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CICLOS DE NEGOCIOS EN PAÍSES EMERGENTES: EL ROL DE LOS BIENES DURABLES Y LAS FRICCIONES FINANCIERAS

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CICLOS DE NEGOCIOS EN PAÍSES EMERGENTES: EL ROL DE LOS BIENES DURABLES Y LAS FRICCIONES FINANCIERAS

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RESUMEN

Una creciente literatura estudia el ciclo económico para economías emergentes. Este documento de trabajo contribuye con esta literatura al examinar cómo la presencia de bienes durables y de fricciones financieras le dan forma a las fluctuaciones cíclicas en una pequeña economía abierta sujeta a choques transitorios y permanentes. Se encontró que los choques permanentes juegan un rol menos importante en el ciclo de las economías emergentes que lo documentado anteriormente. También se encontró que las fricciones financieras son cruciales para explicar algunas propiedades claves del ciclo en estas economías. En nuestro modelo cuantitativo, una prima de préstamo contracíclica interactúa con la compra de los bienes durables dando como resultado un consumo altamente volátil y unas exportaciones netas fuertemente contracíclicas.

BUSINESS CYCLES IN EMERGING MARKETS: THE ROLE OF DURABLE GOODS AND FINANCIAL FRICTIONS

Álvarez-Parra, Fernando; Brandao-Marques, Luis and Toledo, Manuel
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ABSTRACT

There is a growing literature studying business cycles in emerging economies. This paper contributes to this literature by examining how durable goods and financial frictions shape cyclical fluctuations in a small open economy subject to transitory and permanent shocks. We find that permanent shocks play a less important role driving the cycle in emerging economies than previously documented. We also find that financial frictions are crucial to explain some key business cycle properties of these economies. In our quantitative model, a countercyclical borrowing premium interacts with the purchase of durables to deliver highly volatile consumption and strongly countercyclical net exports.

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Business Cycles in Emerging Markets: The Role of Durable Goods and Financial Frictions

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August 30, 2012

Abstract

There is a growing literature studying business cycles in emerging economies. This paper contributes to this literature by examining how durable goods and financial frictions shape cyclical fluctuations in a small open economy subject to transitory and permanent shocks. We find that permanent shocks play a less important role driving the cycle in emerging economies than previously documented. We also find that financial frictions are crucial to explain some key business cycle properties of these economies. In our quantitative model, a countercyclical borrowing premium interacts with the purchase of durables to deliver highly volatile consumption and strongly countercyclical net exports.

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1 Introduction

Business cycles in emerging economies are characterized by strongly countercyclical current accounts and sovereign interest rates and by highly volatile consumption. In particular, total consumption expenditure volatility exceeds that of income (Aguiar and Gopinath, 2007). This fact is known as the *excess volatility of consumption puzzle*. There are two strands of literature which explain these facts. The first strand, represented chiefly by Aguiar and Gopinath (2007), claims that business cycle fluctuations in these economies are driven by permanent shocks to productivity. The second strand argues that financial frictions are not only needed but essential to explain the empirical regularities of emerging economies (Neumeyer and Perri, 2005, and García-Cicco, Pancrazi, and Uribe 2010).¹

In this paper, we investigate the role of consumption of nondurable and durable goods in explaining the business cycle regularities observed in emerging economies. To the best of our knowledge, none of the existing literature highlights the importance of consumer durable goods in shaping the cyclical dynamics of these economies.² The main contribution of our paper is to fill this gap.

To this end, we first study the observed cyclical behavior of disaggregated consumption in emerging economies. Our main empirical finding is that, contrary to total consumption expenditure, nondurable consumption is less volatile than output. We also observe that durable expenditure is much more volatile than output. In addition, we find that spending in both nondurable and durable goods is more volatile in emerging economies than in developed ones.

In order to understand these facts, we build a real business cycle (RBC) model which combines trend and transitory shocks to productivity with consumer durable goods and financial

¹There are alternative explanations which rely on one or the other framework. For instance, Boz et al. (2011) extend Aguiar and Gopinath's (2007) model to include imperfect information, and Fernández-Villaverde et al. (2009) use shocks to the volatility of the borrowing premium to explain the volatility of consumption in emerging economies.

²Several other papers in the business cycles' literature study the importance of durable goods. See, Baxter (1996), De Gregorio et al. (1998), and Engel and Wang (2011), among others. However, they do not focus on emerging economies.

frictions, which then we estimate using data from Mexico. We show that the observed cyclical behavior of nondurable and durable consumption expenditure provides important information to estimate the model and the parameters of the productivity processes. Thus, our estimation results allow us to assess the role that financial frictions and productivity shocks play in driving aggregate fluctuations in emerging economies.

We find that once we account for durable goods, shocks to trend are not enough to replicate neither the excess volatility of consumption spending nor the countercyclical properties of the trade balance and sovereign interest rates we observe in emerging economies. Instead, we find that the model must be augmented to include financial frictions. We also find that accounting for consumer durables greatly reduces the role of permanent shocks to productivity in driving business cycle fluctuations.

Our quantitative results offer evidence against the prominent role of shocks to trend growth found by Aguiar and Gopinath (2007), and lend support to the view of García-Cicco et al. (2010) that financial frictions are crucial to understand business cycles in emerging economies. Unlike the latter, however, we stress the importance of financial frictions in the presence of durable goods. We find that the interaction between financial frictions and durable expenditure provides an important mechanism through which shocks to productivity can generate more volatile consumption and strongly countercyclical net exports. This is so because durable expenditure responds strongly to changes in the interest rate. If financial frictions make the interest rate countercyclical, households would borrow more from abroad during economic expansions in order to take advantage of better credit conditions and thus finance the purchase of durables, which tends to generate a negative trade balance.

In early RBC models for small open economies, interest rates disturbances play a minor role in driving the business cycle (Mendoza, 1991). When one adds endogenous borrowing limits to these models, however, consumption volatility increases substantially as savings cannot be used to smooth consumption when the borrowing limit binds (De Resende, 2006). Alterna-

tively, the excessive volatility of consumption can be explained with a financial friction in the form of a working capital borrowing requirement (Neumeyer and Perri, 2005). In this case, a countercyclical borrowing premium amplifies the variability of consumption because it makes the demand for labor more sensitive to the interest rate. Our results provide an additional channel – durable consumption – through which financial frictions shape business cycles in emerging economies.

The rest of the paper is organized as follows. In the next section, we document new stylized facts regarding cyclical fluctuations in consumption in emerging economies. In Section 3, we present our model. Section 4 describes the estimation procedure, presents the results, and checks their robustness. Section 5 concludes.

2 Data and Stylized Facts

2.1 Data

Our sample comprises thirty-one countries for which we are able to find data on durable goods' spending and, whenever possible, up to the beginning of the recent financial crisis (last quarter of 2008). We split the sample into developed and emerging economies depending on their Morgan Stanley Capital International (MSCI) classification developed by MSCI Inc.³ We then divide the sub-sample of developed economies into two groups according to size and follow the rule that an economy is large if its gross domestic product (GDP) represented at least two percent of the world's GDP in the year 2000. This leaves three groups: small developed economies (Austria, Canada, Denmark, Finland, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, and Sweden), large developed economies (France, Germany, Italy, Japan, United Kingdom, and United States), and emerging economies (Chile, Colombia, Czech Republic,

³We classify a country as developed if it was included in the MSCI Developed Markets index for most of the sample period and as having an emerging market otherwise. This criterion means that we include Israel as an emerging market economy since, for the entire sample period it was defined as such by MSCI Inc. and only recently upgraded to advanced economy status (May 2010).

Estonia, Hong Kong SAR, Hungary, Republic of Korea, Israel, Mexico, Poland, Slovenia, Slovak Republic, South Africa, and Turkey).⁴ For each country we collect data (in real terms) on GDP, total private consumption expenditure, consumption of nondurable goods (including services)⁵, expenditure in durable goods, investment, and the trade balance.

All data is from the OECD's Quarterly National Accounts, except for the U.S. (Bureau of Economic Analysis), Chile (Central Bank of Chile), Colombia (EMED - Emerging Americas database), Hong Kong and Korea (CEIC - Asia database), Mexico (INEGI - Instituto Nacional de Estadística y Geografía), South Africa (Emerging EMEA database), and Turkey (Turkish Statistical Institute). All variables are sampled at a quarterly frequency, seasonally adjusted when needed, converted to logs (except net exports) and detrended using the Hodrick-Prescott (HP) filter with smoothing parameter $\lambda = 1600$.⁶

In Tables 1 and 2, in addition to the sample period used for each country, we report standard deviations for the above mentioned variables and their correlations with GDP. We also show the weighted average of each statistic for the three country groupings using current U.S. dollar GDP in the year 2000 as weights (data from the World Bank's World Development Indicators).

2.2 Facts

When it comes to business cycles in emerging economies and small developed economies, there are four stylized facts often cited in the literature (see Neumeyer and Perri, 2005, Uribe and Yue, 2006, Aguiar and Gopinath, 2007, and García-Cicco et al., 2010). First, emerging market economies have higher volatilities of output and consumption when compared to developed economies. Second, consumption expenditure is more volatile than output in emerging markets while it is not (quite) as volatile as output in developed economies. Third, net exports are

⁴Hong Kong and Israel have been recently upgraded to advanced market status by MSCI.

⁵The inclusion of services under nondurable consumption is standard in the durable goods literature (see Baxter, 1996, for example) and can be justified on the grounds that durables are different than nondurable goods and services because they can be inventoried (Gomes et al., 2009).

⁶Deseasonalization uses the Census Bureaus X-12 ARIMA program. Detrending is needed so that the unconditional moments of these non-stationary series are defined.

more volatile and more countercyclical in emerging markets when compared to developed economies. Finally, real interest rates are countercyclical and leading in emerging markets and acyclical and lagging in developed economies.

To these facts we add three new facts concerning spending in nondurables and durable goods in small economies, based on our sample summarized in Tables 1 and 2.

Fact 1 *Consumption of nondurables is less volatile than output in both developed and emerging economies.*⁷

Fact 2 *Spending in durable goods is much more volatile than output in both sets of economies.*

Fact 3 *Consumption spending in both durables and nondurables is relatively more volatile in emerging economies than in developed economies.*⁸

Our sample shows significant variability on a country-by-country basis within the emerging countries' group in terms of both the relative volatility of total consumption spending and the correlation of the trade balance with output. For the volatility of consumption, emerging countries range between 17 percent below that of output for Poland and 50 above that of output for Turkey. The dispersion of results is even more striking for the countercyclicality of the net exports-output ratio. While developed economies show uniformly mildly countercyclical trade balances (the average correlation of net exports with GDP in our sample of small advanced economies is only -0.10 and in line with the averages of -0.17 and -0.25 for OECD countries reported by Aguiar and Gopinath, 2007 and Engel and Wang, 2011, respectively), emerging economies as a group show an average correlation of the net exports-output ratio with GDP of -0.48 but with some countries having strongly procyclical trade balances (Hong Kong at 0.55) while others have strongly countercyclical net exports (Mexico at -0.86). The reasons why there is such disparity is an issue beyond the scope of this paper.

⁷The sample average of volatility of nondurable consumption relative to that of output is 0.93 in emerging countries and 0.8 in developed economies and in both cases significantly below 1.

⁸The average relative volatility of durable goods expenditure is 3.78 for small developed economies and 4.22 for emerging economies. See Tables 1 and 2.

3 The Model

We model a two-sector neoclassical small open economy populated by a continuum of homogenous households of unit mass. Our stochastic environment combines transitory and trend shocks to productivity in line with recent RBC frameworks focusing on emerging economies (see Aguiar and Gopinath, 2007, and García-Cicco et al., 2010). In addition, the model incorporates consumer durable goods and financial frictions.

In our model economy, firms are competitive and allocate production factors between two sectors. One sector combines capital and labor to produce nondurable goods, $Y_{n,t}$, which can be used for consumption or as an intermediate input in the production of durable goods. The other sector combines capital, labor and the intermediate input to produce durable goods, $Y_{d,t}$, which can be used for consumption or as capital. Production technologies in each sector are

$$Y_{n,t} = F_n(K_{n,t}, L_{n,t}, z_{n,t}, \Gamma_t), \quad \text{and} \quad (1)$$

$$Y_{d,t} = \min \left\{ \underbrace{F_d(K_{d,t}, L_{d,t}, z_{d,t}, \Gamma_t)}_{\text{value added}}; \frac{M_{n,t}}{\Omega} \right\}, \quad (2)$$

where $K_{i,t}$ and $L_{i,t}$ are capital and labor in sector $i \in \{n, d\}$. Γ_t , $z_{n,t}$ and $z_{d,t}$ represent stochastic productivity processes and Ω is the quantity of the intermediate input needed to produce one unit of the durable good. The technology F_i , $i \in \{n, d\}$ takes a Cobb-Douglas form:

$$F_i(K_{i,t}, L_{i,t}, z_{i,t}, \Gamma_t) = e^{z_{i,t}} K_{i,t}^{\alpha_i} (\Gamma_t L_{i,t})^{1-\alpha_i}, \quad \text{with } \alpha_i \in (0, 1).$$

Production of durables has two components. The first component is value added, which is produced using the Cobb-Douglas technology F_d . The second component is the intermediate input. A Leontief technology then combines these two components. The implied assumption of zero elasticity of substitution between the intermediate input and the value added is common in static general equilibrium models (see Kehoe and Kehoe, 1994) and seems to be appropriate for

dynamic settings as well.⁹ Our main results, however, do not rely on this particular specification as confirmed in the robustness section below where we drop the no substitutability assumption.

The term Γ_t is the cumulative product of shocks to trend whereas $z_{n,t}$ and $z_{d,t}$ are the stationary productivity processes for the production of nondurable and durable goods, respectively. We assume that $z_{i,t}$ for $i \in \{n, d\}$ follows an AR(1) process. Hence, we can write

$$\Gamma_t = \Gamma_{t-1} e^{g_t} = \prod_{j=0}^{\infty} e^{g_j}, \quad (3)$$

$$g_t = (1 - \rho_g) \ln \mu_g + \rho_g g_{t-1} + \epsilon_{g,t}, \quad (4)$$

$$z_{n,t} = \rho_n z_{n,t-1} + \epsilon_{n,t}, \text{ and} \quad (5)$$

$$z_{d,t} = \rho_d z_{d,t-1} + \epsilon_{d,t}. \quad (6)$$

The shock to trend, $\epsilon_{g,t}$, is an i.i.d. random variable drawn from a normal distribution with zero mean and standard deviation σ_g . The random vector $(\epsilon_{n,t}, \epsilon_{d,t})$ is also i.i.d. and is drawn from a bivariate normal distribution with zero mean and covariance matrix Σ_Z given by

$$\Sigma_Z = \begin{bmatrix} \sigma_n^2 & \rho_{nd} \sigma_n \sigma_d \\ \rho_{nd} \sigma_n \sigma_d & \sigma_d^2 \end{bmatrix}. \quad (7)$$

Our environment incorporates three sources of sectoral co-movement: (1) the common shock to trend, (2) the nondurable intermediate input in the durable goods sector, and (3) the contemporaneous correlation of transitory shocks, ρ_{nd} . The assumption that the durable and the nondurable goods sectors share a common shock to trend is justified and is not overly restrictive. Galí (1993) uses a similar assumption when modeling the changes in consumption of nondurables and durables as ARMA processes. Moreover, shocks to trend are often associated with clearly defined changes in government policy (Aguiar and Gopinath, 2007) and are,

⁹Using a dynamic general equilibrium model at quarterly frequency, Kouparitsas (1998) estimates the elasticity of substitution between these two components at 0.1, which is very close to the Leontief case. In addition, this assumption makes solving and parameterizing the model simpler.

therefore, expected to affect simultaneously all sectors in the economy.

The presence of intermediate goods acknowledges important inter-sectoral links which characterize modern industrial economies as reflected in input-output matrices. Regarding the third source of co-movement, ρ_{nd} , there is no reason to arbitrarily impose zero correlation between sectoral shocks. Explicitly accounting for intermediate goods and correlation of sectoral shocks improves the ability of the model to replicate the joint dynamics of sectoral output as suggested in Hornstein and Praschnik (1997) and Baxter (1996). In the robustness section we also evaluate the role of these two sources of sectoral co-movement.

There exists an infinitely-lived representative household with preferences over leisure ($1 - L_t$) and a composite consumption bundle C_t , and discount factor $\beta \in (0, 1)$. Period utility $U(C_t, 1 - L_t)$ is Cobb-Douglas, and the consumption bundle is a CES aggregation of non-durable goods N_t and the stock of durables D_t . In particular, let

$$U(C_t, 1 - L_t) = \frac{(C_t^\theta (1 - L_t)^{1-\theta})^{1-\sigma}}{1 - \sigma}, \quad \text{and} \quad (8)$$

$$C_t = (\mu N_t^{-\gamma} + (1 - \mu) D_t^{-\gamma})^{-\frac{1}{\gamma}}, \quad (9)$$

where $\theta \in (0, 1)$ is the utility share of consumption, $\sigma > 0$ is the coefficient of relative risk aversion, $\frac{1}{1+\gamma} > 0$ is the elasticity of substitution between durable and nondurable goods, and $\mu \in (0, 1)$ represents the utility share of nondurable consumption.¹⁰

The household owns the stocks of consumer durables and sector-specific capital. The accumulation of durables as well as capital in each sector is subject to quadratic adjustment costs,

¹⁰Alternatively, we could use separable preferences in leisure and consumption such as GHH. However, since Kydland and Prescott (1982), the RBC literature has a long tradition using non-separable preferences. In fact, Guerron-Quintana (2008), and Katayama and Kim (2010) present compelling evidence that the data favors non-separable preferences. Moreover, in the international finance field, Jermann (2002) finds that non-separability in preferences helps explain home bias in portfolio choice. In the robustness section we consider separable GHH preferences, and show that our main conclusions hold.

as it is standard in the literature. Thus, the law of motions of these three stocks are

$$K_{n,t+1} = X_{k,t}^n + (1 - \delta_k)K_{n,t} - \frac{\phi}{2} \left(\frac{K_{n,t+1}}{K_{n,t}} - \mu_g \right)^2 K_{n,t}, \quad (10)$$

$$K_{d,t+1} = X_{k,t}^d + (1 - \delta_k)K_{d,t} - \frac{\phi}{2} \left(\frac{K_{d,t+1}}{K_{d,t}} - \mu_g \right)^2 K_{d,t}, \text{ and} \quad (11)$$

$$D_{t+1} = X_{d,t} + (1 - \delta_d)D_t - \frac{\psi}{2} \left(\frac{D_{t+1}}{D_t} - \mu_g \right)^2 D_t, \quad (12)$$

where δ_d and δ_k are depreciation rates of durable goods and capital; $X_{k,t}^n$ and $X_{k,t}^d$ are investment in sectoral capital; and $X_{d,t}$ is the household purchases of durable goods.¹¹

Adjustment costs of capital are often used to prevent the model from delivering excessive volatility of investment. Likewise, adjustment costs of the stock of durables help the model reproduce the inertia of durable expenditure observed at the aggregate level.¹²

We also assume that there exists perfect labor mobility across sectors which implies that, in equilibrium, wages are equal in both sectors. Hence, the household is indifferent regarding the sectoral allocation of labor, which is then determined by firms' labor demand.

An important assumption we need to make is that one of the goods must be non-tradable. This assumption is essential to be able to solve for the equilibrium of this economy. If both goods were tradable, the relative price between the two goods would be exogenously given. As a result, the equilibrium system of equations would be overdetermined due to conditions on factor prices across sector that must be satisfied.¹³

We therefore assume that only the durable good can be traded across borders. Our choice is supported by empirical evidence which states that durables account for most of trade in

¹¹We do not restrict $X_{k,t}^n$, $X_{k,t}^d$ and $X_{d,t}$ to be positive. This implies that agents can move capital from one sector to the other, or transform consumer durables into capital (and viceversa). In any case, the sector-specific adjustment cost must be paid. This means that the stock of consumer durables and capital in each sector are state variables.

¹²To generate the observed lumpiness and discontinuous nature of this expenditure at the micro level, however, some degree of consumer heterogeneity and non-convexities in the adjustment technology is needed (see Caballero, 1993).

¹³See Appendix A.5 for a more detailed argument.

goods. For instance, Engel and Wang (2011) find that, for OECD countries, the average share of durables in imports and exports of goods (excluding raw materials and energy) is 69 and 65 percent, respectively. For Mexico, these shares increase to 74 and 78 percent. Mexican data also reveals that domestic nondurable goods represent nearly 96 percent of total nondurable consumption.

Finally, asset markets are incomplete. The only financial asset is an internationally traded one-period bond whose non-contingent payments are defined in units of durable goods. We denote q_t as the price of the bond, and B_{t+1} as the amount of bonds bought by the household at period t . In other words, negative values of B_{t+1} represent borrowing from abroad. As in Schmitt-Grohé and Uribe (2003), households take the bond price as given, which is endogenously affected by country fundamentals. Specifically, the bond price depends on the aggregate bond position \tilde{B}_{t+1} as well as on (expected) next-period output Y_{t+1} . The bond price is given by the following expression:

$$q_t^{-1} = 1 + r^* + \chi \left[\exp\left(\frac{\tilde{B}_{t+1}}{\Gamma_t} - \bar{B}\right) - 1 \right] + \eta \left(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y} \right), \quad (13)$$

where r^* is the exogenous interest rate, and $-\bar{B}$ and \bar{Y} are the steady-state levels of (detrended) aggregate debt and output.¹⁴

The borrowing premium implicit in (13) can be seen as a reduced form of several underlying mechanisms associated with financial frictions, which are central to our analysis. The term $\eta \left(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y} \right)$, with $\eta < 0$, could potentially generate a countercyclical real interest rate typically observed in emerging economies (see Neumeyer and Perri, 2005, for instance), possibly as a consequence of a higher perceived probability of default as in Eaton and Gersovitz (1981). The other term, $\chi \left[\exp\left(\frac{\tilde{B}_{t+1}}{\Gamma_t} - \bar{B}\right) - 1 \right]$, is standard in this literature and often seeks to prevent a non-stationary behavior of net foreign assets (Schmitt-Grohé and Uribe, 2003).

The competitive equilibrium allocation of this economy is equivalent to the allocation cho-

¹⁴Clearly, in equilibrium, $B_{t+1} = \tilde{B}_{t+1}$.

sen by a social planner who takes as given the bond price q_t .¹⁵ Therefore, we focus on the planner's problem and solve for the (constrained) Pareto optimal allocation. Since the economy features a stochastic trend, finding a stationary solution requires making the following variable transformation. Define $\hat{W}_t \equiv W_t/\Gamma_{t-1}$ as the detrended counterpart of W_t .

In order to define the stationary planner's problem, let $S = (\hat{D}, \hat{K}_d, \hat{K}_n, \hat{B}, z_d, z_n, g)$ be the state vector and $x = (\hat{N}, \hat{D}', \hat{K}'_d, \hat{K}'_n, \hat{B}', L, L_d, L_n)$ be the choice vector. It is also useful to denote $\tilde{\beta} \equiv \beta e^{g\theta(1-\sigma)}$ and drop time subscripts. The following Bellman equation describes the planner's dynamic programming problem:

$$V(S) = \max_x \left\{ \frac{\left(\hat{C}^\theta (1-L)^{1-\theta} \right)^{1-\sigma}}{1-\sigma} + \tilde{\beta} E[V(S')|S] \right\} \quad (14)$$

subject to

$$\hat{N} + \Omega F_d(\hat{K}_d, L_d, z_d, e^g) = F_n(\hat{K}_n, L_n, z_n, e^g), \quad (15)$$

$$\begin{aligned} e^g(\hat{D}' + \hat{K}'_n + \hat{K}'_d + q\hat{B}') &= F_d(\hat{K}_d, L_d, z_d, e^g) + (1 - \delta_k)(\hat{K}_n + \hat{K}_d) + (1 - \delta_d)\hat{D} - \\ &\quad \frac{\phi}{2} \left(e^g \frac{\hat{K}'_d}{\hat{K}_d} - \mu_g \right)^2 \hat{K}_d - \frac{\phi}{2} \left(e^g \frac{\hat{K}'_n}{\hat{K}_n} - \mu_g \right)^2 \hat{K}_n - \\ &\quad \frac{\psi}{2} \left(e^g \frac{\hat{D}'}{\hat{D}} - \mu_g \right)^2 \hat{D} + \hat{B}, \end{aligned} \quad (16)$$

$$L = L_n + L_d \leq 1, \quad (17)$$

$$\hat{C} = (\mu \hat{N}^{-\gamma} + (1 - \mu) \hat{D}^{-\gamma})^{-\frac{1}{\gamma}}, \quad (18)$$

together with stochastic processes (4)-(6) and with the usual nonnegativity constraints $L_i \geq 0$, $K'_i \geq 0$, $i \in \{n, d\}$, $N \geq 0$, and $D' \geq 0$.

Equation (15) is the feasibility condition for nondurable goods and reflects the assumption that these goods are non-tradable as well as the fact that optimal intermediate goods demand

¹⁵In the Appendix we show this equivalence.

satisfies $\hat{M}_n = \Omega F_d(\hat{K}_d, L_d, z_d, e^g)$. Equation (16) is the resource constraint for durable goods. It incorporates the fact that these goods are tradable and that the foreign bond is specified in units of durable goods.

In the Appendix we derive the optimality conditions associated with the planner's problem. With these equations and resources constraints, we solve for the optimal allocation using Dynare which linearizes the model around its deterministic steady state.

4 Quantitative Results

In this section, we calibrate the parameters associated with the deterministic steady-state version of the model and estimate the remaining parameters by Generalized Method of Moments (GMM). We parameterize the model to the Mexican economy at a quarterly frequency.¹⁶

4.1 Calibration

Starting with the technology parameters, we set $\alpha_n = 0.52$ and $\alpha_d = 0.32$ to match the income shares of labor of 0.48 and 0.68 in the nondurable and durable sectors, respectively, as in Baxter (1996). From the same source, the annual depreciation rates for capital and durables are set to 7.1 and 15.6 percent. We set the intermediate input coefficient Ω to 0.3, which is close to what Kouparitsas (1998) documents for Mexico (0.28) and, for instance, within the range (between 0.26 and 0.38, depending on the measure) observed for the U.S. by Hornstein and Praschnik (1997). We set $\mu_g = 1.0074$ to match the average quarterly GDP gross growth rate in our sample.

The exogenous interest rate r^* is set to satisfy the steady-state condition $\beta(1 + r^*) = \mu_g^{1-\theta(1-\sigma)}$. The steady-state debt level $-\bar{B}$ is set such that its ratio to GDP is 10 percent.¹⁷ The parameter χ that determines the sensitivity of the bond price to the debt level is set to -0.001,

¹⁶In the Appendix we describe the sources of the Mexican data we use.

¹⁷This ratio only matters to determine the steady-state level of net exports and is immaterial for results.

which is standard in the literature (see Schmitt-Grohé and Uribe, 2003, Neumeyer and Perri, 2005, Aguiar and Gopinath, 2007). The choice of a small value for χ (but different from zero) is justified by the need to avoid the well-known unit root problem of net foreign assets in small open economy models without changing the short-run dynamics as Schmitt-Grohé and Uribe argue.¹⁸

As for the preference parameters, we work with a discount factor β of 0.98 and a coefficient of relative risk aversion σ of 2, which are standard values in the RBC literature. We set $\gamma = 0.163$ to match an elasticity of substitution between goods ($\frac{1}{1+\gamma}$) of 0.86, as in Gomes, Kogan, and Yogo (2009).¹⁹ Finally, given the previous parameter values, we calibrate the utility share of nondurables μ and the Cobb-Douglas exponent for consumption in the utility function θ to jointly match the average share of nondurable consumption in total consumption expenditure of 91.8 percent and a steady-state fraction of time devoted to work of 1/3. This yields $\mu = 0.883$ and $\theta = 0.426$. We summarize the calibrated parameter values in Table 3.

4.2 GMM Estimation Results

We estimate the remaining 10 parameters using GMM. These parameters are the standard deviation of the technology shocks, σ_g , σ_n and σ_d ; the autocorrelation coefficients of the shock processes, ρ_g , ρ_n and ρ_d ; the correlation between sectoral shocks ρ_{nd} ; the coefficients of the adjustment cost of durable goods and capital, ψ and ϕ ; and the financial friction parameter η .²⁰

We include the following 17 moment conditions: the standard deviations of output $\sigma(y)$, output growth $\sigma(\Delta y)$, the net exports-output ratio $\sigma(nx)$, and the borrowing premium $\sigma(bp)$; the

¹⁸Strictly speaking, χ does not affect the steady state because its corresponding term in the bond price equation is zero in the steady state. We choose to calibrate this parameter and set it to a standard value in order to limit its role to render the model stationary. In our model with financial frictions we focus on the parameter η which we associate with the induced country-risk hypothesis of Neumeyer and Perri (2005) and is more in line with a well-known empirical fact, namely, the countercyclical borrowing premium in emerging economies.

¹⁹This value means that the two goods are gross substitutes (the condition being $\sigma > 1 + \gamma/\theta$). It is also consistent with Ogaki and Reinhart's (1998) finding that the intratemporal elasticity of substitution between durables and nondurables is significantly higher than the intertemporal elasticity of substitution. In addition, it is close to the value assumed by Hornstein and Praschnik (1997) of unit elasticity.

²⁰Notice that none of these parameters affect the steady state around which the linearization is performed.

standard deviations relative to that of output of total consumption expenditure $\frac{\sigma(c)}{\sigma(y)}$, nondurable consumption $\frac{\sigma(c_n)}{\sigma(y)}$, durable expenditure $\frac{\sigma(c_d)}{\sigma(y)}$, and investment $\frac{\sigma(i)}{\sigma(y)}$; the correlation of output with total consumption $\rho(y, c)$, investment $\rho(y, i)$, the net exports-output ratio $\rho(y, nx)$, and the borrowing premium $\rho(y, bp)$; the correlation between sectoral outputs $\rho(y_n, y_d)$, and the first-order autocorrelation of output $\rho(y_t, y_{t-1})$, output growth $\rho(\Delta y_t, \Delta y_{t-1})$, and both sectoral outputs $\rho(y_{j,t}, y_{j,t-1})$, $j = \{n, d\}$. All variables are in logs, except the net export-output ratio. We also HP filter all variables, except output growth (Δy_t) which is the first difference of (unfiltered) log output. Furthermore, moment conditions are based on theoretical moments.

The estimated parameter values with standard errors in parentheses are shown in Table 4. We also report the random walk component of sectoral Solow residuals (as calculated by Aguiar and Gopinath, 2007), the share of output volatility attributed to shocks to trend, and the p -value for the J -test of over-identifying restrictions. Table 5 displays the corresponding theoretical and empirical moments.

We begin by estimating a constrained version of the model with $\eta = 0$. We call this specification the *no financial frictions* case. Column 1 in Tables 4 and 5 reports the results for this specification. Column 2 shows the results of the full estimation of the model with financial frictions, where we estimate the whole vector of 10 parameters, including η . We associate this parameter with financial frictions, which is consistent with Neumeyer and Perri's (2005) *induced country risk* hypothesis.

In Table 4 we observe that parameter values in column 2 are estimated with higher precision as standard errors are smaller than in column 1, except for ρ_g , which in both cases is not statistically different from zero. In column 2, all other estimates are significant at 0.01 level. In column 1, however, estimates of ρ_{nd} , ψ and ϕ are not significantly different from zero. It is also worth noting that p -values of the J -statistic for both specifications show that the moment conditions are valid.

In column 1, our estimate of σ_d is larger than σ_n . This is consistent with empirical evidence

for other countries. For instance, Hornstein and Praschnik (1997) and Erceg and Levin (2006) find a more volatile productivity shock in the durable goods sector in the U.S. Using a sample of 111 countries, Braun and Larrain (2005) find industries producing durable goods to be more responsive to recessions.

Specification 1 yields highly persistent temporary shocks with both ρ_n and ρ_d over 0.9, in line with Aguiar and Gopinath (2007). We also obtain a correlation of sectoral shocks ρ_{nd} of 0.5 which is consistent with the findings of Hornstein and Praschnik (1997) for the U.S., who estimate a correlation of sectoral productivity innovations of 0.6.

These estimation results suggest that shocks to trend play a less important role in driving business cycle fluctuations in emerging economies than what Aguiar and Gopinath (2007) find. Our estimates imply that the random walk components ω_n and ω_d are well below the range between 0.88 and 1.13 that Aguiar and Gopinath report for Mexico. As a result, trend shocks account for 37 percent of GDP volatility.²¹

The model with no financial frictions, however, does not deliver the so-called excess volatility of consumption, a central feature of business cycles in emerging economies. This happens because it significantly underestimates the volatilities of both durable and nondurable consumption expenditure (see column 1 of Table 5). In principle, we could match the volatility of total consumption relative to output observed in the data by increasing σ_g . The solid line in Figure 1 illustrates this point. There we plot the volatilities of total consumption, durable expenditure and the net export-output ratio, and the correlation of the net exports-output ratio with output against σ_g .²² This figure also shows that increasing σ_g generates a more counter-cyclical net exports-output ratio, which the model underestimates as well.

The main reason why σ_g is not sufficiently large is because we are also targeting the volatilities of durable expenditure and the net exports-output ratio. This imposes discipline on our

²¹Given Aguiar and Gopinath's (2007) full estimation results for Mexico (see column 4 of their table 4), we calculate that trend shocks account for 77 percent of output fluctuations in their model.

²²The remaining parameters are fixed at the same values estimated in specification 1.

GMM estimation which tends to reduce the importance of shocks to trend. This happens because increasing σ_g in order to match $\frac{\sigma(c)}{\sigma(y)}$ comes at the expense of overestimating $\frac{\sigma(c_d)}{\sigma(y)}$ and $\sigma(nx)$.²³ Our assumption on tradability is crucial to get these two moments to behave in this fashion. It establishes a tight link between the dynamics of durable expenditure and net exports that implies a joint response to shocks which, in turn, makes their volatilities move together.

The moment conditions $\frac{\sigma(c_d)}{\sigma(y)}$ and $\sigma(nx)$ as well as $\rho(y, nx)$ also put a bound on the persistence of the shock to trend and, consequently, the size of the random walk component of total factor productivity. An alternative way of increasing the volatility of consumption relative to output is by having a very persistent trend shock (i.e., ρ_g over 0.9). This makes not only durable expenditure and the net exports-output ratio too volatile but also the latter strongly procyclical. The increase in $\frac{\sigma(c_d)}{\sigma(y)}$ and $\sigma(nx)$ is due to the fact that, with higher ρ_g , any given shock to trend affects the average productivity growth rates for a longer period. Agents respond to this larger change in future income by adjusting their stock of durables and capital more, which in turn makes net exports more responsive as well. The procyclicality of net exports comes from the fact that, with highly persistent shocks to trend, a positive shock causes output to initially fall because labor supply also decreases due to the strong positive income effect.

Figure 1 also shows the response of the selected moments when the rate of depreciation of durables δ_d takes two larger values: 0.5 and 1.²⁴ We observe that, for any given σ_g , a higher δ_d implies lower $\frac{\sigma(c)}{\sigma(y)}$ and $\sigma(nx)$. Moreover, these two moments respond less to a change in σ_g when δ_d is higher. As a result, when durability is low (the two higher δ_d), it takes a large σ_g to deliver a sufficiently volatile total consumption. In contrast, when durability is high

²³In order to explore to what extent these two moments conditions prevent σ_g from being sufficiently large, we do the following estimation exercise. We estimate $(\sigma_g, \sigma_n, \sigma_d)$ by targeting the following four moments: $(\sigma(y), \frac{\sigma(c)}{\sigma(y)}, \frac{\sigma(c_n)}{\sigma(y)}, \frac{\sigma(i)}{\sigma(y)})$. We set the remaining parameters to their estimated value in specification 1. We obtain much larger shocks to trend relative to transitory ones. In particular, we obtain $\sigma_g = 1.91$, $\sigma_n = 1.04$ and $\sigma_d = 0.85$. As a result, shocks to trend account for about 55 percent of output volatility, well above what we obtain in specification 1. Moreover, the model overestimates the volatilities of consumer durable expenditure and of the net export-output ratio, yielding 4.54 and 2.05, respectively.

²⁴In these cases, we recalibrate the parameters μ and θ in order to keep unchanged the share of consumption of both goods and the time devoted to work in the steady state.

($\delta_d = 0.039$), a small σ_g generates a high volatility of consumption. This shows that adding consumer durable goods into the model provides an amplification mechanism of shocks to trend. Therefore, these shocks do not need to be as large, which lowers their importance relative to transitory shocks as driving force of output fluctuations.

Another important reason why consumption volatility in our model without financial frictions is not as high as in the data is the strongly procyclical borrowing premium, which makes consumption spending smoother. In addition, it causes net exports to be much less countercyclical than in the data. Figure 2 shows the effect on consumption and net exports of introducing financial frictions in the model by decreasing the borrowing premium parameter η . As this parameter becomes more negative, the borrowing premium becomes countercyclical, consumption becomes more volatile, and the correlation of net exports-output ratio with output becomes even more negative.

The estimation of the model with financial frictions (specification 2) yields a negative η which generates a countercyclical borrowing premium in line with the empirical evidence.²⁵ As a consequence, consumption expenditure is indeed more volatile than output and net export are much more countercyclical (see column 2 of Table 5). The intuition of these results can be found in the interaction between the accumulation of durables and the countercyclical borrowing premium. Since the financial friction allows the model to generate a countercyclical and more volatile interest rate, during economic booms agents take advantage of cheaper credit by borrowing more in order to increase the stock of durables as well as capital. Since durable goods are tradable, part of the accumulation of durables and capital resorts to imports. As a consequence, net exports fall more and consumption expenditure and investment increase more during economic expansions making the net exports-output ratio more countercyclical and consumption more volatile relative to output. In fact, when we shut down the financial friction, $\frac{\sigma(c)}{\sigma(y)}$ and $\rho(y, nx)$ fall to 0.99 and -0.21, respectively.

²⁵This is also consistent with Neumeyer and Perri's (2005) findings.

To further illustrate the role of financial frictions, we plot, in Figure 3, the impulse-response functions of consumption, investment and the net exports-output ratio for two cases: $\eta = -0.033$ (solid line), as estimated, and $\eta = 0$. The top three graphs show the impact of a transitory shock to the nondurable goods sector whereas the bottom three display the effect of a shock to the durable goods sector. Financial frictions help transitory shocks generate not only more volatile consumption but also a countercyclical net exports. Without financial frictions, we observe that the net exports-output ratio tends to behave procyclically since investment and consumption do not respond enough when a shock occurs.²⁶ In contrast, with financial frictions, consumption and investment increase sufficiently to generate a drop in the net exports-output ratio.

The very different response of consumption to a transitory shock with and without financial frictions is mostly explained by the behavior of durable expenditure. Similarly to investment, it responds much more to shocks in the presence of financial frictions because of the intertemporal substitution effect associated with changes in the interest rate.

The addition of financial frictions yields less persistent transitory shocks with $\rho_n = 0.79$ and $\rho_d = 0.7$. Moreover, sectoral shocks are less positively correlated, with an estimate of $\rho_{nd} = 0.3$. This happens because financial frictions introduce a propagation mechanism through which sectoral shocks affect the economy both across sectors and over time.

We obtain $\sigma_d = 1.34$ which is lower than our estimate in specification 1 because financial frictions amplify the effect of transitory shocks on durable expenditure and investment. Hence, these shocks do not need to be as large to generate as much volatility in these variables. In contrast, our estimate of $\sigma_n = 1.35$ is larger mainly because sectoral shocks are not as correlated which tends to decrease the volatility of nondurable consumption relative to output.

²⁶In fact, total consumption falls after a positive shock hits the durable goods sector because nondurable consumption falls more than what durable expenditure increases. This drop in nondurable consumption is caused by the drop in output in this sector, as labor is directed to the durable goods sector which is experiencing a boost in productivity. In addition, as output in the durable sector increases, nondurable intermediate goods increase as well, which leaves less nondurable output for consumption.

In regard to shocks to trend, we estimate $\sigma_g = 1.84$ which is slightly larger than the value we obtain in specification 1. However, these two estimates do not significantly differ from each other, which is also the case for ρ_g .

These estimates imply that the random walk component of the sectoral Solow residuals are 0.56 and 0.36 in the durable and nondurable sectors, respectively, which are similar to those of specification 1. Thus, these measures of the importance of the shock to trend are also well below of the range found by Aguiar and Gopinath (2007) for Mexico. The variance decomposition of GDP shows that trend shocks account for about 48 percent of output fluctuations.

One important question is whether the model with durable goods needs a smaller degree of financial frictions, measured by η , to deliver the required dynamics. We have argued that the presence of durable goods provides a channel that amplifies shocks and helps explain the cyclical behavior of key variables (see Figure 1). Therefore, it is likely that the omission of the *durability channel* has implications for the estimate of η . Impulse-response functions for different degrees of durability suggest this.²⁷ Differences in the responses of durable expenditure and the net exports-output ratio are remarkable.

To explore this further, we carry out a calibration exercise in which we solve for η , together with $(\sigma_g, \sigma_n, \sigma_d)$, targeting the following four moments: $\sigma(y)$, $\frac{\sigma(c)}{\sigma(y)}$, $\sigma(nx)$ and $\rho(y, bp)$. We do that for $\delta_d = \{0.039, 1\}$.²⁸ In the case of no durability ($\delta_d = 1$), the resulting η is, in absolute value, about 22 percent larger than in the case with $\delta_d = 0.039$. Therefore, when we consider durable goods, the model does indeed require a smaller degree of financial frictions.

In conclusion, we have two main findings. First, including durable goods in an RBC model for emerging economies reduces the role of trend shocks relative to what has been found in the literature. Second, to replicate the observed high volatility of consumption and countercyclicality of net exports and the borrowing premium, we need to incorporate financial frictions.

²⁷We plot IR functions with our benchmark $\delta_d = 0.039$ and $\delta_d = 1$. These IR plots are available upon request.

²⁸When $\delta_d = 1$, there are only nondurable goods. Hence, we also set $\psi = 0$, and recalibrate (μ, θ) .

4.3 Robustness

In this subsection we perform a number of exercises to check the robustness of the main results presented above. In each case, we reestimate the model with financial friction, which makes our specification 2 our point of reference for comparison purposes. The parameter estimates and resulting theoretical moments for each exercise are shown in columns 3 through 8 of Tables 4 and 5.

The first two robustness checks investigate the role of two of the sources of sectoral comovement: correlated sectoral shocks and intermediate inputs in the production of durable goods. In the former case, we impose $\rho_{nd} = 0$. In the latter, we set $\Omega = 0$. Columns 3 and 4, respectively, show the results.

When we have uncorrelated sectoral shocks, the estimation yields larger shocks to trend ($\sigma_g = 1.92$) relative to specification 2. The estimate of σ_n also increases whereas σ_d falls. Moreover, the persistence of both sectoral productivity processes decreases. Instead, ρ_g remains roughly unchanged. Overall, this implies an increase in the importance of shocks to trend, measured by their contribution to output volatility, from 48 to 55 percent. The intuition for this result is that the (common) permanent productivity shock makes up for the lack of correlation of sectoral shocks in order to generate the strong positive correlation between sectoral outputs in the data.

This specification also generates little negative correlation between the borrowing premium and output of -0.03. The reason for this acyclical behavior of the borrowing premium is that trend shocks play a more important role. The main mechanism behind this relationship is as follows. A positive trend shock implies an increase in long-run output and, in consequence, an increase in debt as households borrow more. Since the interest rate tends to increase as debt goes up (due to $\chi < 0$), a larger σ_g tends to make the interest rate procyclical.

In conclusion, imposing $\rho_{nd} = 0$ biases the importance of permanent shocks upward because the only way to generate more sectoral comovement is through σ_g . Even in these case,

however, our model estimates a much less prominent role of shocks to trend than what Aguiar and Gopinath (2007) find.

When we shut down the intermediate input channel (i.e., $\Omega = 0$), the estimation results show one important change with respect to our specification 2. That is, the estimate of ρ_{nd} significantly increases from 0.30 to 0.43 in order to make up for the lack of inter-sectoral linkages. Another somewhat significant change is in the estimate of σ_d which decreases from 1.34 to 1.19. Instead, σ_g and σ_n only slightly fall. Ultimately, the contribution of shocks to trend to output volatility remains at 48 percent. Furthermore, the model generates basically the same moments as the benchmark case with $\Omega = 0.3$. Therefore, the presence of intermediate inputs is not crucial for our results to hold.

A related question is whether our assumption of no substitutability between value added and intermediate inputs in the production of durable goods is too restrictive (i.e., Leontief technology). To explore this, we use a Cobb-Douglas technology which assumes an elasticity of substitution equal to 1. The results, shown in column 5, are essentially the same as in specification 2. We can conclude that our results are not being driven by the assumption of zero elasticity of substitution between intermediate inputs and value added.

We also investigate whether our results hold with GHH preferences, which are often used in the RBC literature. The main result of this exercise is that shocks to trend play a much less important role than in our benchmark case with Cobb-Douglas preferences. These shocks now account for 22 percent of output volatility. This happens because hours worked are much more responsive to shocks to trend because, with GHH preferences, there is no wealth effect on labor supply. As a result, output, durable expenditure, investment and net exports become more volatile than what is found in the data and in specification 2. Financial frictions do not have to be as large and the parameter η falls in absolute value from -0.033 to -0.016. We conclude that the assumption of GHH preferences strengthens our findings.

Next we consider two distinct configurations of the borrowing premium. First, we introduce

a new financial friction in the form of an orthogonal shock (Uribe and Yue, 2006, argue that this is important to explain the behavior of country interest rate premia). Then, we allow for transitory and permanent income shocks to impact the borrowing premium differently.

With the first modified version of the borrowing premium we want the model to generate a more volatile borrowing premium than what we get with our benchmark specification. Now equation (13) becomes

$$q_t^{-1} = 1 + r^* + \chi \left[\exp\left(\frac{\tilde{B}_{t+1}}{\Gamma_t} - \bar{B}\right) - 1 \right] + \eta \left(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y} \right) + \varepsilon_b,$$

where ε_b represents the i.i.d. shock with variance σ_b^2 , which we also estimate. Results are shown in column 7 of Tables 4 and 5. The estimate of $\sigma_b = 0.26$ causes the volatility of the borrowing premium to roughly double with respect to specification 2. The augmented model also delivers a smaller shock to trend, as σ_g goes from 1.84 to 1.34. This happens precisely because the volatility of the borrowing premium increases, which in turn makes durable expenditure and net exports more volatile. Thus, the introduction of orthogonal shocks to the borrowing premium reduces the contribution of trend shocks in terms of output volatility to 30 percent and financial frictions are still needed. Therefore, our main results remain.

The second robustness test on the specification of the borrowing premium requires incorporating an extra term in the borrowing premium that depends directly on the shock to trend ε_g . In particular, we consider the following version of equation (13):

$$q_t^{-1} = 1 + r^* + \chi \left[\exp\left(\frac{\tilde{B}_{t+1}}{\Gamma_t} - \bar{B}\right) - 1 \right] + \eta \left(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y} \right) + \nu \varepsilon_g.$$

The reason why we add the term $\nu \varepsilon_g$ is because trend shocks have a different effect on the borrowing premium than transitory shocks do. A positive shock to trend causes output to be initially below its *new* trend. Given $\eta < 0$, this positive shock makes the borrowing premium increase and, therefore, tends to make it procyclical. Transitory shocks have the opposite effect.

The new term allows the borrowing premium to respond differently to permanent and transitory shocks. Our estimation results (column 8) show the borrowing premium responding positively to trend shocks ($\nu = 0.10$, even if statistically not significantly different from zero). This, however, generates a higher volatility of the borrowing premium compared to specification 2, which tends to make durable expenditure and net exports more volatile. The estimate of σ_g falls and trend shocks contribute less to output volatility. We can conclude from this exercise that our main findings are robust to how we specify the borrowing premium.

5 Conclusions

This paper presents a small open economy neoclassical growth model with consumer durables, nondurable goods, shocks to trend, and temporary sector-specific shocks. We calibrate the model to the Mexican economy as representative of an emerging economy. We find that, in a model with durable goods, financial frictions in the form of a countercyclical country risk premium play an essential role in explaining important empirical business cycle facts in emerging economies such as a highly volatile consumption and strongly countercyclical trade balance and borrowing premium. For this reason, while still finding shocks to trend relevant in explaining output and consumption fluctuations in developing countries, our results reinforce those of García-Cicco et al. (2010).

A natural extension to this paper is to consider other types of shocks. For instance, exogenous shocks to the borrowing premium when durables and nondurables are present should be considered as a complementary explanation, as the work by Uribe and Yue (2006), Fernández-Villaverde et al. (2009) and Gruss and Mertens (2009) seem to suggest. We find that orthogonal shocks to the interest rate help generate more volatile consumption and net exports and, in consequence, reduce the role of permanent shocks to productivity. We believe that other types of shocks to the borrowing premium may also play a role and that more work is needed.

Another possibility for future research could consider exploring the importance of other

types of financial frictions and external shocks in explaining the properties of business cycles in emerging markets. For example, we can think of shocks to external wealth which interact with domestic spending in a variety of ways. One interesting research avenue is to study how these shocks trigger a portfolio rebalancing and cause foreign investors to sell out assets in emerging markets. This in turn depresses domestic asset prices and lowers permanent income thereby affecting consumption of both durables and nondurables.

An alternative driving force to be considered, under the presence of durable goods, comes from shocks to the terms of trade. Many emerging economies are fundamentally producers of commodities and the prices of many commodities, by their nature, are subject to regime switching. Consider, for example, an increase in the variance of the terms of trade. As external income becomes more volatile, default incentives become smaller and, as a consequence, foreign debt conditions endogenously improve. On the one hand, this allows for smoother consumption of nondurables, but on the other hand, the purchase of durables may react as households want to take advantage of better borrowing conditions. As a consequence, this type of shocks may imply a high volatility in the purchase of durable goods and a relatively small volatility of consumption of nondurables with respect to income volatility. This extension would also be important in adding micro-foundations to the borrowing premium within a business cycle model, an important avenue for future research.

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Figure 1: Effect of shocks to trend on consumption and net exports.

A-B: The standard deviations of total consumption expenditure and durable expenditure relative to the standard deviation of output as a function of σ_g . C-D: The standard deviation and the correlation with output of the net-export-output ratio as a function of σ_g . All variables are HP filtered. We draw each each figure for three values of δ_d : 0.039 (our benchmark), 0.5 and 1. For $\delta_d = 0.039$, we use benchmark parameters in Table 3. For $\delta_d = \{0.5, 1\}$, we recalibrate μ and θ . The remaining parameters correspond to specification 1 in Table 4 except σ_g that takes values from 0 to 5.

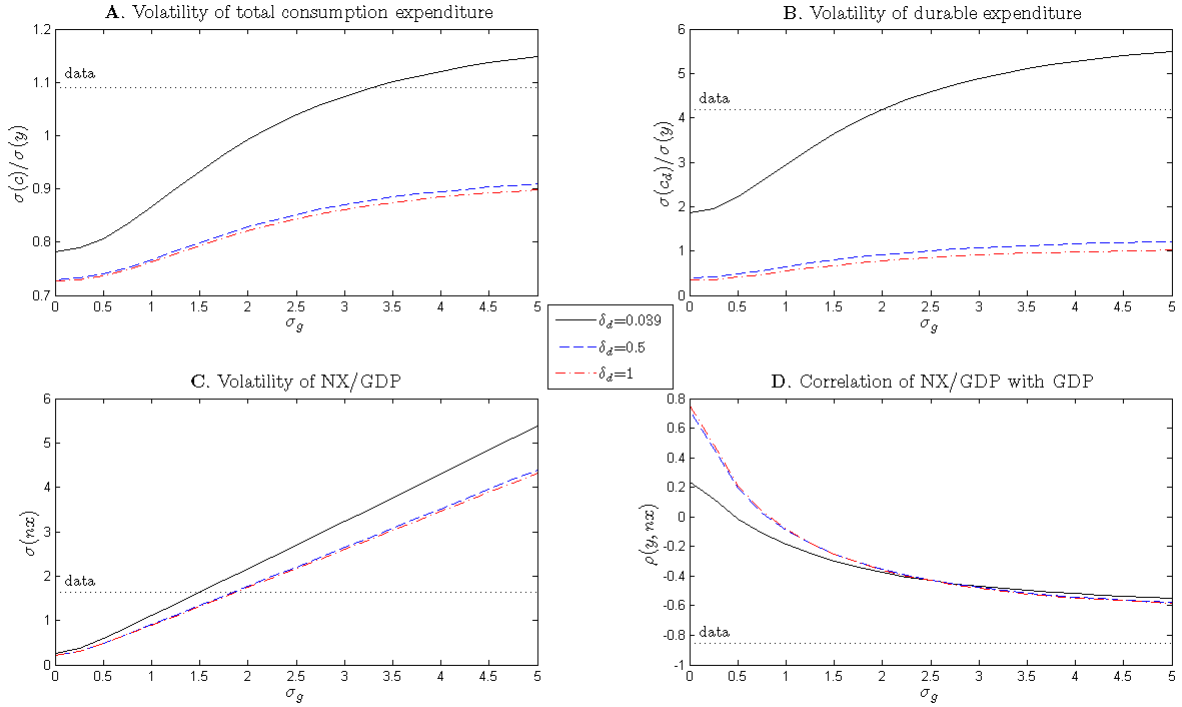


Figure 2: Effect of financial frictions on consumption and net exports.

A-B: The standard deviations of total consumption expenditure, nondurable consumption and durable expenditure relative to the standard deviation of output as a function of η . C-D: The correlation with output of the net-export-output ratio and the borrowing premium as a function of η . All variables are HP filtered. We use benchmark parameters in Table 3 and estimates for specification 1 in Table 4 except η that takes values from -0.01 to 0.

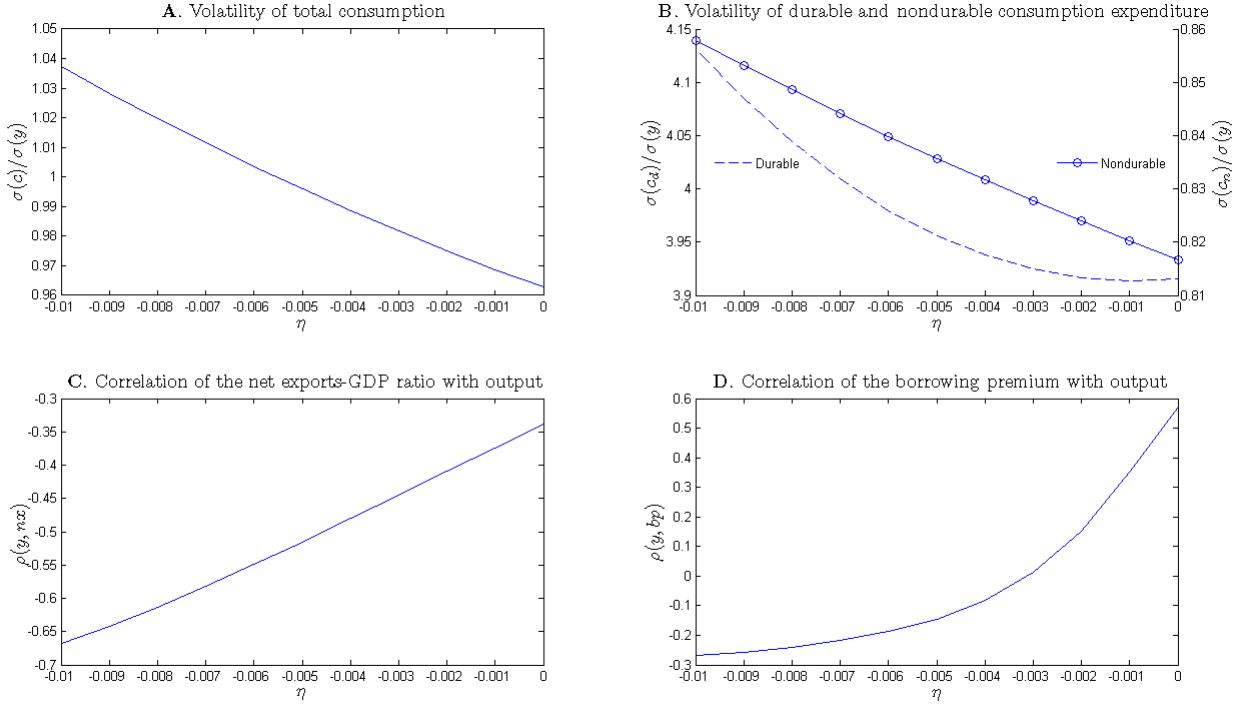


Figure 3: Impulse-response functions for transitory shocks.

A: Impulse-response (IR) functions for a transitory shock to productivity in the nondurable goods sector of total consumption, investment and the net exports-output ratio. B: IR functions for a transitory shock to productivity in the durable goods sector of total consumption, investment and the net exports-output ratio. All variables are in levels. We use benchmark parameters in Table 3 and estimates for specification 2 in Table 4 except η that also takes value 0.

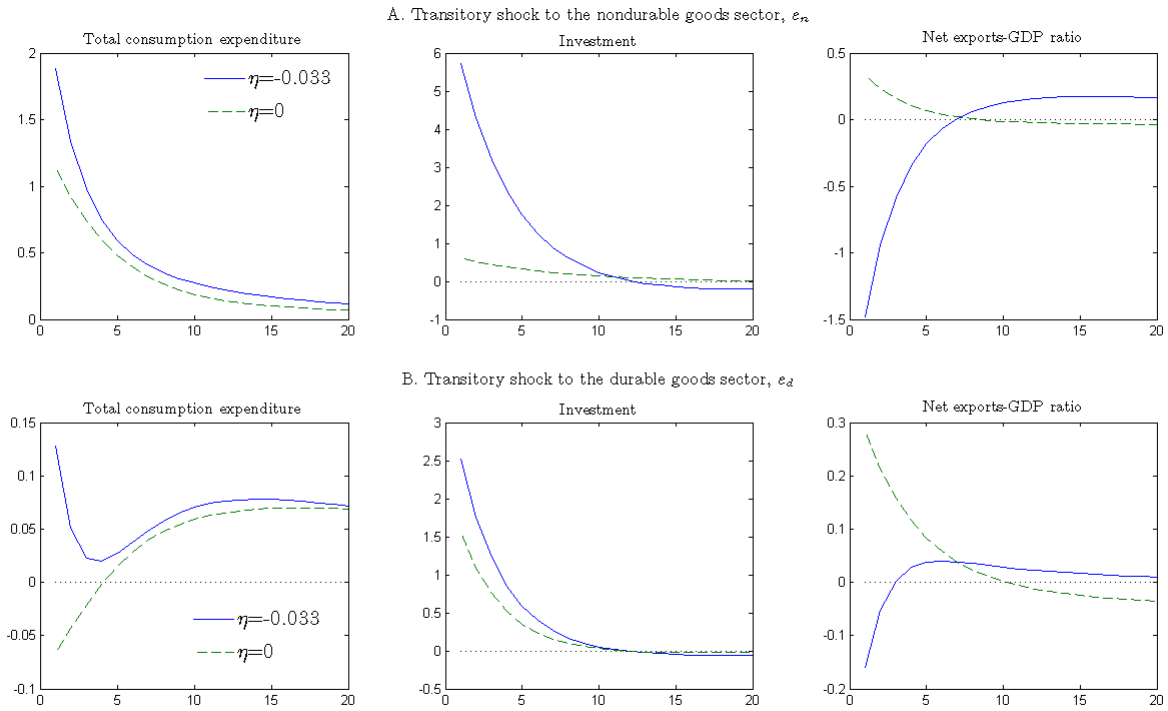


Table 1: Business Cycle Moments in Emerging Market Economies

Macroeconomic volatility measured by standard deviation (σ) of quarterly GDP (y), total consumption expenditure (c), consumption of nondurable goods (c_n), expenditure in durable goods (c_d), investment (i), and net exports-GDP ratio (nx). Cyclical properties of macroeconomic variables measured by contemporaneous correlations (ρ) with quarterly GDP of total consumption expenditure, consumption of nondurable goods, expenditure in durable goods, investment, and net exports-GDP ratio. All variables are in logs (except nx) and detrended using the HP filter. Country weights for sample average calculated using current U.S. dollar GDP in the year 2000. Standard deviation of sample (country GDP and sample size weighted) average in parenthesis.

Country	Sample	$\sigma(y)$	$\frac{\sigma(c)}{\sigma(y)}$	$\frac{\sigma(c_n)}{\sigma(y)}$	$\frac{\sigma(c_d)}{\sigma(y)}$	$\frac{\sigma(i)}{\sigma(y)}$	$\sigma(nx)$	$\rho(y, c)$	$\rho(y, c_n)$	$\rho(y, c_d)$	$\rho(y, i)$	$\rho(y, nx)$
Chile	96:1-03:IV	1.70	1.10	0.76	5.74	4.28	1.68	0.93	0.91	0.89	0.90	-0.46
Colombia	00:1-08:III	1.01	1.01	0.87	2.39	3.39	0.75	0.87	0.85	0.61	0.73	-0.44
Czech Republic	96:1-08:III	1.13	0.93	0.94	3.17	3.02	1.13	0.52	0.52	0.01	0.41	0.18
Estonia	95:1-08:III	2.23	1.33	1.25	3.05	3.79	1.23	0.78	0.80	0.49	0.79	-0.49
Hong Kong	73:1-08:III	4.65	0.97	0.88	2.68	1.28	0.65	0.53	0.46	0.41	0.50	0.55
Hungary	01:1-08:III	0.94	1.32	1.18	5.94	3.39	1.94	0.33	0.25	0.20	0.16	-0.13
Israel	95:1-08:III	1.97	0.90	0.92	3.93	2.22	0.75	0.74	0.58	0.78	0.62	0.21
Korea	70:1-08:III	2.35	1.11	0.94	4.18	4.20	0.81	0.84	0.84	0.83	0.83	-0.61
Mexico	93:1-07:IV	2.35	1.09	0.89	4.19	3.67	1.64	0.94	0.92	0.92	0.95	-0.86
Poland	99:1-08:III	1.13	0.83	0.76	4.79	4.30	0.75	0.45	0.43	0.27	0.81	-0.39
Slovak Republic	97:1-08:III	1.58	1.04	0.98	2.59	4.01	1.59	0.53	0.51	0.39	0.57	-0.01
Slovenia	96:1-08:III	0.87	1.30	0.82	9.01	6.28	1.94	0.40	0.53	0.07	0.51	-0.12
South Africa	60:1-08:III	1.54	1.30	1.04	5.42	3.74	1.33	0.73	0.67	0.61	0.63	-0.58
Turkey	87:1-07:III	3.44	1.50	0.92	4.61	4.34	3.25	0.90	0.87	0.83	0.71	-0.70
Average		2.51 (0.13)	1.14 (0.03)	0.93 (0.02)	4.22 (0.24)	3.65 (0.14)	1.12 (0.09)	0.79 (0.03)	0.76 (0.02)	0.71 (0.04)	0.77 (0.03)	-0.48 (0.05)

Table 2: Business Cycle Moments in Developed Economies

Macroeconomic volatility measured by standard deviation (σ) of quarterly GDP (y), total consumption expenditure (c), consumption of nondurable goods (c_n), expenditure in durable goods (c_d), investment (i), and net exports-GDP ratio (nx). Cyclical properties of macroeconomic variables measured by contemporaneous correlations (ρ) with quarterly GDP of total consumption expenditure, consumption of nondurable goods, expenditure in durable goods, investment, and net exports-GDP ratio. All variables are in logs (except nx) and detrended using the HP filter. Country weights for sample average calculated using current U.S. dollar GDP in the year 2000. Standard deviation of sample (country GDP and sample size weighted) average in parenthesis.

Country	Sample	$\sigma(y)$	$\frac{\sigma(c)}{\sigma(y)}$	$\frac{\sigma(c_n)}{\sigma(y)}$	$\frac{\sigma(c_d)}{\sigma(y)}$	$\frac{\sigma(i)}{\sigma(y)}$	$\sigma(nx)$	$\rho(y, c)$	$\rho(y, c_n)$	$\rho(y, c_d)$	$\rho(y, i)$	$\rho(y, nx)$
Small Developed Economies												
Austria	88:I-08:III	1.28	0.59	0.57	1.73	1.71	3.46	0.79	0.73	0.56	0.62	0.29
Canada	82:I-08:III	1.36	0.72	0.63	2.02	3.12	4.04	0.80	0.78	0.57	0.64	0.07
Denmark	91:I-08:III	1.59	1.04	0.71	4.72	3.40	2.00	0.57	0.53	0.46	0.64	-0.11
Finland	90:I-08:III	2.35	0.73	0.52	3.27	2.47	3.65	0.70	0.72	0.56	0.79	-0.06
Luxembourg	95:I-08:III	2.34	0.78	0.79	1.20	3.27	3.76	0.48	0.41	0.67	0.16	0.29
Netherlands	88:I-08:III	1.28	0.77	0.63	2.88	3.21	1.73	0.74	0.65	0.73	0.73	-0.20
New Zealand	87:II-08:III	1.37	1.30	1.26	1.98	2.36	6.24	0.65	0.58	0.58	0.84	-0.29
Norway	78:I-08:III	1.70	0.97	0.79	3.98	3.38	5.68	0.62	0.59	0.50	0.22	-0.12
Portugal	95:I-08:III	1.10	1.31	0.83	6.38	3.32	1.99	0.87	0.80	0.74	0.78	-0.29
Spain	00:I-08:III	1.34	1.18	1.07	3.55	3.20	2.22	0.75	0.74	0.43	0.79	-0.45
Sweden	93:I-08:III	1.78	0.47	0.40	2.81	2.58	2.23	0.60	0.48	0.51	0.73	-0.18
Average		1.15 (0.05)	0.94 (0.03)	0.80 (0.03)	3.78 (0.26)	3.19 (0.09)	0.77 (0.04)	0.73 (0.02)	0.69 (0.02)	0.57 (0.01)	0.65 (0.03)	-0.10 (0.03)
Large Developed Economies												
France	80:I-08:III	0.84	0.84	0.61	4.28	3.12	0.39	0.74	0.68	0.65	0.88	-0.24
Germany	91:I-08:III	1.01	0.81	0.77	3.00	2.94	0.62	0.57	0.53	0.27	0.81	0.19
Italy	92:I-08:III	0.83	1.01	0.81	4.86	3.03	0.71	0.62	0.61	0.41	0.74	0.19
Japan	94:I-08:III	0.98	0.71	0.67	5.22	2.28	0.42	0.60	0.34	0.60	0.84	-0.18
United Kingdom	97:I-08:III	0.55	0.90	0.99	4.04	4.52	0.40	0.39	0.28	0.23	0.25	0.40
United States	47:I-08:III	1.65	0.58	0.48	2.98	3.01	0.35	0.80	0.79	0.60	0.81	-0.29
Average		1.49 (0.12)	0.63 (0.05)	0.53 (0.06)	3.30 (0.30)	2.99 (0.24)	0.38 (0.05)	0.76 (0.05)	0.72 (0.06)	0.58 (0.06)	0.80 (0.08)	-0.24 (0.09)

Table 3: Calibrated parameters

Parameter	Value	Parameter	Value
β	0.98	α_n	0.52
σ	2	α_d	0.32
θ	0.426	δ_k	0.018
μ	0.883	δ_d	0.039
γ	0.163	Ω	0.3
χ	-0.001	μ_g	1.0074

Table 4: Estimated parameters

Specifications 1 through 8 are as follows: (1) benchmark model without financial frictions; (2) benchmark model with financial frictions; (3) model with uncorrelated sectoral shocks (i.e., $\rho_{nd} = 0$); (4) model with no intermediate goods; (5) model with substitutable intermediate goods; (6) model with GHH preferences; (7) model with i.i.d. shocks to borrowing premium; and (8) model with financial frictions dependent on the type of shock to output. “ ε_g share” is the share of shocks to trends in GDP’s variance decomposition.

Parameter	GMM specification							
	benchmark		robustness					
	1	2	3	4	5	6	7	8
σ_g	1.74 (0.58)	1.84 (0.23)	1.92 (0.09)	1.81 (0.26)	1.83 (0.21)	1.45 (0.30)	1.34 (1.05)	1.32 (0.31)
σ_n	1.22 (0.16)	1.35 (0.14)	1.49 (0.05)	1.35 (0.16)	1.33 (0.15)	1.30 (0.13)	1.34 (0.17)	1.43 (0.10)
σ_d	1.48 (0.18)	1.34 (0.13)	1.18 (0.13)	1.19 (0.11)	1.35 (0.13)	1.50 (0.27)	1.58 (0.55)	1.37 (0.21)
ρ_g	0.13 (0.10)	0.13 (0.14)	0.14 (0.05)	0.12 (0.16)	0.14 (0.15)	0.50 (0.22)	0.26 (0.20)	0.38 (0.15)
ρ_n	0.95 (0.26)	0.79 (0.11)	0.65 (0.04)	0.79 (0.13)	0.81 (0.12)	0.90 (0.10)	0.92 (0.06)	0.79 (0.05)
ρ_d	0.90 (0.13)	0.70 (0.08)	0.62 (0.06)	0.69 (0.08)	0.73 (0.06)	0.56 (0.28)	0.85 (0.06)	0.70 (0.05)
ρ_{nd}	0.50 (0.39)	0.30 (0.12)	—	0.43 (0.11)	0.33 (0.13)	0.40 (0.35)	0.60 (0.44)	0.37 (0.24)
ψ	0.67 (0.59)	0.45 (0.14)	0.27 (0.03)	0.40 (0.12)	0.50 (0.12)	0.30 (0.24)	0.78 (0.44)	0.47 (0.30)
ϕ	3.48 (2.46)	2.14 (0.70)	1.32 (0.15)	1.92 (0.65)	2.41 (0.65)	1.98 (1.37)	3.85 (1.96)	2.21 (1.05)
η	—	-0.033 (0.006)	-0.035 (0.004)	-0.031 (0.005)	-0.031 (0.010)	-0.016 (0.002)	-0.024 (0.018)	-0.033 (0.007)
σ_b / ν^\dagger	—	—	—	—	—	—	0.26 (0.10)	0.10 (0.14)
Statistics								
ω_n	0.41	0.36	0.32	0.35	0.38	0.79	0.33	0.38
ω_d	0.50	0.56	0.66	0.61	0.57	0.92	0.42	0.68
ε_g share	0.37	0.48	0.55	0.48	0.46	0.22	0.30	0.40
J -test	0.67	0.58	0.68	0.58	0.58	0.59	0.48	0.46

† The parameter in this row is σ_b for column 7 and ν for column 8.

Table 5: Empirical and theoretical moments

Specifications 1 through 8 are as follows: (1) benchmark model without financial frictions; (2) benchmark model with financial frictions; (3) model with uncorrelated sectoral shocks (i.e., $\rho_{nd} = 0$); (4) model with no intermediate goods; (5) model with substitutable intermediate goods; (6) model with GHH preferences; (7) model with i.i.d. shocks to borrowing premium; and (8) model with financial frictions dependent on the type of shock to output.

Moment	Data	GMM specification							
		benchmark		robustness					
		1	2	3	4	5	6	7	8
$\sigma(y)$	2.35	2.35	2.23	2.18	2.22	2.25	2.69	2.26	2.24
$\sigma(\Delta y)$	1.50	1.70	1.76	1.80	1.76	1.75	2.15	1.65	1.72
$\sigma(c)/\sigma(y)$	1.09	0.96	1.09	1.12	1.08	1.06	1.09	1.11	1.09
$\sigma(c_n)/\sigma(y)$	0.89	0.82	0.88	0.93	0.88	0.86	0.88	0.88	0.88
$\sigma(c_d)/\sigma(y)$	4.19	3.92	4.14	4.13	4.13	4.00	4.51	4.99	4.19
$\sigma(i)/\sigma(y)$	3.67	3.38	3.66	3.66	3.65	3.62	4.08	3.91	3.68
$\sigma(nx)$	1.64	1.89	1.74	1.74	1.73	1.64	2.40	2.08	1.74
$\sigma(bp)$	2.12	0.04	0.50	0.43	0.46	0.41	0.35	1.08	0.71
$\rho(y, c)$	0.94	0.89	0.93	0.92	0.93	0.93	0.96	0.91	0.93
$\rho(y, i)$	0.95	0.76	0.95	0.95	0.94	0.96	0.85	0.89	0.95
$\rho(y, nx)$	-0.86	-0.34	-0.76	-0.78	-0.75	-0.79	-0.65	-0.66	-0.79
$\rho(y, bp)$	-0.20	0.57	-0.22	-0.03	-0.21	-0.24	-0.45	-0.14	-0.24
$\rho(y_n, y_d)$	0.67	0.70	0.63	0.59	0.63	0.64	0.84	0.66	0.63
$\rho(y_t, y_{t-1})$	0.81	0.77	0.71	0.68	0.71	0.72	0.70	0.76	0.73
$\rho(\Delta y_t, \Delta y_{t-1})$	0.24	0.09	0.02	0.00	0.01	0.04	-0.03	0.07	0.04
$\rho(y_{n,t}, y_{n,t-1})$	0.52	0.75	0.69	0.63	0.69	0.70	0.72	0.75	0.71
$\rho(y_{d,t}, y_{d,t-1})$	0.70	0.76	0.68	0.68	0.68	0.69	0.63	0.72	0.69

A Appendix

In this appendix, we first show the equations characterizing the solution of the planner's problem presented in section 3. Then, we define the competitive equilibrium associated with our environment, and show the equivalence between these two allocations. We also present the non-stochastic steady state relations, and finish with an argument regarding the need of one non-tradable good in the model.

A.1 Planner's optimal allocation

Let λ_n and λ_d be the Lagrange multipliers associated with constraints (15) and (16), and $\tilde{p} = \frac{\lambda_n}{\lambda_d}$. The planner's problem defines a stochastic process for $x = (\hat{N}, \hat{D}', \hat{K}'_d, \hat{K}'_n, \hat{B}', L, L_d, L_n)$ and \tilde{p} that satisfies the following set of optimality conditions (assuming an interior solution):

$$U_C \mathcal{C}_N \tilde{p} (1 - \Psi_{D'}) e^g = \tilde{\beta} E_S \{ U_{C'} [\mathcal{C}_{D'} + \mathcal{C}_{N'} \tilde{p}' (1 - \delta_d - \Psi'_{D'})] \}, \quad (\text{A.1})$$

$$U_C \mathcal{C}_N \tilde{p} (1 - \Phi_{K'_n}) e^g = \tilde{\beta} E_S \{ U_{C'} \mathcal{C}_{N'} [F_{n,K'} + \tilde{p}' (1 - \delta_k - \Phi'_{K'_n})] \}, \quad (\text{A.2})$$

$$U_C \mathcal{C}_N \tilde{p} (1 - \Phi_{K'_d}) e^g = \tilde{\beta} E_S \left\{ U_{C'} \mathcal{C}_{N'} \left[\tilde{p}' (F_{d,K'} + 1 - \delta_k - \Phi'_{K'_d}) + \Omega F_{d,K'} \right] \right\} \quad (\text{A.3})$$

$$U_C \mathcal{C}_N \tilde{p} q e^g = \tilde{\beta} E_S [U_{C'} \mathcal{C}_{N'} \tilde{p}'], \quad (\text{A.4})$$

$$U_C \mathcal{C}_N F_{n,L} = U_L, \quad (\text{A.5})$$

$$F_{n,L} = (\tilde{p} - \Omega) F_{d,L}, \quad (\text{A.6})$$

$$\hat{N} + \Omega F_d = F_n, \quad (\text{A.7})$$

$$e^g (\hat{D}' + \hat{K}'_n + \hat{K}'_d + q \hat{B}') = F_d + (1 - \delta_k)(\hat{K}'_n + \hat{K}'_d) + (1 - \delta_d) \hat{D} - \Psi(\hat{D}', \hat{D}, g) - \Phi(\hat{K}'_d, \hat{K}'_d, g) - \Phi(\hat{K}'_n, \hat{K}'_n, g) + \hat{B}, \quad (\text{A.8})$$

where $E_S = E[\cdot | S]$ is the conditional expectation operator, U_C and U_L are the marginal utilities of consumption and leisure, \mathcal{C}_D and \mathcal{C}_N are the derivatives of the consumption aggregator function (9) with respect to durables and nondurables, and $F_{i,K}$ and $F_{i,L}$ are the marginal products

of capital and labor in sector i . Finally, Ψ and Φ are the adjustment cost functions given by

$$\begin{aligned}\Phi(\hat{K}'_i, \hat{K}_i, g) &= \frac{\phi}{2} \left(e^g \frac{\hat{K}'_i}{\hat{K}_i} - \mu_g \right)^2 \hat{K}_i, \quad i \in \{n, d\}, \text{ and} \\ \Psi(\hat{D}', \hat{D}, g) &= \frac{\psi}{2} \left(e^g \frac{\hat{D}'}{\hat{D}} - \mu_g \right)^2 \hat{D},\end{aligned}$$

and $\Phi_{K'_i}$ and $\Psi_{D'}$ denote their derivative with respect to their first argument. We represent the derivative of next-period adjustment costs $\Phi(\hat{K}''_i, \hat{K}'_i, g')$ with respect to its second argument as $\Phi'_{K'_i}$. Similarly for $\Psi'_{D'}$.

A.2 The competitive equilibrium

Let \hat{w} be the detrended wage rate in units of nondurable goods and r_i be the rental price of capital in sector i . Define p as the price of durable goods in terms of nondurables, and π_i as the profit in sector i (measure in terms of nondurable).

The firm's problem in each sector is:

$$\hat{\pi}_n = \max_{\hat{K}_n^f, L_n} \left\{ e^{z_d} (\hat{K}_n^f)^{\alpha_n} (e^g L_n)^{(1-\alpha_n)} - \hat{w} L_n - r_n \hat{K}_n^f \right\}, \quad (\text{A.9})$$

$$\hat{\pi}_d = \max_{\hat{K}_d^f, L_d} \left\{ (p - \Omega) e^{z_d} (\hat{K}_d^f)^{\alpha_d} (e^g L_d)^{(1-\alpha_d)} - \hat{w} L_d - r_d \hat{K}_d^f \right\}, \quad (\text{A.10})$$

where $x_i^f = (\hat{K}_i^f, L_i)$ is the demand of capital and labor in sector $i \in \{n, d\}$. Let $x^f = (x_n^f, x_d^f)$.

To define the representative household's problem, let $S^h = (\hat{D}, \hat{K}_d, \hat{K}_n, \hat{B}, z_d, z_n, g)$ and $x^h = (\hat{N}, \hat{D}', \hat{K}'_d, \hat{K}'_n, \hat{B}', L)$. Thus, this problem can be represented by the following Bellman equation:

$$V(S^h) = \max_{x^h} \left\{ \frac{\left(\hat{C}^\theta (1-L)^{1-\theta} \right)^{1-\sigma}}{1-\sigma} + \tilde{\beta} E [V(S^{h'}) | S^h] \right\} \quad (\text{A.11})$$

subject to

$$\hat{N} + p e^g (\hat{D}' + \hat{K}'_n + \hat{K}'_d + q \hat{B}') = \hat{w} L + r_d \hat{K}_d + r_n \hat{K}_n + p(1 - \delta_k)(\hat{K}_n + \hat{K}_d) + p(1 - \delta_d) \hat{D} +$$

$$\hat{\pi}_d + \hat{\pi}_n - p \left[\Psi(\hat{D}', \hat{D}, g) + \sum_{i=d,n} \Phi(\hat{K}'_i, \hat{K}_i, g) \right] + p\hat{B}, \quad (\text{A.12})$$

and stochastic processes (4)-(6) as well as standard non-negativity constraints.

Definition 4 *Given the bond price (13), a **competitive equilibrium** is a set of processes for allocations $\{x^h, x^f\}$, profits $\{\hat{\pi}_d, \hat{\pi}_n\}$ and prices $\{\hat{w}, r_d, r_n, p\}$ such that*

1. *Given prices and profits, $\{x^h\}$ solves the household's problem characterized by the following optimality conditions:*

$$U_C \mathcal{C}_{NP} (1 - \Psi_{D'}) e^g = \tilde{\beta} E_S \{U_{C'} [\mathcal{C}_{D'} + \mathcal{C}_{N'} p' (1 - \delta_d - \Psi'_{D'})]\}, \quad (\text{A.13})$$

$$U_C \mathcal{C}_{NP} (1 - \Phi_{K'_n}) e^g = \tilde{\beta} E_S \{U_{C'} \mathcal{C}_{N'} [r'_n + p' (1 - \delta_k - \Phi'_{K'_n})]\}, \quad (\text{A.14})$$

$$U_C \mathcal{C}_{NP} (1 - \Phi_{K'_d}) e^g = \tilde{\beta} E_S \left\{ U_{C'} \mathcal{C}_{N'} \left[r'_d + p' (1 - \delta_k - \Phi'_{K'_d}) \right] \right\}, \quad (\text{A.15})$$

$$U_C \mathcal{C}_{NP} q e^g = \tilde{\beta} E_S [U_{C'} \mathcal{C}_{N'} p'], \quad (\text{A.16})$$

$$U_C \mathcal{C}_N \hat{w} = U_L, \quad (\text{A.17})$$

and household budget constraint (A.12).

2. *Each period, given prices, x^f solves the firms' problems with associated profits $(\hat{\pi}_n, \hat{\pi}_d)$.*

This implies that $(x^f, \hat{\pi}_n, \hat{\pi}_d)$ satisfy the following conditions:

$$\hat{w} = F_{n,L} = (1 - \alpha_n) \frac{F_n}{L_n}, \quad (\text{A.18})$$

$$\hat{w} = (p - \Omega) F_{d,L} = (p - \Omega) (1 - \alpha_d) \frac{F_d}{L_d}, \quad (\text{A.19})$$

$$\hat{r}_n = F_{n,K} = \alpha_n \frac{F_n}{\hat{K}_n^f}, \quad (\text{A.20})$$

$$\hat{r}_d = (p - \Omega) F_{d,K} = (p - \Omega) \alpha_d \frac{F_d}{\hat{K}_n^f}, \quad (\text{A.21})$$

$$\hat{\pi}_d = 0 \Rightarrow F_n = \hat{w} L_n + r_n \hat{K}_n^f, \quad (\text{A.22})$$

$$\hat{\pi}_d = 0 \Rightarrow (p - \Omega) F_d = \hat{w} L_d - r_d \hat{K}_d^f. \quad (\text{A.23})$$

3. *Markets clear each period:*

$$L_d + L_n = L, \quad (\text{A.24})$$

$$\hat{K}_n^f = \hat{K}_n, \quad (\text{A.25})$$

$$\hat{K}_d^f = \hat{K}_d, \quad (\text{A.26})$$

$$\hat{N} + \Omega F_d = \hat{F}_n. \quad (\text{A.27})$$

A.3 Equivalence between the planner's optimal allocation and the competitive equilibrium

We now demonstrate that the competitive equilibrium allocation and the planner's optimal allocation are equivalent. In particular, we show that equilibrium conditions (A.12)-(A.27) boil down to the planner's optimality conditions (A.1)-(A.8).

Claim 5 *The planner's optimal allocation $\{x\}$ coincides with competitive equilibrium allocation $\{x^h, x^f\}$, given the same initial conditions $S_0 = S_0^h$.*

Proof. First, set $p = \tilde{p}$ and notice that equations (A.13), (A.16), (A.27) from the competitive equilibrium coincide with (A.1), (A.4), (A.7) from the planner's problem. Furthermore, firms' optimality conditions (A.18)-(A.19) yield $F_{n,L} = (\tilde{p} - \Omega)F_{d,L}$, which is precisely equation (A.6) from the planner's problem. Next, substitute factor price equations (A.18), (A.20) and (A.21) into household's optimality conditions (A.14), (A.15) and (A.17) which yields planner's conditions (A.2), (A.3) and (A.5). Finally, notice that the household budget constraint (A.12) turns into the planner's resource constraint (A.8) when using equilibrium conditions (A.22)-(A.27). To confirm this notice that

$$\hat{\pi}_d + \hat{\pi}_n + \hat{w}L + r_d \hat{K}_d + r_n \hat{K}_n - \hat{N} = p \hat{Y}_d - \Omega \hat{Y}_d + \hat{Y}_n - \hat{N} = p \hat{Y}_d.$$

Therefore, the system of equations (A.1)-(A.8) that determines the Pareto optimal allocation $\{x\}$ is the same as the reduced system of equations associated with the competitive equilibrium

allocation $\{x^h, x^f\}$ after substituting prices and equilibrium conditions. Consequently, both allocations must be equivalent. ■

A.4 Steady-state conditions

The steady-state variables $\bar{q}, \bar{p}, \bar{L}_n, \bar{L}_d, \bar{K}_n, \bar{K}_d, \bar{Y}_n, \bar{Y}_d, \bar{N}$, and \bar{D} solve the following system of equations:

$$\bar{q} = \beta \mu_g^{\theta(1-\sigma)-1}, \quad (\text{A.28})$$

$$\bar{D} = \left(\frac{(1-\mu)\bar{q}}{\mu\bar{p}(1-\bar{q}(1-\delta_d))} \right)^{\frac{1}{1+\gamma}} \bar{N}, \quad (\text{A.29})$$

$$1 - \bar{L}_d = \left(1 + \frac{1-\theta}{\theta} \frac{\bar{C}}{\bar{C}_N(1-\alpha_n)\bar{Y}_n} \right) L_n, \quad (\text{A.30})$$

$$(1-\alpha_n) \frac{\bar{Y}_n}{\bar{L}_n} = (\bar{p}-\Omega)(1-\alpha_d) \frac{\bar{Y}_d}{\bar{L}_d}, \quad (\text{A.31})$$

$$\alpha_n \frac{\bar{Y}_n}{\bar{K}_n} = \frac{\bar{p}(1-(1-\delta_k)\bar{q})}{\bar{q}}, \quad (\text{A.32})$$

$$\alpha_d \frac{\bar{Y}_d}{\bar{K}_d} = \frac{(\bar{p}-\Omega)(1-(1-\delta_k)\bar{q})}{\bar{p}\bar{q}}, \quad (\text{A.33})$$

$$\bar{Y}_n = \bar{K}_n^{\alpha_n} (\mu_g \bar{L}_n)^{1-\alpha_n}, \quad (\text{A.34})$$

$$\bar{Y}_d = \bar{K}_d^{\alpha_d} (\mu_g \bar{L}_d)^{1-\alpha_d}, \quad (\text{A.35})$$

$$\begin{aligned} \bar{N} = & \bar{Y}_n + (\bar{p}-\Omega)\bar{Y}_d + \bar{p}(1-\delta_k-\mu_g)(\bar{K}_n + \bar{K}_d + \\ & \bar{p}(1-\delta_d-\mu_g)\bar{D} + \bar{p}(1-\bar{q}\mu_g)\bar{B}, \end{aligned} \quad (\text{A.36})$$

$$\bar{Y}_n = \bar{N} + \Omega\bar{Y}_d, \quad (\text{A.37})$$

where \bar{B} is given by the assumption that $\frac{-\bar{B}}{\bar{Y}_n + (\bar{p}-\Omega)\bar{Y}_d} = 0.1$.

These equations come from imposing steady-state conditions (e.g., $N_t = N_{t+1} = \bar{N}$) on system of equations (A.1)-(A.8). We also use production function equations (1) and (2) as well as consumption aggregator (9).

A.5 Tradability assumption

Here we argue why we need to make the assumption that one good must be non-tradable. First, let us look at the steady-state conditions above. In particular, consider equations (A.31)-(A.33). From the assumption of Cobb-Douglas technology, \bar{Y}_i/\bar{L}_i and \bar{Y}_i/\bar{K}_i are both functions of \bar{K}_i/\bar{L}_i , $i \in \{n, d\}$.

Let us argue by contradiction. Let both goods be tradable and the economy be in the deterministic steady state. In this case, \bar{p} is exogenously given because of our small economy assumption. Moreover, \bar{q} is given exogenously for the same reason. Therefore, the capital-labor ratios \bar{K}_i/\bar{L}_i are pinned down by equations (A.32) and (A.33). As a result, both the LHS and RHS of equation (A.31), which determines wage equalization across sectors, are given. Both sides of this equation only depend on parameters and exogenous variables \bar{p} and \bar{q} . Clearly, they need not be equal and, therefore, the economy may not be at the steady state.

We can follow a similar argument by looking at the equilibrium conditions in Appendix A.2. Again, if both goods were tradable, p would be given and capital rental rates r_n and r_d would be pinned down by equations (A.14)-(A.16). In turn, equations (A.20) and (A.21) would determine the capital-labor ratio in each sector. As a result, equations (A.18) and (A.19) are not, in general, simultaneously satisfied. Therefore, the economy is not in equilibrium.

Given that we needed to have one of the two goods non-tradable. We choose nondurable goods because, besides being more in line with observed trade patterns as we mention in Section 3, if we were to choose the durable good as non-tradable, we would impose a strong restriction in the model. That is, the two production factors, labor and capital, would be non-mobile across borders, as capital only comes from durables. This tends to work against co-movement between sectors because capital cannot be imported whenever households need to accumulate more capital in one or both sectors. There are two ways of increasing capital in either sector. Either households move capital from one sector to the other or output in the durable sector increases, or both. They tend to imply a negative relationship between sectoral outputs. In fact, when we parameterize this alternative environment, the model generates little sectoral co-movement, which is counterfactual.

A.6 Data sources

Our Mexican data comes from a variety of sources in addition to those mentioned in Section 2. Sectoral industrial output comes from monthly data published by INEGI – Instituto Nacional de Estadística y Geografía – from Mexico, which we then transform to quarterly frequency. For the borrowing premium we collect data for sovereign interest rates (Emerging Markets Bond Index - EMBI) from Datastream, and U.S. consumer price inflation from the Bureau of Labor Statistics. We then constructed the expected real interest series using the method described in Neumeyer and Perri (2005).