BUSINESS CYCLES AND CYCLICAL BEHAVIOUR OF TRADE FLOWS IN TURKEY

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to my parents ...

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Abstract

Keywords: Capital good imports, emerging economies, trade balance, trade flows in Turkey.

Turkey has a strongly countercyclical trade balance like other emerging market economies. De Bock (2010) claims that the procyclical behavior of capital good imports is an important factor driving the countercyclicality of the trade balance in emerging economies. This paper, following De Bock (2010), documents and analyzes the composition and cyclical properties of the trade balance in Turkey. The analysis of Turkish data shows that capital good imports are a sizable fraction of total imports and they are procyclical as in other emerging markets. Based on this observation, a two sector small open economy model, calibrated to Turkish data, is used to quantitatively analyze the role of import structure in driving the cyclical properties of the trade balance, as well as other business cycle properties. The model is able to generate a strongly countercyclical trade balance and also match the major business cycle regularities in the data.

TÜRKİYE'DE REEL İKTİSADİ DALGALANMALAR VE DIŞ TİCARET HAREKETLERİNİN DEVREVİLİĞİ

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Özet

Anahtar Kelimeler: Dış ticaret dengesi, gelişen ekonomiler, sermaye malları ithalatı, Türkiye'de dış ticaret hareketleri.

Türkiye'nin dış ticaret dengesi, diğer gelişmekte olan ülkelerde olduğu gibi, güçlü bir şekilde ters devrevi özellik göstermektedir. De Bock (2010) gelişmekte olan ülkelerde dış ticaret dengesinin ters devrevi olmasının en önemli nedenlerinden birinin sermaye malları ithalatının devrevi özellik göstermesi olduğunu öne sürmektedir. Bu çalışmada, De Bock (2010)'un çalışması takip edilerek, Türkiye'nin dış ticaret dengesinin oluşumu ve devrevi özellikleri incelenmektedir. Türkiye ekonomisine ait veriler, diğer gelişen ülkelerde olduğu gibi, sermaye malları ithalatının toplam ithalat içerisinde önemli bir paya sahip olduğunu ve sermaye malları ithalatının devrevi özellik gösterdiğini ortaya koymaktadır. Bu gözlemlerden faydalanılarak, ithalatın dış ticaret dengesinin devrevi özellikleri üzerindeki etkisini sayısal olarak inceleyebilmek amacıyla iki sektörlü bir açık ekonomi modeli ele alınmış ve Türkiye verilerine uyumlu hale getirilmiştir. Açık ekonomi modelinin simülasyonu sonucunda güçlü ters devrevi özelliğe sahip dış ticaret dengesi oluşturulmuş ve aynı zamanda Türkiye'nin reel iktisadi dalgalanmalarına ait ana özellikler elde edilmiştir.

TABLE OF CONTENTS

1 INTRODUCTION

In emerging market economies, the trade balance is strongly countercyclical: the trade balance expands in low output episodes and contracts in high output episodes. Different views have been offered in the literature to explain this business cycle fact. One of the explanations, which is provided by De Bock (2010), is that the procyclical demand for capital good imports during expansions of the economy drives the countercyclicality of the trade balance. Capital good imports are one third of total imports and they constitute a sizable fraction of total GDP. Therefore, their behavior throughout the cycles of the economy is an important determinant of the cyclical properties of the trade balance. De Bock (2010) provides a two-sector small open economy model that accounts for this import structure of emerging market economies in order to replicate the business cycle properties that are typical in these emerging markets, with a special focus on the trade balance. The current paper analyzes the Turkish business cycle facts and replicates the model of De Bock (2010) using Turkish data.

In his paper, De Bock analyzes the composition and cyclical properties of different components of the trade balance. He uses quarterly data of UN-NBER for the period 1980-2000. In his analysis, he uses averages of 17 emerging economies and 9 developed economies to document the business cycle properties of emerging economies and compare them with developed economies. He finds that both in emerging and developed economies, capital good imports, which constitute a sizable fraction of GDP, are roughly a third of total imports, and both capital good imports and total imports are procyclical. However, this similarity does not hold for exports, as the share of capital good exports in total exports is low in emerging economies (EM). In EM, capital good exports and overall exports (without procyclical durables) are acyclical. However, since capital good exports constitute a third of overall exports in developed economies their strong procyclicality leads to procyclicality of total exports. As a result of these facts, the trade balance is strongly countercyclical in EM, but acyclical or moderately countercyclical in developed economies. The summary of his findings for emerging economies is as follows:

- $\frac{Capital\_good\_imports}{Total\_imports} \geq \frac{1}{3}$,
- Capital good imports are a sizable fraction of GDP (6.61% of GDP),
- The trade balance is strongly countercyclical in emerging economies,
- Emerging economies have acyclical exports and procyclical imports.

Recent discussions about Turkey's economic problems are consistent with the findings of De Bock (2010). The growing current account deficit has been pointed out as one of the major problems of the Turkish economy. While Turkey has been growing at very high rates in the last couple of years, the current account deficit has also reached very high levels. The growth rate of the Turkish economy is 8.9% in 2005, 6.9% in 2006, 4.7% in 2007, 0.7% in 2008, -4.8% in 2009 and 8.9% in 2010; and the current account deficit to GDP ratio is 4.6% in 2005, 6.1% in 2006, 5.9% in 2007, 5.6% in 2008, 2.3% in 2009 and 6.5% in 2010. Trade data for the January-June period of 2010 and 2011 show that imports grew by 43.4% from 2010 to 2011, but exports grew only by 19.9 percent. Capital goods have the biggest share among all categories in total imports with a percentage of 28.7. These figures show the importance of capital good imports for the current account deficit problem.

In this paper, to be able to compare the cyclical properties of the components of the trade balance for Turkey with the findings of De Bock (2010), quarterly data from Turkish Statistical Institute (TURKSTAT) for the period of 1987-2007 is analyzed. The data show that the share of capital good imports in total imports is 0.329 and the share of capital good exports in total exports is 0.16, which are consistent with the results of De Bock (2010). This fact proves that any change in capital good imports substantially affects total imports. Another result for Turkey is that capital good imports to GDP ratio is 0.058, which is a sizable fraction according to De Bock (2010).[1] Since capital good imports are a sizable fraction of total GDP, their cyclical behavior is important for the business cycle properties of the economy. The correlation coefficient between output and trade balance to output ratio for Turkey is -0.598, which shows that trade balance is strongly countercyclical as can be seen in figure 2. However, the cyclical property of Turkey's exports is not in line with De Bock (2010)'s results. The correlation coefficient between exports and GDP is -0.36, which means that exports are countercyclical. In fact, the countercyclicality of exports makes the countercyclicality of trade balance much stronger. Finally, the cyclical properties of imports are consistent with the observations of De Bock (2010). The correlation coefficient between imports and GDP is 0.495, which proves the procyclicality of imports as shown in figure 4. Besides, the correlation coefficient between GDP and capital good imports is 0.7, which implies that capital good imports are strongly procyclical and this procyclicality affects the procyclicality of total imports in a positive manner.[2] On the other hand, the correlation coefficient between output and capital good exports is -0.0028, which denotes its acyclicality.[3] Overall, the cyclical properties of the trade balance, total imports and capital good imports in Turkey are consistent with the findings of De Bock (2010), with the exception of exports, which are countercyclical. The summary of Turkish data is as below:

- Capital good imports to total imports ratio is obtained as 0.329,

[1] De Bock (2010) finds the median share of capital good imports in GDP for the observed countries as 6.61 percent.

[2] See Figure 5 in Appendix B for the graph "capital good imports vs GDP".

[3] See Figure 6 in Appendix B for graph "GDP vs capital good exports".

- Capital good imports to GDP ratio is 0.058,
- The coefficient of correlation between output and trade balance is -0.598,[4]
- The coefficient of correlation between output and exports is -0.36,[5]
- Finally, the coefficient of correlation between output and imports is 0.495.[6]

De Bock (2010) uses a two-sector small open economy model to account for the business cycle properties of emerging market economies that he documents. The model consists of a domestic sector and an export sector. There is an aggregate investment function which uses both domestically produced goods and imported foreign investment goods to obtain the final investment good. In his model, emerging economies need to import the capital good and exports are not correlated with the domestic economy. He also uses GHH preferences to obtain sufficient volatility for consumption. The model is able to generate a strongly countercyclical trade balance and obtain volatilities similar to data.

The replication of De Bock (2010) for Turkey gives results that are consistent with the data. The model is able to generate a strongly countercyclical trade balance which is not possible to generate by standard one sector model as explained in the next section. Moreover, it is able to generate volatilities similar to the data for output and trade balance. The simulation of model also generates volatility for consumption in accordance with data. Overall, the model generates several important features of the Turkish data, which are not possible to explain with a standard one sector small open economy model. The results of the paper point out that the import structure, and in particular capital good imports, are important factors in explaining the business cycle properties of the Turkish economy.

1.1 Literature Review

Besides De Bock (2010), the literature has been trying to find the possible causes of strong countercyclicality of the trade balance. Backus et al. (1990) extends the domestic models to international models to find out if an international version of a business cycle model is successful to simulate the domestic behaviours and international comovements. They use a two-country extension of Kydland and Prescott (1982)'s domestic economy that includes different technology shocks for distinct countries and agents participation in the international market by bond trade. In their model, an innovation in a country affects other economy's technology. However, data is of U.S. and some other developed economies, and their results suggest that there is no correlation between output and trade balance, although the data[7] suggests a value of -0.28.

[4] See Figure 2 in Appendix B.
[5] See Figure 3 in Appendix B.
[6] See Figure 4 in Appendix B.
[7] They use data of Citibank Citibase and IMF's International Financial Statistics

Mendoza (1991) tries to obtain a model that has consistent results with two stylized facts: domestic savings and domestic investment are positively correlated, and trade balance is countercyclical. He uses a stochastic model where there are two alternatives of investment: domestic capital and foreign bonds. In the different versions of the model, firstly he uses shocks that only affects domestic sector, then he uses shocks to both domestic sector and the world real interest rate, and finally he adds capital adjustment costs to the model. As he states in his paper, he finds that the model with small capital adjustment costs and minimal variability and persistence in exogenous shocks is able to give consistent results with Canadian economy, which is also a developed economy.

Correia et al. (1995) studies a model that is similar to Mendoza (1991), but they use GHH preferences. Their model gives lower values for the correlation coefficient between output and terms of trade compared to the data of Portugal. They claim that replicating important features of business cycles depends on using a utility function proposed by GHH et al. (1988).

Contrary to Mendoza (1991), Neumeyer and Perri (2005) claim that responsibility of the fluctuations is due to variability of interest rates and emerging economies try to apply policies to stabilize the interest rates. In his paper, he also compares the developed economies and emerging economies. Observations related to these economies suggest that interest rate is countercyclical in emerging economies and acyclical in developed economies, and net exports are much more strongly countercyclical in emerging economies. Correlation of net exports with GDP is -0.61 for emerging economies and -0.23 in developed economies. They present two important features in addition to the standard one-good small open economy model: preferences are chosen that they generate labor supply independent of consumption and firms have to pay for factors of production before production takes place. The interest rates consist of both an international rate(risk free rate) and country risk rate. They have shocks on productivity, risk free rate and country risk rate. As a result, simulation with interest rate and productivity shocks gives a value of -0.80 for the correlation between GDP and trade balance(which is -0.89 in data). In addition to Neumeyer and Perri (2005), Tiryaki (2010) calibrates the model of Neumeyer and Perri (2005) to match Turkish data. He finds a value of -0.42 for the correlation between output and trade balance which is -0.69 in Turkey.[8]

Another paper that is trying to model international trade is Engel and Wang (2010). They study on OECD countries and have three main observations: imports and exports are three times volatile than output, imports and exports are procyclical and positively correlated to each other, net exports are countercyclical. In their paper, they use two-country two-sector model where durable goods are traded in accordance with the real trade in which durable goods have an

[8] Observations are on the quarterly data of years 1987-2004.

important share. They suggest that a model with capital good but not durable goods is inadequate. Main focus of this paper is to obtain consistent volatility for exports and imports for which standard models fail and the model is successful to reach results similar to data. Although, their models give countercyclical trade balance, it is not strong countercyclicality and correlation coefficient is low compared to data.

2 MODEL

Following De Bock (2010), we use a small open economy model with two sectors: home sector and export sector. Both sectors use capital and labor for the production of outputs. Capital is a composite good, produced through an aggregate investment function that uses the domestic good and the imported foreign good as inputs. Agents have GHH preferences and everything in the model is stated in per capita terms.

2.1 Home Sector

In the home sector, firms produce a domestic non-tradable good Y_t^H using a Cobb-Douglas technology. The production function is given by

$$Y_t^H = A_t (K_t^{Hf})^{\alpha} (N_t^H)^{1-\alpha}. \tag{1}$$

where A_t is the productivity shock, K_t^{Hf} is the capital stock and N_t^H is the number of hours allocated to home sector.

Firms in the home sector maximize their profits by choosing capital stock level, K_t^{Hf}, and hours of work, N_t^H :

$$max \quad \Pi^H = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} [P_t^H Y_t^H - r_t^H K_t^{Hf} - \omega_t N_t^H - \frac{\theta}{2}(N_t^H - N_{t-1}^H)^2] \tag{2}$$

where P_t^H is the price of domestic investment good when the price of exported investment good is set as numeraire, r_t^H is the cost of one unit of capital in the home sector and ω_t is the cost of one unit of labor. $\boldsymbol{\lambda}_t$ is the lagrange multiplier for household's budget constraint and $\beta^t \frac{\lambda_t}{\lambda_0}$ is the discount factor for firm's profit.

Firms face a labor adjustment cost, which serves the purpose of reducing labor movements between the home sector and the export sector. As stated by De Bock (2010), labor adjustment costs are not very common in the literature of one sector-business cycle models. However, with such a cost, the model would avoid strong negative comovement of labor across the two sectors (De Bock

(2010)). The first order conditions from the firm's profit maximization are as follows:

(N_t^H) :

$$P_t^H A_t(1-\alpha)(\frac{K_t^{Hf}}{N_t^H})^\alpha = \omega_t + \theta(N_t^H - N_{t-1}^H) - \beta\frac{\lambda_{t+1}}{\lambda_t}\theta(N_{t+1}^H - N_t^H) \quad (3)$$

Left hand side is the marginal product of hiring one more unit of labor for home sector and the right hand side is the marginal cost of hiring one more unit of labor for home sector.

(K_t^{Hf}) :

$$P_t^H A_t\alpha(\frac{K_t^{Hf}}{N_t^H})^{\alpha-1} = r_t^H \quad (4)$$

where P_t^H is the price of one unit of home good in terms of one unit of export good. This equation represents that marginal benefit of a unit capital is equal to its marginal cost r_t^H in domestic sector.

2.2 Export Sector

In the export sector, firms produce a tradable export good Y_t^E using a Cobb-Douglas technology. The production function is given by:

$$Y_t^E = B_t(K_t^{Ef})^\alpha(N_t^E)^{1-\alpha} \quad (5)$$

where B_t is the productivity shock, K_t^{Ef} is the capital stock and N_t^E is the number of hours allocated to export sector

Similar to home sector, firms in the export sector maximize their profits by choosing capital stock level, K_t^{Ef}, and hours of work, N_t^E :

$$max \qquad \Pi^E = E_0\sum_{t=0}^{\infty}\beta^t\frac{\lambda_t}{\lambda_0}[Y_t^E - r_t^E K_t^{Ef} - \omega_t N_t^E - \frac{\theta}{2}(N_t^E - N_{t-1}^E)^2] \quad (6)$$

where r_t^E is the cost of one unit of capital.

Firms in the export sector also face a labor adjustment cost, which, as previously stated, serves the purpose of reducing labor movements between the home sector and the export sector. The first order conditions from the firm's profit maximization are as follows:

(N_t^E) :

$$B_t(1-\alpha)(\frac{K_t^{Ef}}{N_t^E})^\alpha = \omega_t + \theta(N_t^E - N_{t-1}^E) - \beta\frac{\lambda_{t+1}}{\lambda_t}\theta(N_{t+1}^E - N_t^E) \quad (7)$$

Left hand side is the marginal product of hiring one more unit of labor for export sector and the right hand side is the marginal cost of hiring one more unit of labor.

(K_t^{Ef}):

$$B_t\alpha(\frac{K_t^{Ef}}{N_t^E})^{\alpha-1} = r_t^E \quad (8)$$

Marginal cost of hiring one unit of capital, r_t^E, is equal to marginal benefit of hiring one unit of capital.

2.3 Investment Technology

In this section, the investment process is explained in detail. Aggregate investment is produced by using a constant elasticity of substitution aggregator. To be able to produce new investment goods both an imported investment good, I_t^F, and a domestic investment good, I_t^H, are needed. New investment good production process is:

$$G(I_t^H, I_t^F) = [\omega_H^{1-\varepsilon}(I_t^H)^\varepsilon + (1-\omega_H)^{1-\varepsilon}(I_t^F)^\varepsilon]^{\frac{1}{\varepsilon}}, \quad (9)$$

where ω_H is the share of domestic investment good and $\sigma_I = \frac{1}{1-\varepsilon}$ is the elasticity of substitution between foreign and domestic investment goods. If the price of exported investment good is set as numeraire and price of domestic investment good is P_t^H, then total expenditures on investment will be:

$$P_t^H I_t^H + I_t^F \quad (10)$$

To be able to calculate P_t^H, aggregate investment is maximized by choosing I_t^F and I_t^H subject to total expenditures (Obstfeld and Rogoff, 1996).

$$max \;\; G(I_t^H, I_t^F) = [\omega_H^{1-\varepsilon}(I_t^H)^\varepsilon + (1-\omega_H)^{1-\varepsilon}(I_t^F)^\varepsilon]^{\frac{1}{\varepsilon}}$$

$$s.t. P_t^H I_t^H + I_t^F = Z$$

then price of domestic investment good is

$$P_t^H = (\frac{1-\omega_H}{\omega_H}\frac{I_t^H}{I_t^F})^{\frac{-1}{\sigma_I}} \quad (11)$$

Aggregate investment in terms of export good is;

$$I_t \equiv P_t^I * G(I_t^H, I_t^F)$$

Definition (Obstfeld and Rogolf, 1996): The price index P_t^I is the minimum expenditure $Z = P_t^H I_t^H + I_t^F$ such that $G(I_t^H, I_t^F) = 1$, given P_t^H.

That is:

$$min\ Z = P_t^H I_t^H + I_t^F$$

$$s.t. G(I_t^H, I_t^F) = 1$$

Then,

$$P_t^I = [\omega_H (P_t^H)^{\frac{\varepsilon}{\varepsilon-1}} + (1-\omega_H)]^{\frac{\varepsilon-1}{\varepsilon}} \tag{12}$$

By setting $\varepsilon = 0 \Rightarrow \sigma_I = 0$; Cobb-Douglas specification is obtained for $G(I_t^H, I_t^F)$ (Bems (2008)):

$$G(I_t^H, I_t^F) = (\frac{I_t^H}{\omega_H})^{\omega_H} (\frac{I_t^F}{1-\omega_H})^{(1-\omega_H)} \tag{13}$$

2.4 Household

In the model, there are infinitely many identical agents, whose preferences are of the GHH form. The GHH utility function, which is studied by Greenwood et al. (1988), is widely used in the small open economy real business cycle literature since it helps generate sufficient volatility for consumption and the countercyclicality of the trade balance (see Schmitt-Grohe and Uribe (2003)). The households maximize

$$U(C_t, N_t) = E_t(\sum \beta^t u(C_t, N_t)), 0 < \beta < 1, \tag{14}$$

where

$$u(C_t, N_t) = \frac{(C_t - \omega \frac{N_t^{1+\theta}}{1+\theta})^{1-\sigma} - 1}{1-\sigma}.$$

In the above utility function, σ denotes the coefficient of relative risk aversion, θ is the labor curvature and ω is labor weight in GHH utility.

The budget constraint of the households is given by:

$$P_t^H C_t + P_t^I * G(I_t^H, I_t^F) + \Psi(D_t) + \Phi(K_{t+1}, K_{t+1}^E, K_t, K_t^E)$$

$$\leq r_t^H (K_t - K_t^E) + r_t^E K_t^E + \omega_t N_t + [D_t - (1+R^*) D_{t-1}] \tag{15}$$

Agents gain interest income r_t^H and r_t^E from capital that they provide to capital sector and export sector, and wage ω_t for supply of labor. They can use their income for consumption, investing in new capital or buying foreign assets, D_t. The foreign assets have an exogenously determined return, R^*. K_t^E is the capital stock that agents allocate to export sector and K_t is the total stock of capital. There are adjustment costs for changes in foreign assets and capital levels. As stated in De Bock (2010), empirical observations show that capital is not very mobile between sectors. Therefore, using an adjustment cost function where agents face an extra cost if they change their capital levels or move capital among sectors reduces the overall volatility of investment as well as the sectoral volatilities.

$$\Phi(K_{t+1}, K^E_{t+1}, K_t, K^E_t) = \frac{\phi}{2}(K_{t+1} - K_t)^2 + \frac{\phi}{2}(K^E_{t+1} - K^E_t)^2 \tag{16}$$

Accumulation of capital is given by:

$$K_{t+1} = (1 - \delta)K_t + G(I^H_t, I^F_t), \tag{17}$$

where δ is depreciation rate. Undepreciated capital and new investment determine the next period's capital level.

To be able to satisfy stationarity in the model, an adjustment cost function $\Psi(D_t)$ is used (Schmitt-Grohe and Uribe (2003)):

$$\Psi(D_t) = \frac{\psi}{2}[D_t - \bar{D}]^2 \tag{18}$$

where interest rate on foreign assets R^* is fixed. The convex cost function imposes an increasing cost to agents if they borrow a level different than the steady state level of $\bar{D}$.

Agents maximize their utilities by choosing aggregate capital level K_{t+1}, export sector capital level K^E_{t+1}, foreign debt D_t, consumption C_t, investment levels I^H_t and I^F_t and supply of labor N_t subject to the budget constraint and the capital accumulation technology.

$$max \quad E_t(\sum \beta^t u(C_t, N_t)), 0 < \beta < 1,$$

$$s.t. \quad P^H_t C_t + P^I_t * G(I^H_t, I^F_t) + \Psi(D_t) + \Phi(K_{t+1}, K^E_{t+1}, K_t, K^E_t)$$

$$\leq r^H_t(K_t - K^E_t) + r^E_t K^E_t + \omega_t N_t + [D_t - (1 + R^*)D_{t-1}] \qquad (\boldsymbol{\beta^t \lambda_t})$$

$$K_{t+1} = (1 - \delta)K_t + G(I^H_t, I^F_t) \qquad (\boldsymbol{\beta^t \mu_t})$$

Then first order conditions are:

(C_t) :

$$(C_t - \omega\frac{N_t^{1+\theta}}{1+\theta})^{-\sigma} = P^H_t \lambda_t \tag{19}$$

(N_t) :

$$(C_t - \omega\frac{N_t^{1+\theta}}{1+\theta})^{-\sigma}\omega N_t^\theta = \lambda_t \omega_t \quad \Longrightarrow \quad P^H_t \omega N^\theta_t = \omega_t \tag{20}$$

The first two FOCs indicate that labor supply decision of household is independent of the consumption decision. It depends wage rate, price of domestic investment good and labor weight in GHH utility.

$(\boldsymbol{K}^E_{t+1})$:

$$\lambda_t \phi(K^E_{t+1} - K^E_t) = \beta\lambda_{t+1}[r^E_{t+1} - r^H_{t+1} + \phi(K^E_{t+2} - K^E_{t+1})] \quad (21)$$

$(\boldsymbol{K}_{t+1})$:

$$\lambda_t \phi(K_{t+1} - K_t) + \mu_t = \beta\lambda_{t+1}[r^H_{t+1} + \phi(K_{t+2} - K_{t+1})] + \beta\mu_{t+1}(1-\delta) \quad (22)$$

$(\boldsymbol{D}_t)$:

$$\lambda_t[1 - \psi(D_t - \bar{D})] = \beta\lambda_{t+1}(1 + R^*) \quad (23)$$

The FOC with respect to foreign bond shows that household buys foreign bond until the return on bond is equal to its cost.

$(\boldsymbol{I}^H_t, \boldsymbol{I}^F_t)$:

$$\lambda_t P^I_t = \mu_t \quad (24)$$

FOCs with respect to $\boldsymbol{I}^H_t$ and $\boldsymbol{I}^F_t$ are the same, they represent that the marginal benefit of one unit of investment is equal to marginal cost of one unit of investment.

2.5 Resource Constraints

The output produced by the home sector is non-tradable. Therefore, it is used for domestic consumption and investment. The resource constraint for the home sector is as follows:

$$C_t + I^H_t \leq Y^H_t. \quad (25)$$

On the other hand, the output of the export sector is exported abroad and the country imports the foreign investment good I^F_t,which is used in the investment process. The resource constraint for the export sector is:

$$I^F_t + [(1 + R^*)D_{t-1} + \Psi(D_t)] \leq D_t + Y^E_t \quad (26)$$

The difference between Y^E_t and I^F_t is defined as the trade balance and this gap is financed by foreign assets D_t.

$$tb{=}Y^E_t - I^F_t \quad (27)$$

where, tb is trade balance.

2.6 General Equilibrium

A competitive equilibrium is allocations of $\{C_t,\ N_t,\ K^E_{t+1},\ K_{t+1},\ D_t,\ I^H_t,\ I^F_t\}^\infty_{t=0}$ for agents, $\{K^{Ef}_t,\ N^E_t\}^\infty_{t=0}$ for export sector firms, $\{K^{Hf}_t,\ N^H_t\}^\infty_{t=0}$ for domestic sector firms and a set of prices $\{P^I_t,\ P^H_t,\ \omega_t,\ r^H_t,\ r^E_t\}^\infty_{t=0}$ such that given exogenously determined process for productivity shocks $\{A_t, B_t\}^\infty_{t=0}$ and deterministic interest rate on foreign debt R^*:

(i) Given prices, household solves its problem,
(ii) Given prices, firms solve their problems,
(iii) Markets clear

$$K^E_t = K^{Ef}_t \tag{28}$$

so that agent's supply for export sector capital is consistent with firm's demand,

$$K_t - K^E_t = K^{Hf}_t \tag{29}$$

so that agent's supply for home sector capital is consistent with firm's demand,

$$N_t = N^H_t + N^E_t \tag{30}$$

total supply of labor is divided into two sectors.
(iv) Resource constraints, equations 25 and 26, hold.

3 CALIBRATION

This section explains the calibration of the model. The model is solved using Turkish data for the period 1987-2007. All the data sources are given in Appendix A. Therefore, whenever there is available data, the model parameters are calibrated to match the business cycle properties of the Turkish economy for the stated period. In case of missing data, the parameters are set using other small open economy RBC studies The values of the utility curvature, σ, the capital share, α, the labor curvature, θ, the elasticity of substitution for investment, σ_I, and the share of home goods in investment, ω_H, are directly taken from De Bock (2010). As he states, these parameters are similar across emerging economies and developed economies. The calibration procedures of the remaining parameters are explained below:

Capital share, α : In the literature there are two different values for capital share of emerging economies. First one is a value of around 0.6 (Senhadji (2000)) and the other one is between 0.3-0.4 (Gollin (2002)). As stated in Tiryaki (2010), the reason for this difference is that the national income accounts are not corrected for the labor income of self-employed workers. Likewise, Gollin

(2002) shows that adjusting the data to account for the labor income of self-employed workers provides values between 0.3-0.4.[9] Therefore, in the model, the capital share of income is set to 0.4 in accordance with De Bock (2010).

Supply of labor, N : Data used to calculate labor supply covers the quarterly data from 1989 to 2007.The formula used to calculate average supply of labor is as below:

$$supply\ of\ labor = \frac{\text{(Hours worked per week)*(Employment)}}{\text{(Discretionary time per week)*(Population)}}$$

Hours worked per week is calculated by using quarterly data of Index of Production Hours Worked In Manufacturing Industry (1997=100) by TURKSTAT and annual average hours actually worked data of OECD Factbook 2010.

Employment and population data are obtained from TURKSTAT. In these two series, quarterly data is available for after 2000. For the years before 2000, data is released twice in a year in April and October. To be able to get values for remaining quarters, constant growth rate is assumed and missing values are calculated by using this constant growth rate assumption.

In the literature, value for discretionary time per week is around 100. Tiryaki (2010) uses a value of 98, Meza and Quintin (2007) prefers a value of 100 (1300 for a quarter). In this model, 100 hours per week is used for discretionary time.

By using these data, the average supply of labor is calculated as 0.179.

Interest rate on debt, R^* : The data for interest rate covers the quarterly period 1998-2008. The formula to calculate the interest rate is as below:

$$R = i_{U.S.} - E(\pi_{U.S.}) + EMBI/100$$

R : real interest rate on debt,
i : nominal interest rate,
π : inflation rate.

Following Neumeyer and Perri (2005), the domestic real interest rate is calculated by subtracting the expected U.S. inflation rate from the nominal U.S. interest rate and adding the country risk premium to this figure. The U.S. nominal interest rate minus the expected U.S. inflation rate gives the real interest rate for the U.S., which is used as a proxy for the international risk-free real interest rate. Adding the country risk premium for Turkey to the international risk-free real interest rate gives the real interest rate faced by Turkey in international markets. The country risk premium is measured using the Emerging

[9] Adjustment calculation is given in Tiryaki(2010)

Markets Bond Index Global (EMBI) of J.P. Morgan. The nominal U.S. interest rate is the interest rate on 90-day U.S. Treasury bills. Expected inflation in period t is computed as the average of U.S. GDP deflator inflation in the current period and in the three preceding periods. The average value for real interest rate used in the model is 1.46%.

Discount rate, β : Discount rate is calculated by using the steady state equation of equation 23:

$$\beta = \frac{1}{1+R^*} = 0.9856$$

Depreciation rate, δ : Depreciation rate is calculated by using the formula that is obtained from steady state equations:

$$\delta = \frac{r}{\alpha * P^I} * \frac{I}{Y}$$

Values of r and P^I are obtained by solving the steady state. Investment to output ratio is calculated by using quarterly data of 1987-2007 released by TURKSTAT. The depreciation rate value is 0.017.

Average trade balance to output, tb/y : Average trade balance to output ratio is calculated by using quarterly data of 1987-2007 period provided by TURKSTAT.[10] The value is -0.063.

Labor weight in GHH utility, ω : Labor weight is calculated by using formula obtained from steady state equations:

$$P^H \omega N^\theta = \bar{\omega} \Rightarrow \quad \omega = \frac{\bar{\omega}}{P^H N^\theta}$$

where $\bar{\omega}$ is steady state wage rate. The value of labor weight is 9.123.

Steady state level of foreign debt, $\bar{D}$ is obtained from steady state solution and its value is -4.226. Finally, capital adjustment cost parameter[11], ϕ, is set to approximately match the volatility of investment and foreign asset adjustment cost parameter, ψ, is set to provide stationarity in foreign asset trade.

[10] For the observations, quarterly national accounts data for the period 1987-2007, released by TURKSTAT, is used. There are two series of data released by TURKSTAT. First one uses 1987 as base year and other uses 1998. Not only the base year, but also the methods are different for the calculations. In this paper, the latter series are used(1998 based). For the missing periods(1987-1997), by using the growth rates of 1987-based series, values are calculated. For details see http://www.tuik.gov.tr/jsp/duyuru/upload/gsyh_8798fark.pdf

All the quarterly data is seasonally adjusted and they are detrended with HP-filter

[11] The volatility of investment is not perfectly matched in the model, since matching this parameter affects the volatilities of the other variables.

Table 1: Calibrated values of parameters for Turkey

Parameter	**Name**	**Value**
σ	curvature utility function	2
β	discount rate	0.9856
δ	depreciation rate	0.017
α	capital share	0.4
θ	labor curvature	0.6
σ_I	Elasticity of substitution for investment	1
ω	Labor weight in GHH utility	9.123
ω_H	share of home goods in investment	0.5
tb/y	average trade balance to output	-0.063
ρ_A	persistence of A_t	0.5
ρ_B	persistence of B_t	No shock on B_t
ψ	foreign asset adjustment cost parameter	0.0009
ϕ	capital adjustment cost parameter	0.35
R	interest rate on foreign debt	0.01456
$\bar{D}$	steady state level of foreign debt	-4.226
σ_A	Standard deviation of innovation ε_A	0.06
σ_B	Standard deviation of innovation ε_B	No shock on B_t
i/y	average investment to output	0.216
N	average supply of labor	0.179

Productivity shocks : The productivity shocks A_t and B_t are independent of each other and logarithm of the shocks follow AR(1) process:

$$\log(A_t) = \rho_A \log(A_{t-1}) + \varepsilon_{A,t}$$

$$\varepsilon_{A,t} \sim N(0, \sigma_A)$$

$$\log(B_t) = \rho_B \log(B_{t-1}) + \varepsilon_{B,t}$$

$$\varepsilon_{B,t} \sim N(0, \sigma_B)$$

Following De Bock (2010), the only shock used in the solution of the model is the productivity shock in the home sector, A_t. The parameter σ_A are set to obtain the volatility of aggregate output of Turkey and ρ_A is set to obtain persistence of output. Table 1 shows all parameter values.

4 RESULTS

In this section, the simulation results of the model and the impulse responses are analyzed

4.1 Simulation

The simulation results of the model are presented in Table 2 and Table 3. The model is simulated for 200 periods and the reported statistics are the mean values over 100 simulations of 200 observations each. The simulated series are in logs and detrended with the Hodrick-Prescott filter.

Table 2: Correlations

Corr(y,.)	tb/y	i^F	c	i
Data	-0,598	0,71	0,89	0,85
Model	-0,981	0,99	0,99	0,99

The model matches the countercyclicality of the trade balance. In fact, it gives a much stronger countercyclicality (-0.981) compared to data (-0.598) and De Bock (2010)'s result (-0.47). The correlation coefficients for foreign investment good, consumption and investment with output are very high in the data and the model is able to generate similar results to data. Moreover, correlation results for foreign investment good, consumption and investment are consistent with De Bock (2010).[12]

Business cycle moments are obtained as below:[13]

Table 3: Actual and simulated business cycle moments

	σ_y	$\frac{\sigma c}{\sigma_y}$	$\frac{\sigma i}{\sigma_y}$	$\frac{\sigma i^f}{\sigma_y}$	σ_n	$\sigma_{tb/y}$
Data	0,0326	1,17	3,13	3,86	0,027	0,021
Model	0,0322	1,23	2,07	0,97	0,009	0,032

The model is able to give very accurate results for the volatility of output and consumption. Although, in data, volatility of consumption is higher than volatility of output, De Bock (2010) obtains results such that volatility of consumption is lower than volatility of output. However, the volatility of consumption generated by this model is very close to data. Another important statistic is the volatility of the trade balance to output ratio and it is also quite close to data. On the other hand, the model is not successful at generating the volatility of foreign investment good, total investment and supply of labor.

[12] See Table 5 in Appendix B for De Bock (2010)'s results.
[13] See Table 6 in Appendix B for De Bock (2010)'s results.

4.2 Impulse Responses

In this section, impulse responses of variables to one standard deviation productivity shock are explained.

Figure 1 shows the effects of a positive productivity shock in home sector to supply of labor, consumption, investment, foreign investment, output and trade balance to output ratio. As it is specified in the calibration part A_t and B_t are independent of each other. That means if A_t is hit by a positive shock, B_t will not be affected. In this model, there is no shock on B_t, which means that B_t is deterministic in the economy.

When a positive productivity shock affects A_t, since one of the factors that specifies the output of home sector is A_t by the equation 1, Y_t^H will increase. This increase in domestic output will raise total output by the equation $Y_t = P_t^H Y_t^H + Y_t^E$. The impulse response graph of output shows this jump as a result of the positive supply shock. The output of home sector is used as either consumption or investment. Therefore, with an increase in home sector output, consumption increases. Because of the consumption smoothing motive, consumption increases less than output, and domestic investment increases as well . The positive productivity shock increases the marginal product of labor and leads firm to hire more labor, which can be seen in the first order condition with respect to labor demand of home sector, equation 3. The impulse response graph of labor supply shows this increase in the supply of labor. As stated above, investment consists of both domestic investment good and imported foreign investment good, as defined in equation 13. In order to increase investment as a result of the positive supply shock, the country needs to import foreign investment goods. The impulse response graph of foreign investment good shows the increase to benefit from the positive supply shock. As a result of the increase in both domestic investment good and foreign investment good, total investment also rises as seen in the graph.

The only variable that is negatively affected by a positive supply shock on domestic sector is the trade balance. As defined in equation 27, trade balance is the difference between export sector output, Y_t^E and imported foreign investment good, I_t^F. In the model, Y_t^E is not affected by a shock to A_t.On the other hand, as explained above, the amount of imported foreign investment good increases as a result of a positive productivity shock in the home sector. Therefore, the increase in I_t^F with no increase in Y_t^E results in a decrease in the trade balance. The impulse response graph shows the affect of a positive supply shock on trade balance to output ratio. Since the trade balance is negatively affected and output is positively affected, the ratio is negatively affected as a result of a positive productivity shock.

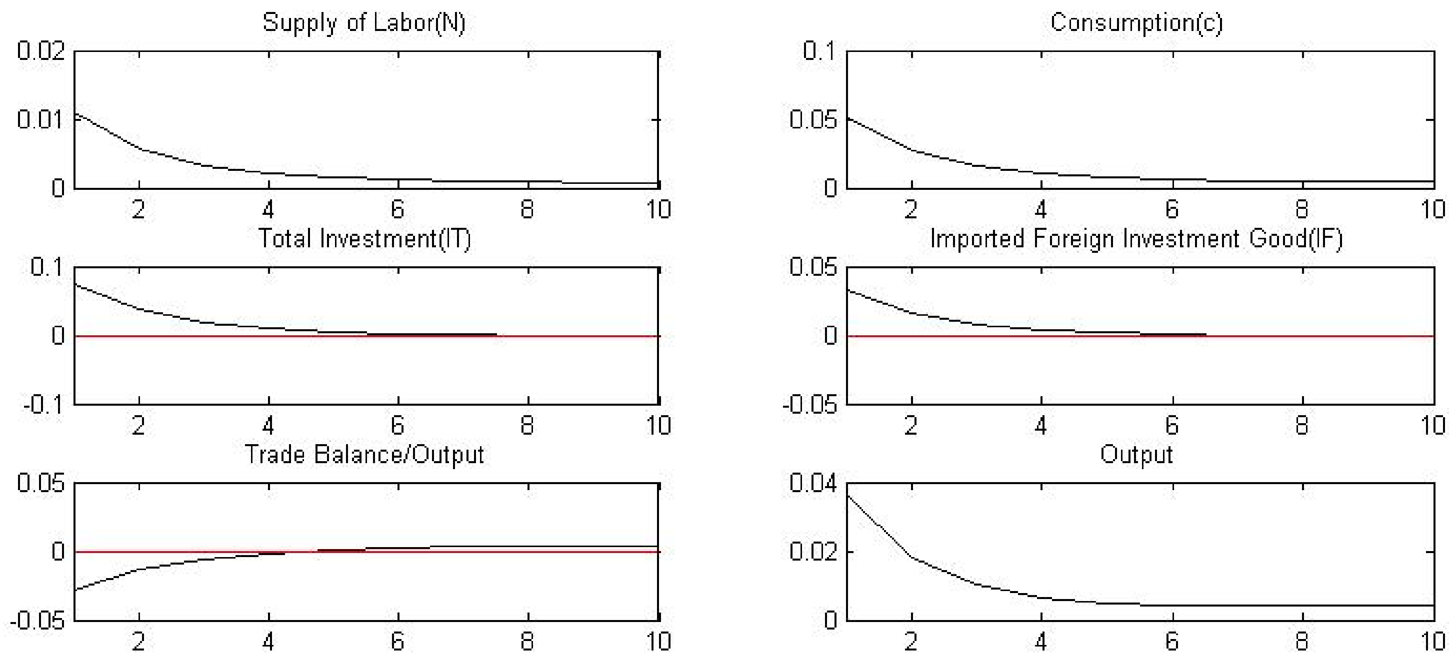

Figure 1: Impulse Response Function to Productivity Shock in the Home Sector

5 SENSITIVITY ANALYSIS

Sensitivity analysis is done by changing the values of σ, curvature utility function, and ω_H, share of domestic good in investment. As it is stated in the introduction part, foreign investment good constitutes the one third of total investments and in literature, for the curvature utility, generally two values are used: 2 and 5. Then, model is simulated by using a value of 0.66 for the share of domestic good investment and 5 for the utility curvature:

Table 4: Sensitivity analysis

		σ_y	$\frac{\sigma_c}{\sigma_y}$	$\frac{\sigma_I}{\sigma_y}$	$\sigma_{tb/y}$	$Corr(y, \frac{tb}{y})$
	Data	0,0326	1,1652	3,1320	0,021	-0,598
$\sigma = 2$	$\omega_H = 0.5$	0,0323	1,3978	2,1078	0,029	-0,979
$\sigma = 2$	$\omega_H = 0.66$	0,0487	0,8551	1,3104	0,017	-0,983
$\sigma = 5$	$\omega_H = 0.5$	0,0240	1,635	3,2769	0,034	-0,965

As it is seen in Table 4, when a value of 5 is used for utility curvature, better results are obtained for the volatility of investment which is approximately same as data. Besides, correlation coefficient between output and trade balance to output ratio is similar to benchmark model. However, other statistics deteriorate compared to the benchmark model.

On the other hand, increasing the value of the share of domestic investment good to 0.66 provides better results for the volatility of trade balance to output ratio, but for the remaining variables, it is worse than the benchmark model.

6 CONCLUSION

It is a well known fact that emerging economies have strongly countercyclical trade balances. This paper, following De Bock (2010), documents and analyzes the composition and cyclical properties of the trade balance in Turkey. A two sector small open economy model is used to quantitatively analyze the role of the import structure in driving the cyclical properties of the trade balance. The model is constructed on the idea that capital goods constitute a substantial fraction of total imports and their procyclical behavior is the major reason for the countercyclicality of the trade balance. The model uses an aggregate investment good, which is a composite of domestic and foreign investment goods. Therefore, investment in new capital requires capital good imports, as documented in the data. This structure enables the model to produce a countercyclical trade balance since an increase in productivity leads to higher investment, which leads to higher imports due to the capital good imports being necessary for investment. Hence, the trade balance contracts while output is expanding and vice versa.

In the paper, first, the business cycle properties of the Turkish economy are examined and it is shown that the Turkish data is consistent with the observations of De Bock (2010) about emerging market economies. Turkey has a strongly countercyclical trade balance, with the correlation coefficient between trade balance to output ratio and output being -0.598. This strong countercylicality is due to the countercyclicality of exports and procyclicality of imports: the correlation coefficient of exports and output is -0.36 and the correlation coefficient of imports and output is 0.495. Based on these observations, the small open economy model initially analyzed by De Bock (2010) has been solved using parameters calibrated to Turkish data. The model generates a strongly countercyclical trade balance, in accordance with the data. The cyclical properties of consumption, total investment and foreign investment good produced by the model are also consistent with the data.

Overall, the model analyzed in this paper successfully explains the countercyclicality of the trade balance, while also being consistent with the major business cycle properties of the Turkish economy. Therefore, this analysis shows that the structure of imports is an important factor that should be taken into account in analyzing the business cycle properties of Turkey, as well as other emerging market economies.

7 REFERENCES

[1] Aguiar, Mark, and Gita Gopinath, 2007. "Emerging market business cycles: the cycle is the trend," Journal of Political Economy, 115 (1), pp. 69-102.

[2] Backus, David K., Kehoe, Patrick J.and Kydland, Finn E., "International Borrowing and World Business Cycles," Federal Reserve Bank of Minneapolis, Research Department, Working Paper No. 426R, 1990.

[3] Correia, Isabel, Joao C. Neves, and Sergio Rebelo, 1995. "Business cycles in a small open economy," European Economic Review, 39 (6), pp. 1089-113.

[4] De Bock, Reinout, 2010. "The Composition and Cyclical Behavior of Trade Flows in Emerging Economies," IMF Working Paper No. 1046, February 2010.

[5] Eaton, Jonathan, and Samuel Kortum, 2001. "Trade in capital goods," European Economic Review, 45 (7), pp.1195-235.

[6] Engel, Charles and Jian Wang, 2007. "International trade in durable goods: understanding volatility, cyclicality, and elasticities," Journal of International Economics, 83(2011), pp. 37-52

[7] Gollin, Douglas. "Getting income shares right." Journal of Political Economy, April 2002, 110 (2), 458-474.

[8] Greenwood, Jeremy, Zvi Hercowitz, and Gregory W Huffman, 1988. "Investment, Capacity Utilization, and the Real Business Cycle," American Economic Review, 78 (3), pp. 402-17.

[9] Kydland, Finn E, and Edward C Prescott, 1982. "Time to Build and Aggregate Fluctuations," Econometrica 50 (6), pp. 1345-70.

[10] Mendoza, Enrique G., 1991. "Real Business Cycles in a Small Open Economy," American Economic Review, 81(4), pp. 797-818.

[11] Neumeyer, Pablo A, and Fabrizio Perri, 2005. "Business cycles in emerging economies: the role of interest rates," Journal of Monetary Economics, 52 (2), pp. 345-80.

[12] Obstfeld, Maurice, and Kenneth Rogoff. Foundations of International Macroeconomics. Cambridge, Mass. : MIT Press, 1996.

[13] Quintin, Ervan, and Felipe Meza, 2007. "Factor Utilization and the Real Impact of Financial Crises," The B.E. Journal of Macroeconomics, 7(1) (Advances), Article 33.

[14] Schmitt-Grohe, Stephanie, and Martin Uribe, 2003. “Closing small open economy models,” Journal of International Economics, 61 (1), pp. 163-85.

[15] Senhadji, Abdelhak. “Sources of economic growth: An extensive growth accounting exercise.” IMF Staff Papers, November 2000, 47 (1), 129-158.

[16] Tiryaki, S. Tolga. "Interest Rates and Real Business Cycles in Emerging Markets" TCMB Working Paper No. 1008, May 2010.

8 APPENDIX A

8.1 Capital Good

Eaton and Kortum (2001) identifies electrical machinery, nonelectrical machinery and instruments industries as equipment producers. And, they show that higher fraction of equipment producer industries' output is used for investment compared to other industries. Moreover, equipment producers provides nearly 80% of investment goods used by manufacturers. Another result is that about 80% of investment goods, which is used not only by manufacturers but anywhere, is produced by equipment producers and transportation equipment industries(equipment producers have nearly 60% share). In accordance with Eaton and Kortum (2001), category 7 of SITC Rev.3 data, which is machinery and transport equipment, is used as capital goods data. Subgroups of this category is as below:

- (71) Power generating machinery and equipment
- (72) Machinery specialized for particular industries
- (73) Metalworking machinery
- (74) General industrial machinery and equipment, n.e.s., and machine parts, n.e.s.
- (75) Office machines and automatic data-processing machines
- (76) Telecommunications and sound-recording and reproducing apparatus and equipment
- (77) Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof
- (78) Road vehicles(including air-cusion vehicles)
- (79) Other transport equipment

8.2 Data Sources

Data	Source
Consumption	Turkish Statistical Institute (TURKSTAT)
GDP	TURKSTAT
Investment	TURKSTAT
Exports	TURKSTAT
Imports	TURKSTAT
Capital good exports	TURKSTAT
Capital good imports	TURKSTAT
U.S. interest rate	IMF, International Financial Statistics
U.S. inflation rate	IMF, International Financial Statistics
EMBI	JP Morgan
Population	TURKSTAT
Employment	TURKSTAT
Hours worked	OECD, Central Bank of Turkey
Current account balance	Central Bank of Turkey

9 APPENDIX B

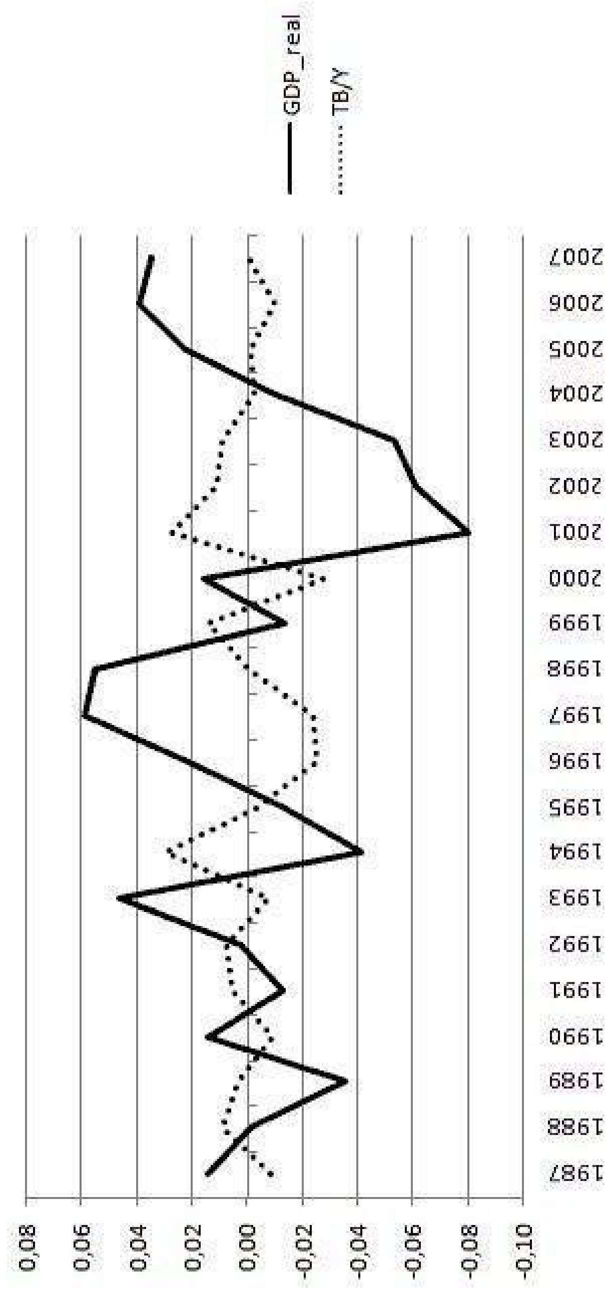

Figure 2: Trade Balance/GDP vs GDP for Turkey

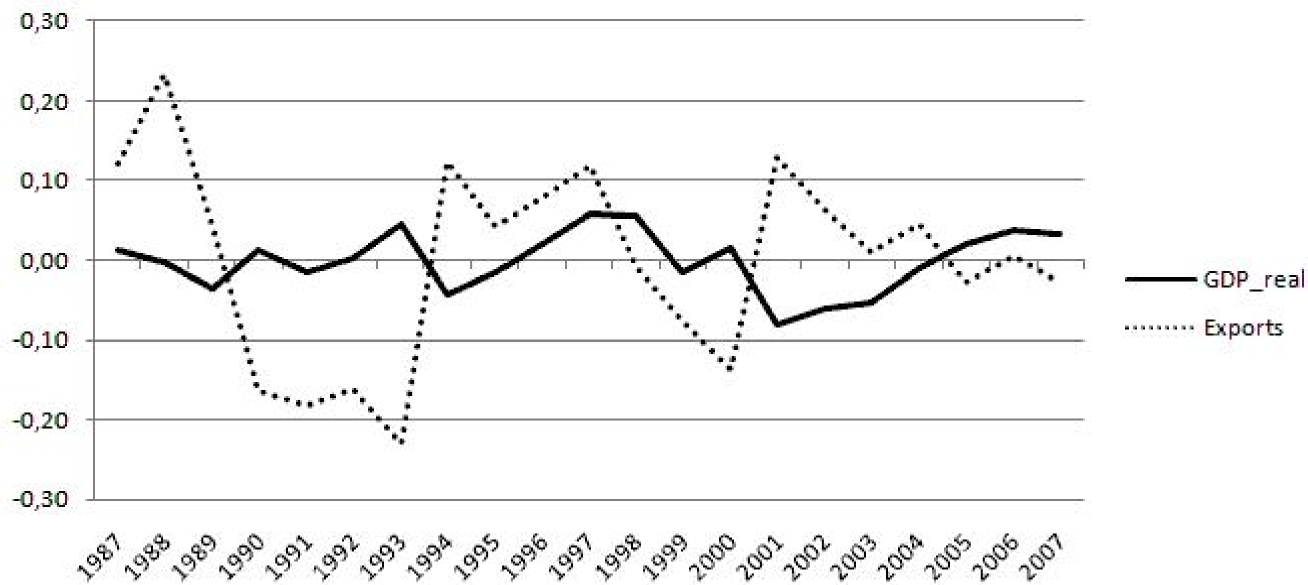

Figure 3: GDP vs exports for Turkey

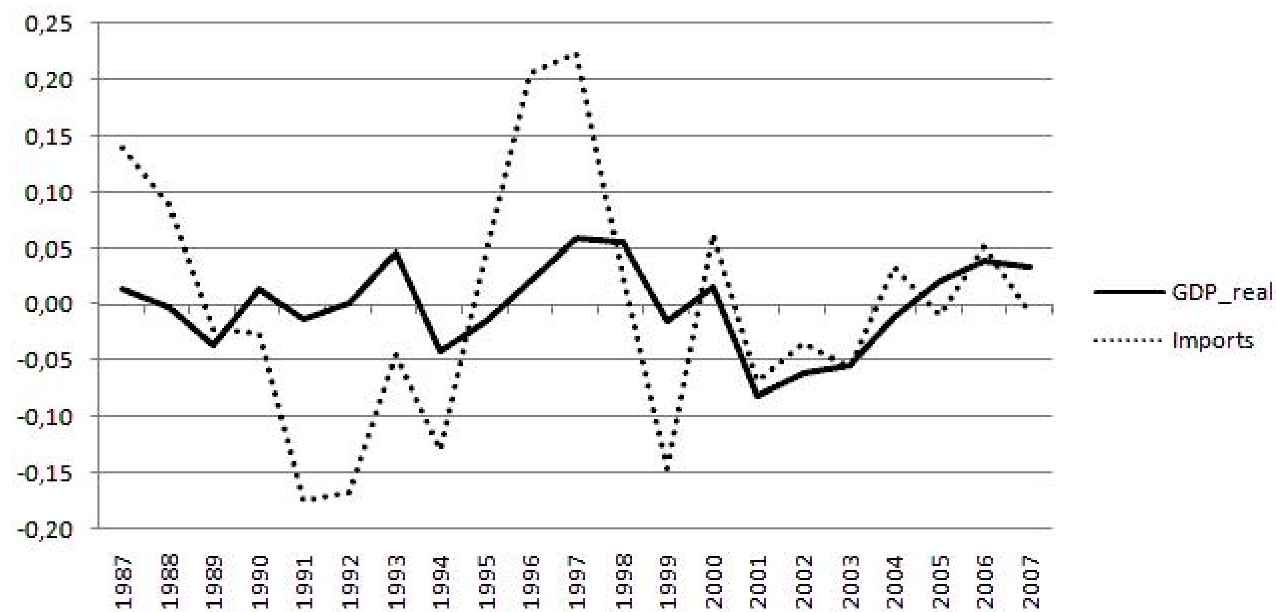

Figure 4: GDP vs imports for Turkey

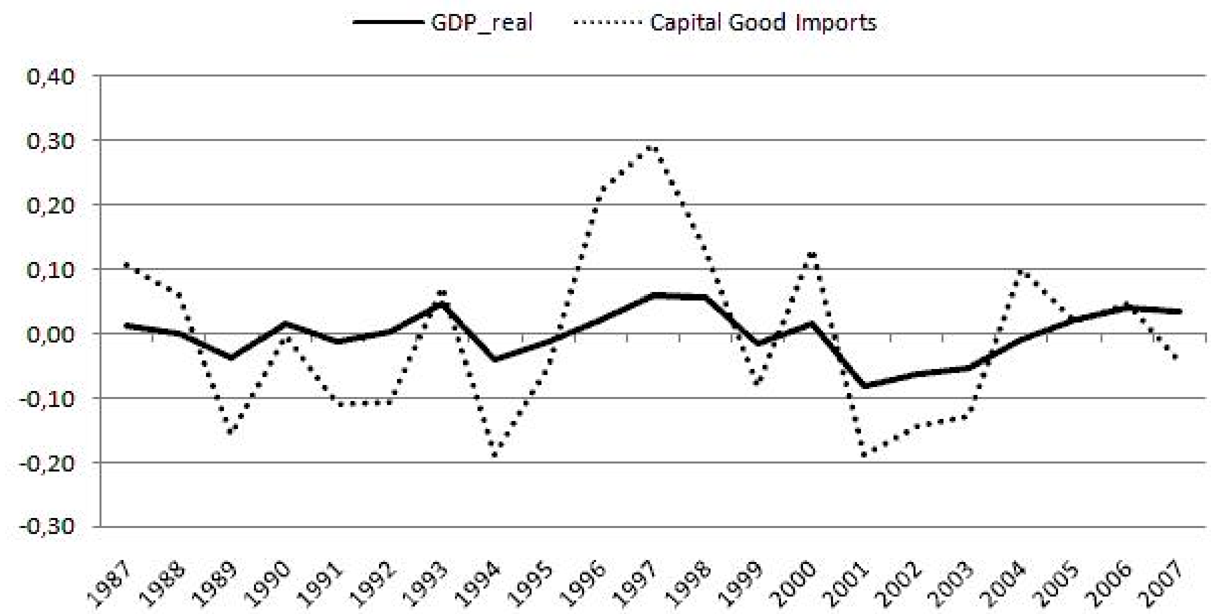

Figure 5: GDP vs capital good imports for Turkey

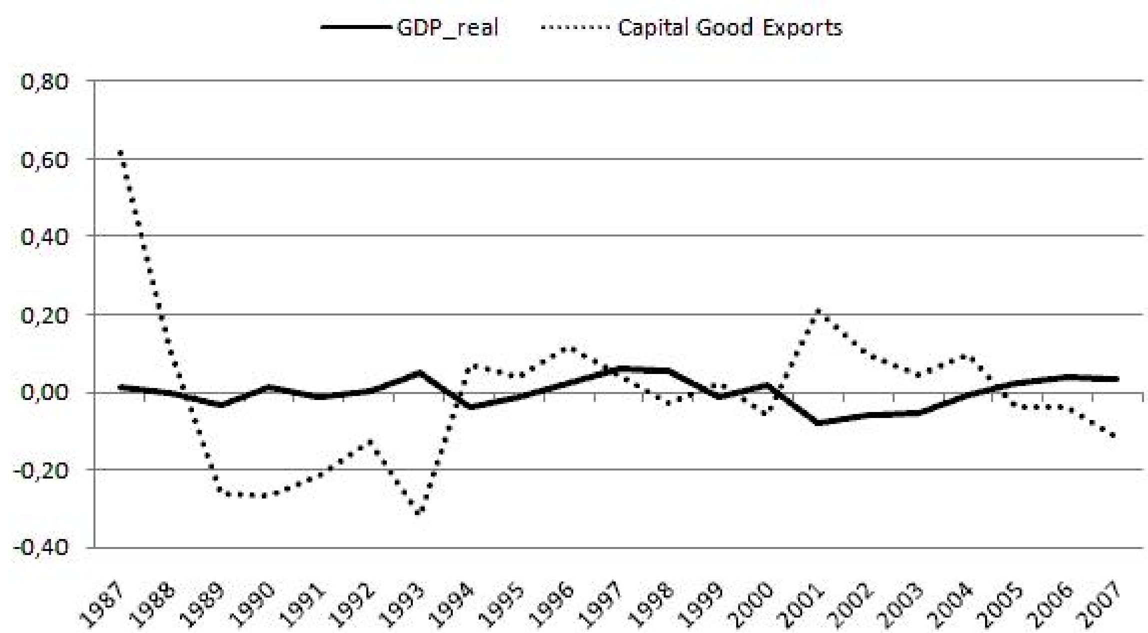

Figure 6: GDP vs capital good exports for Turkey

Table 5: Correlation results in De Bock (2010)

Corr(y,.)	tb/y	i^F	c	i
Data (Argentina)	-0,65	0,59	0,73	0,80
Model	-0,47	0,87	1	0,87

Note: Model statistics are averages over 100 simulations of 200 periods. Series are detrended with the HP-filter.

Table 6: Actual and simulated business cycle moments results in De Bock (2010)

Reported as %	σ_y	$\frac{\sigma c}{\sigma_y}$	$\frac{\sigma i}{\sigma_y}$	$\frac{\sigma i^f}{\sigma_y}$	σ_n	$\sigma_{tb/y}$
Data (Argentina)	2,67	1,92	3,91	6,40	2,99	1,92
Model	2,70	0,71	3,52	3,50	2,94	1,23

Note: Model statistics are averages over 100 simulations of 200 periods. Series are detrended with the HP-filter.