

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

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February 16, 2009

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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.

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1 Introduction

The business cycle for emerging economies has distinctive features. The current account exhibits strong counter-cyclical and the sovereign interest rates are highly counter cyclical, very volatile, and significantly higher than the world interest rate. In addition, consumption volatility exceeds income volatility. For instance, 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*.

One leading explanation for these regularities relies on shocks to income trend. 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 has also been used as an explanation for the puzzle. de Resende (2006) models a small open economy with endogenous borrowing limits, and finds that consumption volatility increases substantially as savings can not 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.

In this paper, we decompose consumption into durable and non durable 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 found 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.

Therefore, a driving force of business cycle in emerging economies should reproduce strongly counter-cyclical interest rates and current account, but at the same time, a volatility of consumption of non-durable smaller than the volatility of income. We find that, to some extent, Aguiar and Gopinath (2007)'s driving force fails the test, since it delivers too little non-durable 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.

The ultimate goal of this paper is to explore possible sources of the observed patterns for consumption volatility when considering durables and nondurables. Specifically, we seek a candidate which is able to reproduce a high volatility of purchase of durable goods together with volatility of consumption of non durable slightly smaller than the volatility of income and a strongly countercyclical current account.

A first candidate are shocks to external interest rates. This is a natural driving force as empirical findings indicate a strong relation between sovereign interest rates and output. Mendoza (1991) finds that for early real business cycle models for small open economies, interest rates disturbances play a minor role in driving the business cycle. However, Neumeyer and Perri (2005) find that if firms have to pay for factors before production takes place, interest rates play a more significant role in shaping the business cycle. The intuition is that now, the demand for labor is sensitive to interest rates. We depart from their environment in different aspects. First, unlike them, our focus is on volatility of consumption. Second, we move attention to the consumer side, and in particular, to the purchase of durable goods, instead of imposing frictions on the productive side. The reason for this is that purchases of durable goods act as a way of saving, given that the consumption of durable can be postponed over time, the purchase of durable should respond strongly to the interest rate. In contrast, the purchase of non durable should be smoothed, as much as possible, by the standard argument based on consumer prefer-

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

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, 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 Stylized 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;
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:

- Consumption of nondurables is not more volatile than output in either small open economies or emerging markets. We found 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 2).

- 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.

3 The model

The model is a two-sector neoclassical growth model as in Aguiar and Gopinath (2007). In this small open economy, there are two types of goods: durables and nondurables. The nondurable good is assumed to be a tradable good and the durable good is assumed to be nontradable. We assume that markets are incomplete since individuals have only access to two assets: physical capital and a risk-free bond. 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 $i = \{N, D\}$ take the following form:

$$Y_{i,t} = e^{z_{i,t}} K_{i,t}^{\alpha_i} (e^{g_t} L_{1,t})^{1-\alpha_i}, \quad (1)$$

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, g_t is the common shock to trend, and $z_{i,t}$ is the temporary stochastic productivity process in sector i . It is assumed that each shock follows an AR(1) process

$$z_{1,t} = \rho_1 z_{1,t-1} + \epsilon_{D,t},$$

$$z_{2,t} = \rho_2 z_{2,t-1} + \epsilon_{D,t},$$

$$g_t = (1 - rho_g) \ln \mu_G + \epsilon_{G,t}$$

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 $N(0, \sigma_g^2)$.

We assume that capital and labor can be freely allocated between these two sectors. Thus, each period,

$$K_t = K_{N,t} + K_{D,t}, \quad (2)$$

$$L_t = L_{N,t} + L_{D,t}. \quad (3)$$

We plan on relaxing this assumption in a future version of this paper by introducing a friction in the movement of inputs across sectors such as some sort of adjustment cost or sector-specific inputs.

The representative agent's expected lifetime utility is

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, 1 - L_t), \quad (4)$$

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

$$U(C_t, L_t) = \frac{(C_t^\theta L_t^{1-\theta})^{1-\sigma} - 1}{1-\sigma}, \text{ where} \quad (5)$$

$$C_t \equiv (\mu N_t^{-\gamma} + (1-\mu)^{-\gamma} D_t)^{-\frac{1}{\gamma}}, \quad (6)$$

and $\frac{1}{1+\gamma}$ is the elasticity of substitution between durables and nondurables, μ is the share of nondurables in total expenditure, θ is the intertemporal elasticity of substitution in labor supply and γ is the coefficient of relative risk aversion. The planner's problem is to maximize (4)

subject to (1)-(3) and the resource constraint

$$\begin{aligned}
N_t + p_t D_{t+1} + K_{t+1} + q_t B_{t+1} &= Y_{N,t} + p_t Y_{D,t} + p_t (1 - \delta_d) D_t \\
&+ (1 - \delta_k) K_t - \Phi(K_{t+1}, K_t) - \Psi(D_{t+1}, D_t) + B_t,
\end{aligned} \tag{7}$$

where the assumption of a second hand market for durable goods is implicit. In (7), p_t is the relative price of durables, δ_k and δ_d are depreciation rates, B_t denotes holdings of one-period risk-free bonds, and q_t is the bond price issued in period t . Moreover, $\Psi(D_{t+1}, D_t)$ and $\Phi(K_{t+1}, K_t)$ represent quadratic adjustment cost for capital and durables, respectively. 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 price of debt depends on the level of outstanding debt B_t as in Schmitt-Grohé and Uribe (2003) which takes care of 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 TFP shocks. This way

$$q_t = \frac{1}{r^* + p_1(B_t) + p_2(z_{Nt}, z_{Dt})}, \tag{8}$$

where p_1 and p_2 are increasing functions. A distinctive feature of emerging economies when compared to industrialized small open economies is that p_2 is much steeper for the former than for the latter. The borrowing premium described by (8) 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). For the moment and to allow comparability with Aguiar and Gopinath (2007), we set $p_2(\cdot) = 0$.

Investment in capital goods and the expenditure in consumption durables are given by

$$X_{Kt} = K_{t+1} - (1 - \delta_K)K_t, \text{ and} \quad (9)$$

$$X_{Dt} = D_{t+1} - (1 - \delta_D)D_t, \quad (10)$$

respectively. Finally, since the durable good is assumed to be nontradable¹, we have the following resource constraint:

$$X_{Dt} = Y_{Dt}. \quad (11)$$

3.1 Pareto optimal allocation

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

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

$$U_{C_t} \mathcal{C}_{N_t} \left[1 - \frac{\partial \Phi_t}{\partial K_{t+1}} \right] = \beta E_t \left\{ U_{C_{t+1}} \mathcal{C}_{N_{t+1}} \left[F_{1K_{t+1}} + 1 - \delta_k - \frac{\partial \Phi_{t+1}}{\partial K_{t+1}} \right] \right\}, \quad (13)$$

$$U_{C_t} \mathcal{C}_{N_t} \left[q_t + \frac{\partial q_t}{\partial B_{t+1}} B_{t+1} \right] = \beta E_t \left\{ U_{C_{t+1}} \mathcal{C}_{N_{t+1}} \right\}, \quad (14)$$

$$U_{C_t} \mathcal{C}_{N_t} F_{1L_t} = U_{L_t}, \quad (15)$$

$$F_{1K_t} = p_t F_{2K_t}, \quad (16)$$

$$F_{1L_t} = p_t F_{2L_t}, \quad (17)$$

where $\mathcal{C}_{D_t}$ and $\mathcal{C}_{N_t}$ are the derivatives of the consumption aggregator with respect to durables and nondurables. The first three equations correspond to intertemporal trade-offs between current nondurable consumption and the accumulation of durable goods, capital and debt. The last three expressions represent static optimality conditions: consumption-leisure, and capital and labor allocation between sectors.

¹The assumption that durable 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.

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, capital and labor for durables and nondurables, and the relative price of durables) and laws of motion for the endogenous states (capital stock, 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 Harald Uhlig's toolkit for Matlab. In Appendix A we present more details on how this was 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 nondurables and 0.68 for durables, as used in Baxter (1996). The utility share of nondurables (μ) is set to match the share of consumption of nondurable goods in total consumption for Mexico, which amounts to 91.8%. 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 3.

The results for the simulation are summarized in Table 4. The results show some mixed evidence as to how well this expanded version of Aguiar and Gopinath's model to include spending in durable goods matches the data. In column (1) of table 4 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 of the temporary sectoral shocks (σ_n , and σ_d , assumed to be equal) and the shock to trend (σ_g). The solution is obtained by matching the standard deviations of output and aggregate consumption. The results 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 Ta-

ble 1). The simulated correlations of output with total consumption and investment are also somewhat smaller than what is found in the data (see Table 2 in Aguiar and Gopinath (2007)). More worryingly, the simulation delivers a countercyclical spending in durables (whereas evidence points to strong cyclicality), cyclical net exports (contrary to data) and the wrong type of persistence for output. Finally, the estimates for the standard deviation of the shocks show that almost all of the volatility has to come from shocks to trend.

In column (2) of the table we present the simulated moments that result from solving for the standard deviations of shocks (without imposing equality restrictions) in order to match the volatilities of output, consumption of nondurables, and spending in durable goods. The simulated correlations present the same pattern as for the previous exercise.

5 Conclusions

This paper presents a preliminary examination of the robustness of Aguiar and Gopinath (2007)'s findings on consumption volatility by considering nondurables and durables. One immediate extension to this work is to include cyclical borrowing constraints as in Neumeyer and Perri (2005). In future versions of this paper we plan on exploring the importance of external shocks in explaining the properties of business cycle of emerging markets. An alternative driving force to be considered under the presence of durable goods, are shocks to the term 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 term of trade. As external income becomes more volatile, default incentive reduces and, as a consequences, 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-durable with respect

to income volatility.

A Appendix

In this appendix we describe the model setup, first order conditions and resource constraints, as well as the non-stochastic steady state relations and the resulting log-linearized equations used to approximate the solutions for the policy functions and laws of motion.

A.1 Problem

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

subject to

$$N + PGD' + GK' + GQB' = Y_n + PY_d + (1 - \delta_k)K - \frac{\phi}{2} \left(G \frac{K'}{K} - \mu_g \right)^2 K + (1 - \delta_d)PD - P \frac{\psi}{2} \left(G \frac{D'}{D} - \mu_g \right)^2 D + B, \quad (\text{A-2})$$

where

$$C \equiv (mN^{-\mu} + (1-m)D^{-\mu})^{-\frac{1}{\mu}}, \quad (\text{A-3})$$

$$L \leq 1, \quad (\text{A-4})$$

$$L_N \geq 0, \quad (\text{A-5})$$

$$L_D \geq 0, \quad (\text{A-6})$$

$$K_N \geq 0, \quad (\text{A-7})$$

$$K_D \geq 0, \quad (\text{A-8})$$

$$Q = (1 + r^* + \chi(\exp(B' - \bar{B})) - 1), \quad (\text{A-9})$$

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

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

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

$$\ln Z'_N = \rho_N \ln Z_N + \epsilon_N, \quad (\text{A-13})$$

$$\ln Z'_D = \rho_D \ln Z_D + \epsilon_D. \quad (\text{A-14})$$

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

A.1.1 F.O.C.

$$U_C C_N \left(1 - \phi \left(G \frac{K'}{K} - \mu_G \right) \right) G = \beta G^{\gamma(1-\sigma)} EV_{K'}, \quad (\text{A-15})$$

$$U_C C_N P \left(1 - \psi \left(G \frac{D'}{D} - \mu_G \right) \right) G = \beta G^{\gamma(1-\sigma)} EV_{D'}, \quad (\text{A-16})$$

$$U_C C_N Q G = \beta G^{\gamma(1-\sigma)} EV_{B'}, \quad (\text{A-17})$$

$$U_C C_N F_{NL} = -U_L \Leftrightarrow \left(1 + \frac{1-\gamma}{\gamma} \frac{C}{C_N \alpha_N Y_N} \right) L_N = 1 - L_D, \quad (\text{A-18})$$

$$F_{NK} = P F_{DK} \Leftrightarrow (1 - \alpha_N) \frac{Y_N}{K_N} = P(1 - \alpha_D) \frac{Y_D}{K_D}, \quad (\text{A-19})$$

$$F_{NL} = P F_{DL} \Leftrightarrow \alpha_N \frac{Y_N}{L_N} = P \alpha_D \frac{Y_D}{L_D}. \quad (\text{A-20})$$

A.1.2 Envelope Conditions

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

$$V_{D'} = U_{C'} \left(C_{N'} \left\{ P'(1 - \delta_D) + P' \frac{\psi}{2} \left[\left(\frac{G' D''}{D'} \right)^2 - \mu_G^2 \right] \right\} + C_{D'} \right), \quad (\text{A-22})$$

$$V_{B'} = U_{C'} C_{N'}, \quad (\text{A-23})$$

where

$$U_C = \gamma C^{\gamma(1-\sigma)-1} (1 - L)^{(1-\gamma)(1-\sigma)}, \quad (\text{A-24})$$

$$C_N = m N^{-\mu-1} (m N^{-\mu} + (1 - m) D^{-\mu})^{-\frac{1}{\mu}-1}, \text{ and} \quad (\text{A-25})$$

$$C_D = (1 - m) D^{-\mu-1} (m N^{-\mu} + (1 - m) D^{-\mu})^{-\frac{1}{\mu}-1}. \quad (\text{A-26})$$

A.1.3 Market Clearing and Resource Constraint Conditions

$$L = L_N + L_D, \quad (\text{A-27})$$

$$K = K_N + K_D, \quad (\text{A-28})$$

$$Y_D = GD' - (1 - \delta_d)D. \quad (\text{A-29})$$

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 $\bar{D}$. $\bar{P}$ is given and the following relationships define the rest:

$$\bar{Q} = \beta \mu_G^{\gamma(1-\sigma)-1}, \quad (\text{A-30})$$

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

$$\bar{L}_N = \frac{1 - L_D}{1 + \frac{1-\gamma}{\gamma} \frac{\bar{C}}{\alpha_N \bar{C}_N \bar{Y}_N}}, \quad (\text{A-32})$$

$$(1 - \alpha_N) \frac{\bar{Y}_N}{\bar{K}_N} = (1 - \alpha_D) \bar{P} \frac{\bar{Y}_D}{\bar{K}_D}, \quad (\text{A-33})$$

$$\alpha_N \frac{\bar{Y}_N}{\bar{L}_N} = \alpha_D \bar{P} \frac{\bar{Y}_D}{\bar{L}_D}, \quad (\text{A-34})$$

$$\frac{\bar{K}_N}{\bar{Y}_N} = \frac{(1 - \alpha_N) \bar{Q}}{1 - (1 - \delta_K) \bar{Q}}, \quad (\text{A-35})$$

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

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

$$\bar{N} = \bar{Y}_N + \bar{P} \bar{Y}_D + (1 - \delta_K - \mu_G) \bar{K} + \bar{P} (1 - \delta_D - \mu_G) \bar{D} + (1 - \bar{Q} \mu_G) \bar{B}. \quad (\text{A-38})$$

A.3 Log-linearized Equations

We have to solve the equations below for $\hat{k}', \hat{k}_N, \hat{k}_D, \hat{l}, \hat{l}_N, \hat{l}_D, \hat{d}, \hat{n}, \hat{q}, \hat{y}_N$, and $\hat{y}_D$, given $\hat{p}, \hat{g}, \hat{z}_N, \hat{z}_D, \hat{k}, \hat{d}, \hat{d}$ and definitions for $\hat{c}, \hat{c}_N$, and $\hat{c}_D$.

1. F.O.C. for K' :

$$U_C C_N \left(1 - \phi \left(G \frac{K'}{K} - \mu_G \right) \right) \approx \bar{U}_C \bar{C}_N \left((\gamma(1-\sigma) - 1)\hat{c} - (1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l} + \right. \\ \left. + \hat{c}_N - \phi \mu_G \hat{g} - \phi \mu_G (\hat{k}' - \hat{k}) \right) \quad (\text{A-39})$$

$$\beta G^{\gamma(1-\sigma)-1} E V_{K'} = E U_{C'} C_{N'} \left\{ F_{NK'} + 1 - \delta_K + \frac{\phi}{2} \left[\left(\frac{G' K''}{K'} \right)^2 - \mu_G^2 \right] \right\} \approx \\ \approx \mu_G^{\gamma(1-\sigma)-1} \beta \bar{U}_C \bar{C}_N E \left\{ \left((1-\alpha_N) \frac{\bar{Y}_N}{\bar{K}_N} + (1-\delta_K) \right) ((\gamma(1-\sigma) - 1)\hat{g} + (\gamma(1-\sigma) - 1)\hat{c}' - \right. \\ \left. - (1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l}' + \hat{c}'_N) + (1-\alpha_N) \frac{\bar{Y}_N}{\bar{K}_N} (\hat{y}'_N - \hat{k}'_N) + \phi \mu_G^2 (\hat{g}' + \hat{k}'' - \hat{k}') \right\}, \\ \text{where } (1-\alpha_N) \frac{\bar{Y}_N}{\bar{K}_N} + (1-\delta_K) = \bar{Q}^{-1}. \quad (\text{A-40})$$

2. F.O.C. for D' :

$$U_C C_N P \left(1 - \psi \left(G \frac{D'}{D} - \mu_G \right) \right) \approx \bar{U}_C \bar{C}_N \bar{P} \left((\gamma(1-\sigma) - 1)\hat{c} - (1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l} + \right. \\ \left. + \hat{c}_N + \hat{p} - \psi \mu_G \hat{g} - \psi \mu_G (\hat{d}' - \hat{d}) \right) \quad (\text{A-41})$$

$$\begin{aligned}
\beta G^{\gamma(1-\sigma)-1} EV_{D'} &= \beta G^{\gamma(1-\sigma)-1} EU_{C'} \left(C_{N'} \left\{ P'(1-\delta_D) + P' \frac{\psi}{2} \left[\left(\frac{G'D''}{D'} \right)^2 - \mu_G^2 \right] \right\} + C_{D'} \right) \approx \\
&\approx \mu_G^{\gamma(1-\sigma)} \beta \bar{U}_C E \left(\bar{C}_N \left\{ (\bar{P}(1-\delta_D) + \bar{C}_D) (\gamma(1-\sigma)\hat{g} + (\gamma(1-\sigma)-1)\hat{c}' - \right. \right. \\
&\quad \left. \left. -(1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l}' + \hat{c}'_N \right\} + \bar{P}(1-\delta_D)\hat{p}' + \hat{P}\psi\mu_G^2(\hat{g}' + \hat{d}'' - \hat{d}') \right\} + \bar{C}_D \hat{c}'_D \right), \tag{A-42}
\end{aligned}$$

3. F.O.C. for B' :

$$U_C C_N Q \approx \bar{U}_C \bar{C}_N \bar{Q} \left((\gamma(1-\sigma)-1)\hat{c} - (1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l} + \hat{c}_N + \hat{q} \right). \tag{A-43}$$

$$\begin{aligned}
\beta G^{\gamma(1-\sigma)-1} EV_{D'} &= \beta G^{\gamma(1-\sigma)-1} EU_{C'} C_{N'} \approx \\
&\approx \bar{Q} \bar{U}_C \bar{C}_N E \left((\gamma(1-\sigma)-1)\hat{g} + (\gamma(1-\sigma)-1)\hat{c}' - (1-\gamma)(1-\sigma) \frac{\bar{L}}{1-\bar{L}} \hat{l}' + \hat{c}'_N \right) \tag{A-44}
\end{aligned}$$

4. F.O.C. for L :

$$\begin{aligned}
U_C C_N F_{NL} &\approx \bar{U}_C \bar{C}_N (\alpha_N \frac{\bar{Y}_N}{\bar{L}_N}) \mu_G \left((\gamma(1-\sigma)-1)\hat{c} - (1-\gamma)(1-\sigma)\hat{l} + \hat{c}_N + \hat{q} \right), \\
-U_L &\approx -\bar{U}_L \left(\gamma(1-\sigma)\hat{c} + ((1-\gamma)(1-\sigma)-1)\hat{l} \right).
\end{aligned}$$

which simplifies to

$$\frac{1-\gamma}{\alpha_N\gamma} \frac{\bar{C}}{\bar{C}_N \bar{Y}_N} \bar{L}_N \left(\hat{c} - \hat{c}_N - \hat{y}_N + \hat{l}_N \right) + \bar{L}_N \hat{l}_N + \bar{L}_D \hat{l}_D = 0. \quad (\text{A-45})$$

5. F.O.C. for K_D :

$$\hat{y}_N - \hat{k}_N = \hat{p} + \hat{y}_D - \hat{k}_D. \quad (\text{A-46})$$

6. F.O.C. for L_D :

$$\hat{y}_N - \hat{l}_N = \hat{p} + \hat{y}_D - \hat{l}_D. \quad (\text{A-47})$$

7. Budget Constraint:

$$\begin{aligned} \bar{N}\hat{n} + \bar{P}\mu_G\bar{D}(\hat{p} + \hat{g} + \hat{d}') + \mu_G\bar{Q}\bar{B}(\hat{g} + \hat{q} + \hat{b}') + \mu_G\bar{K}(\hat{g} + \hat{k}') = \\ \bar{Y}_N\hat{y}_N + \bar{P}\bar{Y}_D(\hat{p} + \hat{y}_D) + (1 - \delta_K)\bar{K}\hat{k} + (1 - \delta_D)\bar{P}\bar{D}(\hat{p} + \hat{d}) + \bar{B}\hat{b}. \end{aligned} \quad (\text{A-48})$$

8. Resource Constraint for Labor:

$$\bar{L}\hat{l} = \bar{L}_N\hat{l}_N + \bar{L}_D\hat{l}_D. \quad (\text{A-49})$$

9. Resource Constraint for Capital:

$$\bar{K}\hat{k} = \bar{K}_N\hat{k}_N + \bar{K}_D\hat{k}_D. \quad (\text{A-50})$$

10. Definitions for Utility Function:

$$C \approx \bar{C}\hat{c},$$

$$C_N \approx \bar{C}_N\hat{c}_N,$$

$$C_D \approx \bar{C}_D\hat{c}_D,$$

where

$$\hat{c} \equiv \frac{m\bar{N}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}}\hat{n} + \frac{(1-m)\bar{D}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}}\hat{d}, \quad (\text{A-51})$$

$$\bar{c}_N \equiv (1+\mu) \left(\left[\frac{m\bar{N}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}} - 1 \right] \hat{n} + \frac{(1-m)\bar{D}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}} \hat{d} \right), \text{ and} \quad (\text{A-52})$$

$$\bar{c}_D \equiv (1+\mu) \left(\frac{m\bar{N}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}} \hat{n} + \left[\frac{(1-m)\bar{D}^{-\mu}}{m\bar{N}^{-\mu} + (1-m)\bar{D}^{-\mu}} - 1 \right] \hat{d} \right). \quad (\text{A-53})$$

11. Technology

$$\hat{y}_N \approx \hat{z}_N + (1 - \alpha_N)\hat{k}_N + \alpha_N(\hat{g} + \hat{l}_N), \text{ and} \quad (\text{A-54})$$

$$\hat{y}_D \approx \hat{z}_D + (1 - \alpha_D)\hat{k}_D + \alpha_D(\hat{g} + \hat{l}_D). \quad (\text{A-55})$$

12. Interest Rate Function:

$$\hat{q} \approx -\chi\bar{B}\bar{Q}\hat{b}'. \quad (\text{A-56})$$

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B Tables

Table 1: Volatility of Output and Relative Volatility of Consumption.

Macroeconomic volatility measured by standard deviation (σ) of GDP (y), total consumption expenditure (c), consumption of nondurable goods (n), and expenditure in durable goods. All data is quarterly except for Colombia, for which it is annual. All variables are in logs 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	$\frac{\sigma_d}{\sigma_y}$
Emerging Market Economies								
Chile	96:I-08:I	2.38	3.39	1.43	2.86	1.20	11.05	4.64
Colombia	65-06	1.64	1.34	0.81	1.10	0.67	5.20	3.17
Czech Republic	96:I-08:I	0.95	1.00	1.06	0.91	0.95	3.35	3.52
Israel	80:II-08:I	1.97	2.94	1.49	2.38	0.81	12.79	5.38
Mexico	93:I-07:IV	2.35	2.57	1.10	2.09	0.89	9.86	4.20
Taiwan	61:I-08:II	2.05	1.65	0.80	1.88	0.92	1.90	0.93
Turkey	87:I-07:III	3.44	5.15	1.50	3.18	0.92	15.85	4.61
Small Developed Economies								
Canada	61:I-08:II	1.33	1.18	0.88	0.81	0.60	4.38	3.27
Denmark	90:I-08:II	1.20	1.44	1.20	1.05	0.87	7.25	6.03
Finland	90:I-08:I	1.68	1.41	0.84	1.00	0.59	8.16	4.85
Netherlands	87:II-08:I	1.02	1.07	0.70	0.88	0.58	3.50	2.30
New Zealand	87:II-08:I	1.40	1.56	1.12	1.12	0.83	3.83	2.74
Spain								
Large Developed Economies								
France	90:I-08:II	0.92	0.82	0.89	0.56	0.61	4.43	4.82
Italy	80:I-08:I	0.91	1.01	1.11	0.78	0.86	3.98	4.38
Japan	94:I-08:I	1.02	0.77	0.75	0.59	0.58	4.48	4.37
United Kingdom	80:I-08:I	1.14	1.30	1.13	0.96	0.84	4.33	3.79
United States	60:I-08:II	1.49	1.12	0.80	0.81	0.54	4.48	3.01

Table 2: 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.

Variable	Weighted Average of Ratio to σ_y		
	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 3: Benchmark Parameter Values.

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

Time preference rate	β	0.98
Elasticity of substitution of labor supply	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	0.05
Depreciation rate of stock of durables	δ_D	0.05
Utility share of nondurables	μ	0.92
Aggregate productivity's long-run mean growth rate	μ_G	1.006
Autocorrelation of shock to trend	ρ_G	0.11
Autocorrelation of shock to nondurable goods	ρ_N	0.95
Autocorrelation of shock to durable goods	ρ_D	0.95
Capital adjustment cost	ϕ	4.0
Durables adjustment cost	ψ	4.0
Coefficient on interest rate premium	χ	-0.001

Table 4: Simulated moments and GMM parameter estimates.

Simulated moments for output (y), total consumption expenditure (C), consumption of non-durables (n), investment in capital goods (inv), durable goods expenditure (xd), net exports (nx), and labor supply (l). Results in column (1) were obtained by solving for $\sigma_n = \sigma_d$ and σ_g in order to match the empirical standard deviation of output and aggregate consumption. Results in column (2) were obtained by solving for σ_n , σ_d and σ_g in order to match the empirical standard deviation of output, nondurables consumption, and expenditure in durable goods.

	(1)	(2)
σ_y	234.9	234.9
$\sigma_{\Delta y}$	129.4	236.0
$\frac{\sigma_C}{\sigma_y}$	1.31	1.45
$\frac{\sigma_n}{\sigma_y}$	0.70	1.00
$\frac{\sigma_{inv}}{\sigma_y}$	3.93	4.52
$\frac{\sigma_{xd}}{\sigma_y}$	1.95	4.17
$\frac{\sigma_{nx}}{\sigma_y}$	1.79	2.61
$\rho(y, y_{-1})$	-0.30	0.07
$\rho(\Delta y, \Delta y_{-1})$	-0.54	-0.28
$\rho(n, y)$	0.67	0.10
$\rho(xd, y)$	-0.35	-0.56
$\rho(inv, y)$	0.24	-0.33
$\rho(nx, y)$	0.14	0.57
$\rho(l, y)$	0.15	0.58
$\rho(C, y)$	0.52	-0.15
σ_n	0.0005	1,2940
σ_d	0.0005	0.9265
σ_g	2.3585	0.0002