Asset price channel of monetary policy in the context of stock markets regionalization in the countries of former Yugoslavia

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Abstract

The aim of this study is to empirically investigate the existence of a sectoral asset price channel of monetary policy in the region of the six republics of former Yugoslavia. The study constructs sectoral indices for the entire region, building on the idea that one regional stock exchange may provide more efficiency for the listed companies in the region, while monetary policy relevance for it may be sector-specific. We employ panel vector autoregressive model to observe impulse responses of sectoral indices to innovations in monetary policy, while then disentangle the long- from the short-run relationships per index through a Pooled Mean Group estimation. Overall, we document presence of the asset price channel in the finance and telecom sectors, likely driven by the established multinational corporate networks fostering sub-market regionalization. Yet, this is not the case for the manufacturing and electricity sectors, which may imply that local stock markets are yet too fragmented and space for a more efficient regional stock market, either in the true sense of the word or, more realistically, though enhanced regional cooperation of the stock exchanges certainly exists.

Keywords: Asset Price Channel, Sectoral Stock Market Indices, Stock Market Regionalization.

JEL classification: C32, E44, E52.

1. Introduction

Following the latest structural shocks i.e., covid-pandemic, supply chain disruptions and energy crisis, central bank authorities have been forced to react after decade long zero-policy rate in an attempt to restore price-stability. The repercussions of these policy adjustments (delayed signaling followed by aggressive tightening), have captured academic attention (Thorbecke, 2023). Yet, despite the initial perception of the structural shocks having a transitory impact on prices, they have led to a reassessment of the extent to which monetary policy affects macroeconomic variables, including asset prices in the post-pandemic period.

Structural shifts in the past two decades, such as financial openness characterized by relaxing barriers to cross-border capital flows and financial liberalization, have played a significant role in emerging economies where bank-based financing has traditionally been dominant (IMF 2021). These shifts, coupled with other market-oriented reforms, have paved the way for transmission channels previously dormant. The introduction of an inflation targeting regime at the beginning of the century, with interest rates as the main operating target, has notably improved monetary policy pass-through in many emerging economies (Mehrotra and Schanz, 2020). This transformation has not only allowed for increased liquidity but has also fostered development in domestic financial markets, particularly in securities markets (Andreasen and Valenzuela, 2016; Tongurai and Vithessonthi, 2022; Lee and Chou, 2022).

Recent work has re-examined the issue of monetary policy, inflation and asset prices following the pandemic. Gagliardone and Gertler (2023) demonstrate that easy monetary policy (i.e., delayed response) coupled with oil shocks propagated the recent surge in inflation even when accommodating for demand shocks and labor market tightness. In a similar vein, Bernanke and Blanchard (2023) attribute price increases to supply-chain constraints and slow adjustment of monetary policy. Besides adjusting the policy rate, central banks employed alternative mechanisms i.e., Quantitative Easing (QE). Such interventions are found to impact risk premia on assets (Delgado and Gravelle, 2023). In this context, a recent work by Kashyap and Stein (2022) revisits how central bank authorities shape market sentiment. They find extensive evidence of reduced risk premia during monetary policy easing. This finding extends to euro and non-euro area countries (IMF, 2023). Although at a different magnitude, the sample of euro-area countries i.e., Greece, Germany and Italy exhibit higher transmission of shocks via stock exchanges relative to non-euro area countries.

Moreover, local capital markets in emerging economies have undergone multiple-stages of development (Woolridge, 2020). In some large emerging economies such as China, this process has led to a rapid increase in the effectiveness of the asset price channel, as a result of increased proportion of securities and real estate (Ajaz et al., 2017; Li et al., 2021). Existence of an effective asset price channel has also been documented in other regions of Asia (Kurniawan and Astuti, 2023) and in fast-transitioning countries in Central and Eastern Europe (CEE) and Eastern Europe (EE) (Stoica et al., 2013), while evidence for some African countries is ambiguous (Tchereni et al., 2022; Belmouss et al., 2023). Nonetheless, inferring general conclusions on the transmission effectiveness of monetary policy in emerging countries is difficult as outcomes are quite conditional on country and region specifics.

Yet, in the republics of the former Yugoslavia, where market-oriented reforms and structural shifts began roughly three decades ago, such reforms related to openness, euroization, EU-membership, can play instrumental role in the attractiveness of financial markets. This, in turn can have positive implications for the region's development and for its transmission of monetary policy. An important aspect in that regard has been the intention to regionalize the local stock markets, ideally through one operational Balkan Stock Exchange, while more realistically as enhanced cooperation of and cross-listing of local companies on the other stock exchanges in the countries of former Yugoslavia. The economic integration of the region has been present in the last decade or two at the least: for example, all of the republics of former Yugoslavia (and some other) form a trade block known as CEFTA, the EU-supported Berlin process fosters unification of many economic processes, while the recent Open Balkan Initiative, despite smaller in scope, adds to the process. In parallel, the financial integration is at least partially ensured through the presence of European large bank in the bank-dominated financial markets of the region, supported by similar emerging trends in insurance, pension funds and investment funds. Multinational corporations are likewise present and strengthen the mutual ties of the region and those of the region with the EU and the rest of the world, common multinationals being present in some sectors like the telecommunications or hotels.

To explore this aspect, we aim to understand the potential working of the asset price channel of monetary policy vis-à-vis the process of stock market regionalization in the republics of former Yugoslavia. Hence, rather than shedding light on monetary policy vis-à-vis stock prices in an aggregated local context, we center around another aspect – investigating the effects of monetary policy through a sectoral stock-market lens for the region as a whole. To our knowledge, no paper has had a similar objective for the republics of former Yugoslavia. The key novelty of the study is the usage of self-constructed sectoral stock-market

indices based on the listed companies of the stock exchanges of North Macedonia, Serbia, Montenegro, Bosnia and Herzegovina, Croatia and Slovenia. Our approach builds on the idea that one regional stock exchange – either in the true sense of the word or as an enhanced cooperation of the national stock exchanges - could foster increased market liquidity, easier access to capital, increased company exposure, greater regional integration and altogether improved regional economic development.

In what follows, we first set the foundation of how monetary policy influences the economy through the transmission channels with a focus on the asset price channel, its relevance and how it has evolved over time. We proceed to discussing the equity price fundamentals and their interlink to monetary policy, the wealth effect, its impact on consumption (via the asset price channel) and investment spending. In the third section we discuss data and methodology. The fourth section presents results and offers a discussion. The fifth section concludes.

2. Monetary policy transmission, with focus on the asset price channel

We first lay the theoretical foundations of this paper, by referring to the channels of monetary policy, with focus on the asset price channel.

The Interest Rate Channel of monetary policy often referred to as the "Keynesian" transmission mechanism is the traditional interest rate channel - whereby monetary authorities use leverage over short-term rates to influence the cost of capital and subsequently investment spending (Bernanke and Gentler, 1995). This mechanism has been a key channel of transmission, a classic textbook model, often described by the following diagram:

$$\textit{Monetary tightening} \downarrow \Rightarrow r \uparrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Empirical evidence on the 'cost of capital-interest rate' relationship (Taylor, 1995; Bernanke and Gentler, 1995; Choi et. al, 2022). For this reason, Bernanke and Gentler (1995) propose an 'enhanced' version of the interest rate channel – the *Credit view*, which operates through the 'balance sheet channel' and 'bank lending channel' and seems to resolve the limitations of the traditional lending channel while amplifying the effects of monetary policy.

The Balance Sheet Channel centers around the external finance premium, emphasizing the relationship between net worth, consumption, and liquidity for firms and households. Monetary tightening affects firms' cash flow and collateral value, leading to a 'cash flow squeeze.'

M↓⇒ I ↑⇒ cash flow ↓⇒ adverse selection ↑ and moral hazard ↑⇒ loans ↓⇒ I ↓ ⇒Y ↓

The second effect of contractionary monetary policy is over share prices (Pe). Fall in the prices of firm's (borrowers') shares reduces their net worth, raising adverse selection problem and causing 'balance sheet deterioration'. This alters bank's perceptions of risk, forcing them to require greater collateral followed with an increased external finance premium and a decrease in lending, rendering a reduction in aggregate output (via investment and spending). As a result of lowered net worth, firm owners (now having less stake) may be incentivized to engage in risky investment activities which could result in credit rationing – a situation whereby lenders are unwilling to advance financing to borrowers at the prevailing market conditions, in turn reducing investment spending and total output (Mishkin, 1996). This concept, labeled as 'financial accelerator' explains how small shocks to borrowers' balance sheets can amplify into more significant shocks, impacting the overall economy. Research finds evidence of the impact of the balance sheet channel on inventory investment decisions, especially for small firms i.e., the firm-size effect (Bernanke and Gertler, 1989; Bernanke et. al, 1996, 1994; Kashyap, Lamont and Stein, 1994 Guariglia, 1999, Choi et. al, 2022).

M ↓⇒ Pe ↓⇒ adverse selection ↑ and moral hazard ↑⇒ loans ↓⇒ I ↓ ⇒Y ↓

Effects on Households. While much focus is on firms, the balance sheet channel also influences consumer spending. Declines in lending due to monetary tightening can reduce demand for consumer durables and housing. Consumer expectations, tied to their balance sheets, play a crucial role. An expansionary (contractionary) monetary policy improves (deteriorates) consumers' balance sheets, affecting their likelihood of experiencing financial distress and influencing consumption (Mishkin, 1996).

M↓⇒ i ⇒ financial assets ↓⇒ probability of financial bottleneck ⇒ durable consumer goods and housing expenditures ↓⇒ Y↓

The Bank Lending Channel operates through alterations in the supply of credit. Contractionary monetary policy reduces bank reserves and credit availability, squeezing out bank-dependent borrowers and decreasing investment and output.

Contractionary monetary policy ⇒ bank reserves & deposits ↓ ⇒ bank loans ↓ ⇒ I↓ ⇒Y ↓

The channel's effectiveness depends on 'bank-specific' and 'country-specific' factors, including liquidity, market development, and the nature of the region (bank-based or financial-market-based). Cross-country studies imply varying

effectiveness, with competition impacting lending activities (Kashyap and Stein, 1995; Olivero et al., 2011; Zhan et al., 2018). In this context, cross-country studies document the existence of the bank lending channel in Europe, Latin America and Asia, concluding that the degree of bank competition and capitalization rate are important for its effectiveness (De Bondt, 1999; Altunbas et al., 2002; Ehrmann et al., 2001; Oliviero et al., 2011). Further important aspect contributing to the effectiveness of the channel is the development of banking sector. Dahl et al. (2019) and Soedarmono et al. (2021) document its effectiveness in Indonesia. Other notable works presenting evidence that credit supply reduces as a result of tightening in the African region are those of Abuka et al. (2015); Hsing and Hsei (2014); Matousek and Solomon (2018).

Although documented in the United States (Bernanke and Blinder, 1989; 1996), the importance of this channel diminished over time due to weakened regulatory framework, innovation and cheaper financing alternatives relative to traditional loans (Mishkin, 1996; and Bernanke and Gertler, 1995). In similar vein, Chami (1999) reveals that asset securitization techniques have advanced to the point of improving conditions for bank-dependent borrowers. In other words, firm size no longer prevents smaller firms from access to the capital markets.

The Asset Price Channel as a transmission mechanism operates through the stock market. Literature proposes two mechanisms operating under the asset price channel i.e., Tobin's Q and Wealth Effect.

Initially presented in Tobin's (1961), the first mechanism implies that monetary policy shocks to the aggregate economy transmit through equities via investment spending. In Tobin's (1961), Tobin's q is defined as the difference between market value of firms and their replacement cost of capital. In this context, firms characterized by high Tobin's q may obtain cheap capital (relative to their market value) with a small issuance of equity, leading to a rise in investment spending.

The convergence between monetary policy and equities can be explained from two different points of view. First, a monetarist's view suggests that a rise in money supply induces a change in spending thereby increasing demand for equities. Second, a Keynesian's view, which operates through interest rates, suggests that during periods of relaxed monetary policy bonds become less attractive than equities, leading to a rise in stock prices. Mishkin (1996) advocates that when both views are combined, there is a rise in stock prices, leading to higher Tobin's q and ultimately higher investment spending. From there, we derive the following schematic:

$$M \uparrow \Rightarrow Pe \uparrow \Rightarrow Tobin's\ q \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow$$

Crowder (2006), for the second mechanism, presents a mathematical model that captures two ways in which monetary policy affects stock returns and therefore the aggregate economy:

$$P_{t+1} = E_t \left[\Sigma\left(\frac{1}{1+R_t}\right)^j D_{t+j}\right] + E_t\left[\left(\frac{1}{1+R_t}\right)^K P_{t+k}\right]$$

Whereby: (P_{t+1}) is the present value of a share, E_t represents the expectations operator based on available information at given time t, Rt is the rate of return applied by market participants, (D_{t+j}) is the value of discounted future cash flows, while K represents the holding period or time horizon. A change in the central bank's base rate influences expected returns and participants' expectations, leading them to revalue equites. The effects are depicted by the following schematic:

$$M \uparrow \Rightarrow \textit{aggregate output} \uparrow \Rightarrow \textit{firm's profitability} \uparrow \Rightarrow Pe \uparrow$$

First, as a result of positive policy shocks to the aggregate economy, economic activity will increase, in turn raising firm's earnings and ultimately stock prices. Second, monetary policy shocks can induce changes in stock prices directly by altering discount rates and thereby expected future cash flows (Crowder, 2006).

Sellin (2001) suggests that a period of tightening should induce a decrease in investors' financial wealth, as a result of lower expected future cash flows or higher discount rate, in turn reducing private investment and consumption expenditure. In Sellin's (2001) and Mishkin's (1996) jargon, this is the 'wealth effect'. The model is depicted by the following schematic:

$$M \downarrow \Rightarrow i \uparrow \Rightarrow Pe \downarrow \Rightarrow \textit{financial wealth} \downarrow \Rightarrow \textit{consumption \& investment} \downarrow \Rightarrow Y \downarrow$$

The 'wealth effect' assumes that a monetary tightening induces a fall in stock prices by impacting expected future cash flows or the discount rate used by market participants. Fuhrer (1996) reveals that many long-term rates follow closely the changes in the short-term base bank rate. Substantial amount of literature supports the notion that equity returns fall during negative monetary policy shocks (Kuttner, 2001; Rigobon and Sack, 2003; Bernanke and Kuttner, 2005; Ehrman and Fratzscher, 2004). However, monetary policy may be endogenous in that stock market movements can influence the aggregate economy by exerting pronounced volatility and boom-bust cycles and thereby be of consideration in the policy design and, to an extent, a ground for central bank reaction (Crowder, 2006).

The issue of whether central bank authorities should adopt a reactive or proactive stance towards asset price misalignments has been a long-standing debate in economic circles. The reactive approach posits that an ex-post reaction, or a "wait-

and-see" approach, is preferred, where a reaction is deemed necessary only if price misalignments reverse and have an impact on price stability and output. To this end, Bernanke and Gertler (2000) suggest that the implementation of a flexible inflation targeting regime would be an effective tool to stabilize output and eliminate misalignments. On the other hand, the proactive approach advocates for authorities to respond to developing price misalignments, i.e., market bubbles. Cecchetti et al. (2000) propose that significant deviations in asset prices may cause price and labor instability that can be further exacerbated when the misalignments are diminished. Therefore, if the asset price deviations originate from the asset markets themselves, a reaction is imminent. Such policies should aim to attenuate disturbances on the real economy, and a preemptive policy may ultimately limit the accumulation of such misalignments and prevent economic imbalances, which would reduce the need for medium-term corrections to price stability and output.

Review of the empirical literature on the asset price channel

The relationship of monetary policy and stock prices evaluated through the asset price channel has been extensive. Hence, we attempt to make an overview of the existing literature on this topic while capturing all periods starting from 1960s.

Early studies, focused on examining the impact of an increased money supply on stock prices. A body of evidence (Sprinkel, 1964; Keran, 1971; Hamburger and Kochin, 1972) arrived at conclusions that contradicted Fama's (1970) Efficient Market Theory. These studies suggested that changes in stock prices result from monetary changes, challenging the notion that stock prices purely reflect all available information. However, Pesando (1974) raised concerns about the established relationship in Sprinkel's (1964) and Keran's (1971) studies due to the presence of serial correlation in individual series. Additionally, most earlier studies overlooked the concept of 'information lag.'

Rozeff (1974) took a step further by testing the Efficient Market Hypothesis against "The Monetary Portfolio Model", which views money as an asset. Developed by Friedman and Schwartz (1963), the Monetary Portfolio Model implies that any shocks to the money supply will result in portfolio rebalancing as investors wish to reestablish desired money holdings. Rozeff (1974) critiques past studies for failing to distinguish that monetary shocks affect stocks with a lag i.e., they employ ex-post data of money supply, assuming zero lag in publication.

Building on Rozeff's work, Rogalski and Vinso (1977) improved the model by synchronizing data intervals, capturing money supply data at the same intervals as stock return data, and accounting for autocorrelation. Their enhanced model

supported Rozeff's findings and confirmed their robustness. The research demonstrated that causality and directionality exist from stock prices to money supply and vice versa, suggesting the potential presence of endogeneity bias in earlier studies.

The presence of endogeneity bias in earlier studies prompted a shift toward a different approach - event studies. Cornel (1983) advocates for the announcement approach, citing two key reasons. Firstly, with respect to the Federal Reserve's announcement, the reported money stock figure is independent of Fed policy or asset prices, as it pertains to the week ending nine days earlier. Any correlation observed between money supply announcements and asset prices suggests a directionality from announcements to asset prices. Secondly, working with announcement dates allows for the use of higher frequency periods and a more powerful observation interval, addressing a limitation of previous studies. Cornel (1983) acknowledges that longer-term intervals might be preferable unless the impact of monetary shocks on asset prices persists for a quarter or longer.

Among the first to take stock of the issue of announcements are Berkman (1978) and Lynge (1981). They find evidence of a negative relationship between money supply announcement and stock prices. Berkman (1978) however, is the first to differentiate between anticipated and unanticipated changes in money supply, suggesting that reaction is imminent only when changes are unanticipated. Lynge's work, on the other hand, does not bear directly on the Efficient Market Hypothesis. Subsequently, Pearce and Roley (1983) reexamined previous evidence using weekly data obtained from survey expectation measure for the period 1977 – 1982, estimating the following model whereby,

$$\Delta P_t = a + b(\Delta M_t^a - \Delta M_t^e) + \varepsilon_t,$$

Where the percentage change of stock price is expressed as a function of the difference between change in announced money stock and expected money stock. Obtaining a negative estimate for 'b', Pearce and Roley's (1983) work corroborated previous findings. A consensus on the impact and effect of weekly money stock announcement (i.e. positive surprises) has also been investigated and corroborated in Urich and Wachtel (1981) and Roley (1982)].

A number of competing hypotheses have been presented in order to explain the asset price reaction to announcements. *The expected inflation hypothesis* is that announcement of unanticipated increase in money stock, raises participants' expectations of inflation, leading to higher rates (Fisher effect). Based on the discounted cash flow model, agents will revise their expected earnings, in turn causing stock prices to fall. *The Keynesian hypothesis* as based on the sticky price model suggests that money supply announcements will have effect only if they

alter expectations about future monetary policy. In this context, positive shocks will precede agents to expect a tightening of monetary policy, lowering stock prices. *The real activity hypothesis* proclaims that announcement of bigger money supply provides information regarding the future money demand. For this link to operate money demand is assumed to depend on expected future output, which infers higher expected future cash flows and thus stock prices. Cornel (1983) addresses the four hypotheses. He finds that when studying them simultaneously at least three can be rejected. In this context, Hafer (1986) also posits that in most cases these hypotheses are not fulfilled when evaluated.

Extending their previous work, Pearce and Roley (1985) investigated effects of economic news i.e., changes in money, inflation and output for the period 1979-1982. They concluded that after a change in Fed's methodology, money announcement surprises have significant negative effect over stock prices. Hafer (1986) supports this notion, indicating that unanticipated changes in money negatively affect stock prices, with no significant difference between the three periods. In contrast, Hardouvelis (1987) finds significance only for the two subperiods (79-82/82-84), demonstrating that monetary variables (money supply) bear significance while non-monetary variables (output) do not—a result that aligns with Pearce and Roley's (1985). They establish that the response of stock prices to macroeconomic news is conditional upon the economic environment. Favorable news about future output in an overheated economy is linked to decreased stock prices, driven mainly by adjustments in expected cash flows rather than alterations in discount rates. Conversely, unfavorable news is associated with an increase in stock prices. These findings provide a rationale for the lack of significance observed in prior research.

The initial evidence supporting the idea that discount rate announcements impact stock prices came from Waud (1970). In similar vein, Roley and Troll, (1984), Smirlock and Yawitz, (1985,) Pearce and Roley , (1985) confirm this, ndicating a significant adverse influence arising mainly from the unanticipated portion of discount rates post-1979 period. Yet, following Santomeros' (1983) suggestion that discount rates respond to market rates with a lag reveals two drawbacks. First, if stock prices react to changes in discount rates, it implies market inefficiency, as even changes aligned with policy objectives are already incorporated into the market. This challenges the explanation of the announcement effect assuming market efficiency. Second, using changes in discount rates as regressors introduces endogeneity bias and therefore misinterpretation of endogenous changes as monetary policy shifts. Subsequently, Smirlock and Yawitz (1985) address this by decomposing the discount rate into 'technical' (endogenous or expected) and 'non-technical' components, the latter conveying information on monetary policy and find evidence of negative effects of announcements only for

the period post 1979, yet explicitly for the non-technical components, reconciling the findings of Pearce and Roley (1985). Other prominent articles are those of Hafer (1986) and Hardouvelis (1987).

However, subsequent to Sims' (1980) this issue has been addressed in terms of vector autoregressive models. Prominent articles include, Thorbecke (1997), Patellis (1997), Lastrapes (2001), Cassola Morana (2004). Thorbecke (1997) examines the relationship on stock prices and monetary policy shocks (measured as orthogonalized innovations in the federal funds rate) concluding i) positive and significant effect on stock returns; ii) presence of firm size effect (in line with Gertler and Gilchrist, 1994). Patellis (1997) finds that monetary policy indicators are significant predictors of excess stock returns, which is justified by the propagation mechanism (Bernanke and Gertler, 1988) and credit view (Bernanke and Gertler, 1995) explained in previous sections.

Hitherto, the presented literature is mainly about advanced economies; (Patellis, 1997; Thorbecke, 1997; Lastrapes, 2001; Cassola Morana, 2004; Bernanke and Kuttner, 2005 and Gal □ı and Gambetti, 2015; Thorbecke, 2023; IMF, 2023) and has addressed the issue from an aggregated perspective. However, pertinent literature from developing economies is emerging: Jarocinski (2010), Yoshino et al. (2014), Stoica et al. (2014), Grabowski and Grabowska (2021), although it remains at an aggregate level.

3. Data and Methodology

In achieving the objective of our paper and aligning with the literature on transmission channels related to monetary models, we employ the index of industrial production (*ip)* as a proxy for the real economy; the central bank foreign exchange reserves changes (*err)*, to capture global dynamics in small open economies with rigid exchange rate regimes; consumer price index (π) to reflect price and dynamics; and the central bank policy reference rates (*irs).* For Slovenia and Bosnia and Herzegovina, given absence of domestic policy rates, we instead take Euribor.

To this set of variables, we would like to add a variable about stock prices. The usual way in the literature is to take aggregate stock market indices. We instead propose alternative approach which disaggregates by sector but aggregates at the regional level. The idea is to understand if domestic monetary policy, which directly or indirectly depends on the monetary policy of the European Central Bank could entice some movements in the sectoral sentiment at the regional level.

We first identify the listed companies of most liquid regional stock indices[1] and categorize them by sectors in accordance with the NACE Rev.2 European Classification i.e., Manufacturing, Information and telecommunications, Finance and insurance activities, and Electricity, gas, steam and air conditioning supply. The four indices are denoted with $index_{kjt,}$ whereby k takes a value from 1 to 4.

Using data on company market capitalization (market cap_{jt}) and stock prices (stock $price_{jt}$) over time ($_t$), we estimate the weight of each $company_{jt}$ in the total sectoral market capitalization. Then we calculate market capitalisation weighted prices to obtain initial index values ($Index_0$) of 100, in order to normalize the index. In periods following (t>0), the index value ($Index_{jt}$) is estimated as $Index_{t-1}$ x $\frac{\Sigma[Stock\ Price jt]}{\Sigma[Stock\ Price jt-1]}$ x Weighted Market $Capitalization_{jt}$. In such manner, we ensure consistent starting value while subsequent index values (t>0) capture the sector related dynamics in a richer dynamics than considering the country level.

The construct secures field for application of a Panel Vector Autoregressive Model or PVAR, which finds support in literature when employed in analyzing transmission of shocks across time (Canova and Ciccarelli, 2013). The PVAR model could be articulated as follows:

$$Y_{it}=A_0+A_1 Y_{it-1}+\ldots+A_p Y_{it-p}+\alpha_I+\varepsilon_{it}, \quad (1)$$

where, Y_{it} is a (8x8) vector of macroeconomic variables ordered as: X_t = [irs_{jt}, err_{jt}, $index_{kjt}$, ip_{jt}, π_i]; A_0, A_1,…, are matrices of coefficients associated with lagged values, representing autoregressive (AR) terms; Y_{it-1}, Yi_{t-2},…,Y_{it} are lagged values of the vector of time series variables up to order p; α_i is a vector of individual-specific effects or fixed effects and ε_{it} is a vector of error terms.

The matrix specification allows for contemporaneous relationship between the variables represented by the diagonal (1) which are set to zero, indicating that the value of each variable is influenced by its own past values and the past values of variables that appear earlier in the ordering.

[1] Some companies were omitted due to data constraints. The full list of companies included in index construction is provided in Appendix.

	$irst_{jt}$	err_{jt}	$indextelecom_{jt}$	$indexman_{jt}$	$indexelec_{jt}$	$indexfin_{jt}$	ip_{jt}	π_{jt}
$irst_{jt}$	1	0	0	0	0	0	0	0
err_{jt}	0	1	0	0	0	0	0	0
$indextelecom_{jt}$	0	0	1	0	0	0	0	0
$indexman_{jt}$	0	0	0	1	0	0	0	0
$indexelec_{jt}$	0	0	0	0	1	0	0	0
$indexfin_{jt}$	0	0	0	0	0	1	0	0
ip_{jt}	0	0	0	0	0	0	1	0
π_{jt}	0	0	0	0	0	0	0	1

A common aspect of our and the papers employing VAR methodology in assessing the effects of monetary policy on stock market is the identification, i.e. Cholesky decomposition, which works so that when the P matrix is lower triangular, we obtain a recursive model, implying that a variable i.e., stock returns, is conditional contemporaneously on the innovations to preceding variables, while subsequent variables react to it with a lag. This implies that structural shocks are recovered using short-run restrictions i.e., due to identification choice, they fail to address two important aspects: interdependent simultaneity and reverse causality. In this context, considering the dynamics of financial markets where prices are fast to react and economic agents influence each other (i.e. central bank and the general public), disallowing "simultaneity" would affect such a scenario, as demonstrated by Bjørnland and Leitimo (2009).

Considering that the PVAR model hinges on the prerequisite of variable stationarity, it inevitably involves a trade-off by foregoing valuable long-run information on the co-movement among variables. To address this limitation we continue by employing a panel vector error-correction model (VECM) framework i.e., Pooled Mean Group model with data where the underlying regressors follow integrated process of order I(1), as follows:

$$\Delta Y_{it} = \alpha + \beta(Y_{it-1} - \bar{Y}_i) + \Sigma_{j=1}^{p} \gamma_j \Delta Y_{it-j} + \delta X_{it} + \epsilon_{it,} \qquad (2)$$

Where Δ represents the first difference operator, Y_{it} is the dependent variable for unit i, at time t, $\bar{Y}_i$ is the mean of Y_i, X_{it} represents exogenous variables, and ϵ_{it} is the error term. The term $\beta(Y_{it-1} - \bar{Y}_i)$ captures the short-run dynamics, while the lagged differences ΔY_{it-j} capture the long-run dynamics. Employing PMG assumes homogenous coefficients across cross-sectional units; while estimating a common set of coefficients for both short- and long-term parameters. Under the assumption of stock market regionalization, this would imply that i) effects of regionalization are expected to be similar across regions, and ii) effects of increased market liquidity, access to capital and overall efficiency would have consistent impact.

Monthly time series data ranging from January 2010 to September 2023 have been used. Domestic three-month money market interest rates and central bank reserves come from central banks' website. Industrial production is obtained from the official State Statistical Offices of each country, and the EURIBOR three-month interest rate is provided by the European Money Markets Institute. Data on stock prices for the purpose of index construction have been sourced from regional stock exchanges, while data on shares outstanding to estimate market capitalization has been obtained from the annual reports of the companies.

4. Results and discussion

4.1 Unit roots and model stability

In establishing the stability of our PVAR model, we follow a systematic approach. Frist, we conduct the Fisher-Augmented Dickey-Fuller test on the panel dataset presented in Table (1) to check for unit roots. Variables in levels do not satisfy the stationarity condition. To achieve stationarity, we employ first-order differencing for all variables. Then, we proceed to perform lag reduction and diagnostic tests which ensure that at two (2) lags our model satisfies basic autoregressive assumptions i.e., no eigenvalues greater than 1 – inverse roots are outside of the unit circle. Refer to Table (2) and Figure (1) for the lag choice and stability condition, respectively.[2]

Table 1. Stationarity. Fisher-Augmented Dickey-Fuller

Variable name	*Variable abbreviation*	*Variables in their levels*	*Variables in first differences*
	Ho: The variable contains a panel unit root (p-values)		
Policy interest rate	irs_{jt}	0,2163	0,0000
Central bank reserves	err_{jt}	0,9964	0,0000
Index of Industrial Production	ip_{jt}	0,2916	0,0000
Consumer Price Index	π_{jt}	1,0000	0,0000
Stock-market index of Telecom	$indextelecom_{jt}$	0,5990	0,0000
Stock-market index of Manufacturing	$indexman_{jt}$	1,0000	0,0000
Stock-market index of Electricity	$indexelec_{jt}$	0,0477	0,0000
Stock-market index of Finance and Insurance Activities	$indexfin_{jt}$	0,9999	0,0000
Source: Author's calculations.			

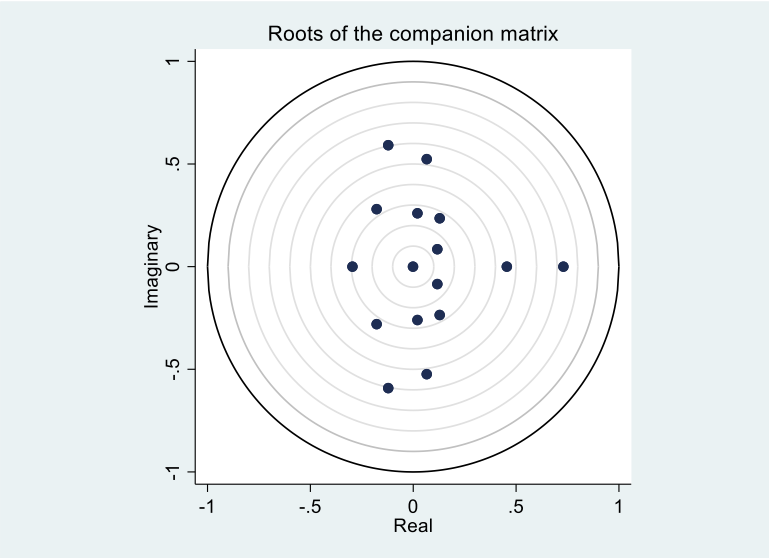
[2] While we base our lag length selection on the Akaike Information Criterion, it is worth noting the PVAR model and the results remain robust even if one lag is selected as advised by MBIC or MQIC criteria.

Table 2. Lag length selection

lag	MBIC	MAIC	MQIC
1	-850.386*	36.6672	-305.133*
2	-637.884	-46.5147*	-274.381
3	-327.318	-31.6339	-145.567
4	.	.	.

Source: Author's calculations.

Figure 1. Eigenvalue stability condition

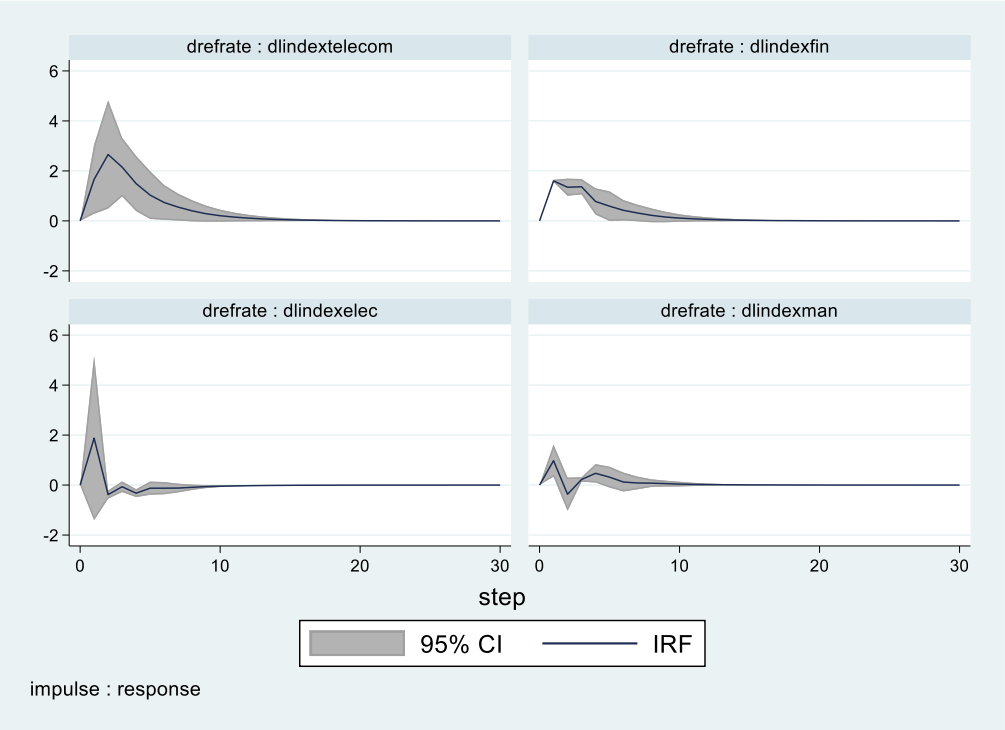


Source: Author's calculations.

4.2 Impulse response functions

In estimating the short-run dynamics between monetary policy and sectoral stock prices, we ground our analysis on panel VAR Impulse Response Functions presented in Figure (3). Figure (3) presents a reaction of sectoral stock indices to a one percentage point of a monetary policy shock.

Figure 3. IRFs. Monetary policy shocks and sectoral response.



Source: Author's calculations.

All sectoral indices are associated with an immediate positive reaction to a negative monetary policy shock (an increase of the reference interest rate), which may be opposite of what conventional economic theory predicts. It may imply that economic agents i.e., market participants interpret policy tightening as a positive signal in anticipation of reduction in inflationary pressures, hence improving their stock-market sentiment. This is particularly the case for the telecom and financial sectors, whereby the shock effect lives for about a year and is statistically significant. The delayed subsequent mean-reversion observed particularly in the telecom sector could be associated with its capital-intensive nature i.e., higher costs of financing which may impact profitability and therefore stock prices for which it may take time to fully materialize in such markets, provided the level of information-efficiency of the regional markets.

The response from the Finance sector is, however, logical from the perspective that a monetary policy shock is absorbed by this sector and transferred onto the final consumer resulting in interest margin expansion and improved profitability for banks, having in mind the bank-financed nature of the region. The mean reverting effect could be associated with changes in loan demand.

The sharper decline in the electricity sector, in contrast to the telecom sector, could be attributed to the demand. Initial perceptions of inelasticity may yield to behavioral adjustments in consumption. This suggests that market participants may subsequently modify their electricity needs, resulting in consumption

reduction. Moreover, initiatives for green transition after the recent structural shocks (OECD, 2022) may imply that the electricity sector faces a need for more frequent technological upgrades resulting in high costs of financing. However, it is worth noting that the reaction of the electricity sector may not be statistically significant, which portrays the market reaction as semi-effective at best.

In a similar vein, the manufacturing sector has an initial positive response to a monetary policy shock, yet its mean reversion is much steeper and negative, stabilizing after approximately (6) months post shock. This raises the possibility of two potential factors i) higher borrowing costs coupled with ii) consumer spending constraints i.e., increase in interest expense and demand reduction take effect within month post policy shock. However, the response is not statistically significant.

Overall, the impulse response functions suggest that the regional stock markets react to monetary policy shocks only partially and to a limited magnitude. The response is positive only in the telecom and finance sectors, suggesting that the operability of the asset price channel of monetary policy when observed regionally is limitedly present likely due to the presence of multinational brands who serve integrative function of the local stock (and overall financial) markets. Responses' mean reversion in about a year could be due to i) the still semi-efficient nature of the regional markets i.e., slower assimilation of information by broader market participants, ii) limited liquidity of these markets, and iii) reliance on bank-based financing rather than equity financing.

4.3 Cointegration and long-run relationships

Table (3) presents the Kao panel test for co-integration of our included variables, considering one regional index at a time. All subtests are significant at 0.05 level. On that ground, we robustly reject the null hypothesis of no cointegration i.e., conclude that long-run co-movement exists among the variables. Subsequently, we proceed with a Panel VECM i.e., apply a PMG estimation method.

Table 3. Kao co-integration test.

Variable name	*Variable abbreviation*	*p-values*
	Ho: No co-integration among variables (p-values)	
Stock-market index of Telecom	$indextelecom_{jt}$	0,0000
Stock-market index of Manufacturing	$indexman_{jt}$	0,0000
Stock-market index of Electricity	$indexelec_{jt}$	0,0000
Stock-market index of Finance and Insurance Activities	$indexfin_{jt}$	0,0000
Source: Author's calculations.		

Table (4) presents the long-run relationships. Results suggest that the manufacturing, finance and telecom sectors exhibit positive long-run association with the reference rate, as evidenced by the statistically significant coefficient on the reference interest rate. The finding is aligned with the observations obtained through the impulse responses, despite the reaction of the manufacturing stock index was unwarranted there. The reaction of the finance sector is particularly significantly larger in magnitude than in the other two sectors, potentially suggesting a stronger integrated regional sub-market, which ensures a stronger reaction of the asset price channel of monetary policy. Similarly, to our PVAR conclusions, we document a slow reaction, as evidenced by the negative but small error correction terms, which imply that should the long-run relation is shocked, its reversion to the pre-shock condition may last between 1.5 and 2.8 years.

Table 4. Long-run relationships

	Stock-market indices per sector			
VARIABLES	Manufacturing	Finance	Electricity	Telecom
Error correction term	-0.0301**	-0.0486***	-0.0549***	-0.0383***
	(0.014)	(0.014)	(0.002)	(0.014)
Log of industrial production	0.643*	0.568	0.628	-0.386
	(0.376)	(0.452)	(0.420)	(0.381)
Log of CPI	-0.773*	-0.15	-0.682	-0.631**
	(0.414)	(0.594)	(0.729)	(0.304)
Changes in reserves	-1.045***	-1.278***	-0.0717	-0.0064
	(0.158)	(0.133)	(0.177)	(0.154)
Reference interest rate	3.887**	9.725***	3.043	3.026***
	(1.826)	(3.343)	(2.241)	(1.021)

Source: Author's calculations.

*Note: *, ** and *** signify statistical significance of the coefficients at 10%, 5% and 1%, respectively. Standard errors are included in parentheses.*

Overall, our findings from the separation of the long- from the short-run dynamics suggest that the asset price channel plays some but not full role in the region. They corroborate the findings from the impulse responses based on a PVAR framework and suggest that the asset price channel of monetary policy is relevant at the regional level to the extent regional sub-markets are integrated, which is probably mostly spurred by the presence of multinational brands through their daughter-companies in the republics of former Yugoslavia. The opposite holds true as well: if sub-markets are manly isolated at the level of a country, for example because of being in dominant state ownership, like the electricity sector, or because their integration is not as advanced as in finance or telecom, like the manufacturing, then asset price channel may not be as effective. Despite, in the

case of manufacturing, the result is mixed, which may also imply that further disaggregation of manufacturing may warrant investigation should richer datasets become available.

5. Conclusion

The study investigates the presence of the asset price channel in six countries which constituted former Yugoslavia. The study constructs sectoral indices for the entire region, building on the idea that one regional stock exchange would provide more efficiency for the listed companies in the region. The paper centers around the idea that sectoral reactions to monetary policies in the region, which are themselves directly or indirectly tied to the monetary policy of the European Central Bank, may be of higher policymakers' interest if countries' stock market integrate at least at the level of enhanced mutual cooperation.

We construct four sectoral indices of the listed companies in manufacturing, finance, telecom and electricity sectors for six countries: North Macedonia, Serbia, Montenegro, Bosnia and Herzegovina, Croatia and Slovenia. We employ panel vector autoregressive model to observe impulse responses of sectoral indices to innovations in monetary policy, while then disentangle the long- from the short-run relationships per index through a Pooled Mean Group estimation.

Our results demonstrate immediate sectoral reactions to a one percentage point monetary policy shock. An initial positive reaction may be unexpected, but since they are significant in the telecom and finance sectors only, they may be associated with the capital-intensive nature of the former and the transmission of the shock onto interest rate margin in the latter. The subsequent mean reversion in a period of about 12 months could be explained by factors such as insufficient market efficiency, limited liquidity, and reliance on bank-based financing influencing delayed adjustments. These results are largely corroborated when the long-run relations are isolated: they suggest that in the telecom, finance and manufacturing sectors, the sectoral stock market indices at the regional level react to shocks in monetary policies in a positive fashion, but the closure of the disequilibrium following the shock is fairly sluggish and takes from a year and a half up to three years.

Overall, we document some but not full operation of the asset price channel of monetary policy transmission in the ex-Yugoslav republics. Actually, the working of the asset price channel at the regional level is documented in the finance and telecom sectors, which have been prone to the influx of foreign capital, which created daughter-companies within the region, which likely worked to regionalize the sub-markets. However, this limited finding may imply that the stock markets of the republics of ex-Yugoslavia are yet too fragmented and space for a more

efficient regional stock market, either in the true sense of the word or, more realistically, though enhanced regional cooperation of the stock exchanges certainly exists. Hence, to policymakers we recommend reconsidering the idea of one regional stock exchange which aside from improved transmission would result in faster financial market development, potentially attracting new investors and fresh capital. This further opens prospects for increased equity financing and reduce the number of bank dependent borrowers. Moreover, such unification could increase financial market awareness and with it greater inclusion of the regional investors. Overall, such decision would likely contribute to greater overall efficiency of stock exchange(s).

Still, all past studies and ours tend to overlook the intricacies of dynamic adjustments that unfold subsequent to the initial shock. Moreover, they often lack consideration for bidirectional causation, typically concentrating solely on either the consequences of monetary policy shocks or stock price shocks. The key question in this regard would be if the central bank at least to some extent keeps an eye on what happens on the stock market, and if this is done at the sectoral level when designing monetary policy. Considering such structuralities has been currently beyond this paper. One technical limitation is that at the time of writing of this paper, Stata did not support a panel structural VAR model estimation. In Sim's jargon (1980), SVAR provides a more systematic approach to imposing restrictions which enable for capturing irregularities previously omitted with other methodologies. It allows for identification of structural shocks without the necessity of imposing short-run restriction while allowing for simultaneous interdependence. On that ground, we recommend to others and intend to revisit this issue addressed in terms of a panel SVAR model to simulate a more realistic financial environment.

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Appendix

Sectoral classification according to NAC.REV2

Table A1

	Sector: Electricity, gas, steam and air conditioning supply
1	Elektroprivreda Crne Gore AD
2	Elektroprivreda BiH d.d. Sarajevo
3	Elektroprivreda HZHB Mostar d.d.
4	Crnogorski Elektroprenosni Sistem AD
5	Fintel Energija AD

Table A2

	Sector: Financial and insurance activities
1	Stopanska Banka AD
2	TTK Banka AD
3	UNI Banka AD
4	NLB Banka AD
5	Komercijalna Banka AD
6	Hipotekarna Banka d.d.
7	NLB Slovenia d.d.
8	Asa Banka d.d. Sarajevo
9	Hrvatska Postenska Banka d.d.
10	Dunav Osiguranje AD
11	Triglav Osiguranje d.d
12	SAVA Group d.d.

Table A3

	Sector: Information and Telecommunications
1	JP Hrvatske Telekomunikacije d.d. Mostar
2	Makedonski Telekom AD
3	Telekom Slovenia d.d
4	BH Telecom Sarajevo d.d
5	Crnogorski Telekom d.d.
6	Hrvatski Telekom d.d.

Table 4

	Sector: Manufacturing
1	Podravka d.d.
2	Atlantic d.d.
3	Plantaze Podgorica AD
4	Impol Seval d.d.
5	Badeco Adria d.d.
6	Messer Tehnogas d.d.
7	Cinkarna Celje d.d.
8	Jedinstvo Sevojna d.d.
9	KRKA d.d.
10	Bosnija Ljek d.d.
11	Alkaloid AD
12	Rade Koncar d.d.
13	Energoinvest d.d.