Journal of Political Economy*, 105(2), pp. 211-48.

22. Pagan, A. and Harding, D. (2002). Dissecting The Cycle: A Methodological Investigation. *Journal of Monetary Economics*, Elsevier, 49(2), pp. 365-381.

23. Pagan, A. and Harding, D. (2001). Extracting, Using and Analysing Cyclical Information. *MPRA Paper* 15, University Library of Munich, Germany.

24. Pagan, A. and Harding, D. (2006). The Econometric Analysis of Constructed Binary Time Series. Working paper #1, *NCER Working Paper Series 1*, National Centre for Econometric Research.

25. Kannan P., Scott A. and Terrones, M. E. (2009). From Recession to Recovery: How Soon and How Strong. *World Economic Outlook*, 01/2009, chapter 3, pp. 97-132.

26. Reinhart, C. M. and Rogoff, K. S. (2009). The Aftermath of Financial Crises, *NBER Working Papers*, 14656.

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THE MACROECONOMIC PASS-THROUGH EFFECTS OF MONETARY POLICY THROUGH SIGN RECTRICTIONS APPROACH: IN THE CASE OF ALBANIA

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Abstract

The monetary transmission mechanism has been an integrated part of empirical and analytical study at the Bank of Albania, trying to identify the impact of the traditional interest rate and exchange rate channels on output and inflation. However, after the global financial and economic crises, little is known about the macroeconomic pass-through effects of monetary policy changes. This paper examines the transmission mechanism of monetary policy in Albania during 2002 M01 - 2014 M12. The main question addresses the macroeconomic pass-through effects of a monetary policy shock. The analysis is based on a structural vector autoregressive model for Albanian economy that includes means sign restrictions approach to identify the monetary policy shock effects with regards to a conventional interest rate and possible different balance sheet policy changes. The idea is to provide updated and new empirical evidences for the optimal monetary policy relating to inflation and output and other macroeconomic variables. The findings could be useful to policymakers at the central bank in the verge of possible use of balance sheet monetary policy response in the aftermath of the crisis.

Keywords: Monetary transmission mechanism, financial market condition, VAR, sign restriction identification.

JEL Classification: C11, C32, E12, E13, E52, E58

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1. INTRODUCTION

The domestic effectiveness of a highly accommodative monetary policy to repair, on the on hand, the monetary transmission mechanism and, on the other hand, to help restoring alone confidence in the financial system, through higher bank liquidity and low bank and sovereign credit risk, and to boost the economic growth recovery, has dominated policy discussion over the recent years[2]. These policy discussions have intensified since in the wake of the global financial crises, many central banks have been responding to turmoil by cutting interest rates to historically low levels and by embarking on what Cour-Thirmann and Winkler (2013) called the non-standard (unconventional) monetary policy response actions in order to counter the risks to economic and financial stability. This saw monetary authorities using policy instruments that changed the composition and expand the size of their balance sheet as the main policy instruments[3], which basically replaced or/and accomplished interest rates as the main policy instrument, even though, they have differed significantly across central banks. This is what Lagarde (2012) believes that another key aspect of the new financial architecture is the role of central banks, while the crisis has prompted a fundamental reassessment of their macroeconomic and financial responsibilities.

In this context, besides cutting interest rates, the central bank in the case of Albania has also been embarking upon some macro-prudential and non-standard balance sheet monetary policies. On the one hand, it has been providing liquidity to the banking system. This was followed by lowering the reserve required ratio in support of deposit withdraws and deteriorating non-performing loans. On the other hand, it has also expanded its exposure to government bond financing through higher financing level and by shifting shorter instruments to longer debt financing. Further, it has employed upon macro-prudential policies to discourage or/and orientate the banking system towards bank lending in domestic currency, an option that would lower risk exposure to exchange rate volatility. The aim of these policies objective has been to repair the monetary transmission mechanism and restore alone, confidence in the financial system, through higher bank liquidity and low bank and sovereign bank lending risk, in the believe that this also helps to anchor economic agents' expectations to the 3.0% inflation target, directly contributing to the improvement of the monetary policy efficiency and the economic growth recovery through bank lending channel and consumer confidence.

Then again, as in the case of the ECB, this approach to date appears to stand out in that the macro- prudential or these non-standard balance sheet policies were not aimed at providing additional direct monetary stimulus to the economy, but primarily at supporting the efficiency of the banking system and the transmission of its conventional monetary policy instrument. Hence, in the case of Albania, these policy measures can be seen as a complement to rather than substitute for standard interest rate policy instrument. Further to that, in the 2013 – 2015 medium-term strategy[4], the central bank's monetary policy will remain orientated toward achieving and maintain price stability. The central bank will continue to rely on market instruments to achieve its monetary policy objectives. At the same time, it will consider developing appropriate policies and inter-institutional cooperation that relates to the identification and implementation of measures for preventing, restraining and handling the financial systemic risks. To that, the priorities to enhance the monetary policy efficiency will be followed by acquiring thoroughly the transmission mechanism channels and monetary policy lags, which are constantly changing due to internal developments of the Albanian economy and global financial crisis.

For a small open economy such as Albania, understanding the transmission mechanism of monetary policy to inflation, output and other real economic variables is a key issue for the central bank to conduct monetary policy effectively. Indeed, the monetary transmission mechanism has

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[2] See Bernanke (2012); Fawley and Neely (2012); and Rajan (2014).

[3] Several bold initiatives includes the Bank of Japan`s Asset Purchase Program, Quantitative Easing (QE1, QE2 and QE3) by U.S. Federal Reserve, and the European Central Bank`s unconventional policies (Supplementary Long Term Refinancing Operations, Securities Market Program, Outright Monetary Transactions bond-purchasing program and lately expanded asset purchase programme).

[4] The medium – term development strategy 2013 – 2015 of the Bank of Albania aims to ensure that the institution's activities focus on fulfilling its legal duties, particularly those relating to monetary and financial stability – the two pillars of modern central banks.

been an integrated part of empirical and analytical study at the central bank[5] and it is vital to re-analyse the pass-through effect of monetary policy channel for two reasons. First, a previous study by Kolasi, Shijaku and Shtylla, (2007), tried to identify the monetary transmission mechanism and evaluate the pass-through effects of monetary policy channels on the real output, inflation and core inflation. However, since then, little is known about macroeconomic pass-through effects of monetary policy, especially after the global financial crisis. Second, to the best knowledge no paper has yet so far analysed the monetary policy transmission mechanism through means of conventional or/ and balance sheet monetary policy variables, associated especially with the periods in the aftermath of global financial crisis. Therefore, it is worthwhile to update previous results reflecting the pass-through effects of monetary policy changes, to utilize on longer times series and, on the top of that, to incorporate conventional and balance sheet variables into the analysis. On top of these, this paper supports the Bank of Albania's "Two-Pillar Approach" strategy, as first, it sheds more lights on supportive evidence on the outlined priorities considering the Medium-term Development Strategy of the Bank of Albania for 2013-2015 and therefore it should guide the Governing Council's strategic decision-making by expanding further the information base on the suitability of different instruments used in decision making to achieve the monetary policy's objectives. Second, it provides some informative evidences on the properties of the changing structure of monetary transmission mechanism in the verge of the aftermath of global financial crisis. Finally, it improves research quantitatively and qualitatively and in the verge of slower economic and bank lending growth level, it is of high interest to understand the effect of both conventional and balance sheet MP instruments.

This paper analysis these issues by exploring the fact that central bank uses mainly its regular channels to implement its extraordinary policy measures, even though through the aftermath of the global financial crises the decision making considered also some measures that consisted of macro- prudential and balance sheet policy type instruments. The main question to be address in this paper focuses on the macroeconomic pass-through effects of conventional monetary policy and whether it is more effective compared to an alternative balance sheet policy changes. The paper intends to address these questions through a structural vector autoregressive (SVAR) model for the Albanian economy. Importantly, identification of structural shocks is based on sign restrictions motivated by theory. To that, the analysis is extended to the inclusion counterfactual components to quantify the relative importance of different transmission channels that could be employed by the central bank to achieve the policy objective and to boost the economic growth recovery through inflation expectations, market confidence and bank credit channels. In particular, comparison is made between the pass-through effects of a conventional and a balance sheet policy shock and also to an alternative model under money market channel.

Empirical findings paint a relatively similar picture under different model specification, albeit with some clear information on the magnitude of the macroeconomic pass-through effects of a stimulus monetary policy, that is with regards to either a policy rate or balance sheet these changes. Monetary policy changes are found to have real short run effect. The macroeconomic pass-through effect of the monetary policy change materialises within 12 periods. Positive monetary stimulus boosts output and prices level due to the demand side effect. Real money balances and bank lending channel reacts positive to a stimulus monetary policy, mainly through greater response on domestic currency counterpart. To that, real price of domestic currency deprecates, which all together with the accommodating monetary policy puts more pressure to the financial market conditions. Finally, the greatest impact, through means of policy rate, is found to be on price level, bank lending and real money stock and the greatest impact, through the liquidity effect, is on output, exchange rate and financial market conditions.

The paper is organised as follows: The second section presents the theoretical and methodological issues link to specified model. Section 3 summarizes the results. The paper concludes in section 4.

[5] See also Muço, Sanfey and Luçi (2001); Muço, Sanfey and Taçi (2004); Peeters (2005); Luçi and Vika (2005); Istrefi and Semi (2007), Tanku, Vika and Gjermeni (2007).

II. THE METHODOLOGY AND THE DATA

A. MODEL SPECIFICATION

There is extensive theoretical as well as empirical literature studying the pass-through effects of monetary policy shocks on inflation and the other real economy aggregate, where VAR techniques have been extensively used as a tool to analyse the transmission mechanism of the pass-through effects of the monetary policy innovations[6]. A typical model in the monetary transmission mechanism literature, as Endut, Morley and Tien, (2015) suggest, consists of variables that represent (i) immediate target or policy instruments; (ii) intermediate targets, i.e. transmission channels; and (ii) the final targets such as output and price level. To that, this paper follows the empirical work by Gambacorta, Hofmann and Peersman (2012) to explore the dynamic pass-through effects of conventional and balance sheet type monetary policy instrument shocks. The model, a VAR specification, has the following representation:

$$\chi_t = \beta_0 + \sum_{i=1}^{p} \beta_i \chi_{t-1} + \varepsilon_t$$

Where, χ_t is a vector of endogenous variables such as output, prices, central bank assets, monetary policy instrument and the level of implied stock market volatility of the national stock market index; β_0 is a vector of constant term, β_i are the matrixes of the coefficients measuring lagged effect of variables on each-other; ε is the vector of disturbance term and $\varepsilon \sim$ iid (0, σ2).

The authors imply that this model aims to grasp the main features of the monetary transmission mechanism under the financial market confidence. Further to this, the study extends the benchmark VAR specification by also including two variables. First, as in the case of Eurozone area, borrowing and lending in Albania predominantly take place though the intermediation of the banking sector and both conventional and balance sheet policy measures taken by the central bank as a response of the crisis primarily aimed at fuelling the banking system and therefore monetary policy disturbances are obviously expected to affect the bank lending channel and vice versa. Thus, based on Peersman (2011) we extended the model by including an endogenous banking lending variable.

Second, the monetary policy is conducted under the inflation targeting and floating exchange rate regimes. Therefore, based on Smets and Wouters (1999), the model specification considers also an exchange rate channel in the monetary transmission mechanism on the assumption that it helps to analyse properly the conduct of monetary policy on the contest of these regimes. This is of considerable interest. First, the conventional interest rate channel is supplemented by significant exchange rate channel. Second, Albania is an import country and a significant ratio of deposits and bank lending is conducted in foreign currencies. Third, the Albanian economy is expected to be affected by decision making of the monetary authorities in its trading partners. Therefore, in order to control for such external effects the model follows Glocker and Towbin (2011) and also considered an exogenous variable to account for the Eurozone monetary policy instrument. Further to that, the model specification includes a dummy variable to account for the global financial crisis. The model has the following representation:

$$\chi_t = \beta_0 + \sum_{i=1}^{p} \beta_i \chi_{t-1} + \sum_{i=0}^{q} \beta_i z_t + \varepsilon_t$$

Where, χ is a vector of endogenous variables representing a scale variable on the economic activity (GDP), the general price level (PRICE), the bank lending in domestic currency ($CREDIT^{ALL}$), the monetary policy instrument (i^{on}), which is latter replaced by a central bank balance sheet variable (BOA^{FA}) to conduct of the pass-through effects of a possible balance sheet policy changes[7]; the exchange rate (EX) and the financial market condition (FSI). The exogenous variables, under the vector (Z), consist of the

6 See also Sims, Stock and Watson, (1990); Stock and Watson (2001); Canova and De Nicolo (2002); Lanne and Luetepohl (2006); Bjørnland and Leitemo (2009); Dumičić, Čibarić and Horvat (2010); Glocker and Towbin (2011); Peersman (2011); Baumeister and Benati (2012); Kimura and Nakajima (2013); Arias, Rubio-Ramírez and Waggoner (2014); Fratzscher, Lo Duca, and Straub, (2014).

7 Based on Gambacorta, et. al., (2012) the empirical analysis on the pass-through effect of policy rate and balance sheet policy is done separately on the assumption that a VAR specification with both of them is at the potential caveat risk e.g. that on variable (balance sheet changes) might capture in part the effects of the other variable (interest rate cuts), and vice versa.

foreign monetary policy rate (i^{ECB}) and a dummy variable to account for the effect of the global financial crisis (CRISIS). The others are as previously defined.

The model is specified following some assumptions. Following Canova and De Nicolo (2002) the VAR model is specified in real terms, as opposed to nominal ones, for two important reasons. First, the estimated model has important implications for real variables. Second, the responses of real variables allow distinguishing monetary from other types of real demand disturbances. At the same time, the approach intends to utilize better among the country specific dynamic behavior factors and the purpose of the main research question. Therefore, the dynamic behaviour of variables such as GDP and Prices are supposed to capture the macroeconomic dimension of the crises [Gambacorta, et. al., (2012)]. The crisis effects are assumed, also, as in the case of Peersman, (2011) to be reflected on the bank lending behaviour, given the prominent role of bank lending as a source of external finance in Albania. The latter represents the bank lending in domestic currency on assumption that any policy rate changes would priority mostly affect this counter-part.

At the same time, based on Luporini, (2008), the monetary policy variable allows identifying the pass- through effect of interest rate channel with respect to other variables. In this case the monetary transmission mechanism identifies monetary policy shocks as innovations to some monetary aggregates or to the baseline interest rate. To that, the Albanian monetary authority uses the open- market interest rate as the main policy instrument to transmit monetary policy signals[8]. Therefore, based on Peersman, (2011), the policy rate instrument is obviously also expected to influence the state of the economy and bank lending channel since the official policy rate is not yet at the zero low bound level, and the bank system overnight rate is a gauge of monetary policy rate. On the other hand, the benchmark model is estimated also to investigate the effect of alternative monetary policy instrument at the disposable of monetary authority. Therefore, the benchmark model is re-estimated, by including the central bank balance sheet variable instead of policy rate, to account for the pass-through effects of a possible balance sheet policy shock innovations. This variable, as Gambacorta and Hofmann, (2012) suggest, represents a monetary policy type instrument[9] and as a quantitative policy it is a better gauge of balance sheet monetary policy during the crisis than the monetary base (M_0)[10].

In addition, the exchange rate channel has always received particular attention in research work in the case of Albania and the focus has been to analyse the role played by the exchange rate as a channel through which monetary policy affects aggregate demand[11]. To that, including the exchange rate supplements the effect of the monetary policy channel and captures the effects of different components e.g. bank lending, government borrowing and other issues linked to the unhedged lending and non-performing loans in foreign currency[12]. Finally, the implied financial market condition index is commonly referred to as a 'fear index' [Whaley (2009)] for possible financial market turmoil and economic risk aversion over the sample period. Therefore, this should also capture the core mechanism that involves

[8] Since 2000 Q03, the monetary policy of the Bank of Albania is implemented through the use of indirect instruments that consis t of a base reference rate such as the repurchase agreements of seven-day maturity, applied in the regular weekly auctions of the Bank of Albania, which are respectively known as repo and reverse repo. Smaghi (2009) implies that ultimately what matters for investment and spending decision is the real interest rate.

[9] Bernanke and Reinhart (2004) and Smaghi (2009) suggest that an alternative way to conduct monetary policy is by expanding the size of the central bank's balance sheet, even before policy rates have been cut to their lower bound.

[10] However, the authors argue that the use of the BoA^{FA} as the balance sheet monetary policy instruments fail to take possible composition effects. It does not grasp announcement effects of the balance sheet monetary policy, even though it is not much clear how such effect could be capture in the VAR set-up. Thus, the model is also analysed on robustness arguments by including the M0 instead of the central bank assets. The latter is defined as the sum of banknotes in circulation and bank reserves.

[11] Kolasi, et. al., (2010) suggest that for the exchange rate channel to work within the monetary transmission framework, two relationships must hold. First, there must be a link between monetary policy and the exchange rate, and second, the exchange rate must infl uence output and inflation. Istrefi and Semi, (2007) and Tanku, et. al., (2007) found that the exchange rate pass-through effect exists, but the power of pass-through effects of exchange rate to domestic prices weakens considerably during periods of low and stable inflation and virtually disappears during the period that the Bank of Albania sets its inflation rate objective between 2 to 4 percent. To that Kolas i, et. al., (2010) conclude that the exchange rate channel is not as strong as reported in previous works, and that central bank should pay attention to the exchange rate fluctuations, as they seem to have an adverse impact on real output fluctuations. Exchange rate developments are found to play a significant role on monetary aggregates [Shijaku, (2007); Tanku (2006); Shijaku 2013] and for credit channel [Shijaku, (2013); Shijaku, G., and Kalluci, I., (2013)].

[12] The unhedged foreign currency lending is seen as a major threat to financial stability and risk of systemic crises in South Ea stern European countries, in case of exchange deprecations and interest rate changes [Brown and De Haas (2010)]. Unhedged foreign currency lending is as high as 60% of total foreign currency lending in the case of Albania [Shijaku, (2013)].

financial intermediaries and the uncertainty shocks that have been an important driver of macro-financial dynamics behaviour during the global financial crisis[13]. In fact, the inclusion of this variable in the empirical analysis of the monetary transmission mechanism should correctly distinguish monetary policy from financial shocks [Ciccarelli, Maddaloni and Peydró, (2013)].

Finally, the benchmark VAR model contains also two exogenous variables, such as the trade partner's monetary policy rate and a dummy variable to account for the financial turmoil and economic crises. The former is proxy by the Eurozone monetary policy rate since Eurozone countries are Albania's biggest trade partners. Therefore, the ECB policy rate (EONIA) is used as a foreign instrument policy[14] The latter is a dummy variable taking the value 1 during a crises time, and 0 otherwise.

B. IDENTIFICATION OF SHOCKS THROGH THE SIGN RESTRICTION APPROACH

The study uses a recursive identification scheme in a model that analyses the responses to a monetary policy shock innovation. The innovations have been identified by following other empirical works[15], that make use of the means of sign restrictions to pin down a particular orthogonal decomposition. In contrast to the conventional identification that imposes the upper triangular part of the innovation matrix to zero, the sign restriction approach does not drop any contemporaneous effects (the variance – covariance is full). This involves extracting orthogonal innovations from the reduced model, which in principle, have no economic interpretation, but have the property of being contemporaneously and serially uncorrelated. Next, as in Endut, et. al., (2015), the signs of the theoretical co-movements of selected variables in response to an orthogonal innovation based on macroeconomic theory are used to study the information content of the disturbances, which then allows us to assign a structural interpretation to them.

To that, this method first utilises the properties of the residuals from Cholesky structural identified to get the variance – covariance matrix and transform them into candidates of orthogonal eigenvalue-eigenvector decompositins, T^*. Following Fry and Pagan (2011), since this SVAR model contains 6 variables, with the structural identification reflects some short run restricted type assumptions $[Ae=Bu$ where $E[uu']=I]$ emplaced, then the approach make use of a combination of a total $15\ (N(N-1/2))$restrictions bivariate Givens rotation matrices admissible $(i=1,\ldots,15)$ to construct the candidate Q's, which are then used to generate the candidate T^*'s, which in this six-variable system are expressed as follows:

$$Q = Q_{1,2}(\theta_1) * Q_{1,3}(\theta_2) * Q_{1,4}(\theta_3) * Q_{1,5}(\theta_4) * Q_{1,6}(\theta_5) * \qquad (5)$$

$$Q_{2,3}(\theta_6) * Q_{2,4}(\theta_7) * Q_{2,5}(\theta_8) * Q_{2,6}(\theta_9) *$$
$$Q_{3,4}(\theta_{10}) * Q_{3,5}(\theta_{11}) * Q_{3,6}(\theta_{12}) *$$
$$Q_{4,5}(\theta_{13}) * Q_{4,6}(\theta_{14}) *$$
$$Q_{5,6}(\theta_{15}),$$

Where, each $Q_{m,n}$ is an identity matrix with the (m, m) element replaced with $\cos\theta$; (n, n) element replaced with $\cos\theta$; (m, n) element replaced with $-\sin\theta$; and (n, m) element replaced with $\sin\theta$, as follows:

$$Q_{3,4}(\theta_j)=\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & \cos\theta_j & -\sin\theta_j & 0 & 0 \\ 0 & 0 & \sin\theta_j & \cos\theta_j & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Where, each θ_j is a radian angle measure between $(0 < \theta j \leq \pi)$ for the row m and n. Each Q will be unique depending on the values of θ_j. Therefore, candidate Q matrices can be generated by conducting

[13] See also Gambacorta, et. al. (2012); Afonso, Baxa and Slavik (2011); Bruno and Shin (2013) and Shijaku (2014b).

[14] The ECB mainly conducts its policy through either the minimum bid rate of variable rate tenders or the rate applied to fixed rate tenders in its main refinancing operations.

[15] See also Canova and De Nicoló (2002); Uhlig (2005); Migliardo (2010); Fry and Pagan (2011).

random normalised draws of θ_j, where θ_j are taken to be uniformly distributed over $(0, \pi)$.

Then to search through the space of T^* for particular decompositions of Σ, sign restrictions are imposed on the short-run co-movements of variables based on important information provided by theory on the signs of the pair-wise dynamic cross-correlations between certain variables in response to a structural shock. Therefore, by making use of that information, it is possible to locate candidate decompositions and for any given orthogonal candidate, it is possible to check whether the shock produces an impulse response that corresponds to the sign of the cross-correlation between variables i and j as prescribed by theoretical economic signs.

The approach through Matlab routine, as in Migliardo (2010) and Endut, et. al., (2015), works as follows: First, it builds matrixes Π and D. it checks if the sign of the shocks match the expected responses. If this does not occur, the algorithm assembles new matrixes $\Pi_{m,n}(\theta_j)=\Pi^*Q_{m,n}(\theta_j)$ using several values of m, n and θ_j. The vector of identified shocks is a particular transformation of sine and cosine functions, the rotation matrix Q defines the selected identification and Q is an explicit function of the sines and cosines of an angle. Therefore, the sign restriction achieves identification by restricting the signs of the structural responses and eliminates any kind of possible puzzle by construction[16]. Finally, the summarised range of possible results follows the common strategy of sorting the impulse responses and reports the median value. This is a good approximation of the central tendency of the impulse responses across the estimation.

Therefore, this paper uses a full matrix with a minimal set of sign restrictions that are robust across the theoretical models. This means that the impulse response function analysis is based on a sign restriction method that has been employed to identify the pass-through effects of monetary policy shock innovations and leave shocks with respect to other variables blanked. The sign restrictions, as in Endut, et. al., (2015), are motivated by theory and are imposed only on the monetary policy variable, as listed in Table 2 to 5, which are fairly generic and intuitive. Theoretically, following a Taylor rule, Kolasi, et. al., (2010) believes that an stimulus (accommodating) monetary policy approach by the central bank, i.e. a decrease in the official nominal interest rate or expansion of the balance sheet, is followed by a fall in real interest rates (given rational expectations and sticky prices framework), which in turn leads to lower cost of capital and increases businesses and consumers investment or bank lending, and finally increases aggregate output[17]. This should also be followed by an increase of the price level in the short run. Migliardo (2010) assumes that stimulus monetary policy decreases price of money. This makes people hold more of it and borrow more for consumption and investment, so both inflation and output gap increases. However, Dreger, Reimers, Roffia, (2006) believes the effect would be negative[18]. To that, based on findings by Vika (2007), it is excepted that balance sheet policy, linked to the liquidity of the banking system, would influence the banking lending channel via the amount of liquid assets held by commercial banks and thereafter the economic activity and price level. It could also influence the banking lending channel via the option to the purchasing of government debt. This should in return stimulated economic activity positively through higher private consumption and investment level. Then such demand side effects finally provide higher inflation pressure.

Policy-induced changes through stimulus monetary policy are also expected to affect the exchange rate. With a flexible exchange rate regime and perfect capital mobility, based on Kolasi, et. al., (2010), other things being equal, an official interest rate cut induces an outflow of capital out of the country, leading to an immediate depreciation in the value of domestic currency relatively to the other currency.[19] Finally, the precise impact on financial market stress of a stimulus monetary policy is uncertain. On the one hand, this policy should low pressure into the financial market as either cost of lending and borrowing are lower or because of the liquidity provided following an increase of the in the central bank

[16] Migliardo (2010) suggests that in contrast to the conventional Cholesky decomposition identification, that drops some contemp oraneous effects by construction, the SVAR with sign restriction that does not drop any as the variance-covariance matrix is full. For more details see Canova and De Nicolo (2002).

[17] See also (Mishkin, 1996).

[18] To that, Tanku (2006) accept it to be positive, but there is also the possibility of a negative effect due to the possible pass-through effect of the accommodating monetary policy to the alternative investments and credit and to the wealth or the substitution effect is picks up. See also Shijaku (2013).

[19] This effect would be similar to an accommodating balance sheet monetary policy.

balance sheet policy. On the other hand, such changes might put more pressure to financial market via the exchange rate channels and the reason is twofold. First, a considerable amount of bank lending is provided in foreign currency, for exporting type firms and mortgages purposes by individuals, and nearly 60% is considered unhedged. Therefore, exchange rate depreciation will be expected to increase cost of lending or the probability to default[20]. Second, the financial market stress index is constructing including the foreign exchange market information and depreciation of price of domestic currency will be reflected in this index.

To this theoretical argumentation, the model is estimating by placing a sign restriction only to those variables upon which the theory is clear on the excepted results. Therefore, an accommodating monetary policy by cutting interest rate (expanding balance sheet) is expected to decrease policy rate (increase in balance sheet), increase the output, price level and bank lending (money stock) and depreciate the exchange rate[21]. The horizon over which the sign restriction is binding is set to three periods. The model makes a 100000 draws (possible candidate matrixes) from the posterior distribution of the SVAR coefficients and from the space of rotation matrices. Then the impulse responses are built on those that satisfy the restrictions and discard the ones that do not. This process is repeated unit a sufficient number of impulse responses have been achieved upon which impulse responses are drawn and reported as median value.

C. THE DATA

The study analysis the monetary transmission mechanism through SVAR method based on the sign restrictions. The variables are output, prices, bank lending, policy rate or balance sheet policy, exchange rate and a financial market condition index. This dataset consists of monthly observations for the period 2002 M01 – 2014 M12.

The variables are approximated as follows. GDP represents the annualised real GDP. PRICE represents the Consumer Price Index. $CREDIT^{ALL}$ is the volume of bank lending in domestic currency. BOA^{FA} is the volume of the Bank of Albania financial assets. i^{ON} consists of the banking system overnight interest rate. EX is the real effective exchange rate of domestic currency against the five main trading partner's currencies[22]. FSI is proxy by a systemic financial stress index taken from Shijaku (2014a) and extended to the end of 2014 M12. The foreign policy rate (i^{ON}) represents the European Central Bank ENONIA rate. The dummy variable (CRISIS) takes the value of 1 during the period 2008 M09 – 2011 M03, and 0 otherwise. The $CREDIT^{ALL}$ and BOA^{FA} are deflated by CPI. Together with, GDP, CPI and EX are seasonally adjusted and log-transformed. This facilitates the interpretation of the coefficients as elasticity. Then, following Migliardo, (2010), the data entered the model as the cyclical component estimated by the Hodrick – Prescott (HP) filter. Further, i^{ON} and i^{ECB} instruments are transformed into real terms by subtracting the respective inflation rate.

The VAR model is estimated in levels based on Endut, et. al., (2015). The data on output and domestic CPI are taken from the Albanian Institute of Statistics. The data on foreign policy rate are taken ECB website. The rest of the data are taken from the Bank of Albania.

III. ESTIMATION RESULTS

A. THE BENCHMARK MODEL

The normalised benchmark SVAR model is analysed on the following procedure. First, endogenous and exogenous variables are analyses for stationary properties through means of unit root (Augmented

[20] Shijaku, (2013) shows that most of the non-performing loan is under the foreign currency lending.

[21] An alternative scheme of a sign restriction set up included the possibility that accommodating monetary policy would PRICE > 0 and other restrictions being unchanged. But, in all the cases there were not enough number of draws that satisfied the restrictions upon which impulse response would be build. The results on that can be provided upon request.

[22] The real effective exchange rate is an index. Hence, an increase in the exchange rate is a depreciation of the Albanian Lek (ALL), while a decrease is an appreciation of the Albanian Lek (ALL).

Dickey-Fuller and Phillips-Peron) tests. Results reported in Table 1 in Appendix, does not reject the null hypothesis on the stationary I(0) at a conventional significance statistical level, besides while ι which enters the model as a first difference. Second, the lag-length selection is based on the usual stringent Schwarz Information Criterion, which suggested a VAR with two lags. However, the benchmark model is includes only 1 lag of the endogenous variables given the relatively higher volatility behaviour to the higher lags and the loss to the degree of freedom. Finally, the model is analysed through means of impulse response function (Figure 1 in Appendix). The solid lines are the "median" impulse response functions and the dashed lines are the 84% symmetric bootstrapped bands. Because all the impulse responses are produced using the same candidate decomposition, it facilitates comparisons across variables.

Figure 1 plots the impulse response functions related to the benchmark model under the interest rate (i^{ON}) channel and the lines show the response of variables to a standard deviation of the monetary policy interest rate shock. A glance at the results confirms that variables react relatively to the response of a monetary policy disturbance according to the predictions obtained from theory and far beyond the horizon upon which sign restrictions are imposed. Following a Talyor rule approach, an accommodating monetary policy shock dictated by an interest rate cut by the central bank, increases output and the price level, boosts bank lending in domestic currency, depreciates the real exchange rate, but to some surprising behaviour it is followed by some higher pressure on financial markets.

An inspection of the figure in more details shows that the inertia that follows a 1 percentage point (pp) negative shock cut in the i^{ON} is associated by an initial decrease of nearly -0.263pp in one period. Then, the magnitude shrinks to nearly -0.076pp (-0.056pp) in two (three) periods. The effect is statistically significant until it diminishes to zero in just six periods. The inertia evaluated by the accumulated impulse response is statistically significant. It materialises at nearly -0.393pp in 3 periods. By the end of the twelve periods the value added is relatively small to peak at nearly - 0.468pp. This implies that the persistence of a shock effect with regards to i^{ON} is high at the beginning, but fades out soon.

At the same time, a 1 pp shock cut in the i^{ON} has initially a relatively slightly positive effect on GDP[23] as it increases by nearly 0.027pp initially, but the magnitude reaches at nearly 0.146pp in two periods and at nearly 0.113pp in three periods. This shock effect fades out to zero after nearly nine periods and is statistically significant. The accumulated response is statistically significant. The impact materialises at nearly 0.285pp in just three periods and then peaks at nearly 0.515pp by the end of twelve periods. This shows that under a simple IS-LM curve, a positive monetary policy stimulus increase output overall due to the possibility both demand and supply side effects.

For the same shock impact inflationary pressure rises initially slightly probably due to the sticky price framework, but the magnitude augments later. PRICEs increases initially by nearly 0.025pp in response to a negative 1pp shock on i^{ON}. As in the case of GDP, the effect amplifies in two periods to peak at nearly 0.215pp. In the following period the magnitude reaches at nearly 0.105pp and the gradually shrinks to zero in twelve periods. By this time the effect becomes statistically insignificant. The accumulated response materialises at 0.323pp in just three periods. By the end of the twelve periods the effect reaches to nearly 0.549pp and is throughout statistically significant. PRICE shows similar patterns to GDP behaviour, but the demand side effects pre-dominate the supply side.

Further to these findings, bank lending channel is found to react positively to a stimulus monetary policy through interest rate cut. As in the case of the previous two variables, a 1pp shock cut in the i^{ON} boosts $CREDIT^{ALL}$ by nearly 0.029pp initially. Then, in the following period the effect is estimated to get at nearly 0.141pp and becomes even stronger in the third period by peaking at nearly 0.153pp. Thereafter, the response starts to shrinks out slowly until it gets to zero in twelve periods. During the course of this lasting period the impact is found to be statistically significant. With regards to the accumulated response the effect is estimated to materialise at nearly 0.323pp by the end of third period. The magnitude is found to more than doubt in twelve periods to reach at nearly 0.665pp. This result is similar to Shijaku and Kalluci (2013). The pass-through effects of a stimulus interest rate cut compared to GDP and PRICEs,

[23] An alternative model specification, using the annual real growth rate of quarterly output instead of GDP, ensembles these findings, but showing that it increases initially by nearly 0.095pp, peaks at nearly 0.151pp in two periods and shrinks gradually to zero thereafter. Still the impulse response is statistically significant.

which are among the main variables to the focus of the decision making, is relatively higher with regards to $CREDIT^{ALL}$, even though further research would require investigating whether this is caused due to demand or supply side effects.

Other results support the view that policy shocks affect also behaviour of the fast moving such as the foreign exchange rate market indicators. A positive stimulus monetary policy leads to an initial strong effect in the foreign exchange rate market, shrinking later mostly to the positive effect of such shock to a higher confidence through better performances of economic activity and bank lending channel. For a similar 1pp negative shock on i^{ON}, EX depreciates initially 0.212pp. The estimated impact gets at nearly 0.179pp in the second period and at nearly 0.149pp in the third one. The impulse response is found to be statistically significant until it diminish to zero in nearly nine periods. The accumulated pass-through effect materialises throughout time to peak at nearly 0.831pp by the end of this twelve period time span. It is evident that interest rate channel matters in transmitting the monetary shocks to foreign exchange rate market, and in fact, plays a greater role with regards to the other variables.

Finally, the picture on financial market condition, FSI, is very much of a clear cut and surprisingly it increases to a stimulus monetary policy shock through an interest rate cut, but under the expected augmented theoretical response[24]. The results imply that FSI increases initially by 0.191pp, the effect shrinks to 0.143pp in two periods and the following it gets at nearly 0.098pp. This impulse response is statistically significant until it fades graduate to zero in nearly nine periods. The accumulated pass-through effect materialises to nearly 0.431pp in the first three periods and peaks to nearly 0.637pp by the end of twelve periods. These results yet support the view that policy changes have an immediate effect of fast moving variables. To that, results point to the need to for policy-makers to take into account the impact that their actions might have on financial market conditions linked to exchange rate movements.

Figure 2 displays results of the impulse response related to the alternative benchmark model that considers the importance of a different accommodating monetary channel that is the responses of variables to a standard deviation of the monetary policy balance sheet policy shock. The responses to this easing monetary policy shock paint a relatively similar picture to those under the model specification with interest rate channel, albeit with some clear information on the magnitude pass- through effects with regards to these two policy shocks scenario. All the impulse responses are statistically significant until they shrink to zero. They have the expected prior behaviour that is an easing monetary condition through an expansionary central bank balance sheet policy (BOA^{FA}) leads to an increase of output, prices and bank lending, followed by a depreciation of the price of domestic currency and higher pressure on financial market condition.

Yet again, a 1pp positive shock on BOA^{FA} is followed by an increase on BOAFA by nearly 0.216pp in the first period. Then the magnitude drops immediately at nearly 0.079pp, followed by a gradually shrink until it get to zero in more than twelve periods. At peak the accumulated response reaches at nearly 0.643pp in twelve periods. These results show that the inertia of balance sheet policy to the shock behaviour is relatively similar to that of i^{ON}, initially high and drops gradually throughout time until it gets to zero, but the persistence is found to be longer and to a greater extend.

Despites support for a demand side effect, GDP responses initially slightly to a positive 1pp shock on BOA^{FA} to peak at nearly 0.184pp in two periods and shrinking at nearly 0.127pp in the following periods and so on until it diminish to zero by twelve periods. However, at the peak, the accumulated impulse response materialises at nearly 0.679pp, that is nearly 0.164pp higher than the estimated impact on response to a 1pp policy rate (i^{ON}) shock. PRICEs increases by nearly 0.021pp in the first period. The effect reaches at nearly 0.167pp in the following period and shrinks immediately at nearly 0.076pp. Then the magnitude of the response diminishes through time to get at zero in twelve periods. At the peak the accumulated response account for nearly 0.264pp in three periods and at nearly 0.494pp by the end of the twelve periods. This effect is nearly -0.055pp smaller to the previous results found under the shock effect of i^{ON}. With regards to bank lending channel, the immediate response is positive, but still low. $CREDIT^{ALL}$ increases initially by nearly 0.032pp to the 1pp positive shock on BOA^{FA}. Indeed, the response peaks at nearly 0.187pp in just two periods, but start to decline thereafter. The pace of the decrease is

[24] The analysis considered also a scenario with sign restrictions such as (GDP>0; PRICE > 0; $CREDIT^{ALL} > 0$; $i^{ON} < 0$; EX > 0; FSI < 0), but found no accepted draws that satisfied these restrictions.

slow, moving from nearly 0.108pp to nearly 0.008pp in twelve periods. The accumulated impact is figured to peak at nearly 0.643pp by the end of the twelve periods. This suggests that quantitative monetary policy easing directed either to higher government finance exposure or to higher bank liquidity portfolio ultimately leads to better economic performance, a demand side effect on price level and greater bank lending under the supply side effects.

At the same time, regarding the fast moving variables, the results demonstrate that to the immediate response of a 1pp positive shock on BOA^{FA}, EX increases to a strong movement. The initially is estimated to be nearly 0.199pp, slightly smaller than the impact found to the response of the same shock to i^{ON}. However, the magnitude drops at nearly 0.169pp in the next period, to be followed by a response of nearly 0.139pp in three periods and so on until it fades out to zero at the end of twelve periods. To that, the accumulated response is estimated to peak at nearly 0.865pp suggesting that the pass-through effect of a balance sheet policy is nearly more than two third completed. The findings suggest that EX is initially more effect by portfolio behaviour link to the interest rate changes, but the persistence appear to be stronger than what is found with model specification through the interest rate channel possible to the stronger inertia found on BOA^{FA}.

Furthermore, the response of financial market condition seems to behaviour similarly regardless of the alternative policy shocks. Indeed, yet again the immediate response of FSI to a BOA^{FA} shock type magnitude is negative, high at the beginning, but dropping gradually throughout time[25]. FSI increases initially by nearly 0.194pp in response to a 1pp positive shock on BOA^{FA}. Then the magnitude drops at nearly 0.148pp and in the third period it dimidiates at nearly 0.106pp. The pace of decline continues gradually until it fades out to zero only after twelve periods, at which the accumulated response peaks at nearly 0.734pp. This is stronger than the effect of a shock to interest rate changes. To that, indeed results on the persistence of FSI are similar to the dynamics of the EX supporting the view that they are link together.

B. ROBUSTNESS CHECK: ALTERNATIVE ESTIMATES

The benchmark VAR specification is re-assessed allowing for robustness checks through alternative modelling choices that consider the responses of macroeconomic variables to a standard deviation of the monetary policy shock. On the one hand, the estimation is replicated by using an alternative sign restrictions approach, by changing either the number of horizons or the number of variables over which sign restrictions are imposed. On the other hand, it consists of four variations to the benchmark VAR, that includes: (i) alternative bank lending variables to account for the effect of monetary policy with respect to total bank lending ($CREDIT^{TOT}$)[26]; (ii) a model using the one week repurchase agreement of seven-day maturity (i^{REPO}) instead of the overnight rate[27]; (iii) an alternative specification considering monetary base (M_0)[28] as the quantitative policy instrument instead of BOA^{FA}; (iv) and another one where a money market variable[29] is used instead of credit market variables.

Figure 3 shows the results of an alternative counterfactual estimate that includes $CREDIT^{TOT}$ under the effect of i^{ON} channel, which implies that it increases initially by 0.077pp to a 1pp positive shock on i^{ON}. The response peaks at nearly 0.174pp in two periods. It drops at nearly 0.154pp and continue so until it fades out to zero in twelve periods. Throughout this time, the response behaviour is statistically significant. The accumulated response accounts for 0.834pp increase in $CREDIT^{TOT}$ by the end of twelve periods, which is nearly 0.104pp higher than the one found in the case of $CREDIT^{ALL}$. These results imply that easing monetary costs provides short run positive stimulus not only to the lending in domestic currency but also to the counterpart in foreign currency.

[25] The alternative scenario with sign restrictions such as (GDP>0; PRICE > 0; $CREDIT^{ALL} > 0$; $i^{ON} < 0$; EX > 0; FSI < 0) showed there was no accepted draws that satisfied these restrictions.

[26] The $CREDIT^{TOT}$ represents total bank lending in domestic and foreign currency to the private sector. First, it is deflated by CPI. Second, seasonally adjusted and log-transformed. Finally, it enters the model as the cyclical component estimated by the HP filter.

[27] This is transformed in real terms by subtracting the inflation rate.

[28] M_0 represents the volume of Net foreign asset plus domestic assets minus other net assets. First, M_0 is deflated by CPI. Second, it is seasonally adjusted and log-transformed. Finally, it enters the model as the cyclical component estimated by the HP filter.

[29] Money market variable is represented by the monetary aggregates e.g. the intermediate money (M_2) and the money supply (M_3).

At the same time, Figure 4 presents the findings to a positive 1pp shock scenario on BOA^{FA}. To that, $CREDIT^{TOT}$ reacts positive, increasing by nearly 0.086pp and materialising in the following period 0.189pp. The magnitude of the response continues to be positive, but the marginal response drops until it materialises at zero in twelve periods. At the peak, the accumulated response reaches at nearly 0.755pp. That is slight smaller than the materialised effect found to the i^{ON} shocks scenario and yet again another confirmation that bank lending is more affected by cost related factors. Furthermore, the response of other variable seems not to be sensitive across sample choices, even though it has to be notice that either under i^{ON} or the BOA^{FA} shock scenario the final accumulated response is higher probably owning to the fact that $CREDIT^{TOT}$ includes also added impact of the counterpart of lending in foreign currency.

Finally, with regards to bank lending channel, Figure 5 (a and b) shows the pass-through effect of monetary policy changes with respect to de-euroisation bank lending components, that is the estimation of the effect upon the behaviour of the ratio of bank lending to the private sector in domestic currency to the total bank lending to the private sector (CREDIT*). Results in Figure 5a implies that CREDIT* increases by nearly 0.165pp initially in response of a positive 1pp shock on i^{ON}. The impact holds unchanged for at least period, but latter on it starts dropping until it fades out to zero in nearly just nine periods by which the accumulated response account for nearly 0.803pp. Figure 5b shows that to the 1pp positive shock on BOA^{FA}, the immediate response of CREDIT* is still high and accounts for nearly 0.160pp in the first period. The magnitude gets at nearly 0.165pp in two periods, but starts to shrink slowly to zero in nine periods, after which the accumulated response materialises at nearly 0.605pp. it is notable that these results provide clear and supportive evidence that easing monetary policy changes stimulus more bank lending in domestic currency, but to a greater extend under the cost reduction related policies.

Yet, despite the support for bank lending view in the benchmark model, the money market view of the short run real pass-through effect of monetary transmission mechanism is clearly relevant as well. Correspondingly, findings (Figure 6 and 7) display the impulse response functions of a standard deviation of the monetary policy shock for model specification using the real money stock channel instead, that is intermediate money (M2) and money supply (M3)[30]. The impulse responses to the monetary policy changes paint a relatively similar picture to those under the model specification with bank lending channel, albeit yet again with some robustness check and clear picture on the on the pass-through effects on monetary policy inertia and other macroeconomic variables. That is all the impulse response functions have the expected prior and founded behaviour. A stimulus monetary policy increase output and price level, depreciate exchange rate and increases pressure to financial market, but most importantly increase real balance stock of money, which are found to be more sensitive compared to bank lending channel.

Figure 6a (7a) displays that the immediate response of M2 (M3) to a negative 1pp shock type to i^{ON} is positive and high, and it starts to decline throughout time. Initially, M2 (M3) increases by nearly 0.175pp (0.216pp) and the pace of the diminishing marginal response is slow until it fades out to zero in twelve periods. At peak the accumulated response of M2 (M3) materialises at nearly 0.492pp (0.556pp) in the first quarter and less than doubles to nearly 0.810pp (0.928pp) by the end of the fourth quarter. The impulse response is found to be statistically significant. Figure 6b (7b) shows that to the positive 1pp shock on BOA^{FA}, the immediate response peaks at nearly 0.202pp (0.225pp) and similarly it starts to decline slowly until it diminish to zero in twelve period. The accumulated response of M2 (M3) peaks to nearly 0.735pp (0.880pp) by the end of twelve periods. This is nearly 0.075pp (0.048pp) smaller than the accumulate response found under the shock effect of i^{ON}.

Furthermore, some additional features are worth noting. Analysis under different monetary channels, that is either the i^{REPO} or M, provide supportive robustness evidences on model specification and provide clear cut picture on the short term real pass-through effects of monetary policy changes, even though in both cases the magnitudes are smaller. Extending the horizon of sign restriction to 2 periods does not change the final outcome, but increase the number of accepted draws. Increasing the number of variables under sign restriction lowers the number of accepted draws. The greatest impact

[30] M_2 represents the volume of M_1 (Demand Deposits in domestic currency plus Currency Out of the Bank) plus Time Deposits). M_3 is the volume of M_2 plus Deposits in foreign Currency (Demand Deposits plus Time Deposits). First, M_2 and M_3 are deflated by CPI. Second, they are seasonally adjusted and log-transformed. Finally, they enter the model as the cyclical component estimated by the HP filter.

of the monetary policy change is on money market and foreign exchange rate channels. The former is more affect related to monetary policy change with regards to interest rate. The latter response to a greater extend to the monetary policy changes with regards to balance sheet policies, even though at the beginning it should that portfolio patterns are more persistent. These effects are followed by the impact on the financial market condition and bank lending. The former responses more to balance sheet policies. The latter is affect more by cost related policies and together with the other two slowing moving variables, output and prices, are found to be initially effected slightly. At peak the responses materialises in the first two periods and overall all of them pick up pick up demand side effects.

In addition, the greatest impact, through means of policy rate, is found to be on price, bank lending and real balance of money stock and the greatest impact, through the liquidity effect, is found on output, exchange rate and financial market conditions. Accommodating monetary policy contributes to the total bank lending and de-euroisation of lending channel. Output exhibits more persistence that price level, even though the persistence was even greater at the other fasting moving variables. To all that said, most importantly the analysis are qualitatively consistent with the consensus view on the transmission mechanism that monetary policy has real short term effects. All models specification show relatively similar dynamics supporting robustness check of the model estimation and monetary policy pass-through effects take place at horizons above 6 – 12 lags. Above all, as in Migliardo (2010), the sign restrictions approach reduces bias, given that the confidence bands for impulse response are tight to the median value.

IV. CONCLUDING REMARKS

This paper analyses the transmission mechanism of monetary policy for the small open economy, Albania with special attention paid to the relative importance of accommodative monetary policy, such as interest rate or/and balance sheet policy changes channels. The idea is to analyse the macroeconomic pass-through effects of conventional and possible balance sheet monetary policy type instruments that can be employed by the monetary authority in the case of Albania to achieve the policy objective and to boost the economic growth recovery through market confidence and bank credit channel. The paper make uses of short-run of structural vector autoregressive model with sign restriction that consist of variables such as output, prices, money or banking lending indicator, policy rate or balance sheet instruments, exchange rate and a financial market condition index. This approach has the advantages of overcoming the Cholesky decomposition and the sign restrictions eliminate possible puzzles. This analysis makes use of the impulse response function and highlights the dynamics effect between a structural monetary policy shock and the main economic variables.

Analysis shows that empirical findings are robust to different model specification channels. Monetary policy changes, either through policy rate cuts or balance sheet expansion, have real short run effect and the pass-through of monetary transmission mechanism materialise within 12 periods. Positive monetary stimulus boosts output, bank lending and real money stocks. To that, real price of domestic currency deprecates, which all together with the accommodating monetary policy puts more pressure to the financial market condition. This point to the need for policy-makers to take into account the impact that their actions might have on financial market conditions possibly to the unhedged bank lending and non-performing loan in foreign currency. To that, it is also to be considered the possibility that easing monetary condition does contribute to the de-euroisation bank lending portfolio. In addition, based on the magnitude, the pass-through effects of the monetary policy changes in the case of Albania are found to be strong with respect to these variables and under this sample approach. Finally, these results provide some vital information with regards to the outcomes of alternative monetary policy instrument that might be employed by the central bank Governing Council. On the one hand, results show that the greatest impact, through means of interest rate instrument, is found to be on inflation pressure channel, bank lending channel and real money stock channel. On the other hand, the greatest impact through the balance sheet liquidity effects is on output, exchange rate channel and financial market conditions. Output exhibits more persistence that price level, even though the persistence was even greater at the other fasting moving variables. Similar money market is more affected than the bank lending channel. Exchange rate and financial market show similar behaviour patterns.

Some other caution is, however, required to this analysis that needs to be borne in mind for future research. First, the analysis does not take explicitly assess the effectiveness of different types of macro- prudential or/and balance sheet policies. This could expand further the information base used in decision making and improve research quantitatively and qualitatively as well as suitability of instruments to achieve the policy objectives. Second, the sample period covers normal times as well as period under financial market stress. To this, future research could consider the effectiveness of balance sheet monetary policies especially during the crisis period, even though there might be a risk to data sufficiency. An alternative solution could consider splitting the sample between pre-crisis and after the crisis, using probably the same model specification, on the argument to analyse through the impulse response function whether the monetary transmission mechanism in the case of Albania has changed in the aftermath of the financial and economic crises. Further to that, the model specification can also be extended to include both bank lending and money stock variable so that to evaluate the full effect of a possible supply or demand shock effects on price level. To that, an alternative approach could consider the inclusion of both policy instruments, policy rate and balance sheet instruments, to check upon on robustness checks whether the estimated response still holds. Finally, the benchmark model could also be assessed on the robustness arguments to the inclusion of additional variables that might have a bearing on the analysis. Among future research might consider a version including the outstanding debt of the government. Another possible solution might be to consider the pass- through effects of monetary policy changes on core inflation or inflation expectations, asset prices and longer term interest rate.

References

Afonso, A., J. Baxa and M. Slavik, (2011), "Fiscal development and financial stress: a threshold VAR analysis", European Central Bank, Macro-prudential Research Network, Working Paper Series No 1319 / April 2011;

Afonso, A., and Silva, J. A., (2014), "The monetary transmission mechanism in the Euro Area: has it changed with the EMU? A VAR approach, with fiscal and financial considerations", ISEG Economics Department Working Paper No. 10/2014/DE/UECE;

Arias, E. J., F. J. Rubio-Ramírez, D. F. Waggoner, (2014), "Inference based on SVARs identified with sign and zero restrictions: theory and applications", Federal Reserve Bank of Atlanta, Working Paper 2014-1, February 2014;

Bank of Albania, (2013), "Medium – Term Development Strategy of the Bank of Albania for 2013 – 2015", Bank of Albania;

Baumeister, C. and L. Benati, (2012), "Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound", presented at the 4th Annual IJCB Fall Conference, Central Bank of Chile, September 27 – 28, 2012;

Bernanke, B. S., and V. R. Reinhart, (2004), "Conducting monetary policy at very low short-term interest rates", American Economic Review, Papers and Proceedings, Vol. 94 (2), 2004, pp: 85 – 90;

Bernanke, B., (2012), "U.S. Monetary Policy and International Implications", A speech at the "Challenges of the Global Financial System: Risks and Governance under Evolving Globalization," A High-Level Seminar sponsored by Bank of Japan-International Monetary Fund, Tokyo, Japan, October (2012);

Bjørnland, H. and K. Leitemo, (2009), "Identifying the interdependence between US monetary policy and the stock market", Journal of Monetary Economics, Vol. 56, pp 275-282;

Brown, M., and D. R. Haas, (2010), "Foreign currency lending in emerging Europe: bank level evidence", European Bank for Reconstruction and Development, Working Paper No. 122;

Bruno, V. and H. S. Shin, (2013), "Capital Flows and the Risk-Taking Channel of Monetary Policy", NBER Working Paper No. 18942, April 2013;

Canova, F. and G. De Nicolo, (2002), "Monetary disturbances matter for business fluctuations in the G-7", Journal of Monetary Economics, Vol. 49, (2002), pp: 1131 – 1159;

Christiano, L. J., M. Eichenbaumy and C. L. Evans, (1999), "Monetary Policy Shocks: What Have We Learned and to What End?", in Taylor J. and M. Woodford (eds), Handbook of Macroeconomics, North-Holland, Amsterdam, pp: 65 – 148;

Ciccarelli, M., A. Maddaloni, J. Peydró, (2013), "Hteregenous transmission mechanism monetary policy and financial fragility in the euro area", European Central Bank, Working Paper Series No 1527/ March 2013;

Claeys, G., (2014), "The (not so) Unconventional Monetary Policy of the European Central Bank since 2008", *Economic and Monetary Affairs Committee*, European Parliament, 9th July 2014, retrieved from the World Wide Web http://www.bruegel.org/publications/publication-detail/publication/837- the-not-so-unconventional-monetary-policy-of-the-european-central-bank-since-2008/;

Cour-Thirmann, Ph., and Winkler, B., (2013), "The ECB's non-standard monetary policy measures: the role of institutional factors and financial structure", European Central Bank (Published version in Oxford Review of Economic Policy, 2012, Vol. 28, pp: 765 – 803;

Dreger, Ch., H. Reimers, B. Roffia, (2006), "Long-run money demand in the new EU member states with exchange rate effects", European Central Bank, Working Paper Series NO 628 / MAY 2006;

Dumičić, K., I. Čibarić, N. Horvat, (2010), "Thje analysis of monetary transmission mechanism in Croatia using cointegration approach", Croatian Operational Research Review (CRORR), Vol. 1, 2010;

Endut, N., J. Morley, P.L., Tien, (2015), "The changing transmission mechanism of the U.S. monetary policy", UNSW Business School Research Paper No. 2015-03;

Fawley, B., and Neely, C. J., (2012), "Four stories of quantitative easing", Federal Reserve Bank of St. Louis Review, January/February (2013), 95(1), pp: 51-88;

Forero, F. J. P. and M. Vega, (2014), "The dynamic effects of interest rates and reserve requirements: a zero-sign restrictions approach", Central Reserve Bank of Peru, May 30, 2014;

Fratzscher, M., Lo Duca, M., Straub, R., (2014), "ECB unconventional monetary policy actions: market impact, international spillovers and transmission channels", presented at a XV Jacques Polak Annual Research Conference IMF, Washington D.C., 13 – 14 November (2014);

Fry, R., and A. Pagan, (2011), "Sign restrictions in the structural vector autoregressions: a critical review", Journal of Economic Literature 2011, Vol. 49 (4), pp: 938 – 960;

Gambacorta, L., B. Hofmann, G. Peersman, (2012), "The effectiveness of unconventional monetary policy at the Zero lower bound: a cross-country analysis", Bank for International Settlements, BIS Working Paper No 384, August 2012;

Glocker, Ch. and P. Towbin, (2011), "The macroeconomic effects of reserve requirements", National French Bank;

Istrefi, K., and Semi, V., (2007), "Exchange rate pass-through in Albania", Bank of Albania, October (2007);

Kimura, T. and J. Nakajima, (2013), "Identifying conventional and unconventional monetary policy shocks: a latent threshold approach", Bnk of Japan, May 2013;

Kolasi, G., H. Shijaku, D. Shtylla, (2010), "Monetary transmission mechanism in Albania", Bank of Albania;

Lagarde, C., (2012), "Opening Remarks", at the Bank of Japan-IMF high-level seminar "Challenges of the global financial system: risks and governance under evolving globalisation", Tokyo, October 14 (2012);

Lanne, M. and H. Luetepohl, (2006), "Identifying monetary policy shocks via changes in volatility"CESIFO Working Paper No. 174, June (2006);

Li, F., (2010), "Financial stress, Monetary Policy and Economic activity", Financial Stability Department and Pierre St-Amant, Canadian Economic Analysis, Bank of Canada Review, Autumn (2010);

Luporini, V., (2008), "The Monetary Transmission Mechanism in Brazil: Evidence from a VAR Analysis", Estudos Econômicos (Sãn Paulo), Vol. 38, No. 1, pp: 7 – 30;

Mallick, S. and R. M. Sousa, (2011), "Inflationary pressures and monetary policy: evidence from BRICS economies", retrieve from the World Wide Web http://www.qass.org.uk/2011-May_Brunel-conference/Mallick.pdf;

Migliardo, C., (2010), "Monetary policy transmission in Italy: A BVAR analysis with sign restriction", AUCO Czech Economic Review 4 (2010), pp: 139 – 167;

Mishkin, F. (1996), "The Channels of Monetary Transmission: Lessons for Monetary Policy", Banque de France: Bulletin: Digest, Vol. 27, pp: 33-44;

Muço, M., Sanfey, P., and Luçi, E., (2001), "Stabilization, monetary policy and financial institutions in Albania", Bank of Albania;

Muço, M., Sanfey, P., and Taçi, A., (2004), "Inflation, exchange rates and the role of monetary policy in Albania", European Bank for Reconstruction and Development, Working Paper 88, August (2004).

Peersman, G., (2011), "Macroeconomic effects of unconventional monetary policy in the Euro Area", European Central Bank, Working Paper Series No 1397 / November 2011;

Peeters, M., (2005), "What about monetary transmission in Albania? Is the exchange rate pass-through (still) the main channel?", paper presented at the fifth conference of the Bank of Albania "Central banking in the time of integration", March 24-25, 2005, Durrës;

Rajan, R., (2014), "Global monetary policy: a view from emerging markets", The Brookings Institution, Washington, D.C., April (2014;

Shijaku, H., (2007), "An Investigation of Monetary Policy Transmission Mechanism in Albania", Bank of Albania and Staffordshire University, November 2007, [Unpublished];

Shijaku, G., (2013), "The role of money as an important pillar for monetary policy: the case of Albania", Bank of Albania, [Forthcoming Bank of Albanian Working Paper], The BCC's annual conference on "Setting up the Monetary Policy Framework: What Role for Financial Sector Considerations" was held jointly with the Swiss State Secretariat for Economic Affairs (SECO) in Geneva on October 17-18 2013. The conference brought together high level academics and policy makers.

Shijaku, G., (2013), "Foreign currency lending in Albania", Bank of Albania, [Forthcoming Bank of Albanian Working Paper] in the 3rd Research Conference "Towards recovery and sustainable growth in the altered global environment", 28-29 April 2014, Skopje;

Shijaku, G., and Kalluci, I., (2013), "Determinants of bank credit to private sector: the case of Albania", Bank of Albania;

Shijaku, G., (2014a), "Matja e indeksit të stresit financiar sistemik në rastin e ekonomive evropiane në zhvillim", Departamenti i Kërkimeve, Banka e Shqipërisë, Buletini i Bankës së Shqipërisë 6M-1 2014, pp: 129 – 141;

Shijaku, G., (2014b), "Fiscal policy, output and financial stress in the case of developing and emerging European economies: a threshold VAR approach", Bank of Albania, [Forthcoming Bank of Albanian Working Paper];

Smaghi, L. B., (2009), "Conventional and unconventional monetary policy", Keynote lecture at the International Center for Monetary and Banking Studies (ICMB), Geneva, 28 April 2009;

Sims, C. A. (1980) "Macroeconomic and Reality", Econometrica, Vol. 48, pp: 1 – 48;

Sims, C., J. Stock and M. Watson, (1990), "Inference in linear time series models with some unit roots", Econometrica, Vol. 58/1, pp: 113 – 144;

Smets, F., and R. Wouters, (1999), "The exchange rate and the monetary transmission mechanism in Germany", DNB Staff Reports 1999, No.35 De Nederlandsche Bank;

Stock, J. H. and M. W. Watson, (2001), "Vector Autoregressions", Journal of Economic Perspectives, Vol. 15, pp: 101 – 115;

Tanku, A., (2006), "Demand for Money in a Transition Economy: The Case of Albania", Research Department, Bank of Albania, September 2006, [Unpublished];

Tanku, A., Vika, I., Gjermeni, M., (2007), "The role of exchange rate in an IT framework, what do we do?", Bank of Albania, November (2007);

Vika, I., (2007), "Roli i bankave në transmetimin e politikës monetare në Shqipëri", Banka e Shqipërisë, Qershor (2007);

Weber, A. A., R. Gerke, A. Worms, (2009), "Has the monetary transmission process in the euro area changed? Evidence based on VAR estimates", BIS Bank, BIS Working Papers No 276, Mars 2009;

Whaley, R., (2009), "Understanding the VIX", Journal of Portfolio Management, Vol. 35, pp: 98 – 105;

APPENDIX I

Table 1. Unit Root Test[a], period 2002 M01 – 2014 M12.

		Level			First difference	
Variable	Intercept	Intercept and trend	None	Intercept	Intercept and trend	None
			Augmented Dickey Fuller (ADF) test			
GDP	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
PRICE	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
CREDITALL	[0.0001]	[0.0008]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
CREDITTOT	[0.0054]	[0.0284]	[0.0003]	[0.0049]	[0.0259]	[0.0003]
M2	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
M3	[0.0026]	[0.0156]	[0.0001]	[0.0000]	[0.0000]	[0.0000]
ION	[0.1703]	[0.3749]	[0.0678]	[0.0004]	[0.0028]	[0.0000]
iREPO	[0.8891]	[0.3983]	[0.2496]	[0.0024]	[0.0090]	[0.0002]
BOAFA	[0.0010]	[0.0060]	[0.0000]	[0.0003]	[0.0017]	[0.0000]
M0	[0.0173]	[0.0755]	[0.0011]	[0.0000]	[0.0000]	[0.0000]
EX	[0.0005]	[0.0032]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
FSI	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
iECB	[0.0061]	[0.0250]	[0.0003]	[0.0000]	[0.0000]	[0.0000]
			Phillips – Peron (PP) test			
GDP	[0.0000]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
PRICE	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
CREDITALL	[0.0455]	[0.1601]	[0.0037]	[0.0000]	[0.0000]	[0.0000]
CREDITTOT	[0.0895]	[0.2709]	[0.0086]	[0.0000]	[0.0000]	[0.0000]
M2	[0.0002]	[0.0017]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
M3	[0.0001]	[0.0008]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
ION	[0.0677]	[0.1976]	[0.0086]	[0.0000]	[0.0000]	[0.0000]
iREPO	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
BOAFA	[0.0231]	[0.1018]	[0.0016]	[0.0000]	[0.0000]	[0.0000]
M0	[0.0100]	[0.0472]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
EX	[0.0107]	[0.0502]	[0.0006]	[0.0000]	[0.0000]	[0.0000]
FSI	[0.0985]	[0.3960]	[0.0188]	[0.0000]	[0.0002]	[0.0000]
iECB	[0.0320]	[0.1267]	[0.0024]	[0.0000]	[0.0001]	[0.0000]

[a] automatic lag selection based on Schwarz Info Criterion (SIC)

Source: Author's calculations

Table 2: Sign restrictions scheme of a model specification with bank lending in domestic and under different MP instruments[(a)].

	Policy rate instruments		Balance sheet instruments	
	i^{on}	i^{REPO}	BoA^{FA}	M_0
(b)	5791	2341	5175	4292
(c)	3	3	3	3
GDP	(+)	(+)	(+)	(+)
PRICE	(+)	(+)	(+)	(+)
$CREDIT^{ALL}$	(+)	(+)	(+)	(+)
i^{on}	(-)			
i^{REPO}		(-)		
BOA^{FA}			(+)	
M_0				(+)
EX	(+)	(+)	(+)	(+)
FSI	(?)	(?)	(?)	(?)

(a) – Based on 100000 draws (rotations) tried during model estimation.
(b) – Number of accepted draws that satisfy the restrictions imposed.
(c) – Number of horizons over which sign restrictions are imposed.
(?) – No sign restriction is impose

Source: Author’s calculations

Table 3: Sign restrictions scheme of a model specification with total bank lending channel and under different MP instruments[(a)].

	Policy rate instruments		Balance sheet instruments	
	i^{on}	i^{REPO}	BoA^{FA}	M_0
(b)	7439	5417	5739	5088
(c)	3	3	3	3
GDP	(+)	(+)	(+)	(+)
PRICE	(+)	(+)	(+)	(+)
$CREDIT^{TOT}$	(+)	(+)	(+)	(+)
i^{on}	(-)			
i^{REPO}		(-)		
BOA^{FA}			(+)	
M_0				(+)
EX	(+)	(+)	(+)	(+)
FSI	(?)	(?)	(?)	(?)

(a) – Based on 100000 draws (rotations) tried during model estimation.
(b) – Number of accepted draws that satisfy the restrictions imposed.
(c) – Number of horizons over which sign restrictions are imposed.
(?) – No sign restriction is imposed.

Source: Author’s calculations

Table 4: Sign restrictions scheme of a model specification with intermediate money (M2) and under different MP instruments[(a)].

	Policy rate instruments		Balance sheet instruments	
	i^{on}	i^{REPO}	BoA^{FA}	M_0
(b)	6762	4491	6390	5285
(c)	3	3	3	3
GDP	(+)	(+)	(+)	(+)
PRICE	(+)	(+)	(+)	(+)
M_2	(+)	(+)	(+)	(+)
i^{on}	(-)			
i^{REPO}		(-)		
BOA^{FA}			(+)	
M_0				(+)
EX	(+)	(+)	(+)	(+)
FSI	(?)	(?)	(?)	(?)

(a) – Based on 100000 draws (rotations) tried during model estimation.
(b) – Number of accepted draws that satisfy the restrictions imposed.
(c) – Number of horizons over which sign restrictions are imposed.
(?) – No sign restriction is imposed.

Source: Author's calculations

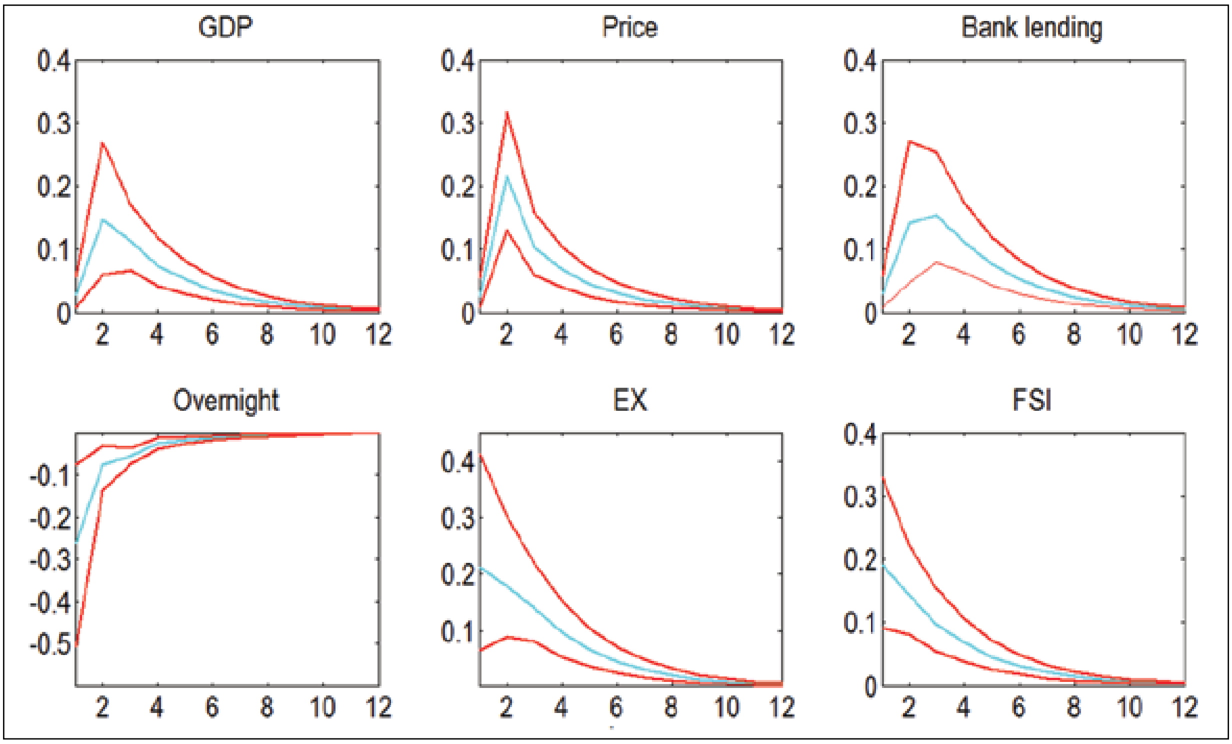
Table 5: Sign restrictions scheme of a model specification with money supply (M3) and under different MP instruments[(a)].

	Policy rate instruments		Balance sheet instruments	
	i^{on}	i^{REPO}	BoA^{FA}	M_0
(b)	6995	5485	5429	5657
(c)	3	3	3	3
GDP	(+)	(+)	(+)	(+)
PRICE	(+)	(+)	(+)	(+)
M_2	(+)	(+)	(+)	(+)
i^{on}	(-)			
i^{REPO}		(-)		
BOA^{FA}			(+)	
M_0				(+)
EX	(+)	(+)	(+)	(+)
FSI	(?)	(?)	(?)	(?)

(a) – Based on 100000 draws (rotations) tried during model estimation.
(b) – Number of accepted draws that satisfy the restrictions imposed.
(c) – Number of horizons over which sign restrictions are imposed.
(?) – No sign restriction is imposed.

Source: Author's calculations

Figure 1. Non-accumulated impulse response to a 1pp shocks on i^{ON}.

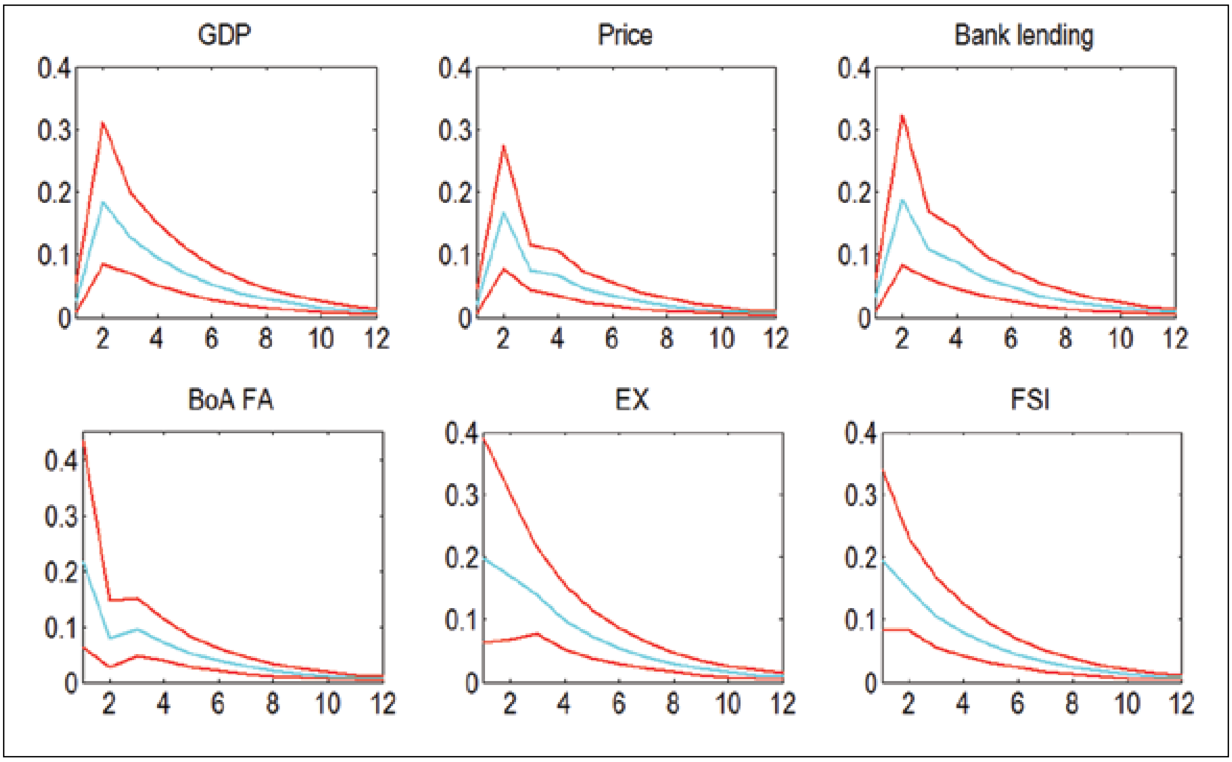


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculations

Figure 2. Non-accumulated Impulse response to a 1pp shocks on BOA^{FA}.

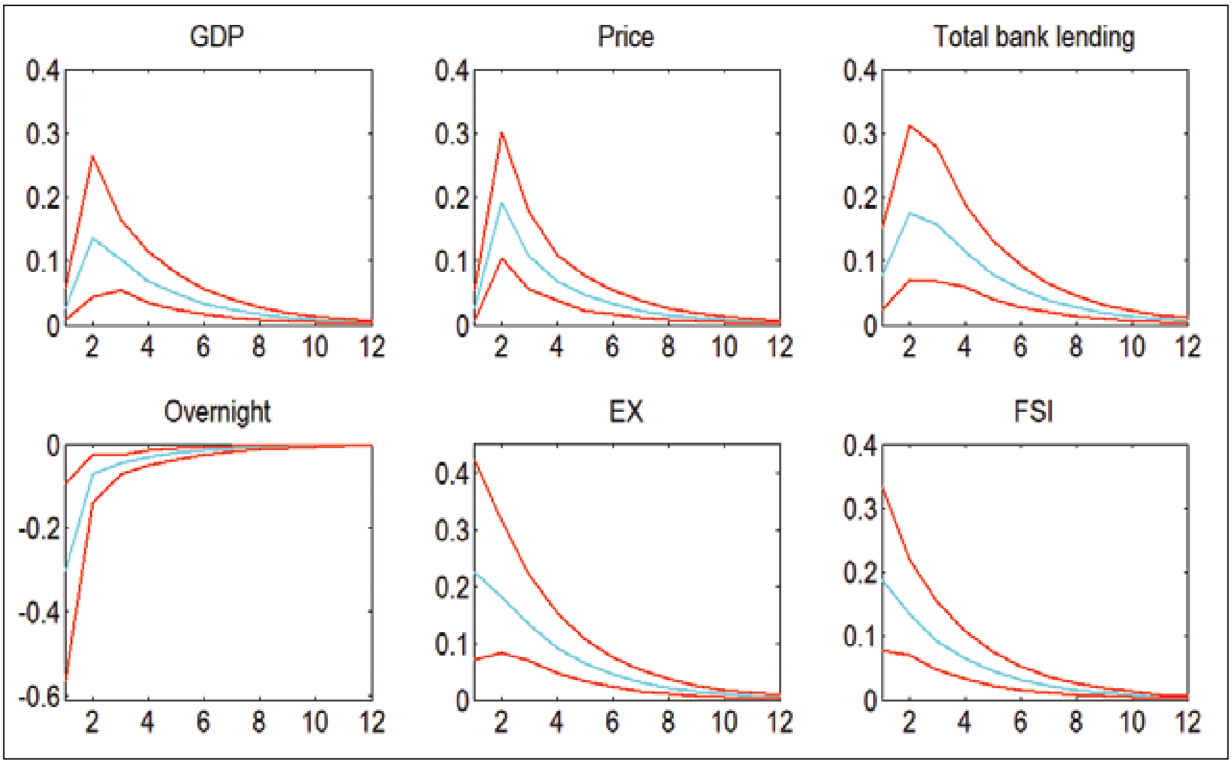


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculations

Figure 3. Non-accumulated Impulse response of $CREDIT^{TOT}$ to a 1pp shocks on i^{ON}.

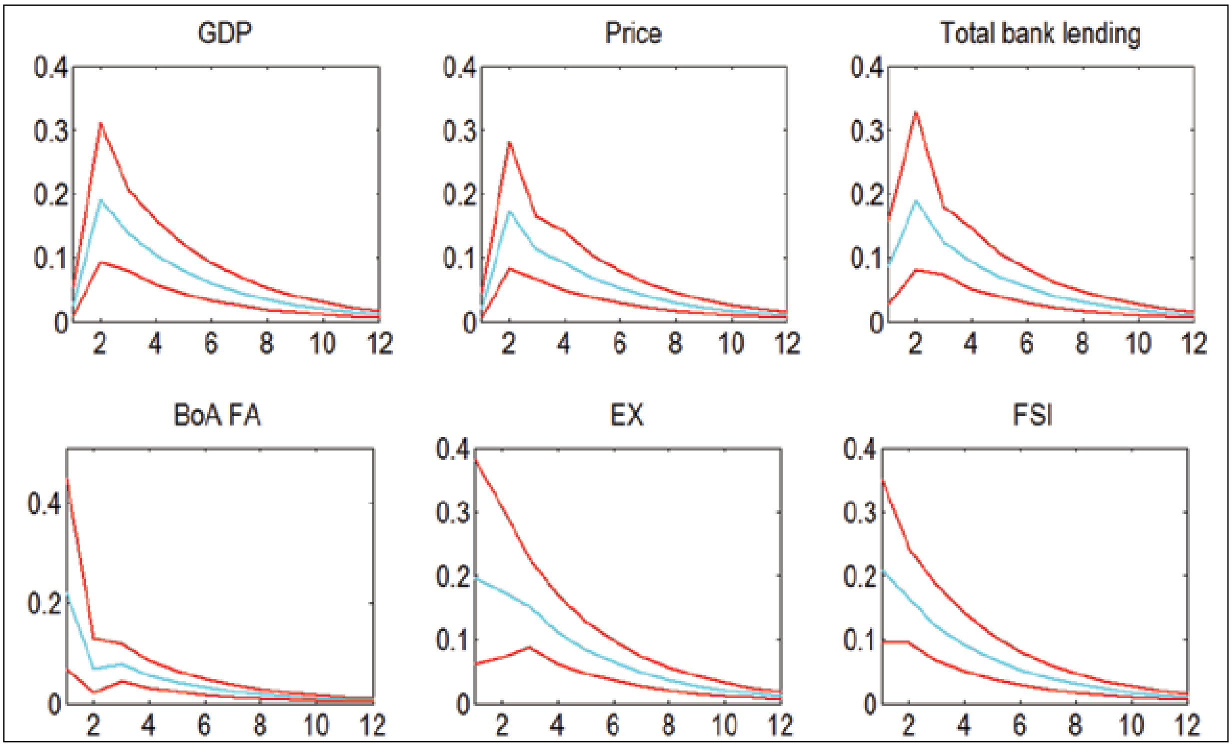


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculations

Figure 4. Non-accumulated Impulse response of $CREDIT^{TOT}$ to a 1pp shocks on BOA^{FA}.

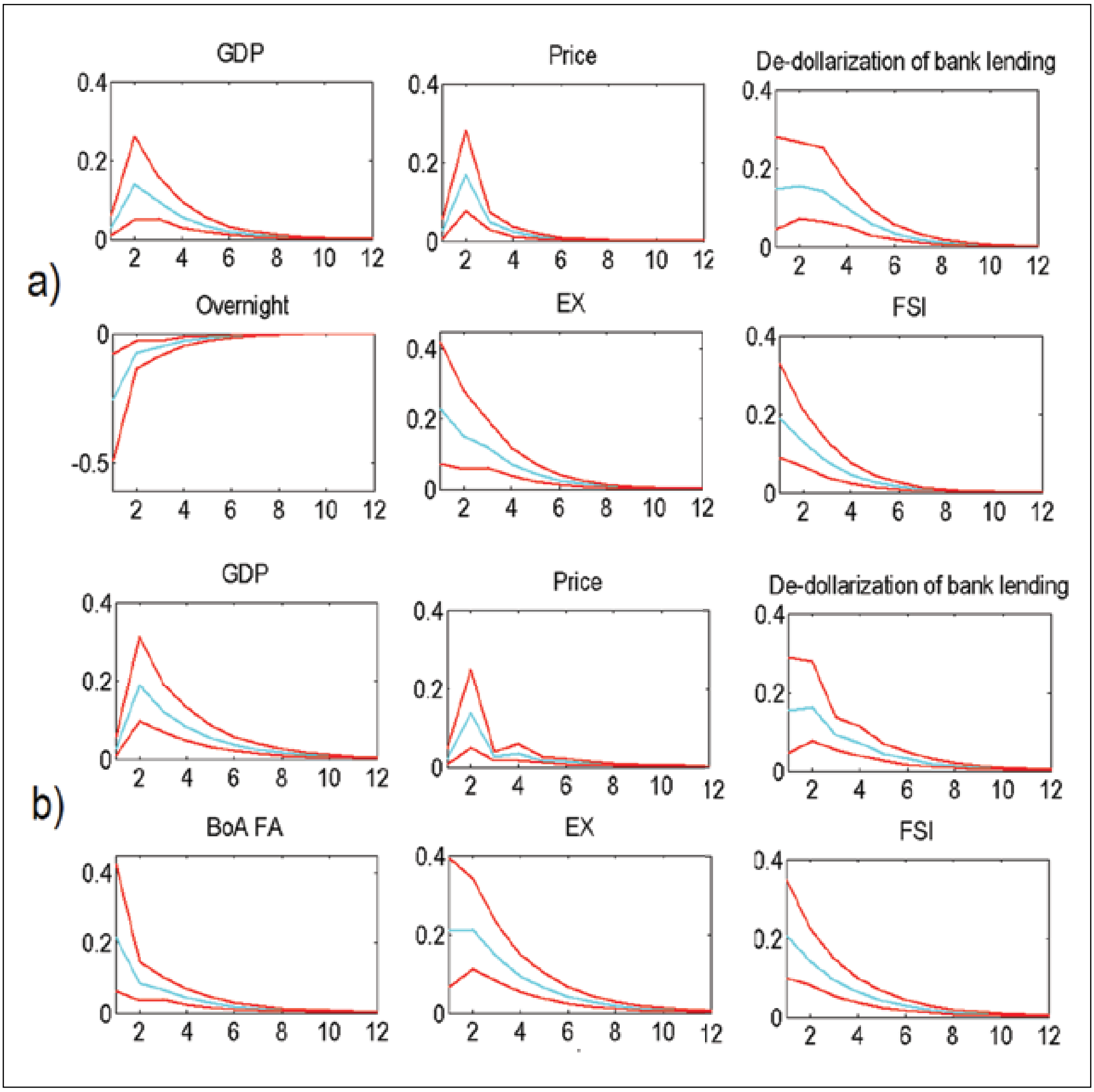


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculationsFigure 5. Non-accumulated Impulse response of CREDIT* to a 1pp MP shock.

Figure 5. Non-accumulated Impulse response of CREDIT* to a 1pp MP shock.

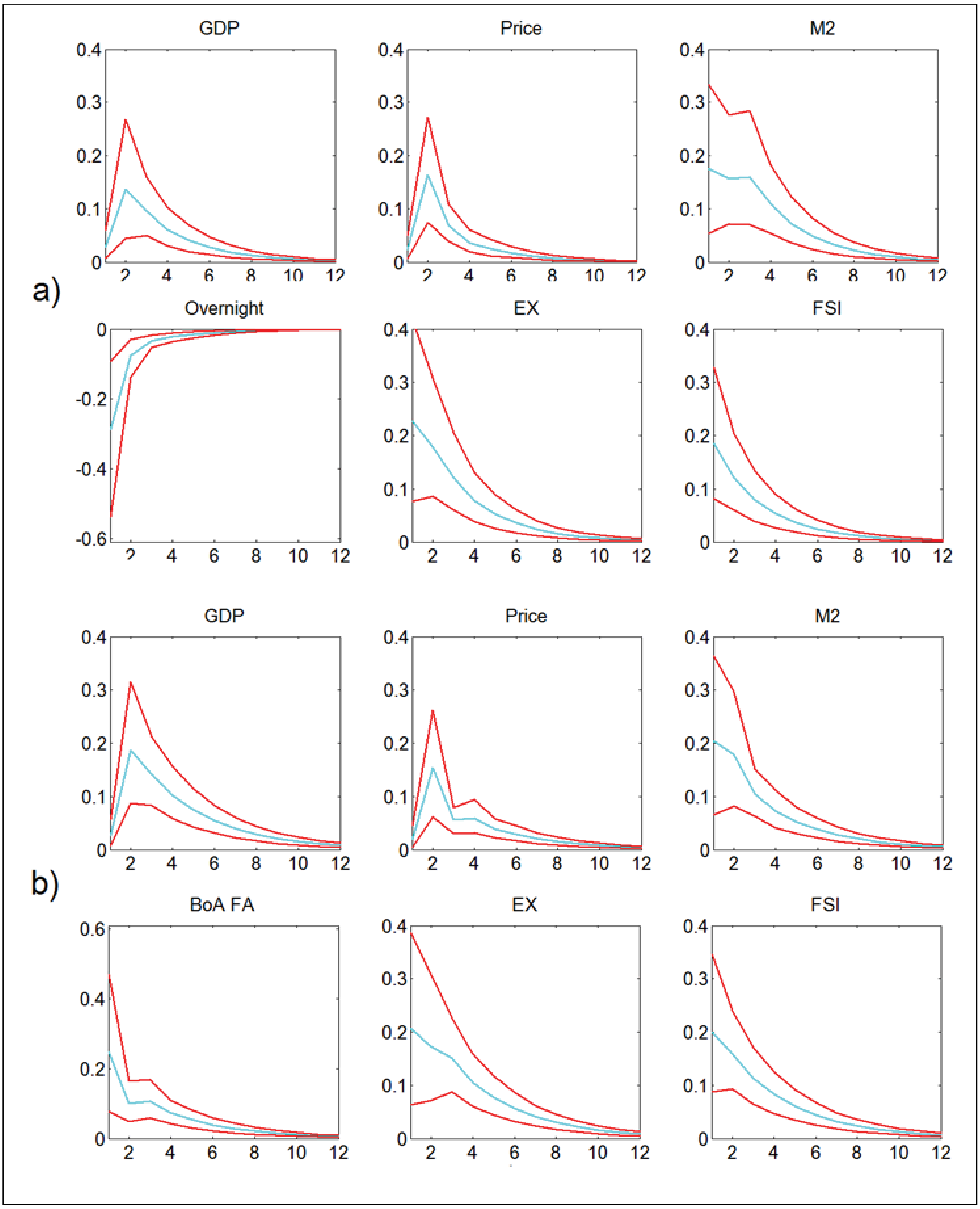


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculations

Figure 6. Non-accumulated Impulse response of M_2 to a 1pp MP shock.

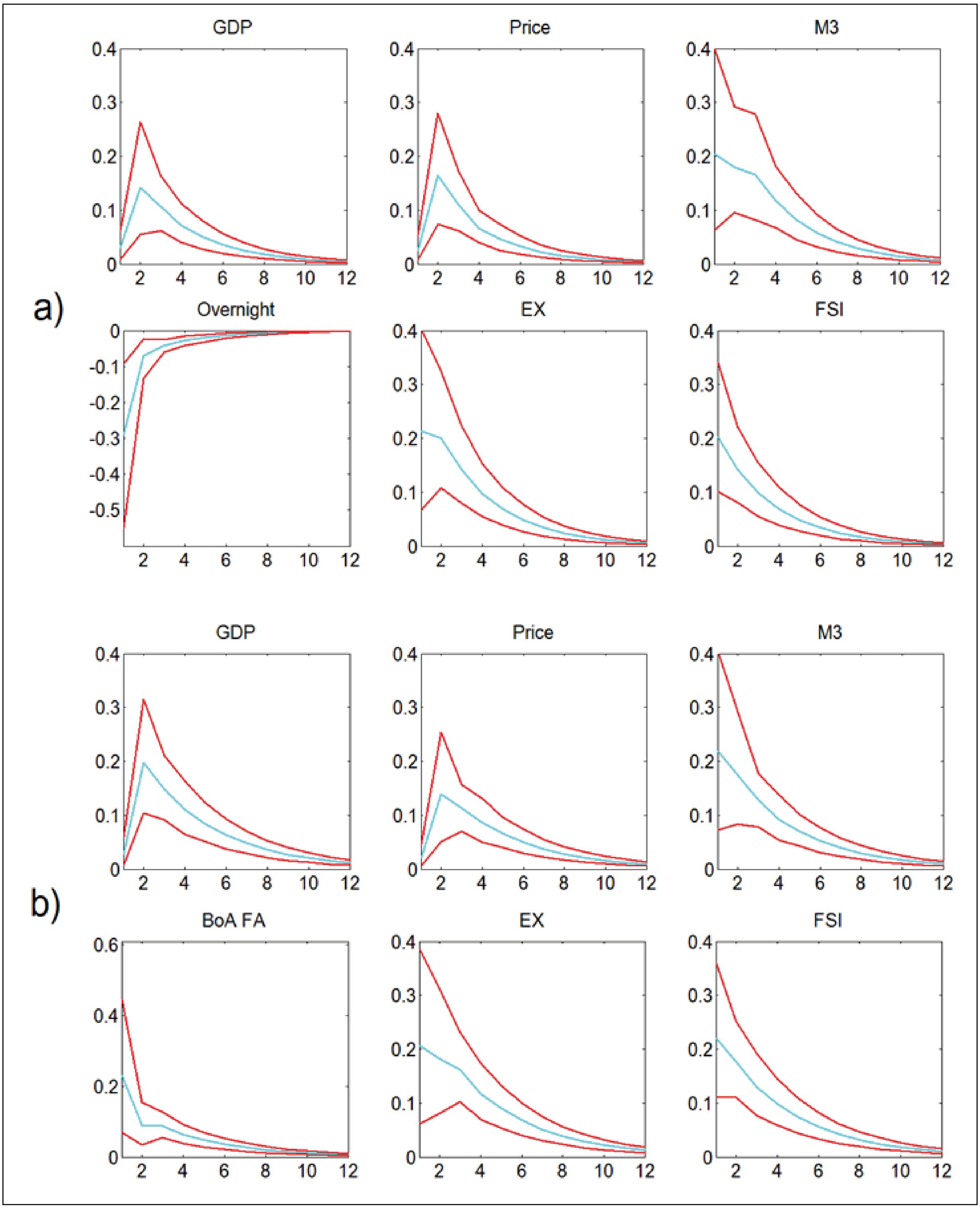


LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author’s calculations

Figure 7. Non-accumulated Impulse response of M3 to a 1pp MP shock.



LAGS

----- IRF ----- Upper and lower bound of the critical values

Source: Author's calculations

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339.1321.133:339.727.2]:303.724(594/595)
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CROSS-BORDER CAPITAL FLOWS IN EMERGING MARKETS: DEMAND-PULL OR SUPPLY-PUSH?

Kurmaş Akdoğan[1], Neslihan Kaya Ekşi[2] and Ozan Ekşi[3,4]

Abstract

We disentangle the cross-border capital flows into demand-pull and supply-push components for four selected emerging markets: Brazil, Indonesia, Malaysia and Turkey. We employ vector autoregressions with sign restrictions method, using two variables: noncore liabilities of banks and the money market rates. Demand shocks are defined as those that move these two variables in the same direction and supply shocks as those that move them in opposite directions. Our results imply that, in the wake of the global financial crisis, worsening demand conditions in the recipient countries and the high levels of uncertainty were the main determinants of the decline in cross border flows. However, once the unconventional policy measures by the advanced economies were put into effect, the proliferation of global liquidity worked as a push factor for cross border flows.

Keywords: Financial stability, capital flows, non-core liabilities, sign restrictions.

JEL Codes: C32, E44, G21

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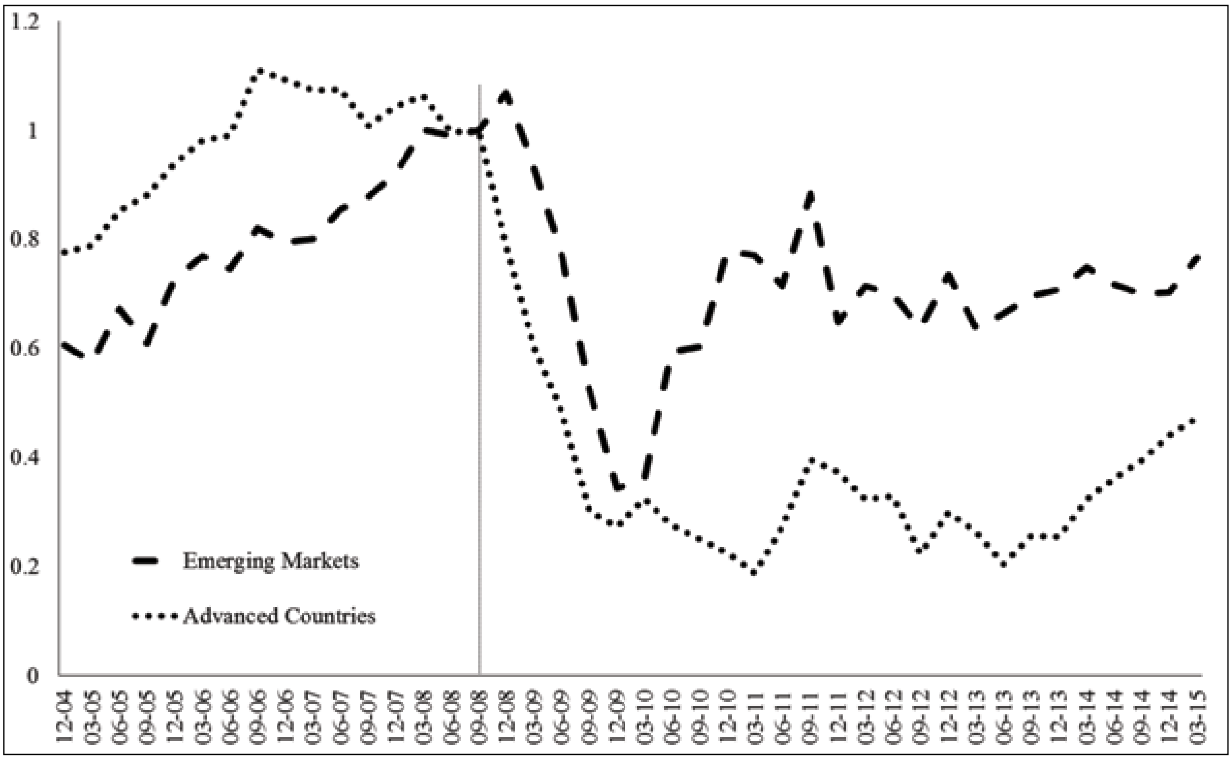
4 The views expressed in this study are those of the authors and do not necessarily represent the official views of the Central Bank of the Republic of Turkey.

1. INTRODUCTION

The post-crisis era reveals a faster recovery in credit growth for the emerging markets as opposed to the advanced countries. Figure 1 depicts the change in credits as a percentage of GDP for 14 advanced countries and 14 emerging markets. The graph suggests an instant plunge in credits after the crisis in both country groups. However, advanced countries and emerging markets decouple in a noticeable way in two years' time after the initial shock.

A significant cause of the rapid recuperation in credits in emerging markets is the surge in direct or indirect cross-border capital flows to these economies. The direct channel refers to the credits extended to the domestic private agents by foreign financial institutions. The indirect channel describes an intermediary, usually a bank, raising wholesale funding from abroad and then lending to local customers. Both channels functioned well for emerging markets in the last years due to the permissive global financial conditions, raising concerns for domestic authorities (Borio et.al, 2011).

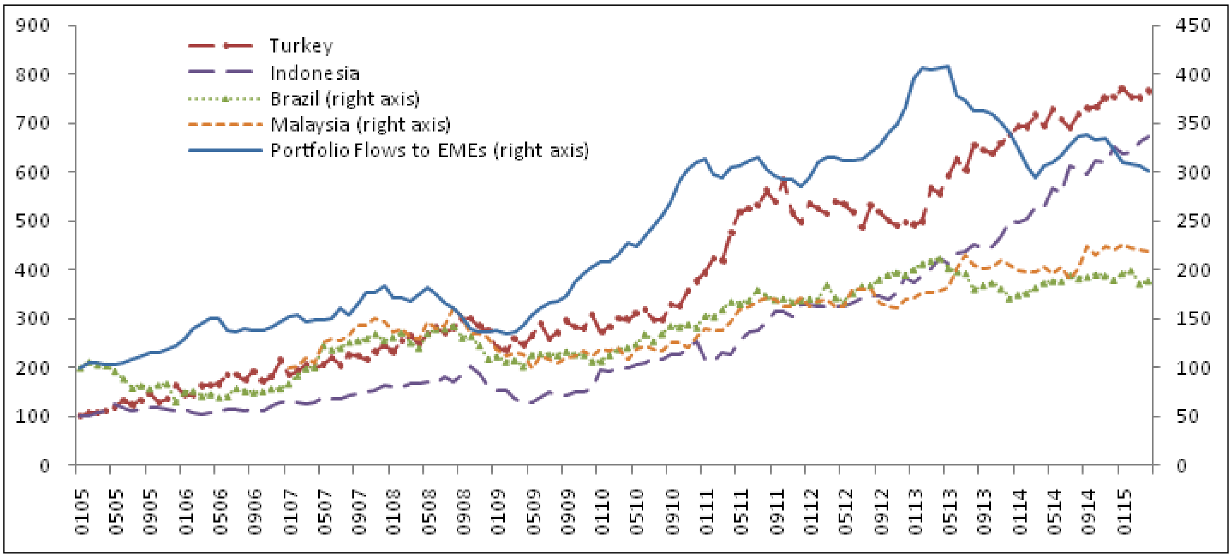
Figure 1: Change in total credits / GDP
(q-o-q change, 4- quarters moving average, indexed as 2008Q3=1)



Notes: *i)* Advanced countries include Australia, Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Malta, Singapore, Spain, Switzerland, UK and USA. Emerging markets include Brazil, Chile, Croatia, Czech Republic, Hungary, Indonesia, Malaysia, Mexico, Poland, Russia, South Africa, Thailand, Turkey and Ukraine. *ii)* Total credit figure is the total credits extended to private sector which is the sum of household credits and business credits for each country. Source: Central banks and/or government statistical agencies.

This study focuses on the developments in the indirect cross-border flows through the lens of the liabilities side of the balance sheet of the banking sectors of four selected emerging economies: Brazil, Indonesia, Malaysia and Turkey. During normal times, banks finance their lending through domestic deposits which constitute the core liabilities of a bank. In contrast, during booms, when domestic deposits are insufficient to finance the growth in lending, banks resort to external funding, reported as the non-core liabilities of a bank. Periods of surges in capital inflows generally tend to be associated with rapid increases in these non-core liabilities of the banking system, which may convey useful information on the stage of the financial cycle and may possibly serve as an early warning indicator of growing risks on financial stability (Hahm et al., 2013). Figure 2 below illustrates that increases in portfolio flows to emerging economies in the aftermath of the global financial crisis are associated with significant increases in non-core liabilities of the banks for all of our sample countries.

Figure 2: Portfolio Flows to EMEs and Non-Core Liabilities
(billions, indexed as 2005m1=100)



Source: EPFR, Central Bank websites.
Notes: *i)* Total non-core liabilities are expressed in billions of domestic currency and are foreign exchange rate adjusted. *ii)* For Malaysia the non-core liabilities are indexed as 2007m1=100. *iii)* Portfolio flows to EMEs constitute the sum of bond and equity flows to EMEs. They are adjusted for exchange rates and prices.

We delve into the relationship between the funding structure of the financial intermediaries and their risk-taking behaviour by analysing the non-core liabilities of the banking sector. For this purpose, we decompose the movements of non-core liabilities into their demand-pull and supply-push components. Differentiating demand and supply components of cross-border flows is crucial from the policy perspective, as it provides valuable information regarding the appropriateness of countercyclical macroprudential policies.

The decomposition is carried out by means of vector autoregressions with sign restrictions, using the framework proposed by Kim et al. (2013). In a two-variable VAR model, we employ non-core liabilities as the quantity variable, and, to capture the ease of funding in the credit market, we use money market rates as the price variable. By means of sign restrictions, demand and supply shocks are defined in a way to decompose the non-core liabilities into their demand and supply-led components. In this regard, we define demand shocks, which indicate the upsurge in credit by local banks, as those that move quantity and price variable in the same direction. On the other hand, supply shocks, which are related with liquidity conditions, are supposed to move quantity and price variables in opposite directions. This methodology allows us to differentiate the domestic component of the amplification mechanism in credit market from the global liquidity impact. The analysis is conducted by dividing the sample that spans the period from 2004 to date, into three parts where the Lehman and the peak of the Eurozone crisis constitute the separating dates in between the regions. This way, significant similarities are observed in terms of the movements of non-core liabilities as well as their demand and supply components.

Our results suggest two important features of the cross-border flows in the aftermath of the global financial crisis. First, the initial decline in non-core liabilities after the crisis is mainly demand driven for most countries in our sample. However, the impact of the quantitative easing reveals itself with a more pronounced supply led growth in cross-border flows almost two years' time after the crisis. This result implies that in the wake of the crisis, worsening demand conditions in the recipient countries and the high levels of uncertainty were the main determinants of the drop in capital flows towards these countries. However, once the unconventional policy measures by the advanced economies were taken in, the proliferation of global liquidity worked as a push factor for capital flows into emerging markets.

Second, after the tapering signal in mid-2013, as capital inflows start to decline, the negative supply-push impact can be observed through outflows. However, it should be noted that, for Indonesia and Turkey, following the tapering signal, positive demand-pull component of the movements in non-core liabilities dominates this negative supply push impact. That heterogenity among countries underscores the need to take into account the differences in the prevailing domestic market conditions and the countercyclical policy responses of authorities in emerging markets. Along this line of reasoning, we further examine the relationship of the movements in non-core liabilities with the macroprudential measures taken by our sample countries.

The paper is structured in five sections. After this brief introduction, the second section motivates our choice of non-core liabilities among other alternative systemic risk indicators to monitor the vulnerabilities in the financial system. Later on, some stylized facts for the countries are documented. In particular, we elaborate on the components of capital inflows, the procyclicality of bank-intermediated flows and the relationship between capital flows, non-core bank liabilities and credit growth. Our focus on credit growth is also essential to understand our motivation of disentangling demand and supply components for the cross-border capital flows. Especially, for the demand-pull forces, the credit demand conditions as well as the risk-taking behaviour of the intermediaries are suggested as important determinants of the capital flows in emerging markets. This section also includes a brief review of the literature and reports some macroprudential measures taken by our sample countries. The third section describes the data and the methodology. The fourth section documents the results of our empirical analysis. The fifth section concludes.

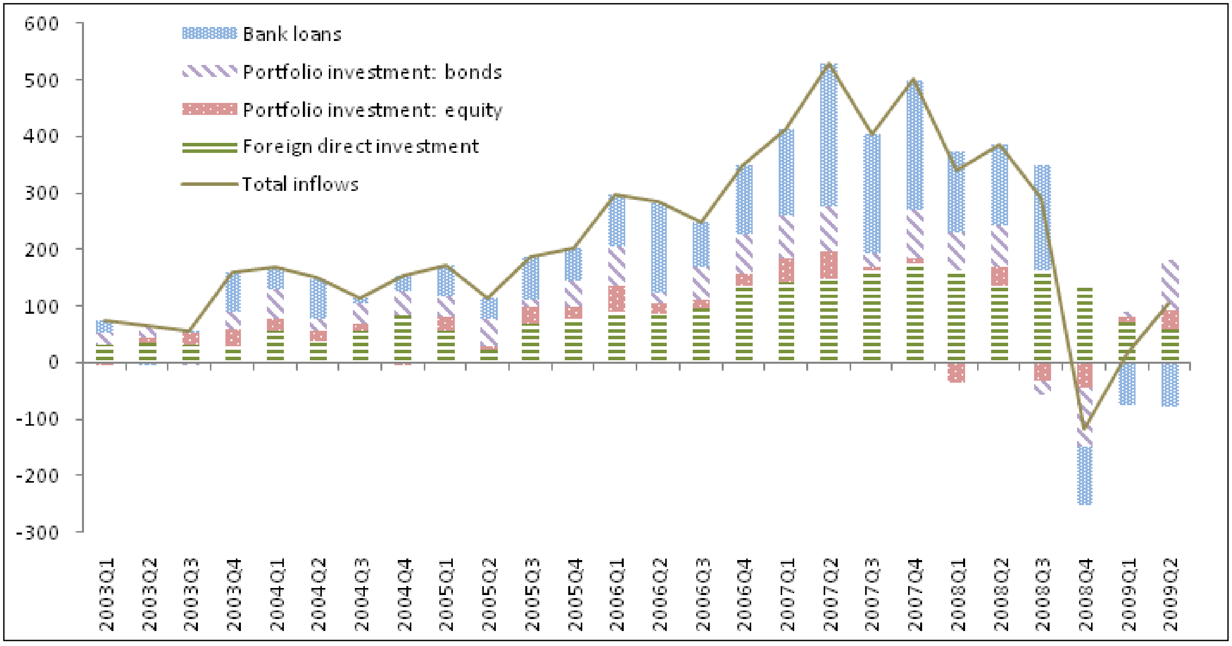
II. STYLIZED FACTS AND LITERATURE SURVEY

The recent global financial crisis period has shown once again that capital flows may amplify the business and financial cycles and lead to systemic risks in the recipient emerging economies. To what extent these flows may raise concerns for the incumbent economy from the stability perspective depends on their types[5]. Typically, FDI flows and portfolio equity flows are less likely to reverse sharply and even if they do, the damage, in most cases, is much less compared to a sudden stop of bank flows. Debt type inflows, on the other hand, are mostly intermediated through the banking system and they lead to rapid domestic credit growth, which in turn poses risks to financial stability. Moreover, risks in such a case are much higher for an incumbent economy struggling with shrinking GDP, price deflation and increasing default risks.

Bank related flows display the most procyclical and volatile component of the capital inflows. Figure 3 illustrates this, displaying the sharp withdrawal of aggregated bank flows from forty one countries, including many emerging economies, starting from the last quarter of 2008. It is apparent from the figure that the volatility of the banking sector flows is much higher than the volatility in the remaining types of capital flows. This relatively higher volatility of bank-related flows helps us to rationalize our choice of non-core liabilities of the aggregate banking sector, among other indicators of financial risk. Along this line of reasoning, we first document some stylized facts on the relationship between capital flows and the credit growth in this section. Later, we explore the broad macroprudential measures taken by the emerging economies in our sample. Lastly, we define non-core liabilities, document their procyclical behaviour and volatility and further motivate our approach on disentangling the demand and supply components of these aggregates, in comparison with the previous literature.

[5] Capital flows differ depending on its nature of the claim (debt or equity); its denominated currency (domestic or foreign); its investor type (portfolio, foreign direct or bank) and its maturity (short or long).

Figure 3: Composition of Capital Inflows
(in billions of U.S. dollars)



Source: IMF Global Financial Stability Report, April 2010 p.123.
Notes: The figure displays the aggregated capital inflows to forty-one advanced and emerging economies.

i) Credit Growth and Macroprudential Policies in our Sample Countries

Capital flows and the resulting growth in credit in emerging markets increase macrofinancial risks through different channels, driving central banks to keep an eye on the resilience of the financial system along with their traditional price stability objective[6]. Hence, the post-crisis period has witnessed the introduction of many novel macro-prudential policy tools designed for the era of abundant global liquidity, as well as the traditional ones. Remarkably, most of these policies were conducted by emerging markets which encounter stronger economic and financial cycles compared to the advanced countries, partially due to the intensity and the volatility of the capital flows (Claessens et al., 2013). Recently, a documentation of macroprudential policies conducted by 119 countries based on an IMF survey points out a positive relationship between the implementation of macroprudential policies and intensity of cross-border funding (Cerutti et al., 2015). Similarly, Ghosh et al. (2014) examines the cross border capital flows of 71 countries and finds a positive impact of capital account restrictions on reducing these flows. Akıncı and Rumsey (2015) suggests that capital control policies targeting the banking sector are more successful than the portfolio restrictions on curbing the credit growth [7,8].

The emerging markets in our sample are selected according to the data availability as will be described in the next section. These countries differ in terms of the macrofinancial risks that are accumulated through the vast capital inflows after the financial crisis; though they have some remarkable similarities both in this matter and the corresponding macroprudential approaches. We briefly provide some common patterns below for our sample countries, referring the reader to the comprehensive studies -the aforementioned ones for comparative analyses and the ones in the next paragraphs for individual country cases- for an extensive exploration of the macroprudential policies, due to our space limitations. Among a vast sphere of policy practices, our examples are selected to motivate our focus on noncore liabilities as an indicator of financial risk that will be discussed following these country case expositions.

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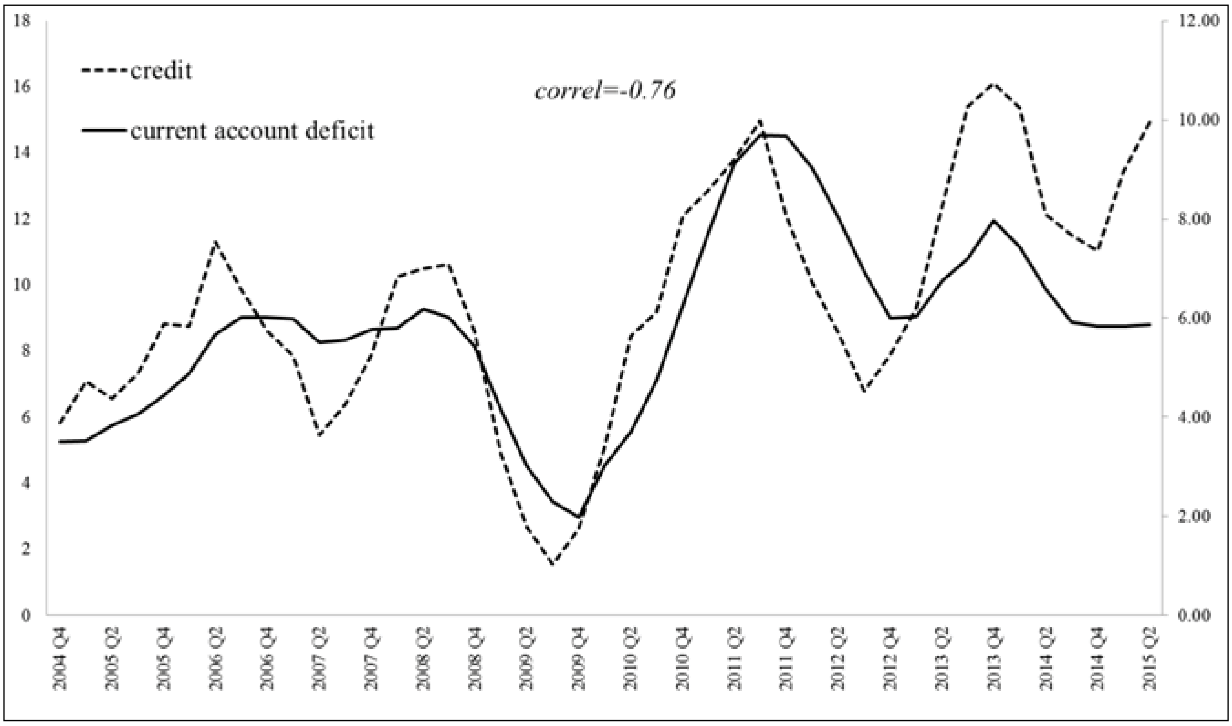
6 The literature suggests excessive credit growth as an important predictor of financial crises. See Gourinchas and Obstfeld (2012), Schularick and Taylor (2012) and references therein.

7 Other examples of case studies are Zhang and Zoli (2014), Bruno et al. (2015) that examine impacts of the capital flow management policies for Asia-Pacific economies.

8 There are also studies which find a partial or no effect for policies implying some form of a capital control on volatility of capital flows such as Forbes and Warnock (2012) or Binici et al. (2014).

First, for countries with a strong external demand (or with high dependence on imported inputs), credit growth usually leads to a widening current account deficit, increasing their vulnerability against sudden stops[9]. Among our sample countries, the strong co-movement between credit growth and current account deficit is illustrated in Figure 4 for Turkey. In view of that, Turkey has applied countercyclical macroprudential rules aiming towards curbing credit growth in the recent years. For this purpose, Central Bank of the Republic of Turkey altered the required reserve ratios for foreign exchange denominated liabilities in order to encourage the banks to extend the maturity of their non-core liabilities (CBRT, 2015, pg. 13-14).

Figure 4: Total Credit and Current Account Deficit, Turkey
(percent of GDP)
Left: Change in Total Credit, Right: Current Account Deficit



Second, as Vasconcelos and Tabak (2014) shows for Brazilian financial system, the ability of domestic banks to obtain foreign funds through carry trade has a positive impact on credit growth, but this comes with the risk of higher foreign exchange exposure. Moreover, Da Silva and Harris (2012) argues that higher demand for domestic assets due to differences in yields between advanced economies and emerging markets put pressure on Brazilian currency to appreciate. In addition to this positive demand shock, global rise in commodity prices was another factor behind inflationary pressures. As a response to these risks of overheating, Brazil applied several macroprudential policies, including different reserve requirements for banks with short foreign exchange positions or capital requirements for certain market segments.

Indonesia was also a recipient of capital flows in the recent years. As a report by Bank of Indonesia (2012) documents, the higher reliance on short-term funding by domestic banks would increase the liquidity risk for the intermediaries. Authorities implemented macroprudential policies including reserve requirements based on loan to deposit ratios and introduction of loan-to-value ratios to curb excessive lending in housing and automotive loans (Bank of Indonesia, 2015).

9 Phillips et al. (2014) finds a negative relationship between credit growth and current account balance. Furthermore, Ekinci et al. (2015) argues that the deterioration in the current account due to higher credit growth is more significant in developing countries compared to the advanced ones.

Regarding the liabilities of Malaysian banks, a recent study argues that, the domestic banks -once bitten twice shy- became less reliant on interbank and wholesale funding after the Asian financial crisis of 1997 (BIS, 2015, pg. 233). However, the surge in external borrowing of non-financial corporations points out to potential problems in the stability of banks' funding sources. This indirect impact is also important because, while the deposits by nonfinancial corporations seem more reliable than that of financial institutions, they are still riskier than that of household deposits. This instability intensifies when the firms act as surrogate financial intermediaries. Shin (2012) gives the example of China where banks cannot borrow from international markets, yet firms can obtain foreign loans and deposit these proceedings into the domestic banking system as collateral[10]. Hence, the open position of the corporate sector could trigger a system-wide shock in case and should be monitored closely. Other than this channel, property and retail lending sectors were at the focus of the macroprudential policies in Malaysia, such as the imposition of a real property gains tax or loan-to-value limit on housing loans (BIS, 2015, pg. 239).

ii) Monitoring the non-core liabilities as a financial risk indicator

The macroprudential policies can be broadly classified into two groups according to their focus (Borio, 2010). On the one hand, countercyclical buffers concentrate on the *time* dimension, i.e. the behaviour of the systemic risk over time. On the other hand, the accumulation of risk in the overall financial sector at a particular moment (e.g. the correlation of exposures under alternative network structures) is monitored by policy tools that are designed to capture the *cross-sectional* dimension.

Among alternative macroprudential tools (such as market-based indicators, early warning indicators or macro stress testing approach) one group that stands out in terms of simplicity and granularity is that of balance sheet indicators[11]. Considering the role of the balance sheet interlinkages within the financial system in a systemic breakdown, Hahm et al. (2013) proposes a classification of the banks' liabilities by the holder of the claim, which they argue, would provide information about their reliability and stability under different periods of the economic cycle. They suggest that, the *core* liabilities, such as demand and time deposits of the *household sector* are reliable and relatively stable sources of funds for banks. The growth rate of these deposits is usually consistent with that of the household wealth during the economic cycle. However, during booms; loan demand growth might be higher than that of the deposits. In these expansionary periods, banks might recourse to other, less reliable and more volatile source of funds such as short-term foreign debt or interbank borrowing, mainly derived from *other financial institutions*. A rise in these *non-core* liabilities in the balance sheet of banks indicates vulnerability against liquidity shocks for two reasons. First, as a result of their short-term nature and unreliability, it would be hard to rollover these funds during a liquidity squeeze. Second, and more importantly, enhanced cross-lending between domestic banks increases the systemic risk due to the contagion effect stemming from bilateral exposures. Hence, banks might play an *active* role in the *propagation* of the financial shocks, rather than being *passive* intermediaries transferring foreign funds into the economy in order to absorb the domestic credit demand.

Figures 5 to 8 illustrate the developments of the non-core liabilities of the aggregate banking sector and total credits for our sample countries[12].

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[10] Hattori et al. (2009) provides another interesting example of this indirect effect as the funding of Japanese firms in 1980s through securitization.

[11] Borio and Drehman (2009) and Galati and Moessner (2010) provides a review of these different indicators under different macroprudential policy frameworks.

[12] Total credits consist of household and private credits for each country. The details of the data of non-core liabilities is provided in the next section and the data appendix.

Figure 5: Non-core Liabilities and Total Credit, Brazil
Left: Non-core liabilities, Right: Total credit
(Change, 6-months average, billions of domestic currency)

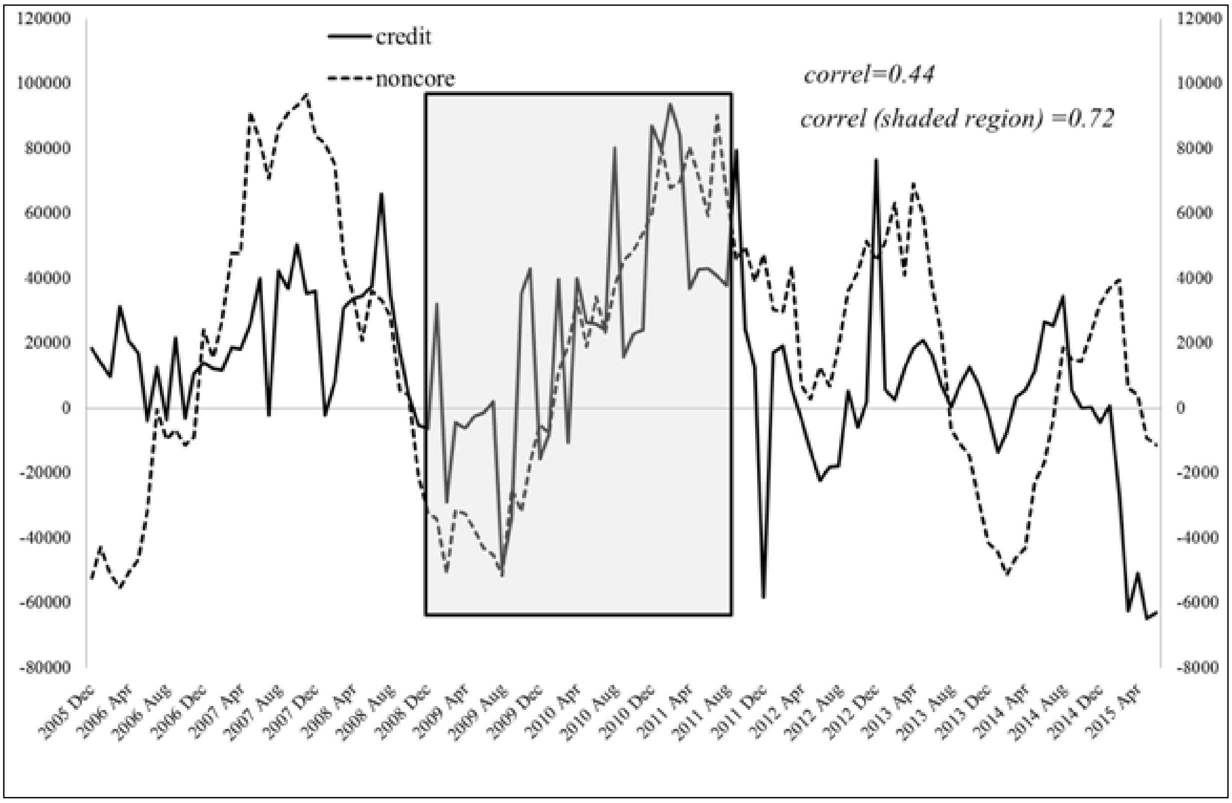


Figure 6: Non-core Liabilities and Total Credit, Indonesia
Left: Non-core liabilities, Right: Total credit
(Change, 6-months average, billions of domestic currency)

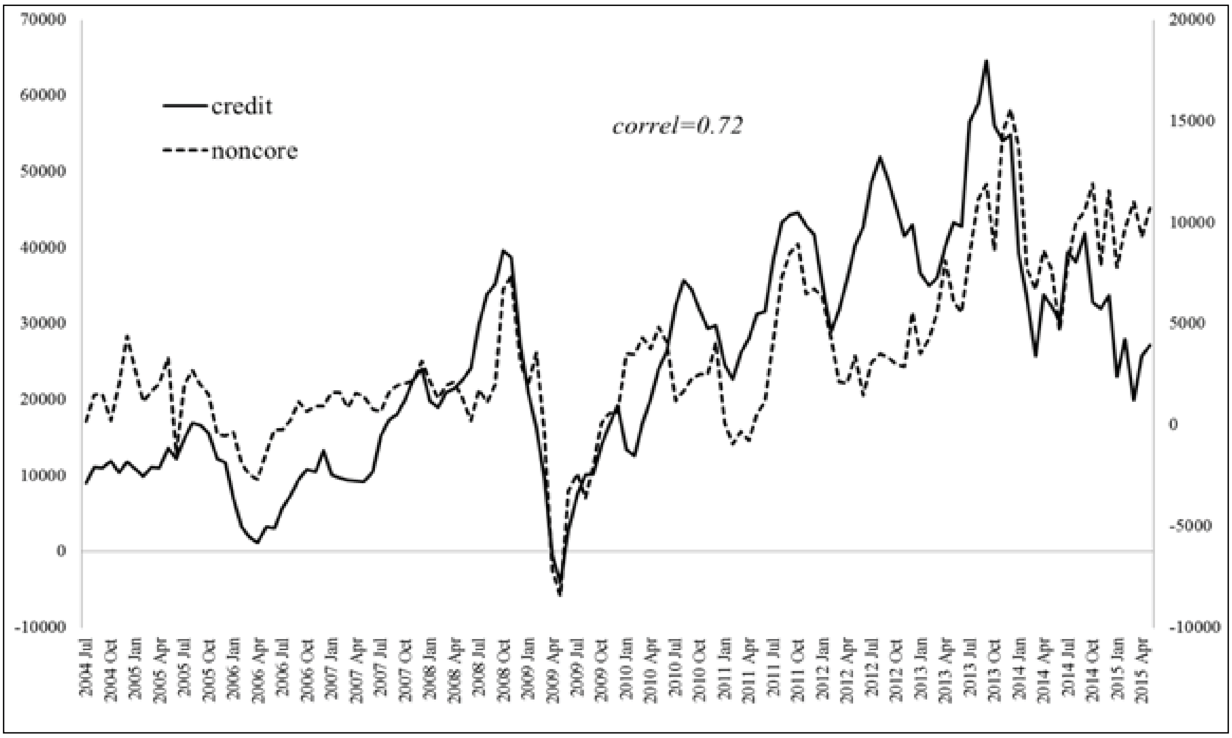


Figure 7: Non-core Liabilities and Total Credit, Malaysia
(Change, 3-months average, billions of domestic currency)

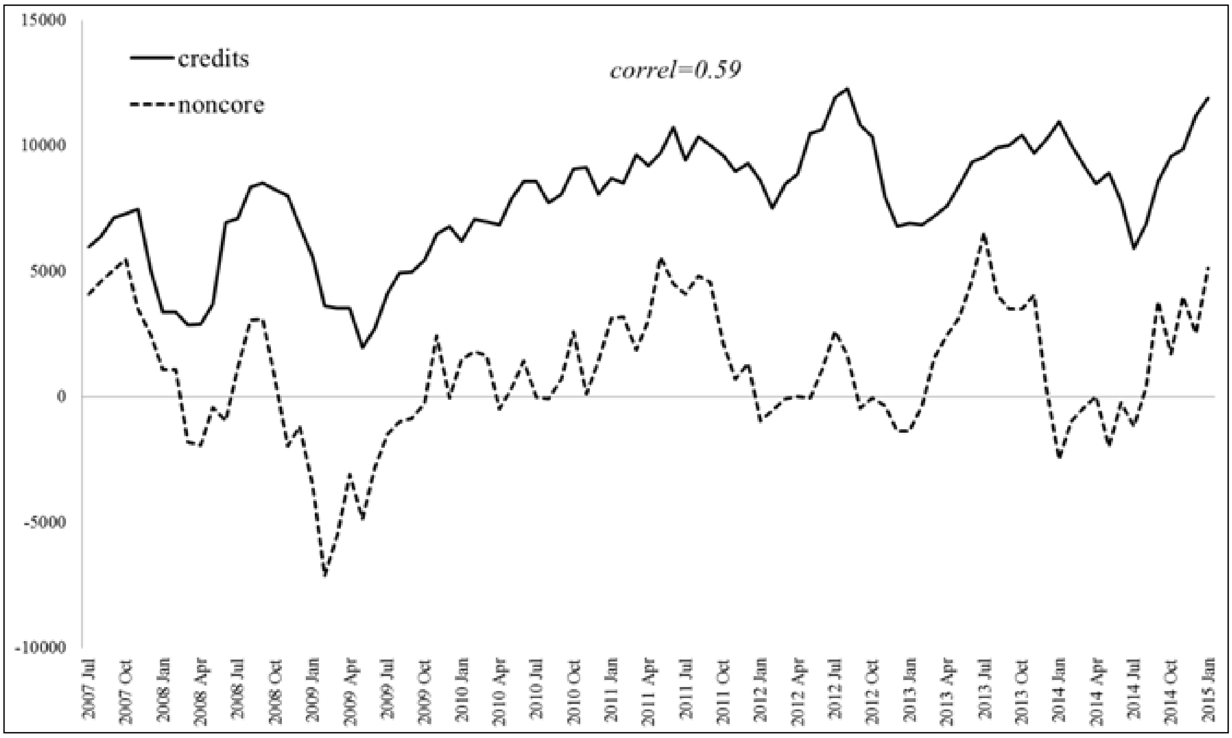
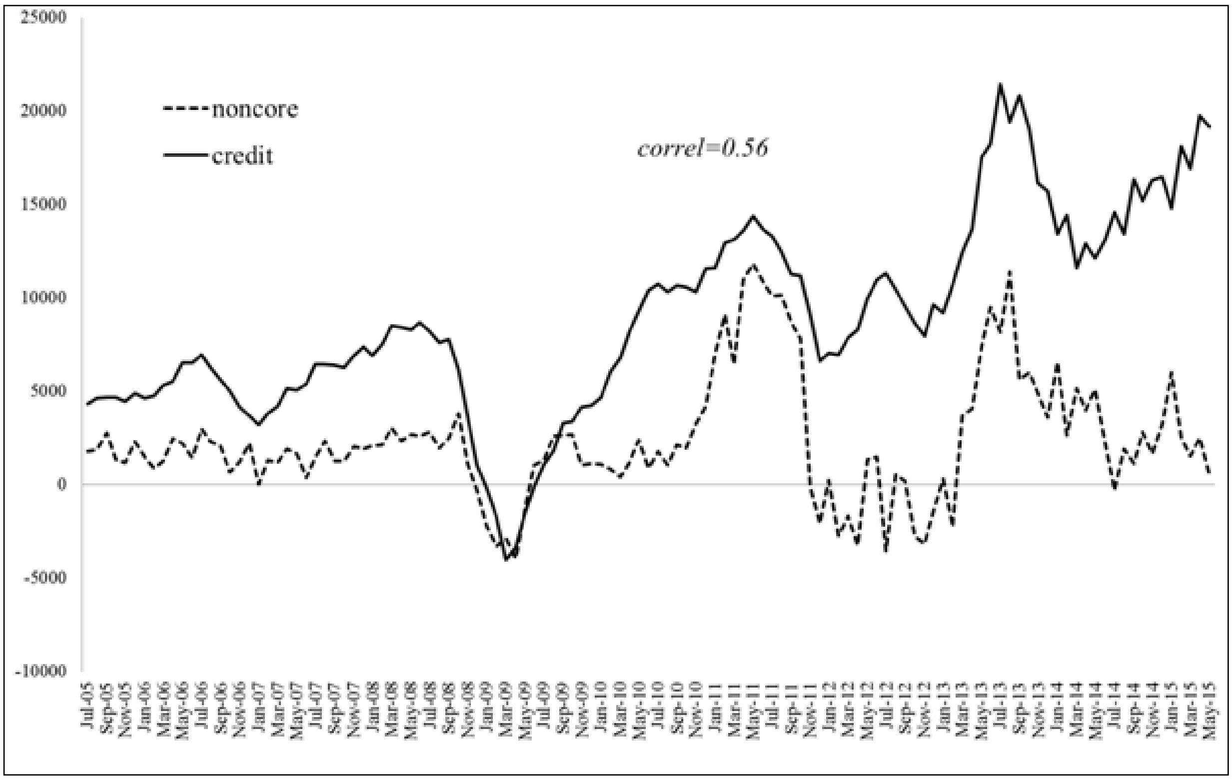


Figure 8: Non-core Liabilities and Total Credit, Turkey
(Change, 3-months average, billions of domestic currency)



A first look at the figures reveals a strong correlation between non-core liabilities and credit growth for Indonesia, Malaysia and Turkey. For all these countries, the figures suggest non-core liabilities as a strong candidate to be an indicator of the recovery in credits[13]. For Brazil, on the other hand, the credits reveal a much more volatile pattern compared to the noncore liabilities, thus the figure does not suggest a strong correlation between the two variables for the whole sample period. Though, the post-crisis era witnesses some periods where the two series display a significant positive relationship.

Our interest in this paper lies in disentangling the supply-push and demand-pull factors that determine the movements in non-core liabilities of these countries. The supply-induced part is associated with the increase in global liquidity, both in pre-crisis period and post-crisis period. The demand-pull factor could be explained by two determinants which are not necessarily exclusive. First, as argued in Kim et al. (2013), non-core liabilities show a procylical pattern, growing during boom times due to increasing risk-appetite of the banks. Hence, it is an important indicator of systemic risk that heightens during expansionary times. In addition to Kim et al. (2013), we argue that a change in demand-pull component could also be motivated with changing macroeconomic conditions, such as an expansionary monetary or fiscal policy. For example a government policy which would support the lenders that would buy their first houses (such as a reduction in housing taxes) would lower the risk of the loans in general and hence would in turn make the bank more eager to provide funds to absorb the credit demand. This would constitute an example for a case where the demand for non-core liabilities goes up but the risk-appetite of the bank does not change at all.

Another point where our approach differentiates from Kim et al. (2013) is our treatment of the non-core data. As discussed above and further detailed in the appendix, non-core liabilities consist of a domestic component of which the biggest portion is the interbank lending; and a foreign lending component. The ratios of the domestic component to the noncore liabilities vary for each country as given in Table 1. Note that while an increase in demand-pull component would increase both domestic and foreign components, at first glance, it is appealing to think that the foreign component would be more affected from the supply-push factor compared to the domestic factor. However, the increase in global liquidity would also imply more funds in the domestic market per se. Hence, some of these funds that could not be allocated as credits would lead to an increase in available funds in the domestic interbank market, which in turn would increase the interbank market transaction volume. Hence, we prefer to conduct our analysis with the total non-core liabilities measure instead of separating it into its domestic and foreign components.

Table 1: The ratio of the domestic non-core liabilities to total non-core liabilities

	Domestic non-core / Total non-core (percent)
Indonesia	14
Malaysia	57
Turkey	38

Note: Brazil data only includes foreign liabilities since aggregate banking sector statistics for interbank lending is not available.

III. DATA AND METHODOLOGY

There are two major setbacks of working with non-core liabilities data. First, there is no standard definition that is applicable to all countries due to the different characteristics of the banking sectors for different countries. Second, none of the countries in our sample provides publicly available non-core liabilities data for the aggregate the banking sector. Hence, we used aggregate banking sector statistics provided by the central banks of each country to calculate non-core liabilities data. We used the sum of the liabilities of the banking sector to the foreign sector and liabilities of the banks to other domestic financial corporations, where available. The data appendix provides a detailed definition of our noncore

[13] Kılınç et.al (2013) finds a positive and robust relationship between noncore liabilities and credit growth for Turkey.

variables and their calculations. The price variables are money market rates for all countries and are taken from IMF-IFS database.

In order to decompose the total non-core liabilities of our sample countries into their demand-pull and supply-push components, we set up a vector autoreggression *(VAR) model* for each country that uses a monetary aggregate and some price measure. Then, we impose *sign restrictions* on the impulse responses of the model to identify supply and demand shocks. In that regard, following Kim et. al (2013), we define demand shocks as those that move the quantity of the monetary aggregate and price in the same direction. In contrast, supply shocks are those that move the quantity and price in opposite directions. Next, we use these identified demand and supply shocks to construct the historical contributions of supply and demand shocks to the total non-core liabilities of sample countries. In our VAR models, foreign exchange rate adjusted total non-core liabilities represent the monetary aggregate and money market rates represent the price measure to capture the tightness of credit markets.

Our sample period spans April 2004 to June 2015, depending on the country employed, as detailed in the appendix. We adopt an OLS approach to estimate the structural VAR model. This model uses yearly growth rates of the variables to ensure their stationarity. The lags of the VAR model are chosen based on the majority rule using several lag-length criteria like AIC, SC and HQ criteria. Sign restriction constructs different decompositions of variance-covariance matrix of VAR residuals and saves the ones satisfying the restrictions imposed on the impulse responses, given that the variance-covariance matrix of structural shocks is normalized to an identity matrix. We use 500 draws; hence, this analysis obtains a distribution of 500 solutions. Median values of these solutions are used as parameter estimates. Finally, the historical decomposition uses the Wold decomposition, which assumes that the value of any stationary stochastic series at time t can be written as the value of the series at time 0 plus the cumulative of shocks to the series from time 0 to time t. In our bivariate VAR context, the series is partitioned into two structural shocks, demand and supply shocks. Historical decomposition explains the contributions of each shock to the deviation of the series from its unconditional mean. Furthermore, if move further away from the initial periods employed, the effect of the initial value of the series will die off and historical decompositions will sum up to the value of the series as well.[14]

IV. EMPIRICAL ANALYSIS

Figures 9 to 12 plot the historical decomposition of the noncore liabilities of the aggregate banking sector into the demand and supply components. The figures include the mean-difference of the noncore liabilities for each country (the straight line), the demand-pull component (the light bars) and the supply induced component (the dark bars). We divide the data sample into three regions for each country. The first one is the pre-crisis region, starting with the initial data point of the corresponding country and ending with the collapse of Lehman brothers in September 2008. The second region, which is indicated by the shaded rectangle in each graph, covers the crisis period up until the peak of the Eurozone crisis at August 2010. The third region includes dates following August 2010 and ends at the last data point of each country.

[14] For estimation details, see "Ambrogio Cesa-Bianchi, 2014. "VAR Toolbox", sites.google.com/site/ambropo/".

Figure 9: Historical decomposition of the y-o-y growth in non-core liabilities, Brazil

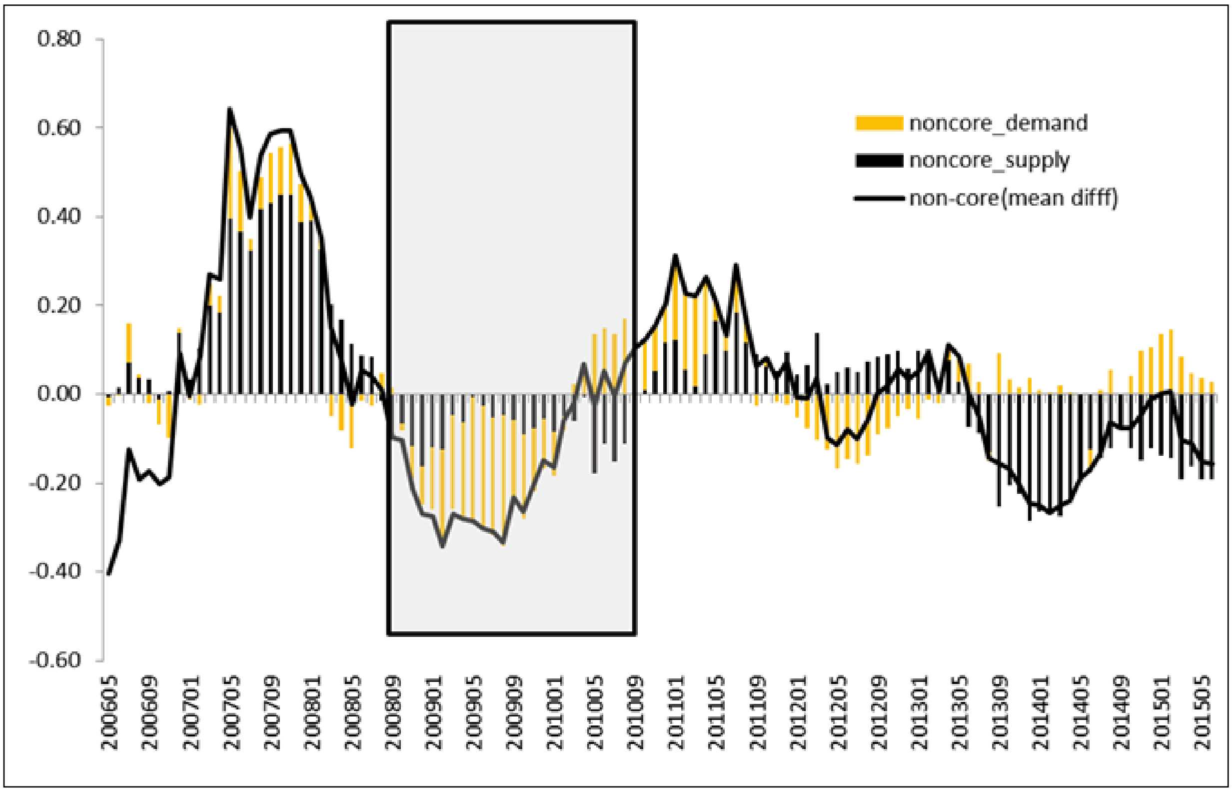


Figure 10: Historical decomposition of the y-o-y growth in non-core liabilities, Indonesia

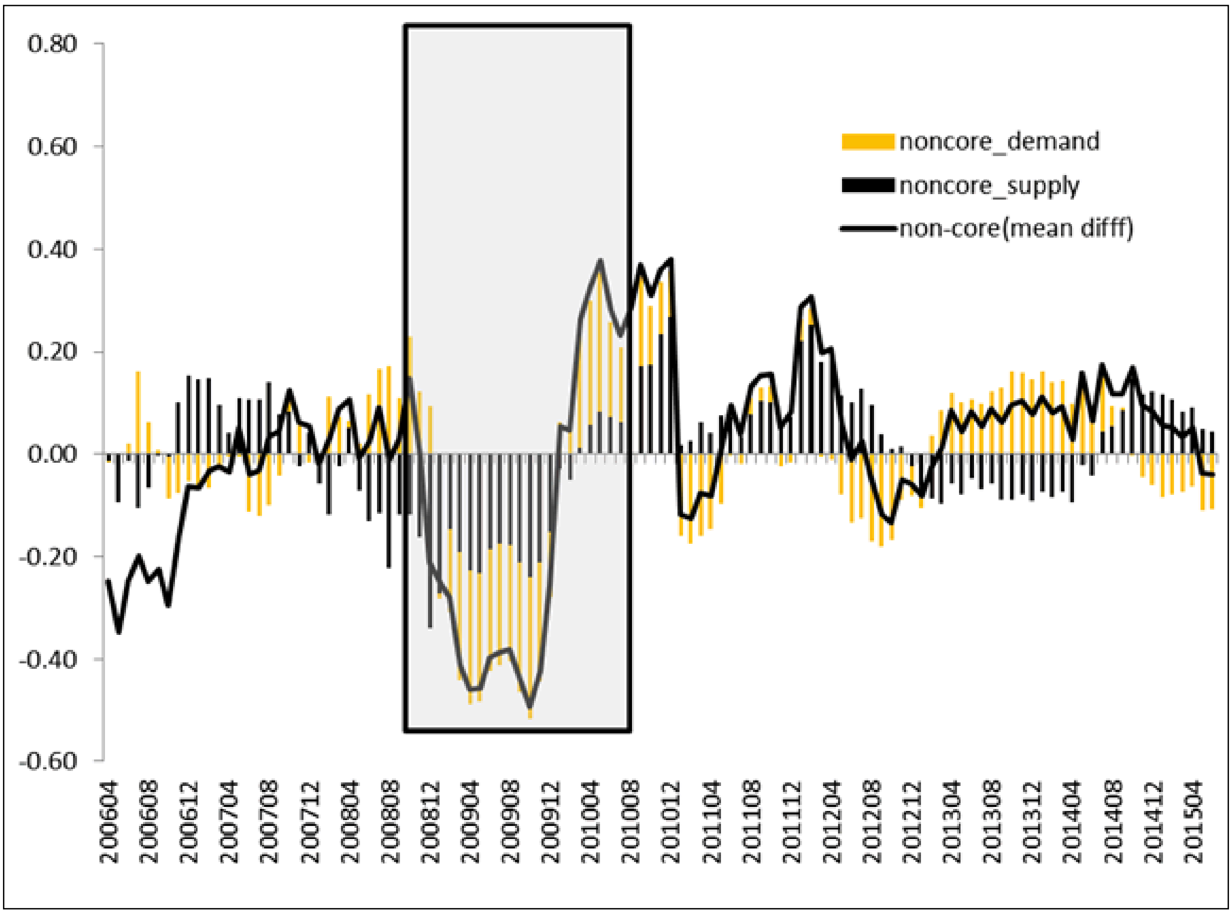


Figure 11: Historical decomposition of the y-o-y growth in non-core liabilities, Malaysia

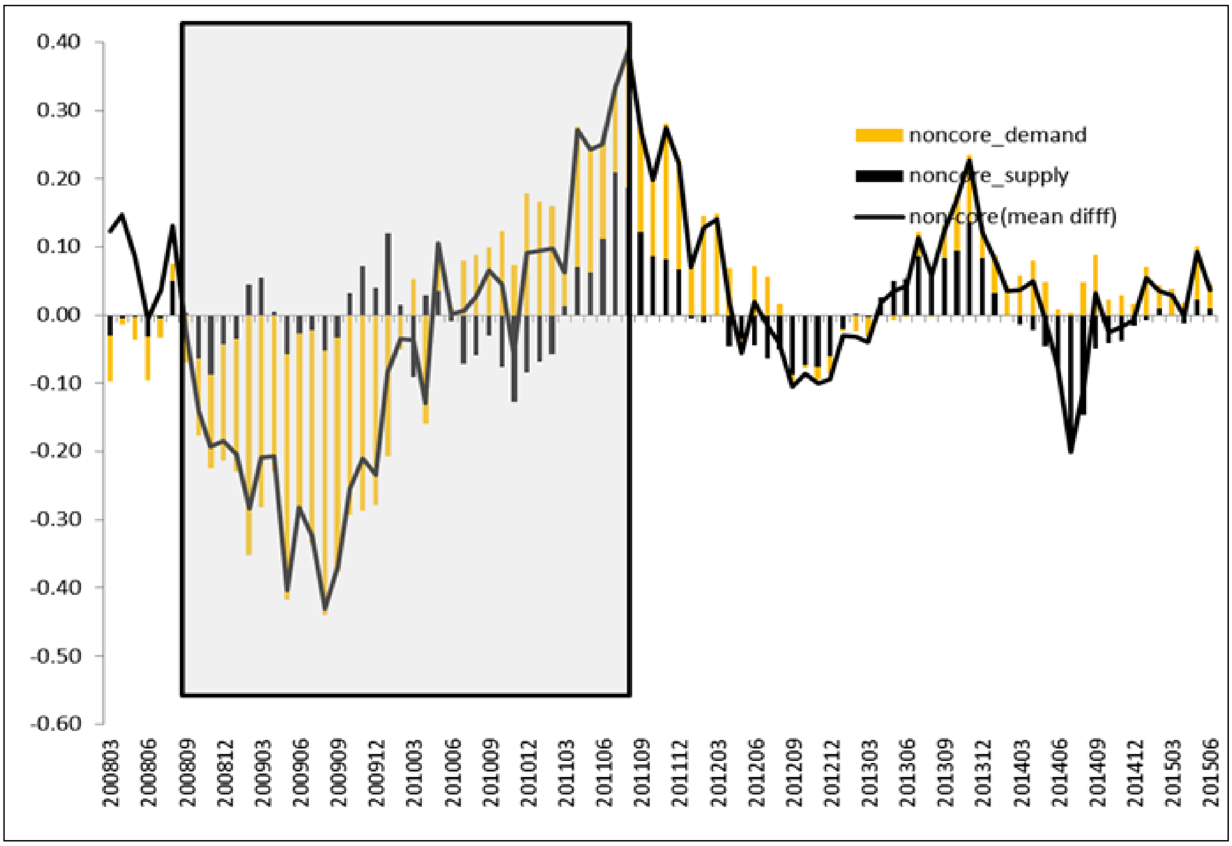
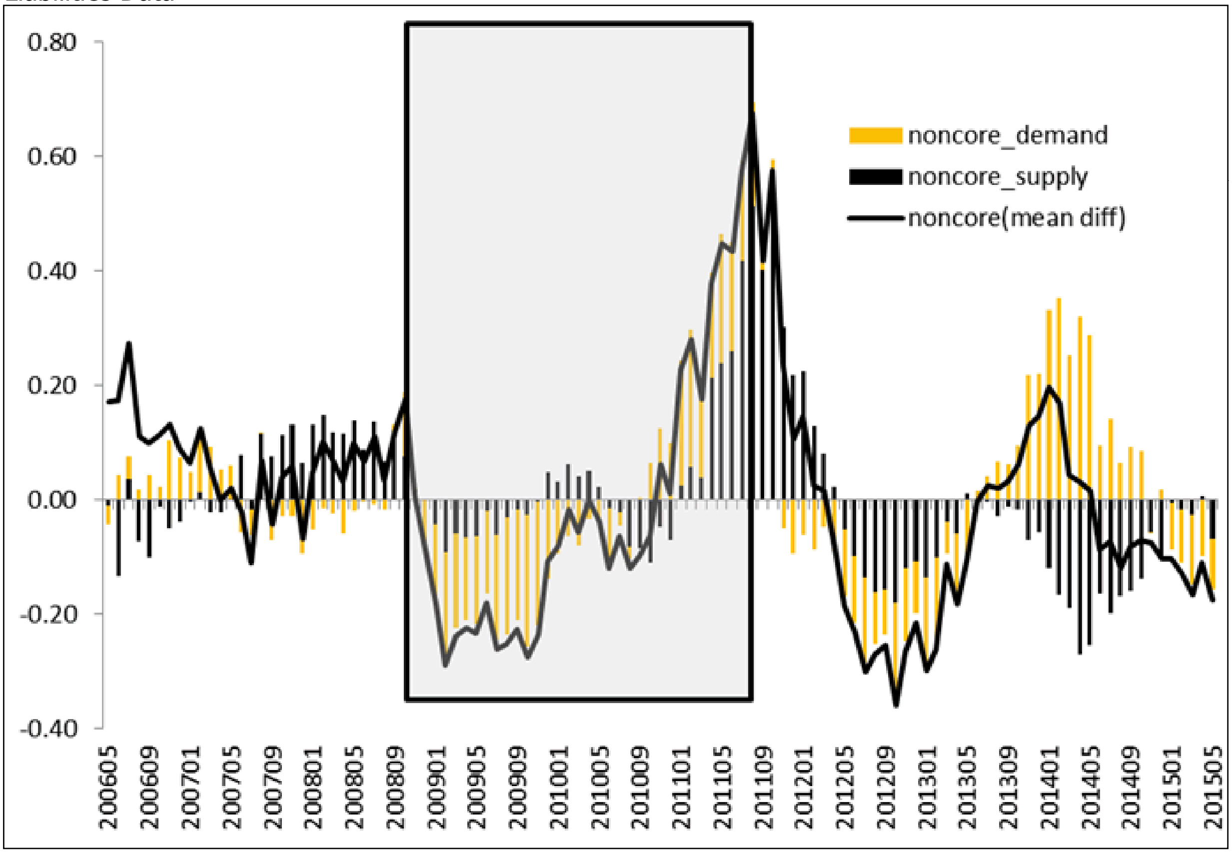


Figure 12: Historical decomposition of the y-o-y growth in non-core liabilities, TurkeyAppendix: Noncore Liabilities Data



Before disentangling the demand and supply components, a first look at the four graphs reveals significant similarities in the movements of noncore liabilities (straight lines) among our sample. First, as would be expected, the initial phase of the global financial crisis remarks a plunge in noncore liabilities for all countries. The recovery which starts in a couple of months continues until the Eurozone crisis deepens for all countries. For Malaysia and Turkey, the turning points of the series match exactly with the end of our shaded region in August 2010, while Brazil and Indonesia display a lag of a couple of months. In the third region, after the peak of the Eurozone crisis, the only notable similarity is that of Malaysia and Turkey's, both showing a decline between August 2010 and September 2012; an increase afterwards and a turning point around the end of 2013.

A careful investigation of the demand and supply components suggests that the immediate decline after the global crisis is mostly demand driven for almost all countries, with the exception of Indonesia which shows a relatively balanced decline in both components. This corroborates with the low growth levels of these countries in this period. In a similar manner, the initial phases of the recovery are mostly demand led for the countries in our sample. The supply induced part of the recovery is rather more observable in two years' time after the crisis, which could be attributed to the impact of quantitative easing policies conducted by the advanced country central banks.

In order to have a closer examination of demand and supply components, we report the share of the (absolute value of) supply shocks in total shocks (sum of the absolute values of demand and supply shocks) in Table 2. As discussed above, the supply induced part is below fifty percent for all countries in the middle region, between the Lehman and the peak of the Eurozone crises. Also, it is clear that on average, the change in noncore liabilities is mainly demand driven for Malaysia. A more stringent look at Figure 11 reveals that supply induced component is briefly effective in the second half of 2013; leading to inflows to Malaysia. For Brazil and Turkey, Table 2 suggests that the period between two crisis (middle region) is dominated by demand component whereas after August 2010 the main driver of the non- core liabilities is the supply led movements of capital.

Table 2: The share of supply shocks in total (absolute value) of shocks

	Total	Before Lehman Brothers (Beginning of the country sample to September 2008)	Between Lehman and Eurozone Crisis (September 2008-August 2010)	After Eurozone Crisis (After August 2010)
Brazil	60.8	76.5	34.8	63.3
Indonesia	49.7	57.5	44.9	50.1
Malaysia	33.7	29.0	18.8	45.2
Turkey	49.2	62.9	26.0	51.7

A joint investigation of Figure 2 and the historical decomposition figures shows that with the tapering signal in May 2013, parallel to the declining trend in portfolio flows to EMEs the non-core bank liabilities of Brazil display a mild downturn, while those of Turkey and Indonesia continue to increase. For the latter countries, this can be explained by the dominant demand-pull component of their non-core liabilities during that era, owing to their much stronger GDP growth rates. On the other hand, during the same era, for Brazil, the supply-push component dominates the non-core liabilities of the banks, which explains the halt in the increase in non-core liabilities following the downturn in capital inflows. For Malaysia, the picture is much blurred in the sense that the increase in the non-core liabilities following the tapering is both demand and supply led.

V. CONCLUSION

The high level of international financial integration between economies all across the world generates significant risks both within and across national borders. Capital flows, in that sense, act as a transmission channel of risks across borders and thus may lead to the build-up of financial sector imbalances. Taking into account the fact that the bulk of these capital flows are intermediated through cross-border banking channels, effective regulation of cross-border banking is essential for domestic and global financial stability. In this paper we build upon this relationship between cross-border flows and financial vulnerability. By monitoring the growth of cross-border flows, a central bank may be able to put in place the appropriate macroprudential policy measures in a timely manner so that they could prevent the build-up of financial vulnerabilities.

Cross border bank lending constitutes the most procyclical component of the cross-border flows and it reverses abruptly when the financial cycle turns. In that regard, the procyclical patterns of cross-border banking sector liabilities to global banks may potentially serve as an indicator of the phase of the financial cycle. In this paper, we have explored one of the potential indictors of financial vulnerability, the so-called noncore liabilities of the banking sector, which we have differentiated into their demand and supply components. Through the instances of four emerging economies, Brazil, Indonesia, Turkey and Malaysia, we have argued that, during and after the global financial crisis, countries have exhibited similar patterns in terms of the movements in their non-core liabilities as well as their supply and demand components. Though, we have noted that the hetereogeneity in terms of the prevailing domestic economic stances of countries has necessitated a differentiation in the countercyclical macroprudentail policies across countries. In this respect, we can see that differentiating the demand and supply components of the non-core liabilities of the banking sector is crucial from the overall macroeconomics policy perspective, as it provides valuable information regarding the appropriate design of countercyclical macroprudential policies.

REFERENCES

Akdoğan, K., & Yıldırım, B. D. (2014). Non-core Liabilities as an Indicator of Systemic Risk and a Liquidity Stress Test Application on Turkish Banking System. *Iktisat Isletme ve Finans, 29*(338), 39-66.

Akinci, O., & Olmstead-Rumsey, J. (2015). How Effective are Macroprudential Policies? An Empirical Investigation. International Finance Discussion Papers 1136. Board of Governors of the Federal Reserve System.

Arslan, Y., & Taskin, T. (2014). International Evidence on the Interaction between Cross-Border Capital Flows and Domestic Credit Growth. *Iktisat Isletme ve Finans, 29*(341), 37-56.

Binici, M., Hutchison, M., & Schindler, M. (2010). Controlling capital? Legal restrictions and the asset composition of international financial flows. *Journal of International Money and Finance, 29*(4), 666-684.

BOI. 2012. *Financial Stability Review*, September, No.19. Bank of Indonesia.

BOI. 2015. *Financial Stability Review*, September, No. 24. Bank of Indonesia.

BIS. (2015). Changing patterns of financial intermediation and implications for central bank policy: the Malaysian perspective. *BIS Papers chapters, 83*, 223-242.

Borio, C. (2010). Implementing a macroprudential framework: Blending boldness and realism. Keynote address for the BIS-HKMA research conference on "Financial Stability: Towards a Macroprudential Approach", Honk Kong SAR, 5-6 July 2010.

Borio, C. and Drehmann, M. (2009). Towards an operational framework for financial stability: 'fuzzy' measurement and its consequences. *BIS Working Papers*, 284.

Borio, C. E., McCauley, R. N., & McGuire, P. (2011). Global credit and domestic credit booms. *BIS Quarterly Review, September.*

Bruno, V., Shim, I., & Shin, H. S. (2015). Comparative assessment of macroprudential policies. *BIS Working Papers, 502.* Bank for International Settlements.

CBRT. (2015). *Financial Stability Review.* November 2015. Central Bank of the Republic of Turkey.

Claessens, S., Ghosh, S. R., & Mihet, R. (2013). Macro-prudential policies to mitigate financial system vulnerabilities. *Journal of International Money and Finance, 39,* 153-185.

Cerutti, E., Claessens, S., & Laeven, M. L. (2015). *The Use and Effectiveness of Macroprudential Policies: New Evidence* (No. 15-61). International Monetary Fund.

Da Silva, L. A. P., & Harris, R. E. (2012). *Sailing through the Global Financial Storm: Brazil's recent experience with monetary and macroprudential policies to lean against the financial cycle and deal with systemic risks* (No. 290).

Ekinci, M. F., Erdem, F. P., & Kilinc, Z. (2015). Credit growth, current account and financial depth. *Applied Economics, 47*(17), 1809-1821.

Forbes, K. J., & Warnock, F. E. (2012). Capital flow waves: Surges, stops, flight, and retrenchment. *Journal of International Economics, 88*(2), 235-251.

Galati, G. And Moessner, R. (2010), Macroprudential policy – a literature review. *De Nederlandsche Bank Working Paper,* 267.

Ghosh, A. R., Qureshi, M. S., & Sugawara, N. (2014). Regulating Capital Flows at Both Ends: Does it Work?. *IMF Working Papers, 14/188*. International Monetary Fund.

Gourinchas, P. O., & Obstfeld, M. (2011). *Stories of the twentieth century for the twenty-first* (No. w17252). National Bureau of Economic Research.

Hahm, J. H., Shin, H. S., & Shin, K. (2013). Noncore bank liabilities and financial vulnerability. *Journal of Money, Credit and Banking, 45*(s1), 3-36.

Hattori, M., Shin, H. S., & Takahashi, W. (2009). *A Financial System Perspective on Japan's Experience in the Late 1980s* (No. 09-E-19). Institute for Monetary and Economic Studies, Bank of Japan.

Kilinc, Z., Karasoy, H. G., & Yucel, E. (2013). Non-Core Bank Liabilities and Credit Growth: Evidence From an Emerging Economy. *International Finance Review, 14,* 71-90.

Kim, Hyun Jeong, Hyun Song Shin, and Jaeho Yun. "Monetary aggregates and the central bank's financial stability mandate." *Federal Reserve Conference Central Banking Before, During and After the Crisis*. 2012.

Lane, P. R., & McQuade, P. (2014). Domestic Credit Growth and International Capital Flows. *The Scandinavian Journal of Economics, 116*(1), 218-252.

Phillips, M. S., Catão, M. L., Ricci, M. L. A., Bems, R., Das, M., Di Giovanni, Ünsal, D.F., Castillo, M. Lee, J., Rodriguez, J. and Vargas, M. M. (2014). *The external balance assessment (EBA) methodology,* International Monetary Fund.

Schularick, M., & Taylor, A. M. (2009). *Credit booms gone bust: Monetary policy, leverage cycles and financial crises, 1870-2008* (No. w15512). National Bureau of Economic Research.

Shin, H. S., & Shin, K. (2011). *Procyclicality and monetary aggregates* (No. w16836). National Bureau of Economic Research.

Shin, M. H. S. (2013). *Procyclicality and the search for early warning indicators* (No. 13-258). International Monetary Fund.

Vasconcelos, B. F. B., & Tabak, B. M. (2014). *Banking Systemic Risk, Foreign Funding, Exchange Rate Exposure and Carry Trade: is there a relation?* Banco Central do brazil Working Papers, No. 365.

Zhang, L., & Zoli, E. (2014). Leaning Against the Wind: Macroprudential Policy in Asia. *IMF Working Papers, 14/22*. International Monetary Fund.

Appendix: Noncore Liabilities Data

Country	Noncore Definition (all items below are collected from the liabilities side of the aggregate balance sheet of the banking sector for each country)	Data Source	Data Range
Brazil	Liabilities to Nonresidents	Banco de Brazil	May 2006 -June 2015
Indonesia	Liabilities to Nonresidents + Liabilities to Other Financial Corporations	Bank Indonesia	April 2004-June 2015
Malaysia	Amount Due to Designated Financial Institutions (Commerical Banks, Islamic Banks, Investment Banks and Other Banking Institutions) +Bills and Acceptances Payable+ Liabilities to Non-residents	Bank Negara Malaysia	May 2008-June 2015
South Africa	Foreign currency funding to the foreign sector + Loans received under repurchase agreements (domestic and foreign sector, excluding central bank)	South African Reserve Bank	April 2006-March 2015
Turkey	Payables to banks + Repo transactions [See Akdogan and Yıldırım (2014) for a detailed definition]	Central Bank of the Republic of Turkey	May 2006-May 2015

UDK 336.71:339.137.2]:303.22(4-672EU)"2004/2013"

IS THERE A COMPETITION-STABILITY TRADE-OFF IN EUROPEAN BANKING?

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Abstract

The trade-off between bank competition and financial stability has always been a widely and controversial issue, both among policy makers and academics. This paper empirically re-investigates the relationship between competition and bank risk across a large sample of European listed banks over the period 2004-2013. However, in contrast to most extant literature, we consider both individual and systemic dimension of risk. Bank-individual risk is measured by the Z-score and the distance-to-default, while we consider the SRISK as a proxy for bank sys- temic risk. Using the Lerner index as an inverse measure of competition and after controlling for a variety of bank-specific and macroeconomic factors, our results suggest that competition encourages bank risk-taking and then increases individ- ual bank fragility. This result is in line with the traditional "competition-fragility" view. Our most important findings concern the relationship between competition and systemic risk. Indeed, contrary to our previous results, we find that compe- tition enhances financial stability by decreasing systemic risk. This result can be explained by the fact that weak competition tends to increase the correlation in the risk-taking behaviour of banks.

Keywords: Bank competition, Lerner Index, Financial stability, Bank- risk taking, Systemic risk, Competition policy

JEL Codes: G21, G28, G32, L51

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1. INTRODUCTION

One of the main responses to the 2008 financial crisis has been to improve the prudential regulation via an increase of capital requirement as implemented in the Basel III agreements. However, prudential regulation can also take other forms and notably incorporates competition policy aspects. In practice, regulation can directly weaken competition through restrictions on bank entries, limitations on space and the scope of activities and high barriers with financial markets and non-bank institutions, and indirectly weaken them by creating incentives to merge due to ill-designed regulation scheme, for example. These types of regulation policies were abandoned prior to the financial crisis in favour of pro-competitive policies, justified by the fact that may lead to an improvement of efficiency and increased innovation. Conversely, the effects of competition on the risk-taking behaviour of financial institutions remain unclear and are a subject of active academic and policy debates.

In the traditional view, bank competition is seen as detrimental to financial stability. This view is supported by many theoretical contributions (Smith, 1984; Hellmann et al., 2000; Matutes and Vives, 2000) and based on the idea that competition erodes bank profits and thus the banks' franchise value. As a result, banks' incentives to take risk increase because the opportunity costs of bankruptcy for shareholders decrease. Other economic theories argue that this trade-off between competition and stability can be explained by higher ability to monitor borrowers when banks earn rents (Boot and Thakor, 1993; Allen and Gale, 2000), greater diversification (Beck, 2008) and better regulators' monitoring in concentrated markets. Keeley (1990) corroborates this idea of a destabilizing competition from an empirical point of view, noting that the intensification of competition in the U.S. banking industry has led to a decline in franchise value and increased risks. Other recent empirical studies also observe the existence of the same trade-off between competition and stability (Berger et al., 2009; Turk-Ariss, 2010; Jiménez et al., 2013; Fungáčová and Weill, 2013).

Contrary to the "competition-fragility" view, Boyd and De Nicolo (2005) demonstrate that market power increases bank portfolio risks. Following Stiglitz and Weiss (1981), as low competition increases loan rates, borrowers tend to shift to riskier projects. "Too Big To Fail" subsidies as a result of implicit or explicit government bailout insurances (Kane, 1989; Acharya et al., 2016) or lack of diversity of diversified bank portfolios (Wagner, 2010) are other arguments allowing the rejection of the competition stability trade-off hypothesis[1] . Recent empirical evidences support this thesis (Boyd et al., 2006; Schaeck et al., 2009; Uhde and Heimeshoff, 2009; Schaeck and Cihák, 2014; Pawłowska, 2015).

Finally, a third way reconciles the two strands of the literature by theoretically and empirically demonstrating the existence of a U-shaped relationship between competition and risk (Martinez-Miera and Repullo, 2010; Berger et al., 2009; Jiménez et al., 2013; Liu et al., 2013).

The conflicting results in the literature make difficult to know whether modification of competition policy and effective competition between financial intermediaries could constitute an alternative means of improving financial stability, complementary to capital requirement. This study re-addresses this traditional debate on the effects of bank competition on financial instability by taking into account the recent developments in the field of financial economics.

Indeed, the financial crisis has led to an overhaul in the risk approach (bottom-up vs. top-down) as well as risk measurements as the latter have been deficient because the regulation was only based on a micro-prudential foundation before the crisis. Therefore, it appeared necessary to complete this micro-prudential risk assessment, based on a partial equilibrium representation, by a macro-prudential assessment of these latter, taking into account a more general equilibrium (Borio, 2003; Aglietta and Scialom, 2010; Brunnermeier et al., 2009). The underlying aim is to no longer exclusively focus on the individual risk-taking of banks but also to consider banks' contribution to systemic risk. In other words, systemic risk externalities must be computed to eliminate systemic risk incentives via the regulation.[2]

1 Political regulatory capture is another potential drawback of high market power banks.

2 In practice, for instance SIFI (Systemic Important Financial Institution) have to hold additional capital.

This study refers to the extensive literature recently developed to define such a Pigovian tax scheme and assess systemic risks[3] .

While most of the empirical literature using individual bank data has only focused on individual risk measures, ignoring the potential contribution to systemic risk, we contribute to the literature and assess the ambivalence of the effect of bank competition by considering both individual and systemic dimension of risk. To the best of our knowledge, only Anginer et al. (2014) have taken into account the systemic dimension of financial risks at the bank-level in the analysis of the effects of bank competition.[4]

As for the regulations, concern for the systemic dimension of risk could help improve the efficiency of competition policy.

From an empirical perspective, this dual dimension of risk requires different risk measures. First, we proxy individual risk with two well-known and popular measures of risks: an accounting measure, the Z-score and a market-based measure, the distance-to-default derived from the Merton (1974) model. These measures are two inverse proxies of risk and represent overall measures of individual risk. These could be seen as the level of risk-taking, i.e., paid risk. Second, we proxy systemic risk by using the recently developed SRISK measure (Brownlees and Engle, 2016; Acharya et al., 2012). Basically, the SRISK can be described as how much a given financial institution contributes to the deterioration of the soundness of the system as a whole. Even if SRISK computation requires market and accounting bank specific-data, it differs from the Z-score and the distance-to-default because the measure is mostly driven by correlations in returns between the bank and the financial system as a whole. The choice of a systemic risk measure can be a challenge because many different measures exist in the literature. However, the following four elements have led us to prefer the SRISK:

(1) large acceptance, (2) large diffusion, (3) global measure of systemic risk, and (4) bank-specific risk measure.[5]

Similar to many previous studies (Berger et al., 2009; Turk-Ariss, 2010; Beck et al., 2013; Anginer et al., 2014), we use the Lerner index to measure banking competition. The Lerner index is a non-structural measure of competition that expresses banks' ability to drive their prices above their marginal costs. Compared to other measures, the indicator has the advantage of being dynamic and individual-based.

From a sample of exclusively European listed banks, our study highlights two main results. First competition leads to an increase of individual risk. This finding seems to corroborate the traditional "competition-fragility" view - bank stressed by competition take more risks. Second, we observe a positive effect of market power on systemic risk. Our results suggest that an increase in market power is associated with more systemic risk, i.e., in our case with an increase of the contribution of financial institutions to the deterioration of the system. These results are contrary to our first results and support the "competition-stability" view.

Highlighting a dual relationship between competition and stability must not be viewed as a discrepancy. Indeed, the two indicators do not share the same dimension. Thus, the indicators of individual risk refer to a partial equilibrium approach and describe the risks internalized by the bank, whereas the indicator of contribution to systemic risk corresponds to externalized risk. Economic theory and the franchise value paradigm in particular can explain these findings. Indeed, franchise value assumes that market power incites banks to take less risk. The first solution to reduce risk is to decrease individual risk-taking, which will result in a higher distance-to-default or Z-score, as our results demonstrate. However, a second solution to reduce its exposure to bankruptcy is to take correlated risks, and therefore increase its systemic risk contribution. This situation corresponds to the "too-many-to-fail" guarantee described by Acharya and Yorulmazer (2007). The Wagner's (2010) model can also explain our findings. Indeed,

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[3] For a very complete review, see Benoit et al. (2016).

[4] Note that our study differs from previous empirical papers that have investigated the competition-stability nexus at the country-level, by studying whether the level of the banking industry competition drives the level of risk or the probability that a systemic banking crisis occurs (see, Beck et al., 2006; Schaeck et al., 2009). Indeed, the analysis of systemic risk is made at the bank level and focuses on the individual contribution to systemic risk.

[5] An other popular indicator of the exposure of a financial institution to systemic risk is the Marginal Expected Shortfall (MES). However, as shown by some recent studies (see, e.g., Idier et al., 2014), the MES is not a good predictor of capital shortfall during a systemic event.

Wagner (2010) demonstrates that the willingness to reduce portfolio risks, that we explain by the franchise value paradigm, leads banks to diversify their portfolio by holding the market portfolio. This action tends to reduce individual risk but increases systemic risk because the entire system has less diversity and more correlated institutions.[6]

Our results have implications for economic policy. As for prudential policy, competition policy should further consider a macroeconomic dimension when considering the impact of market power on risk-taking. This process is likely to lead to a complete change in the results and the implementation of competition policy. However, we do not support the adoption of one approach over another. Both approaches are complementary and can help refine competition policy implementation. Although the market power has a cost of increasing the systemic fragility, it also has a benefit in reducing the individual fragility. Thus, a sophisticated competition policy must arbitrate between these two types of fragility and take into account the influence of prudential regulations. Nevertheless, the important costs and the social aversion to the systemic crisis should guide competition policy toward an enhancing of competition.

The remainder of the study is structured as follows. Section 2 presents the methodology used to compute bank market power and both individual and systemic risks. In section 3, we present our empirical analysis, discussing the data used and estimation methodology. The results are reported and discussed in section 4, and we conduct a battery of robustness checks in section 5. Section 6 concludes.

2. MEASURING BANK COMPETITION AND RISKS

This section presents in detail the measures of bank competition and bank risk considered in this study. As outlined in the introduction, we use the Lerner index as our main measure of banking competition, and we distinguish two levels of bank risk: the individual risk, proxied by Z-score and the distance-to-default, and the systemic risk, measured by the SRISK.

2.1. Competition Measure

Based on a non-structural approach, the Lerner index (Lerner, 1934) is used to measure the degree of bank competition. The Lerner index is a proxy for profits stemming from pricing power in the market and is measured by the mark-up of price over marginal cost. Therefore, it is an inverse proxy for bank competition. A low index indicates a high degree of competition, and a high index indicates a lack of competition. The Lerner index extends between 0 and 1, with the index being equal to 0 in the case of perfect competition, and 1 in the case of a pure monopoly. The Lerner index has two main benefits compared to the other competition indexes, such as the Boone indicator (Boone, 2008), the H-statistic (Panzar and Rosse, 1987), or the Herfindahl-Hirschman index. First, the Lerner index is the only time-varying measure of competition that can be computed at a disaggregated level, i.e. at the firm level. Second, the Lerner index appears to be a better proxy for gauging the level of competition among banks than structural measures, such as concentration indexes. A substantial empirical banking literature has suggested that concentration is not a reliable measure of competition (see, e.g., Claessens and Laeven, 2004; Lapteacru, 2014) which explains why several recent studies have used the Lerner index (Demirgüç-Kunt and Martínez Pería, 2010; Beck et al., 2013; Anginer et al., 2014). Formally, the Lerner index corresponds to the difference between price and marginal cost as a percentage of price, and it can be written as follows:

$$Lerner_{it} = \frac{p_{it} - mc_{it}}{p_{it}} \tag{1}$$

with *p* the price and *mc* the marginal cost for the bank *i* at the year *t*. In our case, *p* is the price of assets and is equal to the ratio of total revenue (the sum of interest and non- interest income) to total assets. To obtain the marginal cost, we adopt a conventional approach in the literature that consists of estimating a translog cost function and deriving it. Consistent with most banking studies, we consider a

[6] The main difference between our two explanations of systemic risk lies in the intentional or otherwise character of the contribution to systemic risk.

production technology with three inputs and one output (see, e.g., Angelini and Cetorelli, 2003; Fernandez de Guevara et al., 2005; Berger et al., 2009). We estimate the following translog cost function:

$$lnTC_{it} = \beta_0 + \beta_1 lnTA_{it} + \frac{\beta_2}{2} lnTA_{it}^2 + \sum_{k=1}^{3} \gamma_k lnW_{k,it} + \sum_{k=1}^{3} \phi_k lnTA_{it} lnW_{k,it}$$
$$+ \sum_{k=1}^{3}\sum_{j=1}^{3} \frac{\rho_{kj}}{2} lnW_{k,it} lnW_{j,it} + \delta_1 T + \frac{\delta_2}{2} T^2 + \delta_3 T lnTA_{it} + \sum_{k=4}^{6} \delta_k T lnW_{k,it} + \varepsilon_{it} \quad (2)$$

C_{it} corresponds to the total costs of the bank *i* at the year *t*, and is equal to the sum of interest expenses, commission and fee expenses, trading expenses, personnel expenses, administrative expenses, and other operating expenses, measured in millions of euros. *T Ait* is the quantity of output and is measured as total assets in millions of euros. $W_{1,it}$, $W_{2,it}$ and $W_{3,it}$ are the prices of inputs. $W_{1,it}$ is the ratio of interest expenses to total assets. $W_{2,it}$ is the ratio of personnel expenses to total assets. $W_{3,it}$ is the ratio of administrative and other operating expenses to total assets. *T* is a trend. Furthermore, to reduce the influence of outliers, all variables are winsorized at the 1st and 99th percentile levels (see, e.g., Berger et al., 2009; Anginer et al., 2014). We further impose the following restrictions on regression coefficients to ensure homogeneity of degree one in input prices: $\sum_{k=1}^{3} \gamma_{k,t} = 1$, $\sum_{k=1}^{3} \phi_k = 0$ and $\sum_{k=1}^{3}\sum_{j=1}^{3} \rho_k = 0$

Under these conditions, we can use the coefficient estimates from the translog cost function to estimate the marginal cost for each bank i at the year *t*:

$$mc_{it} = \frac{TC_{it}}{TA_{it}}[\beta_1 + \beta_2 TA_{it} + \sum_{k=1}^{3} \phi_k lnW_{k,it} + \delta_3 T] \quad (3)$$

The translog cost function is estimated using pooled ordinary least squares (POLS) for each country separately to reflect differences in technology across European banking markets. We also include in the regression a trend *(T)* to control evolution in translog function over time.

2.2. Individual Risk Measures

Following Fu et al. (2014), we use two complementary individual bank risk measures: an accounting-based and a market-based risk measure. The accounting-based risk measure we consider in this study is the widely used Z-score. Because it measures the distance from insolvency, this index is generally viewed in the banking literature as a measure of bank soundness (see, e.g., Lepetit and Strobel, 2013; Laeven and Levine, 2009; Beck et al., 2013; Fu et al., 2014). The Z-score is calculated as follows:

$$Z_{it} = \frac{E_{it}/A_{it} + \mu_{ROA_{it}}}{\sigma_{ROA_{it}}} \quad (4)$$

where *ROAit* is the return on assets, *Eit/Ait* is the equity to total assets ratio, and *σROAit* is the standard deviation of return on assets.

The Z-score is inversely related to the probability of a bank's insolvency. A higher Z-score implies a lower probability of insolvency. Because a bank becomes insolvent when its asset value drops below its debt, the Z-score can be interpreted as the number of standard deviations that a bank's return must fall below its expected value to wipe out all equity in the bank and render it insolvent (Boyd and Runkle, 1993). This study opts for the approach used by Beck et al. (2013),[7] which consists of using a three-year rolling time window to compute the standard deviation of ROA rather than the full sample period, whereas the return on assets and the equity to total assets ratio are contemporaneous. As argued by Beck et al. (2013), this approach has two main advantages. First, it avoids the variation in Z-scores within banks that is exclusively driven over time by variation in the levels of capital and profitability. Second, given the unbalanced nature of our panel dataset, it avoids the computation of the denominator at different window lengths for different banks.

7 See Lepetit and Strobel (2013) for a review of different methodologies to compute the Z-score.

Concerning the market-based measure, we use the Merton (1974) distance-to-default model to estimate the insolvency risk of a bank. The distance-to-default is defined as the difference between the current market value of assets of a firm and its estimated default point, divided by the volatility of assets. The market equity value is modelled as a call option on the firm's assets. The level and the volatility of assets are calculated with the Merton (1974) model using the observed market value, volatility of equity, and the balance-sheet data on debt.

Formally, the distance-to-default is defined as follows:[8]

$$DD_{it} = \frac{ln(\frac{V_{A,it}}{D_{it}}) + (\mu - \frac{\sigma^2_{A,it}}{2})T}{\sigma_{A,it}\sqrt{T}} \quad (5)$$

where $V_{A,it}$ is the bank's assets value, D_{it} is the book value of the debt maturing at time T , μ is the expected return, and $\sigma_{A,it}$ is the standard deviation of assets (i.e., assets volatility). Thus, the distance-to-default increases when the value of assets increases and/or when the volatility of assets declines. An increase in the distance-to-default means that the company is moving away from the default point and that bankruptcy becomes less likely.

Conceptually, the Z-score and the distance-to-default are very close.[11]9 They represent the number of standard deviation moves, required to bring the bank to the default. These two insolvency indexes essentially differ in the data used for their construction. Whereas the Z-score is only based on accounting data, the distance-to-default also requires market data, and it can thus be viewed as a forward-looking measure of bank default risk, which reflects market perception of a bank's expected soundness in the future. Gropp et al. (2006) argue that the distance-to-default provides a better predictor of the probability of default than accounting-based indicators because the distance-to-default measure combines information about equity returns with leverage and asset volatility information, hence encompassing the most important determinant of default risk.

2.3. Systemic Risk Measure

In addition to individual bank risk measures, and contrary to most existing literature, this study also focuses on the systemic risk. The objective is to examine whether the competition influences the correlation in the risk-taking behaviour of banks. As our measure of bank systemic risk, we use the SRISK originally proposed by Acharya et al. (2012) and Brownlees and Engle (2016). The so-called SRISK, based on market data, corresponds to the expected capital shortfall of a given financial institution, conditional on a crisis affecting the whole financial system. From this perspective, the contribution of each financial institution to the systemic risk is appreciated through its expected capital shortfall. The financial institutions with the largest capital shortfall are assumed to be the greatest contributors to the crisis, and the most systemically risky.

Formally, the SRISK is an extension of the marginal expected shortfall (MES) proposed by Acharya et al. (2010). The MES is the marginal contribution of a given financial institution to systemic risk, as measured by the expected shortfall of the market. Following Acharya et al. (2010), the expected shortfall of the market is the expected loss in the index conditional on this loss being greater than a given threshold C, and can be defined as:

$$ES_t = E_{t-1}(r_t \mid r_t < C) = \sum_{i=1}^{N} w_{it} E_{t-1}(r_{it} \mid r_t < C) \quad (6)$$

with N the number of firms, r_{it} the return of firm i at time t, and r_t the market return at time t. The market return is the value-weighted average off all firm returns, $r_t = \sum_{i=1}^{N} w_{it}(r_{it})$, where w_{it} denotes the relative market capitalization of the firm i at the period t.

8 The derivation and estimation procedure of the distance-to-default is described in detail in Appendix 2.

9 Compared to the distance-to default, the Z-score is the most popular measure in the competition-stability literature. As shown by Zigraiova and Havranek (2015) in their meta-analysis, more than 45% of reported competition-stability estimates in the literature are calculated using the Z-score as a proxy for bank stability, while this only represents 6.5% for the distance-to-default.

Then, the MES of a financial firm can be defined as its short-run expected equity loss conditional on the market taking a loss greater than the threshold *C*, defined as its Value-at-Risk at *α*%. Formally, the MES corresponds to the partial derivative of the market expected shortfall (ES_t) with respect to the weight of the firm *i* in the market:

$$MES_{it} = \frac{\partial ES_t}{\partial w_{it}} = E_{t-1}(r_{it} \mid r_t < C) \tag{7}$$

The higher the MES, the higher the individual contribution of a bank is to the risk of the financial system.

However, contrary to the MES, the SRISK also takes into account both the liabilities and the size of the financial institutions. The SRISK is defined as[10]:

$$SRISK_{it} = [\overbrace{k(D_{it} + (1 - LRMES_{it})W_{it})}^{\text{Required Capital}} - \overbrace{(1 - LRMES_{it}W_{it}}^{\text{Available Capital}}] \tag{8}$$

$$SRISK_{it} = [kD_{it} - (1-k)W_{it})(1 - LRMES_{it})] \tag{9}$$

where *k* is the minimum fraction of capital each financial institution needs to hold (i.e., the prudential capital ratio), D_{it} is the book value of total liabilities, and W_{it} is the market value of equity. $LRMES_{it}$ is the long-run marginal expected shortfall and aims to capture the interconnection of a firm with the rest of the system. It corresponds to the expected drop in equity value a firm would experiment if the market falls by more than a given threshold within the next six months. Acharya et al. (2012) propose to approximate the long-run marginal expected shortfall using the daily MES (defined for a threshold C equal to 2%) as $LRMES_{it} = 1 - exp(18 * MES_{it})$. Thus, this approximation represents the firm expected loss over a six-month horizon, obtained conditionally on the market falling by more than 40% within the next six months.

Thus, the SRISK is an increasing function of the bank's liabilities and a decreasing function of the market capitalization. Acharya et al. (2012) restrict SRISK to zero because they are interested in estimating capital shortages that by definition cannot take on negative values. Following Laeven et al. (2014), we do not restrict SRISK at zero, allowing it to assume negative values because they provide information on the relative contribution of the firm to systemic risk.

3. DATA AND METHODOLOGY

In this section, we first describe the data used and offer some details concerning the composition of our sample. Then, we focus on the econometric strategy used to investigate the trade-off between bank competition and financial stability.

3.1. Data

To gauge the relationship between bank competition and risk, we consider an unbalanced panel data set that consists of 97 listed European banks and that covers the period from 2004 to 2013.[11] These banks are the largest banks in the European banking system, and most are identified as systemically important financial institution (SIFI) by the Basel Committee. Table 1 provides more information about the banks included in our sample as well as their country of origin and the size of their balance sheets at the end of 2013 in thousands of dollars. The total assets of the 97 banks at the end of 2013 were 35 trillion dollars, which represents approximately two-thirds of all European banking assets.

[10] The derivation and estimation procedure of the SRISK is described in detail in Appendix 2.

[11] We consider all European listed banks for which balance-sheet data are available from Bankscope over the period of study, and for which risk indicators are available from the "Credit Research Initiative" platform and the "Volatility Institute" website. The choice of considering only the listed banks in our sample is driven by the fact that the distance-to-default and the SRISK measures are based on market data.

Table 1: Banks covered in the study

Bank	Country	Total assets	Bank	Country	Total assets
HSBC Holdings Plc	GB	2671318000	Bankinter SA	ES	76069093
BNP Paribas SA	FR	2496927302	Banca Popolare di Milano SCaRL	IT	68064128
Deutsche Bank AG	DE	2222314148	Pohjola Bank plc-Pohjola Pankki Oyj	FI	60438559
Barclays Plc	GB	2212826156	Aareal Bank AG	DE	59275961
Crédit Agricole S.A.	FR	2094622796	Banco BPI SA	PT	59054474
Royal Bank of Scotland Group	GB	1692816259	Banca Carige SpA	IT	58138601
Société Générale SA	FR	1674517986	Permanent TSB Plc	IE	51860432
Banco Santander SA	ES	1538771193	Jyske Bank A/S (Group)	DK	48405416
ING Groep NV	NL	1491266022	Crédit agricole Ile-de-France	FR	48145358
Lloyds Banking Group Plc	GB	1387318884	Banca Popolare di Sondrio	IT	45193628
UniCredit SpA	IT	1166512748	Credito Emiliano SpA	IT	43484760
UBS AG	CH	1136685305	Banca Piccolo Credito Valtellinese	IT	37510274
Crédit Suisse Group AG	CH	979030798	Crédit Agricole Nord de France	FR	36161356
Nordea Bank AB	SE	869444208	Immigon Portfolioabbau AG	AT	28829264
Intesa Sanpaolo	IT	863719481	Banca Mediolanum SpA	IT	28748999
Banco Bilbao Vizcaya Argentaria SA	ES	803609152	Valiant Holding	CH	28549521
Commerzbank AG	DE	758038886	Sydbank A/S	DK	27323147
Natixis SA	FR	703531922	SpareBank 1 SR	NO	25819901
Standard Chartered Plc	GB	674380000	Van Lanschot NV	NL	24369604
Danske Bank A/S	DK	596200963	EFG International	CH	24339426
Caixabank, S.A.	ES	469342294	Oberbank AG	AT	24178458
DnB ASA	NO	392999667	Vontobel Group	CH	22033874
Skandinaviska Enskilda Banken AB	SE	386816854	Crédit Agricole Alpes Provence	FR	22010067
Svenska Handelsbanken	SE	386799263	Crédit Agricole Sud Rhône Alpes	FR	20511653
KBC Groep NV	BE	329176663	SpareBank 1 SMN	NO	18973684
CIC	FR	321224656	Crédit agricole Normandie-Seine	FR	17139153
Dexia SA	BE	307455521	Paragon Group of Companies Plc	GB	16682765
Swedbank AB	SE	283960129	Crédit Agricole de la Touraine et du Poitou	FR	16183147
Erste Group Bank AG	AT	275986483	Crédit Agricole de l'Ille-et-Vilaine	FR	13797820
Banca Monte dei Paschi di Siena SpA	IT	274590951	Spar Nord Bank	DK	13783305
Banco de Sabadell SA	ES	225517168	Crédit Agricole Loire Haute-Loire	FR	13638256
Deutsche Postbank AG	DE	222723761	Crédit Agricole du Morbihan	FR	13329747
Banco Popular Espanol SA	ES	202330022	Bank für Tirol und Vorarlberg AG	AT	13228244
Bank of Ireland	IE	182227278	Banco Desio	IT	12784857
Raiffeisen Bank International AG	AT	180167976	AEGON Bank NV	NL	11172252
Banco Popolare	IT	173828022	BKS Bank AG	AT	9300510
UBI Banca	IT	171344365	Banca Generali SpA	IT	9105916
Allied Irish Banks plc	IE	162369327	Avanza Bank	SE	8816433
National Bank of Greece SA	GR	152985794	DAB Bank AG	DE	7347262
LBB Holding AG	DE	141272927	Storebrand Bank ASA	NO	6423700
Piraeus Bank SA	GR	126892290	Attica Bank SA-Bank of Attica SA	GR	5591780
Espirito Santo Financial Group S.A.	LU	117017928	Bank of Aland Plc	FI	5360226
Banco Comercial Português	PT	113097503	Banca Profilo SpA	IT	2606399
Banco Espirito Santo SA	PT	111168114	Banco Espanol de Crédito SA*	ES	135136557
Delta Lloyd NV	NL	110749551	Agricultural Bank of Greece*	GR	41716463
Eurobank Ergasias SA	GR	107000413	Emporiki Bank of Greece SA*	GR	35778996
Wüstenrot & Württembergische	DE	103492621	Banco de Valencia SA*	ES	28368913
Alpha Bank AE	GR	101637429	TT Hellenic Postbank S.A*	GR	22135623
Banca popolare dell'Emilia Romagna	IT	85171837			

Source: Bankscope. Total assets are given for 2013 in US dollars, with the exception of banks marked with an asterisk. In this case, total assets correspond to the last available observation.

To compute the Lerner index and the Z-score, we need information on banks' balance sheets. We obtain such information from Bankscope, which is a database compiled by Bureau Van Dijk. As discussed in the previous section, the Lerner index is calculated by estimating a translog panel data cost function. To have a large number of observations and improve the asymptotic efficiency of the estimated parameters, we extended our sample to all listed and non-listed European banks for which we have consolidated data. Thus, our sample for estimating equation (2) is composed of 608 banks.[12] Concerning the other measures of bank risk considered in our study, we use data from two different sources. The distance-to-default is obtained from the "Credit Research Initiative" platform of the National University of Singapore.[15]13 The distance-to-default measure proposed by this source is based on the approach developed by Duan et al. (2012), known as a robust method in the evaluation of the probability of default of firms. Duan et al. (2012) have demonstrated that the Lehman Brothers default could have been predicted three to six months in advance. The SRISK is taken from the "Volatility Institute" (V-Lab) of NYU-Stern.[14] We consider the SRISK at the end of each period.

Finally, following Schaek and Cihák (2008), Schaeck et al. (2009), Laeven and Levine (2009), Berger et al. (2009), and Fu et al. (2014) among others, we also consider several bank-specific and macroeconomic control variables that can influence the level of bank risk. Concerning bank-specific factors, we consider five variables: the bank size measured by the logarithm of total assets, the ratio of non-interest income on total income, the ratio of fixed assets on total assets, the share of loans in total assets, and the liquidity ratio. Data for all these variables are taken from Bankscope. Concerning macroeconomic variables, we consider the annual gross domestic product (GDP) growth and the annual inflation. The GDP growth indicates the position of the economy in the business cycle, whereas inflation is an indicator of macroeconomic imbalances. These variables are taken from the World Bank's World Development Indicators (WDI).

3.2. Methodology

We use the following regression specification for our main analyses:

$$risk_{it} = \alpha + \beta_1 Lerner_{it-1} + \sum_{k=2}^{n} \beta_k X_{it-1} + \mu_i + \gamma_t + \varepsilon_{it} \tag{10}$$

where *i* and *t* are bank and time period indicators, respectively, $risk_{it}$ represents alternatively one of our measures of risk, Lernerit is the Lerner index, and X_{it-1} is the vector of control variables. The term μ_i is an individual specific effect, γ_t is an unobserved time effect included to capture common time-varying factors, and ε_{it} is the random error term. Throughout the study, we will be interested in the sign and significance of the estimated coefficient $\hat{\beta}_z$. This specification is similar in many ways to that considered by recent studies that have investigated the competition-stability trade-off (see, e.g., Berger et al., 2009; Anginer et al., 2014; Fu et al., 2014). Equation (10) is estimated using the fixed effects (FE) estimator, and using the random effects (RE) estimator when we include country-specific effects.

However, examining whether the market power influences the bank risk-taking raises the question of endogeneity bias. Indeed, as argued by Schaek and Cih ́ak (2008), the level of risk-taking could affect the competitiveness of banks, and then our measure of market power. Banks could have incentives to "gamble for resurrection" when they face a high probability of default. Indeed, to access to new financial resources and attract new customers, banks could be more inclined to change the price of their products, thus affecting the existing power market. To address this potential endogeneity issue we further consider an instrumental variable approach using the two-stage least squares (2SLS) estimator. Following the precedents from previous studies, we consider two instrumental variables: the first lag of the Lerner index and the overhead ratio, which is a proxy for bank' efficiency.

[12] We consider all banks (listed and non-listed) for which Bankscope reports consolidated data, with the exception of banks with missing loans to asset ratio or a number of available years inferior to five.

[13] http://www.rmicri.org/

[14] http://vlab.stern.nyu.edu/

4. RESULTS

In this section, we first present and discuss the empirical results concerning the relationship between bank competition and individual risk. Then, we turn to the results obtained by considering the SRISK as the dependent variable. Finally, in the last sub-section, we present several robustness checks.

4.1. Competition and bank individual risk

Tables 2 and 3 present the main results obtained by the estimation of equation (10) by alternatively considering our two measures of bank individual risk. Hence, table 2 reports the results with the Z-score as dependent variable, whereas table 3 refers to the results with the distance-to-default as the endogenous variable. In each table, specifications (1) to (3) present the coefficient estimates for the bank fixed effects regressions, with or without control variables and with or without year-fixed effects. Specification (4) presents the coefficient estimates when we include country-year fixed effects. Inclusion of country-year fixed effects aims to capture differences (potentially moving over time) in terms of the regulatory and institutional environment between European countries. Finally, specifications (5) and (6) present the results when we consider an instrumental variable approach.

For all specifications, we can observe a positive and significant relationship between the bank-level Lerner index and the Z-score and between the Lerner index and the distance-to-default. The Z-score and the distance-to-default are inverse proxies for bank-individual risk, which indicates that the banking market power decreases the individual risk. In other words, the lower the competition, the lower the bank risk- taking. Our results are consistent with previous empirical studies (see, e.g., Berger et al., 2009; Anginer et al., 2014; Fu et al., 2014; Kick and Prieto, 2015). According to the traditional "competition-fragility" view, our findings can be explained by the fact that more bank competition erodes market power, decreases profit margins, and results in reduced franchise value that encourages bank risk-taking.

We find more mixed results for the control variables. First, for all specifications, we find as expected that the ratio of fixed assets to total assets and the GDP growth negatively affects the bank risk exposure. Second, we find that size is associated with lower bank distance-to-default, whereas the result is insignificant or opposite when we consider the Z-score. Third, banks with a larger percentage of loans (relative to total assets) have a greater fragility as measured by the distance to default. Finally, contrary to expectations, the variable liquidity and our proxy for bank business model (Non-interest income / Total income) do not appear to affect bank individual risk.

Table 2: Competition and bank individual risk: results obtained with the Z-score

Dependent variable	Z-score FE	Z-score FE	Z-score FE	Z-score FE	Z-score IV	Z-score IV
Lerner	2.911***	3.148***	2.851***	2.338***	6.300***	7.352***
	(0.577)	(0.588)	(0.568)	(0.662)	(1.522)	(1.581)
Size	0.418		-0.145	-0.095	0.538	
	(0.332)		(0.233)	(0.337)	(0.349)	
Non-interest income / Total income	-0.214*		-0.217*	-0.218**	0.114	
	(0.118)		(0.130)	(0.097)	(0.139)	
Fixed assets / Total assets	83.093***		80.525***	75.068***	68.027***	
	(14.867)		(15.111)	(13.333)	(18.114)	
Liquidity	-0.002		-0.002	-0.007**	-0.002	
	(0.003)		(0.003)	(0.003)	(0.003)	
Loans / Total assets	0.004		-0.007	0.002	0.008	
	(0.010)		(0.009)	(0.013)	(0.011)	
GDP growth	0.098***	0.104***	0.101***	-0.547***	0.095***	0.094***
	(0.034)	(0.032)	(0.022)	(0.121)	(0.033)	(0.032)
Inflation	0.076	0.071	-0.076	-1.347***	0.041	0.044
	(0.067)	(0.070)	(0.059)	(0.211)	(0.069)	(0.071)
Year fixed effects	Yes	Yes	No	Yes	Yes	Yes
Country*Year fixed effects	No	No	No	Yes	No	No
Observations	724	730	724	724	720	726
R-squared	0.286	0.249	0.241	0.509	0.300	0.254
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	-	-	-	20.54	18.8
J-stat	-	-	-	-	1.528	0.995
Hansen test (p-value)	-	-	-	-	0.216	0.318

Note: This table shows the regression results with the Z-score as dependent variable. Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 3: Competition and bank individual risk: results obtained with the distance-to-default

Dependent variable	DD FE	DD FE	DD FE	DD FE	DD IV	DD IV
Lerner	2.423***	2.654***	2.311***	1.684**	4.778**	4.916***
	(0.755)	(0.762)	(0.816)	(0.694)	(1.970)	(1.783)
Size	-0.661		-0.842**	-1.270***	-0.637	
	(0.521)		(0.392)	(0.448)	(0.508)	
Non-interest income / Total income	-0.091		-0.135	-0.118*	0.164	
	(0.075)		(0.087)	(0.064)	(0.111)	
Fixed assets / Total assets	75.937***		75.852***	48.258**	64.788**	
	(24.966)		(28.637)	(19.179)	(25.208)	
Liquidity	-0.003		-0.005	-0.007	-0.002	
	(0.004)		(0.004)	(0.005)	(0.004)	
Loans / Total assets	-0.036***		-0.046***	-0.017	-0.034**	
	(0.014)		(0.016)	(0.017)	(0.015)	
GDP growth	0.121***	0.145***	0.058**	-1.355***	0.120***	0.143***
	(0.033)	(0.034)	(0.027)	(0.302)	(0.034)	(0.035)
Inflation	0.150**	0.151**	-0.104*	-3.438***	0.136**	0.148**
	(0.061)	(0.061)	(0.062)	(0.470)	(0.064)	(0.063)
Year fixed effects	Yes	Yes	No	Yes	Yes	Yes
Country*Year fixed effects	No	No	No	Yes	No	No
Observations	724	730	724	724	720	726
R-squared	0.249	0.210	0.190	0.477	0.243	0.209
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	-	-	-	20.54	17.04
J-stat	-	-	-	-	1.595	2.521
Hansen test (p-value)	-	-	-	-	0.206	0.112

Note: This table shows the regression results with the distance-to-default as dependent variable. Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.4.2

4.2. Competition and systemic risk

Now we turn to the results obtained by considering the SRISK as the dependent variable. As emphasized in introduction, to the best of our knowledge, only the recent paper of Anginer et al. (2014) has previously investigated the link between competition and systemic risk at the bank level. However, unlike our study, Anginer et al. (2014) do not consider the SRISK as a measure of systemic risk, but use the $\Delta C_o V_{ar}$ and a measure based on the correlation between the distance-to-default of each bank and the distance-to-default of the market. As above, specifications (1) to (3) present the coefficient estimates for the bank fixed effect regressions, with or without control variables and with or without year-fixed effects. Specification (4) presents the coefficient estimates when we include country-year fixed effects, whereas specifications (5) and (6) report the results when we consider the 2SLS estimator.

For all specifications, we find that the Lerner index has a positive and significant effect on the SRISK. This result may seem anomalous. Indeed, it is a priori contrary to our previous findings because it means that banking market power (i.e., low competition) increases financial instability. However, the fact that the systemic risk increases with the market power does not necessarily indicate that banks enjoying a higher degree of market power tend to display a riskier individual behaviour. It merely suggests that the market power increases the banks expected shortfall conditional to a stress in the system. Thus our results indicate that market power tends to increase the deterioration of the capitalization of the system as a whole during a crisis (Acharya et al., 2012; Brownlees and Engle, 2016), i.e., the health of the financial system, which is in line with the evidences of Anginer et al. (2014).

If we refer to the franchise value paradigm, which assumes that market power encourages banks to take less risks, two main arguments can be advanced to explain the positive relationship market power and SRISK. First, according to the "too-manyto-fail" theory (Acharya and Yorulmazer, 2007), the risk aversion of banks and their willingness to reduce their exposure to bankruptcy can lead them to take correlated risks, making the financial system more vulnerable to shocks. Second, as shown by Wagner (2010), the willingness of banks to reduce portfolio risks can lead them to diversify their portfolio by holding the market portfolio as suggested by portfolio theory (Markowitz, 1952). This strategy undeniably increases the similarities between banks and thus leads to a higher correlation of bank's asset return, which is an important channel for systemic risk. This allows to explain why, although lower competition induces to take less risk at each individual institution, from the point of view of macro - financial stability this optimal individual behaviour is unwelcome.

Finally, if we refer to the control variables, we find some evidence that contribution to systemic risk as measured by the SRISK does not simply consist in considering size of financial institutions. Indeed, the significant and positive relationship between bank size and systemic risk found by Anginer et al. (2014) and Laeven et al. (2014) is only verified, in our case, for one specification.

Table 4: Competition and bank systemic risk: results obtained with the SRISK

Dependent variable	SRISK FE	SRISK FE	SRISK FE	SRISK FE	SRISK IV	SRISK IV
Lerner	17.815***	14.469**	17.166**	18.126**	43.005***	44.502***
	(6.559)	(6.260)	(7.050)	(7.735)	(16.199)	(15.182)
Size	5.521		13.878***	7.355	6.003	
	(3.857)		(3.275)	(5.269)	(3.754)	
Non-interest income / Total income	-1.074		-1.493	-1.156	0.991	
	(1.090)		(1.075)	(0.877)	(0.960)	
Fixed assets / Total assets	-441.236		-457.055	-76.884	-551.568	
	(389.639)		(413.235)	(271.284)	(456.079)	
Liquidity	0.004		0.004	0.009	0.006	
	(0.039)		(0.042)	(0.039)	(0.040)	
Loans / Total assets	-0.166		0.026	0.183	-0.140	
	(0.211)		(0.172)	(0.177)	(0.209)	
GDP growth	-0.239	-0.353	-0.714***	0.651	-0.265	-0.435
	(0.361)	(0.369)	(0.251)	(1.155)	(0.353)	(0.372)
Inflation	0.612	0.761	1.688***	6.265***	0.432	0.649
	(0.700)	(0.787)	(0.649)	(2.302)	(0.760)	(0.864)
Year fixed effects	Yes	Yes	No	Yes	Yes	Yes
Country*Year fixed effects	No	No	No	Yes	No	No
Observations	724	730	724	724	720	726
R-squared	0.245	0.222	0.198	0.572	0.195	0.160
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	-	-	-	20.54	18.80
J-stat	-	-	-	-	0.031	0.293
Hansen test (p-value)	-	-	-	-	0.86	0.588

Note: This table shows the regression results with the SRISK as dependent variable. Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

5. ROBUSTNESS CHECKS

Table 5: Competition and bank risks: Robustness checks

PART A	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Z-score	Z-score	Distance-to-default	Distance-to-default	SRISK	SRISK
	FE	IV	FE	IV	FE	IV
Efficiency-adjusted Lerner	2.329***	5.922***	1.512***	3.585**	19.018***	49.382***
	(0.463)	(1.305)	(0.575)	(1.493)	(6.103)	(17.028)
Funding-adjusted Lerner	2.742***	6.385***	2.314***	3.798***	16.688***	43.121**
	(0.581)	(1.285)	(0.706)	(1.420)	(6.072)	(18.870)
Sample-specific Lerner	3.076***	7.518***	2.852***	6.642***	20.243***	53.831***
	(0.581)	(1.679)	(0.783)	(2.284)	(6.767)	(19.096)
PART B	(1)	(2)	(3)			
Dependent variable	Z-score	Distance-to-default	SRISK			
	FE	FE	FE			
Country-level Lerner index	2.786*	4.380**	31.884*			
(without including HHI)	(1.516)	(1.946)	(18.169)			
Country-level Lerner index	2.902*	4.428**	30.703*			
(including HHI)	(1.503)	(1.932)	(17.754)			
PART C	(1)	(2)	(3)			
Dependent variable	Z-score	Distance-to-default	SRISK			
	FE	FE	FE			
Moving Average Lerner	4.803***	2.156**	23.539**			
	(0.601)	(0.966)	(10.380)			
Lerner - Robust regression	3.255***	1.547***	2.571***			
	(0.545)	(0.574)	(0.858)			
Lerner - Dummy crisis 2008-2009	2.628***	2.019**	20.750***			
	(0.577)	(0.799)	(7.269)			

Note: To save space, only the coefficient estimates of our variable of interest and their standard errors are reported. Full results are available upon request. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

We test the robustness of our results in several ways. First, following Turk-Ariss (2010), we consider three alternative measures of the Lerner index. The first alterna- tive measure is called efficiency-adjusted Lerner Index and considers profit and cost inefficiencies when computing the Lerner index. In our study, controlling for ineffi- ciency is particularly important because it can affect the difference between price and marginal cost, and consequently, the value of the Lerner index. Indeed, banks with a high market power could adopt a "quiet life" and reduce their cost efficiency (Hicks, 1935; Berger and Hannan, 1998).[15] On the contrary, efficiency could also lead to a market concentrated in the hands of the most efficient banks (Demsetz, 1973; Peltz- man, 1977). As noted by Koetter et al. (2012), no adjustment for inefficiency could bias estimations of the Lerner index. Therefore, the authors propose a correction of the conventional Lerner index:

$$Efficiency - adjusted\ Lerner_{it} = \frac{(\hat{\pi_{it}} + T\hat{C_{it}}) - \hat{mc_{it}}}{(\hat{\pi_{it}} + T\hat{C_{it}})} \tag{11}$$

where $\hat{\pi_{it}}$ is the estimated profit, $T\hat{C_{it}}$ the estimated total cost and $\hat{mc_{it}}$ the marginal cost.

To estimate this efficiency-adjusted Lerner index, we follow Koetter et al. (2012) and first conduct a Stochastic Frontier Analysis (SFA) to estimate the translog cost function. We then obtain $T\hat{C_{it}}$ and $\hat{mc_{it}}$. Such an approach has the advantage of taking into account banks' cost inefficiency, defined

[15] Note nonetheless that empirical results obtained by Maudos and Fernandez de Guevara (2007) for a large sample of European banks do not confirm the so-called "quiet life" hypothesis. On the contrary, they find a positive relationship between market power and the cost X-efficiency.

as the distance of a bank from a cost frontier accepted as the benchmark.[16] Second, we specify an alternative profit function as in Berger and Mester (2003), that we estimate using SFA to obtain $\hat{\pi_{it}}$.

Another potential issue comes from the use of cost funding in the translog cost function because it could partially reflect market power. Therefore, following Maudos and Fernandez de Guevara (2007), we opt for a two-input cost function wherein cost funding is excluded. Finally, the third alternative measure of the Lerner index consists of estimating the translog cost function solely for our sample of listed banks (i.e. 97 banks). Such an approach allows us to take into account the fact that the banks in our sample have technology specificities.[17] Results of estimates using these three alternative Lerner indexes are displayed in part A of table 5. We report the results for each of our risk measures based on the fixed-effects and the 2SLS estimator. The relationship between the Lerner index and our two measures of individual bank risk, namely the Z-score and the distance-to-default, remains positive and statistically significant. Concerning the SRISK, coefficient estimates in columns (5) and (6) of table 5 demonstrate that the relationship between market power and bank systemic risk is robust to our different measures of the Lerner index. We still find a positive and significant relationship between these two variables.

A second way to check the robustness of our results consists in replacing the bank-specific Lerner index with a country-specific Lerner index, which corresponds for each country to the median of individual Lerner indexes. Indeed, the national competitive environment could have a different effect on stability than the individual market-power. In particuler, one can expect that banks may be sensitive to both their own condition-estimated by an individual measure of market power-and to the overall condition of their market. This control is important because the banking industry is a network industry. This robustness check also allows us to report estimation results consistent with Schaeck and Cih´ak (2014), whose study links individual bank risk measures (Z-score) and country-specific competition measures. We consider two different specifications. The first includes the median of individual Lerner indexes, while the second considers in the same regression the median of individual Lerner indexes and an index of banking sector concentration, namely the Herfindahl-Hirschman index (HHI). This index corresponds to the sum of the squared market share of each financial institution in the banking sector. Including in the same regression a competition and a concen- tration measure aims to have a complete view of the banking industry in which firms operate. Our results, reported in part B of table 5, confirm the substance of previous results. We find a positive and significant relationship between the country-specific Lerner index and our alternative measures of risk, while the Herfindahl-Hirschman index appears not statistically significant.

Part C of table 5 presents some additional robustness checks. First, we consider an alternative measure of the Lerner index by using the three-year moving average. This measure aims to smooth cyclical fluctuations of the Lerner index, because the market power of a firm is not likely to radically change in the short-run. Second, we re-estimate our benchmark specification (equation 10) by considering a robust regression approach. The idea of robust regression is to down-weights the influence of high leverage data points and outliers to provide a better fit of the data.[18] Third, we include in our benchmark specification a dummy variable capturing the recent financial crisis. This variable is equal to one for the 2008 and 2009 years, and zero otherwise. Indeed, one could expect that our measures of risk has been impacted by the crisis, regardless the level of competition on the banking sector. As we can see in table 5, our results remain unchanged in both cases. We still find a positive and significant relationship between

[16] Formally, the SFA consists of decomposing the error term of the translog cost function into two components, such as $\varepsilon_{it} = v_{it} + \mu_{it}$. The random error term vit is assumed iid with $v_{it} \sim N(0, \sigma_v^2)$ and independent of the explanatory variables. The inefficiency term μ_{it} is iid with $\mu_{it} \sim N(0, \sigma_\mu^2)$ and independent of the error term v_{it} . It is drawn from a non-negative distribution truncated at zero.

[17] The translog cost function based on our sample of 97 banks includes country fixed effects to control for unobserved heterogeneity across countries.

[18] Robust regression is an alternative when data contains some outliers or high leverage data points. This approach constitutes a compromise between excluding these points entirely from the analysis and including all the data points and treating all them equally in the regression. In practice, robust regression works by assigning a weight to each data point. Weighting is done automatically and iteratively using a process called iteratively reweighted least squares. In the first iteration, each point is assigned equal weight and model coefficients are estimated using ordinary least squares (OLS). At subsequent iterations, weights are recomputed so that points farther from model predictions in the previous iteration are given lower weight. Model coefficients are then recomputed using weighted least squares. The process continues until the values of the coefficient estimates converge within a specified tolerance.

the Lerner index and our three alternative measures of risk.[19]

Table 6: Competition and bank systemic risk: results obtained with the skew adjusted SRISK

Dependent variable	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew	SRISK_skew
	FE	FE	FE	FE	IV	IV
Lerner	0.313***	0.260**	0.291***	0.233***	0.803***	0.769**
	(0.119)	(0.119)	(0.107)	(0.089)	(0.305)	(0.305)
Size	0.047		0.180***	0.031	0.068	
	(0.056)		(0.041)	(0.056)	(0.053)	
Non-interest income / Total income	-0.009		-0.016	-0.009	0.027	
	(0.015)		(0.015)	(0.012)	(0.019)	
Fixed assets / Total assets	-6.812		-7.468	-1.033	-9.191	
	(4.825)		(5.647)	(3.741)	(5.951)	
Liquidity	0.000		0.000	0.000	0.000	
	(0.000)		(0.000)	(0.000)	(0.000)	
Loans / Total assets	-0.003		-0.001	0.002	-0.003	
	(0.004)		(0.003)	(0.002)	(0.004)	
GDP growth	-0.004	-0.006	-0.012***	-0.007	-0.004	-0.006
	(0.005)	(0.005)	(0.004)	(0.011)	(0.004)	(0.005)
Inflation	0.013	0.015	0.020**	0.050***	0.010	0.013
	(0.012)	(0.014)	(0.009)	(0.017)	(0.012)	(0.015)
Year fixed effects	Yes	Yes	No	Yes	Yes	Yes
Country*Year fixed effects	No	No	No	Yes	No	No
Observations	724	730	724	724	720	726
R-squared	0.238	0.213	0.195	0.564	0.184	0.151
Number of banks	97	97	97	97	97	97
F-stat(First step IV)					16.10	16.10
J-stat	-	-	-	-	0.080	0.306
Hansen test (p-value)	-	-	-	-	0.777	0.58

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Finally, we check whether the non-Gaussian and skewed distribution of the SRISK drives our baseline results. To address this issue, we apply a zero-skewness log transformation to the SRISK series to obtain a normal distribution. Results displayed in table 6 confirm a positive and statistically significant relationship between the Lerner index and bank systemic risk.

6. CONCLUSION

This study aims to reconcile the conflicting empirical evidence regarding the relationship between banking competition and financial (in)stability. To this end, we have contributed to the existing literature by considering not only individual bank risk measures but also a measure of bank systemic risk with the SRISK. Similar to Anginer et al. (2014), our objective in this study is to examine whether the banking competition and the degree of market power also affect the bank's contribution to the deterioration of the soundness of the system as a whole. Results that we obtain from a large sample of European listed banks by using the Lerner index as an index of market power indicate that (1) bank market power decreases the individual risk-taking behaviour of bank because in European banking, greater market power is associated

[19] Please not that a non-linear (quadratic) specification has also been considered. However, results that we obtained reveal a non-significant relationship between the squared Lerner index and our alternative measures of risk. The non-significance of the interaction term is nonetheless consistent with the scatter plots reported in Appendix 1, which clearly show a positive and linear relationship between the Lerner index and our three measures of risk (Z-score, distance-to-default, and SRISK).

with lower Z-score and distance-to-default and (2) bank market power increases the bank's systemic risk contribution as seen in the positive and significant relationship between the Lerner index and the SRISK.

We argue that highlighting a dual relationship between the Lerner index and our two types of risk is not inconsistent. On the contrary, this result confirms that individual bank risk and systemic bank risk have two different dimensions and can mainly be explained by the franchise value paradigm. That can appear puzzling because this paradigm traditionally supports the "competition-fragility" view and not a dual relationship. However, we develop the idea that the willingness to reduce risk exposition when franchise value is high, as a result of bank market power, can take two forms: (1) a decrease of individual risk, as traditionally argued by the defenders of the "competition-fragility" view and (2) an increase of systemic risk contribution via an increase of correlation in risk. This can be a strategic choice in order to benefit from the "too-many-to-fail" guarantee (Acharya and Yorulmazer, 2007).This can also simply be the result of reduction in portfolio risks by complete diversification, which induces less diversity in the system and more correlated institutions (Wagner, 2010). Our findings have important policy repercussions. First, the fact that competition has a divergent effect on individual and systemic risk implies that financial regulation and competition policy should complete both a micro-prudential and a macro-prudential exam when analysing the repercussions of bank competition. Second, and on a more practical level, our results suggest that pro-competitive policy should be undertaken in the European banking system to maintain macro-financial stability. In our view concerns about the potential negative effect of this type of policy on individual risk-taking behaviour should not arise because the Basel III regulatory framework well corrects incentives for individual risk-taking.

APPENDIX 1

Table A1: Variable definitions

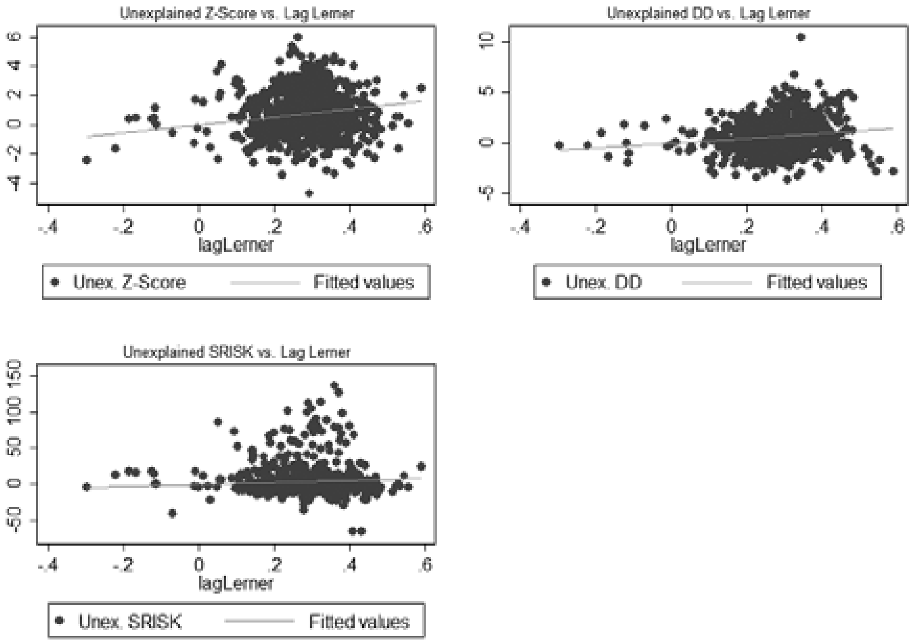
Variable	Definition
Dependent variables	
Z-score	An accounting bank-level measure of individual bank risk. A larger value indicates a higher bank stability and less bank risk-taking. Source: Authors' calculations, BankScope
Distance-to-defaut	A market-based bank-level measure of individual bank risk. A larger value indicates a higher bank stability and less bank risk-taking. Source: Credit Research Initiative of the National University of Singapore
SRISK	A market-based bank-level measure of contribution to systemic risk. A larger value indicates that the bank contribution to the deterioration of the soundness of the system as a whole increases. Source: "Volatility Institute" (V-Lab) of NYU-Stern
Explanatory variables	
Lerner index	A bank-level measure of bank market power. A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Efficiency-adjusted Lerner index	A bank-level measure of bank market power following the methodology proposed by Koetter et al. (2012). A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Funding-adjusted Lerner index	A bank-level measure of bank market power following the methodology proposed by Maudos and Fernandez de Guevara (2007). A higher value indicates more market power and less bank competition. Source: Authors' calculations, Bankscope
Bank size	The log value of Total Assets. Source: BankScope
Non-interest income / Total income	A bank-level measure of business diversification. Source: Bankscope
Fixed assets / Total assets	A bank-level measure of asset composition. Source: Bankscope
Liquidity	A bank-level liquidity indicator, which corresponds to the ratio of liquid assets over deposits and short term funding. A higher value indicates less liquidity risk. Source: Bankscope
Loans / Total assets	A bank-level measure of asset composition. Source: Bankscope
GDP growth	Annual percentage growth rate of GDP at market prices. Source: WDI, World Bank
Inflation	Annual percentage change of consumer prices index. Source: WDI, World Bank

Table A2: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Z-score	3.57	1.32	0.235	6.99
Distance-to-default	1.15	1.67	-1.33	5.54
SRISK	12.2	27.7	-12.1	131
Conventional Lerner	0.285	0.106	-0.115	0.491
Efficiency-adjusted Lerner	0.251	0.138	-0.003	0.647
Funding-adjusted Lerner	0.243	0.12	-0.171	0.457
Sample-specific Lerner	0.274	0.11	-0.073	0.48
Aggregate Lerner	0.26	0.052	0.113	0.372
HHI	0.198	0.084	0.099	0.481
Size	18.4	1.83	14.8	21.8
Non-interest income / Total income	0.404	0.243	-0.214	0.941
Fixed assets / Total assets	0.007	0.005	0.001	0.026
Liquidity	35.1	35.6	3.17	150
Loans / Total assets	56.8	20.9	4.63	87.9
GDP growth	0.664	2.72	-5.6	6
Inflation	1.95	1.23	-0.9	4.7

Source: Bankscope, Credit Research Initiative, Volatility Institute and authors' calculations

Figure A1: Scatter plots between Lerner index and risk measures



Note: These figures plot the one-lagged Lerner index with the unexplained part of the Z-score, the distance-to-default, and the SRISK.

APPENDIX 2: DERIVATION AND ESTIMATION OF THE DISTANCE-TO-DEFAULT AND SRISK

Distance-to-default. The distance-to-default is derived from the Black-Scholes-Merton structural model (Black and Scholes, 1973; Merton, 1974), in which the time path of the market value of assets follows a stochastic process:

$$lnV_A^T = lnV_{A,t} + (\mu - \frac{\sigma_{A,t}^2}{2})T + \sigma_{A,t}\sqrt{T}\varepsilon \quad (12)$$

where V_A^T is the asset value at time T (i.e. maturity of debt), given its current value $V_{A,t}$ its expected return μ, and its standard deviation $\sigma_{A,t}$ (i.e. assets volatility). ε denotes the random component of the firm's return on assets, which the Black and Scholes model assumes is normally distributed. To simplify the notation, we assume that $T=t$, and then that time to maturity equals T at the time of valuation of assets. Within this framework, we assume that banks can cover their debts with their assets. Thus, a bank is considered solvent if, at the maturity of debt, the market value of its assets is higher than the market value of its debt. Conversely, a bank is in a situation of default if the value its assets at maturity is lower than that of its debt. Noting D the value of debt, this implies that default point corresponds to:

$$lnV_A^T = lnD \quad (13)$$

Consequently, the current distance d from the default point can be expressed as:

$$d = lnV_A^T - lnD = lnV_A + (\mu - \frac{\sigma_A^2}{2})T + \sigma_A\sqrt{T}\varepsilon - lnD \quad (14)$$

$$\Leftrightarrow \frac{d}{\sigma_A\sqrt{T}} = \frac{ln(\frac{V_A}{D}) + (\mu - \frac{\sigma_A^2}{2})T}{\sigma_A\sqrt{T}} + \varepsilon \tag{15}$$

That is, the distance-to-default (DD) is repesented by the following expression:

$$DD = \frac{d}{\sigma_A\sqrt{T}} - \varepsilon = \frac{ln(\frac{V_A}{D}) + (\mu - \frac{\sigma_A^2}{2})T}{\sigma_A\sqrt{T}} \tag{16}$$

As we can see, the distance-to-default (DD) is the logarithm of the leverage ratio shifted by the expected return $(\mu - \sigma_A^2/2)T$, and scaled by the volatility $\sigma_A\sqrt{T}$. It represents the number of asset value standard deviations that the bank is from the default point. Thus, values of DD that are close to zero or negative indicate a situation of extreme vulnerability for the bank. The lower is the value of DD, the closer the bank is to insolvency. Conversely, for positive values of DD, an increase in the distance-to-default means that the company is moving away from the default point and that bankruptcy becomes less likely.

More precisely, the distance-to-default is increasing in V_A and μ, and decreasing in D/V_A and σ_A .To illustrate our purpose, consider two different cases. First, consider two banks with identical leverage ratios and volatilities. If the asset value of one is expected to increase at a faster rate μ than the other, the one is characterized by a higher DD, and then to be further away from default. Second, consider two banks with identical leverage ratios and expected returns. In this case, their volatilities will determine which one is farther away from the default point. However, the conclusion depends on the sign of the numerator. If the numerator is positive, meaning that the asset value will cover the debt obligation in average, a lower volatility implies a larger DD, and then the bank is less likely to default. On the contrary, when the numerator is negative, a higher volatility implies a DD less negative. Indeed, with a higher assets volatility, the bank has a higher chance to get its future asset value to exceed the debt obligation.

In practice, the two main challenges for calculating the distance-to-default is that the asset value (V_A) is not directly observable, and that parameters σ_A and μ are unknown and need to be estimated. Indeed, as argued by Duan and Wang (2012), a direct evaluation of asset value is practically impossible, because a firm as a going process presumably possesses intangible assets and their values are hard to detemine. Different estimation methodologies have been proposed in the literature to address these challenges: the market value proxy method used in Brockman and Turtle (2003) and Eom et al. (2004), the volatility restiction method proposed by Jones et al. (1984) and Ronn and Verma (1986), the KMV iterative method developed by Moody's and described in Bohn and Crosbie (2003), and the transformed-data maximum likelihood estimation method proposed first by Duan (1994) and modified later by Duan (2000) and Duan et al. (2012) to deal with financial firms. In this paper, we use data on distance-to-default taken from the "Credit Research Initiative" platform of the National University of Singapore (http://www.rmicri.org/). The estimation method considered by this platform is the transformed-data maximum likelihood estimation method (for more details, see Duan et al., 2012).

SRISK. The objective of the SRISK methodology is to propose a measure of financial distress, wich corresponds to the capital shortfall a firm is expected to experience conditional on a systemic event (Brownlees and Engle, 2016). In other words, it estimates the amount of capital that a financial institution would need to raise in order to function normally if a systemic crisis occurs. In comparison to other existing systemic risk measures, such as the $\Delta CoVaR$ (Adrian and Brunnermeier, 2011) or measures based on the degree of interdependence among financial firms (see, e.g., Billio et al., 2012; Diebold and Yılmaz, 2014), the main contribution of the SRISK is to merge market and balance-sheet data to contruct a market-based measure of financial distress. Moreover, contrary to the systemic risk proposed by Acharya et al. (2012), called Systemic Expected Shortfall (SES), the SRISK does not require observing the realization of a systemic crisis to be estimated.

The starting point of the SRISK is the measure of distress of a financial firm. It corresponds to its capital shortfall, defined as the difference between the capital reserves the firm needs to hold (due to regulation requirements) and the firm's equity. Formally, the capital shortfall of a firm i at the period

t can be written as:

$$CS_{it} = kA_{it} - W_{it} = k(D_{it} + W_{it}) - W_{it} \quad (17)$$

where k is the prudential capital ratio (set in our case at 5.5%), Ait is the value of quasi assets, W_{it} is the market value of equity, and D_{it} is the book value of debt. The capital shortfall can be negative or positive. It is negative when the firm has a capital surplus, and then functions properly, and positive when the firm experiences distress. The second step consists of defining the systemic event. Brownlees and Engle (2016) define it as a market decline below a thresold C over a time horizon h. As argued by Brownlees and Engle (2016), to produce a meaningful stress capital shortfall measure, it is necessary to assume that the systemic event corresponds to a sufficiently extreme scenario. In our case, we consider that a systemic event occurs if the MSCI World Index falls by more than 40% over a six-month horizon.

Denoting the multi-period arithmetic return between period $t+1$ and $t+h$ as $R_{m\ t+1:t+h}$ and the systemic event as $R_{m\ t+1:t+h} < C$, the SRISK corresponds to:

$$SRISK_{it} = E_t(CS_{i\ t+h} | R_{m\ t+1:t+h} < C) \quad (18)$$

$$SRISK_{it} = kE_t(D_{it+h} | R_{m\ t+1:t+h} < C) - (1-k)E_t(W_{it+h} | R_{m\ t+1:t+h} < C) \quad (19)$$

Furthermore, if we assume that in a case of a systemic event debt cannot be renegociated, implying that $E_t(D_{it+h} | R_{m\ t+1:t+h} < C) = D_{it}$, we obtain:

$$SRISK_{it} = kD_{it} - (1-k)W_{it}(1 - LRMES_{it}) \quad (20)$$

$$SRISK_{it} = W_{it}[kLVG_{it} + (1-k)LRMES_{it} - 1] \quad (21)$$

where LVG_{it} denotes the quasi-leverage ratio $(D_{it} + W_{it})/W_{it}$ and $LRMES_{it}$ is the long-run marginal expected shortfall, i.e. the expectation of the firm equity mutli-period arithmetic return conditional on the systemic event. Thus, the long-run marginal expected shortfall aims to capture the interconnection of a firm with the rest of the sytem. It can be written as:

$$LRMES_{it} = -E_t(R_{t+1:t+h} | R_{m\ t+1:t+h} < C) \quad (22)$$

where $R_{t+1:t+h}$ is the multi-period arithmetic firm equity return between period $t+1$ and $t+h$.

There exists different specifications and estimation techniques to compute the expected market and firm returns, and then to obtain estimators of the long-run marginal expected shortfall (for more details, see Brownlees and Engle, 2016). Among these approaches, we find for example the GARCH-DCC methodology, the static bivariate normal model, or the dynamic bivariate copula model. In our case, the computation of the long-run marginal expected shortfall is based on the approximation method proposed by Acharya et al. (2012). They propose to approximate the *LRMES* using the daily Marginal Expected Shortfall (MES), defined for a threshold equal to 2%, as:

$$LRMES_{it} \cong 1 - exp(18 * MES_{it}) \quad (23)$$

Futhermore, as shown by Benoit et al. (2016) and Brownlees and Engle (2016), the MES of a given financial institution is proportional to its systematic risk, as measured by its time-varying beta. The proportionality coefficient is the expected shortfall of the market:

$$MES_{it}(\alpha) = \beta_{it} ES_{mt}(\alpha) \quad (24)$$

where $ES_{mt}(\alpha) = E_{t-1}(R_{mt} | R_{mt} < VAR_{mt}(\alpha))$ is the expected shorfall of the market and $\beta_{it} = \rho_{it}\sigma_{it}/\sigma_{mt}$ the time-varying beta of the financial institution.

Consequently, the SRISK can be expressed as a linear function of the beta, liabilities and market capitalization:

$$SRISK_{it} \cong kD_{it} - (1-k)W_{it}exp[18 * \beta_{it} * ES_{mt}(\alpha)] \tag{24}$$

To conclude, in comparison to other systemic risk measures, the SRISK presents several advantages. First, as argued above, it is a forward-looking measure of systemic risk that merges market and balance-sheet information, and it does not require observing the realization of a systemic crisis to be estimated. Second, the SRISK does not assume that systemic risk is associated with the probability of joint distress of a large proportion of firms in the financial system. Indeed, by taking into account joint dependence among financial institutions, as well as their size and the degree of leverage, the SRISK is able to detect if a small number of large institutions pose systemic threats to the entire system (Brownlees and Engle, 2016). Finally, in pratical terms, the computation of the SRISK is relatively flexible. Indeed, we can easily consider different values of the prudential capital ratio k and change the horizon h and the threshold C for the market index decline. In this paper, the choice of setting the prudential capital ratio at 5.5% is based on the stress tests conducted by the European Central Bank (ECB) and the European Banking Authorithy (EBA), which generally consider a Common Equity Tier 1 (CET1) of 5, 5% in adverse stress test scenario. Concerning the systemic event parameters h and C, respectively set to six months and 40%, they respond to the necessity of capturing the occurrence of a systemic financial crisis, usually characterized by a sharp and prolonged market decline. By considering a lower threshold and time horizon, there would be the risk of gauging the current capital shortfall of a financial institution rather than the stressed conditional capital shortfall (Brownlees and Engle, 2016).

BIBLIOGRAPHY

Acharya, V., Engle, R., and Richardson, M. (2012). Capital shortfall: A new approach to ranking and regulating systemic risks. *The American Economic Review*, 102(3):59–64.

Acharya, V. V., Anginer, D., and Warburton, A. J. (2016). The end of market discipline? Investor expectations of implicit state guarantees. SSRN WP.

Acharya, V. V., Pedersen, L. H., Philippon, T., and Richardson, M. P. (2010). *Measuring systemic risk*. Federal Reserve Board of Cleveland Working Paper No. 10-02.

Acharya, V. V. and Yorulmazer, T. (2007). Too many to fail-An analysis of time-inconsistency in bank closure policies. *Journal of Financial Intermediation*, 16(1):1– 31.

Adrian, T. and Brunnermeier, M. K. (2011). *CoVaR*. NBER Working Paper No. 17454.

Aglietta, M. and Scialom, L. (2010). A systemic approach to financial regulation: An European perspective. *International Economics*, 123:31–65.

Allen, F. and Gale, D. (2000). *Comparing Financial Systems*. MIT press.

Angelini, P. and Cetorelli, N. (2003). The effects of regulatory reform on competition in the banking industry. *Journal of Money, Credit and Banking*, 35(5):663–684.

Anginer, D., Demirguc-Kunt, A., and Zhu, M. (2014). How does competition affect bank systemic risk? *Journal of Financial Intermediation*, 23(1):1–26.

Beck, T. (2008). *Bank competition and financial stability: Friends or foes?* World Bank Policy Research Working Paper Series 4656.

Beck, T., De Jonghe, O., and Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of Financial Intermediation*, 22(2):218–244.

Beck, T., Demirguç-Kunt, A., and Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance*, 30(5):1581–1603.

Benoit, S., Colliard, J.-E., Hurlin, C., and P´erignon, C. (2016). Where the risks lie: A survey on systemic risk. *Review of Finance (forthcoming)*.

Berger, A. N. and Hannan, T. H. (1998). The efficiency cost of market power in the banking industry: A test of the "quiet life" and related hypotheses. *Review of Economics and Statistics*, 80(3):454–465.

Berger, A. N., Klapper, L. F., and Turk-Ariss, R. (2009). Bank competition and financial stability. *Journal of Financial Services Research*, 35(2):99–118.

Berger, A. N. and Mester, L. J. (2003). Explaining the dramatic changes in performance of US banks: Technological change, deregulation, and dynamic changes in competition. *Journal of Financial Intermediation*, 12(1):57–95.

Billio, M., Getmansky, M., Lo, A. W., and Pelizzon, L. (2012). Econometric measures of connectedness and systemic risk in the finance and insurance sectors. *Journal of Financial Economics*, 104(3):535–559.

Black, F. and Scholes, M. (1973). The pricing of options and corporate liabilities. *The Journal of Political Economy*, 81(3):637–654.

Bohn, J. and Crosbie, P. (2003). *Modeling default risk*. KMV Corporation.

Boone, J. (2008). A new way to measure competition. *The Economic Journal*, 118(531):1245–1261.

Boot, A. W. and Thakor, A. V. (1993). Self-interested bank regulation. *The American Economic Review*, 83(2):206–212.

Borio, C. (2003). Towards a macroprudential framework for financial supervision and regulation? *CESifo Economic Studies*, 49(2):181–215.

Boyd, J. H. and De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance*, 60(3):1329–1343.

Boyd, J. H., De Nicolò, G., and Jalal, A. M. (2006). *Bank risk-taking and competition revisited: New theory and new evidence*. International Monetary Fund WP/06/297.

Boyd, J. H. and Runkle, D. E. (1993). Size and performance of banking firms: Testing the predictions of theory. *Journal of Monetary Economics*, 31(1):47–67.

Brockman, P. and Turtle, H. J. (2003). A barrier option framework for corporate security valuation. *Journal of Financial Economics*, 67(3):511–529.

Brownlees, C. and Engle, R. F. (2016). SRISK: A conditional capital shortfall index for systemic risk measurement. *The Review of Financial Studies (forthcoming)*.

Brunnermeier, M. K., Crockett, A., Goodhart, C. A., Persaud, A., and Shin, H. S. (2009). The fundamental principles of financial regulation. Geneva Reports on the World Economy 11.

Claessens, S. and Laeven, L. (2004). What drives bank competition? Some international evidence. *Journal of Money, Credit and Banking*, 36(3):563–583.

Demirguç-Kunt, A. and Martínez Pería, M. S. (2010). *A framework for analyzing competition in the banking sector: An application to the case of Jordan*. World Bank Policy Research Working Paper Series 5499.

Demsetz, H. (1973). Industry structure, market rivalry, and public policy. *Journal of Law and Economics*, 16(1):1–9.

Diebold, F. X. and Yılmaz, K. (2014). On the network topology of variance decompositions: Measuring the connectedness of financial firms. *Journal of Econometrics*, 182(1):119–134.

Duan, J.-C. (1994). Maximum likelihood estimation using price data of the derivative contract. *Mathematical Finance*, 4(2):155–167.

Duan, J.-C. (2000). Correction: Maximum likelihood estimation using price data of the derivative contract. *Mathematical Finance*, 10(4):461–462.

Duan, J.-C., Sun, J., and Wang, T. (2012). Multiperiod corporate default prediction—a forward intensity approach. *Journal of Econometrics*, 170(1):191–209.

Duan, J.-C. and Wang, T. (2012). Measuring distance-to-default for financial and non-financial firms. *Global Credit Review*, 2:95–108.

Eom, Y. H., Helwege, J., and Huang, J.-Z. (2004). Structural models of corporate bond pricing: An empirical analysis. *Review of Financial studies*, 17(2):499–544.

Fernandez de Guevara, J., Maudos, J., and Perez, F. (2005). Market power in European banking sectors. *Journal of Financial Services Research*, 27(2):109–137.

Fu, X. M., Lin, Y. R., and Molyneux, P. (2014). Bank competition and financial stability in Asia pacific. *Journal of Banking & Finance*, 38:64–77.

Fungáčová, Z. and Weill, L. (2013). How market power influences bank failures: Evidence from Russia. *Economics of Transition*, 21(2):301–322.

Gropp, R., Vesala, J. M., and Vulpes, G. (2006). Equity and bond market signals as leading indicators of bank fragility. *Journal of Money, Credit and Banking*, 38(2):399–428.

Hellmann, T. F., Murdock, K. C., and Stiglitz, J. E. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *The American Economic Review*, 90(1):147–165.

Hicks, J. R. (1935). Annual survey of economic theory: The theory of monopoly. *Econometrica*, 3(1):1–20.

Idier, J., Lamé, G., and Mésonnier, J.-S. (2014). How useful is the marginal expected shortfall for the measurement of systemic exposure? A practical assessment. *Journal of Banking & Finance*, 47:134–146.

Jiménez, G., Lopez, J. A., and Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability*, 9(2):185–195.

Jones, E. P., Mason, S. P., and Rosenfeld, E. (1984). Contingent claims analysis of corporate capital structures: An empirical investigation. *The Journal of Finance*, 39(3):611–625.

Kane, E. J. (1989). *The S & L Insurance Mess: How did it happen?* The Urban Insitute.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, 80(5):1183–1200.

Kick, T. and Prieto, E. (2015). Bank risk and competition: Evidence from regional banking markets. *Review of Finance*, 19(3):1185–1222.

Koetter, M., Kolari, J. W., and Spierdijk, L. (2012). Enjoying the quiet life under deregulation? Evidence from adjusted lerner indices for US banks. *Review of Economics and Statistics*, 94(2):462–480.

Laeven, L. and Levine, R. (2009). Bank governance, regulation and risk taking. *Journal of Financial Economics*, 93(2):259–275.

Laeven, L., Ratnovski, L., and Tong, H. (2014). *Bank size and systemic risk*. International Monetary Fund Staff Discussion Note 14/04.

Lapteacru, I. (2014). Do more competitive banks have less market power? The evidence from Central and Eastern Europe. *Journal of International Money and Finance*, 46:41–60.

Lepetit, L. and Strobel, F. (2013). Bank insolvency risk and time-varying z-score measures. *Journal of International Financial Markets, Institutions and Money*, 25:73–87.

Lerner, A. P. (1934). The concept of monopoly and the measurement of monopoly power. *The Review of Economic Studies*, 1(3):157–175.

Liu, H., Molyneux, P., and Wilson, J. O. (2013). Competition and stability in European banking: A regional analysis. *The Manchester School*, 81(2):176–201.

Markowitz, H. (1952). Portfolio selection. *The Journal of Finance,* 7(1):77–91.

Martinez-Miera, D. and Repullo, R. (2010). Does competition reduce the risk of bank failure? *Review of Financial Studies,* 23(10):3638–3664.

Matutes, C. and Vives, X. (2000). Imperfect competition, risk taking, and regulation in banking. *European Economic Review,* 44(1):1–34.

Maudos, J. and Fernandez de Guevara, J. (2007). The cost of market power in banking: Social welfare loss vs. cost inefficiency. *Journal of Banking & Finance,* 31(7):2103– 2125.

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance,* 29(2):449–470.

Panzar, J. C. and Rosse, J. N. (1987). Testing for "monopoly" equilibrium. *The Journal of Industrial Economics,* 35(4):443–456.

Pawłowska, M. (2015). Changes in the size and structure of the European Union banking sector - the role of competition between banks. *National Bank of Poland WP 205.*

Peltzman, S. (1977). The gains and losses from industrial concentration. *Journal of Law and Economics,* 20(2):229–263.

Ronn, E. I. and Verma, A. K. (1986). Pricing risk-adjusted deposit insurance: An option-based model. *The Journal of Finance,* 41(4):871–896.

Schaeck, K. and Cihák, M. (2014). Competition, efficiency, and stability in banking. *Financial Management,* 43(1):215–241.

Schaeck, K., Cihák, M., and Wolfe, S. (2009). Are competitive banking systems more stable? *Journal of Money, Credit and Banking*, 41(4):711–734.

Schaek, K. and Cihák, M. (2008). *How does Competition affect Efficiency and Soundness in Banking? New empirical evidence.* European Central Bank WP 932.

Smith, B. D. (1984). Private information, deposit interest rates, and the stability of the banking system. *Journal of Monetary Economics,* 14(3):293–317.

Stiglitz, J. E. and Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American Economic Review*, 71(3):393–410.

Turk-Ariss, R. (2010). On the implications of market power in banking: Evidence from developing countries. *Journal of Banking & Finance,* 34(4):765–775.

Uhde, A. and Heimeshoff, U. (2009). Consolidation in banking and financial stability in Europe: Empirical evidence. *Journal of Banking & Finance,* 33(7):1299–1311.

Wagner, W. (2010). Diversification at financial institutions and systemic crises. *Journal of Financial Intermediation,* 19(3):373–386.

Zigraiova, D. and Havranek, T. (2015). Bank competition and financial stability: Much ado about nothing? *Journal of Economic Surveys (forthcoming).*

ONLINE APPENDIX

Table A3: Competition and bank risks: results obtained with efficiency-adjusted Lerner

Dependent variable	Z-score	Z-score	Distance-to-default	Distance-to-default	SRISK	SRISK
	FE	IV	FE	IV	FE	IV
Lerner	2.329***	5.922***	1.512***	3.585**	19.018***	49.382***
	(0.463)	(1.305)	(0.575)	(1.493)	(6.103)	(17.028)
Size	0.362	0.166	-0.692	-0.872*	5.002	2.996
	(0.312)	(0.329)	(0.478)	(0.507)	(3.980)	(4.093)
Non-interest income / Total income	-0.028	0.094	0.056	0.124	0.155	1.095
	(0.097)	(0.146)	(0.077)	(0.097)	(0.872)	(0.942)
Fixed assets / Total assets	88.118***	67.634***	81.266***	68.588***	-423.313	-594.698
	(16.189)	(19.426)	(24.032)	(23.375)	(384.378)	(447.659)
Liquidity	-0.002	-0.004	-0.003	-0.004	0.000	-0.012
	(0.003)	(0.004)	(0.004)	(0.004)	(0.039)	(0.039)
Loans / Total assets	0.002	0.002	-0.037***	-0.038***	-0.180	-0.186
	(0.009)	(0.011)	(0.014)	(0.015)	(0.207)	(0.203)
GDP growth	0.101***	0.059**	0.125***	0.100***	-0.239	-0.593
	(0.033)	(0.028)	(0.032)	(0.038)	(0.356)	(0.381)
Inflation	0.061	0.023	0.140**	0.129*	0.497	0.242
	(0.061)	(0.056)	(0.061)	(0.070)	(0.699)	(0.787)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	724	720	724	720	724	720
R-squared	0.297	0.273	0.246	0.224	0.257	0.154
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	19.53	-	19.53	-	19.53
J-stat	-	0.775	-	0.728	-	0.015
Hansen test (p-value)	-	0.378	-	0.393	-	0.902

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table A4: Competition and bank risks: results obtained with funding-adjusted Lerner

Dependent variable	Z-score	Z-score	Distance-to-default	Distance-to-default	SRISK	SRISK
	FE	IV	FE	IV	FE	IV
Lerner	2.742***	6.385***	2.314***	3.798***	16.688***	43.121**
	(0.581)	(1.285)	(0.706)	(1.420)	(6.072)	(18.870)
Size	0.415	0.570	-0.664	-0.629	5.504	6.212
	(0.336)	(0.352)	(0.517)	(0.487)	(3.920)	(3.897)
Non-interest income / Total income	-0.198*	0.142	-0.079	0.151	-0.970	1.165
	(0.116)	(0.156)	(0.073)	(0.107)	(1.069)	(1.013)
Fixed assets / Total assets	84.225***	68.278***	76.761***	69.250***	-433.965	-547.941
	(14.885)	(18.261)	(24.868)	(24.205)	(389.348)	(466.677)
Liquidity	-0.002	-0.002	-0.003	-0.003	0.004	0.006
	(0.003)	(0.003)	(0.004)	(0.004)	(0.039)	(0.040)
Loans / Total assets	0.004	0.008	-0.035***	-0.035**	-0.164	-0.140
	(0.009)	(0.011)	(0.014)	(0.014)	(0.212)	(0.208)
GDP growth	0.101***	0.105***	0.124***	0.128***	-0.220	-0.196
	(0.034)	(0.032)	(0.033)	(0.033)	(0.354)	(0.335)
Inflation	0.076	0.038	0.150**	0.139**	0.613	0.414
	(0.068)	(0.069)	(0.061)	(0.066)	(0.698)	(0.750)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	724	720	724	720	724	720
R-squared	0.284	0.303	0.248	0.251	0.244	0.193
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	12.24	-	12.24	-	12.24
J-stat	-	2.984	-	4.070	-	0.184
Hansen test (p-value)	-	0.224	-	0.13	-	0.667

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table A5: Competition and bank risks: results obtained with sample-specific Lerner

Dependent variable	Z-score FE	Z-score IV	Distance-to-default FE	Distance-to-default IV	SRISK FE	SRISK IV
Lerner	3.076***	7.578***	2.852***	6.642***	20.243***	53.831***
	(0.581)	(1.679)	(0.783)	(2.284)	(6.767)	(19.096)
Size	0.472	0.721**	-0.614	-0.469	5.859	7.323*
	(0.330)	(0.362)	(0.524)	(0.540)	(3.837)	(3.936)
Non-interest income / Total income	-0.205	0.151	-0.096	0.217*	-1.083	1.300
	(0.127)	(0.151)	(0.075)	(0.127)	(1.059)	(0.990)
Fixed assets / Total assets	82.846***	60.878***	74.639***	55.411**	-448.069	-609.661
	(14.927)	(18.422)	(25.083)	(25.997)	(391.977)	(470.083)
Liquidity	-0.001	-0.001	-0.002	-0.002	0.008	0.013
	(0.003)	(0.003)	(0.004)	(0.004)	(0.038)	(0.041)
Loans / Total assets	0.005	0.012	-0.035**	-0.030**	-0.160	-0.113
	(0.009)	(0.011)	(0.014)	(0.015)	(0.211)	(0.202)
GDP growth	0.099***	0.102***	0.121***	0.124***	-0.240	-0.222
	(0.033)	(0.033)	(0.033)	(0.034)	(0.352)	(0.330)
Inflation	0.078	0.040	0.152**	0.133**	0.627	0.421
	(0.067)	(0.069)	(0.060)	(0.064)	(0.696)	(0.752)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	724	720	724	720	724	720
R-squared	0.288	0.295	0.254	0.227	0.247	0.177
Number of banks	97	97	97	97	97	97
F-stat(First step IV)	-	16.10	-	16.10	-	16.10
J-stat	-	0.741	-	1.116	-	0.001
Hansen test (p-value)	-	0.389	-	0.291	-	0.981

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table A6: Competition and risk: results obtained with country-level measure of competition

Dependent variable	Z-score FE	Distance-to-default FE	SRISK FE	Z-score FE	Distance-to-default FE	SRISK FE
Lerner	2.786*	4.380**	31.884*	2.902*	4.428**	30.703*
	(1.516)	(1.946)	(18.169)	(1.503)	(1.932)	(17.754)
HHI				-0.865	-0.357	8.823
				(1.224)	(1.149)	(11.648)
Size	0.396	-0.718	5.107	0.403	-0.715	5.032
	(0.357)	(0.459)	(4.286)	(0.360)	(0.461)	(4.291)
Non-interest income / Total income	-0.075	0.023	-0.239	-0.081	0.020	-0.174
	(0.083)	(0.109)	(1.200)	(0.082)	(0.106)	(1.209)
Fixed assets / Total assets	94.176***	85.009***	-374.514	93.834***	84.868***	-371.024
	(16.779)	(24.982)	(363.877)	(17.007)	(24.760)	(360.361)
Liquidity	-0.002	-0.003	0.001	-0.002	-0.003	0.003
	(0.003)	(0.004)	(0.039)	(0.003)	(0.004)	(0.039)
Loans / Total assets	0.007	-0.032**	-0.136	0.006	-0.032**	-0.131
	(0.009)	(0.013)	(0.204)	(0.009)	(0.013)	(0.200)
GDP growth	0.092***	0.104***	-0.368	0.091***	0.103***	-0.359
	(0.034)	(0.033)	(0.347)	(0.034)	(0.033)	(0.350)
Inflation	0.057	0.122**	0.412	0.055	0.122**	0.429
	(0.071)	(0.062)	(0.645)	(0.069)	(0.061)	(0.654)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	724	724	724	724	724	724
R-squared	0.260	0.244	0.242	0.261	0.244	0.243
Number of banks	97	97	97	97	97	97

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. The Hansen test evaluates the joint validity of instruments used. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table A7: Competition and risk: MA(3) Lerner Index, robust regressions and crisis control

Dependent variable	Z-score FE - MA(3)	Distance-to-default FE - MA(3)	SRISK FE - MA(3)	Z-score Robust reg	Distance-to-default Robust reg	SRISK Robust reg	Z-score Crisis	Distance-to-default Crisis	SRISK Crisis
Lerner	4.803***	2.156**	23.539**	3.255***	1.547***	2.571***	2.628***	2.019**	20.750***
	(0.601)	(0.966)	(10.380)	(0.545)	(0.574)	(0.858)	(0.577)	(0.799)	(7.269)
Size	0.232	-0.813	8.183*	0.328	-0.851***	0.874**	-0.147	-0.844**	13.904***
	(0.303)	(0.499)	(4.282)	(0.231)	(0.243)	(0.362)	(0.233)	(0.384)	(3.191)
Non-interest income / Total income	-0.013	0.091	0.529	-0.165	-0.037	-0.100	-0.200	-0.112	-1.773
	(0.103)	(0.073)	(1.016)	(0.134)	(0.141)	(0.211)	(0.129)	(0.085)	(1.152)
Fixed assets / Total assets	76.745***	81.969***	-443.882	75.748***	73.305***	-78.313***	83.987***	80.403***	-512.788
	(16.169)	(25.400)	(344.138)	(14.825)	(15.614)	(23.311)	(15.622)	(29.211)	(432.139)
Liquidity	-0.002	-0.004	0.050	-0.003	-0.003	0.006	-0.001	-0.004	-0.018
	(0.004)	(0.007)	(0.055)	(0.003)	(0.003)	(0.005)	(0.003)	(0.004)	(0.040)
Loans / Total assets	0.009	-0.038***	-0.264	0.002	-0.039***	0.038***	-0.005	-0.042***	-0.019
	(0.011)	(0.014)	(0.218)	(0.008)	(0.009)	(0.013)	(0.009)	(0.015)	(0.179)
GDP growth	0.128***	0.134***	-0.249	0.070***	0.108***	-0.251***	0.079***	0.028	-0.355
	(0.031)	(0.036)	(0.373)	(0.025)	(0.026)	(0.039)	(0.028)	(0.025)	(0.278)
Inflation	0.045	0.137*	0.326	0.069	0.124***	-0.199***	-0.063	-0.086	1.476**
	(0.058)	(0.071)	(0.760)	(0.044)	(0.047)	(0.070)	(0.059)	(0.060)	(0.575)
2008-2009							-0.216	-0.284*	3.478**
							(0.155)	(0.152)	(1.748)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	664	664	664	724	724	724	724	724	724
R-squared	0.343	0.265	0.262	0.509	0.548	0.436	0.246	0.197	0.208
Number of banks	97	97	97	97	97	97	97	97	97

Note: Constant included but not reported. Robust standard errors clustered at bank level and at country*time level are reported below their coefficient estimates. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

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AVERAGE INDEX OF FINANCIAL STABILITY AND MONETARY MEASURES - THE CASE OF THE REPUBLIC OF MACEDONIA

Aleksandar Petreski and Elena Mucheva Mihajlovska

Abstract

This research introduces a new methodology for creating indexes - the average index of financial stability (average of multiple indexes created with multiple methods), which proved to be more reliable than using individual indexes to present the state of the financial system. Furthermore, this study has contributed with new methods of creating the index as follows: modified portfolio method with decomposition of variance, modified portfolio method with dynamic variances, modified portfolio method with signals and method of VaR (Value at risk).

The financial stability index shows that in the times of stress of the Macedonian financial system due to the effects of the global financial crisis, the most responsive stress indicators are credit and deposit activity of banks, along with the stock index, the housing price index and currency risk indicator (foreign currency deposits/total deposits). Increased financial stress is triggering the materialisation of credit risk, the effects of which are usually felt minimum after a period of two quarters. The tested structural VAR model showed that there is a strong and instant mutual relationship between financial stability index and monetary policy. The TVAR model showed that the reaction of financial stability index to the change in monetary measures depends on the state in which is the financial system (state of stability/state of stress), and that in times of financial stress, restrictive monetary measures add to downward movement of the financial stability index.

TVAR and linear VAR models which incorporate the financial stability index have greater predictive power than linear VAR models excluding the financial stability index.

Keywords: Financial stability indices, financial stress, monetary policy

JEL classification: E5, E17, C43, G10

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1. INTRODUCTION

The latest financial crisis has revealed and emphasized the hidden links between financial markets and economic trends, and generally between financial and economic systems. In response to the crisis, regulators focused their attention mostly on the issue of systemic risk, ie the risk of failure of individual financial institutions, which could disrupt the functioning of the whole financial system (ECB, 2009). According to Bandt and Hartmann (2000), "systemic crisis" (in the narrow and broad sense) can be defined as a systemic event that affects a considerable number of financial institutions or markets, thereby severely impairing the general well-functioning of the financial system. According to the same authors, "systemic event", in the narrow sense, can be defined as an event, where the release of "bad news" about a financial institution, or even its failure, or the crash of a financial market leads in a sequential fashion to considerable adverse effects on one or several other financial institutions or markets, e.g. their failure or crash. In the broad sense, "systemic events" include simultaneous adverse effects on a large number of institutions or markets as a consequence of severe and widespread shocks. Still, it should be mentioned that "systemic risk" is a wider concept then "financial stability", since the contamination effects may also occur in other sectors of the economy, different from the financial system and therefore, systemic risk can only be partially grasped by these indices.

As a consequence of stronger systemic financial-economic links, traditional macroeconomic models include variables that reflect the state of the financial system. Striving to include variables that would trace the whole complexity of relationships in the financial system, financial stability indexes are created. Financial stability index is incorporated in macro-modeling as the representative variable for the financial system, rather than involving numerous variables. The idea is to simplify reality and to represent it by a single variable, by which the state of the financial system (normal state, a state of stress) could be identified in the early phase. However, while facilitating the process of macro-modeling by leaving space for model practitoners to focus on the relationship between macro-economic variables, it raises the question concerning the method of creating financial stability indexes.

The issue of creating financial stability indices is multi-dimensional and poses many sub-questions: which variables should be included in the financial stability index, how to aggregate variables in an index, how much weight to give to each variable, whether the index is credible, can the index be predicted, whether the index as an indicator of systemic risk affects the materialization of other risks and so on.

Thus, to overcome the problem of choosing methods for aggregation of the financial system variables into a single index, in this study indices are aggregated by several methods and an average index of all indices is created. This is precisely one of the contributions of this research – creation of the "average" financial stability index.

The purpose of the indices of financial stability is to timely indicate stress in the financial system and therefore the study tried to answer which of the created indices has the biggest power for early recognition of crisis ie which of the created indices has the strongest short-term prediction power of crises in the financial system. We tested whether the indices of financial stability can accurately identify periods of stress in the Macedonian financial system and in particular, the effects of the global financial crisis of 2008-2009.

The study also aims to identify the main indicators of the financial crisis i.e the segments of the financial system where financial stress was mostly pronounced.

Furthermore, through the Vector Auto Regression (hereinafter VAR) models we analyzed how each of the indices, as the indicators of systemic risk, affects the materialization of credit risk, as the dominant risk in the financial system.

Once the index is created, new questions arise while macro-modeling: by which method to test the relation index - monetary policy, whether the index trully improved the predictive power of the macro-models, whether the index can help to overcome non-linear effects in macro-modeliing etc. Our study attempts to tackle all these questions, although certainly there are other issues that remain to be answered.

Through the use of Structural Vector Auto Regression (hereinafter SVAR) models, the research tries to identify the relationship index -> monetary measures and vice versa, the relation monetary measures -> index. Further, we analyzed whether the reaction of the financial stability index to the change in monetary measures, depends on the state of the financial system (state of stability/state of stress).

In addition we tested whether Vector Auto Regression models with Threshold (hereinafter TVAR) models and Markov Switching Vector Auto Regression (hereinafter MSVAR) models help in identifying periods of stress in the financial system. Because of possible problems with non-linearity in the classic VAR models, the study investigated whether the use of these models, when incorporated financial stability index as a variable and as an indicator of the state of the financial system, helps in macro-economic modeling.

LITERATURE REVIEW

Literature on financial stability indexes begins to evolve in response to the debate about whether regulators should take into account the financial variables when making their decisions. For this purpose, papers appeared which endeavor to present financial variables through indexes. Following the example of monetary indexes, financial indexes were created. Many studies have analyzed the role and effectiveness of financial indexes as early warning indicators of stress in the financial system.

According to the analyzed empirical studies which focus on the financial stability, two different approaches for creating indexes are distinguished: qualitative method or signal approach and quantitative method for calculating stress index on the financial system.

According to the signal method, systemic crisis is identified by the occurrence of certain adverse events (Demirguc, Detragiache (1998); Goldstein, Carmen and Kaminsky (2000) . The idea is that the set of selected variables, would have behaved differently before the crisis than in "normal" conditions. Whenever the value of the indicator exceeds a certain threshold it is identified as a warning signal.

Regarding the nature of the variables that are aggregated, Borio and Lowe (2002) focus on the imbalanced level, rather than on the normal level of the variables. Illing and Liu (2003) built a weighted index using number of different financial stability indicators, which are combined by the method of principal components. Hollo and others (2012) introduced an indicator of stress of the financial system, whose statistical design in aggregating financial variables is based on the application of portfolio theory. Our research among other methods, uses the method of Hollo, as well.

Our study introduces the "average index" as a combination of previously created multiple indexes. The idea of combining models and methods, is not new and numerious empirical studies have drawn upon the idea that combining multiple forecasts leads to increased forecast accuracy.According to Clemen (1989), the work of Reid (1968, 1969) and Bates and Granger's (1969) are considered by most forecasters to be the seminal works in the area of combining forecasts. He also concludes that in many cases one can make dramatic performance improvements by simply averaging the forecasts.

Recently, due to the burst of data analysis software, the number of articles on the combination of forecasts has increased dramatically. We were firstly introduced to this idea, accidentally encountering the work of Stock and Watson (2004), in which they show that a combination of forecast models for predicting gross domestic product (GDP) is more stable than the forecast of the separate model.

As we became aware of the notion of combining forecasts and the value of doing so, we applied it to the theory of indices and consequently, the "average index" was created. In fact, that is one of the biggest contributions of this study, which uses the "average index" of financial stability thereby enriching the existing academic literature for creating indexes. The "average index" proves to be one of the indices that shows the lowest prediction error, which indicate that it can be used for early detection of financial crises.

For the purpose of this research and analysis of the relationship between financial stability and monetary policy, we constructed a composite indicator of monetary measures, as a proxy for the monetary policy stance, similar to the monetary indices in the studies of Eika (1996) and Dudley and Hatzius (2000).

In the literature, there are papers in which effects of financial shocks on the real economy are analyzed (Gertler and Karadi, 2010). Zivanovic (2015) used the Structural Vector Auto Regression (SVAR) model as a method to analyze the effects of financial shocks on economic activity.

In our research we used the SVAR model as well, but to analyze the impact of financial shocks on monetary policy.

The basic assumption of SVAR models is that innovation in the various relationship equations are unconnected (diagonal, orthogonal). According to Bernanke (1986), to explain the intuition behind orthogonal restriction in the SVAR model, one must think about structural innovation as the primitive exogenous forces that can not be directly observed, which drive the system and cause oscillations. Furthermore, because these shocks are primitive, they have no common cause, so it is natural to treat them as approximately unrelated. Since the assumption of incoherence does not correspond with the observed data and theoretical background, instant relationship between the variables should be introduced so that the VAR model could be transformed into the SVAR model (Pfaff, 2008). For this purpose, in order to identify the instantaneous correlation, SVAR model requires imposing restrictions on the correlation structure of VAR residuals. The main drawback of SVAR methodology is that because of the small size of the typical SVAR models, the assumption that innovations (shocks) are unrelated (orthogonal) is probably too restrictive (Gottschalk, 2001). Moreover, there are studies in which the identification is performed by setting short and long term restrictions by the method of Blanchard and Quah (1988). However, our research does not use this approach and focuses exclusively on the establishment of short-term restrictions.

In the time series modeling, the assumption of constant linear structure over time is not appropriate, when the external structural relationship has changed significantly. The article of Ferraresi, Roventini, Fagiolo (2014), has made a good review of the literature that explains this interaction. The existence of financial frictions (Brunnermeier, 2012) implies that financial markets cause shocks in nonlinear way, increasing the size and duration of adverse shocks in supply and demand (Bernanke, 1999; Gertler and Kiyotaki, 2010). Wright and Ng (2013) found that all recessions that hit the US economy in the last 30 years come from shocks in the financial markets.

Such nonlinear shocks are analyzed with models of dynamic processes that can suddenly switch the equilibrium (regime). The recent financial crisis has shown that financial markets are characterized by rapid change in the market sentiment (bull/bear market), the state (regime) of liquidity/ iliquidity, high/ low volatility, credit amplitudes, extended periods of depreciation and appreciation of foreign exchange rates and so on.

In recent econometric literature, when modeling non-linear relationships two types of models are often utilized: Threshold Vector Auto Regressive (TVAR) models and Markov Switching Vector Auto Regressive (MSVAR) models.

TVAR models have interesting features, which makes them useful and flexible tool to address the non-linearity arising from the change of regimes, multiple equilibria and asymmetrical responses to shocks (Atanasova, 2003). In practice, two types of TVAR nonlinear models are applied, where in the first type of model threshold variable is endogenous, while in the other type of model threshold variable is exogenous.

The following variables are used as threshold:

- GDP growth / production gap (Auerbach and Gorodnichenko (2012), Bachman and Sims (2012);
- Financial stress indices (Afonso, Kovner and Schoar, 2011; Hollo and others, 2012);
- Indices of banking crises (Turrini et al., 2010);
- Level of public debt (Baum and others, 2012).

Before these models are applied, an important research question is the test of non-linearity i.e whether the nonlinear model fits the data better than a linear model. This test is non-standard, because some of the parameters cannot be identified under the zero hypothesis (of linearity), when using the univariate likelihood test (Tsay, 1998). In addition, Tsay (1998) and Koop (1996) developed and tested for multi-variable models.

Research closest to our study is the work of Hollo and others (2012), which applied TVAR methodology to the data from EU countries, with the index of financial stability as an endogenous threshold variable in the model.

Unlike their work, this study uses data for Macedonia and focuses only on the mutual relationship between the financial stability index and monetary policy. Furthermore, this study uses multiple indexes created through various methods and tests two models: an endogenous model (in which the financial stability index is an endogenous threshold variable) and an exogenous model (in which the financial stability index is an exogenous threshold variable).

Another popular tool for ascertaining relation between regime (state) of the financial system and other economic variables is Markov Switching VAR. Using this model, Hollo and others (2012) showed that the increase in the index of financial stability leads to a decline in industrial production in the EU, if the index exceeds a certain threshold. Similarly, Hubrich and Tetlow (2012) using the Markov Switching VAR have investigated the impact of financial stability index on the economic activity in the US and proved that economic dynamics is dependent on the regime (state) the financial system. Also, Aboura and Van Roye (2013), using Markov Switching VAR and monthly data for France, have analyzed the relationship between the financial stress index, inflation, industrial production and short-term interest rate and confirmed these results.

In our research, by using Markov Switching VAR model we explore the relationship between an index of financial stability, GDP and monetary variables, using quarterly data for Macedonia, with the focus on the mutual relationship between the financial stability index and monetary policy.

1. FINANCIAL STABILITY INDICIES

The index of financial stability is an attempt to synthesize the complexity of the financial system through one variable. The goal is through its movement to learn about the level of financial stability in the economy, where up state means "stress" ("instability") of the financial system, and down state means "stability" of the financial system.

1.1. Data

In the construction of indices we used quarterly data for the period from the first quarter in 2005 to the third quarter of 2015. Although, the analysis is focused on the state of financial system, the inclusion of more variables from the banking system is no accidental coincidence, given the fact that assets of the banking system participates in the total assets of the financial system with 86.8 %. Therefore, it is expected that the banking system to have dominant impact on the index of financial stability.

The variables reflect all segments of systemic risk:

Banking indicators:

Credit risk:

- Loans to hoseholds / GDP,
- Loans to companies / GDP,

Liquidity risk:

- Loans / deposits,
- Non-financial entities deposits,

Currency risk:

- Foreign currency deposits / total deposits,

Interest rate risk:

- Interest rate on denar long-term loans to households,
- Interest rate on denar long-term loans to companies,
- Interest rate spread between newly approved denar deposits and loans,

Non-banking indicators:

- Macedonian Property Index,
- Macedonian Stock Exchange index (MBI 10),
- Current account balance / GDP.

We include combination of very responsive variables (property index and stock market index) and less responsive variables (loans to GDP, Current account balance / GDP) in order to strike the balance between responsiveness and noise. If we include only very reactive variables, we would encounter with noise in the indices and we could not identify the true state of the financial system.

1.2. Adjustment of variables

At the begining, we checked the direction of data movement. Since the increase of certain variables does not indicate stress, but stability, those were multiplied by (-1). Then, data was tested for stationarity with the Augmented Dickey-Fuller test (Annex 1) and if the null hypothesis was not rejected (if it is integrated), data were differentiated until they became stationary. Lastly, under the assumption of normal distribution of the data, all variables were normalized to one scale (through the formula: $z = \frac{x\text{-}mean}{std}$), and subjected to further processing.

1.3. Methods for construction of indices

In the procedure of creating indices, we first decided which variables to include in the indices and secondly, how much weight should be given to the variables used.

Considering that the description of the financial reality with single index is restrictive and subject to a risk of incorrect assessment of the state of financial stability, we created seven individual indices using different methodologies.

The idea is to get a multifaceted perspective on the state of the financial system and thereby reduce the risk of misidentification of financial stress. Therefore, an "average index" was created as well, as a contribution of this paper to the literature on methodology of creating financial stability indices.

Below we explain the methods for calculation of financial stability indices.

1.3.1. Portfolio method

Similar to the Hollo study (2012), this method uses the principles of portfolio theory in aggregating financial system data into the composite indicator. In contrast to this study, our study involved different variables, specific to the Macedonian financial system, and instead of scaling data using their empirical distribution, the data is standardized assuming normal distribution. Specifically, the variables are aggregated using weight factors that reflect the dynamic (time-varying) cross-correlation structure.

Adjusted data for the variables, used in the index, goes through these calculations:

Financial Stability index $\quad Index=(w*xt)*Ct*(xt*w)'$

Where $w=(w_1, w_2, w_3 ... w_{11})$ is the vector of constant equal weight factors, $x_t=(x_{1,t}, x_{2,t}, x_{3,t} ... x_{11,t})$ is the vector of variables, $(w*x_t)$ is the Hadamard product (element-by-element multiplication of the vector of weights with the vector of variables), while the matrix C_t is matrix of dynamic cross-correlation[1] between the variables:

$$Cross-corelation\ matrix \qquad C_t = \begin{pmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \rho_{14,t} & \rho_{15,t} & \rho_{16,t} \\ \rho_{21,t} & 1 & \rho_{23,t} & \rho_{24,t} & \rho_{25,t} & \rho_{26,t} \\ \rho_{31,t} & \rho_{32,t} & 1 & \rho_{34,t} & \rho_{35,t} & \rho_{36,t} \\ \rho_{41,t} & \rho_{42,t} & \rho_{43,t} & 1 & \rho_{45,t} & \rho_{46,t} \\ \rho_{51,t} & \rho_{52,t} & \rho_{53,t} & \rho_{54,t} & 1 & \rho_{56,t} \\ \rho_{61,t} & \rho_{62,t} & \rho_{63,t} & \rho_{64,t} & \rho_{65,t} & 1 \end{pmatrix}$$

Taking into account the dynamics of cross-correlation between variables, this method gives more weight to the periods in which financial stress occurs simultaneously across multiple variables (segments of the system). It is expected that financial stability risk is greater when the correlation between variables increases.

1.3.2. Modified portfolio method with Forecast Error Variance Decomposition (FEVD)

This new method is one of the contributions to the methodology for creating indices. Similarly to the previous method, we used the principles of portfolio theory, except that the weights for the variables are not equal.

All variables are modeled with the VAR model, Forecast Error Variance Decomposition (FEVD) is calculated and FEVD coeficients are extracted. Using extracted FEVD coefficients of influence of one variable on another, the mean is calculated for every variable, which represents its weight.

The greater the impact of every variable on other variables, the greater the weight.

1.3.3. Modified portfolio method with dynamic variances

This new method is also a modified portfolio method, where weights are obtained from dynamic modeling of variance, instead of using equal weights.

Variance is modelled using the dynamic EWMA model, with parameter $\lambda = 0.94$.

$$\sigma_n^2 = \lambda \sigma_{n-1}^2 + (1 - \lambda) u_{n-1}^2$$

Variables with higher value for the variance have a higher weight.

1.3.4. Modified portfolio method with signals

Opposite to the portfolio method, variables gain appropriate weights according to their predictive power in GDP[2] modeling, as one of the most important macroeconomic variable.

It is observed whether certain variables can predict the direction of movement of GDP, so if they are moving in the same direction with GDP, the variable is assigned the value of "1" and if they are moving in opposite direction, they are assigned "0". Summarized coefficients for every variable are collected for the entire period of observation and the relative share of variable in the total of coefficients is calculated, which is actually a weight factor.

[1] Dynamic cross-correlation is estimated using EWMA (exponentially weighted moving average) = model to predict the volatility of the variables in the future, based on historical volatility of the used data. It emphasis the present value of the variables. It is obtained by the written formula, where the value of the lambda is 0,94:

$$\sigma_n^2 = \lambda \sigma_{n-1}^2 + (1 - \lambda) u_{n-1}^2$$

[2] The method used GDP, because later in the study it is tested whether adding the financial stability index as additional variable in the VAR models, improves their predictive power in GDP modeling. This also retains the consistency of the research. Another fact validates the choice of the GDP, as variable for selecting optimal weights, later, structural VAR tests resulted that the index influences the GDP.

The greater the predictive power of a variable on the direction of GDP movement, the higher the weight.

1.3.5. Modified portfolio method with simulations

This new method is also a modified portfolio method, with the difference that instead using equal weights, it uses weights obtained as optimal in regressing the index on GDP.

Actually, weights are obtained by 10,000 simulations, which are further used in aggregating the index. The index is regressed on the GDP, and the optimal mix of weights and apropriate index is selected[3].

As optimum weights are considered those that display the smallest root mean squared error when regressing the index on GDP.

1.3.6. Principal Components method

This method, which is based on modeling the structure of the variance and the reduction of redundant factors, is quite widespread in the literature for creating financial stability indices: Brave and Butters (2011), Angelopulo, Balfosia and Gibson (2013) and Petrovska and Mucheva (2013). Through eigenvalue decomposition of the matrix of variables variances, major components are extracted i.e linear combination of variables that explain most of the variability among the group of variables.

Covariance matrix V for the variable X is calculated through:

$$\frac{1}{N-1} \times X^{t} \times X$$

which can be decomposed

$W \quad = W\Lambda$ where $W^{-1} = W^{'}$

The main factors are linear combinations of the analyzed variables

$$P_{(N\times m)} = X_{(N\times m)} W_{(m\times m)}$$

where weights are the values for W

$$P_m = w_{1m}X_1 + w_{2m}X_2 \dots w_{Nm} X_N$$

But, with $W^{-1} = W^{'}$, is calculated $X_{(N\times m)} = P_{(N\times m)} W^{'}{}_{(m\times m)}$

$$X_i = w_{i1}P_1 + w_{i1}P_2 \dots w_{i1}P_n$$

Reduction of variables is done by selection of those main components that explain at least 90% of the variance of the system (in this case 7 components out of 11).

Table 1 Principal components explaining the variance of the system

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11
Standard deviation	16.100	14.659	12.558	11.677	100.945	0.86699	0.80268	0.65908	0.51179	0.39132	0.2321
Proportion of Variance	0.2356	0.1954	0.1434	0.1240	0.09264	0.06833	0.05857	0.03949	0.02381	0.01392	0.0049
Cumulative Proportion	0.2356	0.4310	0.5744	0.6983	0.79097	0.85931	0.91788	0.95737	0.98118	0.99510	10.000

Thus, higher weight have the variables that have higher contribution to the total variance (Annex 2).

[3] The GDP is used again for the same reasons as in previous method.

1.3.7. Value at Risk method (VaR) method

Assuming normal distribution of the variables, the weight for each variable is obtained using opposite normal function, wherein the inputs are: probability of 95%, dynamic total average and dynamic total standard deviation.

1.3.8. Average index method

The method of "average index" is one of the contributions of this study. We are not aware of other studies which use an "average index" of financial stability.

The approach consists of the calculation of arithmetic average of all indices obtained using previous methods.

Although the method is simple, its use brings positive effects: successful identification of periods of financial stress, the lowest standard deviation compared to all other indices (Annex 3) and better predictive power.

1.4. Results for financial stability indices

Movement for each of the financial stability indices are presented in Figure 1. The upward direction of movement of each of the indices means increased stress of the financial system (instability) and their decrease indicates a state of stress (stability). It may be noted that the effects of the global financial crisis on Macedonian financial system are felt in the late third quarter of 2008 to the end of the third quarter of 2009. In addition, six of the eight indices of financial stability reach a maximum in the same time period (2009/1), and two indices peak in 2009/2.

Figure 1. Financial stability indices (compared)

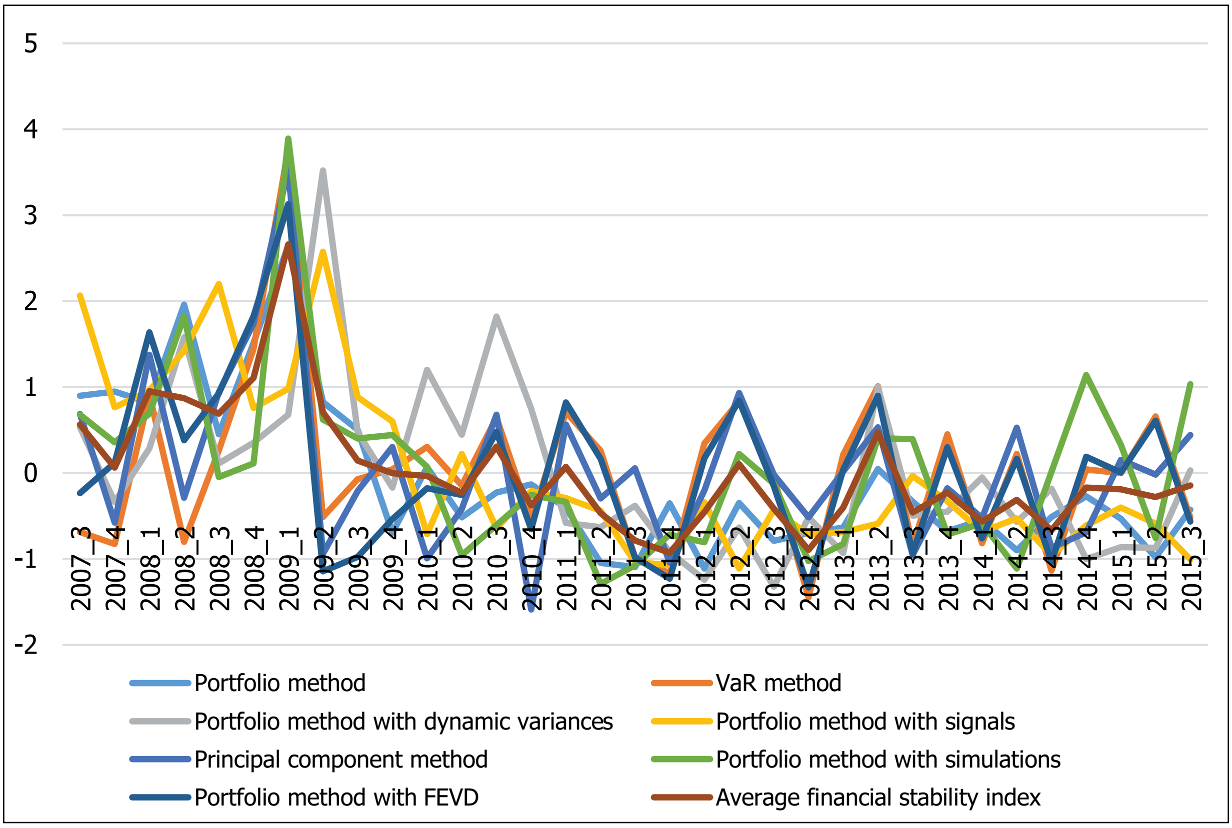
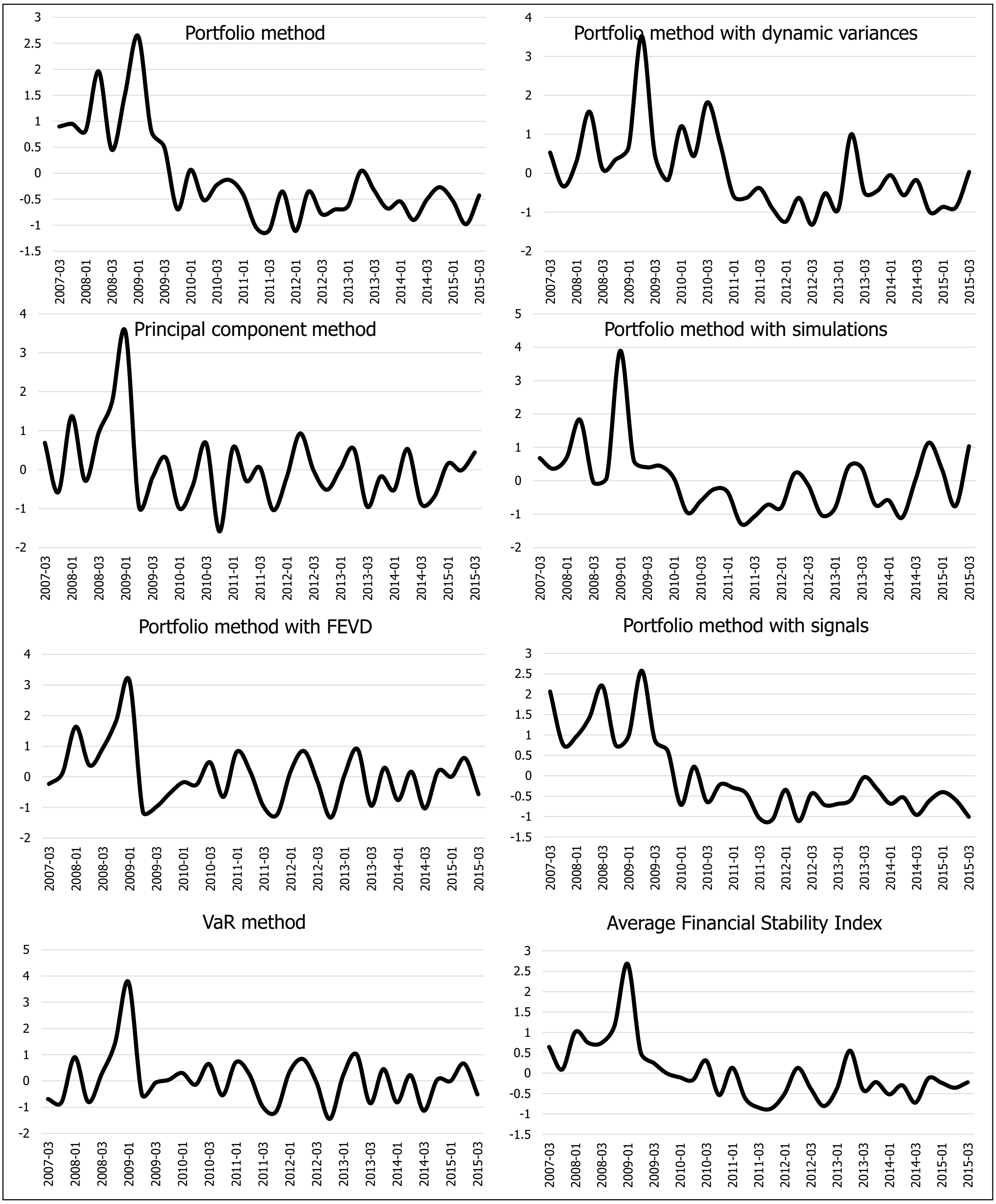


Figure 2. Financial stability indices (shown separately)



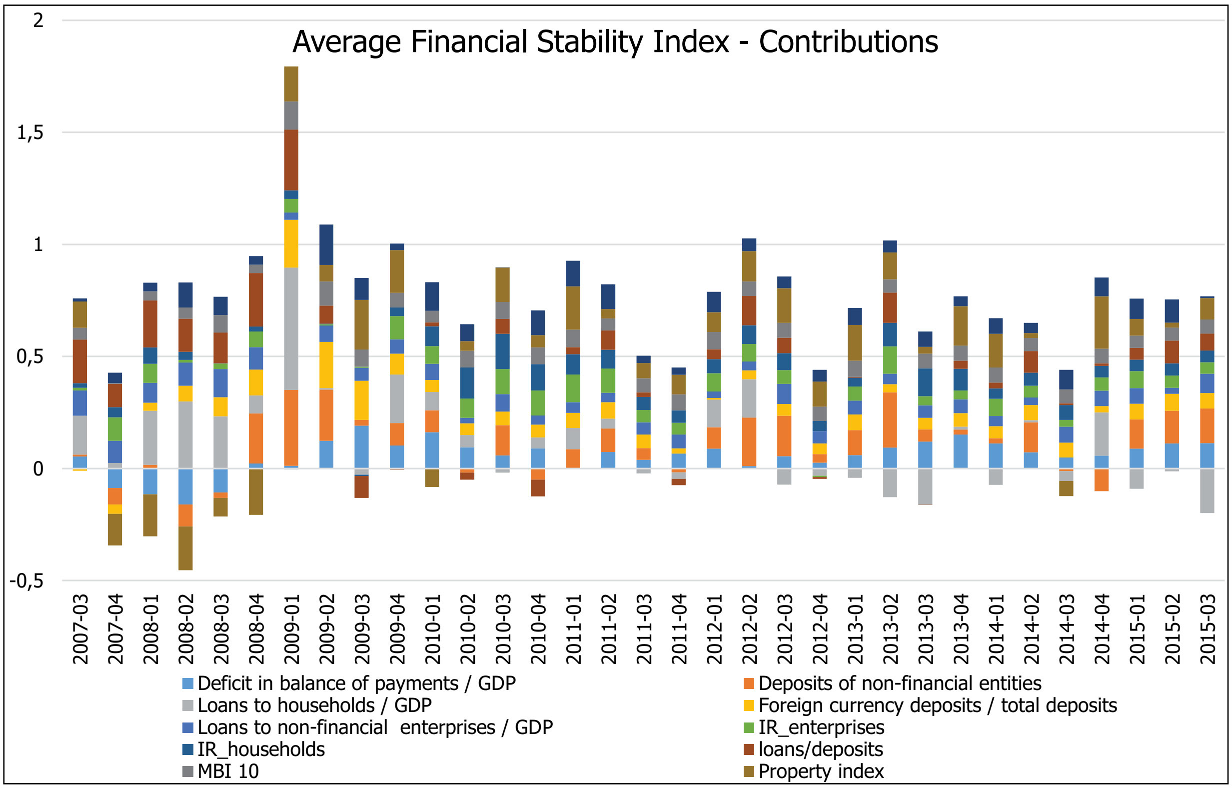
Moreover, a growing gap between constructed indices obtained using correlation between variables and indices without correlation (only weights) may be observed (Annex 4).

When analyzing the indices, one should take into account that not every increase in the index means start of crisis. The main challenge is to identify the real increase in the index i.e the critical level of the index, above which increase means stress. This may be facilitated by two additional parameters: thresholds in indices obtained by TVAR models or calculated probability of being in stress, obtained by MSVAR models.

1.5. Contributions in the financial stability index

Analyzing the results of the eight methods for calculating the financial stability index, it can be noted that in almost all indices, deposit and credit activity of banks are the main drivers of the index (Annex 5). These findings are logical given the fact that the Macedonian financial system is still small and bank-based. During the global financial crisis, the stock index, the property index and currency risk indicator (foreign currency deposits / total deposits) moderately influence stability of the financial system (Figure 3).

Figure 3. Structure of the FS "average index"



1.6. Composite indicator for monetary measures

A composite indicator for monetary measures is constructed combining monetary policy instruments: the amount of central bank bills, their interest rate and reserve requirement ratio.

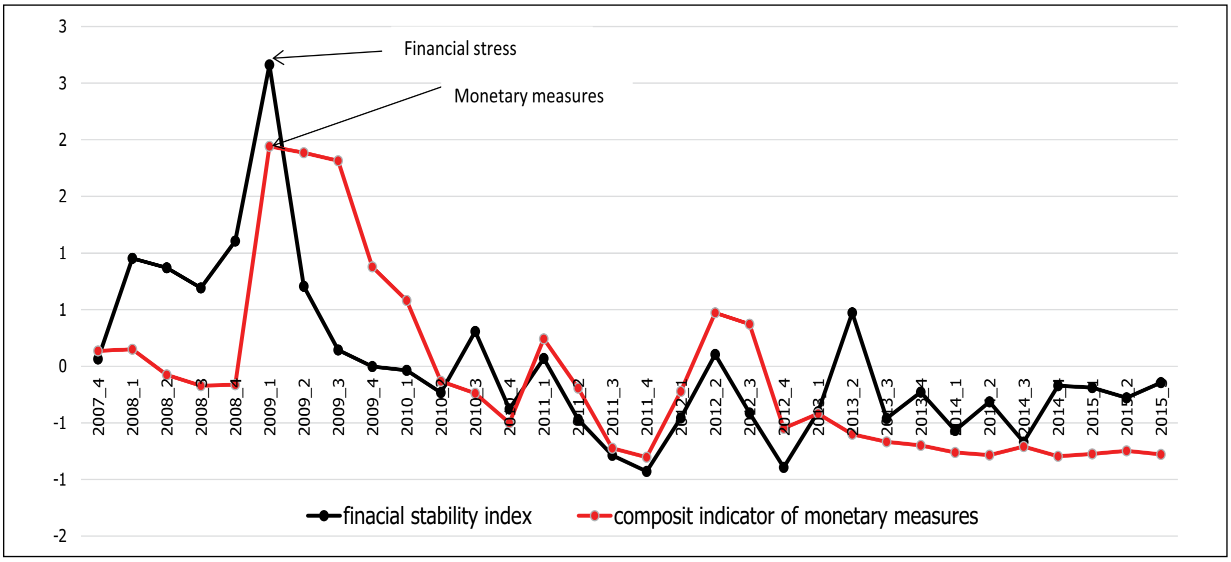
The idea is to create a tool which will avoid static data for monetary policy instruments and possible problems in further empirical calculations and analysis.

The impact or weighting of each of the monetary policy instruments is determined using the same methodology, which was previously used for financial stability indices. However, it must be pointed out that after creating eight composite indicators of monetary measures according to different methods, we used only the "average" composite indicator.

Movement of the composite indicator for monetary measures in the upward direction means restrictive changes in monetary measures, while movement in the downward direction is interpreted as relaxation in the monetary measures.

As shown in Figure 4, the composite indicator of monetary measures spikes in the first quarter of 2009. Similarly the index of financial stability ("average index") reaches its maximum, as an effect of the stress stemming from the global financial crisis. The interest rate on Central Bank bills has the largest contribution to the increase in the composite indicator. In that period, the National Bank increased the interest rate on central bank bills in response to the financial stress.

Figure 4. FS index vs monetary policy measures



2. FINANCIAL STABILITY INDEX AS AN EARLY WARNING INDICATOR AND ITS MATERIALIZATION

The Central Bank is expected to provide timely assessment of the state of the financial system and identify sources of possible crises. For this purpose, a common practice in many countries is to use early warning systems for identification of financial stress, where the main instrument is the financial stability index.

This research attempted to develop an early warning system that would detect timely recognition of the financial crisis. This financial stability index should be able to recognize a financial stress since its inception.

To choose the most stable and suitable financial stability index as an early warning indicator, we performed tests on the projection of the indices. In general, the indices are inherently exogenous and their projection is not easily achievable. However, the structure of indices, created in this research, reflects bank-oriented financial system, which means that impact from stock market and other unpredictable segments is insignificant and allows some short-term predictability. Therefore, these indices are projected only up to four quarters.

An efficient financial system should enable normal channeling of savings into real investments. Systemic shock to the financial system can lead to extreme credit rationing of the real sector. Therefore, this study analyzes the consequences of the detected stress on the materialization of risks. The focus is on the materialization of credit risk, as the largest risk to which banks are exposed (the most dominant group of institutions in the financial system). The share of risk-weighted assets for credit risk in the total risk-weighted assets of the Macedonian banks accounted for 87.6 %, as of 30.09.2015[4].

We use the following indicators[5] for materialisation of credit risk:

1. Absolute level of impairment;
2. Average level of risk (impairment/credit exposure);
3. Non-performing loans/total loans;
4. Ratio between the number of borrowers who transferred to better risk category and those that deteriorated;

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4 Source: NBRM, Quarterly Report for the banking system at the end of the third quarter of 2015.

5 Source for 4, 5 and 6: NBRM, Transition matrix of borrowers in banks.

5. Percentage of borrowers who transferred to a worse risk category in the total number of borrowers;
6. Quarterly change in the percentage of borrowers in risk category "A" and "B" in the total number of borrowers.

2.1. Financial stability index as an indicator for early warning

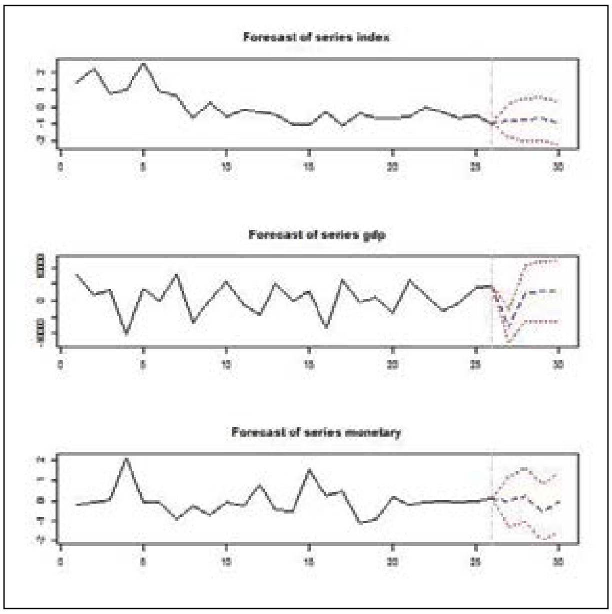
The projection of the index is assessed through vector autoregressive model (VAR model). When projecting the index, we included three variables: real GDP, financial stability index and monetary variable.

We performed 96 projections of the financial stability indices using VAR and restricted VAR models with: three monetary variables (outstanding amount of central bank bills, their interest rate and composite indicator of monetary measures), eight indices of financial stability and the four types of deterministic factors (only constant, only trend trend + constant without deterministic factor).

In order to observe the prediction power of indices as the indicator of financial stability, root mean square standard error (RMSE) is calculated, based on the difference between projected and realized observations, and the results are summarized in Annex 6.

Among monetary variables, on average, models that use the interest rate of central bank bills and the composite indicator of monetary measures (RMSE = 0.53 and 0.54) show the lowest prediction RMSE. Among financial stability indices, on average, the models that use the "average index" and the "index with modified method of signals" show the lowest RMSE in self-predicting, which means the highest power for early crisis recognition. It is interesting to note that while the "index with principal component method" had the best adjustment (fit) of data in the sample it showed the worst results when used for prediction out of the sample.

Figure 5. Projections on index, GDP and monetary policy measures



Furthermore, we tested the residuals of the models through appropriate statistical tests:

1) Normality test – Shapiro - Vilk test[6]
2) Autocorrelation test – Durbin Watson test[7]
3) Homoscedasticity test – Arch –LM test[8]

6 performed using R package {stats} with the function Shapiro.test()
7 performed using R package {lmtest} with the function Dwtest()
8 performed using R package {vars} with the function Arch.test()

The tests results showed that almost all models pass the tests for normality, autocorrelation and homoscedasticity.

2.2. Materialization of financial stress on credit risk

In terms of the types of risks to which the banks are exposed during their operations, the most important is credit risk. Therefore, it is important to analyze how stress in the financial system affects this risk. We tested what would happen to the credit risk, if the index is shocked and appropriate credit risk indicators deteriorate.

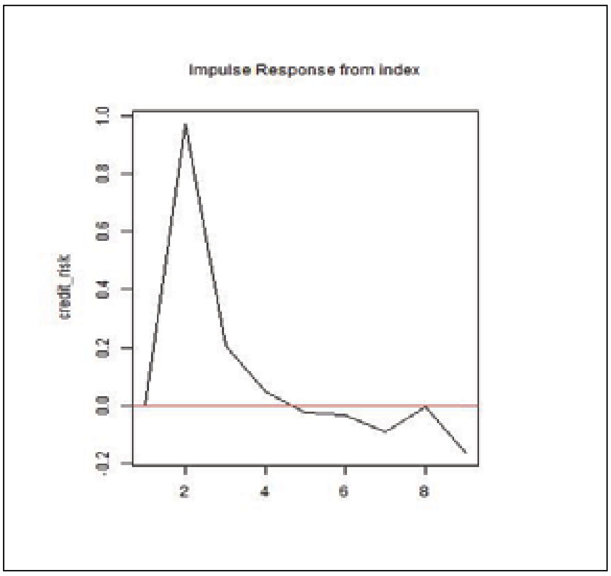
For the purpose of the materialization analysis, we performed 546 assessments of VAR models with four variables: eight financial stability indexes, six credit risk indicators, three types of monetary variables and four types of deterministic factors. Also, at each estimation, we calculated VAR, restricted VAR and performed Cointegration test. If cointegration among the factors occurred Vector Error Correction model (VEC) was performed.

The results (Annex 7) indicate that models that include the "index with principal component method", the "index with modified portfolio method with dynamic variances", the "index with modified portfolio with signals" and the "average financial stability index" show the lowest RMSE.

Furthermore, models residuals were checked through appropriate statistical tests: normality test of residuals, autocorrelation and homoscedasticity test.

Tests results showed that almost all models pass the tests for normality, autocorrelation and homoscedasticity.

Figure 6. Impulse response of credit risk to the shock in the FS index



In conclusion, impulse response functions in Figure 6 show that the reaction of the credit risk to the shock to financial stability index is usually initiated after minimum two quarters. This result is not susrpising, as we include more responsive credit risk indicators, which indicate movement in risk categories, rather then slower changes in impairement. Also, historical results confirm the findings. Macedonian GDP, as a result of reduced export demand and damaged confidence, decreased in the fourth quarter in 2008. The same period was identified by the financial indices as the peak of the financial stress. After two months, in the first quarter of 2009 the stress materialized and banking corporate sector portfolios deterioted as the effect of the financial crisis.

3. SVAR

Through the use of Structural vector auto-regression (SVAR) models, this study sought to investigate the links:

• index -> monetary measures

• monetary measures -> index.

Specifically, the study tries to identify whether the Central Bank perceives the crisis in a timely manner, whether it takes appropriate measures and do undertaken measures affect the stability on the financial system.

3.1. SVAR methodology

In this paper, the Structural vector autoregressive (SVAR) model is used to analyze short-run and contemporaneous relationships between the financial stability index and macroeconomic variables, focusing on interdependence of financial stability and monetary policy.

We used SVAR as a tool, since we are interested in the short run effects of of pure unrelated schocks on the financial stability and on the monetary policy. Therefore, for the purpose of accomplishing unrelated (orthogonal) innovations, the SVAR model requires imposing restrictions on the instantaneous correlation structure of VAR residuals.

Among the different approaches, a Cholesky decomposition is used, with the concurrent assumption of a recursive structure of instant relationship between the variables. Recursion means the first variable depends on innovation in the first equation and in the variables with a time lag, the second variable depends on innovation in the second equation and in the variables with a time lag etc.

The SVAR model is a structural form of VAR:

$$AY_t = \alpha + \sum_{i=1}^{p} B_i\, Y_{t-1} + u_t$$

If left-multiplying equation with the inverse of A:

$$Y_t = A^{-1}\alpha + \sum_{i=1}^{p} A^{-1}B_i\, Y_{t-1} + A^{-1}u_t$$

or

$$Y_t = G_0 + G_1 Y_{t-1} + e_t$$

where

$I = A^{-1}A$

$G_0 = A^{-1}\alpha,$

$G_{1,i} = \sum_{i=1}^{p} A^{-1}B_i$

$e_t = A^{-1}u_t$

Y_t - matrix/vector of endogenous variables

A - matrix/vector of restrictions

α - vector of structural constants

B_i - matrix of structural coefficients with time lag i

u_t - matrix/vector of structural shocks

G_0 - vector of constants,

$G_{1,i}$ - matrix of coefficients with time lag i

e_t - matrix/vector of prediction error in restricted VAR

p - degree of auto-regression

According to Pfaff (2008), the SVAR model is used to identify the shocks (by establishing limits on matrices A and/or B) and to monitor their dynamic effects by analyzing the impulse response functions (IRF) and forward-error variance decomposition (FEVD).

Depending on the imposed restrictions, three types of SVAR- models can be distinguished:

• A model: B is set to I (minimum number of restrictions for identification is P*(P−1)/2,

• B model: A is set to I,

• AB model: restrictions can be placed on both matrices,

where P is the number of variables.

In this study we use model A.

The test of the over-identifying restrictions is computed as[9]

$$LR = T\,(\log det\,(\tilde{\Sigma}_u^r) - \log det\,(\tilde{\Sigma}_u)$$

where,

LR is the value of the test statistic against the null hypothesis that the over-identifying restrictions are valid,

$\tilde{\Sigma}_u$ is the log likelihood from the underlying VAR(p) model,

$\tilde{\Sigma}_u^r$ is the log likelihood from the SVAR model.

In particular, the procedure for testing the SVAR model for each of the indices, goes as follows:

• we tested the degree of integration of the variables using the Augmented-Dickey-Fuller Unit Root Test[10],

• if the variables were integrated, they were subject to differentiation,

• re-test the degree of integration to check whether some variable entered the VAR model as non-stationary,

• optimal lag of the unrestricted VAR was estimated,

• we estimated the parameters of the unrestricted VAR using optimal lag, for various types of deterministic regressors (constant, trend),

• we assessed parameters of limited VAR to eliminate insignificant factors,

• the significance of VAR coefficients was checked via the T-statistic and sign before coefficient,

• a test of causality is performed,

• we defined SVAR restrictions,

• we estimated calculated SVAR model parameters,

• the significance of SVAR coefficients was checked via the T-statistic and coefficient sign,

• impulse response (IR) was analyzed,

• variance decomposition of forecast errors (FEVD) was analyzed.

[9] performed using R package {vars} with the function SVAR().

[10] ADF test is performed using R package {urca} with the function ur.df()

3.2. SVAR results

With the help of restrictions imposed on the SVAR model, the shocks on variables are identified as well as the response of the variables to the shocks. We used a combination of macroeconomic theory and empirical findings (Granger causality[11]), to establish restrictions on the VAR model.

Interaction between three factors was tested: the financial stability index, real GDP, and the monetary variable[12] by using three constraints in each combination of restrictions (10 combinations are created and shown in Table 2).

Table 2. Combinations of restrictions

1) restriction
index -> all variables
monetary measures -> index

	indeks	gdp	monetary measures
indeks	1	0	NA
gdp	NA	1	0
monetary p.	NA	0	1

2) restriction
index -> all variables
monetary measures -> gdp

	indeks	gdp	monetary measures
indeks	1	0	0
gdp	NA	1	NA
monetary p.	NA	0	1

3) restriction
index -> all variables
gdp -> index
monetary measures is not influencing anyone

	indeks	gdp	monetary measures
indeks	1	0	0
gdp	NA	1	0
monetary p.	NA	NA	1

4) restriction
index -> monetary measures
gdp -> index, monetary measures
monetary measures is not influencing anyone

	indeks	gdp	monetary measures
indeks	1	NA	0
gdp	0	1	0
monetary p.	NA	NA	1

5) restriction
index -> monetary measures
gdp -> monetary measures
monetary measures -> index

	indeks	gdp	monetary measures
indeks	1	0	NA
gdp	0	1	0
monetary p.	NA	NA	1

6) restriction
index -> monetary measures
gdp -> monetary measures
monetary measures -> gdp

	indeks	gdp	monetary measures
indeks	1	0	0
gdp	0	1	NA
monetary p.	NA	NA	1

7) restriction
index is not influencing anyon
gdp -> index
monetary measures -> all vari

	indeks	gdp	monetary measures
indeks	1	NA	NA
gdp	0	1	NA
monetary p.	0	0	1

11 Granger, C. W. J. (1969), "Investigating causal relations by econometric models and cross-spectral methods", Econometrica, 37: 424-438.

12 Monetary variables: composite indicator of monetary measures, outstanding amount of central bank bills and interest rate on central bank bills.

8) restriction

index -> gdp

gdp is not influencing anyone

monetary measures -> all variables

	indeks	gdp	monetary p.
indeks	1	0	NA
gdp	NA	1	NA
monetary p.	0	0	1

9) restriction

index -> monetary measures

gdp is not influencing anyone

monetary measures -> all variables

	indeks	gdp	monetary measures
indeks	1	0	NA
gdp	0	1	NA
monetary p.	NA	0	1

10) restriction

index is not influencing anyone

gdp -> monetary measures

monetary measures -> all variables

	indeks	gdp	monetary measures
indeks	1	0	NA
gdp	0	1	NA
monetary p.	0	NA	1

"0" - established restriction

"NA" - no restriction

In the study, 1920 SVAR tests were performed on:

• three types of monetary variables (composite indicator of monetary measures, outstanding amount of central bank bills, interest rate of central bank bills)

• eight financial stability indexes,

• ten combinations of restrictions (shown in Table 2),

• four types of deterministic factors (only constant, only trend, constant and trend, no deterministic factor) .

Tests were carried out on a stationary series, created with the differentiation of simple data. Robustness of the results is confirmed with tests on differentiated logged data. Generaly, models passed the LR test.

Before estimating the SVAR model, we estimated the VAR model in order to see the interaction between variables. The large number of VAR results allowed us to see the impact of categorical variables on the VAR log-likelihood from each test, using dummy variable regression. The regression helped us to analyze which categorical variables (type of monetary variables, type of index, and type of deterministic factors in the model), through the parameters of the model, induce increase in the VAR log-likelihood.

Dummy-variable regression results in Appendix 8 showed that the log-likelihood is mostly influenced by: the "average index", the index with "portfolio method" and the index with "modified portfolio method with signals", compared to the other indexes, "constant and trend" compared to the other deterministic factors used in the model.

Below are presented more detailed statistics on the causality test between variables. Tests of causality[13] are assessing whether a variable predicts (but not influences) other variables. Table 3 presents the percentage of tests that reject the null hypothesis of non-causality (confirm causality):

[13] Using R package "vars" with the function causality ()

Table 3. Tests that confirms Granger causality

	% of granger causality of FS index (average)	% of granger causality of GDP (average)	% of granger causality of monetary measures (average)
amount of central bank bills	3%	0%	3%
composite indicator of monetary measures	13%	9%	22%
interest rate of central bank bills	16%	16%	44%
total	9%	13%	20%
FSI fevd	0%	0%	0%
FSI Holo	25%	0%	33%
FSI pca	33%	8%	0%
FSI average	8%	0%	0%
FSI signal	0%	0%	75%
FSI sim	17%	25%	33%
FSI VaR	0%	0%	0%
FSI variance	0%	33%	42%
total	9%	13%	20%
none	8%	4%	21%
const	13%	13%	25%
trend	8%	8%	25%
both	13%	8%	21%
total	10%	8%	23%

If one compares the percentage of cases of Granger influence among variables (FS index, GDP, monetary measures), the highest percentage have monetary measures.

Monetary measures have predominantly greater percentage of cases of Granger influence in the models that are using "interest rate on central bank bills" as a monetary variable, index with with "portfolio method", index with the "modified portfolio method with variance" and "modified portfolio method with signals", as well as "constant" among deterministic factors.

We further analyzed which combination of SVAR restrictions is best among the 10 combinations and how to detect the best SVAR combination.

The combination of restrictions and other categorical variables (type of monetary variables, type of index, type of deterministic factors in the model) via the parameters affect the log-likelihood[14] of the

[14] SVAR log-likelihood:

$$\ln L_c(A,B) = -\frac{KT}{2}\ln(2\pi) + \frac{T}{2}\ln|A|^2 - \frac{T}{2}\ln|B|^2 - \frac{T}{2}tr(A^\top B^{-1\top} B^{-1} A\tilde{\Sigma}_u)\,,$$

SVAR model. The most appropriate combination would be the one that has the highest contribution to the log-likelihood of the SVAR model.

Similar to the VAR analysis, numerous SVAR results allow us, through dummy-variable regression of categorical variables on the log-likelihood, derived from each SVAR estimation, to observe the impact of categorical variables (type of monetary variables, type of index, type of restriction and type of deterministic factors in the model). The combination of restrictions that increase the log-likelihood the most are most likely to be imposed.

The results from the dummy variable regression (Appendix 9) show that the impact of monetary variables, indexes and deterministic factors is lower compared to the impact of restrictions. Furthermore, the largest contribution to the increase in log-likelihood has a restriction No. 1:

Table 4. Matrix of restriction No.1

	index	gdp	monetary measures
indeks	1	0	NA
gdp	NA	1	0
monetary p.	NA	0	1

"0" - established restriction

"NA" - no restriction

Within the restriction No. 1 (Table 4), it is assumed that in the short term: the index affects the GDP, while GDP does not affect the index; neither monetary measures affect GDP nor does GDP influence monetary measures (due to time delay); the index affects the monetary measures and vice versa, monetary measures have an impact on the index.

We wanted to know exactly which pair of SVAR restrictions is best and how to detect the best SVAR restrictions on pairs of variables.

Again, we assessed the impact of any restriction on the pair variables on the log-likelihood estimated from the SVAR model, through dummy-variable regression of restricted pairs (we use "1" for restriction on pair of variables, and "0" for no restriction on the appropriate pair).

The study investigated restrictions on six possible pairs of relationship (index -> GDP, index -> monetary measures, GDP -> index, GDP -> monetary measures, monetary measures -> index, monetary measures -> GDP).

Each of these relationships and other categorical variables (type of monetary variables, type of index and type of deterministic factors in the model) via the parameters affect the log-likelihood-of the SVAR model.

According to the results from the dummy-variable regression (Annex 10), the following restrictions on pairs contribute to a high degree towards reducing the log-likelihood: the index -> variable monetary and monetary variable -> index. Here the logic is as follows: pairs of variables that reduce the log-likelihood are least likely to be restricted and should be calculated.

Furthermore, from the results obtained in the SVAR estimation, we checked the consistency of the t-statistics for the relationship between the index and monetary variable and sign of the t-statistics in the SVAR model. We estimated the percentage of significant t-statistic that have positive, significant t-statistic that have negative sign and insignificant t-statistics, as well as the percentage of unaccounted coeficients.

Table 5. Distribution of t-statistics of SVAR models

	index -> monetary measures	monetary measures -> index
	">"	"<"
<=-2	21%	34%
> -2 & < 2	1%	12%
>= 2	51%	38%
uncomputed	27%	16%

(% in the table are distribution of t-statistics)

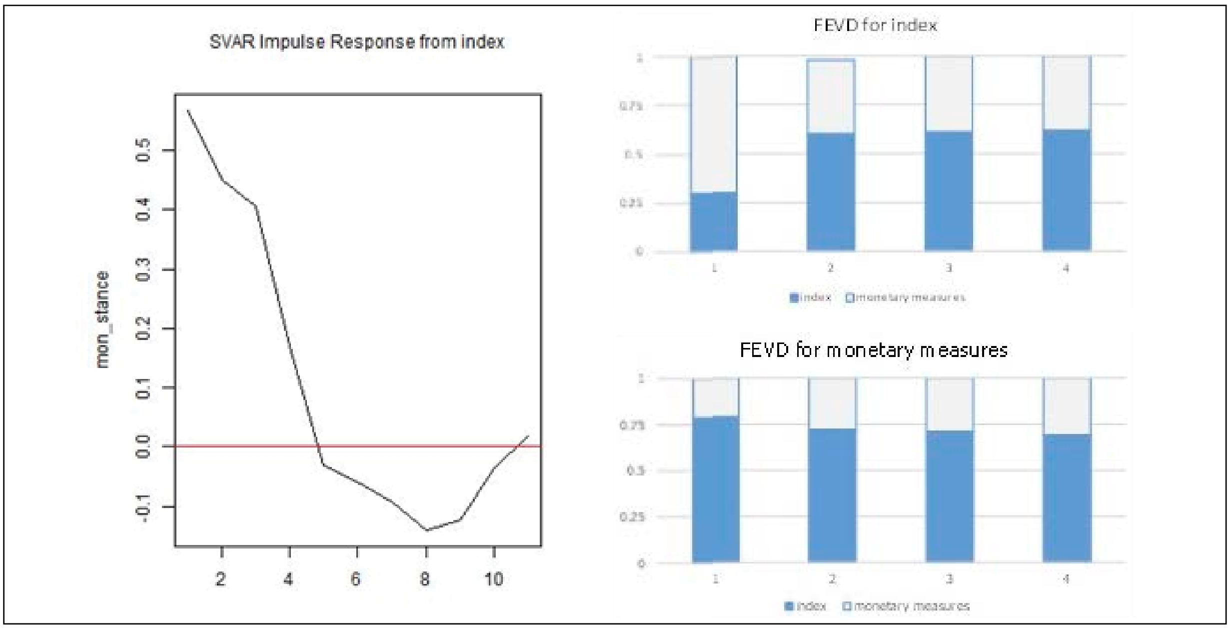
As shown in Table 5, the relation index => monetary variable, is dominated by the "+" sign for the t-statistic, which indicates that when the index changes, the monetary policy instruments operate in the same direction. In the relation monetary variable => index, the t-statistic is positive in some situations and negative in others.

Different signs of reaction of the index to changes in monetary measures, means that in different situations the index reacts differently to the monetary policy measures. It might mean that reaction of the index to monetary measures depends on the state of the financial system (stressful situation, normal).

For example, in financial stress if monetary policy becomes restrictive (increase in: amount of central bank bills, interest rate on central bank bills or reserve requirement ratio) and the sign in relations monetary variable -> index is negative, the index of financial stability will be reduced. In a stable phase, if monetary policy is relaxed (decrease in: amounts of central bank bills, interest rate on central bank bills or reserve requirement ratio) and the sign in relations monetary variable -> index is positive, the index will be reduced.

The analysis of forward error variance decomposition confirms the interaction between the index of financial stability and the monetary variable. Shock in the index results in increase of the restrictiveness of the monetary measures (Figure 7 - left). The impact of the index of financial stability on the monetary measures is stronger than vice versa (Figure 7 – right).

Figure 7. SVAR Impulse response and Forward error variance decomposition



i. Impulse response of the monetary policy measures to the shock in the FS index
ii. Forward error variance decomposition coeficients for the FS index and monetary policy measures

In conclusion, the results show that the Central Bank anticipates the crisis in a timely manner and takes measures. Undertaken measures have an impact on financial stress however the impact of monetary measures on the financial stability index is proportional in some situations and inversely proportional in others.

4. THRESHOLD VAR (TVAR)

4.1. TVAR methodology

The results of the SVAR model indicate that the reaction of the financial stability and monetary policy is perhaps dependent on the state of the financial system (stability/stress). If the reaction is determined by the state, it implies that in certain situations the index should move in the same direction with the measures of monetary policy, while in other situations it should move in the opposite direction. For these reasons, the study uses the VAR model with thresholds (TVAR), by which it seeks to isolate the reaction of the index to the monetary measures under stress and in the conditions of stability.

Also, due to possible problems of nonlinearity in classical VAR models, we investigate whether the use of a TVAR model with the financial stability index as a proxy for the health of the financial system, helps process modeling of macroeconomic relations, or more precisely GDP modelling.

We assumed that the index of financial stability is a threshold variable in TVAR model, which determines the change of the state of relations between the financial sector, economic activity and monetary policy. Monetary policy may have a different approach in terms of high regime (financial stress) when economic activity is reduced or in low regime (no financial stress) when economic activity is increasing.

Furthermore, a very valuable outcome from the TVAR estimation is the threshold, which as a parameter could help in distinguishing whether the financial system is in stress or not. The position of the index is compared with the threshold, so if the index crosses the threshold upwards or downwards, it implies that state of the financial system has changed.

The TVAR model is defined as follows:

$$Y_t = c_j + \sum_{i=1}^{p} A_{j,i} Y_{t-1} + e_{t,j}$$

in which,
regime $j = 1$, if $w_{t-d} < r$
regime $j = 2$, if $w_{t-d} > r$

where,
$w\_(t,j)$ – threshold variable (included in Y_t),
r – value of the threshold,
d – time lag of threshold variable relevant for regime change,
p – degree of auto-regression,
Y_t – matrix/vector of endogenous variables,
c_j – vector of constants, for the respective regime j,
$A_{j,i}$ – matrix/vector of coefficients of the regime j and time lag i,
$e_{t,j}$ – matrix/vector of residuals for appropriate regime j,
$\sum j$ – matrix of variances and covariances for the respective j regime,
m – number of regimes in the case.

In the research, a two - regime TVAR model (regime - stability and regime - stress), is assessed, using quarterly data changes for the case of Republic of Macedonia in the period 2005-2015.

Before perforimg the TVAR estimates, we tested linearity/specification of the models. The linearity test is multivariable expansion of Lo and Zivot (2001) and the method of Hansen (1999). A likelihood ratio (LR) test is performed, which compares the matrix of covariances for individual models.

$$LR_{ij} = T\,(\,ln\,(\det \hat{\Sigma}_i) - ln\,(\det \hat{\Sigma}_j))$$

where $\hat{\Sigma}_i$ the matrix of covariances for two models is assessed.

Three tests are performed:

test 1vs2: linear VAR <-> TVAR with one threshold
test 1vs3: linear VAR <-> TVAR with two thresholds
test 2vs3: TVAR with one threshold <-> TVAR with two thresholds

The first two tests are tests of linearity, and if dropped, the third test is performed, which is a test of specification. If we reject the hypothesis of linearity, specification of the number of regimes is done and the TVAR model is evaluated.

Within the TVAR model we calculated generalized functions of responsiveness to impulses, similar to Feraresi, Roventini and Fragiolo (2014), according to the algoritham of Kopp (1996) (Annex 11).

4.2. TVAR results

For the purposes of the TVAR test, we used stationary data (differences in logged data).

Robustness of data is checked as follows:

1) using different number of variables (three or four variables),

2) using three types of monetary variables (outstanding amount of central bank bills, their interest rate, a composite indicator of monetary measures),

3) using eight different types of indexes and

4) using four combinations of deterministic factors in the VAR model (constant, trend, constant+trend and without deterministic factor).

We performed 192 assessments and forecasts for each of the following models:

1) VAR - with macroeconomic variables (GDP, inflation) and monetary variable,

2) VAR - with macroeconomic variables (GDP, inflation), monetary variable and financial stability index,

3) TVAR - with endogenous macro-economic variables (GDP, inflation), monetary variable and financial stability index, wherein the index is threshold variable,

4) TVAR – with endogenous macroeconomic variables (GDP, inflation) and monetary variable, where the exogenous variable is the index of financial stability, which is also a threshold variable.

At the beginning, both linearity test and specification test of the model[15] are performed, the results of which are summarized in the table below:

[15] We used TVAR.LRtest () function from the R package {TsDyn}.

Table 6. Non-linear cases of the models (percentage in total cases)

	endogenios transition variable	exogenios transition variable	endogenios transition variable	external transition variable
	Linear VAR vs TVAR1 with 1 threshold	Linear VAR vs TVAR2 with 1 threshold	TVAR1 with 1 threshold vs TVAR1 with 2 thresholds	TVAR2 with 1 threshold vs TVAR2 with 2 thresholds
average	23%	8%	5%	6%
3	21%	13%	4%	0%
4	25%	4%	4%	13%
r	38%	13%	6%	19%
b	19%	0%	0%	0%
m	13%	13%	6%	0%
FS_index_Holo	33%	33%	0%	0%
FS_index_VaR	0%	0%	17%	0%
FS_index_variance	0%	0%	0%	0%
FS_index_sig_corel	100%	17%	0%	17%
FS_index_pca	33%	0%	0%	17%
FS_index_sim	0%	0%	0%	0%
FS_index_fevd	0%	0%	0%	0%
FS_index_average	17%	17%	17%	17%

"r" - interest rate on central bank bills
"b" - amount of central bank bills
"m" - composit indicator of monetary measures

Among models, on average, a greater number of non-linear cases (cases of rejection of the hypothesis of linearity) have the endogenous TVAR1 model (23%) compared to the exogenous TVAR2 model. In the endogenous model, only 5% of nonlinear cases show non-linearity with 2 thresholds, as well as in the in exogenous model with 6% of non-linear cases. Due to these reasons, we used a TVAR model with one threshold (two regimes - stability and stress).

In order to check whether the use of a TVAR model with a financial stability index, as a threshold variable, helps the process of macroeconomic modeling, we forecasted GDP up to 4 quarters and compared which model has the lowest average Root Mean Squared Error (RMSE).

First, we split the data set in train set and test set, and than we fit the TVAR model on the train set. We used trained parameters for prediction of GDP for four periods ahead and compared the forecasts with historical performance in the test set. Based on the difference between projected and realized observations, we calculated RMSE, the results of which are presented in Table 7.

Table 7. Average RMSE of the models

	var (rmse)	var + index (rmse)	TVAR1 (rmse)	TVAR2 (rmse)
average	1.7929%	2.1828%	1.6302%	1.7173%
3 variables	1.6517%	1.9234%	1.5092%	1.2321%
4 variables (+ inflation)	1.9342%	2.4421%	1.7513%	2.2025%
r	2.0450%	2.3333%	2.0081%	2.0706%
b	1.7675%	2.2384%	1.6106%	1.6019%
m	1.5663%	1.9766%	1.2719%	1.4794%

"r" - interest rate on central bank bills
"b" - amount of central bank bills
"m" - composit indicator of monetary measures

According to Table 7, the endogenous TVAR1 model has the lowest average RMSE (1.6302%). Among types of models and monetary variables used, the endogenous TVAR1 model with composite indicator of monetary measures as a monetary variable has the lowest average RMSE (1.2719%).

For the purposes of comparison of indices, a "dummy-variable" regression of categorical variables[16] (independent variables) on the RMSE (dependent variable) of the endogenous TVAR1 model (Annex 11) and the exogenous TVAR2 model (Annex 12) was performed, in order to separate out the individual effects of categorical variables.

Among endogenous TVAR1 models, models which use the index based on the "VaR method" and the index based on "modified portofolio method with variance" have the smallest RMSE.

Among exogenous TVAR2 models, models which use the "average index" have the smallest RMSE.

Furthermore, the models' residuals are checked through appropriate statistical tests:

1) Test of normality of residuals - Shapiro-Wilk test.
2) Test of autocorrelation of residuals - Durbin Watson test.
3) Test of homoscedasticity of residuals - Arch-LM test.

The results show that all models pass the tests for autocorrelation and homoscedasticity, while models partially pass the tests of linearity of residuals.

Table 8. Normality check of residuals (Shapiro –Wilk) (% of non-normal cases)

	var + index (shapiro)	TVAR1 (shapiro)	TVAR2 (shapiro)	average
average	40%	50%	48%	46%
3 variables	58%	50%	54%	54%
4 variables	21%	50%	42%	38%
r	47%	44%	44%	45%
b	27%	81%	63%	57%
m	45%	25%	38%	36%
FS_index_Holo	17%	50%	50%	39%
FS_index_VaR	33%	33%	50%	39%
FS_index_variance	79%	100%	67%	82%
FS_index_sig_corel	29%	67%	67%	54%
FS_index_pca	29%	33%	17%	26%
FS_index_sim	33%	83%	100%	72%
FS_index_fevd	46%	17%	17%	26%
FS_index_average	50%	17%	17%	28%

The table shows % of non-linear cases among all tests (who reject the hypothesis of linearity of residuals)
"r" - interest rate on central bank bills
"b" - amount of central bank bills
"m" - composit indicator of monetary measures

The table shows the percentage of non-normal cases (which reject the hypothesis of normality of residuals).

Among models, on average, the VAR model with index has the lowest percentage of non-normal (40%). Among the number of variables, on average, models with four variables have a lower percentage of cases of non-normal residuals compared to the model with three variables (38%). Among monetary variables used in the model , on average, models which use composite indicator of monetary measures have the smallest percentage of cases of non-normal residues (36 %). Among indices, on average, the models which include the index with "method of variance decomposition", "method of PCA decomposition"

[16] Categorical variables include a number of factors, type monetary variables, type of index and type of deterministic factors in the model.

and "average index", have the lowest percentage of cases of non-normal residues (26 %, 26 %, 28 % , respectively).

If we compare the predictive power of models and count the cases where some model has the best performance (lowest RMSE), as shown in Tabe 9, on average, the exogenous TVAR2 model and the VAR+index model have a higher percentage of cases with the best performance (41% and 33%, respectively).

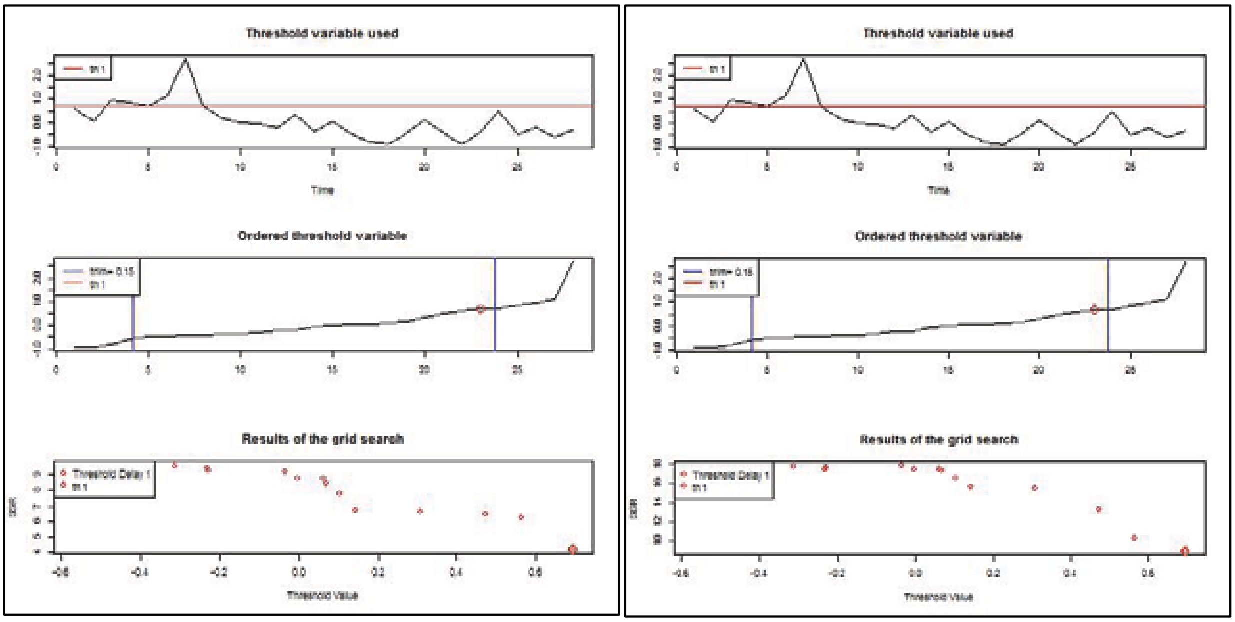
If we consider only cases which pass the tests of normality, non-autocorrelation and homoscedasticity, a higher percentage of cases with the best performance belong to the exogenous TVAR2 model and the VAR+index model (39% and 42%, respectively).

Table 9. Percentage of cases where model has best performance

	% of cases of best model	% cases of non-linear residulas	% of cases of best model (with linear residuals)
rmse VAR	10%	40%	7%
rmse VAR+index	33%	76%	42%
rmse TVAR1	16%	45%	12%
rmse TVAR2	41%	56%	39%

Using threshold parameters from TVAR models one can distinguish whether the stress on financial system has occurred (has passed the threshold) or not. The threshold obtained from TVAR models which use "average index", as the best models, confirm the occurrence of only one peak in the index (period of financial stress) in the period 2008-2009.

Figure 8. Estimated tresholds by TVAR against FS index



i. TVAR1 model treshold, average index
ii. TVAR2 model treshold, average index

Once we obtained results about the coefficients from the estimated exogenous TVAR1 model (where the "average index" of financial stability is an internal threshold variable), we proceeded with consistency checks. We analyzed only coefficients of those relations for which the SVAR model estimation proved not restricted: the relationship index -> monetary measures and relations monetary measures -> index.

• Monetary measures equation

The constant for monetary measures in the regime "financial stress" is higher (2.27) than in the regime "stability" (0.29), which confirms that the monetary policy is becoming restrictive (higher interest rates, higher amount of central bank bills).

The coefficient for reaction to changes in the index, in the regime "stability" is negative and not significant (-0.14), while in the regime "financial stress" the coefficient is positive and stronger (0.75). This might mean that in normal conditions, increase in the index is not perceived as a sign for crisis, but rather a noise and the Central Bank can afford a relaxed policy (react in the opposite way). On the contrary, if the index has increased dramatically, the Central Bank considers that a crisis has begun and takes restrictive monetary measures to counteract it.

Table 10. Coefficients from TVAR fitting (using average index)

average index		constant	index	monetary measures
monetary measures	regime "stability"	0.29	-0.14	0.53
	regime "stress"	2.27	0.75	2.74
index	regime "stability"	-0.43	0.37	0.29
	regime "stress"	2.44	-2.32	-4.84

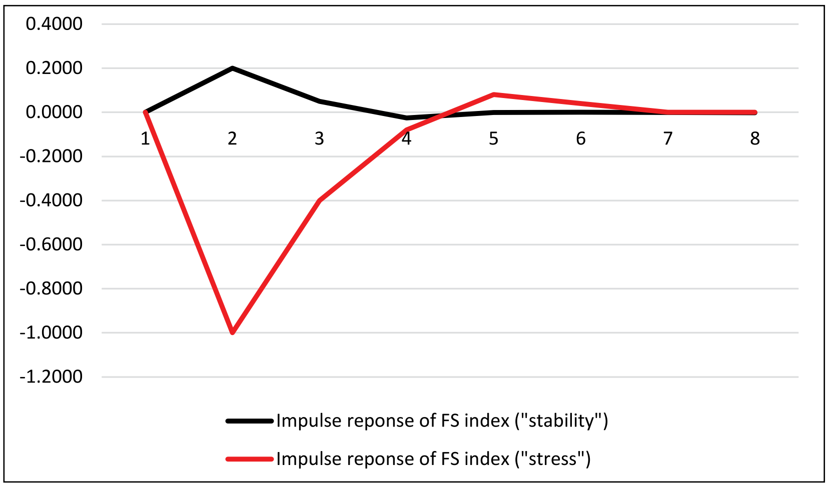
• Index equation

The constant for index in the regime "financial stress" is higher (2.44) than in the regime "stability" (-0.43), as expected. The coefficient for reaction to changes in monetary measures in the regime "stability" is positive and not significant (0.29), while in the regime "financial stress" the coefficient is negative and significant (-4.84).

This means that in normal conditions, decrease in monetary measures (lower interest rates, lower amount of Central Bank bills) is decreasing the index. It might be that market participants perceive the Central Bank signal of relaxed policy as a confirmation that the financial system is stable. Conversely, in crisis, reaction of index switches and the index would decrease, if monetary measures becomes restrictive (higher interest rates, higher amount of Central Bank bills). It might be that market participants, aware of the crisis, perceive the restrictive monetary measures as preparedness of the Central Bank to tackle the situation with all means.

General functions of impulse response (GIRF), presented in Figure 9, confirm the above results. A different reaction of the index to the shock in the monetary variable can be observed, depending on the condition of the regime. In the regime "financial stress" the index is decreasing as a result to the positive shock in the monetary variable, contrary to the reaction in the regime "stability".

Figure 9. Reaction of the index to shock in monetary policy measures (GIRF)



In conclusion, TVAR models contribute with their parameter (threshold), by which it is easy to visualize and distinguish the period of financial stress (Figure 8).

When predicting GDP, non-linear TVAR models which include the financial stability index as a variable, improve the predictive power of the projection compared to the linear model without the index (Table 9). Also, linear models containing the financial stability index, improve the predictive power of the GDP projection compared to linear models without the index.

Finally, TVAR models prove (Table 10), that effects of the monetary policy measures are dependent on the state of financial system. Hence, the Central Bank should be very careful when undertaking monetary measures. In that respect it should be aware of the state of the financial system and the main drivers of the financial stress, before taking monetary measures, otherwise the measures could be counter-productive.

5. MARKOV SWITCHING VAR- MSVAR

5.1. MSVAR methodology

Unlike threshold TVAR models, which are driven by economic variables visible in the form of thresholds, Markov Switching VAR models (MSVAR) are driven by invisible stochastic variables (states, regimes).

$$Y_t = c_{S_t} + \sum_{j=1}^{p} A_{j,S_t} Y_{t-j} + W_{S_t}^{1/2} e_{t,j}$$

with

$$S_t = 1,2 \ldots . H$$

$$e_t \sim IID\ (N(0, I_N)$$

$$W_{S_t}^{1/2} * \left(W_{S_t}^{1/2}\ \right)' = W_{S_t}^{1/2} \equiv Var[\, Y_t | \beth_{t-1}, S_t]$$

where

S_t – state variable,

H – number of states (regimes)

N – number of variables,

p – degree of auto-regression,

Y_t – vector of endogenous variables,

c_{St} – a vector of constants for the corresponding state St,

$A_{j,St}$ – matrix of coefficients for appropriate regime St and the time lag j,

$e_{t,j}$ – a vector of residuals for the corresponding state St,

$\beth_{t-1}$ – information in t-j time, for all previous observations and conditions (filtered states),

$W_{S_t}^{1/2}$ – low triangular matrix for state St at time-space dependent Coleski matrix factorization of variances and covariances of endogenous variables Y_t,

The assumption is that hidden number of states H affects all: the conditional mean, the conditional variance and the conditional correlation structure that characterizes multivariable process. This regime variable S_t is hidden and unobservable, so at best its prediction can be performed in the form of probability.

The hidden S_t state variable is generated by means of discrete-state, homogeneous, irreducible and ergodic Markov chain of first order:

$$\Pr\ (S_t = j \mid \{S_j{}_{j=1}^{t-1}\}, \{Y_T{}_{T=1}^{t-1}\}) = \Pr\ (S_t = j \mid S_{t-1} = i) = \rho_{ij} \in (0,1)$$

where ρ_{ij} is $[i, j]$ element in $H*H$ transitional matrix P. In ρ_{ij} the index i denotes starting state in t-1, while j final state in time t. P is transitional matrix, since it collects the probbailities that are followed by the Markov chain, when is transitioning between states.

So, Markov nature of the state S_t is the result of the fact that having all past information about all states (unobservable) and about endogenous variables, the probability of the successive states depends only on the last set of states in the system.

Posterior modus of MBSVAR[17] (reduced form of Markov Switching Bayesian Auto Regressive model) is estimated using Sims-Zha prior. MBSVAR is estimated using block Expectation–Maximization algorithm, where the blocks are Bayesian VAR regression coefficients for every state and transitional matrix.

Initial values are chosen randomly, while hyperparameters are chosen according to Sims, Vagoner and Zha (2008), for quarterly data: $\lambda 0 = 1.0$, $\lambda 1 = 1.0$, $\lambda 2 = 1.0$, $\lambda 3 = 1.2$, $\lambda 4 = 0.1$, $\mu 5 = 1.0$ и $\mu 6 = 1.0$.

Block optimistion steps is performed such that for any block separate optimization is done, keeping other blocks fixed:

- Maximimzation over constants,
- Maximization over the AR(p) coefficients,
- Maximization over the error covariances Sigma,
- Maximization over the transition matrix Q.

These block optimization are repeated 20 times. Posterior sampling is done using Gibbs sampler and finally, impulse response functions are simulated through the Monte Carlo simulation.

5.2. MSVAR results

The study used a two-regime model MSVAR (regime of stability, regime of financial stress), using quarterly data for Macedonia in the period 2005-2015, where the variables are GDP, an index of financial stability and monetary variable (amount of Central Bank bills, interest rates on Central Bank bills or composite indicator of monetary measures).

In the study we attempted to find whether the use of index on financial stability as the variable in the MSVAR model, helps the process of macroeconomic modeling (GDP). Therefore, we compared GDP prediction performance of the MSVAR model to the GDP prediction performance of an ordinary linear VAR model, which includes the same variables.

Since fiiting MSVAR models utilize Monte Carlo simulations, which could be time-consuming, we have 24 estimation MSVAR models using eight types of finanacial stability indices and three types of monetary variables.

Overall, the MSVAR model showed higher RMSE compared to an ordinary VAR model, except when MSVAR is using an index with portfolio method / variance method, and a monetary index / interest rate on Central Bank bills as monetary variables, respectively.

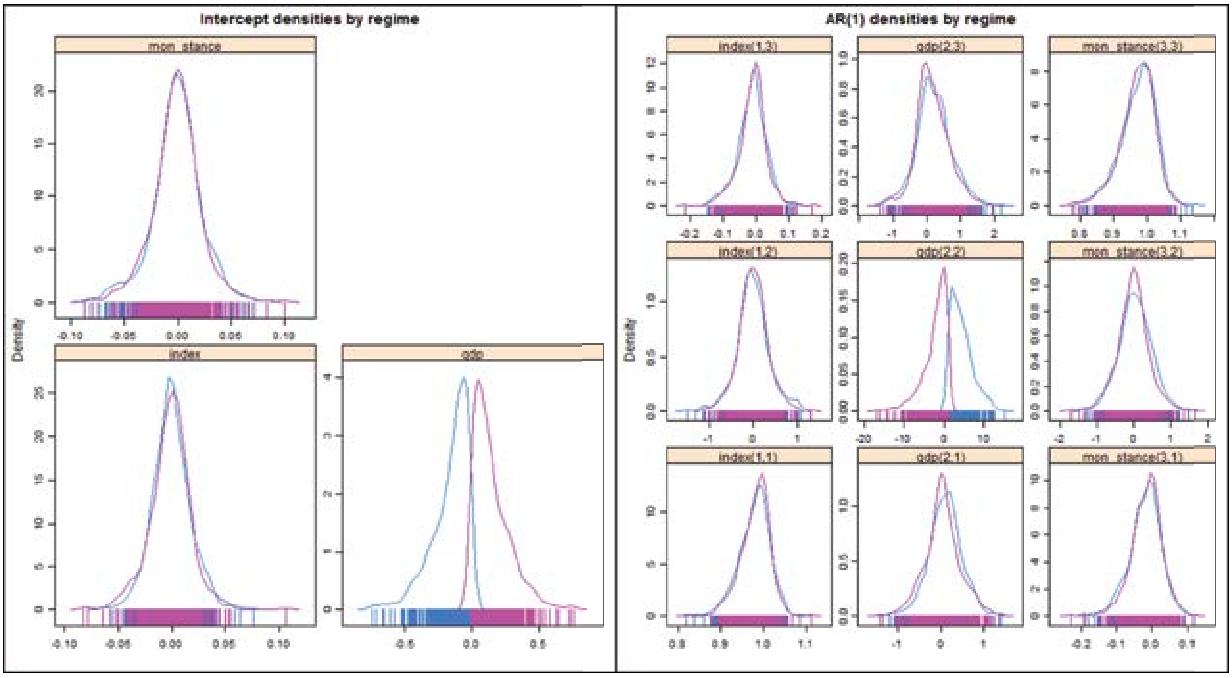
We analyzed the parameters estimated from the MSVAR model in the sample, to check if there is a significant difference in their densities, which could imply different coeficients for different regimes. This is in line with the question raise during SVAR and TVAR modeling, whether the coeficients in the relationship between the financial stability index and monetary policy measures are dependent on the state (regime) of the financial system.

However, as can be seen in Figure 10, only coefficients in the GDP equation (constant and coefficient of relationship GDP - GDP) showed a significant difference among the states. Nevertheless, these results

[17] It is performed in the R package {MBSVAR}

should be taken with caution due to to short series used in the MSVAR model. We assume that the reason for the weaker predictive power of the MSVAR model is that these models have too much parameters relative to short series of data (33 quarterly points) and very low saturation ratio[18].

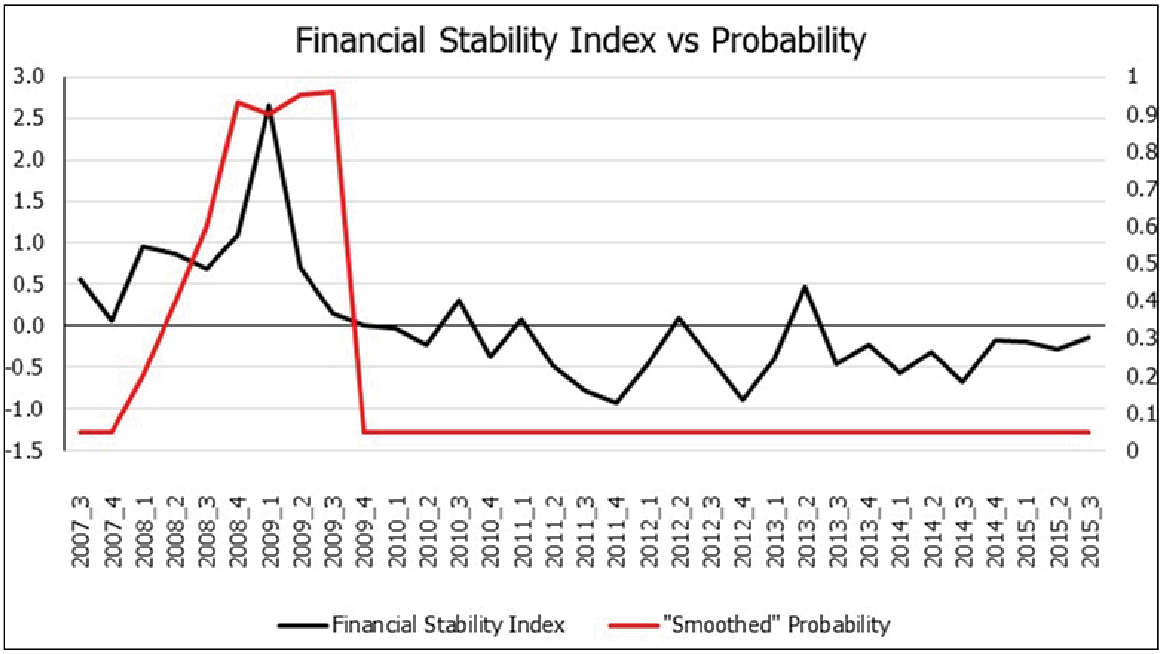
Figure 10. MSVAR densities for two states of financial stability



MSVAR models help in visual identification of low and high regimes (states) of stability, which is a hidden variable. By fitting MSVAR models in the sample, we obtain as a parameter the probability of financial system being in some state (stability/stress).

Almost all models indicate that the probability is high (>0.9) that the Macedonian financial system was in distress, during the recent global financial crisis in 2008-2009.

Figure 11. "Smoothed probability"of the system being in the state of stress and FS "average index"



[18] The saturation ratio is simply the ratio between the total number of observations available for estimation and the total number of parameters.

CONCLUSION

This study introduced the "average index" of financial stability as a contribution to the methodology for creating indexes. We found that the "average index" (average of multiple indexes created by other methods) is more reliable than using individual indexes for the purpose of screening the health of the financial system. The "average index" is one of the indices that show the smallest prediction error, and may potentially be used for early detection of financial crises.

Furthermore, this study contributed by presenting new methods for creating financial stability indices, which are a modified version of the portfolio method of creating indices: modified portfolio method with variance decomposition, modified method with dynamic variances, method of normal Value at risk (VaR) and modified portfolio method with signals.

Using the "average index" and indexes created by other methods, crisis periods were analyzed and results show that indices accurately identify the stress period of the Macedonian economy, induced by the global financial crisis of 2008-2009.

The analyses were complemented with additional tools: index threshold, obtained while estimating the Threshold VAR models, and probability of stress occurrence, obtained while estimating of Markov Swithcing VaR models. Both additional tools identified the time period (2008-2009) as the period of stress in the Macedonian financial system.

Specifically, this study shows that credit and deposit activity of banks are the main drivers of financial stability. Also, the stock index, the property index and currency risk indicator (foreign currency deposits/total deposits) moderately influence stability of the financial system.

The research, apart from analyzing the effectiveness of indices in identifying the situation of stress, analyzed the effects of stress on the materialisation of credit risk, revealing that effects are usually felt after a minimum of of two quarters.

Due to possible problems of nonlinearity in classical VAR models arising from the change of regimes, multiple equilibria and asymmetrical responses to shocks, the study was investigating whether the use of the financial stability index, as a proxy for the health of the financial system, helps the process of macroeconomic modeling. The research showed that adding the financial stability index in the VAR models improves the prediction power of VAR macroeconomic modeling. Except for the Markov Switching VaR model, other models (Threshold VAR and linear VAR models), which include financial stability index, have greater predictive power than linear VAR models without the financial stability index.

Using the "average index" and other indexes, the interdependence of financial stability and macroeconomic variables is analyzed through appropriate models, with the emphasis on interdependence of financial stability and monetary policy. Particularly, we examined the influence of monetary measures on financial stability in different states of the financial system (stability, stress).

The results of the SVAR model showed that there is a strong and instant mutual relationship between the financial stability index and monetary policy. The SVAR model clearly showed that the impact of financial stability index on the monetary policy is proportional. In comparison, the impact of monetary policy on the financial stability index is not so clear, so in some situations it is proportional and inversely proportional in others. Different signs in the reaction of monetary measures to the financial stability index, might mean that in different situations the index reacts differently to the monetary policy measures ie that the reaction of the index to monetary measures depends on the state of the financial system (stability / financial stress or instability).

For these reasons, a Threshold VAR model is used, with the intent to isolate the reaction of the financial stability index to the monetary measures. Estimated results from the Threshold VAR show that in a stable phase, if monetary policy is relaxed and the sign in the relation monetary variable -> index is positive, the index will be reduced. Conversely, in financial stress, if monetary policy becomes restrictive and the sign in relations monetary variable -> index is negative, the index of financial stability will be reduced.

A plausible explanation, might be that in normal conditions, increases in the index is not perceived as a sign for crisis, but rather as a noise and the Central Bank can afford a relaxed policy. On the contrary, if the index has increased dramatically, the Central Bank considers that crisis has begun and it takes restrictive measures against it. In normal conditions, decrease in monetary measures is decreasing the index. It might be that market participants perceive the relaxed policy as a Central Bank signal and confirmation that the financial system is stable. Conversely, in crisis, the reaction of the index switches and the index decreases, if monetary measures become restrictive. It might be that market participants, aware of the crisis, perceive the restrictive monetary measures as preparedness of the Central Bank to tackle the situation with all means.

The aim of our research was to establish a consistent framework for creating indices as a Central Bank tool by which it would be possible to early and accurately detect stress in the financial system. Different methods were used to create several indices, in order to obtain a multifaceted perspective of the state of the financial system and systemic risk. Surely, there exist other methods for creating indices, which could be tested in some further research.

When analyzing the relationship between financial stability and monetary policy we used the Structural VAR model, Threshold VAR models and Markov Switching VaR model. As we expected more from the Markov Switching VaR models, we plan to carry on using these models, albeit with longer time series.

This study was focused only on the short term dynamics of the relationship between financial stability and monetary policy. Although, it was found that the financial stability has mainly negative impact on GDP, we decided not to expand the analysis of this relationship, because we thought that the study would lose its focus. Thus, future research could analyze the relation between financial stability and GDP and other relationships (for example, the relationship between financial stability and inflation). Also, the long-term dynamics in relationships between these variables can be examined in follow-up studies.

BIBLIOGRAPHY

Aboura, S. and Van Roye, B. (2013), "Financial stress and economic dynamics: An application to France", Kiel Institute for the World economy

Angelopoulou, E. Balfoussia, H. and Gibson, H. (2013), "Building a Financial Conditions Index for the Euro Area and Selected Euro Area Countries what does it tell us about the crisis?", ECB Working Paper No. 54

Atanasova, C. (2003), "Credit Market Imperfections and Business Cycle Dynamics: A Nonlinear Approach", Studies in Nonlinear Dynamics and Econometrics, 7.

Auerbach, A. J. and Gorodnichenko, Y. (2010), "Measuring the Output Responses to Fiscal Policy", NBER Working Paper No.16311

Bandt, O. and Hartmann, P. (2000), "Systemic risk: A survey", ECB Working Paper No.35

Bates, J.M., and Granger, C.W.J. (1969), "The combination of forecasts", Operational Research Quarterly, 20,451-468.

Baum A., Poplawski-Ribeiro, and M. Weber, A. (2012), "Fiscal Multipliers and the State of the Economy", IMF Working Paper

Bernanke, B. S. (1986.), "Alternative Explanations of the Money-Income Correlation", NBER Working Paper No. 1842

Bernanke B. S., Gertler, and M. Gilchrist, S. (1999), "The Financial Accelerator In a Quantitative Business Cycle Framework", Handbook of Macroeconomics, Volume 1, edited by J.B. Taylor and M. Woodford

Blanchard, O. J. and Quah, D. (1988), "The Dynamic Effects of Aggregate Demand and Supply Disturbances" NBER Working Paper No. 2737 (Also Reprint No. r1363)

Brunnermeier, K. M. and Oehmke, M. (2012), "Bubbles, Financial Crises, and Systemic Risk" NBER Working Paper No. 18398

Brave, S. and Butters, R. A. (2011), "Monitoring financial stability: A financial conditions index approach" Federal Reserve Bank of Chicago, Economic Perspectives

Breitung, J. and Eickmeier, S. (2014), "Analyzing business and financial cycles using multi-level factor models" Deutsche Bundesbank No.11

Bachmanna, R. and Sims, E. R. (2012), Confidence and the transmission of government spending shocks, Journal of Monetary Economics, Volume 59, Issue 3, April 2012, Pages 235–249

Borio, C. and Lowe, P. (2002), "Asset prices, financial and monetary stability: exploring the nexus", BIS Papers No 114

Clemen R.T, "Combining forecasts: A review and annotated bibliography", International Journal of Forecasting 5 (1989) 559-583, Elsevier Science Publishers B.V. (North-Holland)

Dudley, W. and Hatzius, J. (2000), The Goldman Sachs Financial Conditions Index: The Right Tool for a New Monetary Policy Regime, Global Economics Paper, 44.

Demirguc, D. (1998), "The determinants of banking crises in developing and devoloped countries", IMF Working Paper Vol 45 No1

Drehmann, M., Borio, C. and Tsatsaronis, K. (2012), "Characterising the financial cycle:don't lose sight of the medium term!", BIS Working Paper No 380

Eika, K. H., Ericsson, N. and Nymoen, R. (1996), "Hazards in implementing a monetary conditions index" No 568, International Finance Discussion Papers, Federal Reserve System (U.S.)

Ferraresi T., Roventini A., and Fagiolo G. (2014), "Fiscal Policies and Credit Regimes: A TVAR Approach" SSRN

Gara, A., Kovner, and A. Schoar, A. (2011), "Stressed, Not Frozen: The Federal Funds Market in the Financial Crisis", *Journal of Finance*, Volume 66, Issue 4

Gertler M. and Karadi P. (2010), "A model of unconventional monetary policy", *Journal of Monetary Economics*, 58 (2011) 17–34

Gertler M. and Kiyotaki N. (2010), "Financial Intermediation and Credit Policy in Business Cycle Analysis", in B. M. Friedman and M. Woodford, (eds.), *Handbook of Monetary Economics*, North Holland Elsevier

Gottschalk, J. (2001), "An Introduction into the SVAR Methodology: Identification, Interpretation and Limitations of SVAR models" Kiel Working Paper No. 1072

Guidolin, M. and Ria, F. (2010), "Regime Shifts in Mean-Variance Efficient Frontiers: Some International Evidence ", Federal Reserve Bank of St. Louis working working paper 2010-040B

Hanschel, E. and Monnin, P. (2010), "Measuring and forecasting stress in the banking sector: evidence from Switzerland", BIS Papers No 22

Hanschel, E., and Monnin, P. (2005), "Measuring and forecasting stress in the banking sector: Evidence from Switzerland", BIS Working Paper No 22.

Hansen, B. E. (1999), "Testing for linearity", Journal of Economic Surveys, Volume 13, Number 5, December 1999, pp. 551-576(26)

Holló, D., Kremer, M., Lo Duca, M. (2012), "CISS — A Portfolio-Theoretic Framework for the Construction of Composite Financial Stress Indices"

Hubrich, K. and Tetlow, R. J. (2014), "Financial Stress and Economic Dynamics The Transmission Of Crises", Working Paper Series No 1728

Illing, M. and Liu, Y. (2003), "An Index of Financial Stress for Canada" Bank of Canada" Working Paper 2003-14

Johnson, N. L., Kotz, S. and Balakrishnan, N. (1995), "Continuous Univariate Distributions", volume 1, chapter 13. Wiley, New York

Jovanovic, B., Krstevska, A. and Popovska-Kamnar, N. (2015), "Can monetary policy affect economic activity under surplus liquidity? Some evidence from Macedonia" NBRM

Koop, G. (1996): "Parameter Uncertainty and Impulse Response Analysis", *Journal of Econometrics*, 72(1), pp. 135-49

Kwon, Y. (2003), "Bayesian Analysis of Threshold Autoregressive Models" PhD diss., University of Tennessee

Lo, Zivot (2001) "Threshold Cointegration and Nonlinear Adjustment to the Law of One Price," Macroeconomic Dynamics, Cambridge University Press, vol. 5(4), pg. 533-76

Ng, S. and Wright, J. H. (2013), "Facts and Challenges from the Great Recession for Forecasting and Macroeconomic Modeling", *Journal of Economic Literature*, 51(4), 1120–1154, http://dx.doi.org/10.1257/jel.51.4.1120

Pfaff, B. (2008), "VAR, SVAR and SVEC Models: Implementation Within R Package vars", *Journal of Statistical Software*, 27(4).

Petrovska, M. and Mucheva, E. (2013), "Measures of Financial Stability in Macedonia", *Journal of Central Banking Theory and Practice*, vol. 2, issue 3, pg. 85-110

Petrovska, M. and Georgievska, Lj. (2015), "Alternative indicator of monetary policy stance for Macedonia" National Bank of the Republic of Macedonia

Reid, D.J. (1968) "Combining three estimates of gross domestic product", *Economica*, 35, 431-444.

Reinhart, Carmen & Goldstein, Morris & Kaminsky, Graciela, (2000), "Early Warning System: An Assessment of Vulnerability" MPRA Paper 24579, University Library of Munich, Germany

Sandahl, J. F., Holmf eldt, M., Rydén, A. and Strömqvist, M. (2011), "An index of financial stress for Sweden" Sveriges riksbank economic review

Sims, C.A, Waggoner, D. and Zha, T. (2008), "Methods for inference in large multiple-equation Markov-switching models", *Journal of Econometrics*, vol. 146, issue 2, pages 255-274

Stigler, M. (2010), "Threshold cointegration: overview and implementation in R"

Stock, J., H. and Watson, W. M. (2004), "Combination Forecasts of Output Growth in a Seven-Country Data Set" J. Forecast. 23, 405–430

Tong, H. (2013), "Threshold models in time series analysis-some reflections", Research report, Serial No. 507, The University of Hong Kong

Tsay, R. S.(1998), "Testing and Modeling Multivariate Threshold Models", *Journal of the American Statistical Association*, Vol. 93, No. 443., pp. 1188-1202

Turrini, A., Röger, W. and Székely, I. A. (2010), "Banking crises, Output Loss and Fiscal Policy", CEPR Discussion Papers 7815, C.E.P.R. Discussion Papers.

Vasícek, B., Zigraiová, D., Hoeberichts, M., Vermeulen, R., Smídková, K. andde Haan, J. (2015), "Leading indicators of financial stress: New evidence" DNB Working Paper No. 476

Zivanovic, J. (2015),"An agnostic SVAR approach to financial shocks" Humboldt-Universitat zu Berlin

ANNEXES

Annex 1 – Results from the Augmented Dickey-Fuller test

Subcomponent of index	order of integration	type	confidence interval	test statistic	critical value
Loans to hoseholds / GDP	1	drift	1pct	-5.29	-3.58
Loans to hoseholds / GDP	1	trend	1pct	-6.06	-4.15
Loans to hoseholds / GDP	1	none	1pct	-3.72	-2.62
Loans to companies / GDP	0	drift	1pct	-4.31	-3.58
Loans to companies / GDP	1	trend	1pct	-4.54	-4.15
Loans to companies / GDP	1	none	5pct	-2.2	-1.95
Loans / deposits	0	drift	1pct	-4.62	-3.58
Loans / deposits	0	trend	1pct	-4.57	-4.15
Loans / deposits	1	none	1pct	-3.71	-2.62
Non-financial entities deposits	1	drift	1pct	-4.83	-3.58
Non-financial entities deposits	0	trend	1pct	-4.62	-4.15
Non-financial entities deposits	1	none	10pct	-1.88	-1.61
Foreign currency deposits / total deposits	2	drift	1pct	-3.91	-3.58
Foreign currency deposits / total deposits	0	trend	5pct	-4.1	-3.5
Foreign currency deposits / total deposits	1	none	5pct	-2.38	-1.95
Interest rate on denar long-term loans to households	1	drift	10pct	-2.73	-2.6
Interest rate on denar long-term loans to households	0	trend	10pct	-3.25	-3.18
Interest rate on denar long-term loans to households	0	none	10pct	-1.67	-1.61
Interest rate on denar long-term loans to companies	1	drift	1pct	-5	-3.58
Interest rate on denar long-term loans to companies	0	trend	10pct	-3.48	-3.18
Interest rate on denar long-term loans to companies	1	none	1pct	-4.87	-2.62
Interest rate spread between newly approved denar deposits and loans	2	drift	1pct	-6.59	-3.58
Interest rate spread between newly approved denar deposits and loans	1	trend	5pct	-3.56	-3.5
Interest rate spread between newly approved denar deposits and loans	1	none	10pct	-1.76	-1.61
Macedonian Property Index	1	drift	1pct	-4.3	-3.58
Macedonian Property Index	0	trend	1pct	-4.4	-4.15
Macedonian Property Index	1	none	1pct	-4.4	-2.62
Macedonian Stock Exchange index (MBI 10)	0	drift	1pct	-4.21	-3.58
Macedonian Stock Exchange index (MBI 10)	1	trend	1pct	-4.44	-4.15
Macedonian Stock Exchange index (MBI 10)	0	none	1pct	-3.02	-2.62
Current account balance / GDP	1	drift	1pct	-6.1	-3.58
Current account balance / GDP	1	trend	1pct	-6.18	-4.15
Current account balance / GDP	0	none	10pct	-1.65	-1.61

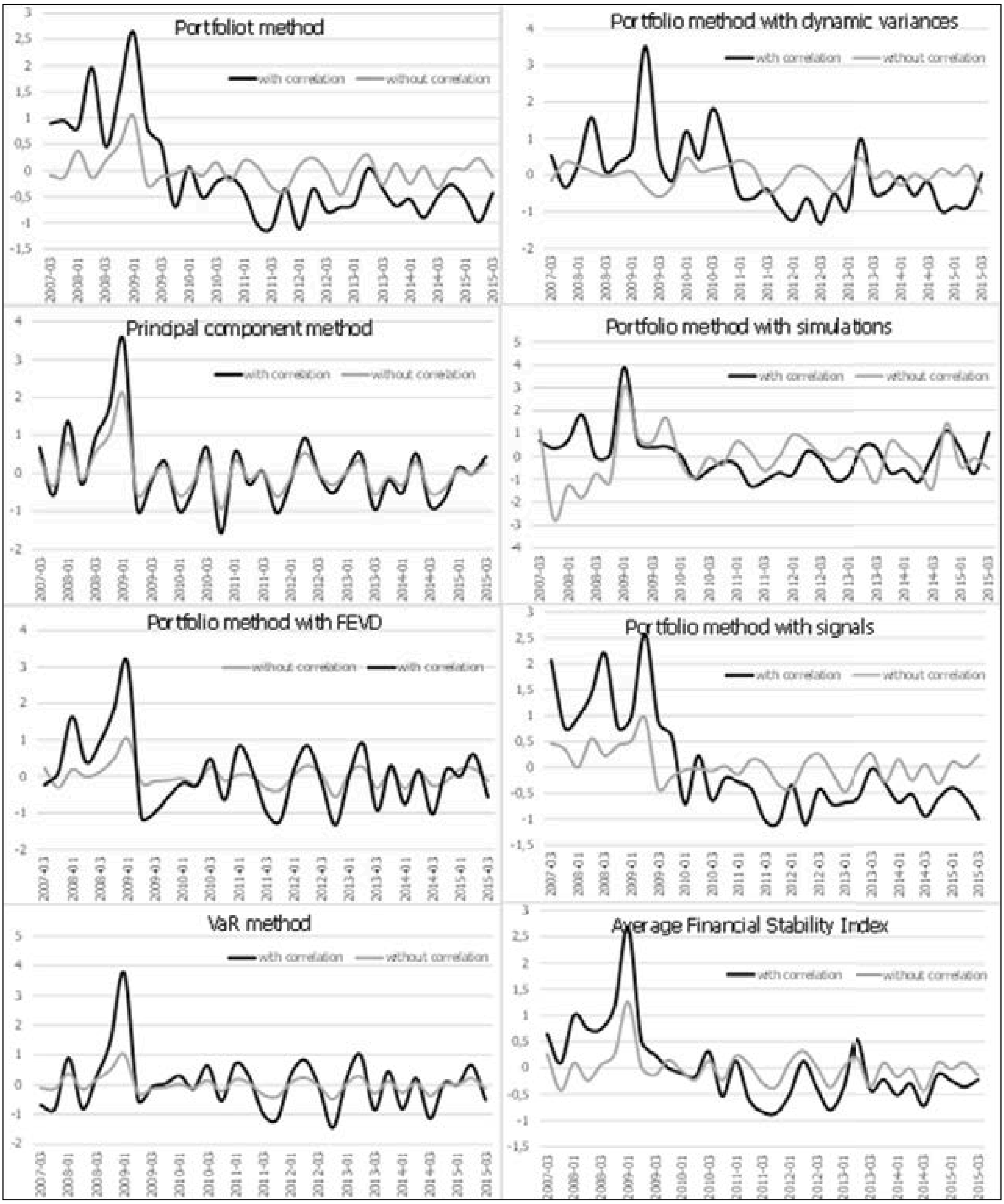
Annex 2 – PCA weights

% of explained total variance	26%	21%	16%	14%	10%	7%	6%	0%	0%	0%	0%	100%
weights	PCA1	PCA2	PCA3	PCA4	PCA5	PCA6	PCA7	PCA8	PCA9	PCA10	PCA11	Total
Loans to hoseholds / GDP	0.29	-0.53	0.07	0.10	0.11	0.34	0.05	-0.02	0.39	0.35	-0.47	0.02
Loans to companies / GDP	0.40	-0.24	0.04	0.38	-0.20	-0.27	0.10	0.50	-0.42	-0.25	-0.18	0.07
Loans / deposits	0.53	0.08	0.06	0.09	-0.16	0.41	-0.34	0.00	-0.11	0.24	0.58	0.17
Non-financial entities deposits	0.22	0.56	0.01	0.10	-0.16	0.34	-0.18	-0.18	0.00	-0.36	-0.54	0.19
Foreign currency deposits / total deposits	0.28	0.40	-0.21	0.28	0.20	-0.16	0.43	0.22	0.55	0.01	0.19	0.20
Interest rate on denar long-term loans to households	-0.04	-0.02	0.38	-0.31	-0.68	0.16	0.45	0.11	0.20	-0.09	0.09	-0.03
Interest rate on denar long-term loans to companies	0.00	0.17	0.61	-0.14	0.16	-0.27	-0.47	0.39	0.30	0.05	-0.07	0.08
Interest rate spread between newly approved denar deposits and loans	0.00	-0.19	-0.56	-0.13	-0.43	-0.21	-0.46	0.11	0.39	-0.17	0.00	-0.23
Macedonian Property Index	-0.20	0.11	0.17	0.61	-0.41	-0.30	-0.09	-0.34	0.06	0.41	-0.05	0.01
Macedonian Stock Exchange index (MBI 10)	0.36	0.25	-0.17	-0.48	-0.10	-0.35	0.10	-0.04	-0.23	0.54	-0.25	0.02
Current account balance / GDP	-0.43	0.22	-0.24	0.09	-0.09	0.38	-0.02	0.61	-0.12	0.38	-0.11	-0.07

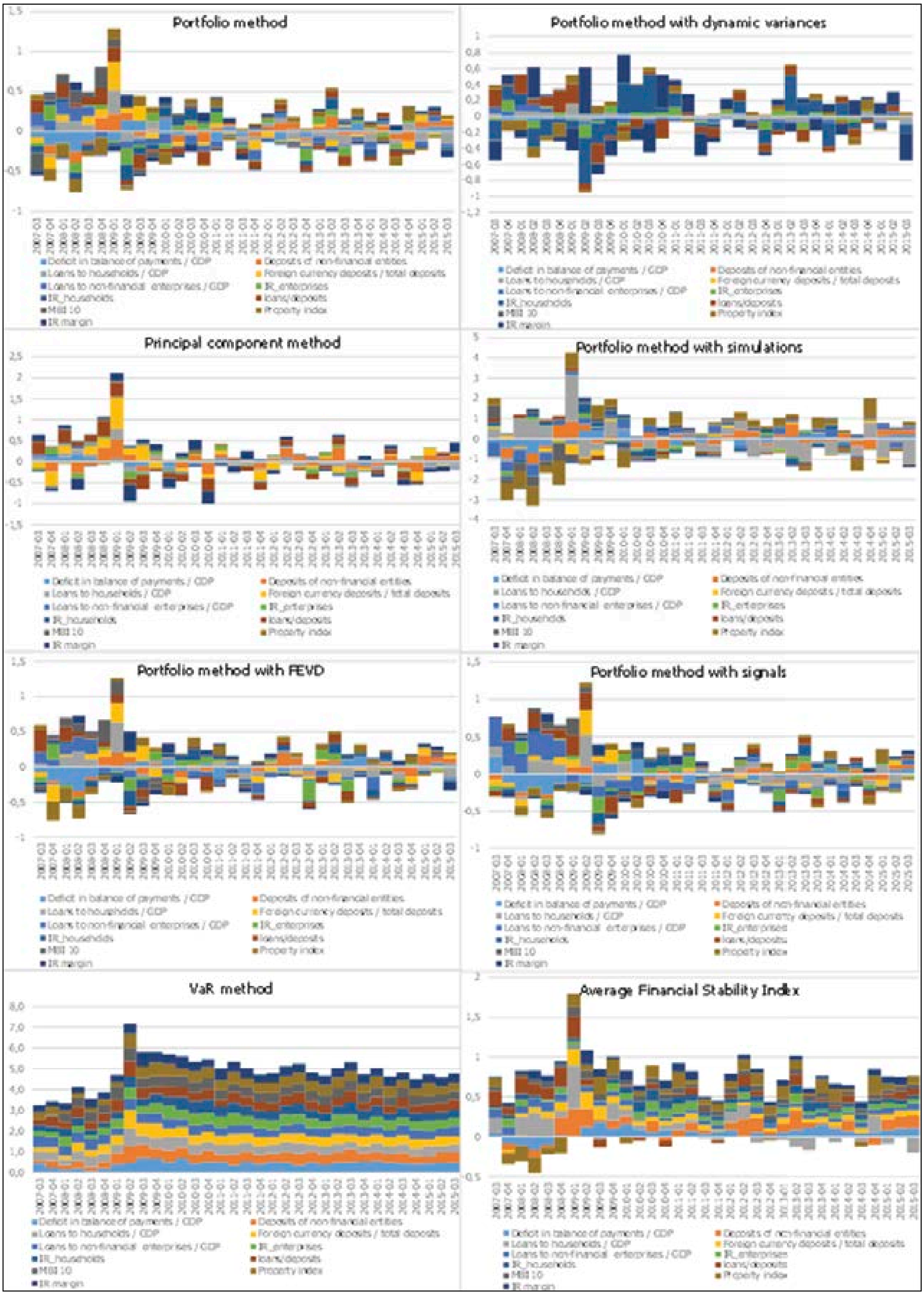
Annex 3 – Overview of the created Financial Stability Indices

quarter	Portfolio method	Portfolio method with dynamic variances	Portfolio method with signals	Portfolio method with simulations	Portfolio method with FEVD	Principal component method	VaR method	Average financial stability index
2007_3	0.8994	0.5296	2.0643	0.6775	-0.2335	0.6870	-0.6887	0.5622
2007_4	0.9471	-0.3379	0.7634	0.3581	0.1183	-0.5796	-0.8247	0.0635
2008_1	0.8152	0.2877	0.9617	0.6903	1.6364	1.3753	0.9054	0.9532
2008_2	1.9606	1.5816	1.4226	1.8262	0.3807	-0.2864	-0.8009	0.8692
2008_3	0.4512	0.1112	2.2010	-0.0478	0.9276	0.9397	0.2620	0.6921
2008_4	1.5144	0.3510	0.7573	0.1120	1.8225	1.7399	1.4466	1.1063
2009_1	2.6437	0.6796	0.9798	3.8920	3.1290	3.5360	3.7675	**2.6611**
2009_2	0.8259	3.5200	2.5745	0.6222	-1.1452	-0.9403	-0.5129	0.7063
2009_3	0.5015	0.4758	0.8812	0.4023	-0.9785	-0.2098	-0.0729	0.1428
2009_4	-0.6946	-0.1712	0.6018	0.4415	-0.5388	0.3044	0.0434	-0.0020
2010_1	0.0653	1.2003	-0.7116	0.0726	-0.1788	-0.9957	0.3030	-0.0350
2010_2	-0.5185	0.4455	0.2230	-0.9573	-0.2542	-0.4199	-0.1452	-0.2324
2010_3	-0.2268	1.8195	-0.6411	-0.6068	0.4776	0.6787	0.6445	0.3065
2010_4	-0.1332	0.7460	-0.2109	-0.2539	-0.6551	-1.5878	-0.5490	-0.3777
2011_1	-0.4047	-0.5804	-0.2940	-0.3371	0.8215	0.5649	0.7116	0.0688
2011_2	-1.0448	-0.6312	-0.4374	-1.2896	0.1638	-0.2951	0.2567	-0.4682
2011_3	-1.0973	-0.3832	-1.0399	-1.0742	-0.9815	0.0537	-0.9796	-0.7860
2011_4	-0.3520	-0.9189	-1.0699	-0.7174	-1.2322	-1.0410	-1.1686	-0.9286
2012_1	-1.1133	-1.2436	-0.3429	-0.8062	0.1725	-0.2021	0.3442	-0.4559
2012_2	-0.3513	-0.6338	-1.1120	0.2228	0.8427	0.9292	0.8329	0.1044
2012_3	-0.7877	-1.3245	-0.4322	-0.1231	-0.1532	-0.0210	-0.0506	-0.4132
2012_4	-0.6992	-0.5164	-0.7179	-1.0260	-1.3329	-0.5177	-1.4472	-0.8939
2013_1	-0.6338	-0.9332	-0.6879	-0.8268	0.0368	0.0197	0.2133	-0.4017
2013_2	0.0445	1.0011	-0.5895	0.4047	0.8980	0.5327	1.0102	0.4717
2013_3	-0.3331	-0.4969	-0.0350	0.3919	-0.9402	-0.9529	-0.8513	-0.4596
2013_4	-0.6796	-0.4495	-0.3279	-0.7146	0.2981	-0.1765	0.4513	-0.2284
2014_1	-0.5455	-0.0515	-0.6840	-0.5851	-0.7607	-0.5227	-0.8170	-0.5667
2014_2	-0.9011	-0.5681	-0.5303	-1.1105	0.1662	0.5294	0.2213	-0.3133
2014_3	-0.5125	-0.1817	-0.9586	0.0135	-1.0343	-0.8729	-1.1377	-0.6692
2014_4	-0.2704	-1.0001	-0.6095	1.1386	0.1895	-0.6909	0.0431	-0.1714
2015_1	-0.5336	-0.8644	-0.4010	0.3270	0.0040	0.1508	-0.0014	-0.1884
2015_2	-0.9825	-0.8708	-0.5913	-0.7580	0.6086	-0.0192	0.6595	-0.2791
2015_3	-0.4282	0.0317	-1.0058	1.0314	-0.5673	0.4412	-0.5145	-0.1445
mean	-0.0780	0.0189	0.0000	0.0421	0.0517	0.0652	0.0471	0.0210
stdev	0.9043	1.0093	1.0000	1.0146	0.9682	0.9702	0.9765	0.7101
curtosis	1.6184	3.2645	0.4834	5.3783	1.9244	3.9922	5.4425	4.7591
minimum	-1.1133	-1.3245	-1.1120	-1.2896	-1.3329	-1.5878	-1.4472	-0.9286
maximum	2.6437	3.5200	2.5745	3.8920	3.1290	3.5360	3.7675	2.6611

Annex 4 - Financial Stability Index, with and without correlation



Annex 5 - Indices and their subcomponents



Annex 6 - Results from index projections

	average log-likelihood (VAR)	average log-likelihood (Restricted VAR)	average adjusted R2 (VAR)	average adjusted R2 (Restricted VAR)	average RMSE (VAR)	average RMSE (Restricted VAR)	average p - value, Shapiro test (VAR)	average p - value, Shapiro test (Restricted VAR)	average p - value, Durbin Watson test (VAR)	average p - value, Durbin Watson test (Restricted VAR)	average p - value, ARCH test (VAR)	average p - value, ARCH test (Restricted VAR)
central bank bills	-590	-604	18%	36%	0.59	0.59	30%	29%	41%	42%	56%	56%
FSI portfolio method with FEVD	-579	-598	21%	26%	0.42	0.40	42%	30%	27%	39%	58%	58%
FSI portfolio method	-600		-6%		0.38		24%		42%		53%	
FSI PCA method	-575	-563	21%	69%	0.66	0.63	48%	99%	60%	75%	58%	62%
FSI average index	-570	-587	29%	43%	0.35	0.18	2%	8%	32%	35%	58%	58%
FSI portfolio method with signals	-595	-611	44%	44%	0.34	0.36	12%	6%	50%	42%	53%	53%
FSI portfolio method with simulations	-609	-625	18%	32%	1.31	1.39	8%	35%	43%	39%	53%	53%
FSI portfolio method with VaR	-585	-600	8%	25%	0.44	0.46	23%	35%	29%	36%	58%	58%
FSI portfolio method with dynamic variances	-607	-622	12%	28%	0.80	0.71	82%	28%	45%	48%	55%	55%
composite indicator of monetary measures	-227	-249	27%	40%	0.54	0.77	41%	42%	50%	27%	56%	53%
FSI portfolio method with FEVD	-211		30%		0.48		49%		63%		62%	
FSI portfolio method	-236	-239	4%	30%	0.26	0.34	42%	55%	40%	27%	49%	53%
FSI PCA method	-204		52%		0.63		9%		57%		62%	
FSI average index	-228		26%		0.47		34%		67%		55%	
FSI portfolio method with signals	-206		58%		0.28		67%		51%		62%	
FSI portfolio method with simulations	-238	-251	40%	54%	0.71	1.08	17%	46%	24%	14%	51%	53%
FSI portfolio method with VaR	-258		-15%		0.59		43%		63%		51%	
FSI portfolio method with dynamic variances	-240	-255	20%	38%	0.91	0.86	64%	30%	36%	36%	53%	53%
interest rate on central bank bills	-253	-266	26%	36%	0.53	0.50	66%	44%	47%	49%	51%	52%
FSI portfolio method with FEVD	-247	-259	4%	30%	0.45	0.31	69%	46%	51%	52%	55%	55%
FSI portfolio method	-260	-274	18%	23%	0.37	0.40	72%	33%	48%	47%	45%	45%
FSI PCA method	-211	-233	63%	53%	0.35	0.48	75%	71%	56%	45%	62%	62%
FSI average index	-247	-261	26%	28%	0.34	0.14	84%	70%	48%	48%	53%	53%
FSI portfolio method with signals	-255	-267	52%	51%	0.24	0.40	75%	46%	46%	55%	51%	51%
FSI portfolio method with simulations	-266	-281	11%	32%	1.18	1.38	11%	7%	32%	29%	47%	47%
FSI portfolio method with VaR	-268	-278	-4%	17%	0.50	0.29	63%	46%	53%	55%	51%	51%
FSI portfolio method with dynamic variances	-267	-280	42%	48%	0.81	0.59	83%	32%	45%	60%	47%	47%
average	-357	-395	24%	36%	0.55	0.57	46%	38%	46%	43%	54%	54%

Annex 7 – Results from stress materialization on credit risk

	average p-value, Granger (VAR)	average p-value, Granger (Restricted VAR)	average log-likelihood (VAR)	average log-likelihood (Restricted VAR)	average log-likelihood (VEC)	average adjusted R2 (VAR)	average adjusted R2 (Restricted VAR)	average RMSE (VAR)	average RMSE (Restricted VAR)	average RMSE (VEC)	average p - value, Shapiro test (VAR)	average p - value, Shapiro test (Restricted VAR)	average p - value, Shapiro test (VEC)	average p - value, Durbin Watson test (VAR)	average p - value, Durbin Watson test (Restricted VAR)	average p - value, Durbin Watson test (VEC)	average p - value, ARCH test (VAR)	average p - value, ARCH test (Restricted VAR)	average p - value, ARCH test (VEC)
The absolute level of impairment	35%	32%	-511.0	-577.8	-684.4	-7%	57%	702	535	2469.32	38%	35%	43%	42%	45%	51%	55%	56%	55%
FSI portfolio method with FEVD	0%	0%	-663.7	-736.9	-578.4	31%	63%	986	532	2299.41	44%	57%	57%	41%	32%	55%	62%	62%	40%
FSI portfolio method	45%	45%	-487.3	-526.9		-16%	55%	523	542		50%	44%		48%	51%		53%	53%	
FSI PCA method	7%		-408.7		-814.1	-17%		586		2554.00	24%		15%	37%		48%	53%		74%
FSI average index	56%	53%	-504.9	-566.6		-10%	57%	653	531		22%	34%		38%	43%		54%	54%	
FSI portfolio method with signals	46%	30%	-493.8	-580.8		-6%	56%	542	536		34%	26%		43%	46%		55%	56%	
FSI portfolio method with simulations	21%	21%	-521.0	-574.5	-588.8	14%	56%	1274	531	2430.85	48%	28%	52%	45%	45%	46%	58%	58%	44%
FSI portfolio method with VaR					-734.4					2499.45			44%			54%			63%
FSI portfolio method with dynamic variances	18%	18%	-546.2	-587.5	-582.3	-25%	56%	632	535	2587.88	48%	31%	55%	38%	47%	43%	55%	55%	34%
Quarterly change in the percentage of borrowers in risk category "A" and "B" in the total number of borrowers	6%	5%	-278.2	-370.2	-665.2	71%	82%	0.42	0.33	0.15	49%	45%	7%	48%	42%	43%	60%	60%	75%
FSI portfolio method with FEVD	7%	10%	-286.2	-395.1		73%	79%	0.32	0.33		66%	27%		48%	48%		61%	60%	
FSI portfolio method	3%	0%	-271.5	-429.9		77%	89%	0.52	0.37		26%	47%		54%	57%		62%	62%	
FSI PCA method	0%	0%	-278.3	-360.3		82%	88%	0.24	0.17		45%	44%		59%	34%		61%	61%	
FSI average index	7%	8%	-329.6	-402.0		70%	86%	0.39	0.31		37%	34%		41%	35%		58%	59%	
FSI portfolio method with signals	7%	0%	-145.9	-207.1	-807.8	65%	89%	0.50	0.29	0.14	22%	45%	1%	40%	37%	48%	62%	62%	89%
FSI portfolio method with simulations	1%	1%	-370.9	-468.3	-354.6	85%	87%	0.69	0.47	0.12	64%	77%	18%	41%	48%	29%	59%	58%	58%
FSI portfolio method with VaR	12%	19%	-210.4	-261.0	-833.1	66%	76%	0.39	0.21	0.18	74%	24%	2%	42%	27%	51%	57%	55%	79%
FSI portfolio method with dynamic variances	7%	2%	-297.3	-348.1		49%	72%	0.41	0.38		62%	57%		50%	42%		61%	62%	
Non-performing loans/total loans	14%	12%	-298.4	-353.6	-371.6	9%	39%	0.91	0.64	0.47	47%	46%	60%	36%	36%	67%	59%	59%	34%
FSI portfolio method with FEVD	0%	0%	-343.5	-441.0	-371.6	0%	34%	1.21	0.64	0.47	59%	51%	60%	34%	28%	67%	62%	62%	34%
FSI portfolio method	9%	2%	-301.6	-330.1		15%	34%	0.84	0.68		54%	50%		48%	44%		54%	54%	
FSI PCA method	13%	13%	-274.6	-335.3		10%	49%	1.08	0.67		36%	48%		35%	32%		62%	62%	
FSI average index	19%	19%	-286.1	-353.9		-1%	36%	0.93	0.66		34%	19%		34%	35%		61%	62%	
FSI portfolio method with signals	7%	7%	-275.8	-356.1		23%	55%	0.77	0.70		59%	65%		39%	43%		62%	62%	
FSI portfolio method with simulations	43%	37%	-326.1	-291.5		-4%	23%	0.71	0.55		43%	69%		17%	24%		54%	53%	
FSI portfolio method with VaR	9%	9%	-280.0	-349.9		10%	34%	1.14	0.62		43%	35%		42%	32%		62%	62%	
FSI portfolio method with dynamic variances	5%	5%	-314.5	-377.6		13%	38%	0.66	0.60		49%	42%		38%	47%		56%	56%	
Ratio between the number of borrowers who transferred to better risk category and those that deteriorated	32%	22%	-426.6	-553.0	-609.8	30%	58%	64.04	36.64	12.47	47%	29%	58%	35%	42%	48%	58%	60%	61%
FSI portfolio method with FEVD	48%	40%	-468.7	-555.1	-520.3	23%	60%	67.21	41.08	19.70	58%	10%	63%	28%	44%	48%	61%	62%	77%
FSI portfolio method	19%	6%	-428.4	-622.6		38%	59%	52.02	27.04		51%	36%		22%	40%		55%	59%	
FSI PCA method	9%	5%	-439.9	-652.9	-519.4	36%	64%	80.85	44.63	8.23	48%	51%	46%	61%	45%	50%	62%	62%	51%
FSI average index	43%	28%	-404.7	-502.4		19%	55%	49.32	32.12		39%	8%		41%	45%		61%	61%	
FSI portfolio method with signals	59%	36%	-310.8	-365.4	-964.1	29%	39%	52.19	9.66	11.17	51%	0%	57%	40%	46%	49%	59%	60%	29%
FSI portfolio method with simulations	21%	23%	-421.9	-547.0		31%	59%	96.27	48.24		39%	48%		25%	37%		56%	58%	
FSI portfolio method with VaR	45%	27%	-486.7	-681.2	-523.3	19%	60%	52.47	36.31	9.69	38%	69%	59%	34%	53%	50%	58%	62%	86%
FSI portfolio method with dynamic variances	16%	11%	-464.4	-542.1	-521.8	48%	66%	59.22	44.29	13.55	61%	25%	63%	39%	32%	46%	57%	58%	61%
Average level of risk (impairment/credit exposure)	23%	23%	-269.5	-354.0	-344.2	-31%	31%	0.24	0.17	0.24	49%	25%	33%	39%	42%	65%	59%	60%	61%
FSI portfolio method with FEVD	28%	27%	-152.6	-345.6		-58%	29%	0.26	0.16		45%	22%		44%	36%		61%	62%	
FSI portfolio method	7%	11%	-291.0	-362.4		-26%	19%	0.22	0.18		38%	34%		42%	59%		55%	57%	
FSI PCA method	20%	20%	-265.3	-310.1		-8%	44%	0.22	0.15		50%	34%		45%	46%		62%	62%	
FSI average index	31%	21%	-273.6	-341.6		-34%	27%	0.22	0.16		57%	12%		42%	39%		59%	60%	
FSI portfolio method with signals	38%	34%	-269.1	-438.2		-25%	29%	0.19	0.19		60%	24%		42%	32%		62%	62%	
FSI portfolio method with simulations	10%	14%	-297.2	-249.5		-30%	23%	0.37	0.25		39%	36%		23%	40%		56%	53%	
FSI portfolio method with VaR	45%	60%	-314.4	-384.2	-344.2	-5%	32%	0.28	0.22	0.24	45%	29%	33%	43%	50%	65%	58%	55%	61%
FSI portfolio method with dynamic variances	15%	13%	-307.9	-398.9		-55%	32%	0.18	0.16		56%	24%		35%	44%		55%	58%	
Percentage of borrowers who have transferred to a worse risk category in the total number of borrowers	3%	4%	-324.9	-424.2	-512.4	79%	94%	0.78	0.80	0.63	47%	43%	9%	40%	39%	46%	61%	60%	40%
FSI portfolio method with FEVD	0%	0%	-348.3	-519.7	-400.5	79%	93%	0.82	0.70	0.47	56%	44%	3%	43%	22%	51%	62%	62%	25%
FSI portfolio method	1%	1%	-360.8	-406.3	-390.2	80%	95%	0.65	0.63	0.80	53%	47%	0%	44%	46%	44%	62%	62%	35%
FSI PCA method	0%	0%	-341.5	-541.7	-397.2	96%	99%	0.42	0.37	0.35	32%	65%	3%	40%	41%	49%	62%	62%	21%
FSI average index	1%	1%	-383.9	-639.9	-384.8	75%	91%	0.86	0.77	0.63	48%	70%	12%	40%	39%	39%	58%	53%	24%
FSI portfolio method with signals	13%	13%	-192.6	-249.3	-849.4	70%	91%	0.79	0.90	0.93	58%	40%	16%	38%	31%	50%	62%	62%	62%
FSI portfolio method with simulations	5%	5%	-414.8	-446.3	-405.0	75%	92%	1.53	1.44	0.47	39%	45%	9%	44%	43%	33%	56%	56%	37%
FSI portfolio method with VaR	0%		-180.5		-636.2	79%		0.85		0.71	39%		15%	49%		52%	62%		58%
FSI portfolio method with dynamic variances	1%	1%	-311.4	-379.6		80%	95%	0.46	0.59		47%	21%		30%	43%		62%	62%	
Grand Total	18%	16%	-340.8	-426.3	-593.3	23%	57%	100.86	84.06	825.65	47%	38%	32%	40%	41%	49%	59%	59%	53%

Annex 8 - Dummy-variable regression on log-likelihood from the VAR model

```
lm(formula = VAR likelihood ~ mon.variable + index + deterministic type)

Residuals:
     Min       1Q   Median       3Q      Max 
-25.6417  -4.8055   0.4775   5.1645  21.1870 

Coefficients:
                    Estimate Std. Error  t value Pr(>|t|)    
(Intercept)          -311.1900     2.9107 -106.911  < 2e-16 ***
interest rate           9.1700     0.9205    9.962  < 2e-16 ***
FSI portfolio method   28.6125     3.2216    8.881  < 2e-16 ***
FSI average            13.6850     3.2216    4.248 2.69e-05 ***
FSI with signals       20.8175     3.2216    6.462 3.01e-10 ***
FSI simulations         8.7412     3.2216    2.713  0.00695 ** 
FSI variance            9.8138     3.2216    3.046  0.00247 ** 
det_type constant      -8.8510     1.3017   -6.799 3.84e-11 ***
det_type none         -25.3120     1.3017  -19.445  < 2e-16 ***
det_type trend        -11.2470     1.3017   -8.640  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 9.205 on 400 degrees of freedom
Multiple R-squared:  0.6557,    Adjusted R-squared:  0.648 
F-statistic: 84.65 on 9 and 400 DF,  p-value: < 2.2e-16
```

Annex 9 - Dummy-variable regression on log-likelihood from the SVAR model (with combination of restrictions)

```
lm(formula = SVAR likelihood ~ monetary variable + index + deterministic type
+ restriction)

Residuals:
    Min      1Q  Median      3Q     Max 
-98.527  -3.132   0.203   2.953 109.541 

Coefficients:
                       Estimate   Std. Error t value Pr(>|t|)    
(Intercept)             -92.8771     1.9008 -48.862  < 2e-16 ***
composit indicator        1.4917     1.0001   1.492  0.13617    
interest rate             5.5752     1.0001   5.575 3.28e-08 ***
FSI portfolio method      4.4270     1.6048   2.759  0.00592 ** 
FSI PCA                  -1.3373     1.6123  -0.829  0.40707    
FSI average               3.0062     1.6013   1.877  0.06081 .  
Fsi signals               3.4440     1.6087   2.141  0.03256 *  
FSI simulations           4.2568     1.5945   2.670  0.00773 ** 
FSI VaR                   0.3447     1.6085   0.214  0.83034    
FSI variance              0.9300     1.6087   0.578  0.56334    
det_type const           -1.9018     1.1325  -1.679  0.09343 .  
det_type none            -3.3112     1.1337  -2.921  0.00358 ** 
det_type trend           -1.3824     1.1388  -1.214  0.22510    
restriction2            -31.9784     1.8289 -17.485  < 2e-16 ***
restriction3            -31.9924     1.8136 -17.640  < 2e-16 ***
restriction4            -31.8743     1.7952 -17.755  < 2e-16 ***
restriction5            -17.2741     1.8181  -9.501  < 2e-16 ***
restriction6            -30.9603     1.8045 -17.158  < 2e-16 ***
restriction7            -31.8761     1.7952 -17.756  < 2e-16 ***
restriction8            -31.9332     1.7998 -17.743  < 2e-16 ***
restriction9            -13.0237     1.8677  -6.973 6.00e-12 ***
restriction10           -30.9895     1.7952 -17.262  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 12.19 on 898 degrees of freedom
Multiple R-squared:  0.461,     Adjusted R-squared:  0.4484 
F-statistic: 36.57 on 21 and 898 DF,  p-value: < 2.2e-16
```

Annex 10 Dummy-variable regression on log-likelihood from the SVAR model (with restrictions on pairs of variables)

```
lm(formula = SVAR likelihood ~ monetary variable + index + deterministic type
     + svar_cig + svar_cim + svar_cgi + svar_cgm + svar_cmg)

Residuals:
     Min       1Q   Median       3Q      Max
-103.747   -4.597   -0.039    4.594  106.166

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)              -160.8632     2.8263 -56.916  < 2e-16 ***
composit indicator          2.6801     1.0711   2.502  0.01252 *
interest rate               6.7108     1.0745   6.245 6.51e-10 ***
FSI portfolio               4.7756     1.6441   2.905  0.00377 **
FSI pca                    -1.0798     1.6520  -0.654  0.51354
FSI average                 2.7127     1.6407   1.653  0.09860 .
FSI signals                 4.1377     1.6478   2.511  0.01221 *
FSI simulations             4.7060     1.6342   2.880  0.00408 **
FSI VaR                     0.9968     1.6481   0.605  0.54547
FSI variance                0.6862     1.6482   0.416  0.67726
det type const             -2.4804     1.1605  -2.137  0.03284 *
det type none              -3.5189     1.1614  -3.030  0.00252 **
det type trend             -1.6394     1.1667  -1.405  0.16031
svar_cig                   17.4172     1.1723  14.857  < 2e-16 ***
svar_cim                   -4.2301     0.9951  -4.251 2.35e-05 ***
svar_cgi                   17.7271     1.2104  14.646  < 2e-16 ***
svar_cgm                   21.3462     1.1013  19.382  < 2e-16 ***
svar_cmg                   19.3944     1.1536  16.813  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 12.49 on 902 degrees of freedom
Multiple R-squared:  0.4318,    Adjusted R-squared:  0.4211
F-statistic: 40.32 on 17 and 902 DF,  p-value: < 2.2e-16
```

Svar_cig = 1/0 restriction on index -> gdp
Svar_cim = 1/0 restriction on index -> monetary policy
Svar_cgi = 1/0 restriction on gdp -> index
Svar_cgm = 1/0 restriction on gdp -> monetary policy
Svar_cmg = 1/0 restriction on monetary policy -> gdp
Svar_cmi = 1/0 restriction on monetary policy -> index

Annex 11 - Dummy-variable regression on RMSE (endogenous TVAR1 model)

```
lm(formula = rmse TVAR1 ~ No.variables + monetary variable + index +
deterministic type)

Residuals:
       Min         1Q     Median         3Q        Max
-0.0088917 -0.0023010 -0.0005521  0.0022271  0.0097000

Coefficients:
                      Estimate  Std. Error  t value   Pr(>|t|)
(Intercept)             0.0140    0.0011    12.2930  < 2e-16  ***
No.variables  "4"       0.0008    0.0006     1.2460   0.2145
composit indicator      0.0025    0.0007     3.3530   0.0010 ***
interest rate           0.0062    0.0007     8.3320   0.0000 ***
FSI portfolio          -0.0008    0.0012    -0.6300   0.5297
FSI PCA                 0.0005    0.0012     0.3830   0.7020
FSI average            -0.0012    0.0012    -0.9720   0.3324
FSI signals             0.0057    0.0012     4.6950   0.0000 ***
FSI simulations         0.0016    0.0012     1.3000   0.1951
FSI VaR                -0.0062    0.0012    -5.0650   0.0000 ***
FSI variance           -0.0031    0.0012    -2.5320   0.0122 *
det.type "constant"     0.0000    0.0009     0.0000   1.0000
det.type "none"         0.0000    0.0009     0.0000   1.0000
det.type "trend"        0.0000    0.0009     0.0000   1.0000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.004218 on 178 degrees of freedom
Multiple R-squared:  0.5089,    Adjusted R-squared:  0.473
F-statistic: 14.19 on 13 and 178 DF,  p-value: < 2.2e-16
```

Annex 12 - Dummy-variable regression on RMSE (exogenous TVAR2 model)

```
lm(formula = rmse TVAR1 ~ No.variables + monetary variable + index
+ deterministic type)


Residuals:
       Min          1Q      Median          3Q         Max
-0.0066292 -0.0021375 -0.0001479  0.0015995  0.0080042

Coefficients:
```

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	0.0094	0.0009	10.2010	0.0000	***
No.variables "4"	0.0019	0.0005	3.8700	0.0002	***
composit indicator	0.0021	0.0006	3.5500	0.0005	***
interest rate	0.0046	0.0006	7.5550	0.0000	***
FSI portfolio	0.0034	0.0010	3.4140	0.0008	***
FSI PCA	-0.0015	0.0010	-1.4700	0.1433	
FSI average	-0.0038	0.0010	-3.8190	0.0002	***
FSI signals	0.0050	0.0010	5.0360	0.0000	***
FSI simulations	0.0053	0.0010	5.3400	0.0000	***
FSI VaR	0.0015	0.0010	1.5550	0.1218	
FSI variance	0.0028	0.0010	2.8560	0.0048	**
det.type "constant"	0.0000	0.0007	0.0000	1.0000	
det.type "none"	0.0000	0.0007	0.0000	1.0000	
det.type "trend"	0.0000	0.0007	0.0000	1.0000	

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.003416 on 178 degrees of freedom
Multiple R-squared:  0.5484,    Adjusted R-squared:  0.5154
F-statistic: 16.63 on 13 and 178 DF,  p-value: < 2.2e-16
```

Annex 13 – Algorithm for creating Generilzed Impulse Response Functions (GIRFs)

Algorithm for Generalized impulse response functions (GIRF), specific to particular regime (state) with R-observationss is the following:

1. pick a history Ω^r_{t-1}

2. pick a sequence of shocks by bootstrapping the residuals of the TVAR taking into account the different variance-covariance matrix characterizing each regime;

3. given the history Ω^r_{t-1} simulate the evolution of the model over the period of interest;

4. repeat the previous exercise by adding a new shock at time 0;

5. repeat B times the steps from 2 to 4;

6. compute the average difference between the shocked path on the non-shocked one;

7. repeat steps from 1 to 6 over all the possible starting points;

8. compute the average GIRF associated with a particular regime with R observations as:

$$y_{t+m}(\varepsilon_0) = \frac{1}{R}\sum_{r=1}^{R}\frac{y_{t+m}(\Omega^r_{t-1}|\varepsilon_0,\varepsilon^*_{t+m}) - y_{t+m}(\Omega^r_{t-1}|\varepsilon^*_{t+m})}{B}$$

UDK 336.748.12]:338.516:339.564}:303.094.3(560)"2005/2015"
336.748.12]:339.743}:303.094.3(560)"2005/2015"

DISAGGREGATED EVIDENCE FOR EXCHANGE RATE AND IMPORT PRICE PASS-THROUGH IN THE LIGHT OF IDENTIFICATION ISSUES, AGGREGATION BIAS AND HETEROGENEITY

M. Utku Özmen[1] and Meltem Topaloğlu[2]

Abstract

For emerging market economies, changes in the import prices and the exchange rate are among the major determinants of inflation. The general framework for analyzing pass-through of foreign prices on inflation is the VAR impulse response analysis. However, such an approach may suffer from various biases of different sort. In this paper, we try to analyze the sources and implications of such biases on pass-through analysis using Turkey as a benchmark, over the sample period of 2005-2015. First one is the identification bias. If global growth and risk appetite are not controlled for, the results of the impulse responses have a high chance of being misleading. Second is related to aggregation. We propose a disaggregated approach and run an extended VAR model for each of 152 subcomponents of the CPI separately. Then, we aggregate the individual impulse responses of those components with significantly positive response to exchange rate and import prices. Our findings reveal a clear aggregation bias. Once disaggregated approach is used, we report a higher pass-through coefficient for exchange rate to inflation. Third point is the heterogeneity in pass-through coefficients. We show that in Turkey, the exchange rate pass-through is not only strong in core goods and energy, but also in food items. Services prices also found to be responding to exchange rates. Fourth finding relates to import price pass-through. When analyzed, component wise, we find that the pass-through of final consumption good import prices to inflation is higher than the pass-through of raw material import prices over the sample period. Finally, our analyses reveal that the pass-through of import prices has lowered after 2013 given the asymmetric effects of the dramatic fall in oil prices.

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The views and opinions presented in this study belong to the authors and do not necessarily represent those of the Central Bank of the Republic of Turkey or its staff.

1. INTRODUCTION

For emerging market economies, changes in the import prices and the exchange rate are among the major determinants of inflation, especially in the short run. Moreover, rapid and sizeable change in import prices and exchange rates at times increases the importance of such factors. Turkey also belongs to the list of countries that are highly prone to international price changes. Furthermore, given the volatile nature of capital flows to emerging markets, exchange rate changes can also be strong. Hence, for a good understanding of inflation dynamics, it is of great importance to understand the impact of such foreign prices on inflation.

The general framework for analyzing pass-through of foreign prices on inflation is the VAR impulse response analysis. In a simple setting, a VAR model with exchange rate, import prices, output gap and inflation would be sufficient to analyze the impact. However, such an approach may suffer from various biases of different sort. In this paper, we try to analyze the sources and implications of such biases on pass-through analysis using Turkey as a benchmark, over the sample period of 2005-2015.

First one is the identification bias. A simple VAR framework as outlined above may not reveal the real nature of the relationship. The domestic output gap and the course of the exchange rate are highly dependent on the course of global demand and of global capital movements. In this respect, if foreign output gap and global risk appetite are not controlled for, the results of the impulse responses have a great chance of being misleading. Second bias is related to aggregation. Given that the CPI is composed of various heterogeneous subcomponents, looking at the aggregate figure may not be informative enough. Indeed, we propose a disaggregated approach and run an extended VAR model for each of 152 subcomponents of the CPI separately. Then, we aggregate the individual impulse responses of those components with significantly positive response to exchange rate and import prices. Our findings reveal a clear aggregation bias. Once disaggregated approach is used, we report a higher (lower) pass-through coefficient for exchange rate (import prices) to inflation.

Third point is the heterogeneity in pass-through coefficients. We show that in Turkey, the exchange rate and the import price pass-through are not only strong in core goods and energy, but also in food items. Services prices also found to be sensitive to exchange rates. Additional sources of heterogeneity are inherited in the choice of import prices and exchange rates. Fourth finding relates to import price pass-through. When component-wise analyzed, we find that the pass-through of final consumption good import prices to inflation is higher than the pass-through of raw material import prices. Fifth, recently, the exchange rate pass-through is higher when the exchange rate basket is considered rather than the US dollar or the Euro, separately.

Finally, our analyses reveal that the pass-through of import prices has lowered after 2013. The tremendous fall in oil prices have resulted in asymmetric effects. The pass-through of falling international energy prices has been much lower than the pass-through of increasing oil prices. Overall, our disaggregated approach provides a very rich environment to analyze many aspects of foreign price pass-through in emerging markets.

2. OVERVIEW OF LITERATURE

2.1. Exchange rate pass-through

Exchange rate pass-through is a popular issue discussed in the literature. Firstly, the focus was on the degree of pass-through of exchange rate to import prices based on the law of one price theory (Irandoust, 2000; Campa and Goldberg, 2005). Besides, some other studies analyze the pass-through of exchange rate on consumer and producer prices (McCarthy, 2007; Hahn, 2003). Furthermore, the dynamics of pass-through gained importance (e.g, McCarthy, 2007; Taylor, 2000; Choudhri and Hakura, 2006; Burstein *et al.*, 2002; Saiki, 2004). These studies show that the volatility and persistence of the shocks, distribution chain structure, size of the economy, inflationary environment and implementation of inflation targeting regime have significant effects on the degree and speed of the exchange rate pass-through.

For many emerging countries, the decrease in pass-through into domestic prices is common due to changes in policy implementation. Saiki (2004) claims that after inflation targeting implementation, pass-through coefficient declines. A survey by the Bank for International Settlements (2006) shows that the exchange rate pass-through into inflation decreased due to changes in policy implementation and successful performance.

This strand of literature analyzes the extent of the pass-through into aggregate import prices and consumer prices. On the other hand, some studies examine the exchange rate pass-through using micro-data, i.e. sub-components of aggregate price indices. Analysis pertaining to the US and Euro Area show the effect of commodity prices on sub-components of price indices. Furthermore, there are few studies examining exchange rate pass-through into sub-components of consumer prices (Rigobon, 2007; Parsley, 2012; Aron *et al.*, 2014).

2.2. Prior studies in Turkey

Most of the literature on Turkish data investigates the exchange rate pass-through into consumer prices in Turkey. Leigh and Rossi (2002), Arbatlı (2003), Kara and Öğünç (2005), Kara *et al*. (2007) are some of the studies conducted on exchange rate pass-through into consumer prices. Mostly, the literature on Turkish data consider the pre-2001 crisis period. For that reason, their findings provide evidence from a period of different monetary police implementation than recent period. Furthermore, some studies divide the whole period into two sub-periods as before and after the flexible exchange rate regime. The results show that under fixed exchange rate regime, exchange rate pass-through was much higher.

More recent studies mostly use the data after 2002. Kara and Öğünç (2008) estimate the 'imported inflation' pass-through into consumer prices before and after the inflation targeting period. Their findings indicate that exchange rate pass-through into consumer prices was high and rapid before the inflation targeting period. They claim that low inflation pass-through is a result of central bank credibility and exchange rate unpredictability. Damar (2010) analyses the exchange rate pass-through both into consumer price index (CPI) and core CPI for two periods, before and after the floating exchange rate regime. The results show that pass-through effect declines through production chain and after the floating exchange rate implementation. Gündoğdu (2013) states similar results, and claims that pass-through effect is lower after the 2008 global crisis. Yüncüler (2011) examines pass-through of import prices and exchange rate into consumer prices and manufacturing industry prices. The results show that as the distribution chain theory suggests, pass-through into producer prices is higher than pass-through into consumer prices. Furthermore, after the inflation targeting regime, pass-through is effectively lower. Overall, studies on Turkey have extensively focused on aggregate price indicators; an approach inevitably fails to thoroughly examine the nature of the pass-through on distinct subcomponents of the CPI.

2.3. Our approach / Need for disaggregation / Motivation

The previous studies in the literature focus on aggregate price series, CPI or some sort of core inflation measure, to study the impact of exchange rate and import prices on inflation in the VAR framework. Although quite appealing, dealing with aggregate price index may hide important information as the aggregate index contains a great deal of heterogeneity. Indeed, it is already documented that the CPI consists of sub groups with very distinct pricing behavior in terms of determinants and frequency of price changes (Özmen and Sevinç, 2016). For instance, some energy prices, i.e. motor fuels, are determined by import prices (oil) and the exchange rate. Meanwhile, services prices are less sensitive to import prices, as most of them are non-tradable, and they mostly depend on domestic costs (Başer *et al.* 2015).

In this regard, our analysis departs from the literature on the grounds that we consider highly disaggregated price indices (152 sub components of the CPI) to detect pass-through evidence. This approach serves several purposes: first, one can document differing pass-through coefficients for major sub groups (i.e. food, energy); second, one can rank individual items in terms of the size of the pass-through; third, one can discuss the nature of heterogeneity and aggregation bias; fourth, one can use this information to generate more robust core inflation measures, among others.

3. METHODOLOGY

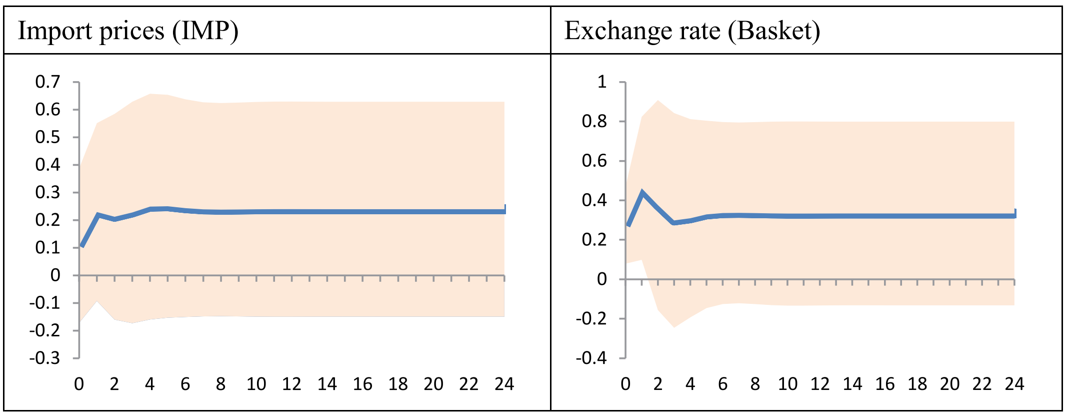
As it is the common benchmark in empirical pass-through analysis, we rely on the VAR framework. In this study, following Öğünç, Özmen and Sarıkaya (2016), we construct an extensive 5-variable VAR model incorporating import prices, exchange rate, output gap, inflation and wages as endogenous variables with respective ordering. We also include several exogenous variables to control for global growth and global risk appetite, and for domestic supply shocks in food prices along with taxes excised on energy items.

As discussed by Öğünç, Özmen and Sarıkaya (2016), these control variables enable better identification of the impact of cost shocks (import prices and exchange rate on inflation). Global output gap and risk appetite measures control for global growth channel. In the last decade, what we observe in the data is that periods of global growth and periods of hike in international commodity prices coincide. Also in these periods, increased risk appetite induces more capital inflows into emerging economies. Thus, an increase in import prices (a cost shock by itself) seems to increase domestic growth and to appreciate the local currency. Thus, if global growth and risk appetite is not controlled for, the identification of import price shocks will be problematic. In the same manner, indicators that capture domestic supply shocks in food market along with indicators that capture tax adjustments in energy items also needs to be controlled for in order to reveal the plausible impact of exchange rate and import prices on domestic prices.

This VAR specification will be applied to each of 152 sub components of the CPI. Once the models are constructed, the response of inflation to shocks to exchange rate and import prices will be analyzed through impulse response functions. Visual inspection of impulse-response functions give a broad idea of whether a price index is significantly affected by exchange rate of import prices. Given that the sample period is relatively short, that we use the aggregated import price series and that there may be additional factors to be controlled for each price index, the confidence intervals around the estimated impulse-response may not always point to a clear indication.

To put the idea on concrete terms, consider the responses of automobile prices, for instance, to import price and exchange rate shock over the sample period (Figure 1). A very high proportion of the automobiles sold in Turkey are imported. Therefore, the domestic prices are highly dependent on the course of import prices and the exchange rate. In practice, we observe that both cost shocks are transmitted into domestic prices of automobiles. However, in Figure 1, we see that the confidence interval around the response does not lie entirely in the positive territory. Even for a price which undoubtedly depends on exchange rate and import prices, the impulse-responses may still assign some probability to the case of pass-through being negative. This outcome is contrary to economic intuition and what is observed in the data. Therefore, looking at the impulse-responses, it will unfair to conclude that automobile prices are not significantly affected by exchange rate and import prices. Two possible reasons may be cited for such a case. First, the sample period may not long enough to identify the relations with a reasonable precision. Second, due to data constraint and with an aim to produce comparable results with aggregate studies, we consider a generic import price index for all the items. Thus, an alternative approach has to be exercised at this stage.

Figure 1: Response of Automobile prices to a unit shock to:



Notes: The responses are cumulative responses for 24 quarters.

With this discussion in mind, we propose a methodology to determine the CPI sub components which are affected by exchange rate of import prices. That is, if 75% of the confidence interval of the response lies in the positive territory, we will declare that price index as being affected by cost measures. That is, for instance, following Figure 1, given that the large enough proportion of the cumulative response of automobile prices to import prices and exchange rate is on the positive side (at least 75%), we conclude that cost shocks to exchange rate and import prices are reflected to domestic automobile prices.

Once each 152 price index is modeled with a VAR specification and for a sample period, we determine the indices that positively respond to exchange rate and import price shock. Then, we aggregate the pass-through responses with respective weights of each component in order to calculate the aggregate group pass-through values. For instance, if 5 energy items are found to be responding to import price shock, we aggregate the responses of these 5 items to calculate the "import price pass-through in energy".

This methodology, although subjective to some extent, produces plausible pass-through coefficients. If one were to stick to the information in the impulse-responses and consider only the items with entire confidence band in the positive territory, would end up with around 6 percent of pass-through both form import prices and exchange rate over the 2005-2015 sample. However, these numbers are way below then what is observed. The reason is that in that case, only 27 out of 152 items are responding to exchange rate and only 11 out of 152 items are responding to import prices. Thus, such a strict approach will be very restrictive and yield misleading results. In fact, using a wide range of single equation models, Özmen and Sarıkaya (2016) show that 100 out of 152 sub components (roughly 2/3rd of the CPI) are significantly affected by import prices in Turkish lira (which combines import prices and exchange rate).

In this regard, one needs to employ a subjective strategy to choose items that positively respond to exchange rate and import prices. Here, we use the 75% threshold as a benchmark for the confidence interval of the responses. Nonetheless, in the appendix, we further discuss the robustness of our findings by analyzing different threshold measures[3].

4. DATA

The data used in the study is composed of a set of endogenous and exogenous variables used in the VAR setting. The endogenous variables include import prices, exchange rates, output gap, consumer prices and wages. The consumer prices are the 152 sub components of the CPI at 5-digit COICOP classification. The price indices are from the Turkstat. We use the quarterly percent change of seasonally adjusted price indices.

For import prices, we use the Import Unit Value Index and its major components in US dollar terms, collected from Turkstat. In this analysis, we use the aggregate import price index (IMP) and its two major components: import prices of raw materials (IMP-Raw) and import prices of consumption goods (IMP-Cons), all at USD terms and used as quarterly percentage change. For exchange rate measures, we consider three different rates: US dollar/Turkish lira (USD), Euro/Turkish lira (Euro) and an exchange rate basket (Basket) composed of half USD and half Euro, collected form the Central Bank of Turkey (CBRT).

The output gap measure is the current estimates of Alp, Öğünç and Sarıkaya (2012). Considering wages, we consider the non-farm real unit wage, calculated using the data from Turkstat.

The external controls include global risk premium, global output gap and controls for domestic food supply shocks and taxes in energy items. For global risk premium, we use the EMBI index, collected from the Bloomberg. The global output gap is the Hp-filtered gap of global growth, a weighted sum of the growth of trading partners of Tukey, calculated within the Central Bank of Turkey. In order to proxy the domestic supply shocks, we use the unprocessed food price index (excl. fresh fruits and vegetables), from Turkstat and CBRT. Finally, taxes in energy items are used as external controls, as taxes constitute an important share of energy prices.

---

[3] We consider 66% and 80% as different thresholds for the share of the confidence interval lying above the zero-line. The results, shown in the Appendix, reveals that the 75% threshold gives a relatively good measure.

The extended sample period considered in the study covers 2005q1-20015q2 period. However, we also work with a shorter period of 2005q1-2013q2 in order to see whether the pass-through coefficients change recently. Finally, for foods items, we consider alternative import prices (food import price index, FAO food price index) and extra control variables (domestic wheat price) to check the robustness of the findings. For energy items, instead, we also control for international oil prices.

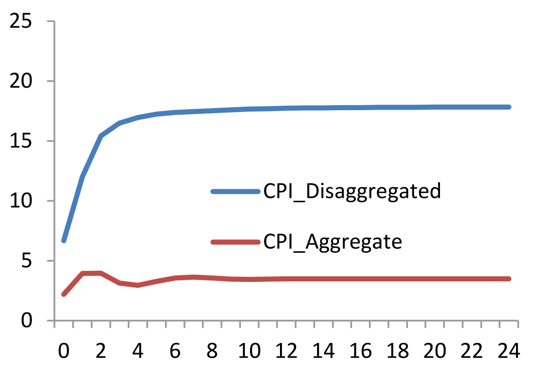
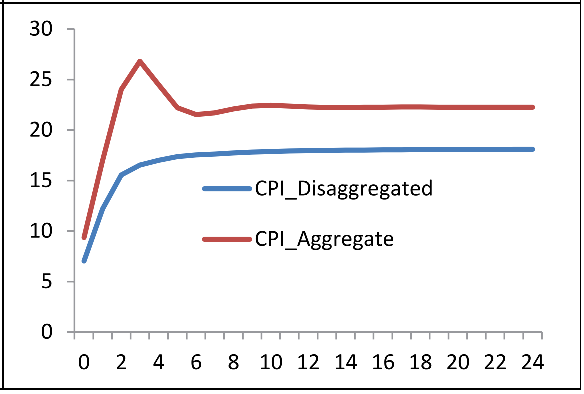
5. FINDINGS

We may discuss our findings on the onset of aggregation bias, heterogeneity on various grounds and recent periods.

5.1. Aggregation Bias

We compare the pass-through results for CPI to exchange rate and import price shocks for two cases: Aggregate and Disaggregated. Aggregate approach refers to the impulse-response results of a VAR specification that uses the aggregate CPI only. Meanwhile, the disaggregated approach refers to the aggregation of individual pass-through paths of items selected according to the discussed methodology. Figure 2 shows the cumulative response of CPI to exchange rate and import prices.

Figure 2: Aggregation Bias-Aggregated CPI pass through vs. Disaggregated approach

Response of CPI to a unit shock to Basket (%)	Response of CPI to a unit shock to IMP (%)
	

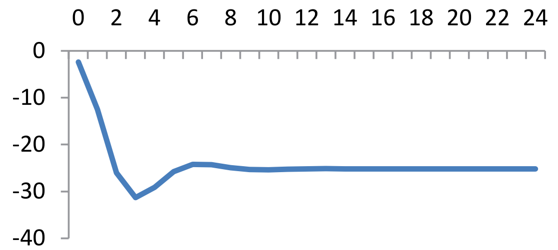
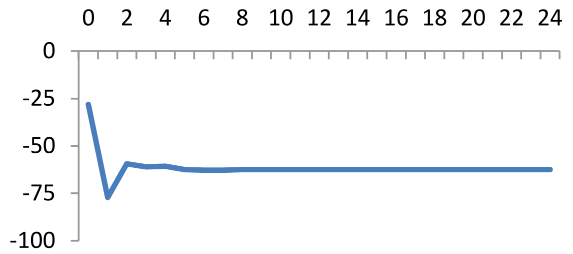
Notes: The estimation sample is 2005q1-2015q2. The VAR specification includes Basket and IMP for exchange rate and import price measure, respectively. Cumulative responses over 24 quarters are reported.

The results points to a clear aggregation bias when the pass-through is calculated only with the headline index. The bias is more severe when the exchange rate basket is considered. The aggregate approach yields a much lower exchange rate pass-through, thus it is downward biased. On the other hand, there is an upward bias for import price pass-through in the aggregate analysis.

The source of aggregation bias for the exchange rate pass-through can clearly be identified with the help of the disaggregated approach. We see that the VAR models predict negative pass-through coefficient of very high magnitudes for several items with sizeable weights in the CPI. The major items of this sort are tobacco products, fresh vegetables, and natural gas among others. Figure 3 shows the cumulative response of the prices of tobacco products and fresh vegetables.

The estimated pass-through coefficients are not economically justifiable and are contrary to intuition. Nonetheless, these two items constitute almost 8% of the total CPI. Thus, such components with very high weights and with very high negative pass-through coefficients are the major source of the aggregation bias. Our disaggregated approach, which discards such items, produces more reliable estimates of pass-through.

Figure 3: Selected Items Inducing Aggregation Bias

Response of Tobacco products to a unit shock to Basket (%)	Response of Fresh vegetables to a unit shock to Basket (%)
	

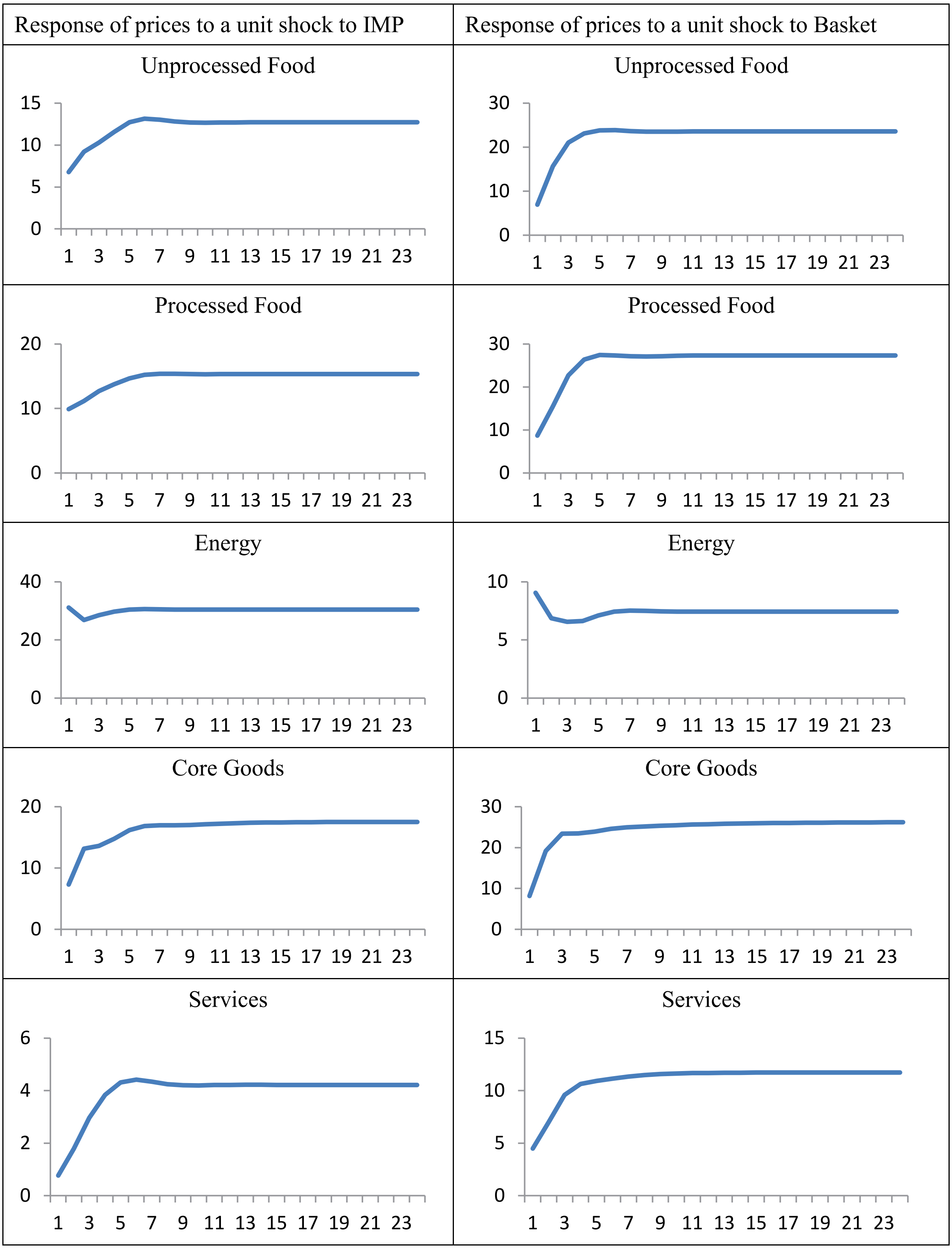
Notes: The estimation sample is 2005q1-2015q2. The VAR specification includes Basket and IMP for exchange rate and import price measure, respectively. Cumulative responses over 24 quarters are reported.

5.2. Heterogeneity across Major Components of CPI

As discussed in the introduction section, the CPI is composed of heterogeneous items with different pricing behavior. Here, we analyze the pass-through to major components of the CPI: core goods, services, energy, unprocessed food and processed food. The Figure 4 reports the cumulative percent response of each component to a unit shock to exchange rate and import prices in the general model for the entire sample of 2005q1-2015q2, where the exchange rate is the Basket and import prices is IMP. Our results point to very different exchange rate and import price pass-through in terms of magnitude and speed across major groups.

The results reveal important points, some of which novel to this study. First, the core goods are significantly affected by both the exchange rate and the import prices. This is not surprising as majority of the core goods, i.e. automobiles, are imported. The import price pass-through to core goods price is around 17% and it is almost completed in about 6 quarters. On the other hand, the exchange rate pass-through to core goods prices is around 25% and it is completed much faster compared to import prices, in about 3-4 quarters. Another major group with strong foreign pass-through is energy. This is also in line with a priori expectations as Turkey is an energy importer. The import price pass-through to energy is around 30% and it is completed fairly quickly. Considering the high share of indirect taxes on energy items, this amount almost corresponds to a one-to-one pass-through of foreign energy prices to domestic prices. Over the sample, exchange rate pass-through to energy is lower than import prices.

Figure 4: Pass-through for Major CPI Components



Notes: The estimation sample is 2005q1-2015q2. The VAR specification includes Basket and IMP for exchange rate and import price measure, respectively. Cumulative responses over 24 quarters are reported.

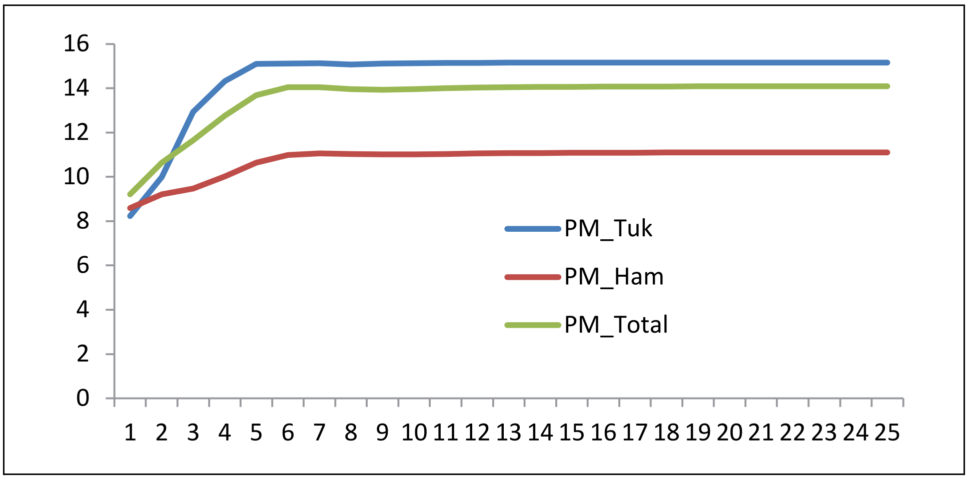
The major findings which are novel to this study are related to services and food prices. First of all, for services sector, which is mostly non-tradable and subject to domestic cost pressures, we observe a non-negligible amount of exchange rate pass-through of around 12%. Meanwhile, as expected the import price pass-through is lower, around 4%, although not inexistent. When it comes to food prices, on the other hand, we see a considerable amount of exchange rate and import price pass-through both for processed and unprocessed food prices. The import price pass-through is on the range of 12-15%, while the exchange rate pass-through is on the range of 23-27%. This finding is quite unique. Food prices, which have been considered as being subject to domestic supply shocks, are actually found to responding to foreign price shocks to a large extent as well. Similar to other sub components, the import price pass-through takes a longer time to complete, compared to exchange rate.

5.3. Heterogeneity across Different Components of Import Prices

The results presented above consider the baseline VAR including the exchange rate basket (Basket) and overall import prices (IMP). The general import prices include different components related to different sectors of the domestic economy. The major components include the consumption good import prices (IMP-Cons) and raw material import prices (IMP-Raw). These two import price definitions actually point to two different transmission channel on inflation. The imported consumption goods affect the inflation directly. Meanwhile, imported raw materials enter into production process and their impact is indirectly observed on consumer inflation. That is, the pass-through these import prices to inflation may differ both in terms of magnitude and in terms of speed.

Figure 5 shows the response of consumer prices to a unit shock in different import price series. Two observations stand out. First, over the sample period, the pass-through of consumption goods import prices is higher than that of raw material import prices (around 15% vs. 11%). Second, the pass-through of raw materials import prices is completed more slowly.

Figure 5: Response of CPI to a unit shock to Different Import Prices



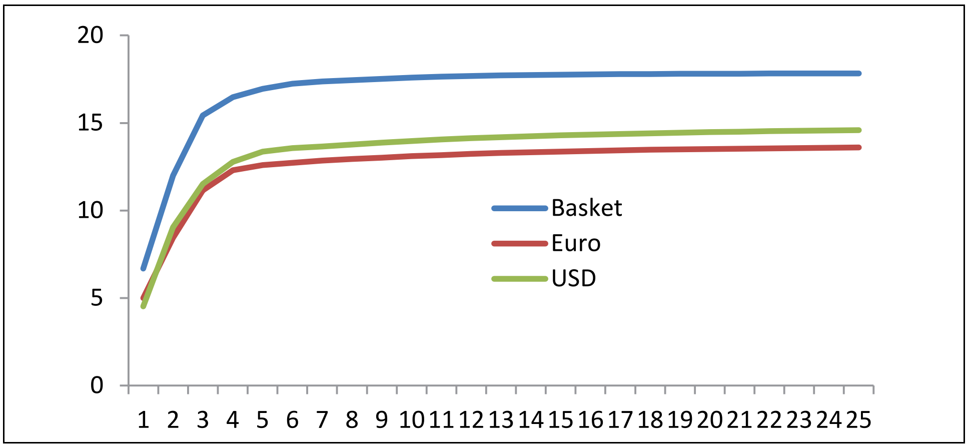
Notes: The estimation sample is 2005q1-2015q2. The VAR specification includes Basket, as exchange rate and different import price definitons, IMP (PM_Total), IMP-Cons (PM_Tuk) and IMP-Raw (PM_Ham), respectively. Cumulative responses over 24 quarters are reported.

5.4. Heterogeneity across Different Exchange Rate Measures

The main results presented consider the baseline VAR including the exchange rate basket (Basket) and overall import prices (IMP). Instead of the basket we may analyze the pass-through of the USD and Euro separately.

Figure 6 shows the response of consumer prices to a unit shock in different exchange rate measures. The results reveal that in fact the pass-through of the basket is higher than individual exchange rates over the sample period.

Figure 6: Response of CPI to a unit shock to Different Exchange Rates

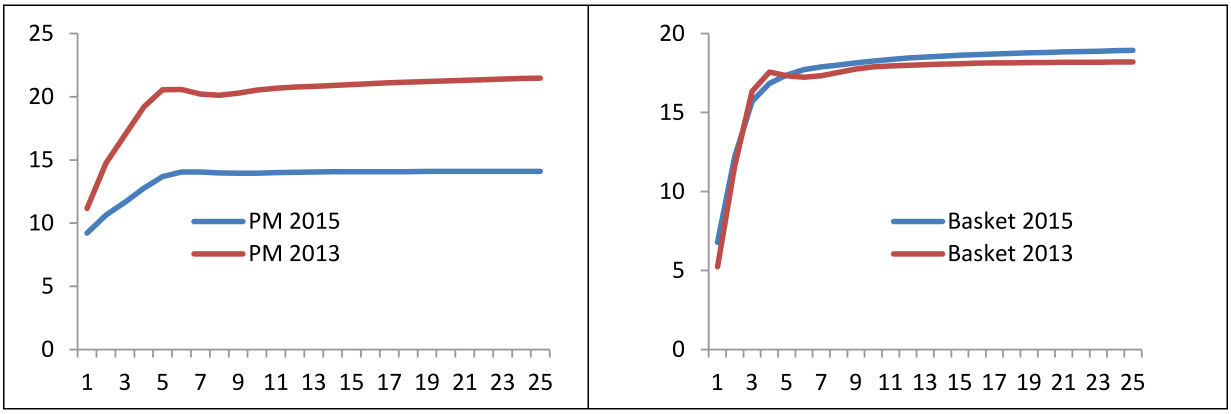


Notes: The estimation sample is 2005q1-2015q2. The VAR specification includes Basket, Euro and USD as exchange rate respectively, and import prices IMP. Cumulative responses over 24 quarters are reported.

5.5. Recent change in Pass-through

In this section, we analyze whether the pass-through rates has changed recently. We compare the results of the baseline model for two different samples in Figure 7: 2005q1-2015q2 (our full sample, labeled as 2015) and 2005q1-2013q2 (labeled as 2013 in figure). We see that there is no change in the pass-through of the exchange rate on inflation in two different samples. However, there is a considerable drop in the pass-through of import prices in the full sample (Figure 7). With the addition of two years of observations, the pass-through of import prices came down from above 20% to around 14%.

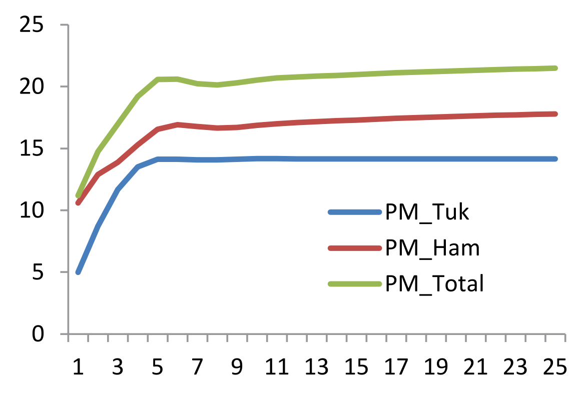
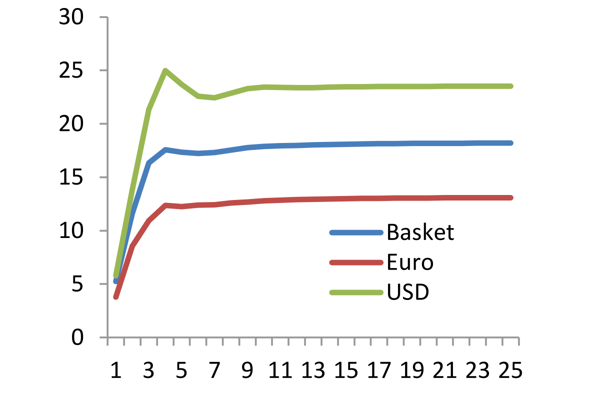
Figure 7: Pass-through in Different Sample Periods



Notes: 2015 referes to 2005-2015 sample, 2013 refers to 2005-2013 sample.

The reason behind this fall is visible in Figure 8. We see that the pass-through of raw material import prices has significantly come down from 17% to 11% in the full sample (see section 5.3). This finding is related to the unresponsiveness of several items in the CPI to the significant fall in international oil prices. Mainly, the energy prices, apart from motor fuel, remained constant over the last years of the sample period. This caused a remarkable reduction in the pass-through of imported raw material into domestic inflation given the significant share of oil in raw material imports. Meanwhile, the pass-through of consumption goods import prices has even gone up slightly.

Figure 8: Pass-through with respect to Different Import Prices and Exchange Rates

Impulse Response of CPI prices to a unit shock to PM (2005-2013 period)	Impulse Response of CPI prices to a unit shock to Basket (2005-2013 period)
	

Notes: PM_Total is the total import prices (IMP); PM_Tuk is the consumption goods import prices (IMP_Cons) and PM_Ham is the raw material import prices (IMP_Raw).

Also, the pass-through of USD to CPI has significantly come down, from 23% to 14% (see section 5.4). When the pass-through of USD to energy prices is reconsidered, the major fall can also be attributed to the case of housing energy prices. Given the considerable hike of the USD rates in the last two years, the fact that the prices of housing energy items (electricity and natural gas), which have a high weight in the CPI, remained constant; the pass-through of USD has weakened recently.

6. CONCLUSION

In this study, we show that the analysis of the foreign price pass-through to inflation with aggregate price series, such as the CPI, may hide a considerable amount of heterogeneity and may thus lead to wrong conclusions. Instead, using a disaggregated approach, by considering each 152 sub component of the CPI separately, presents a very fruitful domain to analysis and to discuss very different aspects of heterogeneity. Such an approach also provides a platform with many policy implications.

We first show that there is an aggregation bias. For the case of exchange rate, considering the CPI itself may underestimate the pass-through to a large extent. Following that, we document that the sub components of the CPI respond very differently exchange rate and import prices. Moreover, we also note that the pass-through rates also differ with the selection of the import price and exchange rate measures. Our analysis also sheds light on the recent changes in the pass-through of import prices to inflation.

A complete understanding of the exchange rate and import price pass-through is very crucial for a better reading of the inflationary process and for formulating policy responses. In that sense, we propose that a disaggregated approach is needed.

REFERENCES

Başer Andiç, S., Küçük, H. and Öğünç, F., 2015. Inflation Dynamics in Turkey: In Pursuit of a Domestic Cost Measure. Emerging Markets Finance and Trade, 51(2), pp.418-431.

Arbatlı,E., 2003. Exchange Rate Pass-Through in Turkey: Looking for Asymmetries. Central Bank Review 3, No. 2, 85-124.

Bank for International Settlements (BIS), 2006. Exchange Rate Pass-Through in Emerging Market Economies: What Has Changed and Why? Basel.

Burstein,A., B.Eichenbaum and S.Rebelo, 2002. Why is Inflation So Low After Large Devaluations?, NBER Working Papers, No. 8748.

Campa, J.M. and Goldberg, L.S., 2005. Exchange rate pass-through into import prices. Review of Economics and Statistics, 87(4), pp.679-690.

Choudhri, E.U. and Hakura, D.S., 2006. Exchange rate pass-through to domestic prices: does the inflationary environment matter?. Journal of International Money and Finance, 25(4), pp.614-639.

Damar, A. O., 2010. Türkiye'de Döviz Kurundan Fiyatlara Geçis Etkisinin İncelenmesi. TCMB Uzmanlık Yeterlilik Tezi.

Gündoğdu, M.K. 2013. Döviz Kurunun Fiyatlara Geçis Etkisi: Türkiye Çalısması. İş Bankası İktisadi Araştırmalar Bölümü, Subat.

Hahn,E., 2003. Pass-Through of External Shocks to Euro Area Inflation. European Central Bank Working Paper Series, No. 243.

Irandoust,M., 2000. Exchange Rate Pass-Through in the Automobile Industry. The International Trade Journal, Vol. 14, No. 1, 37-51.

Kara,A.H., H.Küçük Tuğer, Ü.Özlale, B.Tuğer and M.E.Yücel, 2007. Exchange Rate Regimes and Pass-Through: Evidence from the Turkish Economy. Contemporary Economic Policy, Vol. 25 (2), 206-225.

Kara, A. H., Öğünç, F., 2005. Exchange Rate Pass-Through in Turkey : It Is Slow, But Is It Really Low?. Working Papers 05/10. Research and Monetary Policy Department, Central Bank of the Republic of Turkey.

Kara,A.H., F.Öğünç, 2008. Inflation Targeting and Exchange Rate Pass-Through: The Turkish Experience. Emerging Markets Finance and Trade, November-December 2008, Vol. 44, No. 6, 52-66.

Leigh,D. and M.Rossi, 2002. Exchange Rate Pass-Through in Turkey, IMF Working Paper, No. WP/02/204.

McCarthy,J., 2007. Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. Eastern Economic Journal 33(4), 511-537.

Öğünç, F., Özmen, M.U. and Sarıkaya, Ç., 2016. A bayesian approach to inflation dynamics in Turkey. Central Bank of Turkey, manuscript.

Özmen, M.U. and Sevinç, O., 2016. Price Rigidity in Turkey: Evidence from Micro Data. Emerging Markets Finance and Trade, 52(4), pp.1029-1045.

Özmen, M.U. and Sarıkaya, Ç., 2016. Sensitivity of inflation to domestic demand conditions and foreign costs in Turkey: Determining CPI items responding to output gap, credits and import prices. Central Bank of Turkey, manuscript.

Parsley, D. 2012. Exchange Rate Pass-through in South Africa: Panel Evidence from Individual Goods and Services. Journal of Development Studies, 48, 832–846.

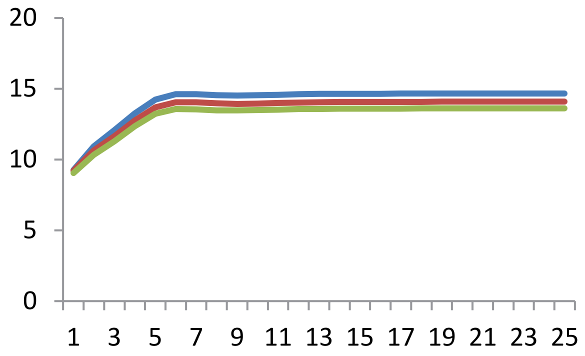
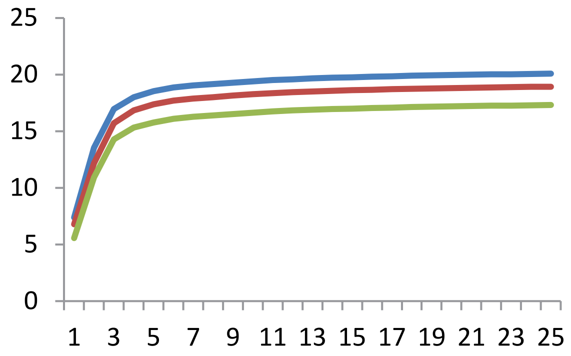
Rigobon, R. 2007. Through the pass-through: Measuring central bank credibility. Harvard University, Center for International Development Working Paper 143.

Saiki, A., 2004. The Change in Inflation Persistence and Exchange Rate Pass-Through for Inflation Targeting Countries. Ph.D. dissertation, International Business School, Brandeis University, Waltham, MA.

Yüncüler, Ç., 2011. Pass-Through of External Factors into Price Indicators In Turkey. Central Bank Review, 11(2), 71-84.

APPENDIX

Robustness of Threshold selection: Overall pass-through of exchange rate and import prices on CPI

Import Price Pass-through	Exchange rate Pass-through
	

Notes: Red line referes to pass-through calculated with the 75% threshold as described in section 3. Similarly, green line refers to 80% and blue line refers to 66% thresholds respectively. Figures show that the import price pass-through is very robust across differetn threshold values. Meanwhile, the exchange rate pass-through exhibits slightly more variation accoring to threshold value. In that sense, the use of 75% threshold provides a reasonable outlook.

NATIONAL BANK OF THE REPUBLIC OF MACEDONIA

P R O G R A M

5th Research Conference "Economic and Financial Cycle Spillovers: Reconsidering Domestic and Cross-Border Channels and Policy Responses"

7-8 April 2016, Skopje

Holiday Inn Hotel

7 April 2016 (Thursday)

8.30- 9.00 Registration

9.00-11.00 Session I - Keynote Lecture and Panel Discussion

9.00 Dimitar Bogov, Governor of the National Bank of the Republic of Macedonia, Opening speech

9.10 Boris Vujčić, Governor, Croatian National Bank, Keynote lecturer

9.40 Panel discussion on policy issues

Chair: Mihail Petkovski, Board member, National Bank of the Republic of Macedonia

Boris Vujčić, Governor of the Croatian National Bank, Keynote lecturer

Dubravko Mihaljek, Bank for International Settlements, Discussant

Marko Košak, Faculty of Economics, University of Ljubljana, Discussant

Marek Dabrowski, Center for Social and Economic Research (CASE), Discussant

10.40 Discussion

10.55 Announcement of the Annual Award of the NBRM for the best paper in macroeconomics and banking written by a young researcher

11.00 Coffee break

11.30 - 13.00 Session II: Economic and Financial Cycles: Synchronization and Spillover Channels

Chair: Lubomír Lízal, Bank Board Member, Czech National Bank

11.30 Thorvardur Tjörvi Ólafsson, Central Bank of Iceland, *The Long History of Financial Boom-Bust Cycles in Iceland*

11.50 Balázs Égert, OECD, *The Nature of Financial and Real Business Cycles: The Great Moderation and Banking Sector Pro-Cyclicality*

12.10 Mite Miteski, Ljupka Georgievska, National Bank of the Republic of Macedonia, *Financial and Real Business Cycle Synchronization in Central, Eastern and Southeastern European Countries*

12.30 Discussant: Meta Ahtik, Head of Section, Bank of Slovenia

12.45 Discussion

13.00 Lunch

14.00 - 15.30 Session III: Monetary Policy Effects on the Economic and Financial Cycles

Chair: Ana Mitreska, Head of Monetary Policy and Research Department, National Bank of the Republic of Macedonia

14.00 Cengiz Tunç, Central Bank of the Republic of Turkey, *The Asymmetric Effects of Monetary Policy on Economic Activity in Turkey*

14.20 Gerti Shijaku, Bank of Albania, *The Macroeconomic Pass-Through Effects of Monetary Policy through Sign Restrictions Approach: In the Case of Albania*

14.40 Tandoğan Polat, Central Bank of the Republic of Turkey, *Contribution of New Monetary Policy Framework to Financial Stability and to Mitigate Capital Flow Volatility: Evidence from an Emerging Market Economy*

15.00 Discussant: Rilind Kabashi, Head of Economic Modelling Unit, National Bank of the Republic of Macedonia

15.15 Discussion

15.30 Coffee break

16.00 - 17.30 Session IV: Economic and Financial Cross-Border Spillovers

Chair: Goran Petrevski, Faculty of Economics, Skopje

16.00 Neslihan Kaya Ekşi, Central Bank of the Republic of Turkey, *Cross-Border Capital Flows in Emerging Markets: Demand-Pull or Supply-Push?*

16.20 Maja Ivanović, Central Bank of Montenegro, *Ownership, Bank-Specific and Macroeconomic Determinants of Non-Performing Loans in Central and Eastern Europe*

16.40 Robert Kelm, National Bank of Poland, *The Subprime Crisis, Exchange Rate and the Polish External Trade: Stylized Facts and Facts*

17.00 Discussant: Mirna Dumičić, Senior Advisor, Financial Stability Department, Croatian National Bank

17.15 Discussion

17.30 End of the first conference day

8 April 2016 (Friday)

9.00 - 10.30 Session V: Financial Stability Challenges: Balancing Stability and Growth

Chair: Frosina Celeska, Deputy Head of the Financial Stability and Banking Regulation Department, National Bank of the Republic of Macedonia

9.00 Yannick Lucotte, ESG Management School, Paris, France, *Is there a Competition-Stability Trade-off in European Banking?*

9.20 Antje Hildebrandt, National Bank of Austria, *Current Risks in the CESEE Residential Property Market: Evidence from the OeNB Euro Survey*

9.40 Ana Martinis, Igor Ljubaj, Croatian National Bank, *Corporate Debt Overhang in Croatia – Micro-Assessment and Macro-Implications*

10.00 Discussant: Piotr Macki, Economist, International Department, European Central Bank

10.15 Discussion

10.30 Coffee break

11.00 - 12.30 Session VI: Financial Stability, Monetary Policy and Expectations

Chair: Aneta Krstevska, Chief Economist, National Bank of the Republic of Macedonia

11.00 Zubeyir Kılınç, Central Bank of the Republic of Turkey, *In Search of the Drivers of the Turkish Consumer Confidence*

11.20 Elena Muceva-Mihajlovska, Aleksandar Petreski, National Bank of the Republic of Macedonia, *Aggregate Indices for Financial Stability as Early Warning Indicators for the Monetary Measures in the Republic of Macedonia*

11.40 Mustafa Utku Özmen, Central Bank of the Republic of Turkey, *Disaggregated Evidence for Exchange Rate and Import Price Pass-through in Turkey in the Light of Identification Issues, Aggregation Bias and Heterogeneity*

12.00 Discussant: Ádám Banai, Head of Applied Research and Stress Testing Department, Central Bank of Hungary

12.15 Discussion

12.30 Wrap-up and closing of the conference

12.30 Lunch