

Labor, Output and Consumption in Business Cycle Models of Emerging Economies

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ABSTRACT

Motivated by the fact that, over the business cycle, labor dynamics in emerging economies differ in nontrivial ways from those observed in developed economies, we assess the relative importance of trend shocks in emerging economies in the business cycle model of Aguiar and Gopinath (2007) when labor data is explicitly taken into account. We study Mexico and Canada as representatives of emerging and developed economies, respectively. We find for Mexico that, in the benchmark case with Cobb-Douglas preferences, the income effect on consumption of trend shocks is too strong, delivering countercyclical and counterfactual fluctuations in employment. The model faces a trade-off between, on the one hand, having sizeable growth shocks, thereby having a good match in terms of relatively high consumption volatility, and, on the other, having procyclical employment dynamics. This is remedied when both quasilinear preferences are assumed and the econometric identification strategy explicitly takes into consideration labor dynamics. In this case trend shocks continue to be relatively stronger in emerging economies. Additionally, we find that differences in labor dynamics across emerging and developing economies are associated with the relatively large informal labor sector in emerging economies. It is in this dimension, when trying to match the dynamics of formal employment, that we find less evidence supporting an important role of trend shocks as being the main driving force of business cycles in emerging economies.

Keywords: Emerging economies, labor dynamics, consumption volatility
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1 Introduction

A crucial challenge for business cycle models of emerging economies is to properly account for the large volatility of aggregate consumption observed in these economies. Previous researchers have found that consumption is more volatile than output, and theories have been proposed to explain this behavior. One of these theories is the one presented in Aguiar and Gopinath (2007) (AG, henceforth) where the information in business cycles is exploited to identify the characteristics of productivity in a standard SOE/RBC model using time series data from emerging and developed small open economies. Their main finding is that, in sharp contrast to the results for developed economies, shocks to the productivity trend, rather than transitory fluctuations around a stable trend, are the primary source of fluctuations in emerging markets, and can properly account for the high consumption volatility that exceeds income volatility. Shocks to trend, which AG relate to deeper frictions in the economy, can also account for "sudden stops" in these emerging economies.

A key feature of AG's analysis is that they explicitly do not attempt to match the dynamics observed in hours or employment in these economies. More generally, a gap in the literature on business cycle models of emerging economies is the little interest paid to predictions regarding labor statistics despite the fact that the behavior of the labor input has traditionally been of prime importance to business cycle theory. This gap is further amplified by the fact that labor dynamics in emerging economies differ in nontrivial ways from those observed in developed small open economies. As will be documented below, for example, comparing Mexico and Canada -the two countries AG studied more closely as representative emerging/developed economies-, employment is significantly more procyclical and volatile, relative to output, in the latter than in the former economy.

This paper aims to fill this gap in the literature by studying whether a business cycle model of an emerging economy, specifically that of AG, can account for the dynamics of both consumption and labor observed in emerging markets data. Our strategy is simple: we assess the robustness of the findings of AG if labor data is explicitly taken into account when measuring the relative importance of trend shocks in emerging economies. We thus specifically ask whether or not trend shocks can also account for these differences across

emerging and developed economies.

Our main findings can be summarized as follows. First, the model of AG -with Cobb-Douglas preferences-, henceforth the benchmark, is unable to reproduce qualitatively the procyclicality of labor in Mexico. Additionally, this manifests in sudden stop simulations where equilibrium labor rises, which is counterfactual. Second, there is a trade-off between having sizeable growth shocks, thereby having a good match in terms of relative consumption volatility, and having procyclical employment dynamics in the model. We show analytically that one cannot have a good match in both dimensions under the benchmark model of AG. Third, using quasi-linear preferences alone is not a remedy. Only when these preferences are assumed *and* the identification strategy explicitly takes into consideration labor dynamics can the modified AG model account for *both* the large volatility in consumption and the mild procyclicality of labor in Mexico. Fourth, when estimated with Canadian data, the modified model continues to favor the hypothesis that trend shocks are more important in Mexico than in Canada. Fifth, digging deeper into the measurement issues surrounding employment data in emerging economies that prevented AG from incorporating this information into their analysis, we find that the main difference between labor statistics in Mexico and Canada comes from the large informal labor in Mexico. It is in this dimension, when trying to match the dynamics of formal employment, that we find less support for trend shocks as being the major driving force of business cycles in emerging economies. The model faces a stronger tension between replicating the volatility of consumption and the high cyclicality of formal labor, becoming unable to match both simultaneously.

The paper is divided as follows. In section 2 we compare our paper to the scarce literature studying labor in small open economies. In section 3 we present the AG model. In section 4 we study its predictions regarding consumption volatility and the correlation of labor with output under different choices for preferences and taking into account labor statistics in the estimation. In section 5 we study the predictions of the model regarding sudden stops. In section 6 we compare model predictions for Mexico and for Canada. In section 7 we analyze the role of government employment and the informal sector accounting for the behavior of labor statistics in Mexico. Finally, section 8 presents some concluding remarks. A technical appendix summarizes the details of our estimation method.

2 Related research

There are few papers that study the behavior of the labor market in business cycle models of small open emerging economies. Neumeyer and Perri (2005) report business cycle statistics for employment and hours across sets of countries of the two groups. In their sample, both employment and hours are less volatile in emerging than in developed countries. Additionally, both employment and hours are less positively correlated with output in emerging than in developed countries. When analyzing the predictions of their model, in which a working capital requirement interacting with interest rates plays a central role, they find that predicted hours are more volatile and more correlated with output than actual hours for Argentina. They propose that part of the explanation is that government employment is used as unemployment insurance in Argentina. In this paper we will address the concern of Neumeyer and Perri (2005) regarding government employment in the case of Mexico.

Boz, Daude and Durdu (2010) ask about the predictions of same model as in Aguiar and Gopinath (2007) when agents imperfectly distinguish and learn about the permanent and transitory components of productivity. They calculate impulse-response functions for the perfect information version of their model, which is equivalent to Aguiar and Gopinath (2007), and report that a positive growth shock produces a fall in labor. Boz, Daude and Durdu (2010) report that introducing learning about the trend reduces the size of the problem, but does not eliminate it. The impulse-response function of their model with imperfect information yields smaller falls in labor after a growth shock. Therefore, a positive growth shock continues to produce a drop in labor. They do not report the predicted correlation between labor and output in the imperfect information case. Part of our contribution is to point out that the model of Aguiar and Gopinath (2007) can produce a positive correlation between labor and output under certain conditions.

Boz, Durdu and Li (2009) embed search-matching frictions of the Mortensen-Pissarides type in the labor market of a small open economy. Their model predicts that consumption is more volatile than output. On the other hand, in their benchmark model the volatility of unemployment is much lower than the one in the data. They analyze the effect of adding to their model procyclical shocks in the technical efficiency at which matches are generated.

They calibrate the persistence and volatility of these shocks to match the volatility of unemployment and its correlation with output, and look at further implications. The predicted autocorrelation of unemployment increases relative to the benchmark but is still away from the observed value.

Li (2011) documents that real wages are about twice as volatile in emerging markets compared with developed economies and that, while procyclical, they lag output by about one quarter. The author builds a small open economy that can account for the high volatility of wages and consumption in emerging economies. While the model uses preferences à la Jaimovich and Rebelo (2009) that allow for a flexible parameterization of the strength of the income effect on labor supply -that we will also explore below-, it focuses on a different propagation mechanism based on exogenous interest rate shocks amplified via a working capital requirement. This paper does not explore the role of shocks to the productivity trend. Moreover, the author reports that the predicted volatility of the labor input is higher than in the data, as in Neumeyer and Perri (2005).

In what follows we will set up the model of AG and explore its performance in trying to match emerging markets data, particularly that of labor, across various types of preferences and information sets when estimating its main parameters.

3 Preliminaries

Before presenting our analysis, we reproduce part of the model of AG to fix concepts. The production function is

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

where

$$z_t = \rho_z z_{t-1} + \epsilon_t^z, |\rho_z| < 1$$

$$\Gamma_t = e^{g_t} \Gamma_{t-1} = \prod_{s=0}^t e^{g_s}$$

$$g_t = (1 - \rho_g)\mu_g + \rho_g g_{t-1} + \epsilon_t^g, |\rho_g| < 1$$

and $\epsilon_t^z, \epsilon_t^g$ are distributed normally with means equal to zero and standard deviations σ_z, σ_g respectively. Variables z_t and g_t represent, respectively, shocks to the transitory component and growth of productivity. We call the latter a growth shock. Variable Γ_t , which depends on the sequence of g_t , is the permanent component of productivity. Since we do not observe directly the values of the parameters ruling z_t and g_t we estimate them in the following section. The utility function used by AG is Cobb-Douglas

$$u(C_t, H_t) = \frac{(C_t^\gamma (1 - H_t)^{1-\gamma})^{1-\sigma} - 1}{1 - \sigma}, \sigma > 0, 0 < \gamma < 1 \quad (1)$$

where C_t is consumption and H_t is labor.

An alternative to these preferences that we will also consider here are the GHH-type of preferences, following Greenwood, et.al. (1988), that have been used frequently in models of small open economies:

$$u(C_t, H_t) = \frac{(C_t - \tau \Gamma_{t-1} H_t^\nu)^{1-\sigma} - 1}{1 - \sigma}, \sigma > 0, \tau > 0, \nu > 1.^2 \quad (2)$$

The values of parameters for both functions are the same as in AG for the Cobb-Douglas case, and the ones in Aguiar and Gopinath (2004) for the GHH case. In Table 1 we display the list of parameter values.³ As is well known, but important for our discussion, the key distinction between the two types of utilities is the income effect governing labor supply decisions in response to different shocks (see Aguiar and Gopinath, 2004; Neumeyer and Perri, 2005). While in the Cobb-Douglas case the labor supply will respond to changes in the productivity process because of its impact on consumption, in the GHH case the labor supply is unmitigated by the response of consumption. Our exploration will assess results across these two types of preferences.

²See Correia, Neves and Rebelo (1995) for a study of the properties of a small open economy model in which productivity has a deterministic trend, unlike in the model under analysis, and a stationary component. They analyzed the predictions of the model using either a Cobb-Douglas utility or a GHH one, and found that the model with the GHH function matched the data more closely.

³In the case of μ_g in all estimations we calibrate it using Table 4 in Aguiar and Gopinath (2004).

4 Alternative models and estimations: predicted business cycle statistics for Mexico

In this section we analyze the implications of the benchmark model and estimation, and carry out four variations, assessing for each case the performance of the model in accounting for the cyclical component of the Mexican data, particularly that of employment. The quarterly sample we use is 1987:I – 2003:II, which is a subset of the sample in AG (who used 1980:I–2003:II). They used data on employment for the period 1987:I–2003:II to compute Solow residuals for Mexico, but did not use these data on employment in their estimations. We use their data on employment, as well as their data for other variables. The benchmark GMM estimation consists of estimating σ_g, σ_z and ρ_g matching the standard deviation of output, the standard deviation of consumption and the covariance of consumption and income⁴. The benchmark estimation is estimation 3 in Table 4 in AG which we follow in order to maximize comparability between our results and theirs.⁵ We first modify the benchmark estimation by adding two moments of labor. The moments are the standard deviation of the cyclical component of HP-filtered employment, and the correlation between the cyclical components of employment and output. The second variation is to assume a GHH utility, while keeping the estimation as in the benchmark. The third variation is to assume a GHH utility and estimate parameters adding the two moments of labor. The last variation is to assume the utility function in Jaimovich and Rebelo (2009), and estimating the model with the two moments of labor.⁶

Our first set of results is reported in Table 2. The left part of the Table serves as a reference as it displays the properties of the data in the sample used in AG. It also reports

⁴See the technical appendix for further details of the estimation strategy used in the benchmark case and the variations of it.

⁵AG report results from three additional estimations, where they modify the number of parameters, and moments used. Results on the size of the random walk component of productivity do not change much. Therefore we use their estimation 3 as a benchmark. We set ρ_z equal to 0.95 as in Table 4 in AG.

⁶We use the computer codes that M. Aguiar and G. Gopinath have posted online. Specifically, we use their code that solves the model assuming a Cobb–Douglas utility. We also use their code that calculates predicted theoretical business cycle moments of HP-filtered data. We use our own code that solves the model in the case of a GHH utility, by making simple modifications to the code of the Cobb–Douglas case. We use the codes described in Burnside (1999) to carry out the GMM estimation (see the appendix for details). Our codes are available upon request.

the estimated values of parameters presented in that article and our replication. As seen in the Table, we closely match the estimated values of parameters.⁷ The right part of the Table presents the main results. It first displays the properties of the data in the sample for which we have data on labor. Then it reports the results of the three variations we study. In all Tables we highlight in color the row reporting the volatility of consumption relative to output, and the row reporting the correlation between labor and output. These are the two statistics that we focus on.⁸

The first result is that the benchmark (Cobb-Douglas utility, estimating σ_g, σ_z and ρ_g , not using data on labor) implies a negative correlation between labor and output of -0.36, as can be seen towards the bottom of column 5. The benchmark has success predicting a volatility of consumption higher than the one of output, but does not have a good prediction regarding the correlation of labor with output. Its value in the data is 0.55. The success and failure of the benchmark are evidently related because of the functional form chosen for preferences. Notice that the volatility of growth shocks is much bigger than the one of transitory shocks. When a large negative growth shock hits the economy, there is a large negative income effect that reduces consumption and increases labor supply. In equilibrium firms end up hiring more labor despite its reduced marginal productivity while, at the same time, output falls.

The second result is that the benchmark, modified by adding to the list of moments the standard deviation of labor and the covariance between labor and output, predicts a much smaller negative labor correlation. In fact it is close to zero. This result says that using information on labor goes in the direction of reducing the gap between the data and the model. This can be seen on column 6. On the other hand, the volatility of consumption relative to the one of output falls slightly, which goes against matching the data.

These results indicate that a trade-off arises between a good fit of the benchmark model in terms of relative consumption volatility and labor dynamics: in order to match the procyclicality of labor the model requires relatively mild growth shocks. This can be analytically pinned down by studying the equilibrium in the labor market which can be

⁷We start with this simple replication simply to verify that our codes do indeed replicate AG's results.

⁸We present the other statistics for completeness; we very briefly comment some of them in parts of the paper.

characterized as follows (in log-deviations from the steady state):

$$\widehat{h}_t = (1 - H) (\widehat{y}_t - \widehat{c}_t)$$

where H is the steady state level of labor.⁹ It is thus straightforward from this equilibrium condition that the trade-off arises because, to the extent that growth shocks deliver a large deviation of consumption relative to output, these shocks will also deliver a negative response of equilibrium labor. This is the reason why the estimated model in column 6 continues to perform poorly in matching the procyclicality of Mexican labor as doing it would require reducing the close match in terms of consumption volatility.

Our third result is that modifying the benchmark by using a GHH utility as was done in Aguiar and Gopinath (2004) is not enough to simultaneously achieve a high volatility of consumption and a positive correlation between labor and employment. Results from this experiment are shown in column 7. The model does predict a volatility of consumption bigger than the one of output, but also predicts a negative correlation of labor and output. This is due to the inclusion of cumulative growth in the disutility of work, as we comment below.

Our fourth set of results comes from the combination of GHH utility and information on labor in the set of moments, which yields a positive correlation between labor and output, as in the data. Simultaneously, this specification predicts a volatility of consumption bigger than output's, although smaller than in previous estimations. Results are shown in column 8. The correlation takes a value of 0.30, and the ratio σ_c/σ_y is equal to 1.22. Evaluating the model along the dimension of simultaneously achieving a positive correlation of labor and high relative volatility of consumption, this version is the most successful of the four discussed. As before, results can be interpreted by studying the equilibrium in the labor market characterized as follows:

$$\widehat{h}_t = \frac{1}{v} \widehat{y}_t.$$

Unlike in the Cobb-Douglas case, consumption will no longer play a role in employment.

⁹In this equation, \widehat{y} represents the log-deviation of detrended output from the steady state, \widehat{c} is the log-deviation of detrended consumption from the steady state, and \widehat{h} is the log-deviation of labor from the steady state.

Thus, the initial response of labor following a (positive) growth shock will be positive, thereby reducing the trade-off between a good performance in the moments of labor or in the relative volatility of consumption. It should be noted, however, that the trade-off does not entirely disappear. Because of the inclusion of cumulative growth in the disutility of labor under the GHH case, a positive growth shock will reduce the labor supply after one period. This can be seen in the version of the previous equilibrium equation written in logs of the levels of the variables:

$$\ln Y_t = \ln \frac{\tau\nu}{\alpha} + \ln \Gamma_{t-1} + \nu \ln H_t.$$

The difference between y_t and Y_t is that the former is detrended by Γ_{t-1} . Provided that positive growth shocks are large and increase the disutility of labor in the next period, this effect could deliver a countercyclical equilibrium labor, as was the case in the previous estimation under GHH but without including moments of labor.¹⁰

Finally, we try one more specification. One concern with using the GHH function is that it goes to the extreme case of fully eliminating the income effect on labor supply. To address this concern we consider the type of utility introduced by Jaimovich and Rebelo (2009) (JR, henceforth):

$$\begin{aligned} u(C_t, H_t) &= \frac{(C_t - \tau H_t^\omega X_t)^{1-\sigma}}{1-\sigma}, \tau > 0 \\ X_t &= C_t^\omega X_{t-1}^{1-\omega}. \end{aligned}$$

The case $\omega = 1$ corresponds to utilities in the class consistent with steady state growth discussed by King, Plosser and Rebelo (1988). The case $\omega = 0$ corresponds to the utility in Greenwood, Hercowitz, and Huffman (1988). The JR utility is consistent with steady state growth with $0 < \omega \leq 1$.

We carry out the estimation with moments of labor. In this process we estimated the same parameters as in previous estimations, and additionally we estimated ω . We show

¹⁰We need to include productivity in the disutility of labor to have a constant amount of employment in the long run. On a different note, we point out that using a GHH utility does not have a big effect on the volatility of consumption. Comparing columns 5 and 7, and 6 and 8, we see that $\sigma(c)/\sigma(y)$ changes by small amounts across specifications, and remains close to the data. The relative volatility of consumption is lower with GHH utility. The same result appears in Aguiar and Gopinath (2004).

results in Table 3, where we compare our previous estimations using Cobb-Douglas and GHH using labor data, to the estimation carried out with the JR function. To facilitate the comparison to the estimation using the JR utility, we reproduce in columns (2) and (3) in this table the results in columns (6) and (8) in Table 2. The model predicts a relative volatility of consumption bigger than one. At the same time labor is highly procyclical, in fact more than in the data. The point estimate of ω is 0.2, denoting a relatively small income effect on labor supply.

In summary, while the benchmark model of AG is unable to reproduce qualitatively the procyclicality of labor in Mexico, it is shown here that it is possible to simultaneously achieve a positive correlation between labor and output and a volatility of consumption higher than the one of output, conditional on using a GHH utility *and* including information on labor in the GMM estimation of productivity parameters. Another specification that achieves both goals is using the JR utility and moments of labor. In fact the small estimated value of parameter ω favors the use of a GHH utility. Additionally, in the next-to-last row in columns 6 and 8 in Table 2, and in column 4 in Table 3, we follow AG and report the J-statistic proposed by Hansen (1982) to test overidentifying restrictions, i.e. number of orthogonality conditions exceeding the number of parameters. Note that the J-statistic is calculated only with the moments used in the estimation.¹¹ The models with Cobb-Douglas and GHH utility are not rejected, whereas the JR specification is. We reject the model if the p-value is 0.05 or less. The respective p-values are 0.18, 0.20 and 0.01. Together with the qualitative advantages of the model with GHH utility, this last result provides further support for it. Finally, in the last row in Tables 2 and 3 we measure the sum of squared residuals (SSR) between all data moments and all model-based moments. Given that this metric uses all moments reported in the tables, comparisons can be made across all columns. This measure of fit indicates that the model with GHH utility estimated with labor data has a better fit than the one with Cobb-Douglas utility. The model with JR utility has an even better fit, but as mentioned earlier is rejected. We turn now to studying the predictions of the model in terms of sudden stops, focusing our attention on labor dynamics.

¹¹See the Appendix for details on the calculation of the J-statistic.

5 Sudden stop experiments

We analyze the predictions of the model in times of sudden stops. Emerging economies have experienced important episodes in which they lose access to international financial markets. Our goal is to find the version of the model and estimation that has the best predictions regarding the behavior of variables during a sudden stop.

The methodology we follow includes defining a sudden stop and then simulating the model to obtain artificial episodes which we analyze. To carry out the simulations we use the estimated parameters found for Mexico. We define a sudden stop as in Mendoza (2010). A sudden stop is a period in which output is at least one standard deviation below trend, and the ratio of net exports to output is at least one standard deviation above trend. We carry out 1000 simulations, each one of the same length as the one of the data sample we use, which is 66 quarters. In Figure 1, we make plots of the HP-filter cyclical components of (the log of) output, labor and consumption during the identified a sudden stop episodes as well as in the three periods before and after it.¹² We plot the median across sudden stop episodes. Together with simulated data, we also plot data from the Mexican Crisis of 1994-1995. There was a large fall in output and consumption in 1995, together with a fall in labor. In the second quarter of 1995 Mexican GDP deviated -7.8% from the trend. This is the quarter in which HP-filtered GDP reached its trough. The standard deviation of the output gap for the entire sample is 2.3%.

The benchmark model predicts a fall in consumption and output, yet it also predicts an increase in equilibrium employment, a counterfactual result. This can be seen in the upper panel of Figure 1. These results are to be expected, given the sizeable income effect induced by a sudden stop driven by a large fall in the permanent component of productivity Γ_t .¹³

The benchmark model modified to use a GHH utility predicts a large fall in consumption, and output but only a minor fall in labor, less than one percent from trend, far from the one observed in the data which is close to 2.5 percent. We plot these results in the middle panel of Figure 1. There is a fall in the permanent component of productivity Γ_t ,

¹²The dynamics of the other macro variables are available upon request.

¹³For the sake of space, we do not report the dynamics of the two productivity processes. However, in all the simulations a sudden stop is reproduced when the stochastic productivity process significantly falls below trend following a growth shock, a result that was already found by AG.

which reduces consumption.

Finally, we evaluate the model in the case of a GHH utility and including data on labor in the estimation. The model predicts a large fall in consumption, and a larger fall in labor than in the previous experiment. In this case the fall in labor is larger than one percent, although still smaller than in the data. We show this in the lower panel of Figure 1. Evaluating the model along the dimensions of achieving a fall in labor of size closer to the data, as well as falls in output and consumption, this experiment has the biggest success replicating the behavior in the data. Thus the results found in the previous section when assessing business cycle moments extend to the case of sudden stop episodes.

6 Comparing Canada and Mexico

A central point in the analysis of AG is the sharp difference in the dynamics of some of the key macroeconomic time series across developed and emerging economies, which they characterize by studying more closely Canada and Mexico. As mentioned above, these differences served as the information set used in the GMM estimation when trying to pin down the persistence -the random walk component- in the productivity process in each of the two economies. A crucial finding of AG in their comparison is that, unlike for Canada, in Mexico shocks to trend predominate over transient shocks to productivity. This led AG to conclude that, for emerging economies, "the cycle is the trend".

Considering the evidence presented in the previous two sections, we now assess whether or not these differences between Canada and Mexico are robust when employment dynamics are incorporated into the analysis. Some of the questions that we seek to answer are: does one also observe sharp differences in the labor dynamics across Mexico and Canada? If so, can trend shocks also account for them? Is "the cycle is the trend" hypothesis robust to including labor dynamics into the information set?

To answer these questions we follow a simple strategy by extending our analysis to Canada, for which we carry out parallel estimations as the ones we did for Mexico. We then compare the characteristics of the productivity processes estimated for the two economies using the different functional forms and information sets we have thus far considered.

Our results are reported in Table 4. Again, the right part of this table presents results for the subsample for which we have data on Canadian labor statistics, 1981:I – 2002:I. An important observation comes from column 4, where it is immediate to notice that, beyond the relative lower volatility in most Canadian macro variables already documented by AG, the procyclicality of labor is much higher than in Mexico. While the output-labor correlation is only 0.55 in Mexico, it reaches 0.89 in Canada. Moreover, in Canada, employment is significantly more volatile, relative to output, compared to Mexico.

The first result comes from inspecting columns 5 through 8, particularly in the dimension of the procyclicality of labor. Differently from the Mexican case, in all estimations the correlation between labor and output is positive. The intuition behind this result can be easily explained. Because of the relatively small volatility in Canadian macro data, the GMM estimation identifies small trend shocks that do not go in conflict with procyclical labor, as was the case for Mexico. Thus the trade-off documented in the previous sections in the estimation of the model with Mexican data is more moderate now. It should be noticed, however, that the trade-off does not disappear. Adding moments of labor to the benchmark estimation mildly reduces the volatility of consumption and increases the correlation of labor and output. This can be seen by comparing columns 5 and 6 in Table 4. Notice also that the specification with GHH utility and using information on labor matches the relative volatility of consumption and produces the correlation between labor and output closest to the observed value. This can be seen by comparing columns 7 and 8.¹⁴

We now turn to discussing the differences in the persistence of the productivity processes across Mexico and Canada throughout the different estimations we perform. We do so by using the same metric used by AG: the magnitude of the random walk component (RWC) of productivity.¹⁵ AG found that it was nearly three times bigger for Mexico than for Canada and that it accounted for a volatility of consumption bigger than the one of output, as in

¹⁴The specification with GHH utility and using information on labor does not have a qualitative advantage over the other ones. The observed correlation between the trade balance and output is negative, while the predicted ones are positive. This however is mainly a consequence of the poor fit of investment volatility which we think could potentially be reduced by estimating the capital adjustment cost parameter in the model. Also, note that the model with Cobb-Douglas utility is not rejected using the J-statistic, whereas the model with GHH utility is. The respective p-values are 0.07 and 0.03. Finally, the GHH specifications do not have a better fit, as they have a bigger SSR than the Cobb-Douglas ones.

¹⁵We calculate the random walk component of productivity as in AG: $\frac{\alpha^2 \sigma_g^2 / (1 - \rho_g)^2}{[2 / (1 + \rho_z)] \sigma_z^2 + [\alpha^2 \sigma_g^2 / (1 - \rho_g^2)]}$.

Mexican data. This result holds across the specifications we have analyzed. The RWC reported in columns 5, 6, 7, and 8 in Table 2 all report a bigger RWC than the corresponding values found for Canada in Table 4. We also notice that when we estimate specifications for Mexico, using a GHH utility yields a much bigger RWC than using a Cobb-Douglas one, whether labor data are used in the estimation or not. This result comes from the fact that, when using GHH utility, the estimated value of the persistence of growth shocks, ρ_g , is bigger than when using Cobb-Douglas utility. In the case of GHH preferences and using labor moments, the case which we argue is the best specification for Mexico, the RWC is many times larger in Mexico than in Canada. Thus, up to this point, there is evidence that "the cycle is the trend" hypothesis is robust to including labor dynamics. We turn now to assess if this result holds when taking into account various measures of Mexican *formal* employment.

7 Measurement issues

We have thus far left aside a crucial topic in our analysis: to what extent do measurement issues in Mexican labor data make our results less reliable? As mentioned in the Introduction, AG make no claim of matching the observed labor dynamics in Mexico because of the measurement issues regarding the data on employment in emerging markets, although they do not provide further details regarding the nature of these issues.

In this last section we dig deeper into these measurement issues by focusing on two potential candidates. First, we assess the role of the informal economy given that the employment data used by AG to compute Mexican Solow residuals, that we also use, do not distinguish between labor allocated to the formal or informal sectors of the economy. Yet, to a large extent, GDP data measures valued added produced in the formal sector of the economy.¹⁶ To make the labor input more comparable to output we adjust the employment series used in our previous estimations. Taking into account the informal sector is important because it may serve as a buffer against large negative shocks to the economy thus

¹⁶The Mexican National Institute of Statistics (INEGI in Spanish) calculates a measurement of GDP produced by the informal sector (via a survey), and is part of total GDP. It represents a small fraction, approximately 12% since this measurement started. The characteristics of these data in terms of starting date and frequency impede a straightforward calculation of a time series of formal sector GDP. See INEGI (2006).

reducing the procyclicality of total employment. The idea that labor is mobile across formal and informal sectors in developing countries has been supported by evidence in Pratap and Quintin (2006) for Argentina, and Bosch and Maloney (2008) for Mexico and Brazil. These last authors report that informal employment is countercyclical and formal employment is procyclical. Additionally, a second issue we study is the one voiced by Neumeyer and Perri (2005), who mention that labor in Argentina has low volatility because employment in the public sector is used as unemployment insurance.

To address the first issue, we gather data aimed at calculating time series for employment in the formal sector of the economy. All data come from the National Survey of Urban Employment (ENEU in Spanish). Because the ENEU does not include any definition of "formal" employment, we construct alternative series for employment allocated to the informal sector and, after seasonally adjusting them, we subtract them from total employment. We are guided by the literature when constructing the following three measures. Formal employment 1 (FE1) is total employment minus employment in establishments with 1 to 5 employees; formal employment 2 (FE2) is total employment minus employees without benefits provided by the labor legislation; formal employment 3 (FE3) is total employment minus wage earners who do not receive benefits provided by the labor legislation.¹⁷ The first measure of formal employment is suggested by evidence that establishments in the informal sector are small. Amaral and Quintin (2006) report data for Argentina. They define formal workers as those receiving pensions and unemployment insurance benefits. These authors find that establishments with a small number of employees account for a significantly higher fraction of employment in the informal sector than in the formal one. The second measure is similar to one used by Pratap and Quintin (2006). So is the third measure.

To address the second measurement issue we calculate total employment net of employment in the government sector. The ENEU reports the distribution of employment by sectors of economic activity, one of them being the government sector. Again, we obtain the series for employment in the government sector, adjust it for seasonality, and subtract

¹⁷Benefits refer to those provided by employers or social security institutions due to the labor market legislation. One difference between FE2 and FE3 is that some individuals employed, who do not receive benefits, may not receive a wage. For example, this would be the case of relatives who work without a monetary compensation for the head of a household.

if from total employment. If the phenomenon described by Neumeyer and Perri (2005) for Argentina is similar in Mexico, then we should observe that the constructed series are more volatile and more correlated with output.

We report in Table 5 a comparison of the properties of the four series of employment previously discussed. We calculate the HP-cyclical component of each one and report their standard deviations relative to the one of the cyclical component of GDP, as well as the correlation with cyclical GDP. We also report the size of each one of the four series relative to total employment. For comparison purposes we also include these statistics for total employment in Canada.

Table 5 unambiguously points out to formal employment in Mexico being more volatile and procyclical than total employment. The three measures of formal employment are much more in line with those of Canada and are consistent with the above mentioned hypothesis that the informal sector serves as a buffer against negative aggregate shocks. Regarding non-government employment, we see that its dynamics are virtually identical to those of total employment, suggesting that the concern in Neumeyer and Perri (2005) is not an issue for Mexico: employment in the government sector does not seem to be used as a buffer against shocks.

The observations pertaining to the cyclicity of formal labor pose a challenge for "the cycle is the trend" hypothesis when assessed using formal employment data because the documented trade-off between matching consumption and labor increases. Indeed, when using the alternative measures of formal employment the model would have to match now a higher procyclicality of labor while at the same time reproducing the large volatility of consumption. As we documented above, a good match of the former would assign a relatively modest role to trend shocks while a good match of the latter would go in the opposite direction.

To formally explore this we estimate the specification that uses GHH preferences using our four alternative measures of labor. Results are reported in Table 6. For convenience we reproduce results from column 8 in Table 2, in column 2 of Table 6. First, note that estimations that use FE1, FE2 and FE3 predict higher correlations between labor and output than previously. The model is trying to match the fact that the correlation takes higher values

for each one of the measures of formal employment. Second, note that the estimations predict a volatility of consumption lower than the one of output. Confronted by the documented trade-off, the estimation gives more weight to matching the now higher procyclicality of labor thereby reducing the role of trend shocks. This explains the large reductions of the RWC. Third, this increased tension between matching the volatility of consumption and the correlation of labor reduced the overall performance of the model as documented by the two statistics at the bottom of Table 6. The model is rejected when estimated using FE1, FE2 and FE3, whereas it was not rejected when using total employment.¹⁸ Additionally, the SSR is bigger than in the specification that uses formal employment. Fourth, note that the estimation carried out with non-government employment, yields basically the same results as the specification that uses total employment. This is due to the fact that total employment and non-government employment have basically the same statistical properties.¹⁹

Summing up, our results suggest that measurement issues in Mexican labor data are indeed relevant through the effect of informality in reducing the procyclicality of total employment. This poses a challenge to "the cycle is the trend" hypothesis because trend shocks can no longer account for the large volatility of consumption and the strong procyclicality of formal labor.

8 Conclusion

In this paper we find specifications under which the model of AG can reproduce qualitatively the procyclicality of labor in Mexico. Using GHH preferences *and* explicitly taking into consideration labor dynamics in the estimation allows the model to account for *both* the large volatility in consumption and the mild procyclicality of labor in Mexico. We evaluate the performance of that specification regarding sudden stops, and find that it has the biggest success replicating the behavior in the data. We also find that when estimated with Canadian data, the modified model continues to favor the hypothesis that trend shocks are

¹⁸The respective p-values for the specifications with formal employment are 0.03, 0.04, and 0.04.

¹⁹We used GDP data to carry out the estimations with non-government employment. To be more precise we could have used data on GDP net of government spending. However, the moments $\sigma(y)$ and $cov(y, c)$ take practically the same values for GDP and GDP net of government spending.

more important in Mexico than in Canada. Digging deeper into the measurement issues surrounding employment data in emerging economies we find that the main difference between labor statistics in Mexico and Canada comes from the large informal labor in Mexico. It is in this dimension, when trying to match the dynamics of formal employment, that we find less support for trend shocks as being the major driving force of business cycles in emerging economies. The model faces a stronger tension between replicating the volatility of consumption and the high cyclicalilty of formal labor, becoming unable to match both simultaneously.

We have scratched the surface of a deeper topic in emerging market business cycle research: the role of the informal sector, both in terms of how it affects statistics and how to include it in a dynamic model. In general, we think that a particularly interesting avenue for research could be to embed with richer labor markets the current vintage of emerging market business cycle models. Two interesting examples of recent research in this direction are Boz, Durdu and Li (2009), and Lama and Urrutia (2011), who embed matching frictions of the Mortensen-Pissarides type in the labor market of an emerging economy. Also, Meza and Quintin (2007) analyze a small open economy model that is extended to include labor hoarding, which could also produce less volatile labor. At the very least, we have made the case that future research on emerging markets ought to include labor data into the analysis.

9 Technical Appendix

To carry out the GMM estimation we follow Burnside (1999). We first define the 3x1 vector of structural parameters to be estimated, $\theta = \{\sigma_g, \sigma_z, \rho_g\}$. Then, in the benchmark AG specification, we write the moment conditions as

$$m_t(\theta) = \begin{bmatrix} \sigma_y^2(\theta) - y_t^2 \\ \sigma_c^2(\theta) - c_t^2 \\ \rho_{y,c}(\theta) - \frac{y_t c_t}{\sigma_y(\theta)\sigma_c(\theta)} \end{bmatrix}$$

where $\sigma_x(\theta)$ and $\rho_{y,c}(\theta)$ denote, respectively, the standard deviation of variable x and the correlation between variables x and y implied by the theoretical model. Variables x and y

are the cyclical components of the variables, computed using the Hodrick-Prescott filter.

We then define $Q(\theta, W, T)$ as

$$Q(\theta, W, T) = \left[\frac{1}{T} \sum_{t=1}^T m_t(\theta) \right]' W \left[\frac{1}{T} \sum_{t=1}^T m_t(\theta) \right]$$

and the GMM estimate of θ , denoted $\hat{\theta}$, is given by:

$$\hat{\theta} = \arg \min_{\theta} Q(\theta, W, T)$$

where W is a compatible symmetric positive definite matrix estimated in two steps (see Burnside (1999) for more details) and T is the empirical sample size. The statistic called in the text J-statistic is equal to $T * Q(\hat{\theta}, W, T)$.

Note that in the cases where we add labor moments to the AG specification the new moment conditions are:

$$m_t(\theta) = \begin{bmatrix} \sigma_y^2(\theta) - y_t^2 \\ \sigma_c^2(\theta) - c_t^2 \\ \rho_{y,c}(\theta) - \frac{y_t c_t}{\sigma_y(\theta) \sigma_c(\theta)} \\ \sigma_h^2(\theta) - h_t^2 \\ \rho_{y,h}(\theta) - \frac{y_t h_t}{\sigma_y(\theta) \sigma_h(\theta)} \end{bmatrix}$$

where h denotes now the cyclical component of employment. In the JR case the parameter vector is now a 4x1 vector $\theta = \{\sigma_g, \sigma_z, \rho_g, \omega\}$.

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Table 1. Calibrated parameters

	Symbol	Cobb-Douglas utility ¹	GHH utility ²	Jaimovich-Rebelo utility (JR) ³
Time preference rate	β	0.98	0.98	0.98
Labor exponent (utility)	ν	NR	1.6	NR
Labor coefficient (utility)	τ	NR	1.4	2.7
Consumption exponent (utility)	γ	0.36	NR	NR
Steady-state debt to GDP	b	10%	10%	10%
Coefficient on interest rate premium	ψ	0.001	0.001	0.001
Labor exponent (production)	α	0.68	0.68	0.68
Risk aversion	σ	2	2	2
Depreciation rate	δ	0.05	0.05	0.05
Capital adjustment cost	φ	4	4	4
Exponent in JR utility	ω	NR	NR	0.2036

1 Values taken from Aguiar and Gopinath (2007), Table 3. NR stands for not required.

2 Values taken from Aguiar and Gopinath (2004), Table 3, except the one for φ . In Aguiar and Gopinath (2004) it was estimated. We use the same value as in Aguiar and Gopinath (2007), in Table 3. Also, for the depreciation rate we use the same value as in Aguiar and Gopinath (2007), Table 3. NR stands for not required.

3 We set most parameters equal to their values in previous calibrations. The exceptions are the labor coefficient in utility τ , and the exponent in JR utility ω . For the first one, we use first order conditions evaluated at the steady state to calibrate it. We estimate the second one as reported in Table 3.

Table 2. Mexico: data, estimated parameters and predicted moments

	Using entire sample (1980:I – 2003:II) Using Cobb-Douglas utility Moments used in estimation: $\sigma(y), \sigma(c), \text{cov}(y,c)^1$			Using subsample for which we have labor data (1987:I – 2003:II)				
	(1)	(2) AG(2007) ³	(3) Replication	(4)	(5) AG specification	(6) Adding $\sigma(h)$, $\text{cov}(y,h)$ in GMM	(7) AG specification	(8) Adding $\sigma(h)$, $\text{cov}(y,h)$ in GMM
Estimated Parameters ²								
σ_g		2.55 (0.52)	2.55 (0.50)		2.48 (0.67)	1.36 (0.36)	1.00 (0.27)	0.47 (0.06)
σ_z		0.54 (0.22)	0.53 (0.23)		0.37 (0.44)	0.26 (0.47)	0.00 (86834.06)	0.48 (0.09)
ρ_g		0.11 (0.10)	0.1093 (0.10)		0.1461 (0.13)	0.3611 (0.08)	0.8072 (0.04)	0.8989 (0.02)
RWC		1.1356	1.14 (0.29)		1.28 (0.44)	1.99 (0.77)	9.37 (2.94)	12.94 (2.52)
Population and model based moments								
Population moments	Mexican Data			Mexican Data				
$\sigma(y)$	2.40 (0.34)	2.41	2.40 (0.34)	2.32 (0.49)	2.32 (0.49)	1.67 (0.43)	2.47 (0.46)	1.91 (0.25)
$\sigma(\Delta y)$	1.64 (0.21)	1.56	1.56 (0.38)	1.61 (0.29)	1.43 (0.52)	0.91 (0.33)	1.47 (0.34)	1.27 (0.18)
$\sigma(c)/\sigma(y)$	1.26 (0.08)	1.2611	1.26 (0.08)	1.31 (0.11)	1.31 (0.11)	1.29 (0.13)	1.27 (0.09)	1.22 (0.05)
$\sigma(l)/\sigma(y)$	4.15 (0.28)	2.6629	2.67 (0.14)	3.80 (0.22)	2.75 (0.19)	2.76 (0.19)	3.27 (0.26)	3.11 (0.12)
$\sigma(nx)/\sigma(y)$	0.90 (0.09)	0.7854	0.79 (0.13)	0.79 (0.07)	0.85 (0.19)	1.08 (0.22)	0.97 (0.16)	1.07 (0.09)
$\sigma(h)/\sigma(y)$	NA	NA	NA	0.42 (0.05)	0.38 (0.09)	0.54 (0.10)	0.48 (0.06)	0.47 (0.02)
$\rho(y)$	0.83 (0.07)	0.8303	0.83 (0.05)	0.82 (0.11)	0.85 (0.07)	0.90 (0.04)	0.90 (0.04)	0.87 (0.01)
$\rho(\Delta y)$	0.37 (0.09)	0.3069	0.31 (0.22)	0.44 (0.10)	0.42 (0.34)	0.64 (0.30)	0.53 (0.21)	0.45 (0.07)
$\rho(y, nx)$	-0.75 (0.08)	-0.5484	-0.55 (0.07)	-0.83 (0.08)	-0.56 (0.09)	-0.21 (0.07)	-0.46 (0.07)	-0.22 (0.03)
$\rho(y, c)$	0.92 (0.02)	0.9152	0.92 (0.02)	0.92 (0.03)	0.92 (0.03)	0.78 (0.05)	0.91 (0.03)	0.82 (0.03)
$\rho(y, l)$	0.91 (0.03)	0.8881	0.89 (0.05)	0.95 (0.02)	0.87 (0.07)	0.71 (0.10)	0.76 (0.06)	0.67 (0.03)
$\rho(y, h)$	NA	NA	NA	0.55 (0.13)	-0.36 (0.10)	-0.02 (0.08)	-0.34 (0.37)	0.30 (0.12)
J-statistic ⁴						3.3967 (0.18)		3.2363 (0.20)
SSR			0.2394		3.0970	3.6259	3.6217	1.3433

1 Notation $\sigma(x)$, $\text{cov}(x,y)$, $\rho(x)$, $\rho(x,y)$, Δx stand for standard deviation of a variable x , covariance between variables x and y , autocorrelation of x , correlation between x and y , and change in variable x , respectively. Variables y , c , l , nx , h stand for output, consumption, investment, net exports-to-output ratio and labor, respectively. All variables are in logarithms, except for net export share. All variables have been HP-filtered, except the change in output. Values of standard deviations are reported in percent. NA stands for not available.

2 Parameters σ_g , σ_z , and ρ_g are defined in the text. RWC stands for the random walk component of productivity. Standard errors are in parentheses.

3 AG stands for Aguiar and Gopinath (2007). Aguiar and Gopinath (2007) do not report the model-based moments for this particular case. However, one is able to recover them by extending their codes in a straightforward manner.

4 J-statistic proposed by Hansen (1982) to test overidentifying restrictions (number of orthogonality conditions exceeding number of parameters). The p-values are shown in parentheses. SSR is the sum of squared residuals between all data moments and all model-based moments, not only those used in the estimation.

Table 3. Mexico: comparison between Cobb-Douglas, GHH and Jaimovich-Rebelo (JR) utilities

	Using subsample for which we have labor data (1987:I – 2003:II) Moments used in estimation: $\sigma(y)$, $\sigma(c)$, $\text{cov}(y,c)$, $\sigma(h)$, $\text{cov}(y,h)$ ¹			
Estimated Parameters ²	(1)	(2) Cobb-Douglas	(3) GHH	(4) JR
σ_g		1.36 (0.36)	0.47 (0.06)	1.13 (0.26)
σ_z		0.26 (0.47)	0.48 (0.09)	0.00 (81615.41)
ρ_g		0.3611 (0.08)	0.8989 (0.02)	0.6324 (0.07)
ω^3				0.2036 (0.05)
RWC		1.99 (0.77)	12.94 (2.52)	4.44 (2.65)
Population Moments	Mexican Data			
$\sigma(y)$	2.32 (0.49)	1.67 (0.43)	1.91 (0.25)	2.71 (0.40)
$\sigma(\Delta y)$	1.61 (0.29)	0.91 (0.33)	1.27 (0.18)	1.37 (0.28)
$\sigma(c)/\sigma(y)$	1.31 (0.11)	1.29 (0.13)	1.22 (0.05)	1.13 (0.06)
$\sigma(l)/\sigma(y)$	3.80 (0.22)	2.76 (0.19)	3.11 (0.12)	2.67 (0.20)
$\sigma(nx)/\sigma(y)$	0.79 (0.07)	1.08 (0.22)	1.07 (0.09)	0.75 (0.13)
$\sigma(h)/\sigma(y)$	0.42 (0.05)	0.54 (0.10)	0.47 (0.02)	0.31 (0.02)
$\rho(y)$	0.82 (0.11)	0.90 (0.04)	0.87 (0.01)	0.91 (0.06)
$\rho(\Delta y)$	0.44 (0.10)	0.64 (0.30)	0.45 (0.07)	0.66 (0.42)
$\rho(y,nx)$	-0.83 (0.08)	-0.21 (0.07)	-0.22 (0.03)	-0.36 (0.08)
$\rho(y,c)$	0.92 (0.03)	0.78 (0.05)	0.82 (0.03)	0.92 (0.03)
$\rho(y,l)$	0.95 (0.02)	0.71 (0.10)	0.67 (0.03)	0.79 (0.07)
$\rho(y,h)$	0.55 (0.13)	-0.02 (0.08)	0.30 (0.12)	0.79 (0.07)
J-statistic ⁴		3.3967 (0.18)	3.2363 (0.20)	6.3169 (0.01)
SSR		3.6259	1.3433	0.9994

1 To facilitate the comparison to the estimation using the JR utility, we reproduce in columns (2) and (3) in this table the results from columns (6) and (8) in Table 2. Notation $\sigma(x)$, $\text{cov}(x,y)$, $\rho(x)$, $\rho(x,y)$, Δx stand for standard deviation of a variable x , covariance between variables x and y , autocorrelation of x , correlation between x and y , and change in variable x , respectively. Variables y , c , l , nx , h stand for output, consumption, investment, net exports and labor, respectively. All variables are in logarithms, except for net exports. All variables have been HP-filtered, except the change in output. Values of standard deviations are reported in percent. NA stands for not available.

2 Parameters σ_g , σ_z , and ρ_g are defined in the text. RWC stands for the random walk component of productivity. Standard errors are in parentheses.

3 This is a parameter in the JR utility function, taking values between zero and one.

4 J-statistic proposed by Hansen (1982) to test overidentifying restrictions (number of orthogonality conditions exceeding number of parameters). The p-values are shown in parentheses. SSR is the sum of squared residuals between all data moments and all model-based moments, not only those used in the estimation.

Table 4. Canada: data, estimated parameters and predicted moments

	Using entire sample (1981:I – 2003:II) Using Cobb-Douglas utility Moments used in estimation: $\sigma(y), \sigma(c), \text{cov}(y,c)^1$			Using subsample for which we have labor data (1981:I – 2002:I)				
					Using Cobb-Douglas utility		Using GHH utility	
Estimated Parameters ²	(1)	(2) AG(2007) ³	(3) Replication	(4)	(5) AG specification	(6) Adding $\sigma(h)$, $\text{cov}(y,h)$ in GMM	(7) AG specification	(8) Adding $\sigma(h)$, $\text{cov}(y,h)$ in GMM
σ_g		0.87 (0.61)	0.88 (0.60)		1.27 (0.68)	0.19 (0.07)	1.82 (0.43)	0.77 (0.13)
σ_z		0.78 (0.08)	0.78 (0.08)		0.74 (0.31)	0.66 (0.08)	0.00 (55594.75)	0.59 (0.08)
ρ_g		0.03 (0.54)	0.0230 (0.53)		-0.3607 (0.81)	0.7848 (0.06)	-0.3280 (0.08)	-0.6698 (0.13)
RWC		0.3818	0.38 (0.13)		0.29 (0.25)	0.71 (0.19)	0.51 (0.15)	0.11 (0.06)
Population and model based moments								
Population moments	Canadian Data			Canadian Data				
$\sigma(y)$	1.55 (0.20)	1.55	1.55 (0.20)	1.58 (0.20)	1.58 (0.20)	1.33 (0.16)	1.94 (0.16)	1.74 (0.16)
$\sigma(\Delta y)$	1.04 (0.08)	1.14	1.14 (0.29)	1.06 (0.08)	1.43 (0.86)	0.95 (0.11)	3.03 (0.52)	2.11 (0.21)
$\sigma(c)/\sigma(y)$	0.74 (0.05)	0.7441	0.74 (0.05)	0.75 (0.05)	0.75 (0.05)	0.69 (0.06)	0.78 (0.03)	0.75 (0.01)
$\sigma(l)/\sigma(y)$	2.67 (0.26)	2.0108	2.01 (0.06)	2.68 (0.26)	1.93 (0.32)	1.87 (0.09)	1.25 (0.53)	1.70 (0.07)
$\sigma(nx)/\sigma(y)$	0.57 (0.09)	0.4217	0.42 (0.13)	0.53 (0.08)	0.41 (0.20)	0.83 (0.08)	0.47 (0.11)	0.34 (0.03)
$\sigma(h)/\sigma(y)$	NA	NA	NA	0.73 (0.04)	0.33 (0.05)	0.57 (0.03)	0.92 (0.13)	0.75 (0.02)
$\rho(y)$	0.93 (0.05)	0.7546	0.75 (0.08)	0.93 (0.05)	0.61 (0.59)	0.77 (0.01)	-0.21 (0.52)	0.29 (0.09)
$\rho(\Delta y)$	0.74 (0.07)	0.0484	0.05 (0.19)	0.73 (0.07)	-0.25 (0.98)	0.07 (0.02)	-0.64 (0.08)	-0.62 (0.07)
$\rho(y, nx)$	-0.12 (0.18)	0.1705	0.17 (0.13)	-0.21 (0.18)	0.19 (0.33)	0.49 (0.05)	0.54 (0.21)	0.38 (0.07)
$\rho(y, c)$	0.87 (0.05)	0.8672	0.87 (0.05)	0.88 (0.05)	0.88 (0.05)	0.54 (0.05)	0.95 (0.03)	0.98 (0.00)
$\rho(y, l)$	0.74 (0.08)	0.9341	0.94 (0.05)	0.74 (0.08)	0.93 (0.13)	0.72 (0.06)	0.61 (0.24)	0.80 (0.04)
$\rho(y, h)$	NA	NA	NA	0.89 (0.04)	0.69 (0.06)	0.74 (0.05)	0.73 (0.10)	0.93 (0.02)
J-statistic ⁴						5.4443 (0.07)		7.3655 (0.03)
SSR			7.2778		7.1092	12.9563	27.3813	15.8127

1 Notation $\sigma(x)$, $\text{cov}(x,y)$, $\rho(x)$, $\rho(x,y)$, Δx stand for standard deviation of a variable x , covariance between variables x and y , autocorrelation of x , correlation between x and y , and change in variable x , respectively. Variables y , c , l , nx , h stand for output, consumption, investment, net exports and labor, respectively. All variables are in logarithms, except for net exports. All variables have been HP-filtered, except the change in output. Values of standard deviations are reported in percent. NA stands for not available.

2 Parameters σ_g , σ_z , and ρ_g are defined in the text. RWC stands for the random walk component of productivity. Standard errors are in parentheses.

3 AG stands for Aguiar and Gopinath (2007). Aguiar and Gopinath (2007) do not report the model-based moments for this particular case. One is able to recover them by modifying their codes.

4 J-statistic proposed by Hansen (1982) to test overidentifying restrictions (number of orthogonality conditions exceeding number of parameters). The p-values are shown in parentheses. SSR is the sum of squared residuals between all data moments and all model-based moments, not only those used in the estimation.

Table 5. Statistics of alternative series of employment in Mexico

	Relative volatility compared to GDP ¹ $\sigma(h)/\sigma(y)$	Correlation with GDP $\rho(y,h)$	Fraction of total employment, in %
Total employment	0.43	0.53	100
Formal employment 1 ²	0.79	0.84	58
Formal employment 2	0.93	0.84	54
Formal employment 3	1.08	0.64	77
Net of government sector	0.44	0.55	94
Canadian total employment	0.73	0.89	100

1 Notation $\sigma(x)$ and $\rho(x,y)$ stand for standard deviation of a variable x and correlation between variables x and y . Variables y and h stand for output and labor, respectively. All variables are in logarithms. All variables have been HP-filtered.

2 Formal employment 1 is total employment minus employment in establishments with 1 to 5 employees; formal employment 2 is total employment minus employees without benefits provided by the labor legislation; formal employment 3 is total employment minus wage earners who do not receive benefits provided by the labor legislation. Net of government sector is total employment minus government employment. Source of the raw data: Encuesta Nacional de Empleo Urbano (ENEU), Instituto Nacional de Estadística, Geografía e Informática (INEGI).

Table 6. Comparing estimations with different measures of formal employment, and non-government employment, in Mexico

Using subsample for which we have labor data (1987:I – 2003:II)										
Moments used in all estimations: $\sigma(y)$, $\sigma(c)$, $\text{cov}(y,c)$ ¹										
	GHH utility with total employment		GHH utility with Formal Employment 1		GHH utility with Formal Employment 2		GHH utility with Formal Employment 3		GHH utility with Non-government employment	
Estimated Parameters ²	(1)	(2) Adding sd(h), cov(y,h) in GMM	(3)	(4) Adding sd(h), cov(y,h) in GMM	(5)	(6) Adding sd(h), cov(y,h) in GMM	(7)	(8) Adding $\sigma(h)$, cov(y,h) in GMM	(9)	(10) Adding $\sigma(h)$, cov(y,h) in GMM
σ_g		0.47 (0.06)		1.45 (0.25)		2.13 (0.19)		2.54 (0.39)		0.47 (0.05)
σ_z		0.48 (0.09)		0.67 (0.13)		0.00 (2844.9)		0.00 (11999)		0.47 (0.11)
ρ_g		0.90 (0.02)		0.36 (0.20)		0.05 (0.17)		0.07 (0.16)		0.90 (0.02)
RWC		12.94 (2.52)		1.50 (0.48)		1.09 (0.23)		1.14 (0.17)		13.23 (2.76)
Population moments	Mexican Data		Mexican Data		Mexican Data		Mexican Data		Mexican Data	
$\sigma(y)$	2.32 (0.49)	1.91 (0.25)	2.32 (0.49)	2.40 (0.23)	2.32 (0.49)	2.26 (0.35)	2.32 (0.49)	2.71 (0.42)	2.32 (0.49)	1.90 (0.26)
$\sigma(\Delta y)$	1.61 (0.29)	1.27 (0.18)	1.61 (0.29)	2.12 (0.21)	1.61 (0.29)	2.87 (0.26)	1.61 (0.29)	3.39 (0.49)	1.61 (0.29)	1.26 (0.19)
$\sigma(c)/\sigma(y)$	1.31 (0.11)	1.22 (0.05)	1.31 (0.11)	0.96 (0.04)	1.31 (0.11)	0.93 (0.04)	1.31 (0.11)	0.94 (0.02)	1.31 (0.11)	1.23 (0.06)
$\sigma(l)/\sigma(y)$	3.80 (0.22)	3.11 (0.12)	3.80 (0.22)	2.17 (0.19)	3.80 (0.22)	1.77 (0.33)	3.80 (0.22)	1.80 (0.33)	3.80 (0.22)	3.13 (0.14)
$\sigma(nx)/\sigma(y)$	0.79 (0.07)	1.07 (0.09)	0.79 (0.07)	0.30 (0.04)	0.79 (0.07)	0.38 (0.08)	0.79 (0.07)	0.37 (0.09)	0.79 (0.07)	1.08 (0.10)
$\sigma(h)/\sigma(y)$	0.42 (0.05)	0.47 (0.02)	0.79 (0.07)	0.72 (0.06)	0.93 (0.10)	0.87 (0.10)	1.07 (0.24)	0.87 (0.12)	0.43 (0.06)	0.47 (0.03)
$\rho(y)$	0.82 (0.11)	0.87 (0.01)	0.82 (0.11)	0.64 (0.13)	0.82 (0.11)	0.21 (0.35)	0.82 (0.11)	0.23 (0.39)	0.82 (0.11)	0.87 (0.02)
$\rho(\Delta y)$	0.44 (0.10)	0.45 (0.07)	0.44 (0.10)	-0.11 (0.15)	0.44 (0.10)	-0.42 (0.15)	0.44 (0.10)	-0.40 (0.17)	0.44 (0.10)	0.46 (0.08)
$\rho(y,nx)$	-0.83 (0.08)	-0.22 (0.03)	-0.83 (0.08)	-0.62 (0.16)	-0.83 (0.08)	-0.09 (0.40)	-0.83 (0.08)	-0.14 (0.39)	-0.83 (0.08)	-0.22 (0.03)
$\rho(y,c)$	0.92 (0.03)	0.82 (0.03)	0.92 (0.03)	0.98 (0.00)	0.92 (0.03)	0.97 (0.02)	0.92 (0.03)	0.97 (0.02)	0.92 (0.03)	0.82 (0.03)
$\rho(y,l)$	0.95 (0.02)	0.67 (0.03)	0.95 (0.02)	0.96 (0.01)	0.95 (0.02)	0.85 (0.12)	0.95 (0.02)	0.86 (0.12)	0.95 (0.02)	0.67 (0.03)
$\rho(y,h)$	0.55 (0.13)	0.30 (0.12)	0.85 (0.05)	0.51 (0.07)	0.86 (0.05)	0.49 (0.06)	0.66 (0.05)	0.47 (0.04)	0.57 (0.13)	0.28 (0.14)
J-statistic ⁴		3.2363 (0.20)		6.8792 (0.03)		6.3377 (0.04)		6.3781 (0.04)		3.1240 (0.21)
SSR		1.3433		3.0410		8.9733		9.3630		1.4324

1 To facilitate the comparison to the estimation using the GHH utility, we reproduce in column (2) in this table the result from column (8) in Table 2. Notation $\sigma(x)$, $\text{cov}(x,y)$, $\rho(x)$, $\rho(x,y)$, Δx stand for standard deviation of a variable x , covariance between variables x and y , autocorrelation of x , correlation between x and y , and change in variable x , respectively. Variables y , c , l , nx , h stand for output, consumption, investment, net exports and labor, respectively. All variables are in logarithms, except for net exports. All variables have been HP-filtered, except the change in output. Values of standard deviations are reported in percent. NA stands for not available.

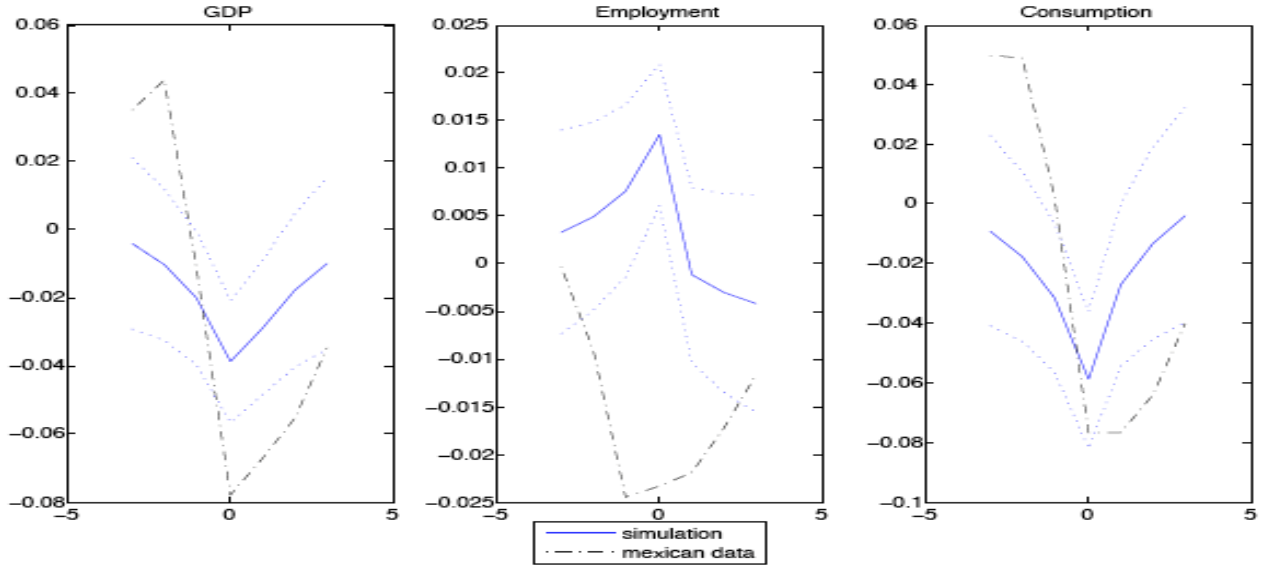
2 Parameters σ_g , σ_z , and ρ_g are defined in the text. RWC stands for the random walk component of productivity. Standard errors are in parentheses.

3 AG stands for Aguiar and Gopinath (2007). Aguiar and Gopinath (2007) do not report the model-based moments for this particular case. One is able to recover them by modifying their codes.

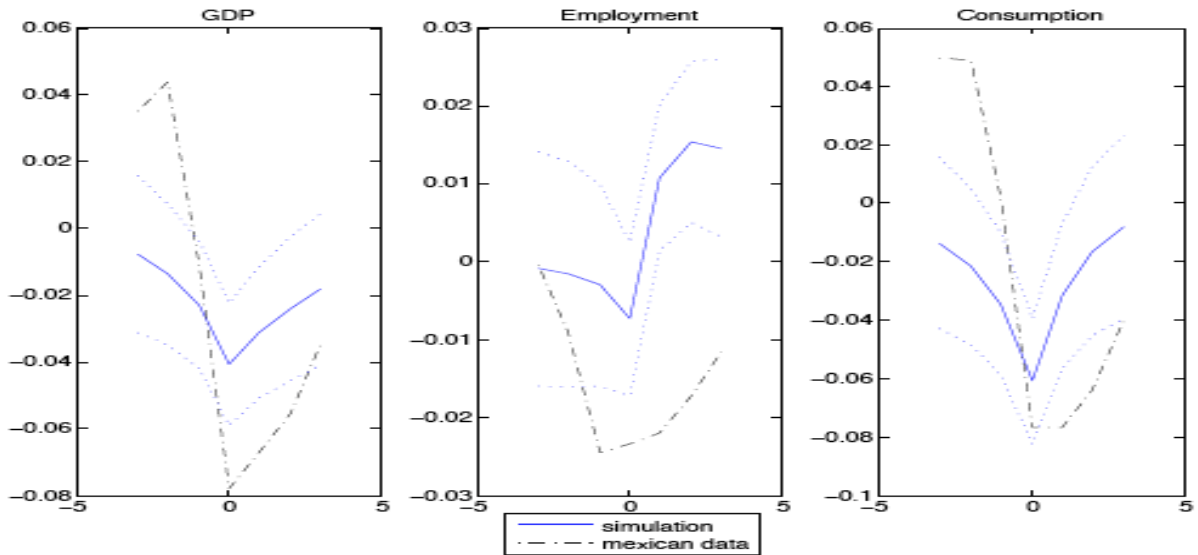
4 J-statistic proposed by Hansen (1982) to test overidentifying restrictions (number of orthogonality conditions exceeding number of parameters). The p-values are shown in parentheses. SSR is the sum of squared residuals between all data moments and all model-based moments, not only those used in the estimation.

Figure 1. Sudden stop events: data and predictions (continued on next page)

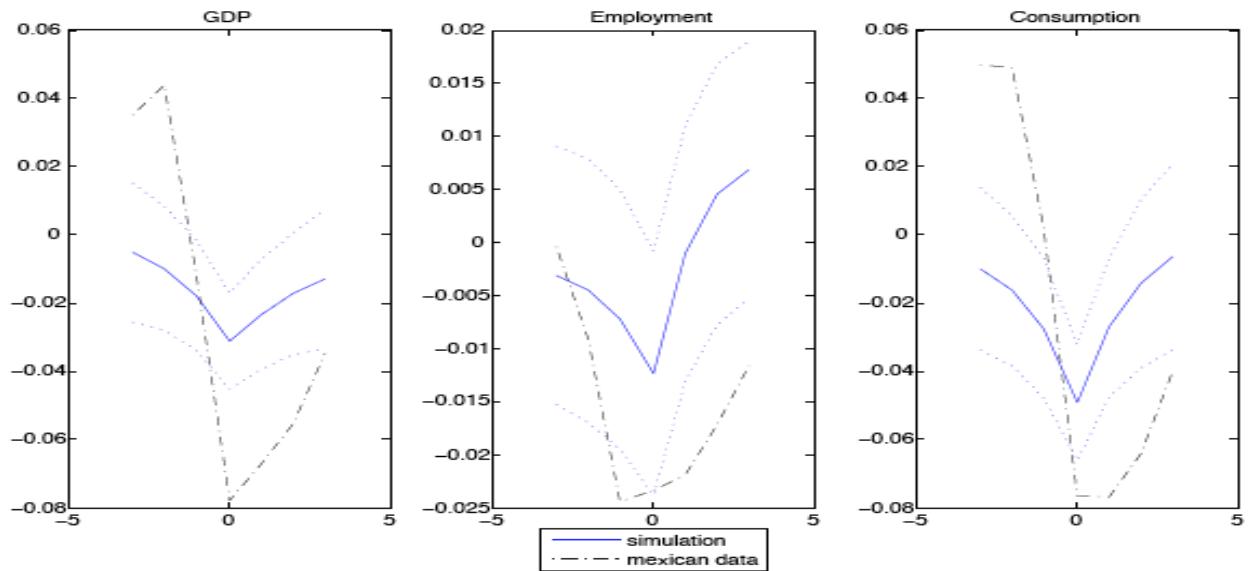
A. Model with Cobb-Douglas utility and GMM estimation excluding moments of labor



B. Model with GHH utility and GMM estimation excluding moments of labor



C. Model with GHH utility and GMM estimation including moments of labor



Note:

The timing for the Mexican sudden stop episode (i.e. $t=0$) is 1995:II. The figures depict the evolution of macroeconomic time series in the vicinity of this episode, three quarters before and after. We carry out 1000 simulations, each one of the same length as the one of the data sample we use, which is 66 quarters. We plot the median across sudden stop episodes. Predictions are presented together with error bands. Error bands are computed as plus/minus one and a half standard deviations.