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Emerging Market Business Cycles: The Cycle is the Trend

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Abstract:
Business cycles in emerging markets are characterized by strongly counter-cyclical current accounts, consumption volatility that exceeds income volatility, and dramatic "sudden stops" in capital inflows. These features contrast with those of developed, small open economies and highlight the uniqueness of emerging markets. Nevertheless, we show that both qualitatively and quantitatively a standard dynamic stochastic, small open economy model can account for the behavior of both types of markets. Motivated by the observed frequent policy-regime switches in emerging markets, our underlying premise is that these economies are subject to substantial volatility in their trend growth rates relative to developed markets. Consequently, shocks to trend growth--rather than transitory fluctuations around a stable trend--are the primary source of fluctuations in these markets.

When the parameters of the income process are structurally estimated using GMM for each type of economy, we find that the observed predominance of permanent shocks relative to transitory shocks for emerging markets and the reverse for developed markets explain differences in key features of their business cycles. Lastly, employing a VAR methodology to identify permanent shocks, we find further support for the notion that, for emerging economies, the cycle is the trend.

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1. Introduction

While business cycle fluctuations in developed markets may have moderated in recent decades,[1] business cycles in emerging markets are characterized increasingly by their large volatility and dramatic current account reversals, the so called ``sudden stop'' phenomenon. The question we explore here is whether a standard real business cycle model can qualitatively and quantitatively explain business cycle features of both emerging and developed small open economies (SOE). Our underlying premise is that emerging markets, unlike developed markets, are characterized by frequent regime switches, a premise motivated by the dramatic reversals in fiscal, monetary and trade policies observed in these economies. Consequently, shocks to trend growth are the primary source of fluctuations in these markets as opposed to transitory fluctuations around the trend. On the other hand, developed markets are characterized by a relatively stable trend. We show that this simple distinction, without recourse to additional frictions, takes us quite far in explaining differences in the two types of economies. In a standard framework with empirically estimated parameters, we generate strongly countercyclical current accounts, consumption volatility that exceeds income volatility and sudden stops, all defining characteristics of emerging markets.

In Section 2 we document several features of economic fluctuations in emerging and developed SOE for the period 1980-2003. A striking feature that distinguishes the business cycle in the two is the strongly countercyclical nature of the trade balance for emerging markets as compared with developed markets. A second regularity is that consumption is forty percent more volatile than income at business-cycle frequencies for emerging markets, as compared with a ratio of little less than one for developed markets. In addition, income growth and net exports are twice as volatile in emerging markets.

[1]See Stock and Watson (2003).

We then show how a standard RBC model reproduces to a large extent the business-cycle features of both emerging and developed economies. The stochastic dynamic general-equilibrium model we specify has two productivity processes--a transitory shock around the trend growth rate of productivity and a stochastic trend growth rate. The intuition for the model's dynamics is straightforward. As agents observe the economy entering a period of high growth, they optimally increase consumption and investment. The fact that a shock to the growth rate implies a boost to current output, but an even larger boost to future output, implies that consumption responds more than income, reducing savings and generating a current account deficit. If growth shocks dominate transitory income shocks, the economy resembles a typical emerging market with its volatile consumption process and counter-cyclical current account. Conversely, an economy with a relatively stable growth process will be dominated by standard, transitory, productivity shocks. That is, a positive shock will generate an increased incentive to save that will offset any increase in investment, resulting in limited cyclicality of the current account and stable consumption. The main aim of this paper is to explore quantitatively the extent to which the behavior of the trend explains the differences between emerging and developed markets.

We estimate the parameters of the stochastic process using GMM and data from a prototypical emerging market, Mexico, and a benchmark developed small open economy, Canada. The estimated process for productivity in Mexico implies a trend volatility that is over twice that of the transitory shock. In the case of Canada, this ratio is roughly one half. The model calibrated to Mexico generates a correlation between output and the trade balance that is -0.6, which is roughly the same as the -0.7 observed in the data. The model fitted to Canadian data generates an acyclical current account, similar to the low cyclicality suggested in the data of -0.2. The model fitted to Mexico predicts a consumption volatility in excess of income volatility of 10 to 15 percent, while the data suggest a difference closer to 25 percent. Conversely, and also consistent with the data, the model fitted to Canada predicts consumption that is roughly 20 percent less volatile than income.

Using the Kalman filter and the estimated parameters, we decompose the observed Solow residual series for Mexico into trend and transitory components. When we feed the decomposed Solow residuals for Mexico through the model, we generate a sharp sudden stop in 1994-95, including an abrupt and sizeable reversal in the trade balance combined with contractions in output, consumption, and investment. The model predicts that the trade balance as a ratio of GDP should reverse by 8.5 percentage points between the last quarter of 1994 and the second quarter of 1995, which is similar to the 8.7 point reversal observed in the data. It is not just the magnitude of the shock, but additionally the association of the negative productivity shock with a change in trend that lies behind the large sudden stop.

Lastly, using VAR analysis we explore the premise that the ``cycle is the trend'' for emerging markets. Specifically, we use the methodology of King, Plosser, Stock, and Watson (1991) to perform a variance decomposition of output into permanent and transitory shocks. This methodology rests on relatively plausible balanced-growth assumptions regarding the co-integration of income with consumption and investment. We find that roughly 50 percent of income volatility in Canada at business-cycle frequencies can be attributed to shocks to the stochastic trend. This ratio is on par with what King et al. (1991) find for the United States. In contrast, the percentage of output volatility due to permanent shocks at business-cycle frequencies is 82 percent in the case of Mexico.

There exists a long and growing literature that seeks to explain the counter-cyclicality of current accounts and sudden stops. Standard RBC models of open economies featuring only transitory productivity shocks typically have a difficult time capturing the behavior of the current account and consumption. With forward-looking agents and transitory shocks, consumption should be ``smooth'' relative to income, and this dampens the counter-cyclicality of the current account and volatility of consumption.[2] As income approaches a random walk, the incentive to smooth consumption in response to an income shock diminishes, and investment becomes more responsive. Both these elements promote a counter-cyclical current account. However, explanations of the differences in current account and consumption behavior that rely solely on a more persistent AR(1) process face an empirical challenge: In the data, (Hodrick-Prescott-filtered) log GDP in emerging markets exhibits roughly the same autocorrelation as in developed small open economies, a fact documented in the next section. However, the correlation of net exports with output is three times the correlation observed in developed economies.

Another aspect of previous RBC studies is a reliance on a particular set of preferences. It has been argued that to obtain significantly countercyclical net exports in a standard SOE model, it is helpful to rely on a specific preference structure, the so-called Greenwood-Hercowitz-Huffman (GHH) preferences (Greenwood, Hercowitz, and Huffman 1988).[3] In our framework, we show that the counter-cyclicality of the current account and the higher volatility of consumption are predictions that follow even from a model with standard Cobb-Douglas preferences.

A second approach in the literature relies on market imperfections to explain counter-cyclical current accounts. An important early paper is Atkeson (1991), in which capital markets are subject to an asymmetry of information. A more recent paper by Neumeyer and Perri (2004) also addresses business cycles in emerging markets, emphasizing exogenous movements in interest rates and GHH preferences. Arellano and Mendoza (2002) survey several credit-frictions approaches to explaining sudden stops and conclude that the ability of these models to quantitatively match the facts is still limited.

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[2]A benchmark SOE RBC model is Mendoza (1991).

[3]For instance, see Correia, Neves, and Rebelo (1995).

Our reading of the literature suggests that this paper is relatively unique in its ability to match several aspects of business cycles in emerging markets, both qualitatively and quantitatively. Our approach has been to take standard elements typically used to characterize developed market fluctuations and show that an empirically driven modification to the underlying productivity process explains key features of emerging-market cycles as well. While we model a frictionless economy in the paper, this is not to say that market imperfections are unimportant.[4] The important question of what drives the trend remains, and the answer may involve frictions. Shocks to trend output in emerging markets are often associated with clearly defined changes in government policy, including dramatic changes in monetary, fiscal, and trade policies.[5] For instance, Restuccia and Schmitz (2004) provide evidence of a 50 percent drop in productivity in the petroleum industry in Venezuela within five years of its nationalization in 1975. Similarly, Schmitz and Teixeira (2004) document almost a doubling of productivity in the Brazilian iron-ore industry following its privatization in 1991. We view such dramatic changes in productivity following reforms and the undoing of reforms as important characteristics of emerging markets. Why emerging markets are subject to such policy swings is an important topic that we leave for future research.

The rest of the paper is organized as follows. In Section 2 of the paper we document key business cycle facts for emerging markets and developed small open economies. Section 3 presents a standard SOE model augmented to include growth shocks, discusses parameter estimation using GMM, and employs impulse responses to distinguish the impact of a standard productivity shock versus a growth shock on

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[4]In some cases, such frictions can be replicated by a model subject only to productivity shocks (see Chari, Kehoe, and McGrattan 2004 for a discussion).

[5]There is a large literature on the political economy of emerging markets in general, and the tensions behind the sporadic appearances of pro-growth regimes in particular, that supports our emphasis on trend volatility. (See, for example, Dornbusch and Edwards 1992.)

consumption, investment, and the current account. In Section 4 we discuss the model's performance in matching several key business cycle moments, Solow residuals, and sudden stops in emerging and developed markets. Section 5 uses VAR methodology to explore the relative importance of shocks to the stochastic trend at business-cycle frequencies in Canada and Mexico through a variance decomposition that rests on long-run identifying assumptions. Section 6 concludes.

2. Empirical Regularities of Emerging-Market Business Cycles

In this section we document key aspects of SOE business cycles with emphasis on the distinction between emerging and developed economies. Table 2 lists the countries included in the analysis. The sample consists of middle-income and developed economies that have at least 40 quarters of data. To focus on ``small'' economies, we exclude all G-7 countries other than Canada. This leaves us with 26 economies, 13 of which are classified as ``emerging markets''. We use the classification system used by Standard and Poors (2000) and the International Finance Corporation to categorize a country as an emerging market.[6] The Appendix provides details on the source of data for each economy in the sample.

Table 2 reports key moments of the business cycle for each economy in our sample. After deseasonalizing the series when a significant seasonal component was discovered,[7] we filtered the series to derive business-cycle movements. We filtered each series using the HP filter with smoothing parameter 1600 and verified our results using the Band Pass (BP) filter at frequencies between 6 and 32 quarters. Moments were calculated using GMM, and standard errors are reported in parentheses. The averages for each group are

[6]The two criteria used in defining a country as an emerging market are that: (i) It is located in a low- or middle-income country as defined by the World Bank and (ii) Its “investable” market capitalization is low relative to its most recent GNP figures. “Investable” is defined as the share of market cap that is accessible to foreign investors.
[7]Deseasonalization is performed using the Census Bureau's X-12 ARIMA program.

reported in Table 1 for the alternative specifications of HP and BP filtering. The main conclusions are insensitive to the choice of filtering methodology. We present details from the HP filtering exercise.

Table 2A reports the volatility and autocorrelation of filtered log output and the first difference of output. Emerging-market economies on average have a business cycle twice as volatile as their developed counterparts. The second column reveals that this difference in volatility is also present in first-differences. The next two columns document the first-order autocorrelation of output and output growth. Note that filtered output in emerging markets, on average, displays roughly the same autocorrelation as that of developed economies. Explanations of strongly counter-cyclical current accounts in emerging markets that rely on the relative persistence of shocks must confront this pattern as well. In our quantitative model discussed in the next section we will constrain our analysis to match the autocorrelation of both the level and the first difference of income.

Table 2B reports the volatility of consumption, investment, and the ratio of net exports to GDP, expressed as a percentage of output volatility. Unfortunately, due to data limitations, we are unable to analyze the behavior of hours worked over the business cycle. Perhaps the most striking fact of Panel B is the volatility of consumption in emerging markets. At business-cycle frequencies, consumption is roughly 40 percent more volatile than income in emerging markets. Conversely, in developed economies the ratio is slightly less than one on average. While individual economies show exceptions to the average, the data suggest that emerging markets experience relatively volatile consumption at business-cycle frequencies, even controlling for the already high income volatility. There is a large literature on the excessive ``smoothness'' of consumption in the U.S. data. (See, for example, Campbell and Deaton 1989). Of course, whether consumption is excessively smooth in developed economies or excessively volatile in emerging markets depends on the underlying process for income. Once we parameterize and calibrate the income processes for developed and emerging markets in the next section, we can revisit the question of whether consumption is too volatile in emerging markets. Contrary to the evidence on consumption, investment volatility (as a ratio of income volatility) is not dramatically different in emerging markets than in developed economies. This is perhaps surprising given the pattern of consumption and the relative underdevelopment of financial markets in emerging markets.

Table 2C documents the correlation of consumption, investment, and net exports with income at business-cycle frequencies. A distinguishing feature of emerging-market business cycles is the large, negative correlation of net exports and output. The average correlation for emerging markets is -0.51, with several countries approaching -0.8. Conversely, developed economies exhibit weakly counter-cyclical trade balances, with an average correlation of -0.17. As noted in the introduction, an innovation of the paper is to link the volatility of growth with the counter-cyclicality of the current account. Figure 1 reveals that there is a striking relationship between the counter-cyclicality of the trade balance and the volatility of growth rates. In particular, the horizontal axis represents the standard deviation of GDP growth for our sample of economies. The vertical axis represents the correlations between net exports and GDP. The figure represents a significant negative relationship between the two. In the next section, we document that this relationship is a prediction of a standard business-cycle model augmented to account for shocks to growth.

One concern with the empirical regularities documented in Tables 1 and 2 is the measurement error associated with emerging-market data, particularly at the quarterly frequency. We calculated the same set of moments reported in Table 1 using annual data over the same time frame and found that the patterns are robust to this particular concern. For both quarterly and annual data, we found that the 1980s and 1990s separately exhibited similar patterns as those observed from pooling both decades. However, using annual data, for which a longer time series is available, we found that several of the distinguishing features of emerging-market business cycles documented using the more recent data are weaker or not present at all in the 1960s or 1970s.[8] This lack of stationarity is perhaps to be expected given the dramatic transformation of these economies over the longer period. Specifically, many of our emerging-market economies were essentially closed economies during the earlier period. We therefore confine our analysis to the patterns observed over the last 20 years. While the length of the quarterly time series for some of our emerging-market countries is quite short, extending the series back in time would not be particularly useful as it is only in the most recent decades that the phenomenon of ``emerging-market economies'' is observed.

The ``sudden-stop'' phenomenon has been described in detail in Calvo and Reinhart (2000) and Arellano and Mendoza (2002), among others. It is specifically associated with an abrupt and large reversal in net capital inflows and the current account. An instance of the sudden-stop phenomenon is the Mexican Tequila crisis, when there was an 8.7-percentage-point reversal in the ratio of the trade balance to GDP, from a deficit of 4.45 percent to a surplus of 4.2 percent, between the fourth quarter of 1994 and the second quarter of 1995. Over the same period, output fell by 12 percent, private consumption by 11 percent, and investment by 40 percent.

In the next sections, we provide a simple explanation for the observed differences between emerging- and developed-market fluctuations that relies on the differences in the underlying income process for these countries. We argue that for emerging markets ``the cycle is the trend.'' A well-recognized fact about emerging markets is that they experience fairly volatile cycles. A perhaps less appreciated fact is that emerging markets are subject to extremely volatile shocks to the stochastic trend. This is evident in Figure 2, where we plot log GDP for three small open economies--Canada, Mexico, and

[8]Specifically, the volatility of consumption is greater than that of income for the emerging market group in both the pre- and post-1980 period. However, the negative correlation between the trade balance and GDP is larger for the developed sample (-0.34) than for the emerging-market sample (-0.18) in the pre-1980 period. This is reversed in the post-1980 period, for which the correlations are -0.32 and -0.54, respectively.

Argentina. The plot for each economy includes the log level of GDP (where we have extracted any significant seasonal component) and the stochastic trend. The latter was calculated using the methodology of King, Plosser, Stock, and Watson (1991), discussed in detail in Section 5 and Appendix B, and represents fluctuations due to ``permanent'' shocks. To be precise, the trend is obtained by setting the transitory shocks to zero and feeding only the permanent shock through the system. This should not be confused with equating the trend to the random-walk component à la Beveridge and Nelson (1981). Casual observation of the plots suggests that Canada, our benchmark developed SOE, experiences relatively small fluctuations around a stable trend. On the other hand, Mexico and particularly Argentina display a volatile trend that mirrors movements in GDP at high frequencies. Figure 3 plots the Solow residual for Canada and Mexico, the calculation of which is discussed in Section 4 and Appendix A. The movement in these series is clearly different. The remainder of this paper will be devoted to exploring this impression rigorously--both empirically and theoretically--and linking it to the observed behavior of consumption, investment, and net exports over the business cycle.

3. Stochastic Growth Model

3.1 Model

Motivated by the above facts, in this section we construct a quantitative model of business cycles for a small open economy. The goal of this exercise is to replicate the key characteristics of SOE business cycles, including the differences between emerging markets and developed economies, in a simple, optimizing framework. The model is a standard, single-good, single-asset SOE model, augmented to include transitory and trend shocks to productivity. Specifically, technology is characterized by a Cobb-Douglas production function that uses capital, K_t, and labor, L_t, as inputs:

$$Y_t = e^{z_t} K_t^{1-\alpha} (\Gamma_t L_t)^{\alpha},$$

where $\alpha \in (0,1)$ represents labor's share of output. The parameters z_t and Γ_t represent productivity processes. The two productivity processes are characterized by different stochastic properties. Specifically, z_t follows an AR(1) process

$$z_t = \rho_z z_{t-1} + \varepsilon_t^z$$

with $|\rho_z| < 1,$ and ε_t^z represents iid draws from a normal distribution with zero mean and standard deviation $\sigma_z.$

The parameter Γ_t represents the cumulative product of ``growth'' shocks. In particular,

$$\Gamma_t = g_t \Gamma_{t-1} = \prod_{s=0}^{t} g_s$$
$$\ln(g_t) = (1-\rho_g)\log(\mu_g) + \rho_g \ln(g_{t-1}) + \varepsilon_t^g,$$

where $|\rho_g| < 1$ and ε_t^g represents iid draws from a normal distribution with zero mean and standard deviation $\sigma_g.$ The term μ_g represents productivity's long-run mean growth rate. We loosely refer to the realizations of g as the ``growth'' shocks as they constitute the stochastic trend of productivity. We use separate notation for shocks to the ``level'' of productivity (z_t) and the ``growth'' of productivity (g_t) to simplify exposition and calibration.[9]

Given that a realization of g permanently influences $\Gamma,$ output is nonstationary with a stochastic trend. For any variable $x,$ we introduce a hat to denote its detrended counterpart:

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[9]Of course, given the nature of the production function, we could designate a single productivity shock (equal to the product of e^z and Γ^α) which would have a corresponding, more complicated dynamic process, that would be isomorphic to our approach.

$$\hat{x}_t \equiv \frac{x_t}{\Gamma_{t-1}}.$$

Note that we normalize by trend productivity through period $t-1.$ This ensures that if x_t is in the agent's information set as of time $t-1,$ so is $\hat{x}_t.$ The solution to the model is invariant to the choice of normalization.

We consider two alternative specifications of the representative agents' preferences over consumption and leisure. The first is the so-called GHH preferences (introduced by Greenwood et al. 1988) and the second is the standard Cobb-Douglas preferences. The reason we consider both these specifications is to highlight the fact that our results are not sensitive to the choice of preferences.

GHH preferences take the form

$$u_t = \frac{(C_t - \tau\Gamma_{t-1}L_t^{\upsilon})^{1-\sigma}}{1-\sigma},$$

where $\upsilon > 1$ and $\tau > 0.$ The elasticity of labor supply is given by $(\frac{1}{\upsilon-1}),$ and the intertemporal elasticity of substitution is given by $\frac{1}{\sigma}.$ To ensure that labor supply remains bounded along the growth path, we include cumulative growth in the disutility of labor. This can be motivated in a model of home production by assuming productivity in the home sector grows at the same rate (with a lag) as in the market sector. Absent this term, the substitution effect will always dominate the income effect along the growth path, leading to unbounded growth in hours worked.[10] To ensure that utility is well defined, we assume that $\beta\mu_g^{1-\sigma} < 1.$ For detrended consumption to be well-behaved in the steady state, we require that $\beta(1+r^*)^{\frac{1}{\sigma}} = \mu_g$, where r^* is the world interest rate.

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[10]The presence of Γ_{t-1} in the utility function is not simply a renormalization, but rather a direct assumption regarding preferences or home production.

In the Cobb-Douglas case, period utility is

$$u_t = \frac{\left(C_t^{\gamma}(1-L_t)^{1-\gamma}\right)^{1-\sigma}}{1-\sigma},$$

where $0 < \gamma < 1$. All other equations remain unchanged. For well-behaved consumption in the steady state, we now require $\beta(1+r^*) = \mu_g^{1-\gamma(1-\sigma)}$. In Section 5, we will report results for both preference specifications.

The equilibrium is characterized by maximizing the present discounted value of utility subject to the production function (1) and the per-period resource constraint:

$$C_t + K_{t+1} = Y_t + (1-\delta)K_t - \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - \mu_g\right)^2 K_t - B_t + q_t B_{t+1}.$$

Capital depreciates at the rate δ, and changes to the capital stock entail a quadratic adjustment cost $\frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - \mu_g\right)^2 K_t$. We assume international financial transactions are restricted to one-period, risk-free bonds. The level of debt due in period t is denoted B_t, and q_t is the time t price of debt due in period $t+1$. The price of debt is sensitive to the level of outstanding debt, taking the form used in Schmitt-Grohe and Uribe (2003)[11]

$$\frac{1}{q_t} = 1 + r_t = 1 + r^* + \psi\left[e^{\frac{B_{t+1}}{\Gamma_t} - b} - 1\right],$$

where r^* is the world interest rate, b represents the steady-state level of debt, and $\psi > 0$ governs the elasticity of the interest rate to changes in indebtedness. In choosing the optimal amount of debt, the representative agent does not internalize the fact that

[11]This is needed for the level of bond holdings to be determined in the steady-state equilibrium. Otherwise, bond holdings will not be a stationary variable. In the parameterizations, ψ is set at 0.001, implying a negligible elasticity.

she faces an upward-sloping supply of loans.

In normalized form, the representative agent's problem can be stated recursively:

$$V(\widehat{K}_t,\ \widehat{B}_t,\ z_t, g_t) = \max_{\{\widehat{C}_t, L_t, \widehat{K}_{t+1}, \widehat{B}_{t+1}\}} \left\{ u(\hat{C}_t, L_t) + f(\beta, g_t) E_t V(\widehat{K}_{t+1},\ \widehat{B}_{t+1},\ z_{t+1}, g_{t+1}) \right\},$$

where $u(\hat{C}_t, L_t)$ is $\frac{\left(\widehat{C}_t - \tau L_t^{\nu}\right)^{1-\sigma}}{1-\sigma}$ in the case of GHH preferences and $\frac{\left(\hat{C}_t^{\gamma}(1-L_t)^{1-\gamma}\right)^{1-\sigma}}{1-\sigma}$ in the case of Cobb-Douglas preferences. $f(\beta, g_t)$ is $\beta g_t^{1-\sigma}$ in the case of GHH preferences and $\beta g_t^{\gamma(1-\sigma)}$ in the case of Cobb-Douglas preferences. The optimization is subject to the budget constraint:

$$\widehat{C}_t + g_t \widehat{K}_{t+1} = \widehat{Y}_t + (1-\delta)\widehat{K}_t - \frac{\phi}{2}\left(g_t \frac{\widehat{K}_{t+1}}{\widehat{K}_t} - \mu_g \right)^2 \widehat{K}_t - \widehat{B}_t + g_t q_t \widehat{B}_{t+1}.$$

The evolution of the capital stock is given by,

$$g_t \hat{K}_{t+1} = (1-\delta)\hat{K}_t + \hat{X}_t - \frac{\phi}{2}\left(\frac{\hat{K}_{t+1}}{\hat{K}_t} g_t - \mu_g \right)^2 \hat{K}_t.$$

The first order conditions are

$\widehat{K}_{t+1}$:

$$u_c(\hat{C}_t, L_t)\left(g_t + \phi\left(g_t \frac{\widehat{K}_{t+1}}{\widehat{K}_t} - \mu_g \right) g_t \right) = f(\beta, g_t) E_t \frac{\partial V}{\partial \widehat{K}_{t+1}},$$

$\widehat{B}_{t+1}$:

$$u_c(\hat{C}_t, L_t) g_t q_t + f(\beta, g_t) E_t \frac{\partial V}{\partial \widehat{B}_{t+1}} = 0,$$

L_t :

$$u_L(\hat{C}_t, L_t) + u_c(\hat{C}_t, L_t)\frac{\partial \hat{Y}_t}{\partial L_t} = 0$$
.

The key distinction between GHH and Cobb-Douglas preference is the income effect governing labor supply decisions in response to a productivity shock. In the case of GHH preferences, (12) reduces to

$$\tau \upsilon L_t^{\upsilon-1} = \alpha \frac{\hat{Y}_t}{L_t}.$$

Accordingly, the labor-supply response in the case of GHH preferences is unmitigated by consumption's response. Hours worked, therefore, displays strong cyclicality. (Recall that the disutility of labor is governed by trend growth, preserving an offsetting income effect along the growth path.) The ease of substitution between leisure and consumption in the GHH specification induces a pro-cyclicality in consumption as well. That is, the incentive to forgo some consumption in response to a positive transitory shock is minimized by the sharp drop in leisure. Conversely, in the case of Cobb-Douglas preferences, the income effect mitigates labor's response to productivity shocks, as evident from the first-order condition for leisure:

$$\frac{(1-\gamma)\hat{C}_t}{\gamma(1-L_t)} = \alpha \frac{\hat{Y}_t}{L_t}$$
.

The labor supply now varies with consumption, with a higher level of consumption reducing the incentive to work. Moreover, compared with the case of GHH preferences, leisure and consumption are not easily substituted. Both effects preserve the incentive to smooth consumption over the business cycle by saving in response to a positive shock.

Existing data suggest that the correlation of hours with output is much lower in emerging markets (for example, 0.52 for Argentina and 0.57 for Mexico compared with

0.86 for Canada), suggesting room for a stronger income effect on labor supply over the cycle. However, the income effect implicit in Cobb-Douglas preferences may still be too strong, potentially generating an initial decline in labor supply in response to a positive shock to trend growth. With GHH preferences, the initial response of labor supply is always positive. However, a shock to trend will begin to reduce labor supply after one period because of our assumption regarding the disutility of labor. In the GHH framework, the persistence of the labor-supply response to trend shocks--and by extension the cyclicality of employment in an environment dominated by shocks to trend--depends on how quickly trend productivity impacts the disutility of labor (or the home sector). Given the measurement issues surrounding the data on employment in emerging markets, we do not attempt to estimate this parameter and therefore make no claims of matching the observed pattern for hours.

Given an initial capital stock, $\hat{K}_0$, and debt level, $\hat{B}_0$, the behavior of the economy is characterized by the first-order conditions (10-12), the technology (1) and budget (8) constraints, and transversality conditions.

3.2 Parameter Estimation

We solve the normalized model numerically by log-linearizing the first-order conditions and resource constraints around the deterministic steady state. Given a solution to the normalized equations, we can recover the path of the non-normalized equilibrium by multiplying through by Γ_{t-1}.

We study two parameterizations of the model--the ``Emerging Market'' and ``Developed'' parameterizations--estimated using data from Mexico and Canada, respectively. We use the data to estimate parameters governing productivity and capital adjustment costs. All other parameters are kept constant across the two parameterizations. In this way, we can isolate how differences in the income process that characterize emerging markets and developed economies translate into dynamics in consumption, investment, and the trade balance.

The non-estimated baseline parameters are detailed in Table 3. We follow the existing literature in choosing the preference parameter values. We take a period in the model to represent a quarter. The quarterly discount rate β is set to 0.98, and the risk-free world interest rate is set to satisfy the condition that $\beta(1+r^*)^{\frac{1}{\sigma}} = \mu_g$ in the case of GHH preferences and $\beta(1+r^*) = \mu_g^{1-\gamma(1-\sigma)}$ in the case of Cobb-Douglas preferences. Labor supply elasticity is set to 2.5, implying that $\upsilon = 1.6$. This is very similar to the 1.45 used by Mendoza (1991), the 1.66 used by Neumeyer and Perri (2002), and the 1.7 used by Correia et al. (1995). We calibrate $\tau = 1.4$ to achieve a steady-state supply of labor equal to 0.28. In the Cobb-Douglas case, $\gamma = 0.36.$ The labor share in production is standard and set at 0.68. The parameter for risk aversion is set at 2, and the depreciation rate at 0.03.

The coefficient on the interest-rate-premium term is set at 0.001, which is the number used in the literature (Schmitt-Grohe and Uribe 2003, Neumeyer and Perri 2004). The steady-state level of debt-to-GDP is set at 0.1 for both specifications. We maintain a common long-run level of debt to isolate differences that arise from the income process. The results are insensitive to alternate levels of steady-state debt-to-GDP.

This leaves the following parameters to be estimated: $(\mu_g, \sigma_z, \rho_z, \sigma_g, \rho_g, \phi).$ We estimate these parameters using $GMM.$ Specifically, given a parameter vector $\theta = (\mu_g, \sigma_z, \rho_z, \sigma_g, \rho_g, \phi)$, we can solve the model and calculate the implied variances and cross-correlations of any variables of interest. (See Burnside 1999 for a description of how this is implemented in practice.) Based on the patterns described in Table 2, we select the following moments to be calculated: the standard deviations of log (filtered) income, investment, consumption, net exports-to-GDP, as well as the correlations of the latter three with output. We also calculate the mean and standard deviation of (unfiltered) income growth and the autocorrelation of (filtered) income and (unfiltered) income growth. Letting $m(\theta)$ be the vector of model moments for a given parameter vector θ, we then have

$$m(\theta) = (\sigma(y),\sigma(\Delta y),\sigma(I),\sigma(c),\sigma(nx),\rho(y_t,y_{t-1}),\rho(\Delta y_t,\Delta y_{t-1}),\rho(y,nx),\rho(y,c),\rho(y,I),E(\Delta y))',$$

where y, Δy, c, I, nx represent filtered output, unfiltered income growth, filtered consumption, filtered investment, and filtered (net exports/GDP), respectively. Letting $m_i(\theta)$ stand for the i^{th} element of $m(\theta)$, we have the following moment conditions:

$$\begin{aligned}
E\{m_1(\theta)^2 - y_t^2\} &= 0\\
E\{m_2(\theta)^2 - (\Delta y_t - m_{11}(\theta))^2\} &= 0\\
E\{m_3(\theta)^2 - I_t^2\} &= 0\\
E\{m_4(\theta)^2 - c_t^2\} &= 0\\
E\{m_5(\theta)^2 - nx_t^2\} &= 0\\
E\left\{m_6(\theta) - \frac{y_t y_{t-1}}{m_1(\theta)^2}\right\} &= 0\\
E\left\{m_7(\theta) - \frac{(\Delta y_t - \mu_g)(\Delta y_{t-1} - \mu_g)}{m_2(\theta)^2}\right\} &= 0\\
E\left\{m_8(\theta) - \frac{nx_t y_t}{m_1(\theta)m_5(\theta)}\right\} &= 0\\
E\left\{m_9(\theta) - \frac{c_t y_t}{m_1(\theta)m_4(\theta)}\right\} &= 0\\
E\left\{m_{10}(\theta) - \frac{I_t y_t}{m_1(\theta)m_3(\theta)}\right\} &= 0\\
E\{m_{11}(\theta) - \Delta y_t\} &= 0
\end{aligned}$$

.

Given these eleven moment conditions, we can estimate the six parameters using *GMM*.[12]

[12]In practice, we follow standard procedure by using the two-step *GMM* procedure. We first use the identity matrix as the weighting matrix to find consistent estimates of the parameters. We use these first stage parameters to form the Newey-West variance-covariance matrix of the moment conditions. This matrix is used in the second stage to estimate the reported parameters.

The estimated parameters along with their standard errors are reported in Table 4. The first two columns are estimates using Canadian data and GHH and Cobb-Douglas preferences, respectively. These estimated parameters will be the basis of our ``Developed'' model. The last two columns are the estimates using Mexican data under the two alternative preference specifications, which will form the basis of our ``Emerging Market'' model. To gauge the relative importance of shocks to trend, consider the ratio of σ_g to σ_z. In the case of Canada, this ratio is 0.25 and 0.61, depending on preferences. The corresponding ratios for Mexico are 2.5 and 5.4. That is, the relative importance of trend shocks is an order of magnitude larger for Mexico than for Canada. Note as well that the autocorrelation of transitory shocks is roughly equal in Canada and Mexico. This parameter plays an important role in governing current-account dynamics in standard models. However, the estimates downplay this parameter as a source behind the different current-account behavior in emerging markets and developed economies. Our results rest instead on the data's implication that shocks to trend constitute a disproportionate share of total volatility in emerging markets.

We allow the capital adjustment cost parameter, ϕ, to vary between Canada and Mexico. However, the estimates do not differ substantially across the two economies. Moreover, the standard error is large. We have estimated the model treating this parameter as known *a priori* and constant across the two economies with little difference in the model's predictions.

Finally, the last line of Table 4 reports the test of the model's overidentifying restrictions as suggested by Hansen (1982). Hansen showed that the value of the GMM objective function (that is, the optimally weighted sum of squared residuals) evaluated at the minimum is distributed Chi-square with $n-k$ degrees of freedom, where n is the number of moment conditions and k the number of parameters. The last line of Table 4 reports the P-value of this test. In all cases, the model cannot be rejected at standard confidence intervals.[13]

3.3 Impulse Responses

To gain insight into why consumption and the trade balance behave differently over the cycle in emerging markets, we first study the impulse responses to our two productivity shocks. Figure 4 contrasts the impulse responses following from a 1 percent shock to the level of technology (that is, $\varepsilon_1^z = .01$) with the impulse responses to a 1 percent growth shock (that is, $\varepsilon_1^g = .01$). The figure depicts the response under the "Emerging-Market" parameterization using GHH preferences. In response to a transitory productivity shock, the trade-balance (as a fraction of output) deteriorates by a small magnitude and very quickly overshoots the initial steady-state level. The magnitude of this initial deficit is two tenths of one percent of GDP. Given that output remains above trend throughout the transition, a shock to z tends to produce a positive relationship between output and the current account.

The response of the economy to a shock to trend growth is markedly different. Following a 1 percent growth shock , the trade balance deficit is 1.3 percent of GDP on impact and the deficit persists for 16 quarters following the shock. The magnitude of the initial deficit is six times larger than was the case for a transitory shock. The source of this difference can be seen in Panel 2 of Figure 4. A growth shock induces a drop in savings in anticipation of even higher income in the future so that consumption responds more than output. On the other hand, the transitory shock induces saving in anticipation of lower income in the future, resulting in a decline in $\frac{C}{Y}$ on impact. The large consumption response is reminiscent of the large consumption booms that frequently accompany current-account deficits in emerging markets. It also explains why consumption is more volatile than income in economies primarily subject to growth

[13]As discussed by Newey (1985), failure to reject must be viewed cautiously given the limited power of this test.

shocks. The initial response of investment is larger in response to a trend shock. Moreover, intuitively the permanent shock induces more persistence in the investment response. In response to a trend shock, the relatively large and persistent response of consumption and investment combine to push the trade balance into deficit and keep it there along most of its transition back to the steady-state growth path.

In Figure 5, we compare the impulse responses of the trade balance to a transitory shock (first panel) and growth shock (second panel) for varying levels of ρ_z and ρ_g. Naturally, the biggest effects on the trade-balance in both cases are when the shocks are most persistent. However, there is an important distinction between persistence in levels and persistence in first differences. The possibility that a growth process with little persistence can still generate a counter-cyclical trade balance is evident in the impulse responses. On the other hand, a positive transitory shock with limited persistence generates a trade surplus.

4. Emerging vs. Developed Markets

4.1 Business Cycles

The impulse responses discussed in the previous section indicate that the response of the trade balance and consumption to a productivity shock depends sensitively on whether the shock is mean-reverting or represents a change in trend. The question, then, is whether quantitatively the differences observed between developed and emerging SOE can be attributed to the relative magnitudes of the two types of shocks. To answer this question, we use the parameters reported in Table 3 and Table 4 and explore the stationary distribution of the model economies. In particular, recall that our ``Developed'' model economy estimated the productivity process parameters $(\mu_g, \rho_z, \rho_g, \sigma_z, \sigma_g)$ using Canadian data and the moments reported in Table 5. Similarly, our ``Emerging Market'' model matches the same moments for Mexico.

Tables 5a and 5b report the key moments of our theoretical business cycles for the case of “Emerging Markets” and “Developed” parameterizations, respectively. Standard errors were obtained from the standard errors of the underlying estimated parameters using the Delta method. For comparison, the table also reports the empirical moments for Mexico and Canada originally presented in Table 2.

The models do a fairly good job of replicating the volatility of income and the growth rate of income. The difference with the data lies in the fact that the model underpredicts the volatility of the level of output and overpredicts the volatility of the first difference of log income. This ability to match the moments for income and growth may not be surprising, given the estimation strategy. The fact that our productivity parameters have a tight relationship with the moments for income suggests these moments will be weighted heavily in the estimation.

The data in Table 2 strongly suggested that the volatility of consumption relative to income was much higher in emerging markets. This feature is reflected in the model. The ratio $\sigma(c)/\sigma(y)$ is 0.77 in the Canadian data. The model generates a ratio of 0.82 for GHH preferences and 0.77 for Cobb-Douglas preferences. As predicted by standard theory in which transitory shocks predominate, consumers smooth consumption relative to income in the “Developed” model. The model fitted to Mexican data predicts a ratio of 1.10 and 1.17, depending on preferences. While this is less than the data's ratio of 1.25, it clearly supports the notion that consumption volatility should exceed income volatility in emerging markets. Such ``excess'' volatility is perfectly consistent with optimizing consumers, given the nature of the underlying income process. Moreover, it is consistent with Cobb-Douglas preferences, which typically have difficulty in generating sufficient consumption volatility.

In regard to net exports, the “Emerging Market” parameterization yields a strongly negative correlation with income that is essentially the same as that observed in the data. Regardless of preferences, the emerging-market model yields a correlation between net exports (as a percentage of GDP) and output that is roughly 85 percent of the observed correlation of -0.74.The "Developed" parameterization predicts an acyclical trade balance, while the data suggest that Canada experiences relatively weak counter-cyclicality.

4.2 Solow Residuals

We have relied on the structure of the model and the response of key aggregates to identify the parameters of the underlying productivity process. This approach has the virtue that it uses the information implicit in the decisions made by agents. An associated risk is that incorrect modeling choices will bias the estimates. An alternative would be to estimate the parameters directly from the time series of Solow residuals. There are several problems with this approach. Firstly, estimating quarterly Solow residuals for most countries, especially developing countries, is limited by data availability for capacity utilization, materials used, reliable measure of hours worked, etc. In the presence of terms-of-trade shocks and non-competitive pricing, measuring Solow residuals is also problematic. Moreover, the shortness of the time series available from emerging markets makes it impossible to reliably separate permanent from transitory shocks. This is why we feel a structural model is necessary.

Nevertheless, we can check our results using what data are available on Solow residuals. We have constructed a Solow residual series using the available data on hours, employment, and capital stock for Mexico and Canada. The Appendix contains the details of our calculations. For Mexico, we can construct a quarterly series for the Solow residual starting only in 1987, while for Canada we calculate the series starting in 1981. As a test of our structural model estimation, we compare the volatility and autocorrelation of the log empirical Solow residuals (in differences and HP-filtered) with that implied by the estimated parameters.

Recall that in the model, the Solow residual $\ln(SR) = z + \alpha \ln(\Gamma)$. The implied moments for the Solow residual can therefore be calculated directly from the estimated parameters of the process for z and Γ.

The comparison of the implied moments with those calculated from the observed sample is reported in Table 6. The predictions of the model compare quite favorably with the data. In the data, the growth rate of the Solow residual in Mexico has a volatility between 1.3 and 1.4, depending on the employment series used. The model parameters predict a volatilty between 1.2 and 1.8. Moreover, the data suggest that Mexico is roughly twice as volatile as Canada, a ratio similar to that suggested by the estimated parameters. The autocorrelations of the observed Solow residual, both filtered and first differenced, are similar in Canada and Mexico. The parameters estimated from the Cobb-Douglas model generate a similar persistence across countries, while the GHH specification generates higher persistence for Mexico.

4.3 Sudden Stops

A major challenge to models of emerging markets is explaining the large current-account reversals observed in the data, the so-called ``sudden stops.'' We can explore how well our model does in replicating such phenomena by asking whether the observed process for Solow residuals generates a sudden stop when fed into the model. To do this, we first use the Kalman filter and the estimated parameters (GHH specification) to decompose the Solow residuals calculated using Mexican data into permanent (g) and transitory (z) processes.[14] We then feed these shocks through our

[14]Specifically, we calculate $E\{g_t|SR_1,\ldots,SR_T,\theta\}$ and $E\{z_t|SR_1,\ldots,SR_T,\theta\}$ for each t. SR denotes the observed Solow residuals and $\theta = \{\sigma_z, \rho_z, \sigma_g, \rho_g, \mu_g)$. Note that we use the entire path of Solow residuals for each point in time (the Kalman filter with ``smoothing'').

model and calculate the predicted path of net exports for the period surrounding the 1994-1995 Tequila crisis in Mexico. We plot the predicted and actual path of net exports as a percentage of GDP in Figure 6, where we have normalized both series to zero for the first quarter of 1991. As the plot indicates, the model generates a clear sudden stop during the Tequila crisis of late 1994. In the data, the ratio of the trade balance to GDP reversed 8.7 percentage points between the last quarter of 1994 and the second quarter of 1995. The model predicts a reversal of 8.5 percentage points over this same period. Similarly, and also consistent with the data, the model predicts large contractions in output, consumption, and investment during the crisis. Figure 6, however, also reveals that the model predicts a quicker resumption of trade deficits after the crisis than is found in the data. The model's prediction of a sudden stop in 1994 stems from the fact that much of the observed drop in the Solow residual can be attributed to a shock to trend. One should keep in mind that this attribution is a product of both the observed path of Solow residuals and the parameters used in constructing the Kalman filter.

5. Variance Decomposition

To match the distinguishing features of SOE business cycles, we emphasized the need for relative volatility in trend growth rates for emerging markets and transitory shocks for developed economies. To generate the results of the previous section, we calibrated the relative volatilities to match the observed moments. In this sense, we ensured our simulated productivity process was empirically valid. In this section, we provide additional evidence that emerging-market business cycles are predominantly driven by trend shocks relative to the cycles of more developed economies. To do this, we utilize the methodology of King, Plosser, Stock, and Watson (1991), which we henceforth refer to as $KPSW$.

Specifically, we consider a three-variable system consisting of (log) real output, private consumption, and investment. Let y denote log output, c log consumption, i

investment, and $x = (y, c, i)'$. We assume these variables are $I(1)$ and the first difference of x can be represented in reduced form as

$$\Delta x_t = C(L)\varepsilon_t ,$$

where $C(L)$ is a polynomial in the lag operator and ε_t is iid over time with a within period 3×3 covariance matrix Σ_ε. The $KPSW$ methodology rests on two identifying assumptions. The first is that log consumption and log investment are both co-integrated with log income. That is, the ``great ratios'' of consumption to income and investment to income are stationary. This is an implication of balanced growth. Consequently, we represent the system as a vector error correction model:

$$\Delta x_t = \alpha_0 + BA'x_{t-1} + \alpha_1 \Delta x_{t-1} + \ldots + \alpha_k \Delta x_{t-k} + \varepsilon_t.$$

The columns of A are the co-integrating vectors relating y to c and i, respectively. That is,

$$A = \begin{pmatrix} -1 & -1 \\ 1 & 0 \\ 0 & 1 \end{pmatrix}.$$

Let $\eta = (\eta^1, \eta^2, \eta^3)$ denote the ``structural'' shocks to the system such that η^1 denotes the permanent shock. Given the two co-integrating vectors in our three-variable system, there is a single permanent shock. The second identification assumption in the $KPSW$ methodology is that the permanent shock is orthogonal to the transitory shocks: $\eta^1 \perp \eta^2, \eta^3$. [15]

[15] An additional, implicit assumption of $KPSW$ is that the short run dynamics are adequately modeled by a low order VAR. Given the length of the data series, increasing lag length severely affects the degrees of freedom. We use lag lengths of 8 for Canada and Mexico. ($KPSW$ use lag lengths of 8.) The main finding, that permanent shocks explain a larger fraction of the variance in Mexico, is unchanged when we increase lag lengths to 12.

These two assumptions are sufficient to extract the permanent shock η^1 from the observed reduced-form shock process ε. The details of this translation are provided in Appendix B. To provide a sense of the economy's response to a permanent shock, we plot in Figure 7 the impulse response of consumption, investment, and output to a one-standard-deviation permanent shock using the parameters estimated with Mexican data. Similar to the theoretical impulse response presented in Figure 4, log consumption responds essentially one-for-one to a permanent shock. This implies that there is little change in the savings rate at the onset of a permanent shock. Investment responds dramatically to a permanent shock. We also plot the implied response of net exports to GDP. To obtain this impulse response, note that $NX/Y = 1 - C/Y - I/Y,$ recalling that Y is net of government expenditures. Then. $d(NX/Y) = (dY/Y - dC/C) * C/Y + (dY/Y - dI/I) * I/Y.$ Using the sample average of C/Y and $I/Y,$ we translate the impulse responses of $y, c,$ and i into $d(NX/Y).$ As predicted by the previous section's model, net exports responds strongly and negatively to a positive permanent shock.

Having identified our permanent shock, we can decompose the variance of output, consumption, and investment at various horizons into the portion due to the permanent shock and that due to transitory shocks. We report this decomposition for Canada and Mexico in Tables 7A-7B . At horizons of 12 quarters, roughly 50 percent of Canadian output volatility is due to permanent shocks. While 50 percent may represent a sizeable percentage of variance, permanent shocks account for roughly 82 percent of business-cycle volatility in Mexico.

As was the case with income, the fraction of investment volatility at the 12-quarter horizon due to permanent shocks is greater in Mexico than is the case for Canada, though the numbers for investment in Canada seem implausibly low. The numbers are similar for Mexico and Canada for consumption. Although we do not report variance decompositions for our simulated models, it is the case that the model implies that almost all movements in consumption are driven by permanent shocks. This is not surprising given the fact that consumers are rational, infinitely lived, and can self-insure in the model. At business-cycle frequencies, therefore, consumption in practice seems to exhibit a sluggish response to permanent shocks even in emerging markets. The dichotomy between the data and the model on this point is consistent with the notion that consumption is ``excessively smooth'' relative to permanent income shocks. (See Campbell and Deaton 1989.) It may be the case that consumers face a signal-extraction problem regarding whether a shock is permanent or transitory, and therefore underreact to a permanent shock.

Inevitably, as with any study of permanent shocks using a finite amount of data, standard errors are large. In this regard, we take the results in the spirit of Cochrane (1988)'s statement : ``The most promising direct use for the point estimates of the size of a random walk component...may be the calibration of a given model rather than a test that can distinguish competing classes of models.'' In that paper, Cochrane proposed an alternative methodology for estimating the random-walk component of a series using the variance of long-horizon differences. This approach is impractical in the emerging-market context, given the absence of historical data. In part, we gain additional insight from the data we have by exploiting the assumption that the series are co-integrated.[16] Given the weak power of tests of co-integration, we must rely on theory as a justification for this assumption.

6. Conclusion

In this paper we document several business-cycle characteristics that distinguish

[16]See Faust and Leeper (1997) for a general critique of structural VARs identified through long-run restrictions.

emerging markets from developed small open economies. We demonstrate that a standard business-cycle model can explain important differences between emerging markets and developed economies once we appropriately model the composition of shocks that affect these economies. In particular, we show that a model that appropriately accounts for the predominance of shocks to trend growth relative to transitory shocks characteristic of emerging markets reproduces the behavior of the current account and consumption observed at business-cycle frequencies. Moreover, when calibrated to the much stabler growth process of developed small open economies, the same model generates weaker cyclicality of the current account and lower volatility of consumption, consistent with the data. We do not assume different market frictions for the two types of economies. However, this is not to say that market imperfections are not important in emerging markets. In particular, these features may be necessary for understanding why what we term productivity is so volatile in emerging markets. Our goal has been to evaluate the extent to which the composition of shocks within a standard model can explain the facts, without recourse to additional frictions, and we find that the standard model does surprisingly well.

Appendix A: Data

The data sources and sample lengths are listed in Table A1. Consumption is ``household consumption'' and excludes government consumption. When household consumption is unavailable, we use ``private consumption,'' which combines household and non-profit institution consumption. Investment is gross fixed capital formation. Net exports is constructed as the difference between exports and imports. The GDP deflator was used to convert all series into real values. In the case of Argentina, private consumption data start in 1993 and, accordingly, this is the sample we use for Tables 2A-2C. To compute the plot of the stochastic trend in Figure 2, however, we use the longer sample period starting in 1980, for which consumption includes government consumption. For Canada we use the longer data series, starting in 1959, while performing the variance decomposition. The results are unchanged if we start the sample in 1980.

To obtain Solow residuals, we calculate a series for capital stock (K) and both hours and employment (L) for Canada and Mexico. The residual is defined as $\ln(Y_t) - \alpha \ln(L_t) - (1-\alpha)\ln(K_t)$. We use $\alpha = 0.68$ for both countries. For Canada, employment is the Canadian civilian employment series. To calculate total hours, we use hours per worker in manufacturing as a proxy for average hours per worker and scale the employment series accordingly. For Mexico, the employment series was calculated as (1-unemployment rate)*(rate of activity of population over 12 years of age)*(fraction of population over 12 years of age)*(total population). All series were obtained from the Mexican Government Statistical database (through Datastream) with the exception of the total population series, which is from the World Development Indicators. The employment series was extended back to 1987 using Neumeyer and Perri (2004). For Mexico, quarterly hours per worker in manufacturing was calculated from OECD data as (total hours in manufacturing)/(total employment in manufacturing). This ratio was then used to calculate total hours from total employment. The capital stock series was calculated using the perpetual inventory method. The Penn World Tables report gross fixed capital formation starting in 1950. As in Bernanke and Gurkaynak (2002), we assume that capital and output grew at the same rate from 1950 to 1960. The initial capital stock for 1949 was then calculated as the ratio of investment in 1950 to the sum of the depreciation rate and annual average growth rate for 1950-60. We use a 10 percent annual depreciation rate. Starting with the capital stock in 1949 and updating using the data for investment from the Penn World Tables, we arrive at the capital stock for 1980. Post 1980 we use the quarterly investment series from OECD.

Appendix B: Identification and Estimation of Variance Decompositions

In this appendix we fill in the details for the $KPSW$ methodology used in Section 7. Our reduced form $VECM$ can be expressed:

$$\Delta x_t = \mu + C(L)\varepsilon_t ,$$

where $x = (y, c, i)'$. The structural model is given by

$$\Delta x_t = \mu + \Gamma(L)\eta_t.$$

The structural shocks η are related to ε by $\Gamma_0 \eta_t = \varepsilon_t,$ where we assume Γ_0^{-1} exists. Our balanced-growth (cointegration) assumption states

$$\Gamma(1) = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix},$$

where the first element of $\eta,$ denoted $\eta^1,$ is the permanent shock, and we have normalized its long-run impact to one. This last assumption is without loss of generality as the variance of η is unrestricted. Note that $C(1) = \Gamma(1)\Gamma_0^{-1}.$ Let D represent the first row of Γ_0^{-1} and $\widetilde{A}$ be a 3×1 vector of ones. Then

$$C(1) = \widetilde{A}D.$$

We can solve for D as

$$D = (\widetilde{A}'\widetilde{A})^{-1}\widetilde{A}'C(1).$$

The fact that $\eta_t = \Gamma_0^{-1}\varepsilon_t$ implies that the first element of η can be recovered as $\eta_t^1 = D\varepsilon_t.$

We also have $\sigma_{\eta_1}^2 = D\Sigma_\varepsilon D',$ where we have made use of the fact that $\eta^1 \perp \eta^2, \eta^3.$ To obtain the impulse response to a permanent shock, we start with $\Gamma(L) = C(L)\Gamma_0.$ Let H denote the first column of $\Gamma_0.$ The first column of $\Gamma(L)$ is therefore $C(L)H.$ From $\varepsilon_t = \Gamma_0\eta_t,$ we have $\Gamma_0^{-1}\Sigma_\varepsilon = E(\eta_t\eta_t)\Gamma_0'.$ The orthogonality assumption regarding η^1 implies that $D\Sigma_\varepsilon = \sigma_{\eta_1}^2 H',$ which gives

$$H = \Sigma_\varepsilon D'/\sigma_{\eta_1}^2.$$

The impulse responses and variance decompositions regarding η_t^1 can then be recovered from $\Gamma(L) * (\eta^1, 0, 0)' = C(L)H\eta^1$. The stochastic trend depicted in Figure 2 is constructed by feeding the recovered η_t^1 through $\Gamma(L)$. Note that our stochastic trend is defined as all fluctuations due to permanent shocks. This obviously differs from the classical Beveridge-Nelson decomposition in that we are not restricting the trend to be a random walk.

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Table 1: Emerging vs. Developed Markets (Averages)

	Emerging Markets		Developed Markets	
	HP	BP	HP	BP
$\sigma(Y)$	2.74	2.02	1.34	1.04
$\sigma(\Delta Y)$	1.87	1.87	0.95	0.95
$\rho(Y)$	0.76	0.86	0.75	0.90
$\rho(\Delta Y)$	0.23	0.23	0.09	0.09
$\sigma(C)/\sigma(Y)$	1.45	1.32	0.94	0.94
$\sigma(I)/\sigma(Y)$	3.91	3.96	3.41	3.42
$\sigma(TB/Y)$	3.22	2.09	1.02	0.71
$\rho(TB/Y,Y)$	-0.51	-0.58	-0.17	-0.26
$\rho(C,Y)$	0.72	0.74	0.66	0.69
$\rho(I,Y)$	0.77	0.87	0.67	0.75

This table lists average values of the moments for the group of emerging (13) and developed (13) economies. The values for each country separately are reported in Table 2. HP refers to HP-filtered data using a smoothing parameter of 1600. BP refers to Band Pass filtered data at frequencies between 6 and 32 quarters with 12 leads and lags. The definition of an emerging market follows the classification in S&P (2000).

Figure 1

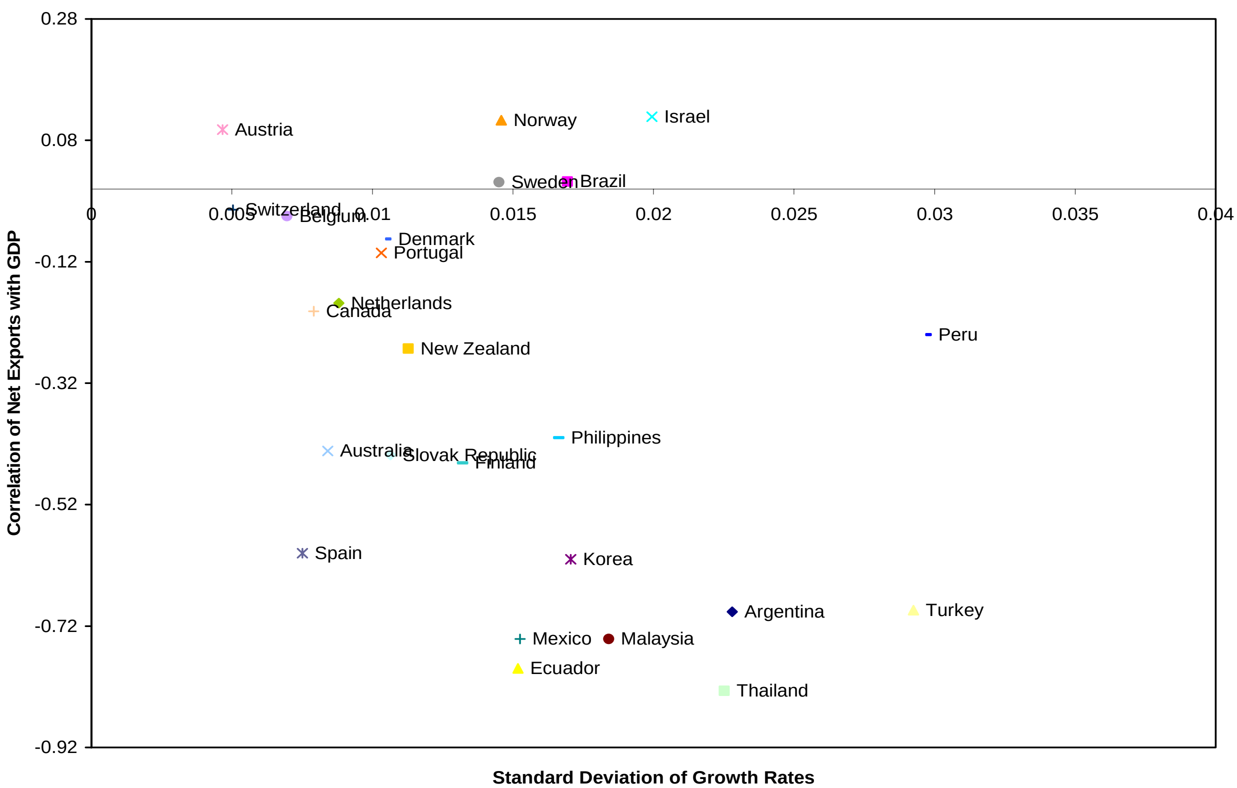


Table 2A: Volatility and Autocorrelation of Filtered Income and Growth Rates

	$\sigma(Y)$		$\sigma(\Delta Y)$		$\rho(Y_t,Y_{t-1})$		$\rho(\Delta Y_t,\Delta Y_{t-1})$	
Emerging Markets								
Argentina	3.68	(0.42)	2.28	(0.37)	0.85	(0.02)	0.61	(0.08)
Brazil	1.98	(0.20)	1.69	(0.33)	0.65	(0.04)	0.35	(0.15)
Ecuador	2.44	(0.52)	1.52	(0.38)	0.82	(0.05)	0.15	(0.14)
Israel	1.95	(0.14)	1.99	(0.17)	0.50	(0.10)	0.27	(0.05)
Korea	2.51	(0.46)	1.71	(0.27)	0.78	(0.08)	0.17	(0.19)
Malaysia	3.10	(0.65)	1.84	(0.37)	0.85	(0.02)	0.56	(0.16)
Mexico	2.48	(0.33)	1.53	(0.25)	0.82	(0.01)	0.27	(0.11)
Peru	3.68	(0.70)	2.97	(.50)	0.64	(0.11)	0.12	(0.10)
Philippines	3.00	(0.43)	1.66	(0.27)	0.87	(0.07)	0.17	(0.15)
Slovak Republic	1.24	(0.20)	1.06	(0.24)	0.66	(0.18)	0.20	(0.13)
South Africa	1.62	(0.16)	0.82	(0.11)	0.89	(0.06)	0.58	(0.06)
Thailand	4.35	(0.65)	2.25	(0.40)	0.89	(0.02)	0.42	(0.20)
Turkey	3.57	(0.41)	2.92	(0.36)	0.67	(0.06)	0.05	(0.13)
MEAN	**2.74**		**1.87**		**0.76**		**0.23**	
Developed Markets								
Australia	1.39	(0.21)	0.84	(0.10)	0.84	(0.04)	0.36	(0.10)
Austria	0.89	(0.09)	0.47	(0.00)	0.90	(0.08)	0.52	(0.09)
Belgium	1.02	(0.09)	0.71	(0.05)	0.79	(0.05)	0.18	(0.09)
Canada	1.64	(0.21)	0.81	(0.09)	0.91	(0.04)	0.55	(0.11)
Denmark	1.02	(0.16)	1.04	(0.09)	0.49	(0.14)	0.15	(0.11)
Finland	2.18	(0.39)	1.32	(0.11)	0.85	(0.09)	0.01	(0.20)
Netherlands	1.20	(0.13)	0.88	(0.09)	0.77	(0.07)	0.03	(0.08)
New Zealand	1.56	(0.20)	1.13	(0.14)	0.77	(0.10)	0.02	(0.13)
Norway	1.40	(0.10)	1.46	(0.13)	0.48	(0.11)	0.46	(0.10)
Portugal	1.34	(0.14)	1.03	(0.13)	0.72	(0.11)	0.28	(0.17)
Spain	1.11	(0.12)	0.75	(0.09)	0.82	(0.03)	0.08	(0.18)
Sweden	1.52	(0.20)	1.45	(0.32)	0.53	(0.21)	0.35	(0.11)
Switzerland	1.11	(0.13)	0.50	(0.04)	0.92	(0.05)	0.81	(0.04)
MEAN	**1.34**		**0.95**		**0.75**		**0.09**	

Note: The series for each country was deseasonalized if a significant seasonal component was identified. The income series were then logged and filtered using an HP filter with a smoothing parameter of 1600. For growth rates the unfiltered series was used. GMM-estimated standard errors are reported in parentheses. The standard deviations are reported in percentage terms.

Table 2B: Relative Volatility of Consumption, Investment, and Net Exports

	σ(C)/σ(Y)		σ(I)/σ(Y)		σ(NX/Y)	
Emerging Markets						
Argentina	1.38	(0.07)	2.53	(0.01)	2.56	(0.67)
Brazil	2.01	(0.07)	3.08	(0.03)	2.61	(0.92)
Ecuador	2.39	(0.01)	5.56	(0.01)	5.68	(1.07)
Israel	1.60	(0.00)	3.42	(0.04)	2.12	(0.18)
Korea	1.23	(0.06)	2.50	(0.04)	2.32	(0.51)
Malaysia	1.70	(0.03)	4.82	(0.02)	5.30	(0.77)
Mexico	1.24	(0.05)	4.05	(0.02)	2.19	(0.32)
Peru	0.92	(0.08)	2.37	(0.01)	1.25	(0.15)
Philippines	0.62	(0.12)	4.66	(0.02)	3.21	(0.34)
Slovak Republic	2.04	(0.08)	7.77	(0.02)	4.29	(0.56)
South Africa	1.61	(0.08)	3.94	(0.03)	2.57	(0.50)
Thailand	1.09	(0.07)	3.49	(0.01)	4.58	(0.85)
Turkey	1.09	(0.06)	2.71	(0.03)	3.23	(0.40)
MEAN	**1.45**		**3.91**		**3.22**	
Developed Markets						
Australia	0.69	(0.00)	3.69	(0.03)	1.08	(0.12)
Austria	0.87	(0.14)	2.75	(0.04)	0.65	(0.04)
Belgium	0.81	(0.13)	3.72	(0.04)	0.91	(0.07)
Canada	0.77	(0.09)	2.63	(0.03)	0.91	(0.08)
Denmark	1.19	(0.10)	3.90	(0.02)	0.88	(0.14)
Finland	0.94	(0.07)	3.26	(0.02)	1.11	(0.10)
Netherlands	1.07	(0.09)	2.92	(0.03)	0.71	(0.09)
New Zealand	0.90	(0.10)	4.38	(0.02)	1.37	(0.18)
Norway	1.32	(0.12)	4.33	(0.03)	1.73	(0.19)
Portugal	1.02	(0.11)	2.88	(0.05)	1.16	(0.12)
Spain	1.11	(0.07)	3.70	(0.03)	0.86	(0.07)
Sweden	0.97	(0.14)	3.66	(0.04)	0.94	(0.09)
Switzerland	0.51	(0.31)	2.56	(0.05)	0.96	(0.09)
MEAN	**0.94**		**3.41**		**1.02**	

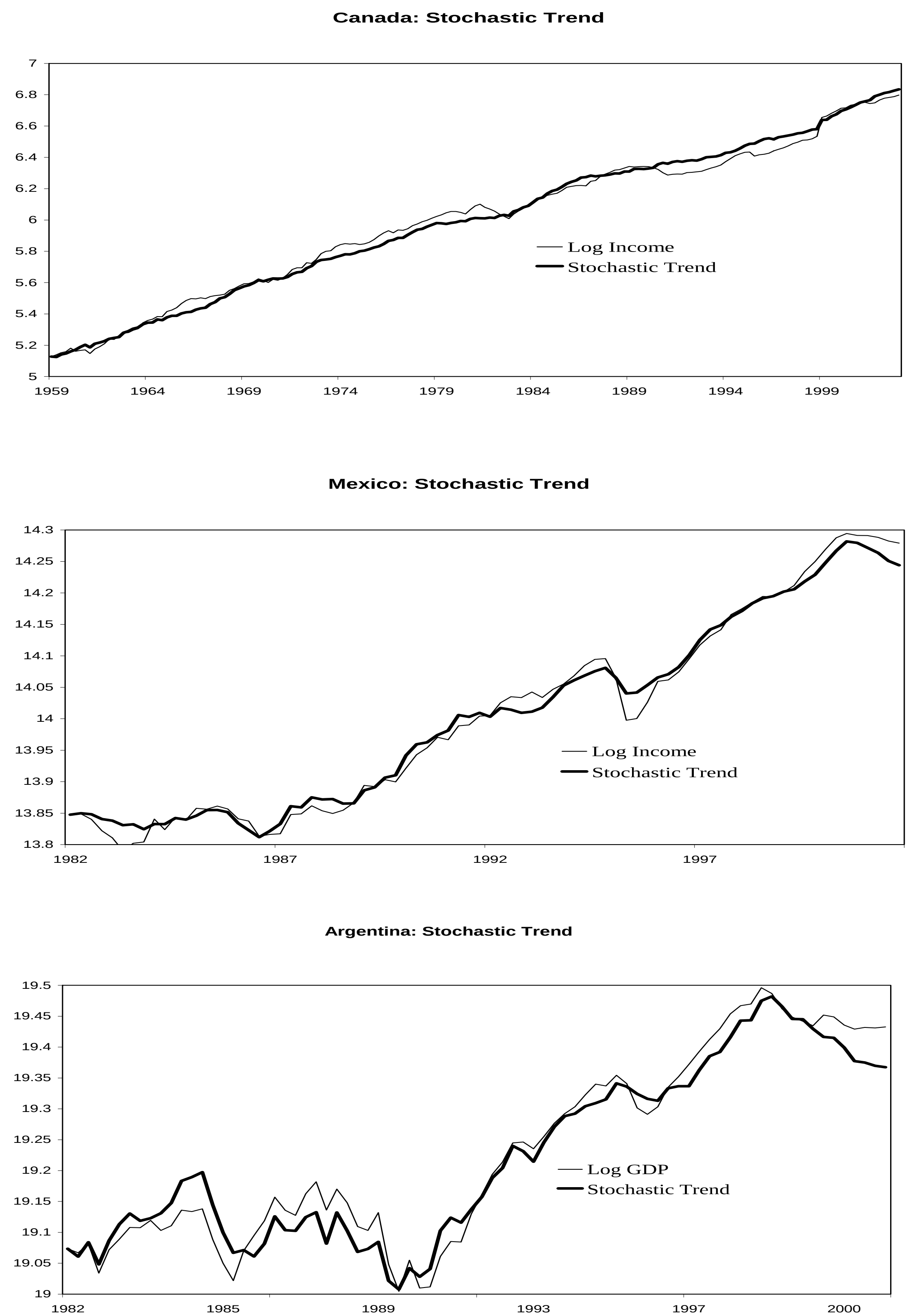
Note: The series for each country was deseasonalized if a significant seasonal component was identified. The series were then logged (except for TB/Y) and filtered using an HP filter with a smoothing parameter of 1600. GMM-estimated standard errors are reported in parentheses. The standard deviation of the ratio of net exports to GDP are reported in percentage terms.

Table 2C: Contemporaneous Correlation with Output

	ρ(C,Y)		ρ(I,Y)		ρ(NX/Y,Y)	
Emerging Markets						
Argentina	0.90	(0.14)	0.96	(0.04)	-0.70	(0.17)
Brazil	0.41	(0.22)	0.62	(0.19)	0.01	(0.19)
Ecuador	0.73	(0.11)	0.89	(0.09)	-0.79	(0.11)
Israel	0.45	(0.15)	0.49	(0.12)	0.12	(0.16)
Korea	0.85	(0.08)	0.78	(0.15)	-0.61	(0.17)
Malaysia	0.76	(0.15)	0.86	(0.14)	-0.74	(0.18)
Mexico	0.92	(0.09)	0.91	(0.10)	-0.74	(0.14)
Peru	0.78	(0.17)	0.85	(0.14)	-0.24	(0.13)
Philippines	0.59	(0.14)	0.76	(0.11)	-0.41	(0.16)
Slovak Republic	0.42	(0.16)	0.46	(0.21)	-0.44	(0.13)
South Africa	0.72	(0.09)	0.75	(0.13)	-0.54	(0.13)
Thailand	0.92	(0.10)	0.91	(0.08)	-0.83	(0.12)
Turkey	0.89	(0.09)	0.83	(0.10)	-0.69	(0.13)
MEAN	0.72		0.77		-0.51	
Developed Markets						
Australia	0.48	(0.13)	0.80	(0.14)	-0.43	(0.16)
Austria	0.74	(0.20)	0.75	(0.11)	0.10	(0.13)
Belgium	0.67	(0.14)	0.62	(0.14)	-0.04	(0.10)
Canada	0.88	(0.08)	0.77	(0.13)	-0.20	(0.21)
Denmark	0.36	(0.20)	0.51	(0.11)	-0.08	(0.18)
Finland	0.84	(0.09)	0.88	(0.10)	-0.45	(0.17)
Netherlands	0.72	(0.11)	0.70	(0.11)	-0.19	(0.09)
New Zealand	0.76	(0.11)	0.82	(0.13)	-0.26	(0.15)
Norway	0.63	(0.12)	0.00	(0.11)	0.11	(0.11)
Portugal	0.75	(0.12)	0.70	(0.14)	-0.11	(0.15)
Spain	0.83	(0.09)	0.83	(0.12)	-0.60	(0.12)
Sweden	0.35	(0.17)	0.68	(0.13)	0.01	(0.12)
Switzerland	0.58	(0.14)	0.69	(0.17)	-0.03	(0.17)
MEAN	0.66		0.67		-0.17	

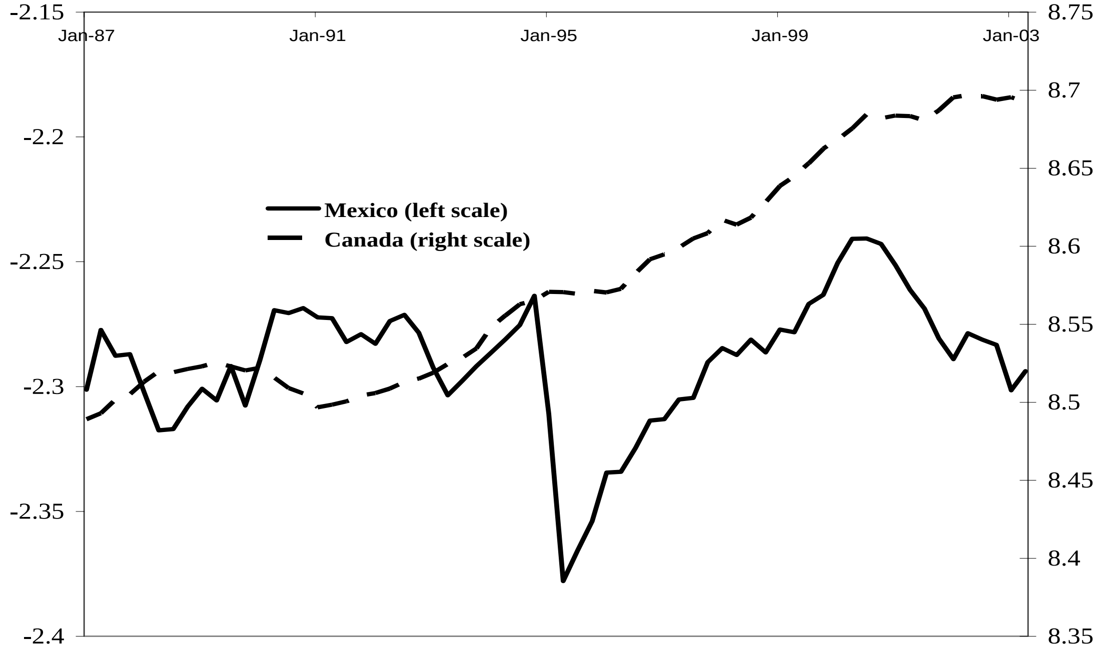
Note: The series for each country was deseasonalized if a significant seasonal component was identified. The series were then logged (except for TB/Y) and filtered using an HP filter with a smoothing parameter of 1600. GMM-estimated standard errors are reported in parentheses.

Figure 2: Stochastic Trends Estimated using the KPSW(1991) Methodology



Note: Stochastic trend is calculated using the methodology described in Section 5 and Appendix B. See text for details.

Figure 3: Solow Residuals: Mexico and Canada (1987.1-2003.2)



Note: See Section 4 and Appendix A for details on the data sources and the calculation of Solow residuals.

Table 3: Benchmark Parameter Values

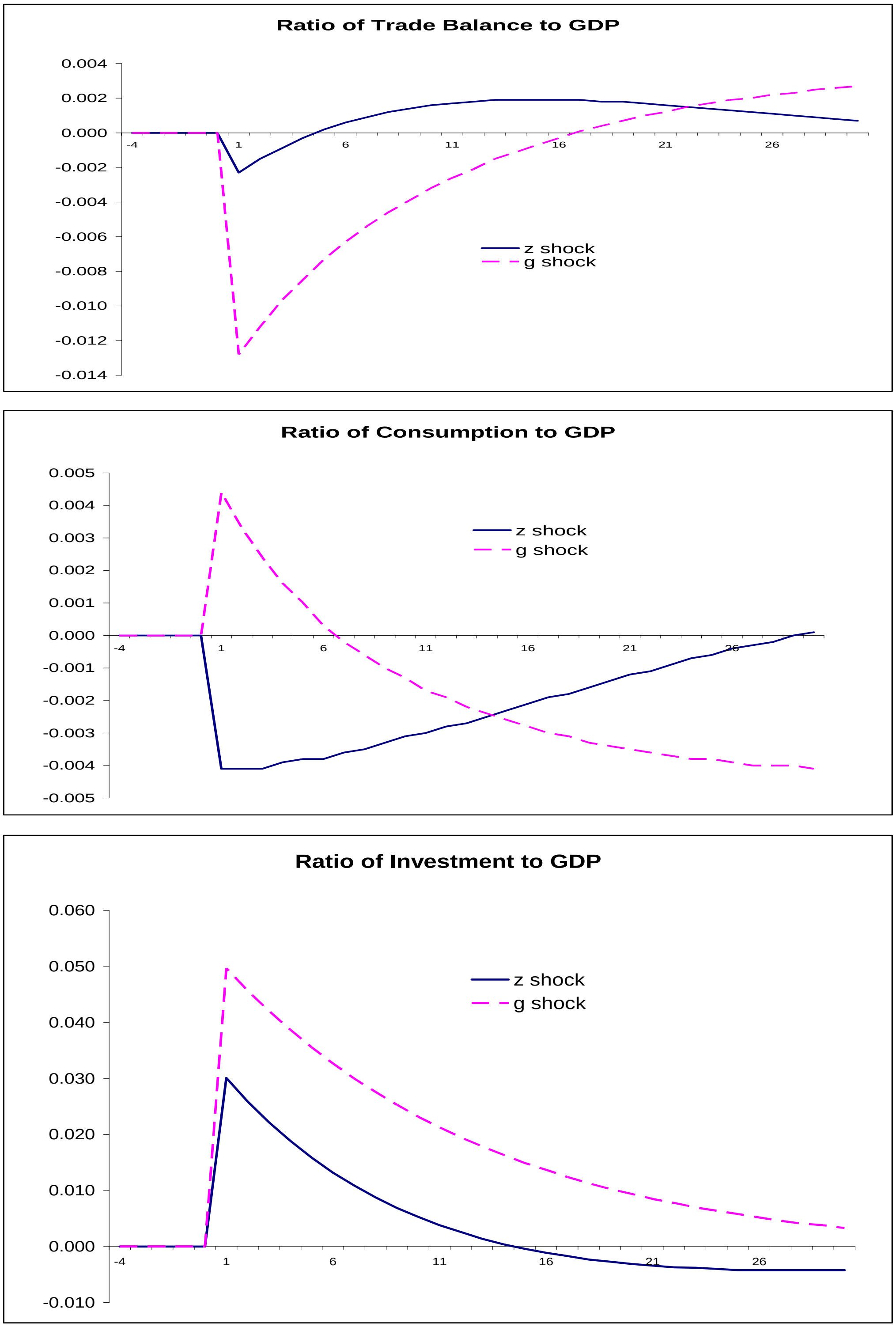
		GHH	Cobb Douglas
Time preference rate	β	0.98	0.98
Labor exponent (utility)	υ	1.6	NA
Labor coefficient (utility)	τ	1.4	NA
Consumption exponent (utility)	γ	NA	0.36
Steady-state debt to GDP	b	10%	10%
Coefficient on interest-rate premium	ψ	0.001	0.001
Labor exponent (production)	α	0.68	0.68
Risk aversion	σ	2	2
Depreciation rate	δ	0.03	0.03

Table 4: Estimated Parameters

		"Developed" (Canada)		**"Emerging Market" (Mexico)**	
		GHH	**Cobb Douglas**	**GHH**	**Cobb Douglas**
Mean growth rate	μ_g	1.007	1.007	1.006	1.005
		(0.001)	(0.001)	(0.001)	(0.001)
Volatility of z	σ_z	0.57	0.72	0.41	0.46
		(0.04)	(0.09)	(0.42)	(0.37)
Autocorrelation of z	ρ_z	0.88	0.96	0.94	0.94
		(0.08)	(0.02)	(0.29)	(0.13)
Volatility of g	σ_g	0.14	0.44	1.09	2.50
		(0.06)	(0.32)	(0.37)	(0.27)
Autocorrelation of g	ρ_g	0.94	0.50	0.72	0.06
		(0.04)	(0.26)	(0.08)	(0.04)
Adjustment cost parameter	ϕ	2.63	3.76	3.79	2.82
		(1.25)	(0.52)	(0.96)	(0.48)
Test of model fit (P-Value)		0.12	0.16	0.13	0.44

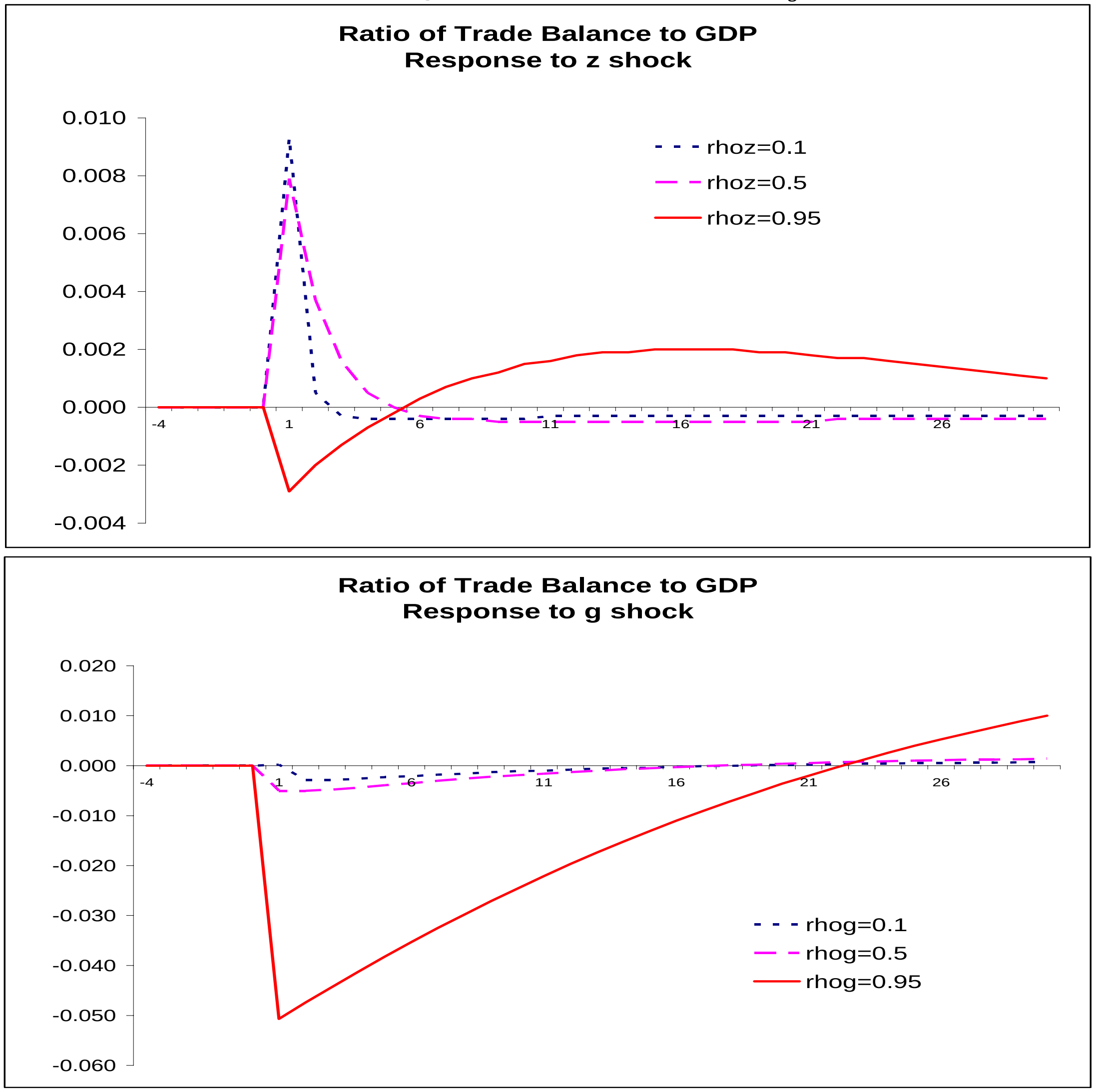
Note: GMM estimates with standard errors in parentheses. See text for details of estimation. Standard deviations are reported in percentage terms.

Figure 4: Impulse Responses from the Model



Note: Figure 4 contrasts the impulse response following a 1 percent shock to the level of technology with the impulse response to a 1percent growth shock. The values plotted are deviations from steady state. The parameterization corresponds to the Emerging Market Parameterization using GHH preferences.

Figure 5: Sensitivity to ρ_z and ρ_g



Note: Figure 5 contrasts the impulse response of the trade balance to a transitory (first panel) and growth shock (second panel) for varying values of the persistence of the level shock and growth shock, respectively. The values plotted correspond to deviations from steady state.

Table 5: Theoretical Business Cycle Moments

Table 5a: Moments for "Developed Market"

	Data	GHH	CD
$\sigma(y)$	1.64	1.30	1.39
		(0.13)	(0.09)
$\sigma(\Delta y)$	0.81	1.06	0.97
		(0.06)	(0.06)
$\sigma(I)$	4.33	4.09	4.08
		(0.37)	(0.33)
$\sigma(c)$	1.27	1.12	1.08
		(0.15)	(0.12)
$\sigma(nx)$	0.91	0.91	0.96
		(0.08)	(0.08)
$\rho(y)$	0.91	0.74	0.79
		(0.04)	(0.01)
$\rho(\Delta y)$	0.55	0.06	0.11
		(0.05)	(0.04)
$\rho(y,nx)$	-0.20	-0.01	0.05
		(0.13)	(0.12)
$\rho(y,c)$	0.88	0.87	0.80
		(0.05)	(0.04)
$\rho(y,I)$	0.77	0.77	0.81
		(0.07)	(0.05)

Table 5b: Moments for "Emerging Market"

	Data	GHH	CD
$\sigma(y)$	2.48	2.33	2.32
		(0.28)	(0.26)
$\sigma(\Delta y)$	1.52	1.57	1.58
		(0.16)	(0.16)
$\sigma(I)$	10.08	9.13	9.60
		(1.22)	(1.15)
$\sigma(c)$	3.08	2.57	2.71
		(0.37)	(0.32)
$\sigma(nx)$	2.19	1.82	2.12
		(0.23)	(0.22)
$\rho(y)$	0.82	0.82	0.81
		(0.03)	(0.02)
$\rho(\Delta y)$	0.27	0.23	0.21
		(0.07)	(0.07)
$\rho(y,nx)$	-0.74	-0.62	-0.64
		(0.09)	(0.07)
$\rho(y,c)$	0.92	0.96	0.94
		(0.01)	(0.02)
$\rho(y,I)$	0.91	0.85	0.88
		(0.04)	(0.03)

Note: Theoretical moments are calculated from the model using the parameters reported in Tables 3 and 4. Standard errors reported in the parentheses are calculated from the parameter standard errors reported in Table 4 using the Delta method. Standard errors for the data sample moments are not reported here but can be found in Table 2.

Table 6A: Solow Residual for Canada (1981.1-2003.2)

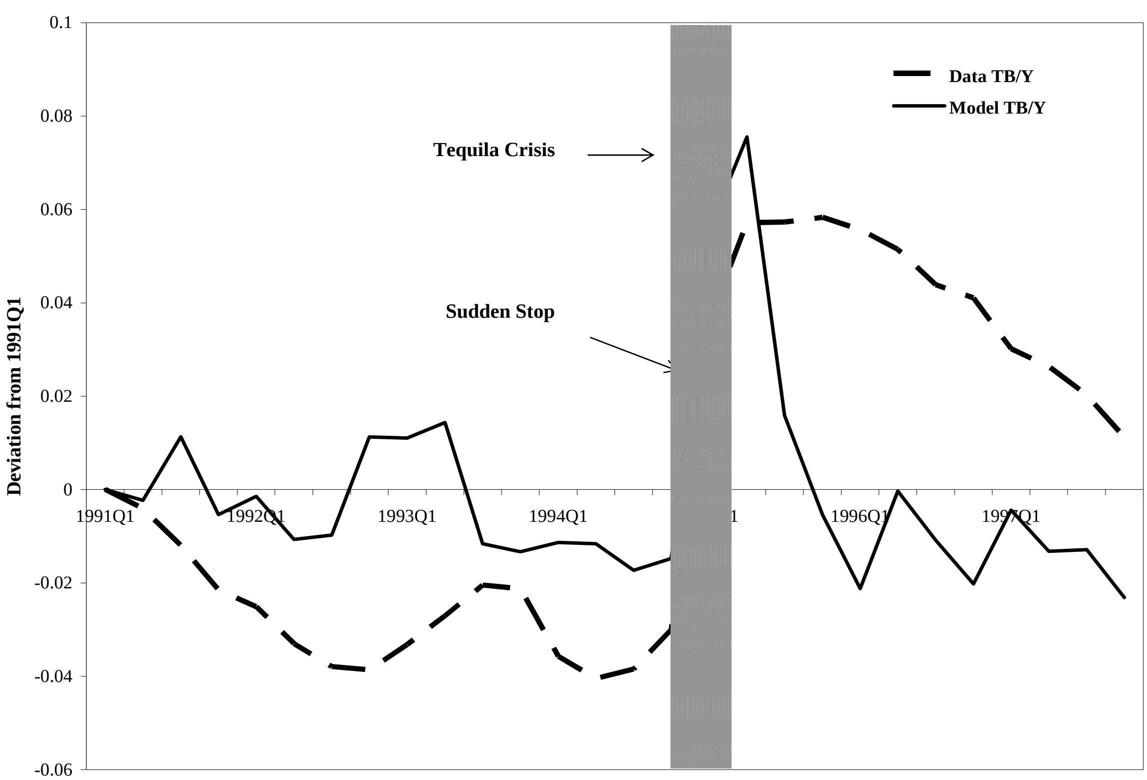
	Data		Model	
	Hours Based	Employment Based	GHH	CD
$\sigma(SR)$	0.93	1.04	0.85	1.14
$\rho(SR)$	0.75	0.85	0.76	0.77
$\sigma(\Delta SR)$	0.68	0.59	0.64	0.81
$\rho(\Delta SR)$	-0.06	0.21	0.12	0.08

Table 6B: Solow Residual for Mexico (1987.1-2003.2)

	Data		Model	
	Hours Based	Employment Based	GHH	CD
$\sigma(SR)$	1.80	1.99	2.30	2.32
$\rho(SR)$	0.77	0.77	0.91	0.74
$\sigma(\Delta SR)$	1.30	1.41	1.15	1.77
$\rho(\Delta SR)$	0.20	0.22	0.62	0.05

Note: Solow residuals are calculated as $\ln(Y_t) - \alpha \ln(L_t) - (1-\alpha)\ln(K_t)$. $\sigma(SR)$ and $\rho(SR)$ represent the standard deviation (%) and autocorrelation of the HP-filtered (smoothing parameter 1600) Solow residual series. $\sigma(\Delta SR)$ and $\sigma(\Delta SR)$ represent the same for the growth rate of the Solow residual. Appendix A describes the data used in calculating the residual.

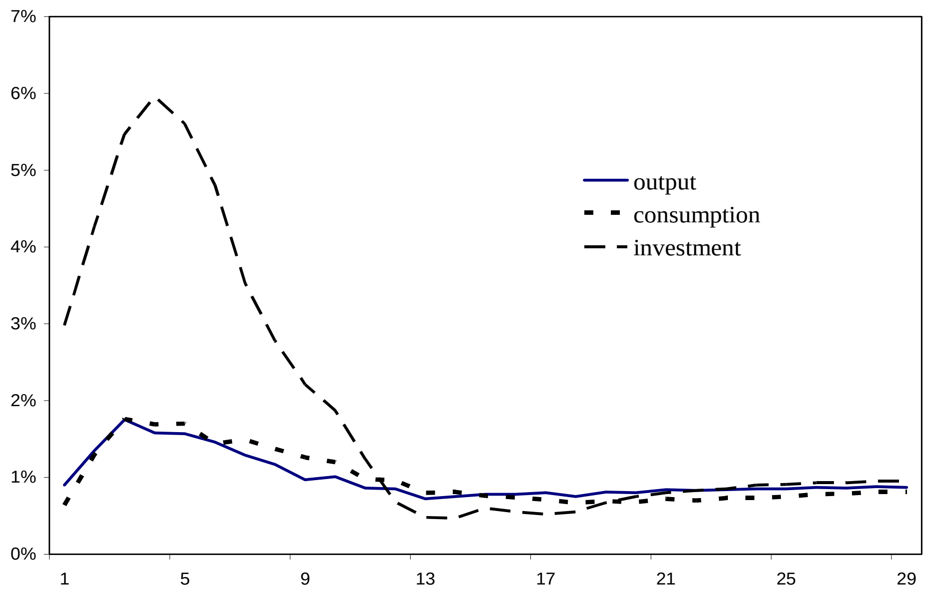
Figure 6: Sudden Stop – Mexico Tequila Crisis (1994-1995)



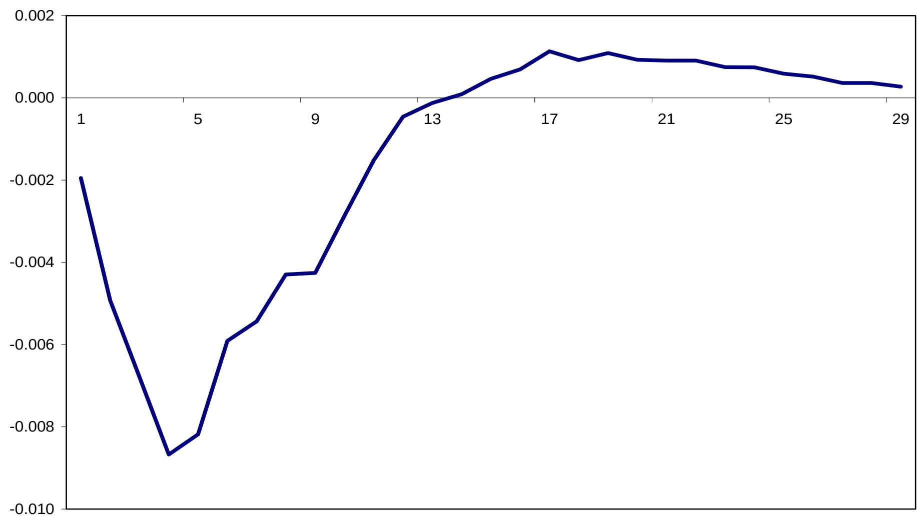
Note: Both series are deviations from 1991Q1. The dashed line represents the observed ratio of net exports to GDP in Mexico and the solid line represents the ratio predicted by the model from the observed Solow residuals. See text for details.

Figure 7: Impulse Responses from a Vector Error Correction Model

Impulse Response to One Std Dev Permanent Shock (Mexico Data)



Response of TB/Y to One Std Deviation Permanent Shock (Mexico Data)



Note: The figure plots the impulse responses in a three-variable VAR to a one standard deviation permanent shock, using Mexican data and the VAR methodology discussed in Section 5 and Appendix B. The first panel plots the impulse response of log output, log consumption, and log investment. The second panel plots the implied response of net exports as a ratio to GDP.

Table 7A: Variance Decomposition for Canada

Horizon	Y	C	I
1	0.39	0.61	0.00
	(0.26)	(0.27)	(0.22)
4	0.29	0.56	0.00
	(0.25)	(0.27)	(0.23)
8	0.41	0.57	0.02
	(0.26)	(0.27)	(0.24)
12	0.49	0.59	0.06
	(0.26)	(0.26)	(0.24)
16	0.55	0.62	0.11
	(0.25)	(0.25)	(0.25)
20	0.59	0.66	0.15
	(0.23)	(0.23)	(0.24)
24	0.63	0.70	0.19
	(0.21)	(0.21)	(0.24)
∞	1.00	1.00	1.00

Table 7B: Variance Decomposition for Mexico

Horizon	Y	C	I
1	0.85	0.19	0.34
	(0.38)	(0.29)	(0.24)
4	0.72	0.42	0.44
	(0.32)	(0.26)	(0.25)
8	0.79	0.49	0.48
	(0.33)	(0.27)	(0.25)
12	0.82	0.53	0.50
	(0.32)	(0.28)	(0.25)
16	0.85	0.57	0.50
	(0.31)	(0.27)	(0.24)
20	0.86	0.60	0.49
	(0.28)	(0.25)	(0.22)
24	0.86	0.60	0.49
	(0.26)	(0.23)	(0.21)
∞	1.00	1.00	1.00

Note: The tables indicate the fraction of the forecast error variance attributed to the permanent shock. This is based on the VAR methodology discussed in Section 5 and Appendix B. The estimates were calculated using 8 lags of ΔX_t , where X is a vector of log output, log consumption, and log investment, and one lag of the error correction terms (c_t-y_t,) and (i_t-y_t,), and a constant. Standard errors shown in parentheses were computed by Monte Carlo simulations using 500 replications. The sample for Mexico is 1980.1-2003.1. For Canada we have a longer time series data from 1959.1-2003.1

Table A1: Data Sources

	Quarters	Source
Emerging Markets		
Argentina	1993.1-2002.4	IFS
	1980.1-2002.1	NP
Brazil	1991.1-2002.1	NP
Ecuador	1991.1-2002.2	IFS
Israel	1980.1-2003.1	IFS
Korea	1979.4-2003.2	OECD
Malaysia	1991.1-2003.1	IFS
Mexico	1980.1-2003.1	OECD
Peru	1990.1-2003.1	IFS
Philippines	1981.1-2003.1	IFS
Slovak Republic	1993.1-2003.2	OECD
South Africa	1980.1-2003.1	IFS
Thailand	1993.1-2003.1	IFS
Turkey	1987.1-2003.2	OECD
Developed Markets		
Australia	1979.1-2003.2	OECD
Austria	1988.1-2003.2	OECD
Belgium	1980.1-2003.2	OECD
Canada	1981.1-2003.2	OECD
	1957.1-2003.1	IFS
Denmark	1988.1-2003.1	OECD
Finland	1979.4-2003.2	OECD
Netherlands	1979.4-2003.2	OECD
New Zealand	1987.2-2003.2	OECD
Norway	1979.4-2003.2	OECD
Portugal	1988.1-2001.4	NP
Spain	1980.1-2003.2	OECD
Sweden	1980.1-2003.1	IFS
Switzerland	1980.1-2003.2	OECD

NP stands for Neumeyer and Perri (2004).