Excess Volatility of Consumption in Developed and Emerging Markets: The Role of Durable Goods

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February 28, 2010

Abstract

We examine how much of the excess volatility of consumption puzzle in small open economies (Aguiar and Gopinath, 2007) can be explained away by adding consumption of durable goods. Once we account for that, consumption is not as volatile as income for both developed and emerging market economies. However, the fact remains that consumption is still more volatile (relative to income) in emerging markets than in developed ones. We extend Aguiar and Gopinath's model of a small open economy with shocks to trend and cycle to include consumption of durable goods. Based on our simulations of a small open economy model with consumption of durable goods, we question the role for shocks to trend that have been previously documented in the literature. Furthermore, we find that financial frictions seem to be shaping the business cycle in developing economies.

*We have benefited from comments by participants of the 2008 WEGMANS Conference in Rochester, NY, the Society for Economic Dynamics 2009 Meeting, in Istanbul, and the IV REDg-DGEM, in Barcelona. We thank Pravin Krishna for helpful discussions. Alvarez is affiliated with the Corporación Andina de Fomento. Marques is affiliated with Paul H. Nitze School of Advanced International Studies, Johns Hopkins University and with CEMPRE. Toledo is affiliated with Universidad Carlos III de Madrid, Department of Economics.

1 Introduction

The business cycle in emerging market economies is characterized by a strongly countercyclical current account and by sovereign interest rates which are also highly countercyclical, very volatile, and significantly higher than the World interest rate. In addition, consumption volatility exceeds income volatility. Aguiar and Gopinath (2007) report that consumption is 40% more volatile than income for emerging economies, while slightly less volatility than income for developed economies. This fact is known as the *excess volatility of consumption puzzle*.

The ultimate goal of this paper is to explore possible sources of the observed patterns for consumption volatility when considering durables and nondurables.

One leading explanation for these regularities relies on shocks to trend income. Aguiar and Gopinath (2007) find that a standard equilibrium model is consistent with the cyclical properties of emerging economies, once the income process incorporates shocks to trend in addition to transitory fluctuations around the trend. The intuition comes from the permanent income hypothesis: a change in the trend of income implies a stronger response of consumption than a transitory fluctuation around the trend. They conclude that the business cycle in emerging economies is principally driven by shocks to trend growth.

Limited access to international borrowing and other shocks which directly or indirectly affect external interest rates have also been used as an explanations for the puzzle. This is a natural driving force because empirical findings indicate a strong relation between sovereign interest rates and output. Mendoza (1991) finds that for early real business cycle models models for small open economies, interest rates disturbances play a minor role in driving the business cycle. Resende (2006) models a small open economy with endogenous borrowing limits and finds that consumption volatility increases substantially as savings cannot be used to smooth consumption when the borrowing limit binds. Similarly, Neumeyer and Perri (2005) explain the excessive volatility of consumption with a financial friction in the form of a working capital borrowing requirement. 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. Fernández-Villaverde et al. (2009) also exploit the interest rate channel and find that shocks to the volatility of the borrowing premium play a significant role in explaining the volatility of consumption in emerging market economies.[1]

In this paper, we decompose consumption into durables and nondurables and show that the puzzle is explained away in the sense that (nondurable) consumption *is not* more volatile than income either in emerging or in developed economies. In particular, we find that the ratio of standard deviation of nondurables consumption to income is 0.9, for a sample of emerging economies, and 0.72, for a sample of developed economies.

A good explanation of business cycles in emerging economies should reproduce strongly countercyclical interest rates and current account, but at the same time, a volatility of consumption of nondurables smaller than the volatility of income. We find that, to some extent, Aguiar and Gopinath's (2007) driving force fails the test, since it delivers too little nondurable consumption and durable spending volatility, and more importantly, fails to replicate key business cycle correlations observed in the data. In their environment, the preponderant role of shocks to trend may emerge from treating consumption in an aggregate fashion.

Besides Aguiar and Gopinath's (2007), our paper relates most to Neumeyer and Perri's (2005). However, unlike the latter, our focus is on volatility of consumption and we move attention to the consumer side, and in particular, to the presence of durable goods, instead of imposing frictions on the production side. The reason for this is that purchases of durable goods act as a way of saving, given that the consumption of durables can be postponed over time.[2] This way, the purchase of durable consumption goods should response strongly to the interest rate. In contrast, the purchase of nondurables should be smoothed, as much as possible,

[1]There are other explanations for the emerging market consumption volatility puzzle which are not explored here. For instance, Boz et al. (2008) extend Aguiar and Gopinath's model to include imperfect information and Restrepo-Echevarria (2008) explore the role of the informal economy.

[2]A similar hypothesis has been tested, for instance, by Rosenzweig and Wolpin (1993), according to whom, farmers in India use a durable capital good (bullocks) as the primary vehicle for saving and dissaving.

by the standard argument based on consumer preferences.

Related to the current paper is Gregorio et al.'s (1998) work on inflation stabilization programs in emerging market economies and the consumption of durable goods. There, a boom-recession cycle in consumption is generated through the wealth effect associated with disinflation (in a cash-in-advance economy) and the existence of nonconvex adjustment costs for the purchase of durables. Our paper, however, does not consider nominal rigidities and does not exploit the timing of purchase of durable consumption goods. Closely related too our work is Engel and Wang (2008) where a two-country model with durables and nondurables is used to explain the volatility and ciclicality of exports and imports in the United States. In as much as they are focusing on one economy such as the U.S., for which there is no excess volatility of consumption puzzle, and not on emerging market economies, their paper cannot be seen as a challenge to Aguiar and Gopinath's (2007) results.

One of the main results of the paper is that, with durable and nondurable goods, the role played by shocks to trend as a driving force for the cycle in emerging economies seems much smaller than found in Aguiar and Gopinath (2007). This result is robust across the different variations of the model and independent of the targets chosen for calibration purposes. If the main source of fluctuations are shocks to trend, both durable and nondurable consumption should be very volatile. However, as documented here, the volatility of durable expenditure is significantly higher than the volatility of consumption of nondurables. The smaller volatility of nondurable consumption relative to expenditure in durables, seems to be incompatible with a preponderant role of shocks to trend.

In alternative experimentations, under the benchmark model, we calibrate the variance of the shocks to match certain targets. In each of these versions, the model fails to reproduce some crucial regularities of the Mexican economy. In particular, the correlation between output and both types of consumption is too low relative the data. More worryingly, net exports are countercyclical, contrary to the data.[3] However, under these alternative parameterizations, the model does well in reproducing Canadian facts and, as in Aguiar and Gopinath (2007), we find that shocks to trend are less important for developed economies. We conclude that the difference in performance between developed and emerging economies cannot rely exclusively on the relative importance of shocks to trend.

In the benchmark model with durable goods, the strong countercyclicality for Mexico is hard to get even if we target it. We explore the borrowing premium channel and calibrate the sensitivity of the interest rate to borrowing. Although we are able to get countercyclical net exports, the model is far from being a satisfactory representation of the Mexican economy. This suggests that this benchmark model needs to be augmented to fully account for the dynamics of emerging economies. We bring into our model the countercyclicality of the borrowing premium by making the bond price dependent on future expected output. We get countercyclical net exports but, again, less so than in the data.

Finally, we study an alternative specification in which a borrowing cost enters explicitly in the relevant resource constraint. We can think of this cost as a proxy for financial frictions. For instance, the cost associated to posting collateral to guarantee borrowing. In this setting, the interest rate does not depend on borrowing, but still depends on expected output. The model improves its ability to match the data even for Mexico and shocks to trend are still less significant than shocks to the cycle. The most important lesson form this exercise is that Mexico and Canada differ importantly in the cost associated with borrowing (collateral constraint). This suggests that differences in the economic dynamics of developed and emerging economies are rooted in financial frictions and not only in the properties of the socks affecting the economy.

In the next section, we present some stylized facts about the business cycle in open economies, with emphasis on consumption of nondurables and spending in durable goods. In Section 3 we set up a dynamic equilibrium model where preferences are defined over nondurables, durables,

[3]Only when we set the variance of the shocks to trend to zero, do we get a coefficient of correlation of -0.06

and leisure, and technological shocks are analogous to the ones found in Aguiar and Gopinath (2007). Section 4 presents the solution method, calibration procedure and results, and Section 5 concludes.

2 Data and Stylized Facts

2.1 Data

The countries for which we were able to find data and that form the sample we use in this paper are split into three groups: small developed economies, large developed economies, and emerging market economies. The emerging market economies in the sample are: Chile, Colombia, Czech Republic, Israel, Mexico, Taiwan, and Turkey. In the small developed economies we include Canada, Denmark, Finland, Netherlands, New Zealand, and Spain. The large open economies are: France, Italy, Japan, United Kingdom, and United States. For each country we collect data (in real terms) on gross domestic product, total private consumption expenditure, consumption of nondurable goods, and expenditure in durable goods. All data is quarterly, except for Colombia for which it is annual. Sample sizes vary and are detailed in Table 2.

Our data come from a variety of sources. For the developed economies and the Czech Republic, all data is from the OECD's Quarterly National Accounts, except for the U.S., for which it is from the Bureau of Economic Analysis. For Chile, data is from Central Bank of Chile. Data for Colombia comes from DANE - Departamento Administrativo Nacional de Estadstica. Data for Israel is from the Bank of Israel and the Central Bureau of Statistics. Mexican data comes from INEGI - Instituto Nacional de Estadstica y Geografa. For Taiwan, we retrieve the data from National Statistics, Republic of China (Taiwan). Finally, for Turkey we use data from the Turkish Statistical Institute. All variables are seasonally adjusted when needed, converted to logs and detrended using the Hoddrick-Prescott filter.

2.2 Facts

When it comes to emerging market economies and small open developed economies, the following stylized facts about the business cycle are often cited in the literature (see Neumeyer and Perri, 2005, and Aguiar and Gopinath, 2007):

1. Real interest rates are countercyclical and leading in emerging markets and acyclical and lagging in developed economies;
2. Emerging market economies have higher volatilities of output and consumption when compared to developed economies;
3. Consumption expenditure is more volatile than output in emerging markets while it is not (quite) as volatile as output in developed economies;
4. Net exports are very volatile in emerging markets when compared to developed economies.

To these facts we add the following concerning spending in nondurables and durable goods, based on our sample:

- Consumption of nondurables is not more volatile than output in either small open economies or emerging markets. We find that the ratio of standard deviation of consumption-to income is 0.9, for a sample of emerging economies, and 0.72, for a sample of developed economies (see Table 3);
- Spending in durable goods is much more volatile than output in both sets of economies;
- Overall, consumption spending in both durables and nondurables is relatively more volatile in emerging markets than in developed economies.

The facts concerning the volatility of consumption and, in particular, the relative volatility of consumption of both durables and nondurables seem to be at odds with the literature stemming from Campbell and Deaton (1989). They argue that consumption spending is not only not very volatile, but in fact too smooth to comply with the Permanent-Income Hypothesis (PIH from now on). For instance, Galí (1993) looks at the variability of durable and nondurable consumption in six OECD countries, and finds that total consumption and consumption of nondurables is smoother that what is implied by the PIH and that consumption of durables is excessively smooth. We must add two caveats at this point. First, these studies look only at developed economies. Second, one can reasonable argue against its applicability in this context for several reasons. For instance, Diebold and Rudebusch (1991) argue that these results are not robust to uncertainty around the choice of an ARIMA representation for the income process. Furthermore, as noted in Campbell and Mankiw (1990), consumption and income series are closer to being log-linear than linear, which implies time-varying heteroscedasticity. In this case, the statistic used by Galí (1993) for the volatility of durables relative to the volatility of nondurables (the ratio of sample standard deviations of changes in consumption) is not robust. In fact, just looking at the U.S. data, using the same sample size as Galí (1993), the ratio of the standard deviations of durables and nondurables changes from 0.4, when using first differences, to 8.3, when using log-differences, much closer to estimates presented in that paper consistent with the PIH. The bottom line is that choosing to scale the data with logs matters and we follow the real business cycles tradition of working with log data detrended either with the first difference or the Hoddrick-Prescott filter.

Looking at the data in Table 3 in more detail, it becomes apparent that the relative volatility of consumption (i.e., the ratio of the standard deviation of consumption to the standard deviation of GDP) shows considerable variation within each group. In the case of the emerging market economies, we have Chile, Israel, and Turkey at the high end and Taiwan and Colombia at the low end. While the low value (0.81) of Colombia can be attributed to the annual frequency at which the data is sampled, the value for Taiwan (0.80) deserves further exploration. It is certainly conceivable that Taiwan experienced throughout the sample period smaller shocks to trend growth. Another possible explanation is that Taiwan has a high saving rate and therefore its consumers are seldom facing binding borrowing constraints. In Figure 1 we plot the relative volatility of consumption against the average saving rate for the 1960-1995 period for all countries in our sample.[4] Although we do not want to imply any sort of causation, at this stage, there clearly is a negative relationship.

3 The model

The importance of the distinction between durables and nondurables has been stressed by Ogaki and Reinhart (1998) who establish that failing to do so severely bias downwards the estimates of the intertemporal elasticity of substitution. This happens because of the intratemporal substitution effect between durables and nondurables arising from changes in the real interest rate and nonseparability of preferences in nondurable and durable goods. Bernanke (1985) shows that “the presence of adjustment costs of changing durables stocks may substantially affect the time series properties of both components [i.e., durables and nondurables] of expenditure under the PIH [permanent income hypothesis].” The time series properties of durable purchases have been further investigated by Caballero (1993). In that paper, the observed inertia observed for durables purchases at the aggregate level (which can be explained with Bernake’s convex adjustment costs) is made compatible with the observed lumpiness and discontinuous nature of this spending at the micro level.[5] Another take on the importance of explicitly accounting for the spending in and consumption of durable goods is to be found in the work of Yogo (2006) and Gomes et al. (2008) who develop a general equilibrium asset pricing model to explain the observed correlations between expected asset returns of stocks of durable goods and nondurable goods producers and market returns.

A contrarian view as to the importance of durables is defended by Baxter (1996). In spite of

[4] Data is from the World Bank’s World Saving Database

[5] The mechanism relies on some degree of consumer heterogeneity and nonconvexities in the adjustment technology. While, at this point, beyond of the scope of this paper, this is certainly an issue to keep in mind in future research.

finding that introducing home durables consumption helps solving the "comovement problem" which used to plague international real business cycle models, Baxter claims that the durability of consumer durables is not important to explain business cycle facts in a closed economy.[6] This result, however, seems to come from the fact that, in her model, investment in capital is uncorrelated across sectors (see Christiano and Fitzgerald, 1998).

The model we use here is a two-sector neoclassical growth model similar to the one in Aguiar and Gopinath (2007). In this small open economy, there are two types of consumption goods, one durable and one nondurable. The nondurable good is assumed to be nontradable while the durable good is tradable across borders. We assume that markets are incomplete since individuals have only access to one financial asset, a risk-free bond which pays interest in units of the durable good. Output in each sector is produced with labor and a sector-specific capital stock and can be used either for consumption or for own-sector capital accumulation. The economy is subject to two temporary sectoral aggregate TFP shocks and one aggregate shock to trend. In particular, the Cobb-Douglas technology in each sector $i = \{N, D\}$ takes the following form:

$$Y_{i,t} = e^{z_{i,t}} K_{i,t}^{\alpha_i} (\Gamma_t L_{i,t})^{1-\alpha_i} \equiv F_i(K_{i,t}, L_{i,t}), \tag{1}$$

where $K_{i,t}$ and $L_{i,t}$ denote capital and labor inputs, $\alpha_i \in (0,1)$ represents the capital's share of output, Γ_t is the common trend, g_t is the (stationary) shock to trend, and $z_{i,t}$ is the temporary stochastic productivity process in sector i. As in Aguiar and Gopinath (2007), $\Gamma_t = \Gamma_{t-1} e^{g_t}$. It is assumed that each shock follows an AR(1) process such that

$$\begin{aligned} z_{1,t} &= \rho_1 z_{1,t-1} + \epsilon_{D,t}, \\ z_{2,t} &= \rho_2 z_{2,t-1} + \epsilon_{D,t}, \\ g_t &= (1-\rho_g)\ln \mu_G + \rho_g g_{t-1} + \epsilon_{G,t} \end{aligned}$$

[6]This problem consists of the negative correlation between input uses across countries generated by one-sector IRBC models.

where $\{\epsilon_{N,t}, \epsilon_{D,t}\}$ is an i.i.d. bivariate random variable $N(0, \Sigma_Z)$ and ϵ_{Gt} is i.i.d $N(0, \sigma_g^2)$. The assumption that the nondurable goods and the durable goods sectors share a common shock to trend is not overly restrictive[7]. For instance, Galí (1993) models the changes in consumption of nondurables and durables as ARMA processes using the same assumption.

We assume that labor can be freely allocated between these two sectors so that in each period,

$$L_t = L_{N,t} + L_{D,t}. \tag{2}$$

The representative agent's expected lifetime utility is

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, 1 - L_t), \tag{3}$$

where $C_t = C(N_t, D_t)$ is a total consumption bundle which depends on both the current consumption of nondurable goods N_t and the stock of durable goods D_t.

We assume a constant elasticity of substitution between durables and nondurables, constant relative risk aversion, and a Cobb-Douglas specification for the aggregate consumption bundle and leisure. The period utility function takes the form

$$U(C_t, 1 - L_t) = \frac{\left(C_t^{\theta}(1 - L_t)^{1-\theta}\right)^{1-\sigma} - 1}{1 - \sigma}, \text{ where} \tag{4}$$

$$C_t \equiv \left(\mu N_t^{-\gamma} + (1 - \mu) D_t^{-\gamma}\right)^{-\frac{1}{\gamma}}, \tag{5}$$

and $\frac{1}{1+\gamma}$ is the elasticity of substitution between durables and nondurables, μ is the utility share of nondurables, θ is the utility share of consumption, and σ is the coefficient of relative risk aversion.

[7] In fact, all that is required, with respect to this, in order for the problem to have an interior solution is to restrict the trends to have the same long run mean growth.

We assume that the nondurable good is nontradable.[8]. Thus, the economy has the following two resource constraints:

$$N_t + X_{K,t}^N = Y_{N,t}, \tag{6}$$

$$X_{D,t} + X_{K,t}^D + q_t B_{t+1} = Y_{D,t} + B_t, \tag{7}$$

where B_t denotes holdings of one-period risk-free bonds, and q_t is the bond price issued in period t.

Investment in capital goods $X_{K,t}^i$, and the expenditure in durable goods $X_{D,t}$ are given by

$$X_{K,t}^N = K_{N,t+1} - (1-\delta_K)K_{N,t} + \Phi_N(K_{N,t+1}, K_{N,t}), \tag{8}$$

$$X_{K,t}^D = K_{D,t+1} - (1-\delta_K)K_{D,t} + \Phi_D(K_{D,t+1}, K_{D,t}), \text{ and} \tag{9}$$

$$X_{D,t} = D_{t+1} - (1-\delta_D)D_t + \Psi(D_{t+1}, D_t), \tag{10}$$

where δ_K and δ_D are depreciation rates. Moreover, $\Psi(D_{t+1}, D_t)$, and $\Phi_N(K_{N,t+1}, K_{N,t})$ and $\Phi_D(K_{D,t+1}, K_{D,t})$ represent quadratic adjustment cost for durables and each sector's capital stock, respectively. The importance of these convex adjustment costs to explain the slow adjustment of durable purchases has been highlighted by Bernanke (1985). Notice also that the assumption of a second hand market for durable goods is implicit in (10).

The price of debt depends on the level of outstanding debt B_{t+1} as in Schmitt-Grohé and Uribe (2003), which takes care of the nonstationarity of net foreign assets. To reflect an increased borrowing premium during recessions (possibly the consequence of higher perceived probability of default as in Eaton and Gersovitz, 1981) we also allow q_t to be dependent on the expected next-period output level. This way

$$q_t = \frac{1}{1 + r^* + \chi\big[\exp(\frac{B_{t+1}}{\Gamma_t} - \bar{B}) - 1\big] + \eta\big(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y}\big)}, \tag{11}$$

[8] The assumption that nondurable goods are not traded across countries is needed to avoid an overdetermination arising from the small country assumption for the bond market and factor price equalization across sectors.

where $\bar{B}$ and $\bar{Y}$ are the steady-sate levels of the detrended counterpart of the stock of bonds and total output. A distinctive feature of emerging economies when compared to industrialized small open economies is that η is much smaller, even negative, for the former than for the latter. The borrowing premium described by (11) can be seen as reduced form of several underlying mechanisms which generate a strongly countercyclical real interest rate (see Neumeyer and Perri, 2005, for instance). Initially, to allow comparability with Aguiar and Gopinath (2007), we set $\eta = 0$.

3.1 Pareto optimal allocation

We focus on the Pareto optimal allocation by solving the planner's problem. The planner maximizes (3) subject to (1), (2), and (6)-(11).

From the planner's problem we obtain the following optimality conditions:

$$U_{C_t}\mathcal{C}_{N_t}p_t = \beta E_t\left\{U_{C_{t+1}}\left[\mathcal{C}_{D_{t+1}} + \mathcal{C}_{N_{t+1}}p_{t+1}(1-\delta_D)\right]\right\}, \tag{12}$$

$$U_{C_t}\mathcal{C}_{N_t}\left[1 - \frac{\partial \Phi_{N,t}}{\partial K_{N,t+1}}\right] = \beta E_t\left\{U_{C_{t+1}}\mathcal{C}_{N_{t+1}}\left[F_{N,K_{t+1}} + 1 - \delta_K - \frac{\partial \Phi_{N,t+1}}{\partial K_{N,t+1}}\right]\right\}, \tag{13}$$

$$U_{C_t}\mathcal{C}_{N_t}p_t\left[1 - \frac{\partial \Phi_{D,t}}{\partial K_{D,t+1}}\right] = \beta E_t\left\{U_{C_{t+1}}\mathcal{C}_{N_{t+1}}p_{t+1}\left[F_{D,K_{t+1}} + 1 - \delta_K - \frac{\partial \Phi_{D,t+1}}{\partial K_{D,t+1}}\right]\right\}, \tag{14}$$

$$U_{C_t}\mathcal{C}_{N_t}\left[q_t + \frac{\partial q_t}{\partial B_{t+1}}B_{t+1}\right] = \beta E_t\left\{U_{C_{t+1}}\mathcal{C}_{N_{t+1}}\right\}, \tag{15}$$

$$U_{C_t}\mathcal{C}_{N_t}F_{N,L_t} = U_{L_t}, \tag{16}$$

$$F_{N,L_t} = p_t F_{D,L_t}, \tag{17}$$

where $\mathcal{C}_{D_t}$ and $\mathcal{C}_{N_t}$ are the derivatives of the consumption aggregator with respect to durables and nondurables, and $F_{i,K}$ and $F_{i,L}$ are the marginal products of capital and labor, respectively, in sector $i = \{N, D\}$. Moreover, p_t is the ratio (λ_D/λ_N) of the Lagrange multipliers associated with the resources constraints (7) and (6), which can be interpreted as the relative price of durables to nondurables.

The first four equations correspond to intertemporal trade-offs between current nondurable consumption and the accumulation of durable goods, capital and debt. The last two equations represent static optimality conditions for the consumption-leisure decision and labor allocation between sectors.

4 Calibration and Results

The model presented in the previous section is solved using a standard first order log-linearization procedure as described in the technical appendix to Aguiar and Gopinath (2007). The solution consists of policy functions for the control variables (consumption of nondurables, spending in durables, output of nondurables and durables, labor for durables and nondurables, and the relative price of durables) and laws of motion for the endogenous states (capital stocks, durables stock, and bond holdings) as a function of the states and forcing variables (shocks to durables and nondurables and shock to trend). For this effect, we used Dynare for Matlab. In Appendix A, we present more details on how this is done.

After solving for the policy functions and laws of motions of the state variables we calibrate the model to match some empirical moments of output and consumption for Mexico. The calibration closely follows that of Aguiar and Gopinath, with a few changes to accommodate for durable goods. Specifically, the share of labor is set to 0.48 for nondurables and 0.68 for durables, as used in Baxter (1996). From the same source, the annual depreciation rates for capital and durables are set to 7.1% and 15.6%, respectively. The utility share of nondurables (μ) is set to match the share of consumption of nondurable goods in total consumption for Mexico (91.8%), and Canada (74.5%). The elasticity of substitution ($\frac{1}{1+\gamma}$) is set to 0.86, following Gomes et al. (2008). The calibration parameters are summarized in Table 4.

The first set of simulation results are summarized in Tables 5 and 6. Here we stay as close as possible to Aguiar and Gopinath's model. In particular, in (11), we set $\eta = 0$. The results show some mixed evidence as to how well this expanded version of their model (to include spending in durable goods) matches the data. In these tables, we present the simulated moments for output, consumption, nondurable consumption, spending in durables, net exports, labor supply, and investment when we solve for the variances and correlations of the temporary sectoral shocks and the shock to trend (σ_g) and adjustment costs[9].

In column 1, a solution for σ_g and σ_n is obtained by matching the standard deviations of output and aggregate consumption while setting $\sigma_d = 0$ and all other parameters at benchmark values (see Table 4). The results for Mexico show a relative volatility of nondurable consumption somewhat smaller and a relative volatility of durables expenditure substantially smaller than the one found in the data (see the first column in the table). The simulated correlation of output with total consumption is somewhat smaller and the one with investment is much higher than what is found in the data. Additionally, the simulation delivers only mildly procyclical spending in durables (whereas evidence points to strong cyclicality) and cyclical net exports (contrary to data). Finally, the estimates for the standard deviation of the shocks show that almost all of the volatility has to come from shocks to nondurables.

The results for Canada, on the contrary, are remarkably good: the solution is exact (the problem is exactly identified) and most moments are well approximated, except for the volatility of spending in durables and of net exports, which turn out to be too low when compared to the data. In line with what is found by Aguiar and Gopinath, the shock to trend is much less important than the temporary shock to nondurables.

We try again matching the volatilities of income and total consumption spending by solving for the variances of the sectoral shocks (σ_n and σ_d), while shutting down the shock to trend. The results, in column 2 of Tables 5 and 6, show a good fit for Canada and a bad one for Mexico. In particular and for the latter, all the variance is coming from durables but we cannot

[9]None of these parameters affect the deterministic steady state around which the linearization is performed.

find an exact solution for the moment-matching problem and the quality of fit (measured by the sum of square deviations for all moments in the tables) is worse than in the previous case.

In column 3 of the same tables, we present the simulated moments that result from solving for the standard deviations of shocks to trend and cycle in order to match the volatilities of output, consumption of nondurables, and spending in durable goods. Now we are able to find an exact solution for Mexico and a slightly better quality of fit than in column 1 but we still are unable to capture the strong countercyclicality of net exports and the results reinforce the finding that the temporary sectoral shocks dominate the shocks to trend. In the case of Canada, it is interesting to note how well the model works. Take the example of columns 3 and 4 of Table 6: we are able to match the mild countercyclicality of net exports even though we are not targeting this moment. Additionally, Aguiar and Gopinath's (2007) story holds here since the shocks to trend are relatively unimportant, as expected.

We then try to match the volatilities of output and total consumption spending and the correlation of net exports with output by solving for the variance of the sectoral shocks and the adjustment cost of durables, ψ (column 5) or by solving for the variance of all three shocks (column 4). In the latter case, for Mexico, we have the same problem as before: we are not able to match the correlation of net exports with output and the simulation delivers too much volatility for the spending in durables. Shutting down the shock to trend and solving for ψ does not change results and neither does solving for all variances and the adjustment cost. In our opinion, this means something else must be happening. In particular, we need to exploit the borrowing premium channel, more in line with Neumeyer and Perri's (2005) explanation. This is what we do in column 7 where we add χ to the list of free parameters and set the variance of the shocks to trend to zero. Compared to column 6, this calibration does a slightly better job since it at least delivers countercyclical net exports (albeit only mildly so, i.e., -0.28).

As stated in Section 2, one of the stylized facts of emerging markets business cycles is a countercyclical borrowing premium. We explicitly account for this in Table 7 while trying, at the same time, to deliver a more countercyclical behavior in net exports. We do this by allowing the parameter η in (11) to be different from zero. In the columns 1 of Table 7 we try to match the volatilities of output, consumption spending in nondurables and durables, and of the borrowing premium, for Mexico and Canada. We see that the calibration delivers a countercyclical borrowing premium for Mexico and a procyclical one for Canada, in line with the data. In both cases we are able to exactly match the targeted moments and subsidiarily we get countercyclical net exports. In the case of Mexico, however, we still fail by a matter of degree: with a simulated correlation of net exports with output of -0.27 we are still far from the -0.82 observed in the data.

In columns 2 of Table 7, we explicitly try to match the correlation between the net exports-output ratio and output by additionally solving for the borrowing premium parameter χ. In the case of Canada, we are able to exactly match all five moments and the overall fit improves. For Mexico, there is no longer an exact solution mainly because the model is not able to replicate the correlation of the net exports-output ratio and output. However, we do get a more countercyclical net exports compared to column 1.

It is not hard to understand why this is the case. If net exports are strongly countercyclical and there is a drop in output, we have that the trade balance increases. Since the current account (CA), which is net exports (NX) plus net factor payments (NFP), and the capital and financial account (KFA) have to sum to zero, it has to be the case that either NFP decreases or KFA decreases, or both. On the one hand, given a negative initial level of borrowing ($B < 0$), a decrease in NFP requires an increase of the real interest rate, i.e., of the borrowing premium. On the other hand, a decrease in KFA means that the amount of borrowing falls (B increases). However, since most shocks to output are temporary (the shock to trend, in most calibrations, is small), following a drop in output, the representative agent would like to borrow more. By having a countercyclical borrowing premium due to $\eta < 0$, the model is able to generate precisely an increase in the interest rate of enough magnitude in order to make borrowing too costly. Moreover, by solving for χ, which turns out to be lower (i.e., higher in absolute value) than its benchmark value, we are able to reinforce this channel. As a result, B and, therefore, net exports end up increasing, which is precisely what we observe in emerging economies.

In principle, we could reproduce the strong countercyclicality of net exports by increasing the (indirect) response of the borrowing premium to shocks by setting a sufficiently negative χ and η. However, since we are targeting the variance of the borrowing premium, the amount this variable can fluctuate is limited. Therefore, we seem to have a conflict between the variance of the interest rate and the degree of countercyclicality of net exports in the case of Mexico.

One solution to this problem is to have the volatility of the amount of borrowing or lending to depend on an adjustment cost which will not count towards the borrowing premium. Schmitt-Grohé and Uribe (2003) find that, for a small open economy, the ergodic distribution of the simulated economy does not depend on the way the adjustment cost is introduced (borrowing premium dependent on the debt level or a convex adjustment cost). This way, we suggest setting $\chi = 0$ and adding a new adjustment cost, given by $\nu(\exp(-(B' - \bar{B})) - 1)$. The resource constraint for durables (7) becomes

$$D_{t+1} + K_{D,t+1} + q_t B_{t+1} + \nu(e^{-(B_{t+1}/\Gamma_t - \bar{B})} - 1) = \\ Y_{D,t} + (1-\delta_d)D_t + (1-\delta_k)K_{D,t} - \Phi_D(K_{D,t+1}, K_{D,t}) - \Psi(D_{t+1}, D_t) + B_t,$$

and the real interest rate is $r^* + \eta\big(E_t \frac{Y_{t+1}}{\Gamma_t} - \bar{Y}\big)$. We can think of this adjustment cost a as a proxy for some financial friction. The approximation is not perfect since the adjustment cost is not floored at zero: for values of borrowing below the steady state value it becomes a revenue (albeit a small one) rather than a cost as it converges to $-\nu$ as $B \to +\infty$.

The results of the simulation are in the columns 3 of Table 7. Specifically, we solve for variances of the three shocks, η and ν in order to match the variances of output, consumption of nondurables, spending in durables, and of the borrowing premium, and the correlation of net exports with output. Again, in the case of Mexico we cannot find an exact solution but we are able to improve upon the preceding simulations. As expected, we get net exports more strongly countercyclical and a very strongly countercyclical borrowing premium. Compared to the exercise in column 3 of Table 5, which is the one closest in spirit to Aguiar and Gopinath (2007) and where we solve the variances of the shocks to match the volatilities of output and spending in durables and nondurables, we find now a much more procyclical spending in durables and we capture the countercyclical behavior of the trade balance. Furthermore, we also get a marked improvement relative to columns 5 and 6 of Table 5 where we were targeting net exports as well. In this exercise, like in most exercises before, the dominant shock to productivity is the shock to nondurables and the least important is the shock to trend. When compared to the results for Canada, in the same table, we find that, as expected, we get a negative value for η for Mexico and a positive one for Canada and also a much larger value for the adjustment cost ν for the former than for the latter.

5 Conclusions

This paper presents an examination of the robustness of Aguiar and Gopinath's (2007) findings on consumption volatility by considering nondurables and durables. We find that the model of shocks to trend and shocks to cycle does have some difficulty in matching the data for Mexico, in particular when it comes to the countercyclicality of the current account and the procyclicality of consumer durables spending.

We also find that a procyclical borrowing premium (possibly reflecting cyclically binding borrowing constraints) does a better job at matching the business cycle moments for emerging markets. The difference between what we propose and Neumeyer and Perri's (2005) model is that we do not need to include any rigidity on the firm side and exploit only the nature of durables accumulation to achieve the desired magnification effect on spending. The simulations seem to show, though, that some work needs to be done in terms of matching some moments like the volatility of investment and the correlation of the trade balance with output.

Summing up, the results indicate that shocks to trend are more significant in developing countries than in developed economies; however, they do not appear to be the main source of economic fluctuation in emerging economies. Moreover, developed and emerging economies differ beyond the nature of the shocks. In particular, the presence of important financial frictions seem to be shaping the business cycle in emerging economies, but they seem unimportant for developed economies.

An 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 an alternative explanation, as the work by Fernández-Villaverde et al. (2009) and Gruss and Mertens (2009) seems to suggest. Another avenue for future research should consider exploring the importance of 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 straightforward channel is to see 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, are 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 get 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 advance 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 non-durables with respect to income volatility.

A Appendix

In this appendix, we describe the basic model setup, first order conditions and resource constraints, the non-stochastic steady state relations, and the resulting log-linearized equations. The model is the one of Aguiar and Gopinath (2007) extended to include durables and non-durables. This appendix describes the first order conditions and market clearing conditions of a decentralized equilibrium equivalent to the planner's problem described in the text. It is immediate to see that the relative price of durables used ahead is equal to the ratio of the multipliers associated with (6) and (7), in the text. This section draws heavily on that paper and its technical appendix.

A.1 Problem

$$V = \max \frac{(C^{\theta}(1-L)^{1-\theta})^{1-\sigma}}{1-\sigma} + \beta G^{\theta(1-\sigma)} EV(K'_N, K'_D, D', B', Z'_n, Z'_d, G') \tag{A-1}$$

subject to

$$\begin{aligned} N + PGD' + G(K'_N + PK'_D) + GPQB' = \\ Y_n + PY_d + (1-\delta_k)(K_N + PK_D) - \frac{\phi}{2}(G\frac{K'_N}{K_N} - \mu_g)^2 K_N - \\ \frac{\phi}{2}(G\frac{K'_D}{K_D} - \mu_g)^2 PK_D + (1-\delta_d)PD - P\frac{\psi}{2}(G\frac{D'}{D} - \mu_g)^2 D + PB, \end{aligned} \tag{A-2}$$

where

$$C \equiv \left(\mu N^{-\gamma} + (1-\mu)D^{-\gamma}\right)^{-\frac{1}{\gamma}}, \tag{A-3}$$

$$L \leq 1, \tag{A-4}$$

$$L_N \geq 0, \tag{A-5}$$

$$L_D \geq 0, \tag{A-6}$$

$$K_N \geq 0, \tag{A-7}$$

$$K_D \geq 0, \tag{A-8}$$

$$Q = (1 + r^* + \chi(\exp(B' - \bar{B}) - 1) + \eta(EY' - \bar{Y}))^{-1}, \tag{A-9}$$

$$Y_N = Z_N K_N^{1-\alpha_N} (GL_N)^{\alpha_N}, \tag{A-10}$$

$$Y_D = Z_D K_D^{1-\alpha_D} (GL_D)^{\alpha_D}, \tag{A-11}$$

$$\ln G' = (1 - \rho_G) \ln \mu_G + \rho_G \ln G + \epsilon_G, \tag{A-12}$$

$$\ln Z'_N = \rho_N \ln Z_N + \epsilon_N, \tag{A-13}$$

$$\ln Z'_D = \rho_D \ln Z_D + \epsilon_D. \tag{A-14}$$

The forcing variables in this problem are the shocks to Z_N, Z_D, and G. The endogenous states are K_N, K_D, D, and B. The controls are P, N, L_N, and L_D.

A.1.1 F.O.C.

$$U_C C_N \left(1 + \phi(G\frac{K'_N}{K_N} - \mu_G)\right) G = \beta G^{\theta(1-\sigma)} EV_{K'_N}, \tag{A-15}$$

$$U_C C_N P \left(1 + \phi(G\frac{K'_D}{K_D} - \mu_G)\right) G = \beta G^{\theta(1-\sigma)} EV_{K'_D}, \tag{A-16}$$

$$U_C C_N P \left(1 + \psi(G\frac{D'}{D} - \mu_G)\right) G = \beta G^{\theta(1-\sigma)} EV_{D'}, \tag{A-17}$$

$$U_C C_N Q G = \beta G^{\theta(1-\sigma)} EV_{B'}, \tag{A-18}$$

$$U_C C_N F_{NL} = -U_L \Leftrightarrow \left(1 + \frac{1+\theta}{\theta} \frac{C}{C_N \alpha_N Y_N}\right) L_N = 1 - L_D, \tag{A-19}$$

$$F_{NL} = PF_{DL} \Leftrightarrow \alpha_N \frac{Y_N}{L_N} = P\alpha_D \frac{Y_D}{L_D}. \tag{A-20}$$

A.1.2 Envelope Conditions

$$V_{K'_N} = U_{C'}C_{N'}\left\{F_{NK'} + 1 - \delta_K + \frac{\phi}{2}\left[(\frac{G'K''_N}{K'_N})^2 - \mu_G^2\right]\right\}, \tag{A-21}$$

$$V_{K'_D} = U_{C'}C_{N'}P'\left\{F_{DK'} + 1 - \delta_K + \frac{\phi}{2}\left[(\frac{G'K''_D}{K'_D})^2 - \mu_G^2\right]\right\}, \tag{A-22}$$

$$V_{D'} = U_{C'}\left(C_{N'}\left\{P'(1 - \delta_D) + P'\frac{\psi}{2}\left[(\frac{G'D''}{D'})^2 - \mu_G^2\right]\right\} + C_{D'}\right), \tag{A-23}$$

$$V_{B'} = U_{C'}C_{N'}, \tag{A-24}$$

where

$$U_C = \theta C^{\theta(1-\sigma)-1}(1 - L)^{(1-\theta)(1-\sigma)}, \tag{A-25}$$

$$C_N = \mu N^{-\gamma-1}\left(\mu N^{-\gamma} + (1 - \mu)D^{-\gamma}\right)^{-\frac{1}{\gamma}-1}, \text{ and} \tag{A-26}$$

$$C_D = (1 - \mu)D^{-\gamma-1}\left(\mu N^{-\gamma} + (1 - \mu)D^{-\gamma}\right)^{-\frac{1}{\gamma}-1}. \tag{A-27}$$

A.1.3 Market Clearing and Resource Constraint Conditions

$$L = L_N + L_D, \tag{A-28}$$

$$Y_N = N + GK'_N - (1 - \delta_k)K_N + \frac{\psi}{2}(G\frac{K'_N}{K_N} - \mu_G)^2. \tag{A-29}$$

A.2 Steady State Relationships

The steady state variables are: $\bar{Q}$, $\bar{P}$, $\bar{L}_N$, $\bar{L}_D$, $\bar{K}_N$, $\bar{K}_D$, $\bar{Y}_N$, $\bar{Y}_D$, $\bar{N}$, and $\bar{D}$. The steady state is defined by the following relationships:

$$\bar{Q} = \beta \mu_G^{\theta(1-\sigma)-1}, \tag{A-30}$$

$$\bar{D} = \left(\frac{\mu}{1-\mu} \bar{P}(1 - \bar{Q}(1-\delta_D)) \right)^{-\frac{1}{1+\gamma}} \bar{N}, \tag{A-31}$$

$$\bar{L}_N = \frac{1 - L_D}{1 + \frac{1-\theta}{\theta} \frac{\bar{C}}{\alpha_N \bar{C}_N \bar{Y}_N}}, \tag{A-32}$$

$$\alpha_N \frac{\bar{Y}_N}{\bar{L}_N} = \alpha_D \bar{P} \frac{\bar{Y}_D}{\bar{L}_D}, \tag{A-33}$$

$$\frac{\bar{K}_N}{\bar{Y}_N} = \frac{(1-\alpha_N)\bar{Q}}{1 - (1-\delta_K)\bar{Q}}, \tag{A-34}$$

$$\frac{\bar{K}_D}{\bar{Y}_D} = \frac{(1-\alpha_D)\bar{Q}}{1 - (1-\delta_K)\bar{Q}}, \tag{A-35}$$

$$\bar{K}_N = \mu_G (\frac{\bar{K}_N}{\bar{Y}_N})^{1/\alpha_N} \bar{L}_N, \tag{A-36}$$

$$\bar{K}_D = \mu_G (\frac{\bar{K}_D}{\bar{Y}_D})^{1/\alpha_D} \bar{L}_D, \tag{A-37}$$

$$\begin{aligned} \bar{N} = {} & \bar{Y}_N + \bar{P}\bar{Y}_D + (1 - \delta_K - \mu_G)\bar{K_N} + \bar{P}(1 - \delta_K - \mu_G)\bar{K_D} + \\ & \bar{P}(1 - \delta_D - \mu_G)\bar{D} + \bar{P}(1 - \bar{Q}\mu_G)\bar{B}. \end{aligned} \tag{A-38}$$

$$\bar{Y}_N = N + (\mu_G - 1 + \delta_K)\bar{K_N}. \tag{A-39}$$

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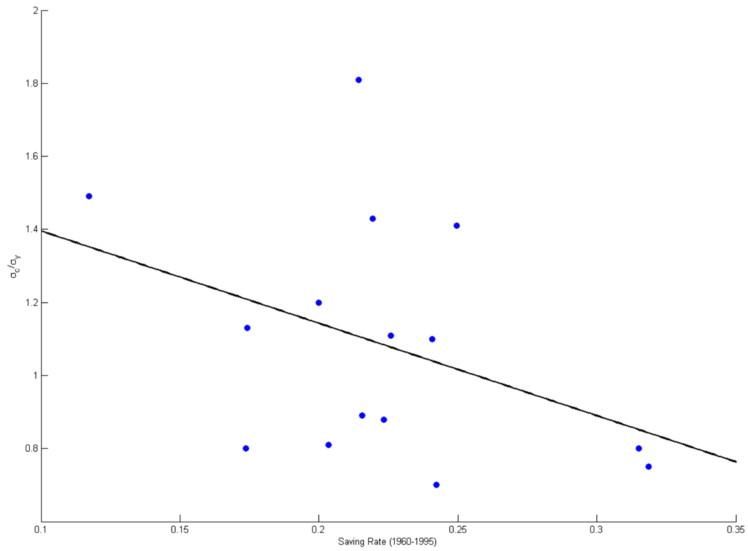

Figure 1: Relative Volatility of Consumption and Saving Rates

Table 1: Volatility of Output and Relative Volatility of Consumption, Investment and Net Exports.

Macroeconomic volatility measured by standard deviation (σ) of GDP (y), total consumption expenditure (c), consumption of nondurable goods (n), expenditure in durable goods (d), investment (I), and Net Exports as a fraction of GDP (nx). All data is quarterly except for Colombia, for which it is annual. All variables are in logs (except nx) and detrended using the HP filter.

Country	Sample	σ_y	σ_c	$\frac{\sigma_c}{\sigma_y}$	σ_n	$\frac{\sigma_n}{\sigma_y}$	σ_d	$\frac{\sigma_d}{\sigma_y}$	$\frac{\sigma_I}{\sigma_y}$	σ_{nx}
		Emerging Market Economies								
Chile	96:I-08:I	2.38	3.39	1.43	2.86	1.20	11.05	4.64	1.28	2.78
Colombia	65-06	2.70	2.75	1.02	2.18	0.81	9.53	3.54	3.89	4.94
Czech Republic	96:I-08:I	0.95	1.00	1.06	0.91	0.95	3.35	3.52	1.92	1.53
Israel	80:II-08:I	1.95	3.38	1.74	2.34	1.20	12.72	6.52	3.24	1.22
Mexico	93:I-07:IV	2.35	2.57	1.10	2.09	0.89	9.86	4.20	6.11	1.68
Taiwan	61:I-08:II	2.05	1.65	0.80	1.88	0.92	1.90	0.93	11.88	1.87
Turkey	87:I-07:III	3.44	5.15	1.50	3.18	0.92	15.85	4.61	4.34	3.25
		Small Developed Economies								
Canada	61:I-08:II	1.33	1.18	0.88	0.81	0.60	4.38	3.27	1.89	0.91
Denmark	90:I-08:II	1.20	1.44	1.20	1.05	0.87	7.25	6.03	5.02	0.94
Finland	90:I-08:I	1.68	1.41	0.84	1.00	0.59	8.16	4.85	1.60	1.26
Netherlands	88:I-08:I	1.02	1.07	0.70	0.88	0.58	3.50	2.30	4.32	0.64
New Zealand	88:I-08:I	1.40	1.56	1.12	1.12	0.83	3.83	2.74	5.35	1.45
Spain	01:I-08:I	2.82	5.20	1.84	4.51	1.60	2.55	9.02	1.62	0.56
		Large Developed Economies								
France	78:I-08:II	0.86	0.76	0.88	0.54	0.63	4.11	4.77	4.87	0.41
Italy	81:I-08:I	0.91	1.01	1.11	0.78	0.86	3.98	4.38	4.20	0.78
Japan	94:I-08:I	1.02	0.77	0.75	0.59	0.58	4.48	4.37	3.03	0.38
United Kingdom	80:I-08:I	1.14	1.30	1.13	0.96	0.84	4.33	3.79	4.63	0.54
United States	47:I-08:IV	1.65	1.26	0.76	0.79	0.48	5.13	3.11	4.77	0.36

Table 2: Correlations with Output.

All data is quarterly except for Colombia, for which it is annual. All variables are in logs (except for NX/Y, which is in levels) and detrended using the HP filter (except for Δy).

Country	Sample	$\rho_{y,c}$	$\rho_{y,n}$	$\rho_{y,d}$	$\rho_{y,inv}$	$\rho_{y,nx}$	$\rho_{y,y_{-1}}$	$\rho_{\Delta y,\Delta y_{-1}}$
Emerging Market Economies								
Chile	96:I-08:I	0.42	0.54	0.50	0.74	0.11	0.07	-0.52
Colombia	65-06	0.78	0.78	0.64	0.51	-0.45	0.51	-0.30
Czech Republic	96:I-08:I	0.36	0.34	0.29	0.55	0.18	0.89	0.70
Israel	80:II-08:I	0.45	0.41	0.45	0.40	0.04	0.57	0.03
Mexico	93:I-07:IV	0.94	0.92	0.92	0.92	-0.82	0.81	0.25
Taiwan	61:I-08:II	0.70	0.63	0.57	-0.05	0.25	0.79	0.16
Turkey	87:I-07:III	0.90	0.87	0.83	0.71	-0.70	0.67	-0.02
Small Developed Economies								
Canada	61:I-08:II	0.81	0.77	0.73	0.77	-0.19	0.84	0.47
Denmark	90:I-08:II	0.51	0.45	0.40	0.64	-0.11	0.55	-0.28
Finland	90:I-08:I	0.79	0.67	0.69	0.85	-0.05	0.91	0.49
Netherlands	88:II-08:I	0.78	0.73	0.67	0.70	-0.17	0.89	0.33
New Zealand	87:II-08:I	0.80	0.58	0.83	0.72	-0.27	0.74	-0.01
Spain	01:I-08:I	0.51	0.58	0.13	0.55	-0.17	0.77	0.32
Large Developed Economies								
France	78:I-08:II	0.76	0.74	0.59	0.84	-0.30	0.89	0.38
Italy	81:I-08:I	0.66	0.60	0.59	0.78	-0.13	0.85	0.33
Japan	94:I-08:I	0.70	0.45	0.70	0.92	-0.19	0.79	0.13
United Kingdom	80:I-08:I	0.86	0.81	0.80	0.73	-0.32	0.89	0.43
United States	47:I-08:IV	0.76	0.78	0.59	0.83	-0.28	0.84	0.34

Table 3: Average Relative Volatility of Consumption.

All data is quarterly. Emerging Market economies exclude Taiwan and Colombia. All variables are in logs and detrended using the HP filter.

	Weighted Average of Ratio to σ_y		
Variable	Large Economies	Small Economies	Emerging Economies
Total Consumption	0.94	0.99	1.30
Non-durables	0.68	0.72	0.90
Durables	3.83	3.85	4.48

Table 4: Benchmark Parameter Values.

Benchmark parameters taken from Aguiar and Gopinath (2007), Baxter (1996), and Gomes et al. (2008) or chosen to match either Mexico's or Canada's national statistics.

Time preference rate	β	0.98
Consumption utility share	θ	0.36
Elasticity of substitution between durables and nondurables	$\frac{1}{1+\gamma}$	0.86
Risk aversion	σ	2
Income share of labor in nondurables sector	α_N	0.48
Income share of labor in durables sector	α_D	0.68
Depreciation rate of capital stock	δ_K	0.01775
Depreciation rate of stock of durables	δ_D	0.039
Utility share of nondurables (Mexico)	μ	0.885
Utility share of nondurables (Canada)	μ	0.654
Aggregate productivity's long-run mean growth rate	μ_G	1.006
Autocorrelation of shock to trend	ρ_G	0.01
Autocorrelation of shock to nondurable goods	ρ_N	0.95
Autocorrelation of shock to durable goods	ρ_D	0.95
Capital adjustment cost (benchmark)	ϕ	4
Durables adjustment cost (benchmark)	ψ	1
Debt coefficient on interest rate premium (benchmark)	χ	-0.001
Steady-state normalized debt	b	-0.1

Table 5: Simulated moments and GMM parameter estimates for Mexico.

Simulated moments for output (y), total consumption expenditure (C), consumption of nondurables (n), investment in capital goods (inv), durable goods expenditure (xd), and net exports (nx). Results in column (1) were obtained by solving for σ_n and σ_g, while setting $\sigma_d = 0$, in order to match the empirical standard deviation of output and aggregate consumption. Results in column (2) were obtained by solving for σ_n and σ_d, while setting $\sigma_g = 0$, in order to match the empirical standard deviation of output and aggregate consumption. Results in column (3) were obtained by solving for σ_n, σ_d and σ_g in order to match the empirical standard deviation of output, expenditure in nondurable goods, and expenditure in durable goods. Results in column (4) were obtained by solving for σ_n, σ_d and σ_g in order to match the empirical standard deviations of output and total consumption expenditure, and the correlation between normalized net exports and output. Results in column (5) were obtained by solving for σ_n, σ_d and ψ, while setting $\sigma_g = 0$, in order to match the empirical standard deviations of output, total consumption expenditure, and the correlation between normalized net exports and output. Results in column (6) were obtained by solving for σ_n, σ_d, σ_g, and ψ in order to match the empirical standard deviations of output, expenditure in nondurable goods and expenditure in durable goods, and the correlation between normalized net exports and output. Results in column (7) were obtained by solving for σ_n, σ_d, ψ, and χ while setting $\sigma_g = 0$, in order to match the empirical standard deviations of output, expenditure in nondurable goods and expenditure in durable goods, and the correlation between normalized net exports and output. Results in column (8) were obtained by solving for σ_n, σ_d, σ_g, and ψ in order to match the empirical standard deviations of output, expenditure in nondurable goods, expenditure in durable goods, normalized net exports and investment and their correlations with output, and the first order autocorrelation of output. Results in column (9) were obtained solving for σ_n, σ_d, σ_g, ψ, ϕ, χ, ρ_n, ρ_d, and ρ_d in order to match the same moments as in (8). Results in column (10) were obtained solving for σ_n, σ_d, σ_g, ψ, ϕ, χ, ρ_n, ρ_d, ρ_d and $\rho_{n,d}$ in order to match the same moments as in (8). Unless otherwise specified, parameters are set at their benchmark values (see Table 4).

	Data	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
σ_y	2.35	**2.35**	**2.35**	**2.35**	**2.35**	**2.35**	**2.35**	**2.35**	**2.62**	**1.96**	**2.35**
$\frac{\sigma_C}{\sigma_y}$	1.10	**1.10**	**0.96**	1.04	**1.21**	**1.07**	1.00	0.66	2.15	1.00	0.40
$\frac{\sigma_n}{\sigma_y}$	0.89	0.97	0.11	**0.89**	0.11	0.43	**0.72**	**0.61**	**2.11**	**0.89**	**0.89**
$\frac{\sigma_{inv}}{\sigma_y}$	6.11	2.77	2.17	2.63	2.16	2.39	2.24	1.98	**5.46**	**5.87**	**6.11**
$\frac{\sigma_{xd}}{\sigma_y}$	4.20	2.76	12.55	**4.20**	15.20	12.60	**4.22**	**4.20**	**4.38**	**4.22**	**4.20**
σ_{nx}	1.68	0.42	1.51	0.55	1.93	1.52	0.57	0.02	**0.83**	**2.05**	**1.68**
σ_{spr}	2.64	0.16	0.80	0.26	0.89	0.80	0.14	1.89	0.41	17.37	0.26
$\rho(y,y_{-1})$	0.81	0.71	0.76	0.72	0.76	0.76	0.72	0.71	**0.68**	**0.53**	**0.75**
$\rho(n,y)$	0.92	0.65	0.92	0.65	0.87	0.28	0.82	0.99	**0.43**	**0.50**	**0.92**
$\rho(xd,y)$	0.92	0.26	0.84	0.34	0.78	0.84	0.26	0.38	**0.32**	**0.62**	**0.93**
$\rho(inv,y)$	0.92	0.64	0.93	0.69	0.93	0.82	0.84	1.00	**0.12**	**0.57**	**0.92**
$\rho(nx,y)$	-0.82	0.17	-0.11	0.09	**-0.19**	**-0.11**	**-0.01**	**-0.28**	**0.38**	**-0.29**	**-0.81**
$\rho(C,y)$	0.94	0.63	0.78	0.67	0.71	0.71	0.70	1.00	0.45	0.60	0.44
$\rho(spr,y)$	-0.49	0.19	0.73	0.28	0.78	0.73	0.40	0.24	0.12	0.82	0.54
σ_n		10.61	0.00	10.22	0.00	0.00	10.66	11.31	10.39	3.09	24.07
σ_d		0	12.29	3.33	12.21	12.26	0.01	7.83	5.04	7.70	14.63
σ_g		1.32	0	1.17	0	0.69	0.73	0	3.85	0.58	0.10
ψ					0.57		0.04	14.55	3.98	1.60	122.24
ϕ										0.06	1.06
χ								-1.99		-.0524	-.0004
ρ_n										0.78	0.99
ρ_d										0.47	1.00
ρ_g										.00	0.79
$\rho_{n,d}$											0.98
Residual		2.45×10^{-18}	0.02	1.12×10^{-16}	0.41	0.51	0.69	0.37	5.45	1.09	.004
Quality of fit		0.70	-.18	0.73	-.84	-.17	0.68	0.72	0.84	-1.85	0.90
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_n$		0.35	-	0.30	-	100	0.11	-	3.05	0.81	0.00
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_d$		-	-	5.47	-	0.15	99.99	-	21.17	0.26	0.00

Table 6: Simulated moments and GMM parameter estimates for Canada.

Simulated moments for output (y), total consumption expenditure (C), consumption of nondurables (n), investment in capital goods (inv), durable goods expenditure (xd), and net exports. Results in column (1) were obtained by solving for σ_n and σ_g, while setting $\sigma_d = 0$, in order to match the empirical standard deviation of output and aggregate consumption. Results in column (2) were obtained by solving for σ_n and σ_d, while setting $\sigma_g = 0$, in order to match the empirical standard deviation of output and aggregate consumption. Results in column (3) were obtained by solving for σ_n, σ_d and σ_g in order to match the empirical standard deviation of output, consumption of nondurable goods, and expenditure in durable goods. Results in column (4) were obtained by solving for σ_n, σ_d and σ_g in order to match the empirical standard deviations of output and total consumption expenditure, and the correlation between normalized net exports and output. Results in column (5) were obtained by solving for σ_n, σ_d and ψ, while setting $\sigma_g = 0$, in order to match the empirical standard deviations of output, total consumption expenditure, and the correlation between normalized net exports and output. Results in column (6) were obtained by solving for σ_n, σ_d, σ_g, and ψ in order to match the empirical standard deviations of output, consumption of nondurables and expenditure in durable goods, and the correlation between normalized net exports and output. Results in column (7) were obtained by solving for σ_n, σ_d, ψ, and χ while setting $\sigma_g = 0$, in order to match the empirical standard deviations of output, consumption of nondurables and expenditure in durable goods, and the correlation between normalized net exports and output. Results in column (8) were obtained by solving for σ_n, σ_d, σ_g, and ψ in order to match the empirical standard deviations of output, expenditure in nondurable goods, expenditure in durable goods, normalized net exports and investment and their correlations with output, and the first order autocorrelation of output. Results in column (9) were obtained solving for σ_n, σ_d, σ_g, ψ, ϕ, χ, ρ_n, ρ_d, and ρ_d in order to match the same moments as in (8). Results in column (10) were obtained solving for σ_n, σ_d, σ_g, ψ, ϕ, χ, ρ_n, ρ_d, ρ_d and $\rho_{n,d}$ in order to match the same moments as in (8). Unless otherwise specified, parameters are set at their benchmark values (see Table 4).

	Data	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
σ_y	1.33	**1.33**	**1.33**	**1.33**	**1.33**	**1.33**	**1.33**	**1.33**	**1.43**	**1.34**	**1.33**
$\frac{\sigma_C}{\sigma_y}$	0.88	**0.88**	**0.88**	1.02	**0.88**	**0.88**	1.00	0.77	1.10	1.22	1.17
$\frac{\sigma_n}{\sigma_y}$	0.60	0.67	0.53	**0.60**	0.53	0.53	**0.60**	**0.54**	**0.61**	**0.64**	**0.64**
$\frac{\sigma_{inv}}{\sigma_y}$	1.89	2.00	1.90	2.06	1.90	1.90	2.08	1.73	**2.01**	**1.90**	**1.90**
$\frac{\sigma_{xd}}{\sigma_y}$	3.27	1.25	2.54	**3.27**	2.53	2.53	**3.27**	**3.27**	**3.31**	**3.28**	**3.27**
σ_{nx}	0.91	0.25	0.45	0.61	0.46	0.46	0.59	0.00	**0.72**	**0.89**	**0.90**
σ_{spr}	1.54	0.10	0.18	0.23	0.18	0.18	0.24	0.28	0.24	0.03	0.22
$\rho(y,y_{-1})$	0.84	0.72	0.73	0.73	0.73	0.73	0.73	0.71	**0.73**	**0.89**	**0.74**
$\rho(n,y)$	0.77	0.87	0.96	0.82	0.96	0.96	0.80	0.95	**0.85**	**0.79**	**0.79**
$\rho(xd,y)$	0.73	0.73	0.59	0.58	0.59	0.57	0.60	0.70	**0.52**	**0.74**	**0.74**
$\rho(inv,y)$	0.77	0.89	0.98	0.90	0.98	0.91	0.89	1.00	**0.91**	**0.81**	**0.78**
$\rho(nx,y)$	-0.19	-0.13	-0.19	-0.20	**-0.19**	**-0.19**	**-0.19**	**-0.19**	**-0.21**	**-0.16**	**-0.17**
$\rho(C,y)$	0.81	0.89	0.92	0.83	0.92	0.84	0.84	1.00	0.79	0.79	0.85
$\rho(spr,y)$	-0.49	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.60	0.66
σ_n	-	4.77	4.48	4.25	4.47	4.33	4.19	4.27	4.78	4.06	5.39
σ_d	-	0	1.06	1.37	1.07	1.28	1.47	2.70	1.12	1.34	1.85
σ_g	-	0.25	0	0.22	0	0.21	0.23	0	0.23	0.18	0.00
ψ	-				1.01		1.18	6.52	0.48	0.37	0.24
χ	-							-3.77		-0.0001	-0.0006
ϕ	-									2.92	3.55
ρ_g	-									-0.03	0.65
ρ_n	-									0.99	0.97
ρ_d	-									0.84	0.85
ρ_{nd}	-										-0.54
Residual		9.86 $\times 10^{-15}$	4.27 $\times 10^{-18}$	2.06 $\times 10^{-25}$	3.90 $\times 10^{-17}$	2.17 $\times 10^{-15}$	6.09 $\times 10^{-18}$	3.63 $\times 10^{-3}$	0.15	0.02	0.01
Quality of fit		0.7140	0.8810	0.9156	0.8808	0.8820	0.9165	0.8864	0.9167	0.8927	0.9147
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_n$		0.06	-	0.06	-	0.05	0.07	-	0.05	0.04	0.00
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_d$		-	-	1.17	-	1.22	1.11	-	1.90	0.72	0.00

Table 7: Simulated moments and GMM parameter estimates for Mexico and Canada, Model II.

Simulated moments for output (y), total consumption expenditure (C), consumption of nondurables (n), investment in capital goods (inv), durable goods expenditure (xd), net exports (nx), the borrowing premium (spr), and the amount of borrowing as a percentage of output (b). Results in column (1) were obtained by solving for σ_n, σ_g, σ_d, and η, in order to match the empirical standard deviation of output, consumption of nondurable goods, expenditure in durable goods, and the borrowing premium. Results in column (2) were obtained by solving for σ_n, σ_g, σ_d, χ, and η, in order to match the empirical standard deviation of output, consumption of nondurable goods, expenditure in durable goods, and the borrowing premium and the correlation between output and net exports. Results in column (3) were obtained by solving for σ_n, σ_g, σ_d, ν, and η in order to match the empirical standard deviation of output, consumption of nondurable goods, expenditure in durable goods, and the borrowing premium and the correlation between output and net exports. Results in column (4) were obtained by solving for σ_n, σ_g, σ_d, ν, and η in order to match the empirical standard deviations of output, expenditure in nondurable goods, expenditure in durable goods, normalized net exports, investment, and the borrowing premium and their correlations with output, and the first order autocorrelation of output. Unless otherwise specified, parameters are set at their benchmark values (see Table 4). Data for spread and borrowing is from Neumeyer and Perri (2005).

	Mexico						Canada					
	Data	(1)	(2)	(3)	(4)	(5)	Data	(1)	(2)	(3)	(4)	(5)
σ_y	2.35	**2.35**	**2.31**	**2.43**	**2.57**	**2.58**	1.33	**1.33**	**1.33**	**1.33**	**1.33**	**1.33**
$\frac{\sigma_C}{\sigma_y}$	1.10	1.07	1.00	1.06	2.23	2.23	0.88	0.95	1.01	1.01	1.09	1.11
$\frac{\sigma_n}{\sigma_y}$	0.89	**0.89**	**0.81**	**0.85**	**2.05**	**2.05**	0.60	**0.59**	**0.60**	**0.59**	**0.70**	**0.68**
$\frac{\sigma_{inv}}{\sigma_y}$	6.11	2.66	2.40	2.51	**5.24**	**5.21**	1.89	1.95	1.81	1.77	**1.95**	**1.96**
$\frac{\sigma_{xd}}{\sigma_y}$	4.20	**4.20**	**4.18**	**4.12**	**4.61**	**4.60**	3.27	**3.27**	**3.27**	**3.28**	**3.37**	**3.34**
σ_{nx}	1.68	0.57	0.47	0.59	**0.51**	**0.47**	0.91	0.59	0.51	0.54	**0.56**	**0.54**
σ_{spr}	2.64	**2.64**	**2.68**	**2.66**	**2.66**	**2.63**	1.54	**1.54**	**1.54**	**1.54**	**1.53**	**1.52**
σ_b	-	2.01	1.34	1.47	1.24	1.05	-	2.11	1.41	1.41	1.48	1.36
$\rho(y,y_{-1})$	0.81	0.72	0.72	0.72	**0.66**	**0.67**	0.84	0.73	0.73	0.72	**0.73**	**0.73**
$\rho(n,y)$	0.92	0.69	0.78	0.77	**0.54**	**0.54**	0.77	0.74	0.89	0.93	**0.83**	**0.83**
$\rho(xd,y)$	0.92	0.51	0.57	0.66	**0.71**	**0.67**	0.73	0.50	0.57	0.53	**0.53**	**0.64**
$\rho(inv,y)$	0.92	0.71	0.78	0.77	**0.11**	**0.11**	0.77	1.85	0.93	0.95	**0.84**	**0.87**
$\rho(nx,y)$	-0.82	-0.27	**-0.42**	**-0.58**	**-0.65**	**-0.61**	-0.19	0.11	**-0.19**	**-0.19**	**-0.19**	**-0.39**
$\rho(C,y)$	0.94	0.72	0.81	0.82	0.60	0.61	0.81	0.77	0.87	0.87	0.83	0.88
$\rho(spr,y)$	-0.49	-0.99	-0.87	-1	**-0.95**	**-0.61**	0.25	0.98	0.81	1.00	**1.00**	**0.28**
σ_n		10.76	10.96	11.85	12.00	11.98		3.79	4.45	4.61	4.63	4.76
σ_d		2.85	2.53	1.68	0.02	.0001		1.55	1.38	1.26	1.29	1.35
σ_g		1.14	0.91	1.02	3.62	3.63		0.27	0.18	0.14	0.29	0.27
χ			-.0089			-.0242			-.0062		-.0114	
η		-.0034	-.0040	-.0032	-.0033	-.0051		.0034	.0019	.0037	.0037	-.00116
ν				.0340	.0673	.0768				.0104	.0000	
Residual		1.12 $\times 10^{-9}$	0.17	0.07	4.80	4.76		2.75 $\times 10^{-19}$	2.25 $\times 10^{-15}$	3.55 $\times 10^{-15}$	0.88	0.36
Quality of fit		0.8187	0.7963	0.8107	0.9198	0.9203		0.9164	0.9754	0.9640	0.9654	0.9877
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_n$		0.26	0.16	0.17	2.04	2.06		0.12	0.04	0.02	0.09	0.07
$\left(\sigma^2_{\Delta\tau}/\sigma^2_{\Delta sr}\right)_d$		6.86	5.62	14.50	100	100		1.38	0.78	0.56	2.27	1.81