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Saving Rates in Latin America: A Neoclassical Perspective*

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Abstract

This paper examines the time path of saving rates between 1970 and 2010 in Chile, Colombia, and Mexico through the lens of the neoclassical growth model. The findings indicate that two factors, the growth rate of TFP and fiscal policy, are able to account for some of the major fluctuations in saving rates observed during this period. In particular, we find that the model accounts for the low saving rates in Chile compared to Colombia until the late 1980s and the reversal in the saving rates thereafter. Also, a combination of high TFP growth and tax reforms that substantially reduced capital taxation seems to be responsible for the impressive increase in Chile's saving rate in mid 1980s.

Keywords

Total factor productivity, Saving rate, Latin America.

JEL Classification Numbers

E21, O47

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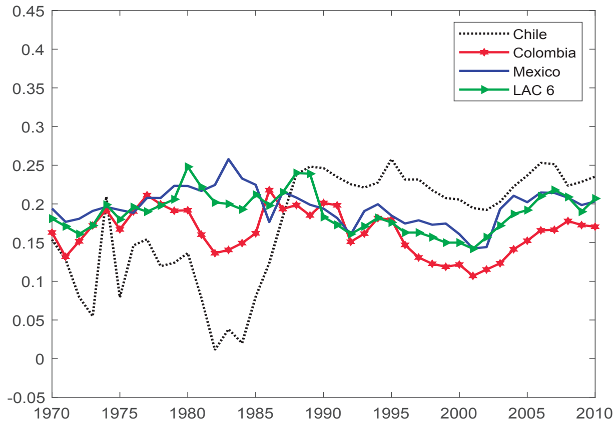
1 Introduction

This paper examines the time path of saving rates in three Latin American countries–Chile, Colombia, and Mexico–between 1970 and 2010 through the lens of the neoclassical growth model. We focus on these three countries for tractability and because they appear to be representative of the Latin American region. The average saving rate across the three countries between 1970 and 2014 is 18%, virtually identical to that of the larger pool of Latin American countries depicted in Figure 1. At the same time, while these countries have similar average saving rates for the overall period–17.6% in Chile, 16.4% in Colombia, and 19.9% in Mexico, there are marked differences in their time paths, thus providing enough variability to assess how alternative forces have played different roles through time. For example, the saving rate in Chile is initially lower than the saving rates in Colombia and Mexico. After the mid 1980s, the saving rate in Chile increases while it decreases in Colombia and Mexico, reversing the earlier pattern. In fact, the saving rate in Chile triples between 1985 and 1988, rising from 8% to 24%. During the same time, the saving rate in Mexico declines from 23% to 21% while it increases slightly in Colombia.

What accounts for the time path of saving rates in these countries? To what extent have these rates been related to the forces that have shaped economic growth in the region? In this paper, we address these questions using a neoclassical growth model where we take the capital stock in 1970 as an initial condition and feed in the actual time paths of total factor productivity (TFP) growth, tax rates, government spending, and population growth for these countries between 1970 and 2014. We conduct deterministic simulations and examine the path of the model-generated saving rates, as well as other economic variables, against their data counterparts. We then use the model economy to examine the relative importance of each of the exogenous factors in accounting for the observed saving rates. In a final experiment, we counterfactually substitute the observed growth rate of TFP for that of Asian countries, and assess the extent to which differences in these driving forces can account for the differences in the time-path of saving rates across regions.

Our findings indicate that two factors, TFP growth and fiscal policy (tax rates and the share of government expenditures), are capable of accounting for some of the major changes in saving rates in Chile and Colombia. The model accounts for the low saving rates in Chile compared to Colombia until the late 1980s and the reversal in the saving rates after that period, while also accounting for the behavior of capital and labor in the data.

Figure 1: Gross National Saving Rate



Note: The graph presents the simple average of gross national saving rates across six Latin American countries (LAC6)–Argentina, Brazil, Chile, Colombia, Mexico, and Peru–in green; and, individually, the gross national saving rates of Chile, Colombia, and Mexico. Source: World Bank's WDI.

Both fiscal policy and TFP growth behave quite differently in Chile and Colombia throughout this time period. The data series we construct point to a dramatic decline in the capital income tax rate in Chile from over 50% until 1986/87 to around 10% afterward.[1] The share of government expenditure in this country also exhibits a modest decline after 1987. In Colombia, on the other hand, both the average capital income tax rate, and the share of government expenditure *increase* substantially during the same period.

TFP growth rates in Chile and Colombia also start diverging after 1987. The average annual TFP growth rate between 1970 and 1987 is 1.3% in Colombia and 1.8% in Chile. Between 1989 and 2010, the average TFP growth rate increases to 2.5% in Chile while it declines to 1% in Colombia. The decline in the tax rate and the higher rate of TFP growth contribute to the increase in the saving rate in Chile after 1989, leading to the divergence in saving rates of the two countries.

While the model's performance–i.e., the extent to which it can account for the dynamics of savings–is weaker for Mexico, there are interesting insights learned from the comparison between Mexico and Chile as well. For example, both Mexico and Chile reform their tax systems in 1987. Yet, while the saving rate triples in Chile between 1985 and 1989, it actually declines in Mexico. This observation is not puzzling in light of our findings. It turns out that the behavior of another factor that affects saving rates is very different between the two countries between 1985 and 1989. The average annual growth rate of TFP

[1] Available evidence (Cerda et al., 2015; Hsieh and Parker, 2007) confirms this decline in tax rates.

is -4% during this time period while it is 4.5% in Chile. High productivity growth results in high returns to capital, incentivizing higher savings. Thus, in Chile, the reduction in tax rates that coincides with a higher TFP growth results in a spectacular increase in the saving rate.

We also examine if differences in TFP growth rates between the Asian and Latin American countries can account for the differences in the time path of their saving rates. In particular, we investigate how much saving rates in Latin America would have increased had they experienced TFP growth rates similar to those of the Asian economies. We pay close attention to the 1989-2000 period, where saving rates declined in Latin America but remained stable in Asia. Our findings indicate that while the counterfactual saving rates would have been higher in the 1989-2000 period, the decline would still have happened, albeit later, fueled by changes in fiscal policy. Overall, higher TFP growth rates observed in Asian countries are not enough to close the large differences in saving rates across these regions. Recent research on China, for example, highlights alternative explanations that account for the high observed saving rates including income uncertainty, lack of comprehensive pension coverage, lack of long-term-care insurance, and the decline in family insurance due to the one-child policy.[2] Differences in these dimensions may account for most of the differences in the level of saving rates across these regions. A more comprehensive study of these issues is left for future work.

Two strands of the recent literature are particularly relevant for this paper. First, our methodological approach follows recent research geared toward using neoclassical growth theory to study macroeconomic phenomena as best exemplified in the volume edited by Kehoe and Prescott (2007) that aims at accounting for large economic downturns. The work by Bergoeing et al. (2002) in that volume is closely related to ours as they compare the differences in economic performance between Chile and Mexico before and after the debt crises of the 1980s. They argue that Chile recovered much faster than Mexico after the debt crises due to its earlier policy reforms that generated faster productivity growth. Unlike this research, however, they do not study the differences in saving rates across the two countries. Chen et al. (2006) use the same methodological approach by calibrating a neoclassical growth model to study the behavior of saving rates but focus only on Japan during the second half of the twentieth century. To the best of our knowledge, this is the first paper to use such an approach to study the dynamics of saving rates in Latin America.

[2]See for example, Chamon et al. (2013); Choukhmane et al. (2013); Curtis et al. (2015); He et al. (2015); Imrohoroglu and Zhao (2016); and Wei and Zhang (2011).

Our work relates also to earlier studies that have analyzed the saving rates in Latin America although from alternative methodological frameworks. Some works, for example, focus on the role of the saving rates in Chile relative to Mexico in facilitating high growth. The spectacular increase in the saving rate in Chile in the late 1980s is attributed to sustained growth of GDP in Morande (1998), higher total factor productivity and higher public savings in Holzmann (1997), and financial reforms and implementation of mandatory fully funded pension systems in Rodrik (2000). The Chilean experience has often been suggested as a path to prosperity for other Latin American countries. Low saving rates in Latin America have been a source of concern in Edwards (1996); Loayza et al. (2000); and Grigoli et al. (2015) while high saving rates in Asia have been hailed as an important factor in their economic growth (Stiglitz, 1996). Policies geared toward increasing the saving rate for Latin American countries have been suggested by De La Torre and Ize (2015) and Cavallo and Serebrisky (2016), among others. We contribute to this literature by investigating the endogenous response of the saving rate to changes in productivity and fiscal policy. Our results indicate that both of these factors have an important role to play in shaping the time path of the saving rate.

The remainder of the paper is as follows. Sections 2 and 3 present the neoclassical model used and its calibration. The main results of the paper are gathered in Section 4, including the various counterfactual experiments that we undertake. Section 5 concludes. Further technical details are gathered in an Appendix at the end.

2 The Model

We use a simple version of the one-sector neoclassical model (e.g., Cass, 1965; Koopmans, 1965). In this model, there is a stand-in household with N_t working-age members at date t. This representative household decides on labor, consumption, and capital accumulation so as to maximize lifetime utility subject to resource and technological constraints. Formally, the household's objective function is:

$$\sum_{t=0}^{\infty} \beta^t N_t \left[\log c_t + \alpha \log \left(T - h_t\right)\right], \tag{1}$$

where $N_{t+1}/N_t = n_t$ is the growth of the household size, $c_t = C_t/N_t$ and $h_t = H_t/N_t$ are per capita consumption and labor choices, T is the total endowment of hours per household, β is the subjective discount factor, and α is the share of leisure in the utility function.

Technology takes the form of a constant return to scale production function that combines capital (K_t) and labor (H_t) inputs: $Y_t = A_t K_t^{\theta} H_t^{1-\theta}$, where A_t is a measure of TFP. Agents' choices are thus subject to the resource constraint:

$$C_t + X_t \leq w_t H_t + \left[r_t - \tau_t \left(r_t - \delta_t\right)\right] K_t + \pi_t \tag{2}$$

where X_t is investment, r_t is the rental rate of capital, τ_t is the tax rate on capital returns, δ_t is capital depreciation, and π_t is a lump-sum tax that is used to ensure that the government budget constraint is satisfied each period: $G_t - \tau_t \left(r_t - \delta_t\right) K_t = \pi_t$ with G_t denoting exogenous government consumption.[3] The economy-wide resource constraint is given by $C_t + X_t + G_t = Y_t$ whereX_t enters the capital law of motion as:

$$X_t = K_{t+1} - \left(1 - \delta_t\right) K_t. \tag{3}$$

The optimal saving decisions by households will be determined by the exogenous driving forces, namely the growth rate of the productivity (TFP) factor, $\gamma_t = \left(A_{t+1}/A_t\right)^{1/(1-\theta)}$, as well as G_t, τ_t, n_t, and δ_t through the way they affect the standard equilibrium conditions that include a labor supply equation, the resource constraint, and the Euler equation:

$$\frac{\tilde{c}_{t+1}}{\tilde{c}_t} = \frac{\beta}{\gamma_t} \left\{ 1 + \left(1 - \tau_{t+1}\right) \left[\theta \left(\frac{\tilde{k}_{t+1}}{h_{t+1}} \right)^{\theta - 1} - \delta_{t+1} \right] \right\} \tag{4}$$

where $\tilde{c}_t = C_t A_t^{1/(\theta-1)} / N_t$ and and $\tilde{k}_t = K_t A_t^{1/(\theta-1)} / N_t$ are de-trended values of C_t and K_t.[4]

When calibrating the model as well as when comparing its performance against the data we will work with the gross national saving rate, formally defined as:

$$s_t = \frac{Y_t - G_t - C_t}{Y_t}.$$

[3] At first one may be concerned by the omission of labor income taxes. We do so mainly for practical purposes as data on effective labor income taxes is hard to come by for Latin American countries. For Colombia we were able to obtain data for 1994-2010 and carried out the benchmark exercise with the addition of this fifth exogenous driving force. Results (available upon request) showed that that while the inclusion of labor income taxes does have a substantial effect on labor supply, this has only a modest impact on the model-implied saving rate. For Mexico we could only obtain data for 1993-2001 (a period too short for simulations), while for Chile we found no reliable data whatsoever.

[4] It is worth clarifying that population growth (n) is not present in (4) by construction as variables are in effective per-capita terms. This does not mean that fluctuations in n do not affect savings rate. If one rewrites (4) in levels, population growth affects the path of (aggregate) consumption and, hence, the saving rate.

3 Calibration and Measurement

We calibrate the neoclassical model of the previous section for three Latin American countries: Chile, Colombia, and Mexico. We summarize the calibration results in Table 1. The model's time period is taken to be a year. In all cases, the capital share in production, θ, is set to 0.3, and the depreciation rate, δ, is set to 0.035.[5] The remaining parameters are calibrated so as to match certain features of the country-specific data for the period 1970-2010. Data for saving (GNSR), household and government consumption, working age population, and gross national product are taken from the World Bank's World Development Indicators (WDI). Total annual hours worked are taken from the Conference Board Total Economy Database.

A crucial step in our calibration of the model is to obtain an adequate measure of the capital stock. In doing so, we follow Hayashi and Prescott (2002) and include the current account balance in investment. More precisely, we first use data on investment and inventories along with equation (3) to construct a series of total capital in the economy. To this we add net foreign assets from the External Wealth of Nations (Lane and Milesi-Ferretti, 2007) database to obtain a measure of national capital. We then use this measure along with GNP and hours worked to obtain a series of total factor productivity (TFP).

Thus, while our setup does not allow for trade with the rest of the world, the capital series that we build, which serve as input for computing the TFP growth used, do include the current account balance as part of investment flows (see also Hayashi and Prescott (2002)). This adjustment allows us to include the aggregate effects of capital flows into the model. For example, a large current account surplus in the data, by which a country exports capital abroad, will be recovered in our capital series as an increase in the stock of capital. Hence, our setup is partially capturing open economy features by means of accounting for changes in capital flows that feed onto movements in the capital stock series that we build. Nevertheless, our framework is not well suited to examining the possible impact of world interest rate shocks on saving rates. This may be especially important in the period after the 1990s where market-oriented reforms had increased the openness of these countries to international trade.

[5]The value $\alpha = 0.3$ is also used in previous growth accounting work for Chile and Mexico (Bergoeing et al., 2002; Kehoe and Meza, 2011). Our value $\delta = 0.035$ is lower than that used in the latter studies (which is closer to 5%) but corresponds to the average annual depreciation rate for 1960-2013 used by Chile's Potential GDP Advisory Council of the Ministry of Finance (DIPRES, 2016) in its growth accounting exercises and is very close to the average of Colombia's Central Bank estimate for the 1950-96 period (GRECO, 2002).

Table 1: Baseline Calibration

Parameter	Description	Mexico	Chile	Colombia
β	Discount factor	0.946	0.960	0.933
θ	Capital share	0.3	0.3	0.3
α	Disutility of labor	3.1	3.4	3.2
δ	Depreciation rate	0.035	0.035	0.035
K_0/Y_0	Capital-output ratio	1.95	2.45	2.5
Steady-state				
γ	Productivity growth	1.001	1.020	1.014
g	Government share	0.107	0.130	0.170
n	Population growth	1.020	1.011	1.014
τ	Tax rate on capital	0.084	0.120	0.080

Note: The upper panel reports the values for the parameters used in the calibration of the benchmark neoclassical growth model for each of the three countries considered–Chile, Colombia, and Mexico. The lower panel presents the steady state values for the four driving forces considered in the benchmark model. Time period used in the model is a year.

Another critical input in our quantitative exercise is a measure of effective capital tax rates. For Colombia, we are able to construct a time series of such rates following Mendoza et al. (1994) using data from national sources. However, such data are partially available in Chile only for the years 1996-2010 and in Mexico only for the 1993-2010 period. For the missing years we follow Bergoeing et al., 2002 in assuming a constant tax rate of 41% in Mexico and 56% in Chile during the period 1970-1987 and then in 1988 let the rate fall to the first value computed using national sources (10.1% in Mexico and 11.2% in Chile).[6] Hsieh and Parker (2007) and Cerda et al. (2015) present compelling evidence that corporate tax rates were lowered by these approximate magnitudes around 1987-88 in Chile while Urzua (2000) documents that a considerable corporate tax reform also took place in Mexico around the same time.[7] As in previous studies (e.g., Bergoeing et al., 2002), we assume that the tax reforms in Mexico and Chile were unanticipated. To incorporate this into our framework, we first simulate the model economy for the full period and let it converge to the steady state using the pre-reform (higher) tax rate for all years (and

[6] In Bergoeing et al. (2002), the tax rate falls permanently in 1988 to 10% in both countries.

[7] An important reason for focusing on these three Latin American countries is that serious limitations exist for other countries in this region in terms of the data required for a proper calibration of the model, particularly related to long time series data on effective tax rates.

for the steady state). We then simulate the model again starting in 1988 with the actual post-reform tax rates, i.e., we "surprise" agents with a tax reform.[8]

To calibrate the remaining model parameters, we proceed as follows. We choose the country-specific discount factor so that, given the other parameter choices, the model's steady state gross saving rate approximate the average observed saving rate during the 1970-2015 period.[9] The model steady state saving rates are 18.85% for Chile, 14.11% for Colombia, and 17.03% for Mexico; the corresponding period averages are, respectively, 17.6%, 16.4%, and 19.7%. Model implied real return to capital based on the discount rates are 7.2% for Colombia, 4.2% for Chile, and 5.7% for Mexico. Next, we set the labor elasticity parameter, α, to match the corresponding average weekly hours worked per household.[10] Finally, we use the initial K/Y in the data for 1970 as a way to pin down the initial capital stock that we use when solving the model.[11]

We use a shooting algorithm to numerically compute the equilibrium transition path of the endogenous macroeconomic aggregates generated by the model as it converges from its initial conditions to a steady state. This, however, requires us to take a stand on what the steady state values are for the exogenous variables: TFP factor growth, population growth, government spending, and capital taxes. For steady state government spending, we use the period average for Chile and Mexico. In the case of Colombia, we use the average for the 1991-2010 sub-period instead since the 1991 constitutional change resulted in a large–and rather permanent–shift in government spending. For the TFP growth factor, we use the period average in Colombia and Chile; in the case of Mexico, we use the post-1990 average since the average for the entire period is negative, which prevents convergence of the algorithm. The steady state rate of capital taxation in Colombia corresponds to the post-1991 average (again due to a large permanent increase observed after the constitutional change), while for Chile and Mexico, we use the post-reform (i.e., post-1988) average. For (working age) population growth in all three cases, we use the last available value from the WDI (2014).

[8] While this method allows us to incorporate such tax reforms as unexpected events, our methodology abstracts from the effects that uncertainty can have on saving decisions, as opposed to other works that have incorporated uncertainty in the non-linear solution method employed (e.g. Mendoza (2010)).

[9] From equation (4) it can be seen that, since both β and τ affect the capital accumulation decision, these results could also be obtained by using an identical discount factor for all countries but different capital "wedges" that can possibly account for mismeasurement in our capital tax rates or other distortions to the accumulation of capital.

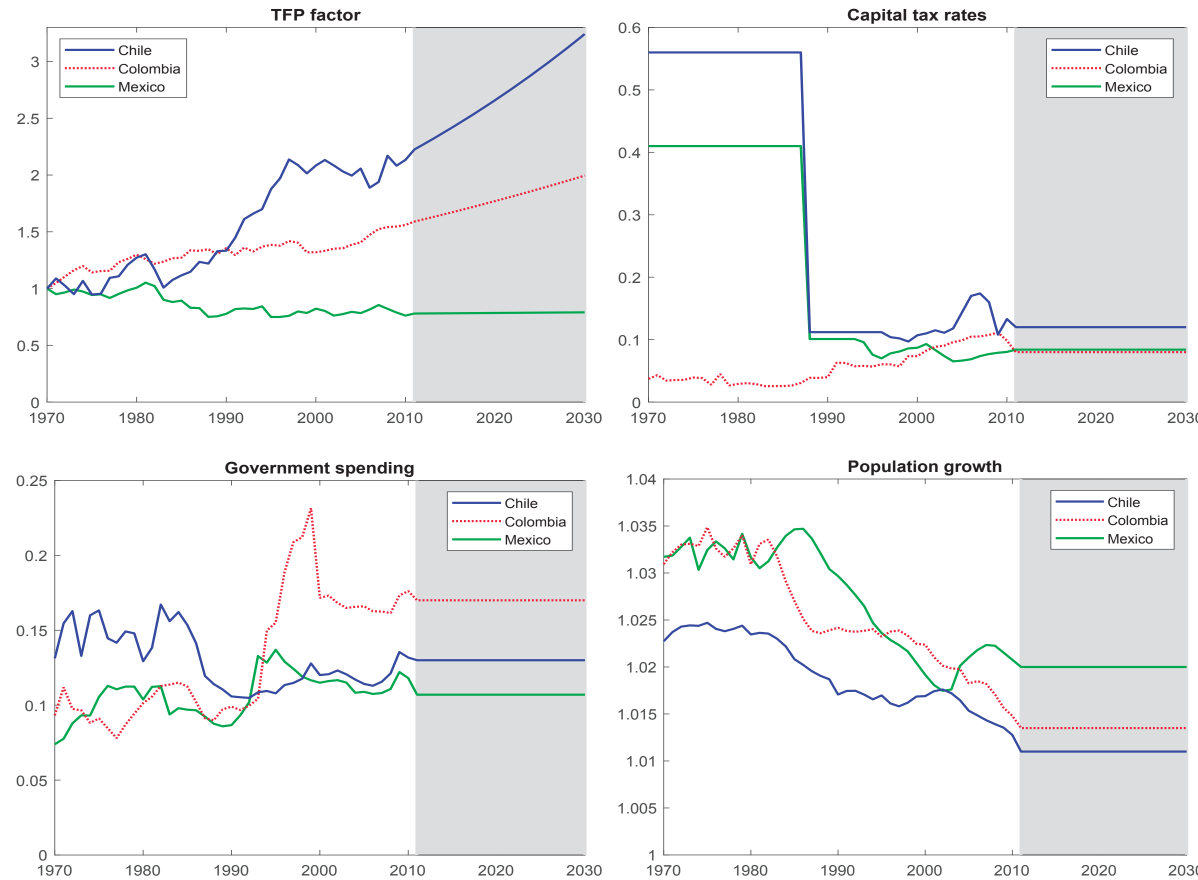
[10] The average weekly hours worked from the Conference Board Total Economy Database are: 22.5 in Chile, 23.4 in Colombia, and 24.5 in Mexico.

[11] Given that Y is endogenous and ultimately a solution of the set of non-linear equations the equilibrium K/Y for 1970 may differ from the K/Y in the data.

Figure 2 displays the data for the four driving forces between 1970 and 2010 for each of the three countries considered, and the their assumed values for 2011 and onward.[12] There are significant similarities and differences between the countries in these exogenous factors. It is evident from the first panel that TFP in Chile grew much faster than in Colombia and Mexico, leading to a higher level of TFP by the mid-1980s. Tax rates were much higher in Chile and Mexico compared to Colombia and were lowered significantly in the mid-1980s. The share of government consumption in GNP fell in Chile in the mid-1980s while it increased in Mexico and more so in Colombia after the new constitution in 1991. Population growth rates fell in all the countries after the mid-1980s with Chile displaying the lowest and Mexico the highest levels overall.

[12] We present the evolution of the TFP factor in levels merely to facilitate comparison, but notice that it is the growth rates that are presented in Table 1, not the levels, that enter the model's equilibrium equations.

Figure 2: Four Driving Forces



Note: The four plots present the time series for each of the four driving forces considered–TFP growth (γ_t), capital tax rate (τ_t), government spending (G_t/Y_t), and population growth rate (n_t)– when simulating/calibrating the benchmark neoclassical growth model across the three Latin American countries considered: Chile, Colombia, and Mexico. The shaded region (2011-2030) shows the assumed behavior of these driving forces in steady state. See text and appendix for details and sources used in each driving force.

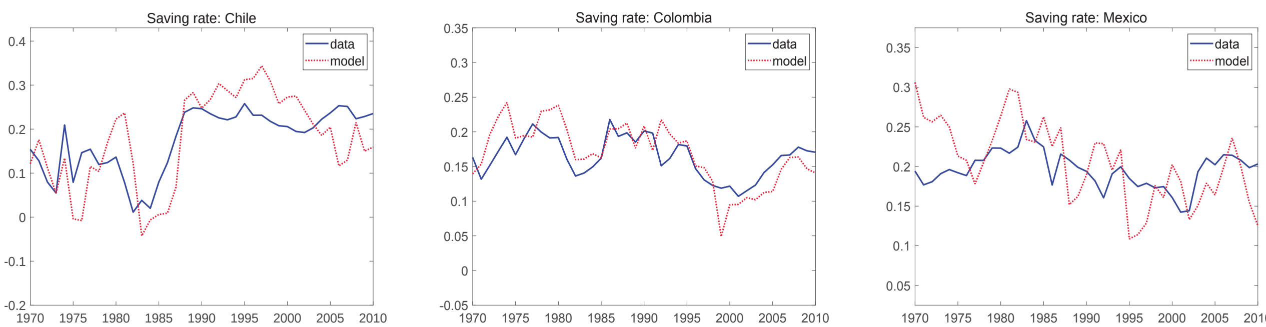
4 Benchmark Results

Figure 3 presents the simulated GNSR in Colombia, Chile, and Mexico between 1970 and 2010 generated with our benchmark economies when time series data for all five driving forces –the tax rate, the share of government consumption in GNP, and the growth rates of the TFP factor and population– are fed into the calibrated models.[13] Figure 3 also

[13]With our exogenous driving forces assumed to reach their steady state values after 2011, saving rates after 2011 converge rather quickly to their steady state values (see Figure 17 in Appendix A.5). Also, while our focus is on national saving rates, our calibration incorporates the government budget and redistributes the surplus/deficit to the households in a lump-sum fashion as shown in equation 2. In Appendix A.4, we provide the data on public and private saving behavior in Chile, Colombia, and Mexico, which shows that private savings accounts for most of the variation of total saving rates.

displays the observed GNSR in the three countries so we can compare the model's ability to account for the actual behavior of saving rates. We present further evidence of the model's performance in terms of capturing other dynamics in the data in Figure 4, where we report the model's generated hours worked and capital-to-output ratio together with their data counterparts for the three countries. Notice that in this model, the saving rate can change for two reasons. First, as in the standard neoclassical model, the saving rate may change as the capital intensity converges to that of the economy's steady state. Secondly, in any given period, the saving rate may change because of current or (perfectly anticipated) future changes in each of the four driving forces. In our specific application for these three specific countries, however, the initial values for K/Y are not too far from those of the steady state (except for Mexico), so that fluctuations in the saving rate come mostly from the exogenous driving forces.[14]

Figure 3: Saving Rate: Model and Data



Note: The plots present the observed gross national saving rate ("data," blue/solid) and the simulated one using the calibrated benchmark neoclassical model ("model," red/dashed) when all four driving forces are used for the three Latin American countries considered: Chile, Colombia, and Mexico. Sources: World Bank's WDI and authors' calculations.

The main takeaway from Figure 3 is the relatively good performance of the model in terms of its ability to account for the broad dynamics of the saving rates observed during the 40 year period of analysis, particularly in the cases of Chile and Colombia. For the case of Chile, the model captures the dramatic increase in the saving rate in the mid-1980s and its decline in the previous years. Similarly, for Colombia, the model captures the decline from around 15%-20% from 1970 until the mid-1990s to around 10% in the early 2000s as well as its subsequent recovery. In the case of Mexico, the performance of the model is relatively weaker as the simulated saving rates display more short-run fluctuations than

[14] Figure 14 in the Appendix confirms this. The initial and steady state values of K/Y are, respectively: for Chile, 2.28 and 2.8; for Colombia, 2.47 and 2.33; and for Mexico, 1.3 and 3.0.

are observed in the data. Nonetheless, the model does account for the long-run trends in the Mexican saving rate: an increase in the first years of the sample up to the early 1990s followed by a decline until the early 2000s and a recovery since then. These relative differences in the performance of the model can be seen in the correlations between the data and the model-generated saving rates: 0.70 for Chile, 0.75 for Colombia, and 0.42 for Mexico.

Figure 4 also documents the calibrated model's ability to account for part of the dynamics of the inputs used in production, capital, and labor. For Chile, the model accounts for the relative increase of labor in the second half of the sample as well as the U-shaped path of the capital-to-output ratio across the 40 years of analysis. The correlations across model and data are 0.64 and 0.52 for labor and capital-to-output. In Colombia, the model can also replicate the behavior of labor in the second half of the sample and the gradual accumulation of capital's share until the 2000s, when the trend reverses.The correlations across model and data are 0.45 and 0.57 for labor and capital-to-output. For Mexico, again, the performance of the model is more modest, capturing only the upward trend in the capital-to-output ratio throughout the sample. Here the correlation in labor is actually negative (-0.45), although it is high for the capital-to-output (0.86).

There are, nonetheless, some dynamics that the simulated time series exhibit that are counterfactual. In terms of the saving rates, the model displays relatively larger fluctuations than in the data. This is particularly the case for Mexico, though it also holds for the other two countries.[15] In addition, the model generates a declining saving rate in the late 2000s for Chile, while in the data we observe a steady saving rate. In Colombia, the model generates a sharp decline in the saving rate in 1999 that is not observed in the data.

In terms of capital and labor inputs, in the early years, the model-generated hours worked misses some of the major changes observed in the data in Chile and Colombia. For example, hours worked declines dramatically in Colombia in the mid-1980s, and the model is not able to capture this. In Chile, the model-implied hours worked increases significantly in the late 1970s while in the data hours worked remain stable. For Mexico, neither the level nor the dynamics of hours worked are well captured by the model, and the level of the capital-to-output ratio is not properly matched.

[15] A statistic that summarizes this behavior is the ratio of standard deviations from the simulated series and the data. This number is 1.52 for Chile, 1.54 for Colombia, and 1.91 for Mexico. In other words, the standard deviation of the simulated series in Mexico is 91% higher than that of the observed series.

Figure 4: Labor and Capital: Model and Data

Note: The plots present the time series for labor, measured in hours per week, in the left column, and capital-to-output shares in the right column from the data ("data," blue/solid) and the simulated one using the calibrated benchmark neoclassical model ("model," red/dashed) when all four driving forces are used, for the three Latin American countries considered: Chile, Colombia, and Mexico. Sources: World Bank's WDI, Conference Board Total Economy Database, and authors' calculations.

There are, of course, multiple reasons for the discrepancies between the model-generated results and the data. The model's counterfactually high volatility is likely to be a consequence of the perfect foresight assumption as discussed in Chen et al. (2006).[16] In addition, there are potential measurement issues that are likely to impact the TFP series obtained from the data.[17] We also have not incorporated any life-cycle reasons for savings such as the changes in the social security system that happened during this time period in Chile or changes that may have taken place in other social insurance programs (see footnote 20). Our framework presents an attempt to understand how the national saving rate is affected by three simple factors: changes in demographics, fiscal policy, and the growth rate of productivity. In the next section, we investigate the role these different factors play in generating the benchmark results by running a set of counterfactual experiments.

4.1 Counterfactuals

In this section, we present a set of counterfactual experiments to isolate the impact of the exogenous factors on the time path of the saving rate in each country. We focus on Chile and Colombia, the two countries where the performance of the model is satisfactory in accounting for the observed dynamics of saving rates.[18] We investigate the role of the productivity growth rate by setting all three remaining exogenous processes equal to their long-run averages. This experiment allows us to isolate the impact of productivity growth on the saving rate. Next, we examine the role of changing demographics by setting all exogenous variables except the population growth rate equal to their long-run averages. Lastly, we examine the role of fiscal policy by only allowing G/Y and tax rates to change

[16] In a model with perfect foresight, saving rates react to changes in the TFP growth rate with large swings. That is why, for example, in Chile saving rate after 1990 is larger than the data. This results in K/Y to be larger in the model especially after 1990s in Chile. Notice that the opposite happens in Colombia around year 2000. TFP declines a lot in that period which leads to a large decline in the saving rate. Again, this decline is larger than the one observed in the data, mostly due to the perfect foresight assumption. This leads the model generated K/Y to be lower than its data counterpart starting around year 2000.

[17] Note that we do not adjust the capital input for variable capacity utilization when constructing our measures of TFP. Nonetheless, for the countries (and years) for which data on capacity of capital utilization rates exist–Chile (1970-2010) and Colombia (1980-2010)–we provide evidence in the Appendix that results are strongly robust when one does account for this additional dimension. Indeed, TFP growth rates with and without capacity utilization rates are strongly correlated in both Chile (0.98) and Colombia (0.85) for the sub periods mentioned above.

[18] The results of the counterfactuals for Mexico are, nonetheless, presented in the Appendix. They suggest that a possible culprit for the model's poor performance is an overly volatile TFP series, which in turn may be a symptom of poorly measured production inputs (capital and labor).

as they did in the data while we set the TFP and population growth rates equal to their long-run averages.[19]

Our findings indicate a small impact of the change in demographics on the time path of the saving rate. Therefore, we present those results in the Appendix. The main question that remains is the role of productivity growth versus fiscal policy in accounting for the changes in the saving rate. That is what we examine next in detail for each country.

4.1.1 Chile

In the left panel of Figure 5, labeled "Chile: TFP only," we present the model generated saving rate for Chile when the only time-series path used in the simulations is the TFP factor growth rate. All other factors are set to their long-run averages. For comparison, the saving rate generated by the benchmark economy and the data are also included in the same graph. The saving rate obtained in this counterfactual reveals some interesting observations. First, for many periods, the saving rate generated in this counterfactual resembles the one in the benchmark economy. In particular, the fluctuations observed in the saving rate seem to be mostly due to the changes in the growth rate of the TFP factor. Indeed, the saving rate with "TFP only" seems to generate some of the major changes in the saving rate. For example, between 1980 and 1982, the saving rate in Chile declines from 13.6% to 1.1%. The counterfactual experiment "TFP only" does indeed generate a large decline in the model as well, albeit too large compared to the data. The observed growth rate of the TFP factor declines from 2.3% in 1980 to -13.7% in 1982. This decline alone seems to generate a large decrease in the saving rate in that period. In fact, it is useful to compare the results generated by the alternative counterfactual experiment displayed in the right panel of Figure 5, labeled "Chile: Fiscal policy only." In this case, the TFP factor growth rate is set to its long-run average while the actual G/Y and tax rates that are observed in the data are used in the simulations. Notice that in this counterfactual experiment there is no decline in the saving rate between 1980 and 1982. Thus, between the two exogenous forces, our results identify the TFP growth rate as the culprit behind the decline in the saving rate between 1980 and 1982 in Chile.

[19] Note that looking at G/Y and tax rates separately implies additional changes in π_t, the lump sum tax that is used to ensure that the government budget constraint is satisfied. Given the large changes in G/Y, we think it is appropriate to consider both driving forces to be active at the same time when studying the effects of fiscal policy. In Appendix A.2, Figure 12 we isolate the effect of capital income taxation on the one hand, and government spending with lump-sum taxes on the other.

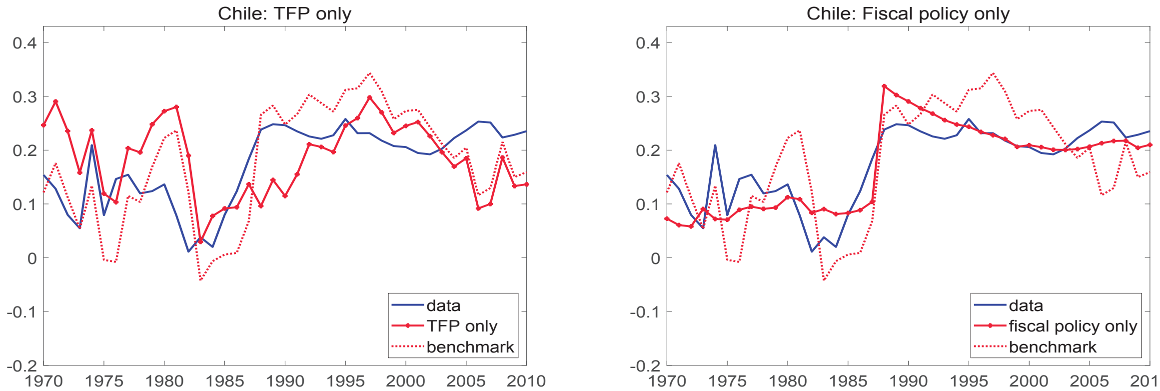
Another dramatic change in the saving rate takes place between 1984 and 1988 where the observed saving rate increases from 2% to 24%. In our first counterfactual experiment, "TFP only," there is an increase in the saving rate that starts in 1983, but the increase is much more subdued compared to the data. For example, in 1988, the model-generated saving rate with "TFP only" generates a saving rate of about 9%. In the second counterfactual experiment, "fiscal policy only," the saving rate does indeed show a dramatic increase, reaching 33% by 1988. The actual timing of the increase, however is later than in the data. In the model, the tax reform takes effect in 1987, which is why the saving rate in this counterfactual experiment increases dramatically after that year. The gradual increase in the saving rate observed in the benchmark economy after 1983 and before the tax reform is, therefore, due to the increase in the productivity growth rate.[20] As mentioned before the "fiscal policy only" experiment combines changes in both the G/Y and capital taxation. In Section A.2 we run counterfactual experiments designed to seperate the effect of G/Y from capital taxes and show that the main driving force in this experiment is the changes in the tax rate. Changes in G/Y alone have little effect on the saving rate itself.

Lastly, we can also uncover the reasons why the model-generated saving rate diverges from the data after 2005. In the data, the saving rate hovers around 20% between 2005 and 2010. Yet, in the model, the saving rate declines during this period. The reason for this decline appears to be the path of the TFP factor growth rate used in the simulations. Indeed, TFP growth in Chile in this last part of the sample is considerably slower than the historical average, largely boosted by the relatively high TFP growth rates observed in parts of the 80s and 90s.

We conclude that both the changes in the TFP factor growth rate and changes in fiscal policy that allowed for a large decline in the tax rate in 1987 play an important role in shaping the time path of the saving rate in Chile. The relative importance of these two factors, however, is different in different time periods.

[20]While we do not directly model the Social Security reform that took place in Chile in 1981, where the pay-as-you-go system was replaced with a funded system, we do incorporate the decline in the tax rates that took place during this time. The early periods of the transition were marked with high government deficits while the government promised to fulfill its obligations toward the current old generations. In fact, a detailed study of the role of pension reform on saving rates can be found in Holzmann (1997), which concludes that the contribution of pension reform to national saving was negative between 1981 and 1988. Thus, the dramatic increase in the saving rate that took place during this period is unlikely to be caused by the social security funds of the new system.

Figure 5: Saving Rate in Chile: Counterfactual Experiments



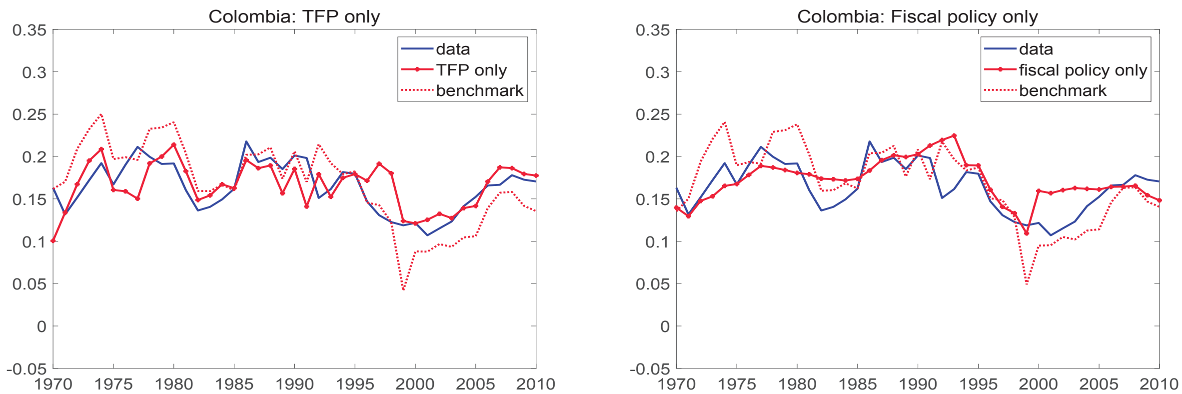
Note: The left plot compares the observed gross national saving rate in Chile ("data," blue/solid) against the counterfactual case in which the only driving force that is active when simulating the model is the TFP growth rate and the remaining three driving forces are set equal to their steady state levels ("TFP only," red/marker). The right plot compares the observed gross national saving rate in Chile ("data," blue/solid) against the counterfactual case in which the only two driving forces that are active when simulating the model are the capital tax rates and the government spending shares while the remaining two driving forces are set equal to their steady state levels ("fiscal policy only," red/marker). Both plots also present the simulated series using the calibrated benchmark neoclassical model when all four driving forces are used ("benchmark," red/dashed). Sources: World Bank's WDI and authors' calculations.

4.1.2 Colombia

The saving rate in Colombia fluctuates around 18% from 1970 to 1994, declines to 13% between 1995 and 2001, and fully recovers by 2010. Two driving forces go through major changes in this period. First, there is a decline in the TFP growth rate after 1995. The average TFP growth rate between 1970 and 1995 is 1.34%. Starting in 1996, the TFP growth rate declines to around zero. In fact, the average TFP growth rate between 1996 and 2000 is 0%. After 2002, the TFP growth rate recovers to generate an average growth rate of 1.8 % between 2002 and 2010. The second development, in the mid-1990s, is the large increase in the share of government expenditures in GNP accompanied by an increase in taxes as displayed in Figure 2. This ratio increases from roughly 10% throughout the early 1990s to 23% in 1999 while the tax rate increases from around 3% until 1990 to around 10% in the mid-2000s.

In the next two counterfactual experiments, we isolate the impact of TFP growth versus fiscal policy on the time path of the saving rate. The left panel in Figure 6 displays the saving rate in the counterfactual experiment where we only feed in the time series path of the TFP growth rate. Notice that the saving rate generated in this experiment is similar to the benchmark case except for certain periods. In particular, this counterfactual does not capture the decline in the saving rate that occurs in the data in 1996.

Figure 6: Saving Rate in Colombia: Counterfactual Experiments



Note: The left plot compares the observed gross national saving rate in Colombia ("data," blue/solid) against the counterfactual case in which the only driving force that is active when simulating the model is the TFP growth rate and the remaining three driving forces are set equal to their steady state levels ("TFP only," red/marker). The right plot compares the observed gross national saving rate in Colombia ("data," blue/solid) against the counterfactual case in which the only two driving forces that are active when simulating the model are the capital tax rates and the government spending shares while the remaining two driving forces are set equal to their steady state levels ("fiscal policy only," red/marker). Both plots also present the simulated series using the calibrated benchmark neoclassical model when all four driving forces are used ("benchmark," red/dashed). Sources: World Bank's WDI and authors' calculations.

The counterfactual experiment that is depicted in the right panel of Figure 6 where the exogenous path of taxes and G/Y are included is, however, better able to capture the decline in the saving rate in the 1990s. In this "fiscal policy only" experiment, the saving rate actually starts declining earlier than in the data. Moreover, further analysis in Appendix A.2 reveals that, overall, government expenditures appear to have mattered more than capital taxes.

As in the case of Chile, one conclusion that can be drawn from these two experiments is that both factors play a role in the decline of the saving rate between 1995 and 2001, while the behavior in the years before appears mostly driven by TFP growth. The increase in the size of the government in the 1990s results in the sharp decline in the saving rate early in this episode while the low TFP growth rate prolongs the decline in the saving rate into 2001. The recovery observed in the saving rate by 2010, however, seems to be mostly accounted for by the TFP growth rate. In the second counterfactual experiment "fiscal policy only," the saving rate remains stable after the year 2000. In the "TFP only" experiment, the saving rate gradually increases to around 18% in 2010, similar to what is observed in the data.

4.2 Comparisons Across Countries

Note that in our model saving and investment rates are the same. While it is well known that investment rates move closely with TFP, our results indicate that changes in other exogenous variables also play a significant role in the time path of saving rates. The analyses conducted so far identifies fiscal policy, in addition to TFP, as playing an important and distinct role in shaping the time path of the saving rates at different time periods in Colombia and Chile. In this section, we examine the extent to which these two factors may explain the differences in saving rates across these two countries. This exercise may be particularly interesting given the reversal in the saving rate between the two countries. Until the mid-1980s, the saving rate in Colombia is higher than the saving rate in Chile. This is completely reversed after the mid-1980s, and the saving rate in Chile remains much higher than that of Colombia until the end of the period analyzed.

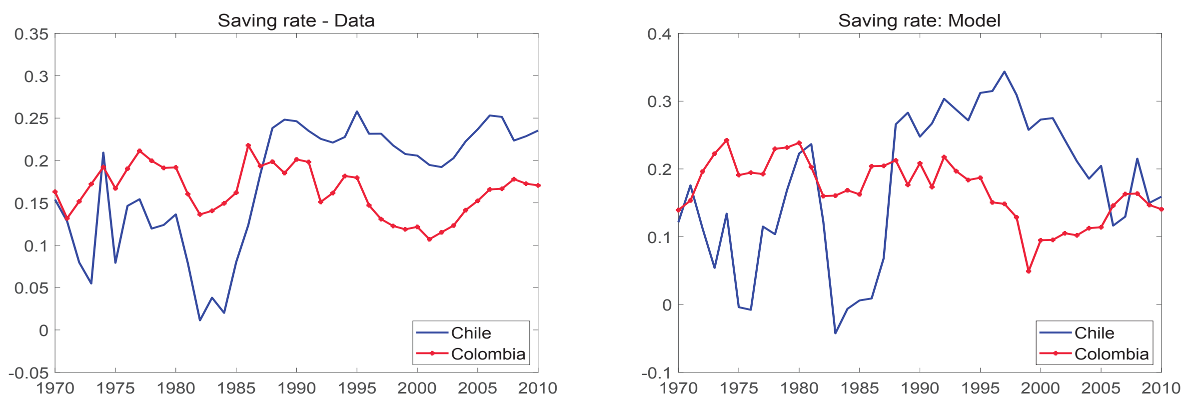
4.2.1 Chile Versus Colombia

In the left panel of Figure 7, we present the data for the saving rates in the two countries together. In the right panel, we present the results obtained from the benchmark model. The model mimics some of the similarities and the differences between the two countries rather well. In particular, the model is able to capture the initial low saving rates in Chile relative to Colombia and the reversal in the saving rates of the two countries in 1988. The average saving rate before 1988 is 17.5% in Colombia and 11.4% in Chile. The model-generated average saving rates for this period are 19.6% and 14.6% for Colombia and Chile, respectively. For the period after 1988, the average saving rate in the data is 15.6% for Colombia and 22.7% for Chile, while the model generates an average saving rate of 14.6% and 24.3% for Colombia and Chile, respectively. These results are summarized in the first four columns of Table 2.

Next, we investigate the extent to which differences in TFP growth and/or fiscal policies between these countries might account for the reversal in their saving rates. Before 1989, annual TFP growth rates in Colombia and Chile are similar to each other with an average of 1.3% and 1.8% in the two countries between 1970 and 1988. From 1989 until 2010, however, the average TFP growth rate in Colombia declines to 0.9% while it increases to 2.5% in Chile. In addition, tax rates and government expenditures decline dramatically in Chile in the mid-1980s while they continue increasing in Colombia.

We examine to what extent the reversal in TFP growth rates and the changes in the path of fiscal policy might have impacted the reversal in their saving rates by running two counterfactual experiments. In the first one, we subject the Colombian economy to the Chilean TFP growth rate starting in 1989. The model economy otherwise is calibrated to the Colombian economy. The results are displayed in column "Exp. 1" in Table 2. The results reveal that the saving rate in Colombia would have been two percentage points higher, relative to the benchmark, after 1989 if Colombia had experienced the same TFP growth rate as in Chile (16.6% vs 14.6%). Nevertheless, the saving rate after 1989 would not have risen to the levels seen in Chile in this sub period (22.7%). In the next experiment, we assume that tax rates and government expenditures as a percent of GDP in Colombia continue at their levels in 1988.[21] The results are displayed in column "Exp. 2" in Table 2 where the saving rate in the 1989-2010 period increases by another percentage point (17.6).

Figure 7: Saving Rate: Model and Data



Note: The left panel presents the observed gross national saving rates in Chile (blue/solid) and Colombia (red/marker). The right panel presents the simulated saving rates by the benchmark neoclassical model for these two countries when all four driving forces are active. Sources: World Bank's WDI and authors' calculations.

These experiments reveal that the decline in the TFP growth rate and the increase in the share of the government in Colombia both play a role in the decline in their saving rate in the second half of the sample, which stands in contrast to the behavior observed for Chile.

[21] In the data, the capital income tax rate increases from 3.9% in 1988 to around 10% in the late 2000s. Government expenditures as a share of GDP also rise from 9% in the early 1980s to above 16% in the 2000s. In this experiment, we keep the tax rate at 3.9% and the government expenditure share at 9% after 1989.

Table 2: Saving Rate: Chile and Colombia

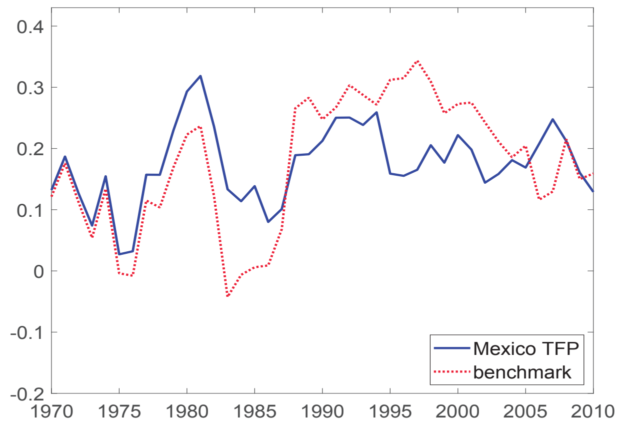
	Chile		Colombia		Colombia: Counterfactual	
	Data	Model	Data	Model	Exp 1.	Exp. 2
1970-1988	11.4	9.04	17.5	19.4	18.1	17.1
1989-2010	22.7	24.3	15.4	14.6	16.6	17.6

Note: The first four columns present observed and simulated GNS rates with the benchmark model. "Counterfactuals/Exp.1" presents simulated GNS rate with the benchmark model for Colombia when TFP growth rate is the one observed in Chile only for the 1989-2010 sub period. "Counterfactuals/Exp.2" presents the simulated GNS rates with the benchmark model when TFP growth rate is the one observed in Chile only for the 1989-2010 sub-period and tax rates and G/Y continue at their 1988 levels. Sources: World Bank's WDI and authors' calculations.

4.2.2 Chile Versus Mexico

While the model's performance is weaker for Mexico, there are interesting insights that can be learned from the comparison between Mexico and Chile. There is a big difference between the saving rate behavior of these two countries in the late 1980s after they both reform their tax systems. Recall that in our benchmark exercise, effective capital tax rates drop from 56% to 11% in Chile and from 41% to 10% in Mexico. Yet while the saving rate triples in Chile between 1985 and 1989, it actually declines in Mexico. This observation need not be puzzling in light of our findings. It turns out that the behavior of another factor that affects saving rates is very different between the two countries after the mid-1980s. Between 1983 and 2010, the average annual TFP growth rate in Mexico is -0.26% while it is 1% in Chile. The difference in their performance is even more striking between 1983 and 1988: in Mexico, average TFP growth is -2.94%, while in Chile it is 4.38%. High productivity growth increases returns to capital, incentivizing higher savings.

Figure 8: Saving Rate in Chile



Note: Figure 8 presents the gross saving rate simulated by the calibrated benchmark model for Chile when all four driving forces are active ("benchmark," red/dashed). The blue solid line presents the counterfactual simulation for the Chilean gross saving rate when all four driving forces are active but TFP growth rate is identical to that of Mexico after 1983 ("Mexico TFP"). Sources: World Bank's WDI and authors' calculations

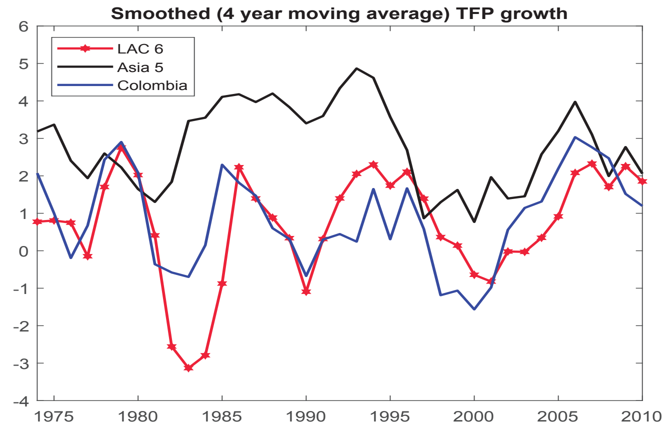
To examine the impact of the differences in the TFP growth rates between Chile and Mexico in affecting their saving rates, we conduct a counterfactual experiment where we subject Chile to the Mexican TFP growth rate after 1983. The saving rate labeled "Mexico TFP" in Figure 8 displays the saving rate in Chile for this hypothetical case. Notice that there would still have been an increase in the saving rate after the tax reform in Chile, but this increase would have been smaller and much shorter lived.

4.2.3 Latin America Versus Asia

Saving rates in Latin America have been persistently lower than the saving rates in many Asian countries. For example, between 1970 and 2010, the average gross national saving rate in the "Asia 5" (China, Korea, Singapore, Hong Kong, and Taiwan) was 35.5%, while the average saving rate for the "Latin America 6" (Argentina, Brazil, Chile, Colombia, Mexico, and Peru) was just 18.9%. In addition, there were significant differences in the time path of the saving rates between these groups of countries. For example, between 1988 and 2000, the saving rate in LAC 6 declined from 24% to 15% while it remained rather steady in Asia 5. During the same time period, TFP growth rates in these countries were also markedly different (See Figure 9).[22]

[22]To compute TFP series for the Asian countries, we follow the same strategy as that used in the case of Mexico, Chile, and Colombia. That is, we use data on investment from the World Bank's WDI tables to

Figure 9: TFP Comparison

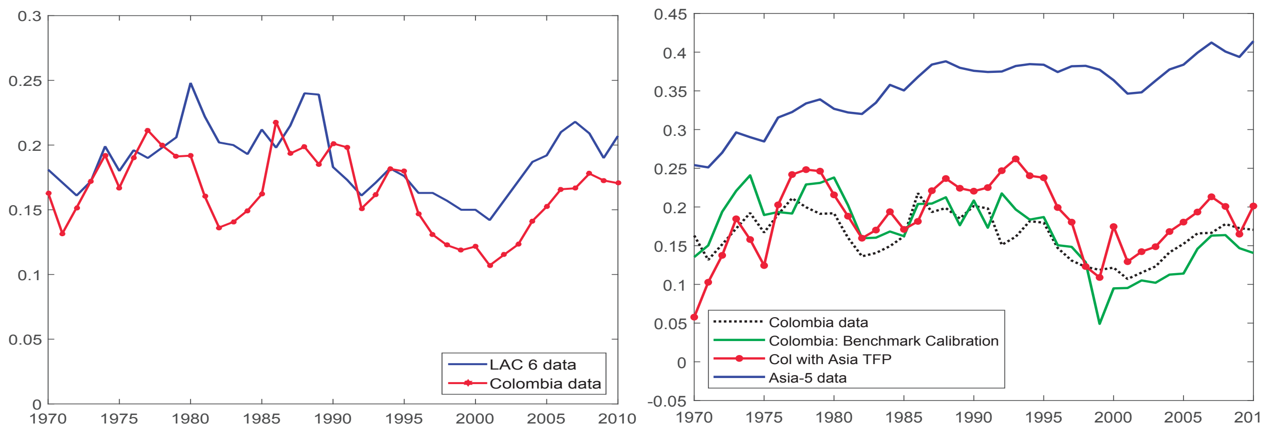


Note: Figure 9 presents the simple average of annual TFP growth rate across six Latin American countries (LAC6)–Argentina, Brazil, Chile, Colombia, Mexico, and Peru–in red/marker and across five South East Asian countries (Asia 5)–China, Korea, Singapore, Hong Kong, and Taiwan–in black/solid. Saving rate for Colombia is provided in blue. See text for further details on TFP growth rates. Source: World Bank's WDI and authors' calculations.

In this counterfactual experiment, we examine the extent to which differences in TFP growth rates between Latin America and Asia may have influenced the differences in the time-path of saving rates. For example, would the decline in the saving rate between 1988 and 2000 disappear if Latin America were facing TFP growth rates as in Asia?

construct a measure of the capital stock, using equation (3). We then adjust this capital stock by adding net foreign assets to obtain a measure of national capital. Finally, we also use WDI data for output (GNI) while the labor series come from the Conference Board Total Economy Database.

Figure 10: Saving Rate in Latin America, Colombia and Asia



Note: The left panel presents the simple average of observed gross national saving rates across six Latin American countries (LAC6)–Argentina, Brazil, Chile, Colombia, Mexico, and Peru–in solid/blue and Colombia alone in red with markers. The right panel presents the simple average of the gross national saving rates across five South East Asian countries ("Asia 5-Data", blue/solid)–China, Korea, Singapore, Hong Kong, and Taiwan–the observed gross national saving rate in Colombia ("Colombia data", black/dashed), and the counterfactual simulated series of gross national saving rate with the model calibrated to Colombia when all four driving forces are active and TFP growth rate is that of Asia-5 ("Col with Asia TFP", red/circles), as well as the saving rate from the benchmark calibration ("Colombia: Benchmark Calibration", green/solid). Source: World Bank's WDI and authors' calculations.

For this purpose, we take Colombia as a typical Latin American country and ask what would have happened to the saving rate in Colombia had it faced the same TFP growth rate as in "Asia 5" during this time period.[23] We choose Colombia as a typical Latin American country because of the similarities between the saving rate in Colombia and the average saving rate of the group of six Latin American countries displayed in the left panel of Figure 10. This counterfactual experiment might allow us to generalize about the role of TFP growth–or the lack thereof–in accounting for the time series path of the saving rates in Latin America.

The right panel of Figure 10 displays the results for this counterfactual experiment, labeled "Col with Asia TFP," together with the benchmark results (Colombia: Benchmark Calibration) and the data on saving rates in "Asia 5" and Colombia. Notice that the higher TFP growth rate does increase the saving rate in Colombia relative to the benchmark, especially in the 1990s. For example, between 1989 and 2000 average saving rate in Colombia becomes 20.4% with Asian TFP growth rates, as opposed to 16.0% with their domestic TFP growth rates (see Table 3). Differences in the growth rate of TFP between Asia and Colombia in this period is 2 percentage points. In other words our results indicate

[23]For this experiment, we use the same benchmark calibration for Colombia except for the time series path of the TFP growth rate which is the TFP growth rate "Asia 5". The steady state TFP growth rate is assumed to be equal to 2%.

Table 3: Saving Rate: Colombia with Asia TFP

			Colombia with Asia TFP
	Data	Model	COL 1
1970-2010	16.4	16.9	18.6
1970-1988	17.5	19.4	18.1
1989-2000	15.8	16.0	20.4
1989-2010	15.6	14.6	19.0

Note: The first two columns present the observed and simulated GNS rates with the benchmark model. Column "with Asia TFP/COL1" presents the simulated GNS rate from the model when all driving forces are active but TFP growth rate is coming from the simple average across five South East Asian countries. Sources: WDI and authors' calculations.

that if Colombian TFP growth were to be higher by 2 percentage points in this period, their saving rate would have been higher by 4.4 percentage points. More importantly, the decline in the saving rate in Colombia would have been delayed until mid-1990s where changes in fiscal policy started playing a role in the decline of the saving rate as discussed in Section 4.1.2. However, significant differences in the level of saving rates between Asia-5 and Colombia remain.[24]

5 Concluding Remarks

In this paper, we explore what accounts for the dynamics of saving rates in Latin America and the extent to which they have been related to the forces that have shaped economic growth in the region. We build a one-sector, neoclassical growth model and calibrate it to a subset of Latin American economies: Chile, Colombia, and Mexico. A crucial element in our quantitative analysis is to use (and in some cases construct from primary sources) time series of the forces that have driven economic growth in these countries for the past 40 years.

The main takeaway is the relatively good performance of the model in terms of its ability to account for the broad dynamics of the saving rates observed during this period of analysis, particularly in the cases of Chile and Colombia. Furthermore, we reach a number of conclusions based on our counterfactual experiments. First, both for Chile and Colombia, changes in the TFP growth rate together with the changes in the tax rates and

[24]Studies of the saving behavior in China, for example, point to the role of income uncertainty, lack of comprehensive pension coverage and long-term-care insurance, and the decline in family insurance due to the one-child policy as some of the explanations for its high saving rates (Imrohoroglu and Zhao (2016)).

the size of the government have played an important role in shaping the changes in their saving rates. For Chile, the timing of the increase in the saving rate in the mid-1980s is affected more by the tax reforms than the growth rate of TFP. For Colombia, the decline in the saving rate in the mid-1990s seems to be due to a combination of the decline in the growth rate of TFP and the increase in the tax rate. In fact, these two factors are capable of generating the reversal of the saving rates in the two countries in the mid-1980s. We also find that high TFP growth rates observed in the Asian countries would not have been capable of generating similarly high saving rates in Latin America. Our counterfactual experiments indicate that the higher TFP growth rate experienced in the Asian countries during the 1989-2010 period could have increased the saving rate by almost five percentage points in Latin America. While this is not a trivial increase, it still falls short of filling the gap with respect to the high saving rate observed in the Asian countries.

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A Appendix

A.1 Data Sources and Methods

To construct the capital stock series, we use data on gross fixed capital formation and changes in inventories from national sources, which are virtually identical to those reported in the WDI, along with a constant depreciation of 3.5% in all cases. We use these data to iterate equation (3) starting from an initial capital value. To obtain the latter, we use an initial capital to output ratio and multiply by constant prices GDP (from WDI). For Mexico, this initial value corresponds to the capital-to-output ratio for 1970 in Kehoe and Meza (2011) of 1.48, which is very close to the 1.51 found in Bergoeing et al. (2002). For Chile, the 1970 capital-to-output ratio (2.69) is taken from DIPRES (2016), while for Colombia (2.76), it is taken from GRECO (2002). Once we have a series for total capital, we add net foreign assets (NFA) in constant prices, which in turn is obtained by deflating current prices NFA from Lane and Milesi-Ferretti (2007) using the investment deflator from

WDI. The resulting measure of capital is used, along with data on gross national product from WDI and equation to obtain our closed economy TFP series.

Our labor input series is obtained by dividing total weekly hours worked from the Conference Board Total Economy Database into working age population from WDI. To calibrate the labor disutility parameter, we use the period average for this labor input series and for consumption and output from WDI in the steady state version of the labor supply equation:

$$\alpha = (1-\theta)\frac{(T-h)}{h}\frac{y}{c}$$

For the years in which effective capital tax rates can be constructed (Colombia 1970-2010, Chile 1996-2010, Mexico 1993-2010) we follow Mendoza et al. (1994). Formally, we define:

$$\tau = \frac{\tau_h(OSPUE + PEI) + TIPC + RTIP + TFCT}{OS} \tag{5}$$

$$\tau_h = \frac{TIPCIH}{OSPUE + PEI + W} \tag{6}$$

where τ_h is the effective tax rate paid by households; $OSPUE$ is unincorporated business net income; PEI is interest, dividends, and investment receipts; $TIPCIH$ is taxes on income, profits, and capital gains paid by households; W corresponds to wages and salaries of dependent employees; $TIPC$ is taxes on income, profits, and capital gains paid by corporations; $RTIP$ is recurrent taxes on immovable property; OS is net operating surplus of the overall economy, and $TFCT$ is taxes on financial and capital transactions. In Colombia, all of these series are taken from the national statistics office (DANE). For Chile, the data are taken from the OECD's Revenue Statistics dataset for variables in numerator of equations (5)-(6) and National Accounts dataset for variables in the denominator. For Mexico, we use the actual rates reported in Anton-Sarabia (2005) for 1993-2001 and update them using, again, series from OECD and equations (5)-(6).

As in previous studies (e.g., Bergoeing et al., 2002), we assume that the tax reforms in Mexico and Chile were rather unexpected. To incorporate this into our framework, we simulate the model economy for the full period and let it converge to the steady state using the pre-reform (higher) tax rate for all years (and for the steady state). Then we simulate the model again starting in 1988 with the actual post-reform tax rates, i.e., we "surprise" agents with a tax reform.

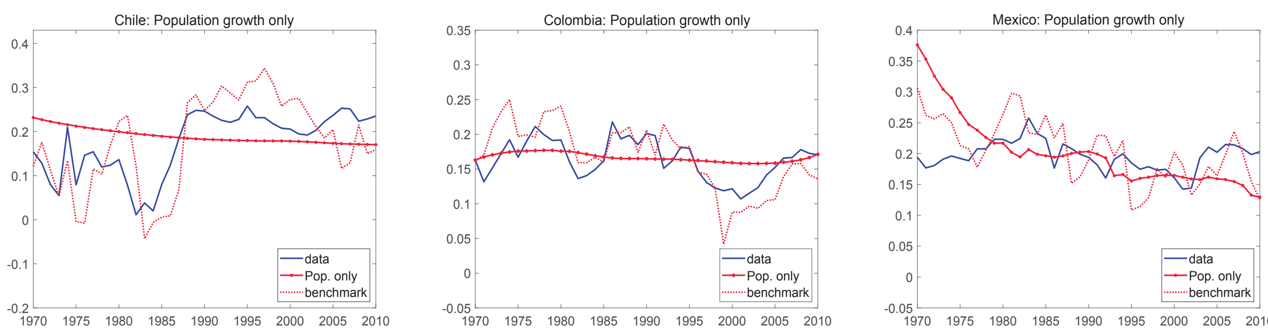
Our series of the share of government in output is found by dividing government consumption into GNP (both from WDI). Population growth is simply the annual growth of working age population (also from WDI).

The full data series can be found at the end of this Appendix.

A.2 Additional Counterfactuals

Below, we present three additional sets of counterfactuals not presented in the main text. In the first of these exercises, we turn off all the driving forces except for population growth. The results can be seen in Figure 11.

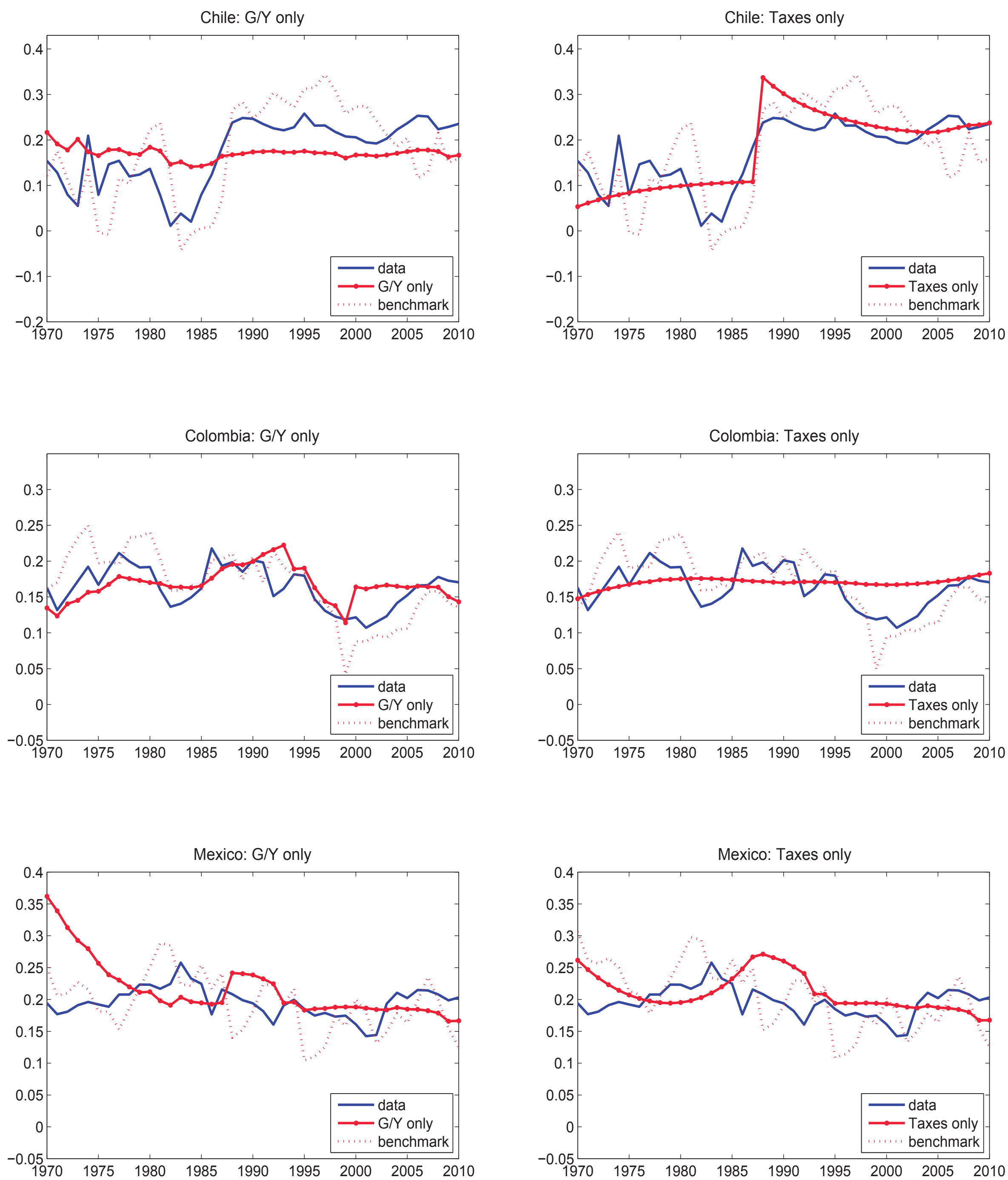
Figure 11: Saving Rate (additional counterfactuals): Population Only



Note: These plots compare the observed gross national saving rate in Colombia ("data," blue/solid) against the counterfactual case in which the only active force is population growth. Sources: World Bank's WDI and authors' calculations.

In this second set of counterfactual, we provide two additional experiments to isolate the effects of taxes on the one hand, and government spending on the other. In particular, we present an exercise in which all driving forces except taxes are turned off (left panel of Figure12), and then another counterfactual in which all forces except government spending are turned off (right panel of Figure 12). The results show that, in Chile, the impact of capital taxation on the saving rate dwarfs that of government spending, while in Colombia almost the exact opposite is true.

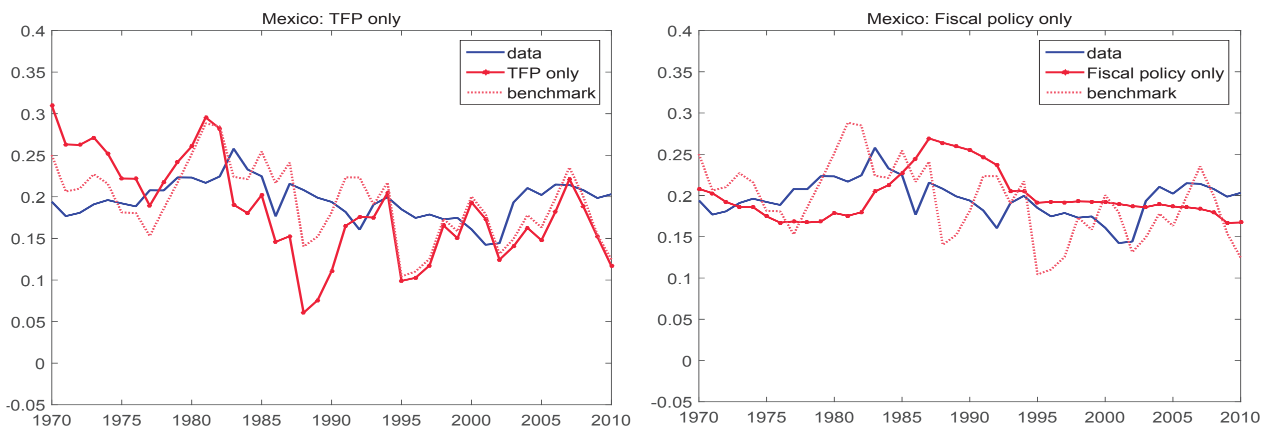
Figure 12: Saving Rate (additional counterfactuals): Government and Taxes



Note: The plots in the left column show the model-simulated saving rate that result when the only driving forces at work are government spending and lump sum taxes (red solid line). The plots in the right column show the model-simulated saving rate that result when the only driving force at work is capital income taxes (red solid line). For comparison purposes the plots also show the benchmark model-simulated saving rate (red dashed line) and the observed saving rate (blue line).

Next, we replicate the exercises of sections (4.1.1) and (4.1.2) for the case of Mexico. The left panel of Figure 13 displays the counterfactual experiment where only the time series data for the TFP growth rate are used in the simulations. Notice that this case generates even larger fluctuations than the benchmark economy. Therefore, the excess volatility generated in the benchmark simulations summarized in Figure 3 is likely due to the impact of the TFP growth rate that is used in the model. In the right panel where we feed in only the change in the tax rate and G/Y that took place in Mexico, the model generates very smooth saving rates that indeed increase due to the decline in the tax rates in 1986.

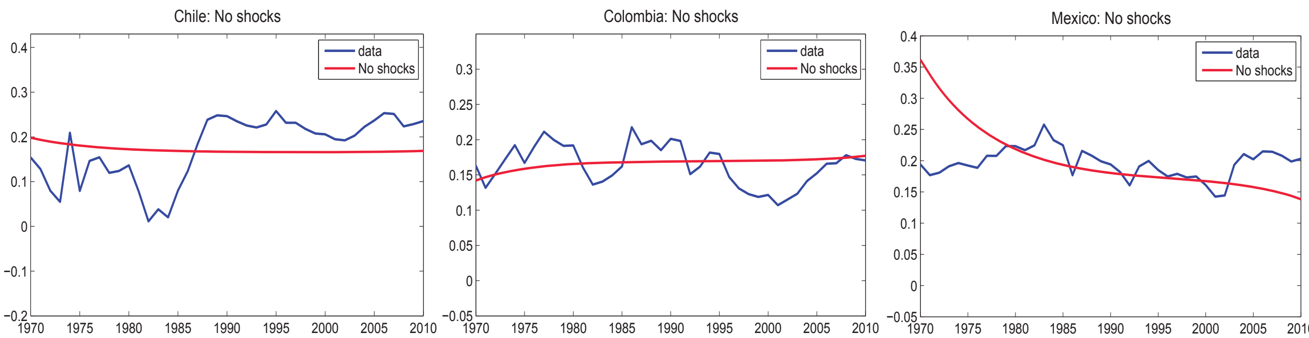
Figure 13: Saving Rate in Mexico: Counterfactual Experiments



Note: The left plot compares the observed gross national saving rate in Mexico ("data," blue/solid) against the counterfactual case in which the only driving force that is active when simulating the model is the TFP growth rate and the remaining three driving forces are set equal to their steady state levels ("TFP only," red/marker). The right plot compares the observed gross national saving rate in Mexico ("data," blue/solid) against the counterfactual case in which the only two driving forces that are active when simulating the model are the capital tax rates and the government spending shares while the remaining two driving forces are set equal to their steady state levels ("Fiscal policy only", red/marker). Both plots present also the simulated series using the calibrated benchmark neoclassical model when all four driving forces are used ("benchmark," red/dashed). Sources: World Bank's WDI and authors' calculations.

Finally, we shut down all exogenous forces –fixing them at their average for the entire simulation period– in order to confirm that variations in saving rates are little influenced by initial conditions (K_0).

Figure 14: Saving Rate (additional counterfactuals): No Shocks

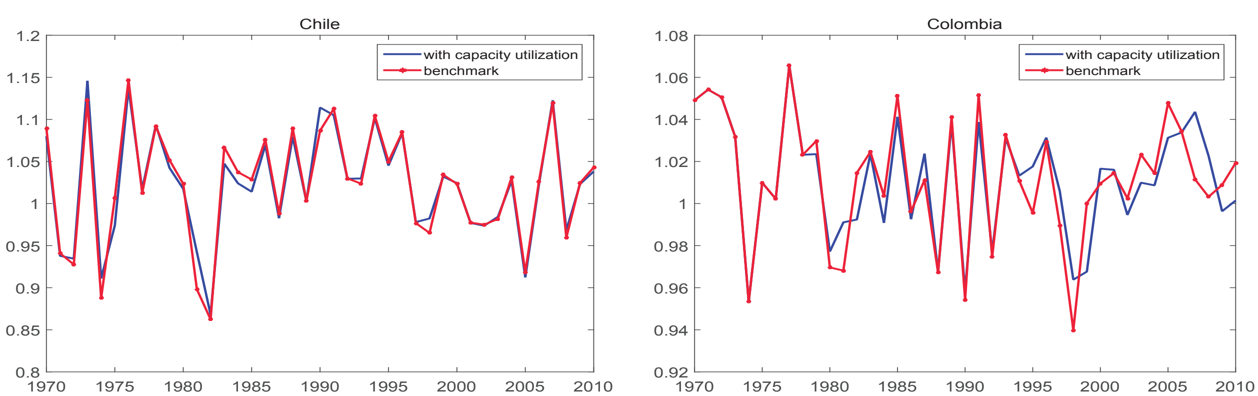


Note: These plots compare the observed gross national saving rate in Colombia ("data," blue/solid), against the model-simulated saving rate where all driving forces are fixed at their average for the entire period ("No shock", red/solid). Sources: World Bank's WDI and authors' calculations.

A.3 Capacity Utilization

Finally, the figures below present the times series for TFP growth rate for Chile and Colombia for the cases where capital is not adjusted for capacity utilization (benchmark) and when it is (robustness) in the two countries of the three (and years) that we study for which data on capital capacity utilization rates exist: Chile (1970-2010) and Colombia (1980-2010). Results are strongly robust when one does account for this additional dimension. Indeed, TFP growth rates with and without capacity utilization rates are strongly correlated in both Chile (0.98) and Colombia (0.85) for the sub periods mentioned above.

Figure 15: TFP With and Without Capacity Utilization

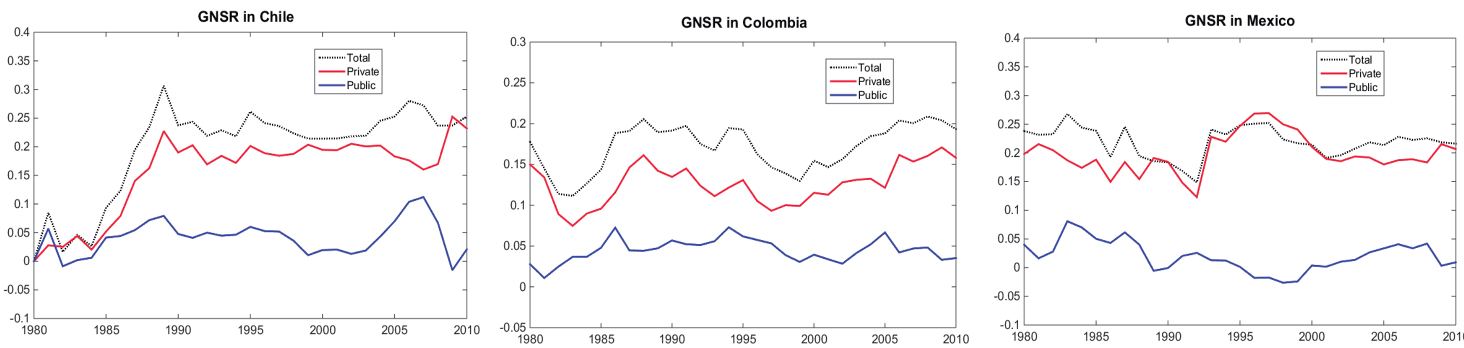


Note: The TFP series are computed by pre-multiplying the capital stock (after NFA adjustments) by the capacity utilization index. For Chile, the source for the utilization series is DIPRES (2016), while for Colombia the series is obtained from Fedesarrollo's Enterprise Survey (http://www.fedesarrollo.org.co/encuestas/boletines-empresarial-eoe/).

A.4 Public vs Private Saving

We obtain (nominal) public and private saving rates from the IMF's World Economic Outlook[25] and compare their evolution with respect to total saving rates. We present the results from this comparison in Figure 16. In all three countries it is easy to see that private saving rates closely trace the behavior of total saving rates. Moreover, the levels of private and total saving rates are very close in Chile and Mexico even though government saving rates deviate from the total saving rates at different times in the sample. In particular, in Chile after 2003, private and public saving rates seem to run opposite to each other. This may well be explained by the introduction of a fiscal rule, which dictated that the government saved most of the surge in revenues that followed from the sharp increase in copper prices during the mid-2000s. But fiscal rules are a very recent phenomenon, at least in Latin America, and play no role in public/private saving behavior during most of our sample.

Figure 16: Public Versus Private Saving



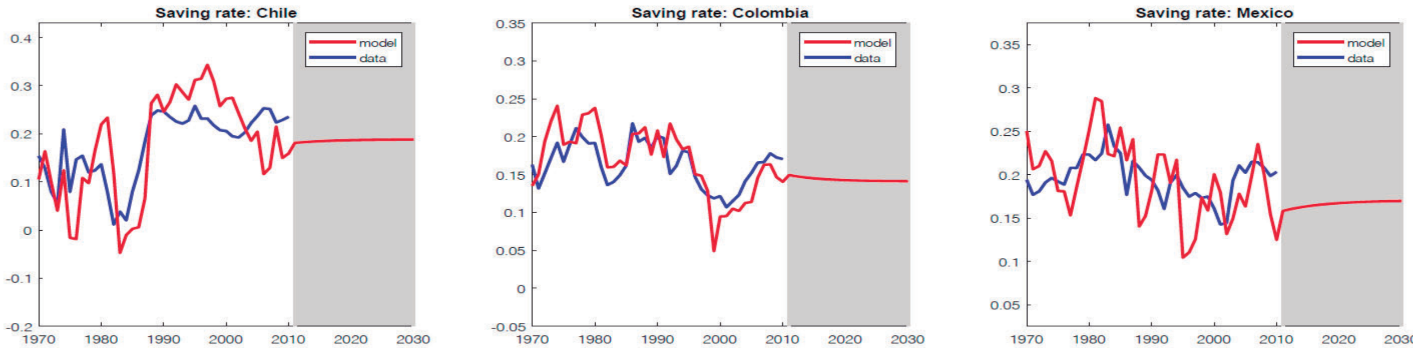
Note: These saving rates are obtained by dividing private and public saving in current units of local currency by gross national disposable income. Source: IMF's World Economic Outlook.

A.5 Convergence to the Steady State

Finally we provide an expanded version of Figure 3 which shows how the saving rate for the three countries converges to its steady state.

[25] To obtain saving figures, the IMF subtracts (public/private/total) consumption expenditure from gross national disposable income (GNDI), while we subtract from gross national income (GNI). The difference in final measures will be slim, but to produce consistent public and private gross national saving rates using the IMF data, we first obtain GNDI by adding consumption expenditure and savings from the IMF's WEO. Then we obtain the ratio of savings to GNDI as our measures of public and private saving rates.

Figure 17: Saving Rate: Convergence to the Steady State



Note: The figure presents the model-simulated saving rate as it converges to the steady state (red line) along with the observed saving rate (blue line). The shaded region represents the steady state convergence period.

Table 4. Full Dataset Colombia

year	TFP	pop	gov	labor	tax	K-toY data	Saving rate
1970	1.049	1.031	0.093	23.829	0.037	2.477	0.163
1971	1.054	1.032	0.112	23.772	0.043	2.402	0.132
1972	1.051	1.033	0.098	23.685	0.034	2.357	0.152
1973	1.032	1.033	0.097	23.581	0.035	2.320	0.172
1974	0.953	1.033	0.088	23.474	0.036	2.331	0.192
1975	1.010	1.035	0.091	23.886	0.039	2.391	0.167
1976	1.002	1.033	0.085	23.734	0.038	2.450	0.190
1977	1.066	1.032	0.078	23.946	0.028	2.477	0.211
1978	1.023	1.033	0.087	23.760	0.045	2.452	0.200
1979	1.017	1.034	0.094	23.581	0.027	2.508	0.191
1980	0.985	1.031	0.101	23.187	0.029	2.497	0.192
1981	1.015	1.033	0.106	23.401	0.030	2.544	0.160
1982	0.971	1.034	0.113	22.929	0.029	2.611	0.136
1983	1.023	1.032	0.114	22.103	0.026	2.607	0.141
1984	0.978	1.029	0.115	21.525	0.026	2.599	0.149
1985	1.031	1.027	0.112	21.378	0.026	2.573	0.162
1986	0.989	1.025	0.102	21.472	0.027	2.477	0.218
1987	1.036	1.024	0.091	21.929	0.031	2.502	0.193
1988	0.968	1.024	0.090	22.116	0.039	2.526	0.199
1989	1.036	1.024	0.097	22.535	0.039	2.603	0.185
1990	0.962	1.024	0.099	22.508	0.040	2.572	0.201
1991	1.026	1.024	0.097	23.418	0.063	2.652	0.198
1992	0.979	1.024	0.100	23.144	0.063	2.600	0.151
1993	1.030	1.024	0.104	24.134	0.057	2.557	0.162
1994	1.016	1.024	0.150	24.642	0.058	2.534	0.182
1995	1.040	1.023	0.155	25.148	0.057	2.513	0.180
1996	1.033	1.024	0.189	24.718	0.061	2.603	0.147
1997	1.022	1.024	0.209	24.601	0.060	2.514	0.131
1998	0.988	1.023	0.212	23.997	0.057	2.647	0.123
1999	0.936	1.022	0.231	22.937	0.074	2.914	0.119
2000	1.024	1.022	0.172	23.189	0.074	2.954	0.122
2001	1.018	1.021	0.173	22.888	0.082	2.923	0.107
2002	0.987	1.020	0.168	22.896	0.089	2.835	0.115
2003	0.997	1.020	0.165	23.177	0.090	2.813	0.123
2004	1.003	1.020	0.166	23.548	0.096	2.762	0.141
2005	1.015	1.018	0.166	24.011	0.099	2.703	0.152
2006	1.033	1.018	0.163	24.345	0.105	2.621	0.166
2007	1.077	1.018	0.162	24.812	0.105	2.576	0.167
2008	1.042	1.017	0.161	24.783	0.108	2.597	0.178
2009	0.984	1.016	0.173	24.388	0.111	2.701	0.173
2010	0.984	1.015	0.176	24.645	0.098	2.696	0.171

Table 5. Full Dataset Chile

year	TFP	pop	gov	hh	tax	K-toY data	Saving rate
1970	1.089	1.023	0.131	21.866	0.560	2.280	0.154
1971	0.941	1.024	0.155	22.176	0.560	2.175	0.128
1972	0.928	1.024	0.163	22.485	0.560	2.272	0.080
1973	1.123	1.024	0.133	22.178	0.560	2.361	0.055
1974	0.888	1.024	0.160	21.011	0.560	2.139	0.209
1975	1.007	1.025	0.163	19.708	0.560	2.233	0.079
1976	1.147	1.024	0.145	19.500	0.560	2.331	0.146
1977	1.013	1.024	0.142	19.851	0.560	2.133	0.154
1978	1.092	1.024	0.149	19.523	0.560	2.121	0.120
1979	1.052	1.024	0.148	19.397	0.560	2.009	0.124
1980	1.023	1.023	0.129	19.996	0.560	1.873	0.136
1981	0.898	1.024	0.138	19.959	0.560	1.887	0.079
1982	0.862	1.024	0.167	18.197	0.560	2.053	0.011
1983	1.067	1.023	0.156	18.986	0.560	2.231	0.038
1984	1.037	1.022	0.162	19.429	0.560	2.000	0.020
1985	1.029	1.021	0.154	20.211	0.560	1.793	0.080
1986	1.076	1.020	0.141	20.892	0.560	1.743	0.124
1987	0.988	1.020	0.120	21.304	0.560	1.639	0.184
1988	1.089	1.019	0.114	22.196	0.112	1.722	0.238
1989	1.003	1.019	0.110	22.998	0.112	1.616	0.248
1990	1.087	1.017	0.106	23.100	0.112	1.718	0.246
1991	1.113	1.017	0.105	23.158	0.112	1.624	0.235
1992	1.030	1.017	0.105	23.923	0.112	1.516	0.226
1993	1.024	1.017	0.109	24.947	0.112	1.467	0.221
1994	1.104	1.017	0.110	24.783	0.112	1.507	0.228
1995	1.050	1.017	0.108	24.849	0.112	1.466	0.258
1996	1.085	1.016	0.113	25.144	0.112	1.465	0.232
1997	0.977	1.016	0.115	24.671	0.104	1.423	0.232
1998	0.965	1.016	0.118	25.283	0.102	1.499	0.218
1999	1.034	1.017	0.128	24.354	0.097	1.658	0.208
2000	1.023	1.017	0.120	24.220	0.107	1.639	0.206
2001	0.977	1.017	0.121	23.866	0.110	1.676	0.195
2002	0.975	1.018	0.123	23.974	0.115	1.746	0.192
2003	0.982	1.017	0.121	24.318	0.111	1.812	0.203
2004	1.031	1.016	0.117	24.483	0.118	1.938	0.223
2005	0.918	1.015	0.114	24.180	0.144	1.981	0.237
2006	1.026	1.015	0.113	24.317	0.170	2.258	0.253
2007	1.119	1.014	0.116	24.203	0.174	2.398	0.251
2008	0.960	1.014	0.121	24.171	0.160	2.167	0.223
2009	1.025	1.014	0.135	23.445	0.108	2.458	0.229
2010	1.043	1.013	0.132	23.797	0.133	2.423	0.235

Table 6. Full Dataset Mexico

year	TFP	pop	gov	hh	tax	K-toY data	saving rate
1970	0.950	1.032	0.074	20.355	0.410	1.300	0.194
1971	1.017	1.032	0.078	20.778	0.410	1.413	0.177
1972	1.026	1.033	0.088	21.208	0.410	1.449	0.181
1973	0.982	1.034	0.093	21.627	0.410	1.452	0.191
1974	0.969	1.030	0.093	22.035	0.410	1.520	0.196
1975	1.006	1.032	0.106	22.685	0.410	1.610	0.192
1976	0.966	1.033	0.113	22.889	0.410	1.582	0.189
1977	1.039	1.033	0.111	23.076	0.410	1.677	0.208
1978	1.033	1.031	0.112	23.406	0.410	1.676	0.208
1979	1.024	1.034	0.112	24.057	0.410	1.674	0.223
1980	1.044	1.032	0.104	24.719	0.410	1.679	0.223
1981	0.971	1.031	0.112	24.785	0.410	1.676	0.217
1982	0.882	1.031	0.113	24.878	0.410	1.508	0.225
1983	0.978	1.033	0.094	24.240	0.410	1.851	0.258
1984	1.014	1.034	0.098	24.474	0.410	1.943	0.233
1985	0.930	1.035	0.097	24.847	0.410	1.828	0.225
1986	0.997	1.035	0.097	24.792	0.410	1.803	0.177
1987	0.906	1.034	0.092	24.813	0.410	1.786	0.216
1988	1.007	1.032	0.088	24.859	0.101	2.186	0.208
1989	1.029	1.030	0.086	24.995	0.101	2.183	0.199
1990	1.053	1.030	0.087	25.127	0.101	2.134	0.194
1991	1.007	1.029	0.093	24.447	0.101	2.101	0.182
1992	0.994	1.028	0.102	24.500	0.101	2.098	0.160
1993	1.029	1.026	0.133	24.790	0.101	2.151	0.191
1994	0.889	1.025	0.128	25.398	0.096	1.986	0.200
1995	1.001	1.024	0.137	24.750	0.076	2.213	0.185
1996	1.013	1.023	0.129	25.529	0.070	2.243	0.175
1997	1.051	1.022	0.124	26.979	0.078	2.165	0.179
1998	0.983	1.022	0.119	26.208	0.081	2.183	0.173
1999	1.049	1.020	0.117	26.836	0.086	2.196	0.175
2000	0.976	1.019	0.115	26.065	0.087	2.263	0.161
2001	0.949	1.018	0.116	25.300	0.093	2.437	0.142
2002	1.017	1.017	0.117	26.028	0.083	2.494	0.144
2003	1.026	1.018	0.115	25.164	0.074	2.570	0.193
2004	0.986	1.020	0.108	25.350	0.065	2.544	0.211
2005	1.041	1.021	0.109	25.777	0.066	2.562	0.202
2006	1.048	1.022	0.108	25.551	0.069	2.517	0.215
2007	0.961	1.022	0.108	25.234	0.074	2.519	0.214
2008	0.961	1.022	0.111	25.816	0.077	2.588	0.208
2009	0.965	1.022	0.122	23.924	0.079	2.898	0.199
2010	1.024	1.021	0.118	25.908	0.080	2.802	0.203