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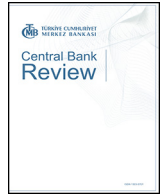
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Imported inputs and the countercyclicality of net exports in emerging markets

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ABSTRACT

This paper shows that the strong countercyclicality of net exports observed in emerging market economies can be explained to a large extent by the use of imported inputs in production. We build a single-sector small open economy business cycle model featuring imported inputs and variable capital utilization in production, and a working capital constraint. The model yields countercyclical net exports and realistic business cycle dynamics. The magnitude of the countercyclicality of net exports increases with the share of imported inputs. The elasticity of substitution between domestic and imported inputs is also critical in obtaining this result. The model also attributes an important role to import prices in matching the business cycle facts in emerging markets.

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1. Introduction

Recent small open economy real business cycle models have been tackling the issue of relatively stronger countercyclicality of net exports in emerging market economies compared to mildly countercyclical or even acyclical net exports in developed small open economies. These studies document the differences between emerging market business cycles and developed economy business cycles, among which higher consumption volatility and countercyclical net exports and real interest rates in emerging market economies are the most emphasized ones.¹

Neumeyer and Perri (2005) obtain countercyclical net exports using a small open economy business cycle model of calibrated to match Argentine data. The essential ingredient of the model is feedback from expected productivity to current real interest rate, which is specified as a negative linear relationship between the two variables. This new channel introduces an extra source of amplification through which the saving-investment differential becomes significantly more sensitive to productivity shocks, resulting in countercyclical net exports. The same model also yields countercyclical net exports when calibrated to match Turkish data in

Tiryaki (2011). However, Tiryaki (2011) shows that the countercyclicality depends on the magnitude of the working capital parameter, the persistence of productivity shocks, and the factor shares. He also finds that the correlation structure between shocks affects the countercyclicality of the real interest rate and net exports.

Another important contribution comes from Aguiar and Gopinath (2007) who explain the causes of differences between business cycle properties in developing and developed economies. They find that permanent shocks dominate transitory shocks in developing economies in contrast to what is observed in more developed economies. In consequence, they attribute the two distinct properties of emerging market economies—consumption volatility greater than output volatility and strongly countercyclical net exports in emerging market economies—to their finding that permanent shocks dominate transitory shocks in those economies.

Raffo (2008), on the other hand, analyzes the countercyclicality of net exports in a two-country international real business cycle model along the lines of Backus et al. (1994, 1995). He argues that the Backus-Kehoe-Kydland model delivers countercyclical net exports as a result of large terms of trade effects—which is at odds with the observed behaviour of the terms of trade. He introduces GHH utility, due to Greenwood et al. (1988), and also capital adjustment costs to the Backus-Kehoe-Kydland model in order to increase the volatility of domestic absorption through higher consumption volatility without creating counterfactual investment volatility. His model, then, is able to produce countercyclical net

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¹ See Correia et al. (1995), Aguiar and Gopinath (2007), Neumeyer and Perri (2005), Raffo (2008), Boileau and Normandin (2008), Garcia-Cicco et al. (2006), Garcia-Cicco (2008), and Köse (2002) among others.

exports in real terms with much weaker terms of trade effects.

Our main hypothesis in this paper is that imports of intermediate goods cause countercyclical net exports; and the higher the share of imported inputs in the final good, the stronger is the magnitude of countercyclicity. This hypothesis is based on the observation that small open economies rely to a greater extent on imported inputs. We consider a production technology in which imported inputs have a non-trivial share. For such an economy, the larger the share of imported inputs in the final good, the stronger is the response of demand for imported inputs to changes in relative prices or productivity in domestic production. The degree of substitutability between imported and domestic inputs is another critical variable for the dynamics of net exports.

We build a small open economy business cycle model featuring imported inputs, capital adjustment costs, and GHH utility, among other necessary ingredients to replicate business cycle dynamics at a reasonably realistic degree. We run the model over a wide range of parameter values in order to examine the model's implications for the countercyclicity of net exports. The model is able to provide support for our hypothesis that the countercyclicity of net exports depends on the relative share of imported inputs in the final good, as well as the elasticity of substitution between domestic and imported inputs. We show that the correlation between net exports and GDP becomes smaller as the share of imported inputs rise within a range, the width of which is the larger, the weaker is the substitutability between domestic and imported inputs.

The model's performance in terms of matching other business cycle properties is satisfactory. Both impulse responses and model-implied theoretical moments amply demonstrate that the elasticity of substitution between domestic and imported inputs acts as an amplifier of the effect of shocks on the economy.

The organization of this paper is as follows. In the next section, we provide evidence of an association between the countercyclicity of net exports and the intensity of imported inputs use in production. In the third section, we develop a small open economy real business cycle model to account for the reported business cycle statistics. Section 4 reports the quantitative findings of the paper and shows how the predicted countercyclicity of net exports changes with the intensity and substitutability of imported. Finally, Section 5 concludes the paper.

2. Descriptive statistics

Globalization of the world economy manifests itself not only by increased international trade of final goods and services but also by means of increased integration of the production processes across borders. De Backer and Yamano (2007) show evidence for a sample of 28 OECD countries and 10 non-OECD countries that the use of imported intermediate goods have increased relative to domestic intermediate goods from mid-1990s to early 2000s. Their data also indicate that smaller countries have a greater tendency to import inputs in contrast to larger countries.

Table 1 presents some evidence for our hypothesis that imports of intermediate goods in emerging market economies are an important factor in producing countercyclical net exports. Selection of countries used in the table is based on Aguiar and Gopinath (2007). On average emerging market economies have greater imported intermediate goods to GDP ratio compared to developed small open economies. Also, on average net exports are more strongly countercyclical in emerging market economies. Despite the fact that the ratio of imported goods to GDP is far from being uniform within country groups, there exists a negative correlation of -0.22 between the share of imported inputs in GDP (second column) and cyclicity of net exports (third column). There is also

variation between the two groups of countries. Fig. 1 presents the relationship between the share of intermediate goods imports and the countercyclicity of net exports in emerging market economies and also in developed economies. Notice that the slope of the simple regression line of the scattered points is negative in the emerging markets panel, while positive in the latter group. This lends support to our hypothesis that the countercyclicity of net exports is increasing in the share of imported inputs in the final good in emerging market economies.

Another striking feature documented in this study is that net exports (as a ratio of GDP) excluding imports of intermediate goods (henceforth, nxy^*) behave differently from aggregate net exports (henceforth, nxy). The use of imported inputs in the production of the final good naturally implies a positive correlation between intermediate goods imports and output. Thus, there is a direct linkage from imports of intermediate goods to the countercyclicity of net exports. Consequently, the cyclical properties of the adjusted net exports variable nxy_t^* are somewhat different from those of the unadjusted net exports variable nxy_t . Taking Turkey's business cycle statistics as an example, the first difference is that nxy_t^* is considerably less countercyclical than nxy_t . The coefficient of correlation between GDP and nxy in Turkey is -0.41 , whereas the same correlation is -0.17 with nxy_t^* . Second, the correlation between the price of imported inputs and nxy_t^* is stronger than the correlation with nxy_t . Similarly, the correlation between the interest rate spread and nxy_t^* is stronger than with nxy_t .

3. The model

3.1. Overview

The model is a one-sector small open economy real business cycle model in which the representative firm produces an internationally traded final good using labour, capital services, and imported inputs. The firm is subject to a working capital constraint, so it needs to borrow a fraction of the production cost from the international financial market by issuing a one-period bond that pays the same rate of interest in all states of the world. Capital services are provided by adjusting the utilization of the capital stock, which is subject to depreciation as a function of utilization.

These main features of the model capture the main characteristics of the production structure in many small open economies. One of the main issues with small open economy real business cycle models is that Solow residuals as a proxy for productivity can be a misleading proxy. King and Rebelo (1999), Meza and Quintin (2007), and Gertler et al. (2007) show that capital utilization and labour hoarding can also contaminate the Solow residual. King and Rebelo (1999) and Letendre (2004) document that variable capacity utilization enhances the amplification of the standard real business cycle model. Turkey's business cycle statistics also indicate high correlation between Solow residuals and capacity utilization, imports of intermediate goods, and the country-specific real interest rate spreads. In light of the discussions above, we conclude that the use of imported inputs in production, variable capital utilization in the supply of capital services, and interest rate disturbances should be present in a model which aims to examine business cycles in emerging market economies.

The preferences of the infinitely-lived representative household are defined over the expected utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma} (C_t - \psi \Gamma_t l_t^\nu)^{1-\sigma}, \quad (1)$$

where C_t denotes consumption, l_t denotes hours worked, and Γ_t is

Table 1
Imports of intermediate goods and countercyclicity of net exports.

	Imports of intermediate goods/GDP	Correlation between Net Exports/GDP and GDP
Argentina	7.02	− 0.70
Brazil	6.95	0.01
Ecuador	13.46	− 0.79
Israel	22.74	0.12
Korea	23.92	− 0.61
Malaysia	65.40	− 0.74
Mexico	19.69	− 0.74
Peru	9.20	− 0.24
Philippines	41.81	− 0.41
Slovak Republic	47.72	− 0.44
South Africa	13.22	− 0.54
Thailand	42.83	− 0.83
Turkey	18.83	− 0.69
Average	25.60	− 0.51
Median	19.69	− 0.61
Australia	7.86	− 0.43
Austria	22.33	0.10
Belgium	47.88	− 0.04
Canada	16.82	− 0.20
Denmark	13.88	− 0.08
Finland	16.73	− 0.45
Netherlands	31.21	− 0.19
New Zealand	11.20	− 0.26
Norway	9.39	0.11
Portugal	18.61	− 0.11
Spain	14.27	− 0.60
Sweden	16.36	0.01
Switzerland	16.66	− 0.03
Average	18.71	− 0.17
Median	16.66	− 0.11

Note: The first column shows the value of intermediate goods imports as a percentage of GDP in current prices. Data for imports is compiled from United Nations Commodity Trade Statistics Database, and data for GDP is from World Bank's World Development Indicators Database. Sample period is 2000–2006. The second column shows the correlation between net exports to GDP ratio and GDP reported in Aguiar and Gopinath (2007).

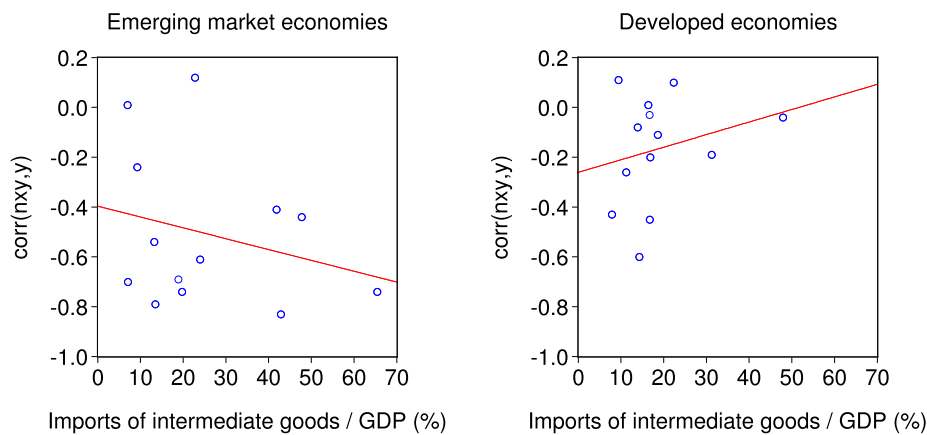


Fig. 1. Share of intermediate goods imports and countercyclicity of net exports.

the deterministic labour-augmenting technical progress defined as $\Gamma_t = \gamma^t$. The parameter β is the subjective discount factor, and the rate of technical progress γ is expressed in gross terms with $\gamma > 1$. The parameter σ is the inverse of the elasticity of intertemporal substitution, ν is a parameter governing the wage elasticity of labour supply, and ψ is a scaling parameter.

The representative household earns wage income and also receives dividend payments Π_t from the firm. The household spends this income on consumption and lump-sum taxes T_t . It can also borrow from international bond markets in order to smooth consumption intertemporally. Thus, the representative household's budget constraint is described as

$$C_t + r_{t-1}D_{t-1} + G_t \leq W_t l_t + \Pi_t + D_t \quad (2)$$

where D_t represents the amount of borrowing by bonds, r_t is the gross interest rate on bonds, and W_t is the wage rate per hour. Government levies lump-sum taxes T_t to finance its expenditure G_t , and runs a balanced budget at all times so that $G_t = T_t$.

The final good is produced in two stages. In the first stage, the representative firm produces a domestic intermediate good Y_t^d using labour and capital services. This process also involves stochastically-driven total factor productivity a_t . The first stage of production is represented by the following constant-returns-to-scale Cobb-Douglas production function:

$$Y_t^d = a_t (u_t K_{t-1})^\alpha (\Gamma_t l_t)^{1-\alpha} \quad (3)$$

where u_t represents the rate of capital utilization, and α is the capital's share parameter with $0 < \alpha < 1$.

In the second stage of production, the representative firm combines the domestically produced intermediate good Y_t^d with imported inputs Z_t to produce the final good Y_t , by a constant-elasticity-of-substitution production technology

$$Y_t = \left[\chi^{1/\omega} (Y_t^d)^{(\omega-1)/\omega} + (1-\chi)^{1/\omega} (Z_t)^{(\omega-1)/\omega} \right]^{\omega/(\omega-1)} \quad (4)$$

where ω denotes the elasticity of substitution between domestic and imported intermediate goods, and χ is a share parameter.

The representative firm hires labour services from the household, invests I_t in physical capital to supply capital services, and imports intermediate goods from the rest of the world; then, distributes the profit Π_t to the household, the owner of the firm. The operation of the firm necessitates that the firm must pay a fraction θ of the factor costs upfront because of the working capital requirement. These factor costs consist of the wage bill $W_t l_t$, capital utilization/maintenance costs $\delta_t K_{t-1}$, and imports bill $p_t^z Z_t$. The only way the firm can maintain the required working capital is borrowing from the international bond market at the beginning of each period. These bonds expire at the end of the period and are paid out by the firm from its earnings. Therefore, the period profit function of the firm is

$$\Pi_t = Y_t - W_t l_t - I_t - p_t^z Z_t - \theta(r_{t-1} - 1)(W_t l_t + \delta_t K_{t-1} + p_t^z Z_t). \quad (5)$$

Capital evolves according to

$$K_t = I_t + (1 - \delta_t)K_{t-1} - \Phi(\varphi, \gamma, K_t, K_{t-1}) \quad (6)$$

where $\Phi(\cdot)$ represents the capital adjustment cost with

$$\Phi(\varphi, \gamma, K_t, K_{t-1}) = \frac{\varphi}{2} K_{t-1} \left(\frac{K_t}{K_{t-1}} - \gamma \right)^2, \quad (7)$$

and δ_t is the time-varying depreciation rate defined as

$$\delta_t = \frac{h}{1 + \zeta} u_t^{1+\zeta}. \quad (8)$$

The maximization problem of the firm is written as

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{U_{C,t}}{U_{C,0}} \Pi_t. \quad (9)$$

in the formulation of the firm's problem, we use the household's marginal utility of consumption $U_{C,t} = (C_t - \psi \Gamma_t l_t^\nu)^{-\sigma}$ so that the stochastic discount factor of the firm is equal to that of the household. This is to ensure that the firm maximizes its value in an appropriate metric by taking the welfare of its owner into account.

The aggregate resource constraint of the economy is obtained by substituting Π_t into the household's budget constraint and rearranging

$$Y_t = C_t + I_t + G_t + p_t^z Z_t + r_{t-1} D_{t-1} - D_t + \theta(r_{t-1} - 1)(W_t l_t + \delta_t K_{t-1} + p_t^z Z_t). \quad (10)$$

here, the sum of the last three terms $r_{t-1} D_{t-1} - D_t + \theta(r_{t-1} - 1)(W_t l_t + \delta_t K_{t-1} + p_t^z Z_t)$ or, equivalently, income less absorption, which includes the interest payments,

represents the current account; and net exports nxy_t is defined as $-(D_t - D_{t-1})$. This definition of net exports naturally includes the imports of the intermediate good. To contrast this, net exports excluding imported inputs, that is, $p_t^z Z_t - (D_t - D_{t-1})$, is named as adjusted net exports, nxy_t^* . For the rest of the analysis, we use the net exports and adjusted net exports as a ratio of gross domestic product by defining $nxy_t = -(D_t - D_{t-1})/Y_t$, and $nxy_t^* = p_t^z Z_t/Y_t - (D_t - D_{t-1})/Y_t$.

The model's steady state is characterized by a balanced growth path because of the presence of non-stationary labour-augmenting technical progress Γ_t . Therefore, all trending variables are divided by Γ_t to obtain their stationary components, and denote them by lowercase letters. Note that, because of our preference of the timing convention in which stock variables indicate end-of-period levels with $t-1$ time subscripts, stock variables with $t-1$ time subscripts are divided by Γ_t as well. So, we define

$$c_t = \frac{C_t}{\Gamma_t}, \quad g_t = \frac{G_t}{\Gamma_t}, \quad w_t = \frac{W_t}{\Gamma_t}, \quad \pi_t = \frac{\Pi_t}{\Gamma_t}, \quad y_t = \frac{Y_t}{\Gamma_t}, \quad y_t^d = \frac{Y_t^d}{\Gamma_t}, \quad z_t = \frac{Z_t}{\Gamma_t}, \quad i_t = \frac{I_t}{\Gamma_t},$$

and

$$d_{t-1} = \frac{D_{t-1}}{\Gamma_t}, \quad k_{t-1} = \frac{K_{t-1}}{\Gamma_t}.$$

The transformed discount factor $\tilde{\beta}$ and the Lagrangean multiplier $\tilde{\lambda}$ become $\tilde{\beta} \equiv \beta \gamma^{1-\sigma}$ and $\tilde{\lambda}_t \equiv \lambda_t \Gamma_t^\sigma$, respectively.

3.2. Optimal allocations

First order conditions for the representative household's stationary Lagrangean with respect to consumption, hours worked, and borrowing, respectively, are

$$\tilde{\lambda}_t = (c_t - \psi l_t^\nu)^{-\sigma} \quad (11)$$

$$\tilde{\lambda}_t w_t = (c_t - \psi l_t^\nu)^{-\sigma} \psi \nu l_t^{\nu-1} \quad (12)$$

$$\gamma = \tilde{\beta} E_t \left[\left(\frac{\tilde{\lambda}_{t+1}}{\tilde{\lambda}_t} \right) r_t \right]. \quad (13)$$

they must also satisfy the budget constraint

$$c_t + r_{t-1} d_{t-1} + g_t = w_t l_t + \pi_t + \gamma d_t. \quad (14)$$

First order conditions for the representative firm's stationary maximization problem with respect to labour hours, capital utilization, imported inputs, and capital, respectively, are

$$(1-\alpha)\chi^{1/\omega} \left(\frac{y_t^d}{y_t} \right)^{(\omega-1)/\omega} = \left(\frac{w_t l_t}{y_t} \right) [1 + \theta(r_{t-1} - 1)] \quad (15)$$

$$\alpha\chi^{1/\omega} \left(\frac{y_t^d}{y_t} \right)^{(\omega-1)/\omega} = h \left(\frac{k_{t-1}}{y_t} \right) u_t^{1+\zeta} [1 + \theta(r_{t-1} - 1)] \quad (16)$$

$$(1-\chi)^{1/\omega} = p_t^z \left(\frac{z_t}{y_t} \right)^{1/\omega} [1 + \theta(r_{t-1} - 1)] \quad (17)$$

$$\gamma + \varphi\gamma^2 \left(\frac{k_t}{k_{t-1}} - 1 \right) = \tilde{\beta} E_t \left\{ \left(\frac{\tilde{\lambda}_{t+1}}{\tilde{\lambda}_t} \right) \left[\frac{\alpha \chi^{1/\omega} y_{t+1}^{1/\omega} (y_{t+1}^d)^{(\omega-1)/\omega}}{k_t} + 1 - \delta_{t+1} \left[1 + \theta(r_t - 1) \right] + \frac{\varphi\gamma^2}{2} \left(\frac{k_{t+1}^2}{k_t^2} - 1 \right) \right] \right\} \quad (18)$$

3.3. Exogenous processes

The interest rate is composed of a world interest rate component r_t^* and a country-specific spread $sprd_t$ over the world rate. The world interest rate is purely exogenous to our small open economy. The country spread component, on the other hand, depends on the ratio of the indebtedness and an independent process s_t reflecting other factors not specific to our economy. The debt-elastic interest rate specification is used by many recent small open economy business cycle models, see [Schmitt-Grohé and Uribe \(2003\)](#). Hence, the postulated functional form of the interest rate is

$$r_t = r_t^* sprd_t \quad (19)$$

where

$$sprd_t = \exp[(d_t - d) - (y_t - y)]^k s_t. \quad (20)$$

There are five independent stochastic processes driving the dynamics of the model: total factor productivity, government expenditure, relative price of imported inputs, world interest rate, and country spread over world interest rate, which evolve according to the following first-order autoregressive processes

$$\log a_t = (1 - \rho_a) \log a + \rho_a \log a_{t-1} + \varepsilon_t^a, \quad (21)$$

$$\log g_t = (1 - \rho_g) \log g + \rho_g \log g_{t-1} + \varepsilon_t^g, \quad (22)$$

$$\log p_t^z = (1 - \rho_p) \log p^z + \rho_p \log p_{t-1}^z + \varepsilon_t^p, \quad (23)$$

$$r_t^* = (1 - \rho_r) r^* + \rho_r r_{t-1}^* + \varepsilon_t^r, \quad (24)$$

$$s_t = (1 - \rho_s) s + \rho_s s_{t-1} + \varepsilon_t^s, \quad (25)$$

where the autoregressive parameters $\rho_a, \rho_g, \rho_p, \rho_r,$ and ρ_s all lie between zero and one. The innovations $\varepsilon_t^a, \varepsilon_t^g, \varepsilon_t^p, \varepsilon_t^r,$ and ε_t^s are serially and mutually uncorrelated, independently and normally distributed with zero means and standard deviations $\sigma_a, \sigma_g, \sigma_p, \sigma_r,$ and σ_s .

3.4. Calibration

Steady state equilibrium conditions are obtained by substituting all time-indexed variables in optimality conditions (11)–(18) and other equations of the model with their steady state values.

The model is calibrated so that the solution to the system of steady state equations characterize the long-term features of the Turkish economy. The baseline parameterization is carried out using data between 1987Q1 and 2007Q3. The parameter values are summarized in [Table 2](#).

Following the common practice in business cycle models, e.g., [Neumeyer and Perri \(2005\)](#) and [Letendre \(2004\)](#), the rate of labour-augmenting technical progress γ is set to the average growth rate of per capita GDP.

For the *ex ante* world real interest rate, we use the London Interbank Offer Rate (LIBOR)² on 3-month US dollar deposits deflated by the expected US inflation $\hat{\lambda}_t$. The price index is the quarterly US GDP deflator, and inflation is calculated as the percentage change between period t and $t - 4$. Expected inflation is the fitted values in the regression of inflation on its lagged values up to and including 9 quarters, with the lag-length is determined by a general-to-specific strategy. The estimated parameters and t-statistics (in parentheses) are as follows:

$$\begin{aligned} \hat{\lambda}_t = & 1.52 \hat{\lambda}_{t-1} - 0.43 \hat{\lambda}_{t-2} + 0.08 \hat{\lambda}_{t-3} - 0.68 \hat{\lambda}_{t-4} + 0.70 \hat{\lambda}_{t-5} \\ & - 0.11 \hat{\lambda}_{t-6} - 0.01 \hat{\lambda}_{t-7} - 0.35 \hat{\lambda}_{t-8} + 0.27 \hat{\lambda}_{t-9} + 0.02. \\ & (21.16) \quad (-3.27) \quad (0.59) \quad (-5.06) \quad (5.24) \\ & (-0.86) \quad (-0.11) \quad (-2.75) \quad (3.92) \quad (1.54) \end{aligned} \quad (26)$$

The average quarterly world real interest rate in the calibration sample is 0.6275 percent.

For the country spread (risk premium), s_t , component of the interest rate, we use the spreads produced by JP Morgan's Emerging Market Bond Index (EMBIG) for Turkey. This series indicates an average spread of 1.2403 percent per quarter, making the average quarterly real interest rate 1.8756 percent.

After observing the average rate of technical progress and real interest rate, the discount factor β is set to satisfy $\gamma = \tilde{\beta}r$ and $\tilde{\beta} = \beta\gamma^{1-\sigma}$.

The steady state value of hours worked l is average number of hours worked per worker per day in manufacturing industry, normalized by total time endowment, that is, 24 hours. Following [Neumeyer and Perri \(2005\)](#),³ we set the labour's curvature parameter ν in the utility function as $\nu = 1.6$. This value implies a wage elasticity of labour supply equal to $1/(\nu - 1) = 1.67$. Given the steady state values of the wage rate w and hours worked l , the scaling parameter ψ is calibrated from the steady state labour supply equation $w = \psi\nu^{p-1}$.

We set the elasticity of capital depreciation with respect to utilization, ζ , and the parameter determining the level of depreciation given utilization rate, h , so that steady state rate of depreciation is $\delta = 0.025$ per quarter, and steady state rate of utilization is $u = 0.77$.

We solve for the steady state depreciation rate δ , using $\gamma = \tilde{\beta}r$, steady state versions of the firm's optimality conditions with respect to capital and capital utilization, and the equation relating capital utilization to depreciation, which yields

$$\delta = \frac{r - 1}{[1 + \theta(r - 1)]\zeta}. \quad (27)$$

We use the first order conditions in steady state for labour demand and capital utilization and solve for the steady state level of capital

$$k = \frac{\alpha w l}{(1 - \alpha)(1 + \zeta)\delta}, \quad (28)$$

from which we can calculate investment as

$$i = (\gamma - 1 + \delta)k. \quad (29)$$

² The choice of LIBOR as the representative world interest rate is appropriate because syndicated loans to Turkish banks are almost always expressed as LIBOR plus a spread.

³ [Neumeyer and Perri \(2005\)](#) take the intermediate value between the value of 1.5 used by [Mendoza \(1991\)](#) and the value of 1.7 used by [Correia et al. \(1995\)](#). They also note that $\nu = 1.6$ is consistent with micro studies for the United States and Canada.

Table 2
Parameter values.

Model 1 ($\omega = 2$)				Model 2 ($\omega = 0.5$)			
α	0.45	ν	1.6	α	0.45	ν	1.6
β	0.9859	θ	0.40	β	0.9859	θ	0.40
γ	1.022	h	0.0688	γ	1.022	h	0.0688
σ	2	ζ	0.7446	σ	2	ζ	0.7446
ω	2	κ	0.00075	ω	0.5	κ	0.00075
χ	0.8595	φ	1.7847	χ	0.8595	φ	2.4558
ψ	1288			ψ	1354		
ρ_a	0.9398	$\sigma_{a,g}$	0.0008	ρ_a	0.8752	$\sigma_{a,g}$	0.0007
ρ_g	0.8277	$\sigma_{a,p}$	0.0013	ρ_g	0.8277	$\sigma_{a,p}$	0.0010
ρ_p	0.8102	$\sigma_{a,r}$	0	ρ_p	0.8102	$\sigma_{a,r}$	0
ρ_r	0.9637	$\sigma_{a,s}$	0	ρ_r	0.9637	$\sigma_{a,s}$	0
ρ_s	0.8562	$\sigma_{g,p}$	0	ρ_s	0.8562	$\sigma_{g,p}$	0
σ_a	0.0325	$\sigma_{g,r}$	0	σ_a	0.0291	$\sigma_{g,r}$	0
σ_g	0.0807	$\sigma_{g,s}$	0	σ_g	0.0807	$\sigma_{g,s}$	0
σ_p	0.1083	$\sigma_{p,r}$	0	σ_p	0.1083	$\sigma_{p,r}$	0
σ_r	0.0012	$\sigma_{p,s}$	0.0001	σ_r	0.0012	$\sigma_{p,s}$	0.0001
σ_s	0.0025	$\sigma_{r,s}$	0	σ_s	0.0025	$\sigma_{r,s}$	0

Using the first order conditions in steady state for capital utilization and for imported input demand together with the CES production function, and rearranging obtains the steady state level of output

$$y = (1 + \zeta)\delta k[1 + \theta(r - 1)] \left[\alpha - \frac{\alpha(1 - \chi)}{(p^z)^{\omega-1}[1 + \theta(r - 1)]^{\omega-1}} \right]^{-1} \quad (30)$$

and then y^d and z . The Cobb-Douglas domestic intermediate good production function yields the steady state total factor productivity level a .

The elasticity of substitution between domestic and imported inputs is set at $\omega = 2$, which is also used by [Kehoe and Ruhl \(2009\)](#). [Ruhl \(2008\)](#) discusses in detail the value of this elasticity being set relatively large in computable general equilibrium models of trade policy, and relatively small in dynamic general equilibrium models. The value of $\omega = 2$ implies greater substitutability than the unitary-elastic standard Cobb-Douglas function. We also provide a sensitivity analysis based on different values of the elasticity ranging from $\omega = 2$ (high substitutability) to $\omega = 0.5$ (low substitutability) in the forthcoming section.

The ratio of debt to quarterly GDP at steady state is 1.46. This figure comes from the database by [Lane and Milesi-Ferretti \(2006\)](#), and is used to calculate the steady state level of debt. Similarly, the steady state level of government expenditure is obtained by observing the government expenditure to GDP ratio (9 percent) and multiplying it by the steady state level of y . Steady state consumption follows from the budget constraint of the household.

As in [Tiryaki \(2011\)](#), we set the working capital constraint parameter θ to 0.4. This value of θ makes the working capital roughly 34 percent of GDP. In contrast with [Neumeyer and Perri \(2005\)](#), who assume $\theta = 1$, [Mendoza \(2006\)](#) also assigns a smaller value of $\theta = 0.25$, which corresponds to 19 percent of GDP in steady state.

Equations 21–25 characterize the driving processes of the model economy. These equations are estimated independently to obtain first order autoregressive coefficients and the variance-covariance matrix of the shocks.

Total factor productivity series is constructed as a residual from the domestic intermediate good production function. For this, quarterly capital stock series is constructed using the investment and capacity utilization series, as well as model parameters.

Utilization series comes from the Business Tendency Survey of the manufacturing industry, so it is only an approximation to the model-defined capital utilization. Capital depreciation series is constructed from $\delta_t = (h/(1 + \zeta))u_t^{1+\zeta}$. The evolution of the capital stock is written as

$$\gamma k_t = i_t + (1 - \delta_t)k_{t-1} - \frac{\varphi\gamma^2}{2}k_{t-1} \left(\frac{k_t}{k_{t-1}} - 1 \right)^2. \quad (31)$$

The capital adjustment cost term complicates expressing k_t in terms of other variables. There are two roots for this polynomial; however, we use the greater root, which yields stationary capital stock series, to construct Solow residuals.

We create the detrended domestic intermediate input y_t^d using the detrended version of equation (4), parameters γ , χ , and ω , and observing the variables y_t and z_t , which are detrended by the deterministic common trend, γ^t , of the economy. After that, we use the log of the Cobb-Douglas domestic input production function and the calculated or observed time series for y_t^d , u_t , $k_{1,t}$, and l_t to create the series for total factor productivity a_t . Finally, persistence and standard deviation of the total factor productivity process is estimated by running a first order autoregression of the series.

First order autoregressions given in equations 21–25 are estimated. The exogenous country spread series s_t is defined as the residuals from the regression $EMBIG_t = c + \kappa \log(d_{t-1}/y_t) + s_t$, where d_{t-1}/y_t is the total foreign debt/GDP ratio. Here, the point estimate of κ is 0.0076 with a t -statistic of 2.3272. However, in order to obtain comparable results with the literature, $\kappa = 0.00075$ is used as in [Schmitt-Grohé and Uribe \(2003\)](#).

4. Quantitative results

4.1. Second moments

Second-order moments of the model are reported in [Tables 3 and 4](#). Model 1 refers to the economy with high substitutability between imported and domestic inputs with an elasticity of $\omega = 2$, whereas Model 2 refers to the economy with a low substitution elasticity of $\omega = 0.5$.

The model's amplification of shocks is very strong. Using the estimated persistence and variability parameters for the driving forces, the model generates such excessive volatility that the volatility of output implied by Model 1 is almost four times as volatile as the actual time series for output. However, the

Table 3
Theoretical moments implied by the model.

	Standard deviation			Relative standard deviation			First order autocorrelation		
	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)
a_t	0.0352	0.0423	0.0368	1.1680	0.3169	0.4153	0.5319	0.7098	0.6779
c_t	0.0328	0.0813	0.0583	1.0869	0.6090	0.6580	0.6478	0.7096	0.6863
g_t	0.0729	0.0993	0.0993	2.4183	0.7438	1.1208	0.3294	0.6471	0.6471
i_t	0.1016	0.4499	0.2985	3.3700	3.3700	3.3705	0.6974	0.6797	0.6767
l_t	0.0199	0.0711	0.0559	0.6612	0.5326	0.6309	0.2610	0.7059	0.6846
nxy_t	0.0246	0.0764	0.0660	0.8168	0.5723	0.7449	0.5454	0.6775	0.6847
nxy_t^*	0.0257	0.0757	0.0685	0.8529	0.5670	0.7731	0.7396	0.6788	0.6817
p_t^z	0.1316	0.1317	0.1317	4.3650	0.9865	1.4865	0.6330	0.6347	0.6347
r_t	0.0038	0.0031	0.0031	0.1252	0.0232	0.0350	0.6780	0.6728	0.6738
r_t^*	0.0023	0.0016	0.0016	0.0756	0.0120	0.0181	0.8603	0.7170	0.7170
$sprd_t$	0.0033	0.0031	0.0031	0.1085	0.0232	0.0350	0.6598	0.6628	0.6637
u_t	0.0235	0.0650	0.0511	0.7788	0.4869	0.5767	0.5412	0.6891	0.6750
y_t	0.0302	0.1335	0.0886	1.0000	1.0000	1.0000	0.6140	0.6858	0.6863
y_t^d	0.0350	0.1024	0.0885	1.1596	0.7670	0.9989	0.6099	0.7229	0.6870
z_t	0.0961	0.3655	0.1132	3.1872	2.7378	1.2777	0.6710	0.6423	0.6635

Note: All series are seasonally adjusted, in natural logs, and Hodrick-Prescott filtered with a filtering parameter of 1600.

Table 4
Model implied correlations with output, import price, and country spread.

	Correlation with y_t			Correlation with p_t^z			Correlation with $sprd_t$		
	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)	Data	Model 1 ($\omega = 2$)	Model 2 ($\omega = 0.5$)
a_t	0.7262	0.4759	0.9202	0.5681	0.3429	0.3220	0.1001	0.1086	0.0471
c_t	0.7845	0.9551	0.9845	0.3432	-0.4110	-0.1743	-0.0482	-0.1542	-0.1498
g_t	0.3409	0.2226	0.3286	-0.2637	0.0019	0.0019	-0.1717	-0.1095	-0.1104
i_t	0.6832	0.7251	0.5309	-0.3010	-0.3925	-0.3418	-0.6579	-0.4861	-0.5583
l_t	0.2815	0.9729	0.9950	-0.2445	-0.4615	-0.1499	-0.1906	-0.1465	-0.1073
nxy_t	-0.4092	-0.3303	0.0661	0.2806	0.1966	0.2877	0.5857	0.5629	0.5914
nxy_t^*	-0.1678	-0.0955	0.0581	0.7362	-0.1653	0.3867	0.7293	0.4616	0.5982
p_t^z	0.1867	-0.6540	-0.0517	1.0000	1.0000	1.0000	0.4625	0.2825	0.2644
r_t	0.1178	-0.1740	0.0373	0.5063	0.3626	0.3457	0.7824	0.8617	0.8607
r_t^*	0.3138	0.0356	0.2109	0.2648	0.1596	0.1596	-0.2094	-0.2420	-0.2465
$sprd_t$	-0.2060	-0.1950	-0.0742	0.4625	0.2825	0.2644	1.0000	1.0000	1.0000
u_t	0.4665	0.9357	0.9614	-0.3855	-0.4577	-0.1622	-0.4941	-0.1267	-0.0947
y_t	1.0000	1.0000	1.0000	0.1867	-0.6540	-0.0517	-0.2060	-0.1950	-0.0742
y_t^d	0.8407	0.8556	0.9953	0.5001	-0.1679	0.0451	0.0662	-0.0574	-0.0482
z_t	0.4301	0.8374	0.8128	-0.5079	-0.9611	-0.6237	-0.6302	-0.2787	-0.2152

Note: All series are seasonally adjusted, in natural logs, and Hodrick-Prescott filtered with a filtering parameter of 1600.

performance of the model is reasonably good in matching the ranking of relative volatilities and cross correlations.

In contrast to the finding in Tiryaki (2011), the net exports to output ratio is countercyclical even when country spreads do not depend on expected productivity. The coefficient of correlation between nxy_t and y_t in Model 1 is -0.33 , whereas it is -0.41 in the data. Adjusted net exports nxy_t^* in Model 1 has a small negative correlation (-0.10) with output, while actual correlation is -0.17 in the data. The countercyclicity of net exports depends critically on both the share of imported inputs in production and the elasticity of substitution between imported and domestic inputs. We discuss in the following section how sensitive our results to changes in both parameters. For now, note that countercyclicity of net exports disappears with a smaller elasticity of $\omega = 0.5$.

Correlations with imported input price are captured reasonably well for factors of production and investment. Labour hours, imported inputs, capital utilization, and investment are negatively correlated with the price of imported inputs. However, the model also predicts counterfactually negative correlation between the price of imported inputs and consumption, output, as well as domestic intermediate goods. The model predicts positive association between the price of imported inputs and net exports, which is in

line with our observation. However, the price of imported inputs has a negative correlation with adjusted net exports nxy_t^* when the elasticity of substitution is high, and positive correlation when the elasticity is low, with the latter result being closer to reality.

The model provides reasonably close estimates for country spreads' correlation with almost all of the variables.

4.2. Impulse response analysis

Figs. 2–4 plot impulse responses to one standard deviation shocks to total factor productivity, price of imported input, and world interest rate, respectively. The impulse response functions are obtained by assuming that the variance-covariance matrix is diagonal. The ordering of variables become important in the case of the non-diagonal variance-covariance matrix, in which Cholesky factorization is employed in order to identify exogenous shocks. Note that we considered the non-diagonal variance-covariance matrix in calculating model-implied moments. But, in the calculation of the impulse responses, we refrained from taking into account the covariation among shocks so that the effect of each shock can be seen in isolation.

One-standard-deviation positive shock to total factor

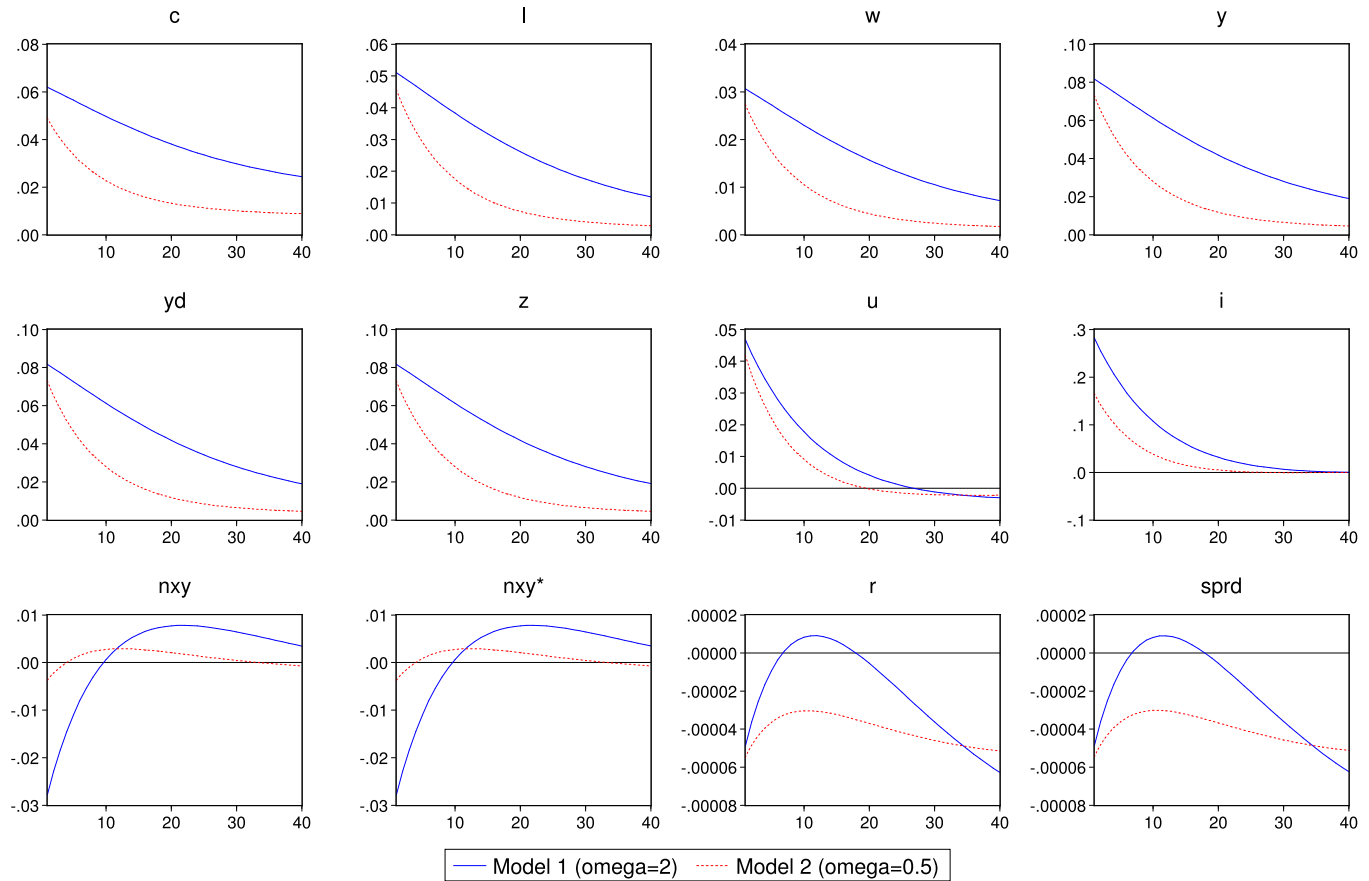


Fig. 2. Impulse responses to one standard deviation shock in productivity.

productivity raises the representative firm’s demand for all factors of production. Labour hours rise by around 5 percent; demand for capital services rises so both investment and rate of capital utilization increases. In effect, the production of domestic input \hat{y}_t^d rises by around 8 percent on impact, which also brings about a proportionate demand for imported inputs to produce the final good. Due to the constant-elasticity-of-substitution technology and the fact that relative price of imported inputs does not change, the response of imported inputs matches exactly the response of domestic inputs. Also, the linear homogeneous production function for the final good translates into a quantitatively same response of the final goods output. Since investment rises more than domestic savings, the net exports to GDP ratio $n\hat{x}y_t$ falls below its steady state value by 2.78 percentage points. The response of the adjusted net exports to GDP ratio $n\hat{x}y_t^*$ is exactly the same as that of $n\hat{x}y_t$. This is because the response of imported inputs \hat{z}_t is cancelled out by the response of final output \hat{y}_t and $\hat{p}_t^z = 0$.⁴

Notice how the substitution elasticity amplifies the responses to exogenous shocks. For example, in Fig. 2, we see that the initial response of consumption to one-standard-deviation shock to productivity is slightly more than 6 percent with high elasticity, while the initial increase in consumption is around 5 percent with low elasticity. More strikingly, the countercyclicality of net exports conditional on the productivity shock is much stronger with high elasticity.

As a response to one-standard-deviation shock to the import

price of intermediate goods, and when the elasticity of substitution between domestic and imported inputs is set at $\omega = 2$, the demand for these goods immediately drops by around 30 percent. Firms substitute domestic inputs for imported inputs so the equilibrium output of domestic inputs does not fall as much as imported inputs. This results in a fall in final output by around 10 percent. Capital utilization also follows a similar pattern, by decreasing around 4 percentage points from the steady state at the time of impact. On the demand side, both consumption and investment falls on impact, returning to steady state gradually. The response of the net exports nxy_t is countercyclical on impact and in the consequent 8–9 quarters. The response of the adjusted net exports nxy_t^* , however, is procyclical.

When the elasticity of substitution between domestic and imported inputs is set at $\omega = 0.5$, the domestic and imported inputs become closer to being complements of each other in the production of the final good. On impact of a positive imported input price shock, the firm has limited scope for substitution as compared to the case when $\omega = 2$, so it does not decrease its demand for imported inputs as much it would when $\omega = 2$. In this case, net exports, nxy , fall below steady state, whereas the adjusted net exports, nxy^* , jump to a level higher than the steady state, which implies procyclical nxy and countercyclical nxy^* .

In response to world interest rate shocks, investment demand falls immediately. The fall in investment is compensated for by a hump-shaped response of capital utilization. The rise in the cost of capital forces the firms to exploit existing capital more by raising the rate of capital utilization. Demand for other inputs, both domestic and imported, follows an inverse hump-shaped response. Net exports immediately jump, then come down gradually, which

⁴ In log-linear form adjusted net exports is written as $nxy^*(n\hat{x}y_t^*) = nxy(n\hat{x}y_t) + (p^z z/y)(\hat{p}_t^z + \hat{z}_t - \hat{y}_t)$.

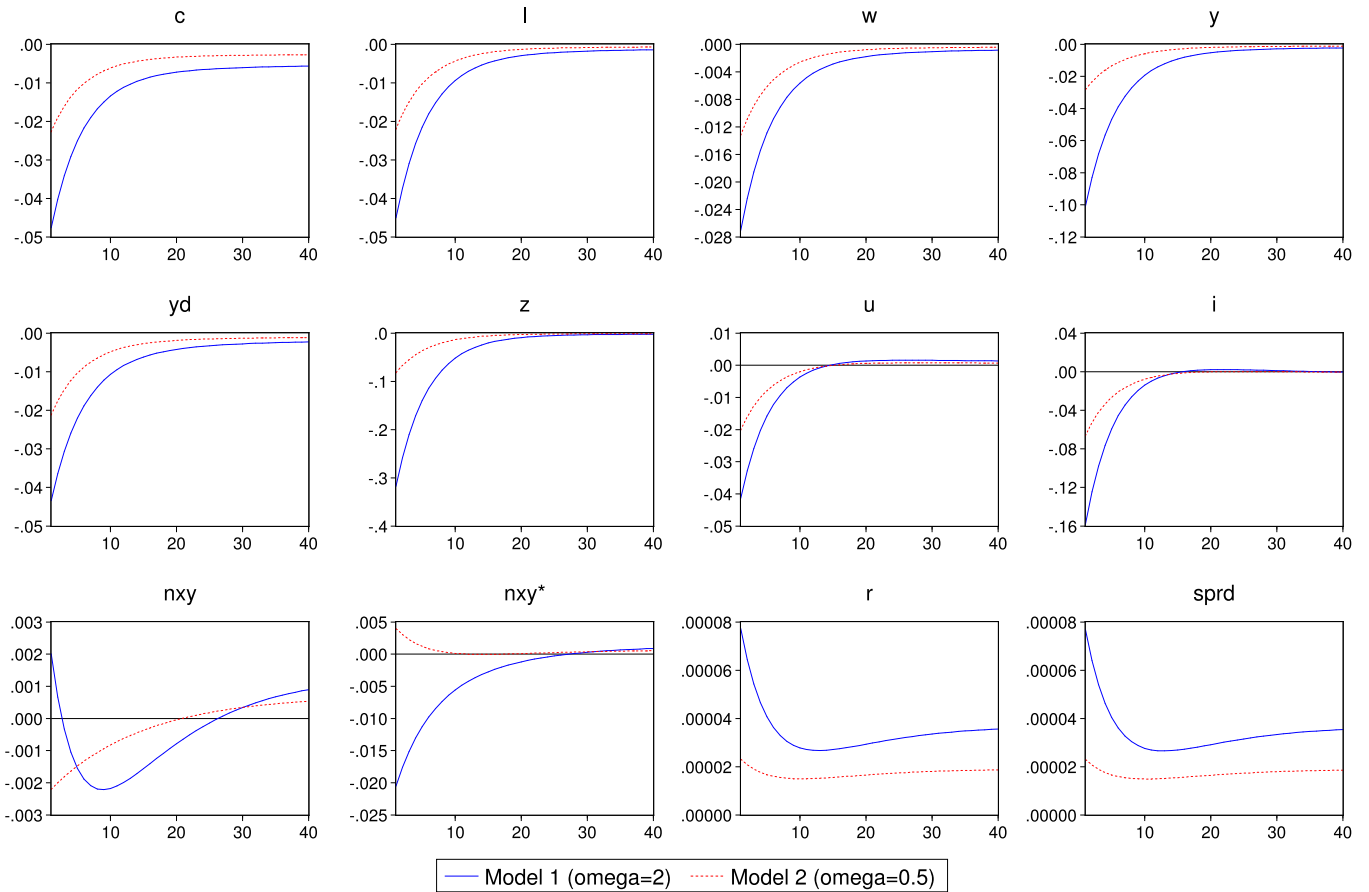


Fig. 3. Impulse responses to one standard deviation shock in imported input price.

is to a large extent a reflection of the response of investment.⁵

4.3. Countercyclicality of net exports

The main objective of this paper is to highlight the channel through which imports of intermediate goods may be accounted for the observed strong countercyclicality of net exports in emerging market economies. The elasticity of substitution between domestic and imported inputs, ω , and the parameter governing the share of imported inputs in the final good, χ , are the most critical parameters to affect the countercyclicality of net exports. The main argument of the hypothesis is that countercyclicality of net exports is increasing in the relative share of imported inputs in the final good. Another supporting argument stipulates that the easier domestic and imported inputs can be substituted for each other, the stronger is the countercyclicality of net exports. Figs. 5 and 6 provide the basis for our both hypotheses in which they look at the same issue from two alternative angles.

Each subplot of Fig. 5 depicts, for given values of the elasticity of substitution ω , the correlation coefficient between the net exports to GDP ratio (both nxy and nxy^*) and GDP along the parameter χ which governs the share of domestic inputs in the final good (hence, $1 - \chi$ represents the share of imported inputs). Moving rightwards along the χ axis implies greater share of imported inputs in the final good.

Three major conclusions emerge from Fig. 5. First, for sufficiently large share of imported inputs in the final good, more specifically, for values of $\chi \leq 0.85$, the model produces countercyclical net exports at varying degrees depending on the value of the elasticity. For example, when substitutability is low between domestic and imported inputs at $\omega = 0.5$, the coefficient of correlation between net exports and GDP is barely on the negative side for $\chi = 0.85$, whereas, when substitutability is high at $\omega = 2$, the same correlation stands at -0.34 for the same value of χ .

Second, there exists a region, within $0.75 \leq 1 - \chi \leq 1$, where the coefficient of correlation between net exports and GDP is decreasing in $1 - \chi$, the share of imported inputs in the final good. Notice that the empty circles in Fig. 5 have a negative slope until around $\chi = 0.75$, and then slightly bend upwards or remain flat along the $1 - \chi$ axis.

Third, the countercyclicality of adjusted net exports, nxy^* , is stronger than the countercyclicality of unadjusted net exports, nxy , for elasticity values smaller than unity, which is the Cobb-Douglas case. For higher elasticity of substitution values the slope of the countercyclicality of the adjusted net exports curve turns positive for relatively smaller values of $1 - \chi$. The observation in that the adjusted net exports has relatively weaker countercyclicality than the unadjusted net exports is only consistent with relatively larger elasticities. Notice that the empty circles almost coincide with the filled circles in Fig. 5 for elasticity values of $\omega = 0.95$ and $\omega = 1.05$.⁶

⁵ Impulse responses to a shock in the country spread component of the interest rate are qualitatively similar.

⁶ The cyclicality of the net exports and the adjusted net exports are identical in the Cobb-Douglas case, i.e., when $\omega = 1$.

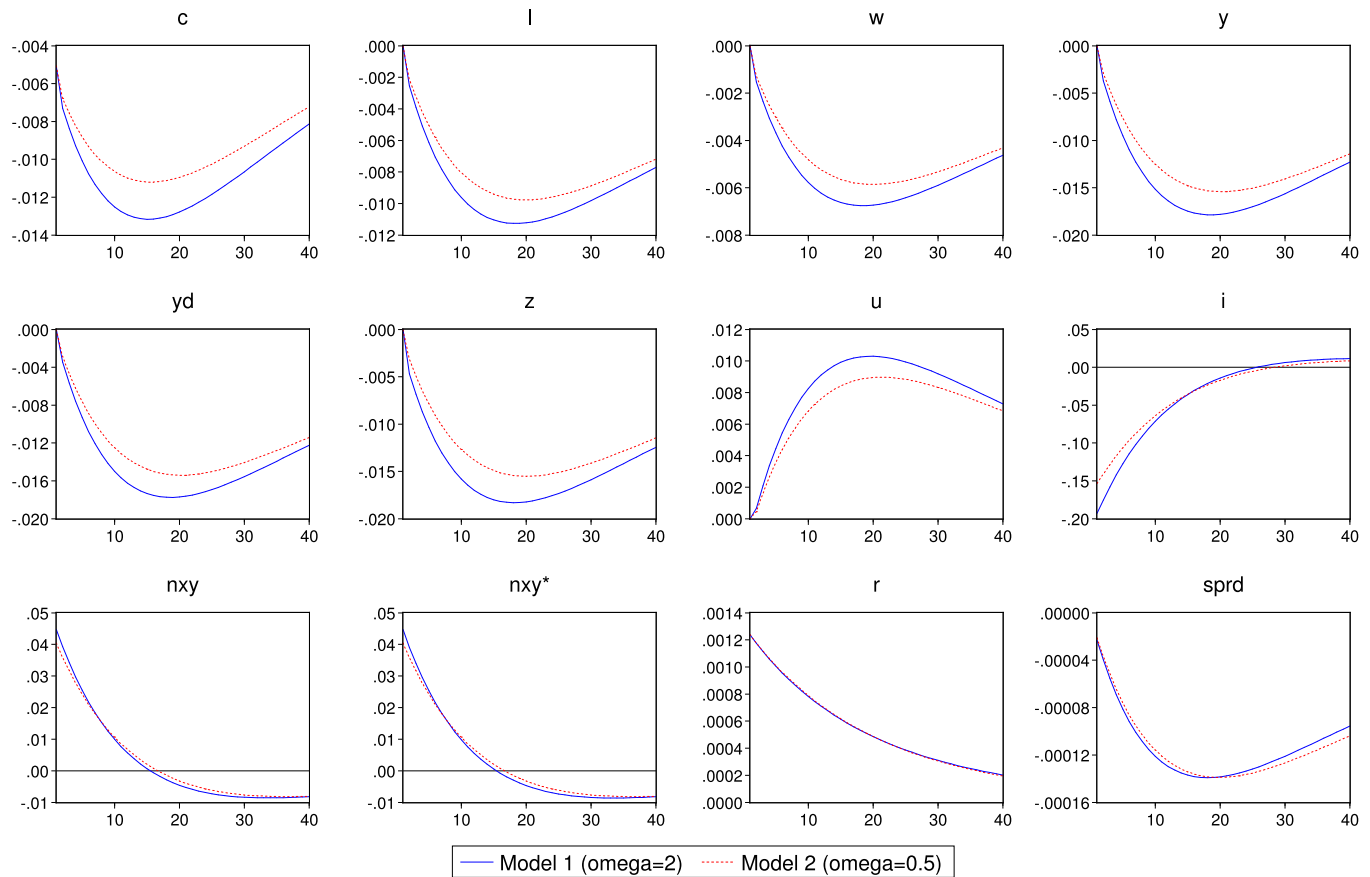


Fig. 4. Impulse responses to one standard deviation shock in world interest rate.

Each plot of Fig. 6 shows how the countercyclicality of net exports (both nxy and nxy^*) changes with the elasticity of substitution between domestic and imported inputs, for given values of the share of imported inputs in total final output. When imported inputs constitute only 5 percent of the final good (that is, $\chi = 0.95$), notice that in the top left panel the countercyclicality of nxy and nxy^* are almost identical. As χ becomes smaller, the cyclical properties of nxy and nxy^* start to decouple.

In the data, net exports excluding the imports of intermediate goods, nxy^* , has a smaller degree of countercyclicality than net exports including imports of intermediate goods, nxy . This property of data is only matched for values of the elasticity greater than unity. The higher the elasticity, the larger is the difference between the cyclical properties of nxy and nxy^* . Also, this effect is more material, the larger is the share of imported inputs in the final good.

Fig. 6 shows no regular pattern for the sensitivity of the cyclical property of net exports to different values of the elasticity ω for given values of the share parameter χ . For example, the cyclicity of nxy is downward-sloping for $\chi \geq 0.85$, is almost flat for $\chi = 0.80$ and $\omega \geq 1$.

4.4. Variance decompositions

The model also enables us to make a quantitative assessment of the sources of business fluctuations. Fluctuations in foreign variables such as interest rates and imports prices are important contenders against productivity shocks in accounting for business cycles in small open emerging market economies.

We use unconditional asymptotic variance decompositions in order to assess the relative weight of each exogenous shock in

driving the business cycles in the model economy. When the covariance matrix of exogenous shocks is not diagonal, variance decompositions are computed through Cholesky factorization of the covariance matrix in order to identify the effect of each shock, which is identical to the procedure used in the vector autoregressions literature. Therefore, the ordering of the shocks can have dramatic effects on variance decompositions. Our general principle for ordering is to write foreign variables before domestic variables, and quantity variables before price variables. The resulting ordering of the exogenous shocks is ε^p , ε^r , ε^a , ε^g , and ε^s . Table 5 presents the contribution of each shock in percentages to the variability of each variable in the model.

The variance decomposition exercise is sensitive to the value of the elasticity of substitution between domestically produced inputs and imported inputs. When the elasticity is set at $\omega = 2$, import price shocks account for almost as much as productivity shocks of the final output volatility. As expected, the largest contribution to the variability of the domestic input comes from total factor productivity shocks. Import price shocks also account for a sizeable portion of the variability in capital utilization, consumption, and labour hours, and more than 92 percent of the variability in imported inputs. Shocks to the interest rate components are important sources of variation in net exports and investment. About 75 percent of the variability in net exports is due to the interest rate shocks.

When the elasticity is set at $\omega = 0.5$, the weight of the import price shocks diminishes considerably to the extent that they could explain less than one percentage point of the variability in the final output. Productivity shocks, on the other hand, raise their role as the dominant driving force of consumption, labour hours, capital

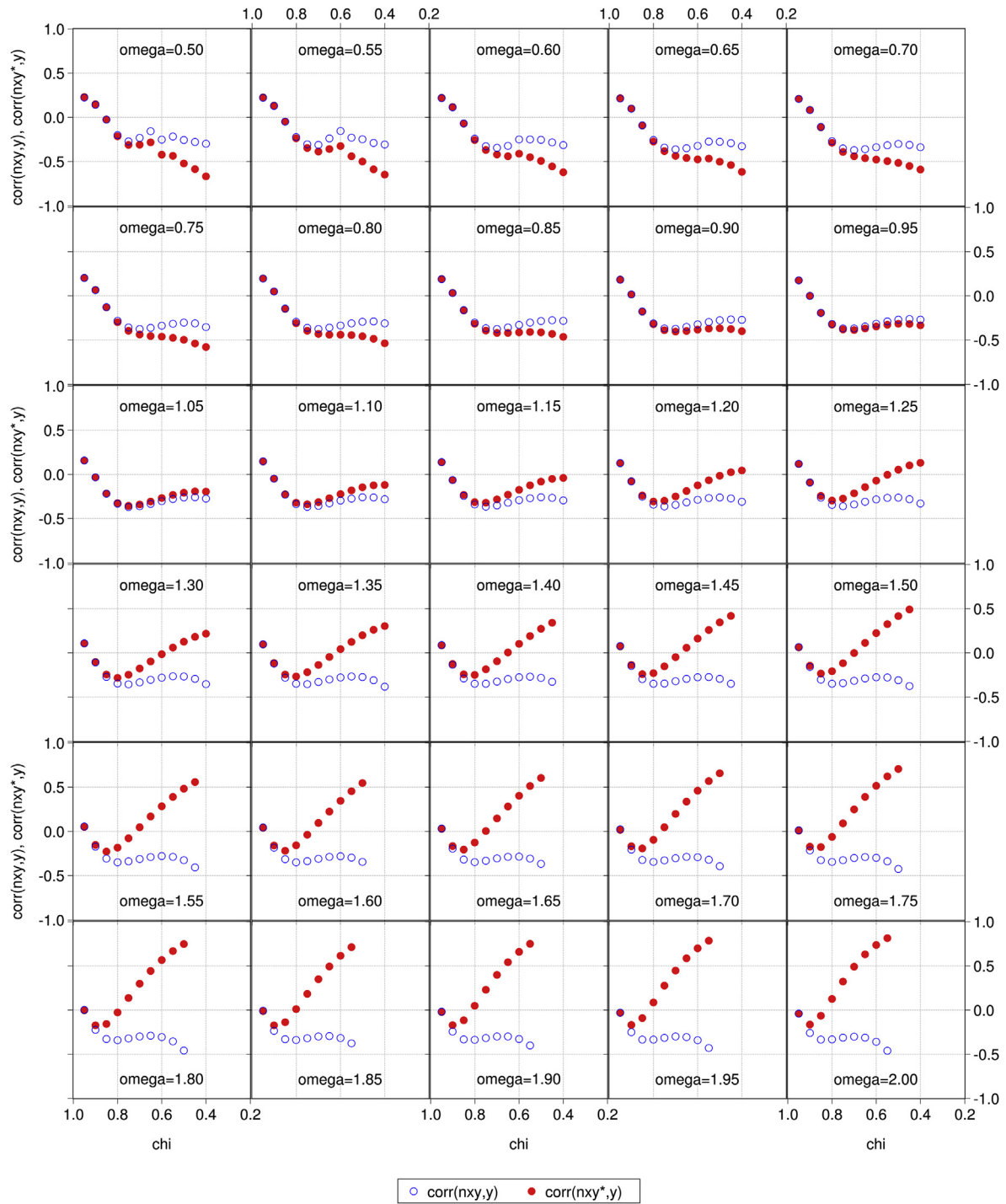


Fig. 5. Sensitivity of the countercyclicality of net exports to the share of imported inputs.

utilization, imports of inputs, and the final output. Similarly, country spreads have relatively more share in accounting for the fluctuations in net exports and investment in comparison to the case of higher elasticity.

5. Conclusion

In this paper, we identified several observations regarding the countercyclicality of net exports in small open economies. First, we referred to earlier research to highlight the stylized fact that net

exports are more strongly countercyclical in emerging market economies compared to developed small open economies. Second, we documented for a sample of countries, including both emerging market economies and more advanced small open economies, that the production of the final good in the first group of countries relies more intensively on imported inputs relative to the production in the latter group. In addition, the countercyclicality of net exports in emerging markets becomes stronger, the higher is the ratio of imports of intermediate goods to GDP. However, the relationship between the magnitude of the countercyclicality and the imports of

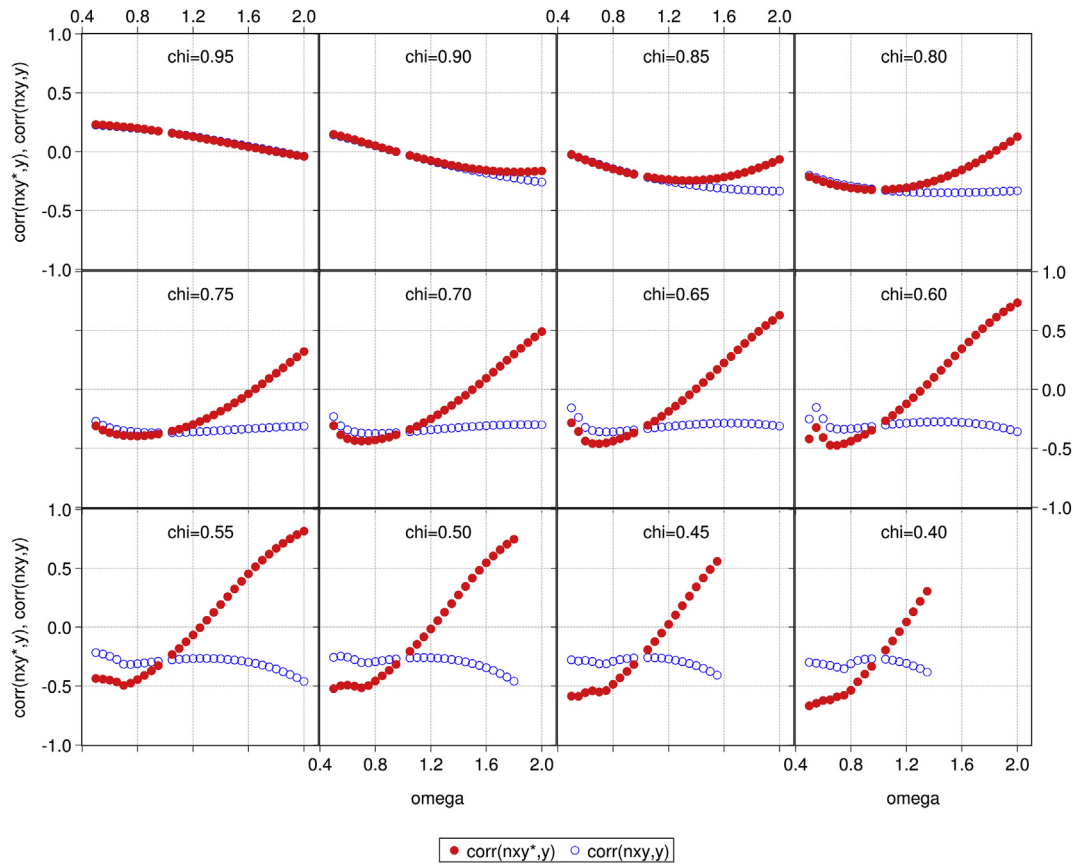


Fig. 6. Sensitivity of the countercyclicity of net exports to the elasticity of substitution.

Table 5
Variance decompositions.

Model 1 ($\omega = 2$)					
	ε^p	ε^r	ε^d	ε^g	ε^s
c_t	17.20	1.47	80.09	0.01	1.22
i_t	16.11	5.98	47.48	0.65	29.78
l_t	21.84	3.11	74.02	0.02	1.01
nxy_t	4.12	20.61	16.79	4.33	54.15
nxy_t^*	3.01	20.89	17.11	4.38	54.61
r_t	13.53	5.70	0.44	1.97	78.36
$sprd_t$	8.04	9.26	0.45	2.02	80.23
u_t	23.56	2.61	73.08	0.02	0.73
y_t	43.18	2.28	53.85	0.02	0.67
y_t^d	3.52	3.89	91.49	0.02	1.08
z_t	92.42	0.30	7.16	0.00	0.11
Model 2 ($\omega = 0.5$)					
	ε^p	ε^r	ε^d	ε^g	ε^s
c_t	3.06	3.22	91.99	0.02	1.71
i_t	11.69	10.74	36.77	0.71	40.09
l_t	2.28	6.47	90.20	0.02	1.03
nxy_t	8.32	31.40	0.67	4.57	55.05
nxy_t^*	14.99	29.13	0.62	4.24	51.02
r_t	12.31	5.72	0.09	1.70	80.18
$sprd_t$	7.04	9.35	0.09	1.73	81.78
u_t	3.45	4.44	91.37	0.01	0.73
y_t	0.31	6.64	92.13	0.02	0.90
y_t^d	0.25	6.65	92.19	0.02	0.89
z_t	38.93	4.06	56.41	0.01	0.59

intermediate goods is the opposite in more advanced small open economies. Third, we showed that net exports excluding imports of

intermediate goods is only weakly countercyclical in Turkey, a representative emerging market economy, in contrast to the strong countercyclicity of net exports including imports of intermediate goods.

We built a small open economy business cycle model featuring imported inputs in production, variable capital utilization, working capital requirement, capital and bond adjustment costs, and stochastic disturbances to productivity, imported input price, interest rate components, and government expenditure. The model is simple, yet it is sufficiently rich to provide us with a framework in order to examine the empirical observations about net exports as well as other typical business cycle characteristics of emerging market economies. We calibrated the model to match the properties of the Turkish business cycles.

The model successfully captures the observation that higher share of imported inputs in the final good leads to stronger countercyclicity of net exports. We run the model for a wide range of both the share parameter and the elasticity of substitution between domestic and imported inputs. We identified a range for the values of the share parameter in which the model-implied coefficient of correlation between net exports and GDP is decreasing as the share of imported inputs rises. This range is also the wider, the smaller is the elasticity of substitution between domestic and imported inputs.

The model's prediction about the cyclical property of net exports excluding imports of intermediate goods depends on the presence of imported input price shocks and the value of the elasticity of substitution. In order for the model to be able to replicate the weaker countercyclicity of net exports excluding imports of intermediate goods, the elasticity of substitution should be greater

than unity. When the production technology allows for high substitutability between domestic and imported inputs, a positive shock to the price of imported inputs significantly reduces the demand for imported inputs relative to the demand for domestic inputs, as for a given expenditure level, the representative firm is able to switch relative expenditure from imports to domestic factors of production. In contrast, when domestic and imported goods are close to being complements in production, the rise in the cost of imports lead to comparably small fall in the demand for imported inputs, leading to a modest contraction in GDP. This variation in the magnitude of responses creates opposite predictions for the direction of net exports.

Our results also show that the propagation mechanism of the model is considerably affected by the elasticity of substitution. High elasticity of substitution strengthens the amplification of shocks, in particular, shocks to the price of imported inputs. The proportion of GDP volatility accounted for by the shocks to the price of imported inputs significantly varies with the elasticity of substitution.

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