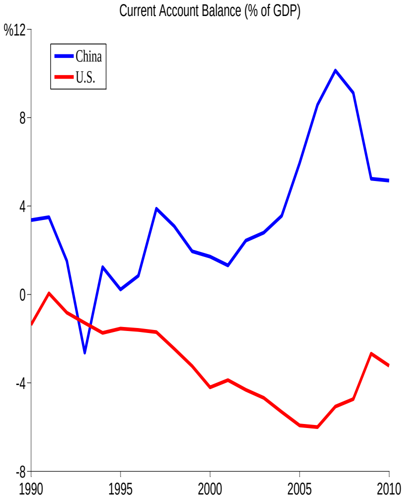
Towards a Structuralist Interpretation of Saving, Investment and Current Account in Turkey

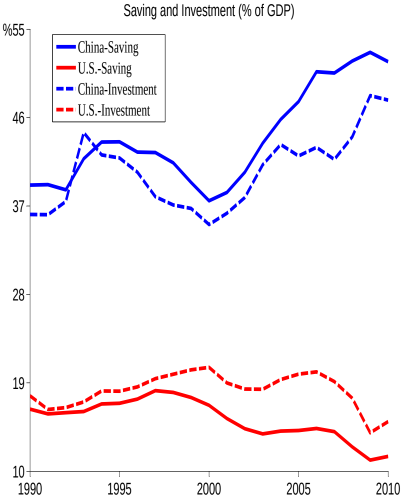
MURAT ÜNGÖR
Central Bank of the Republic of Turkey

http://www.muratungor.com/

April 2012

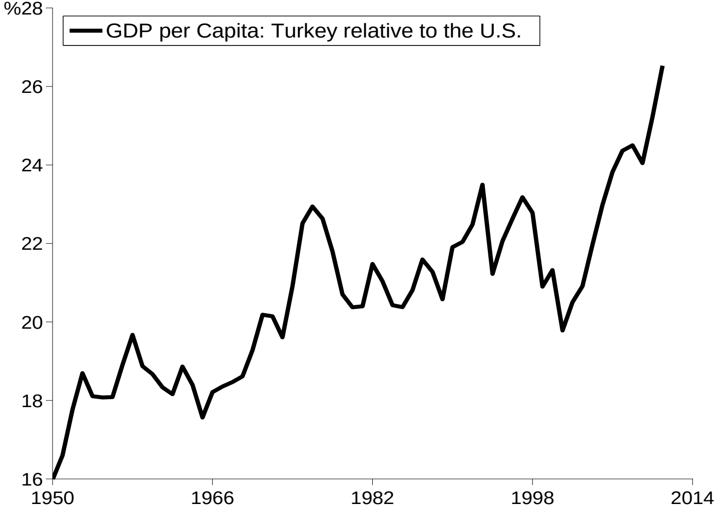
We live in the age of global imbalances...





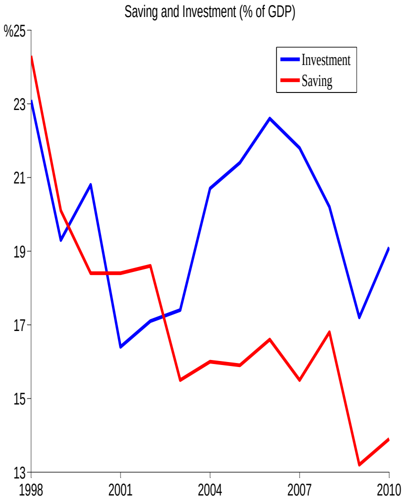
(Source: World Bank Development Indicators Database)

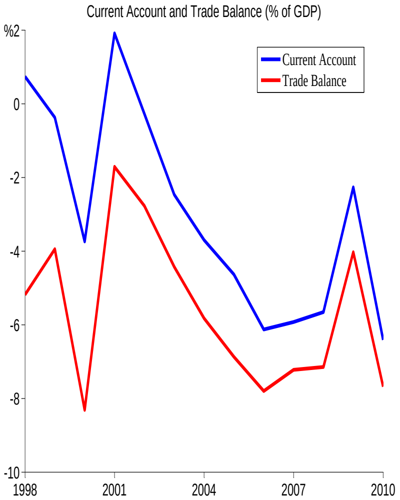
Convergence to the Frontier, 1950-2011



(Source: The Conference Board Total Economy Database)

Saving, Investment, and Current Account in Turkey, 1998-2010





(Source: T.R. Ministry of Development)

To what extent can a growth model be an effective tool in understanding the behavior of the saving/investment rate in Turkey?

Do changes in the total factor productivity (TFP) growth rate alone generate most of the changes in the saving/investment rate in Turkey?

MODEL

Technology

The aggregate production function is given by

$$Y_t = A_t K_t^{\theta} (H_t)^{1-\theta} \tag{1}$$

Y_t is aggregate output

A_t is TFP

K_t is aggregate capital

H_t is aggregate hours

θ is capital's share of income

Technology

TFP factor grows exogenously at the rate γ_t:

$$\gamma_t \equiv (A_{t+1}/A_t)^{1/(1-\theta)} \tag{2}$$

The capital stock evolves according to the law of motion:

$$K_{t+1} = (1-\delta)K_t + X_t \tag{3}$$

X_t is aggregate investment and δ is the depreciation rate of capital at time t.

Households

The stand-in household's utility function is:

$$\sum_{t=0}^{\infty} \beta^t N_t \Big(\log c_t + \alpha log(T - h_t) \Big), \tag{4}$$

The size of the household evolves over time exogenously:

$$\eta_t \equiv N_{t+1}/N_t. \tag{5}$$

$c_t \equiv C_t/N_t$ is per member consumption

T is time endowment per member

$h_t \equiv H_t/N_t$ is hours worked per member

α is the share of leisure in the utility function

β is the discount factor, $0 < \beta < 1$.

The stand-in household solves

$$max \quad \sum_{t=0}^{\infty} \beta^t N_t \Big(\log c_t + \alpha log(T - h_t) \Big)$$

subject to

$$C_t + X_t = \omega_t H_t + r_t K_t - \tau_t (r_t - \delta) K_t - \pi_t, \qquad t = 0, 1, 2, ...,$$

given $K_0 > 0$.

ω_t is the real wage

r_t is the rental rate of capital

τ_t the tax rate on capital income

π_t is a lump sum tax

Households are assumed to own the capital stock, K_t, and rent it to businesses.

Government

There is a government that taxes income from capital (net of depreciation) and uses the proceeds to finance an exogenously given stream of government purchases G_t.

A lump-sum tax π_t is used to ensure that the government budget constraint is satisfied each period:

$$G_t = \tau_t(r_t - \delta)K_t + \pi_t. \tag{6}$$

By treating the capital tax income rate τ_t as a policy parameter, we are assuming that changes in government purchases are financed by changes in the lump-sum tax π_t.

Thus, Ricardian Equivalence holds.

SOLUTION PROCEDURE

Hayashi-Prescott (2002) and Chen-İmrohoroğlu-İmrohoroğlu (2006)

1. We derive the equilibrium conditions of the model, detrend variables to induce stationarity, and then impose these steady-state conditions.
2. We calibrate the model parameters and exogenous variables, and compute a steady-state for Turkish economy.
3. We use a shooting algorithm from given initial conditions toward the steady-state to compute the transition path.
4. We start from a given value of K_0; guess a value for C_0 and use the Euler equation and resource constraint to obtain a path for C_t, H_t and K_{t+1} towards their steady-state values.
5. If the path does not connect with the steady-state, we iterate on the initial guess for C_0 using this algorithm until convergence to the steady-state is obtained.
6. Equipped with the equilibrium path of C_t, H_t and K_{t+1} ; we can then use other equilibrium conditions to construct time paths of all aggregate quantities and prices.

Equilibrium Conditions

Substituting the production function, the marginal productivity conditions, and the capital accumulation equation into the household's first-order conditions and the resource constraint, we obtain the following equilibrium conditions:

$$C_t = (1/\alpha)(T - h_t) N_t (1-\theta) A_t K_t^{\theta} (H_t)^{1-\theta} \tag{7}$$

$$\frac{C_{t+1}}{N_{t+1}} = \frac{C_t}{N_t} \beta \left\{ 1 + (1 - \tau_{t+1}) \left[\theta A_{t+1} K_{t+1}^{\theta-1} (H_{t+1})^{1-\theta} - \delta \right] \right\} \tag{8}$$

$$K_{t+1} = (1-\delta) K_t + A_t K_t^{\theta} (H_t)^{1-\theta} - C_t - G_t \tag{9}$$

These equations together determine the sequence of $\{C_t, K_t, H_t\}$ given the sequence of $\{A_t, N_t, G_t\}$ as well as the initial value for K_t.

We can detrend the model by defining

$$\tilde{k}_t \equiv \frac{K_t}{A_t^{\frac{1}{1-\theta}} N_t}, \quad \tilde{c}_t \equiv \frac{C_t}{A_t^{\frac{1}{1-\theta}} N_t}, \quad \tilde{y}_t \equiv \frac{Y_t}{A_t^{\frac{1}{1-\theta}} N_t},$$

$$\gamma_t \equiv \left(\frac{A_{t+1}}{A_t}\right)^{\frac{1}{1-\theta}}, \quad \eta_t \equiv \frac{N_{t+1}}{N_t}, \quad \Psi_t \equiv \frac{G_t}{Y_t}.$$

Detrended capital-labor ratio, $\tilde{x}_t \equiv \frac{\tilde{k}_t}{h_t}$.

Now, three equilibrium conditions become

$$\tilde{c}_t = (1/\alpha)(T - h_t)(1-\theta)x_t^{\theta}, \tag{10}$$

$$\tilde{c}_{t+1} = \frac{c_t}{\gamma_t}\beta\Big[1 + (1-\tau_{t+1})(\theta x_{t+1}^{\theta-1} - \delta)\Big], \tag{11}$$

$$\tilde{k}_{t+1} = \frac{1}{\gamma_t \eta_t}\left\{\Big[(1-\delta) + (1-\Psi_t)x_t^{\theta-1}\Big]\tilde{k}_t - \tilde{c}_t\right\}. \tag{12}$$

These three equations determine $\{x_t, \tilde{c}_t, \tilde{k}_t\}$ given $\{\gamma_t, \eta_t, \tau_t, \Psi_t\}$.

Steady State

If $\{x, \tilde{c}, \tilde{k}\}$ are steady-state values of $\{x_t, \tilde{c}_t, \tilde{k}_t\}$ when $\{\gamma_t, \eta_t, \tau_t, \Psi_t\}$ are constant at $\{\gamma, \eta, \tau, \Psi\}$, they satisfy

$$\tilde{c} = (1/\alpha)(T - h)(1 - \theta)x^{\theta}, \tag{13}$$

$$1 = (\beta/\gamma)\Big[1 + (1 - \tau)(\theta x^{\theta-1} - \delta)\Big], \tag{14}$$

$$\tilde{k} = (1/\gamma\eta)\Big\{\Big[(1 - \delta) + (1 - \Psi)x^{\theta-1}\Big]\tilde{k} - \tilde{c}\Big\}. \tag{15}$$

These three steady-state equations can be solved for $\{x, \tilde{c}, \tilde{k}\}$ as

$$x = \left(\frac{\frac{\frac{\gamma}{\beta}-1}{1-\tau} + \delta}{\theta}\right)^{\frac{1}{\theta-1}}, \tag{16}$$

$$\tilde{c} = (1/\alpha)(1 - \theta)(T - h)x^{\theta}, \tag{17}$$

$$\tilde{k} = \frac{\tilde{c}}{(1 - \delta) + (1 - \Psi)x^{\theta-1} - \gamma\eta}. \tag{18}$$

The steady-state value of detrended output is given by $\tilde{y} = \tilde{k}x^{\theta-1}$

Saving Rate

Time-varying saving rate, s_t, is given by:

$$s_t = \frac{Y_t - G_t - C_t - \delta K_t}{Y_t - \delta K_t} \tag{19}$$

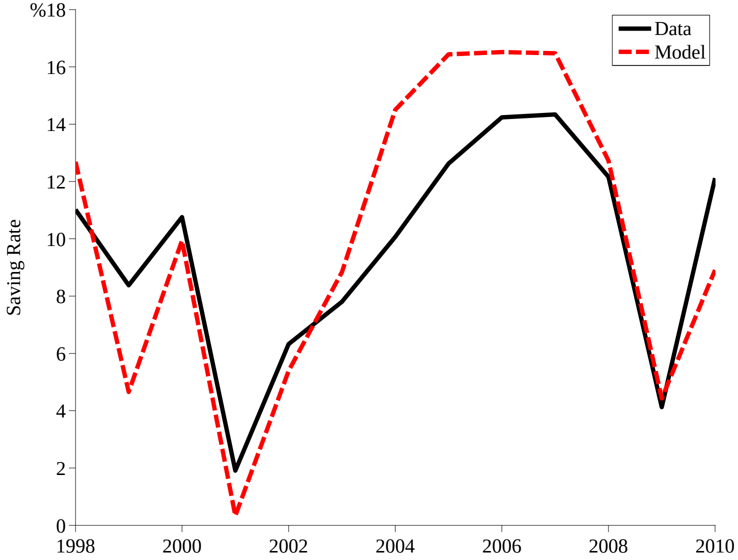
The detrended steady-state saving rate, $\tilde{s}$, is given by:

$$\tilde{s} = \frac{(\gamma\eta - 1)\tilde{k}}{\tilde{y} - \delta\tilde{k}} \tag{20}$$

Calibration

- Calibration of the 1988-2010 Period
  - In my benchmark simulation, I use the actual time series data between 1988 and 2010 for the exogenous variables: TFP growth rate, population growth rate, share of government purchases in output, and capital income tax rate.
- Calibration of the Steady State
  - For the computation of the steady state, I set the exogenous variables equal to their sample averages.
- Calibration of 2011 and beyond
  - Between 2011 and the steady state, I assume that all exogenous variables take their steady state values.

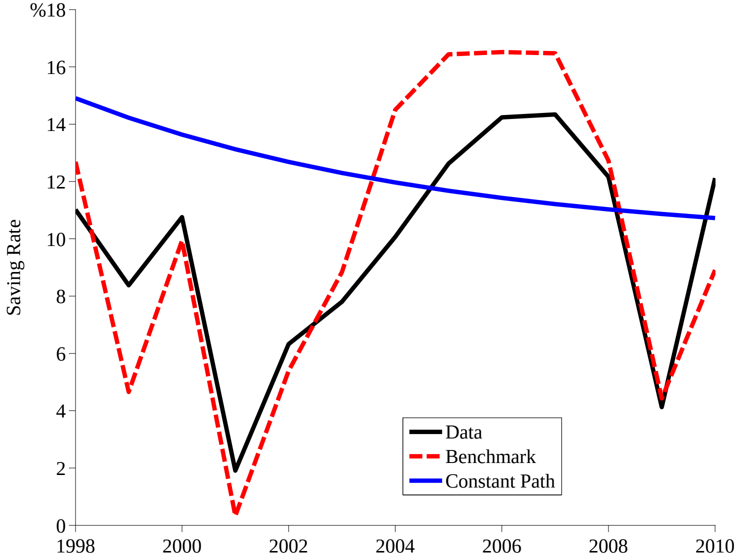
Benchmark Economy, 1998-2010



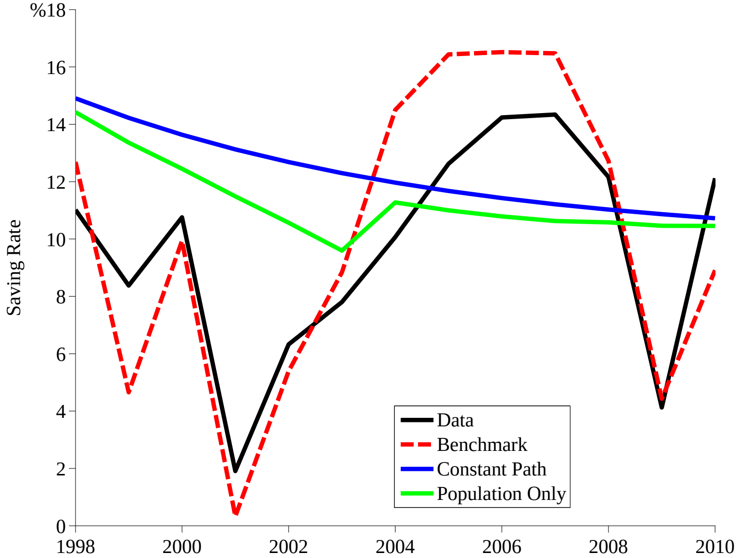
Counterfactual Experiments

- In order to isolate the effects of each exogenous variable, I first consider an economy where all the exogenous variables are held constant at their long-run averages throughout the 1988-2010 period.
- Next, I introduce the actual time series path of one exogenous variable at a time.

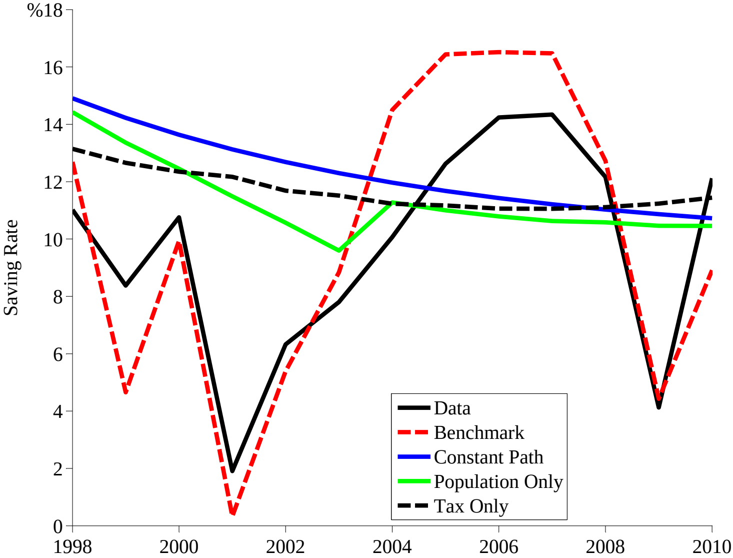
Experiment: Shutting down all the channels



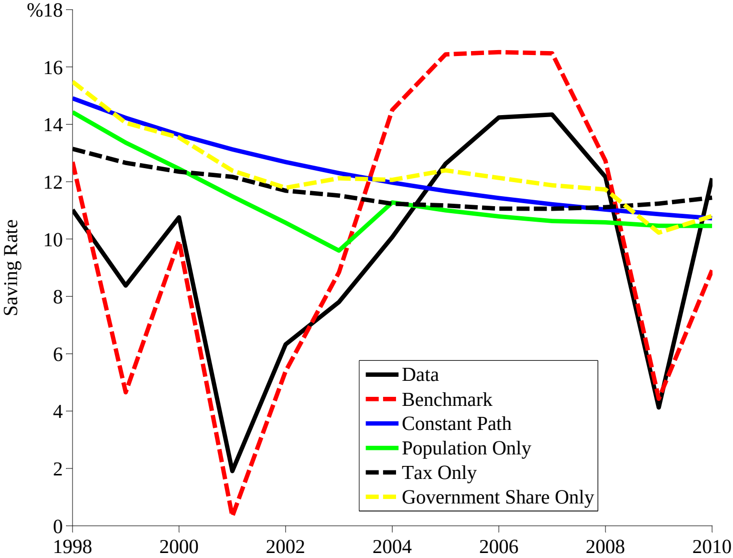
Experiment: The effects of population growth



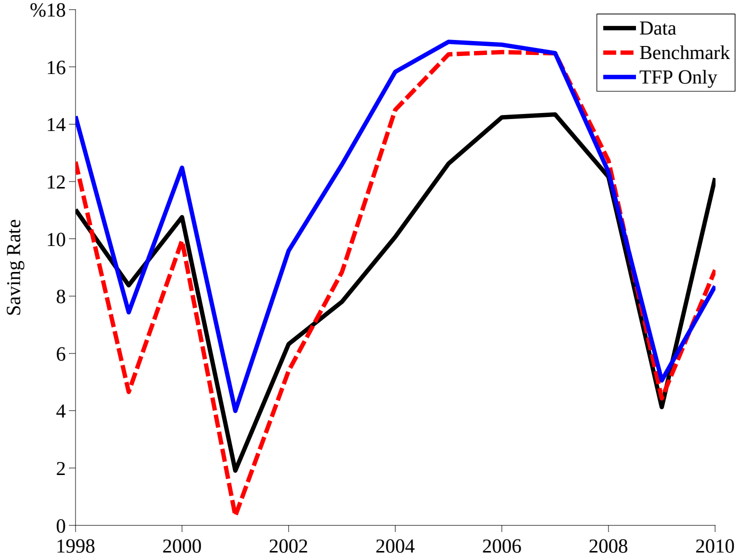
Experiment: The effects of tax rate



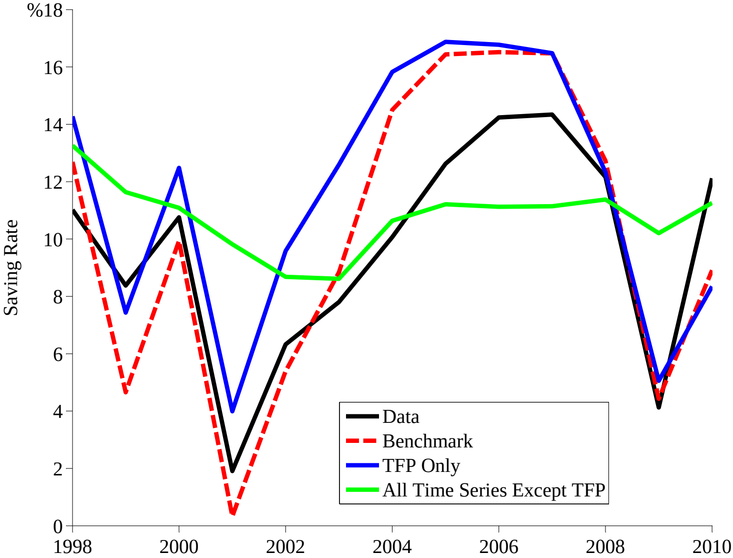
Experiment: The effects of government share



Experiment: The effects of TFP growth

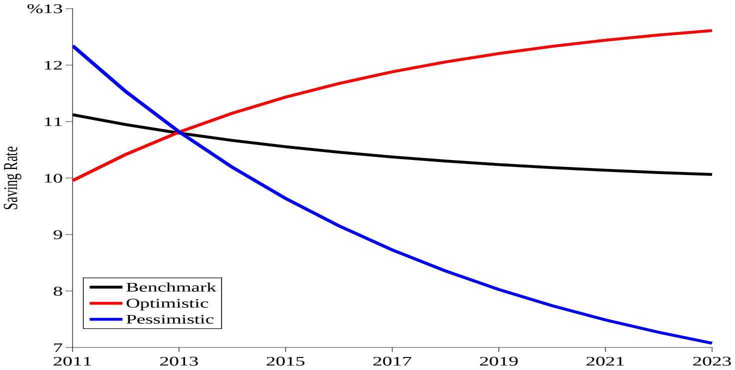


Experiment: Main Determinants of the Saving Rate



Some Forecasts

$$\textit{TFP Factor Growth Rate} = \begin{cases} 0.11\% & \text{for } 2011 \leq t, \text{ pessimistic} \\ 2.11\% & \text{for } 2011 \leq t, \text{ benchmark} \\ 4.11\% & \text{for } 2011 \leq t, \text{ optimistic} \end{cases}$$



Concluding Remarks

- Changes in the TFP growth rate alone can generate most of the secular changes in the Turkish saving/investment rate.

- A detailed analysis of the factors behind TFP growth would further enhance our understanding of the saving/investment behavior.

- My quantitative results are obtained in a simple growth model that abstracts from potentially important economic factors. Possible important extensions are left for future research.

A Research Agenda: Implications for Current Account Deficits

For each country $i = \{1, 2\}$, there is a stand-in household with N_t^i working-age members at date t. Both capital and labor are immobile across countries. We assume that there is a risk-free bond traded internationally each period. The size of the household evolves over time exogenously. In this framework a representative household maximizes

$$\sum_{t=0}^{\infty} \beta^t N_t^i (\log c_t^i + \alpha log(T - h_t^i))$$

subject to

$$\begin{aligned} & B_{t+1}^i + C_t^i + X_t^i + \phi K_t^i \left(\frac{X_t^i}{K_t^i} - \varphi^i \right)^2 \\ \leq \;& B_t^i \left(1 + r_t^B\right) + w_t^i H_t^i + r_t^i K_t^i - \tau_{kt}^i (r_t^i - \delta^i) K_t^i + TR_t^i - \pi_t^i \\ K_{t+1}^i =\;& \left(1 - \delta^i\right) K_t^i + X_t^i \\ & B_0^i, K_0^i \text{ given,} \end{aligned}$$

Saving Rate and Current Account Deficit

National account identity is given by:.

$$C_t^i + I_t^i + G_t^i + B_{t+1}^i = Y_t^i + B_t^i \left(1 + r_t^B\right).$$

or

$$C_t^i + I_t^i + G_t^i + CA_t^i = Y_t^i + B_t^i r_t^B = GNP_t^i$$

One can compute the saving rate using

$$s_t^i = \frac{GNP_t^i - G_t^i - C_t^i - \delta_t^i K_t^i}{GNP_t^i - \delta_t^i K_t^i}.$$

and one can compute the current account deficit as a percentage of GDP as

$$ca_t^i = \frac{B_{t+1}^i - B_t^i}{Y_t^i}$$