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Business cycle accounting for Argentina utilizing capital utilization*

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Abstract

We use a variation on the business cycle accounting method of Chari, Kehoe and McGrattan [3] to study the business cycle in Argentina from 1972 to 2006. We use capital utilization as a household decision variable to be able to better extract the wedge that functions as a tax on capital. Applying the model to Argentina, we find that all four wedges are important in explaining the evolution of output over this period (although net exports is the least important). The major political subperiods can be charaterized by the relative importance of each wedge. We compare the results of this technique to the standard narrative. JEL classifications: E22, E32, N16

1 Introduction

Using a prototype growth model, Chari, Kehoe and McGrattan [3] (henceforth, CKM) propose an accounting procedure for guiding researchers in developing and analyzing quantitative models of economic fluctuations. This procedure uses real data together with the equilibrium conditions of a prototype growth model to measure four wedges that are explained by the variables of the model. These wedges can be viewed as "distortions" from a perfectly competitive economy and represent the set of policies and institutions which affect productivity and factors input[1]. The authors show that a large class of economic models, including

*The opinions expressed here are those of the authors and should not be taken to represent those of the Banco Central de la República Argentina. Sabastian Katz and Carlos Zarazaga provided helpful comments.

[1]These are wedges in the sense that they measure how different the economy is from a closed, non-stochastic, perfectly competitive economy.

those with various additional features (e.g., financial frictions, nominal rigidities, entrepreneur decisions, and monetary shocks) are equivalent to a prototype growth model with time-varying wedges. Institutions, public policies, fiscal, monetary, income and labor policies affect the four wedges and therefore affect the allocations of capital and labor, net exports and productivity in the economy.

In their standard model for business cycle accounting, CKM use four wedges that are explained by four variables of the model. The period t value for three of the wedges, government expenditures and net exports, total factor productivity, and an implicit labor tax, are found using the model and period t data. The fourth wedge, an implicit capital tax, is found using the intertemporal relations of the model and its aggregate effects on output are found as a residual of the effects of the other three wedges. For the US data used by CKM, the capital wedge is found to be quite small. It is not clear if this is a characteristic of the US data they are using or a result of their calculation technique.

Making use of capital utilization data provides an alternative way of finding the capital wedge. Capital utilization information can be used directly in the production function (since it is utilized capital that creates production) and in the household budget constraint (since it is utilized capital that earns rents). In addition, it is quite natural to think of depreciation as being a function of capital utilization, since the more that capital is utilized in a period, the more likely it is to wear out and need replacement parts or maintaince. Given these characteristics of capital utilization, it becomes a household choice variable, households choose how much capital to send to the market each period, and adds an additional first order condition to the model. One can use this extra first order condition to extract, using period t data, a period t capital wedge.

CKM do provide an alternative specification in which they use variable capital utilization to adjust the capital stock. What they do not do, and what we do here, is make capital utilization a choice variable for the households, get the additional first order condition and use this extra equation to extract the capital tax and construct the capital wedge. Once the wedges are constructed it is possible to assess what fraction of output fluctuation can be attributed to each wedge separately and in combination.

In this paper, we apply a model with endogenous capital utilization to the Argentine economy[2] from 1972 to the end of 2006. The accounting procedure allows us to analyze the Argentine economy during a time period subject to several structural breaks and where these can be associated with different economic regimes. The wedge decomposition helps to explain several features that characterize each of the different economic regimes. Emphasis is given to the evolution of labor and capital wedge as well as factor productivity. In this model, total factor productivity is based on labor and utilized capital.

It should be noted that many of the nominal and real frictions that are often added to standard RBC models can be captured with one of our four wedges.

[2] Methods similar to those of the basic CKM method have been applied to both the modern Japanese economy and the prewar economy by Hayashi and Prescott [8] and [9] and to the French economy by Prescott [13]. Cole and Ohanan [4] have applied the basic model to the U.S. and U.K. and Cavalcanti [2] to Portugal.

CKM make much of this in their paper. Determining which wedges are most important for explaining the Argentine business cycle is a first step towards determining which frictions are most important in generating a productive RBC model of Argentina, especially if these models are to be used for forecasting or for analyzing monetary policy and monetary transmission channels.

2 The model with capital utilization

We assume that capital depreciation, δ_t, is a function of capital utilization, μ_t. Let depreciation in period t be given by

$$\delta_t = \overline{\delta} \exp\left(a\left(\mu_t - \overline{\mu}\right)\right)$$

where $\overline{\delta}$ is the average depreciation rate, a measures how strongly depreciation responds to capital utilization, and $\overline{\mu}$ is the average utilization. This formulation produces the average depreciation rate whenever utilitization is average and makes depreciation an increasing function of utilization. With this addition equation, we write the CKM model as

$$U = E_t \sum_{i=0}^{\infty} \beta^i u\left(c_{t+i}, h_{t+i}\right)$$

subject to

$$c_t + k_{t+1} - \left(1 - \overline{\delta} \exp\left(a\left(\mu_t - \overline{\mu}\right)\right)\right) k_t = \left(1 - \tau_t^h\right) w_t h_t + \left(1 - \tau_t^k\right) r_t \mu_t k_t + T_t$$

and a production function of the perfectly competitive firms of

$$Y_t = A_t \left(\mu_t K_t\right)^{\theta} \left(\gamma^t H_t\right)^{1-\theta}.$$

Expected utility for a representative household is a function of a constant discount factor, β, and an in-period sub-utility function that depends on the household's consumption, c_t, and on the labor it supplies, h_t. The household accumulates capital, k_t, and pays lump sum taxes, T_t. In the household budget constraint, the variables τ_t^h and τ_t^k are the implicit taxes being imposed by policies that are not oberved on labor and capital, respectively. Output of the one good is competitive and depends on the level of technology (total factor productivity), A_t, the aggregate capital being used, $\mu_t K_t$, and the aggregage supply, H_t, adjusted by the growth in labor augmenting technology, γ^t. The first order conditions for the firms (and the factor markets) are

$$w_t = (1 - \theta) \gamma^t A_t \left(\mu_t K_t\right)^{\theta} \left(\gamma^t H_t\right)^{-\theta}$$

and

$$r_t = \theta A_t \left(\mu_t K_t\right)^{\theta - 1} \left(\gamma^t H_t\right)^{1-\theta}.$$

Note that the rental rate calculated here, r_t, is that paid on utilized capital and not on total capital, and this is taken into account in the household budget constraint.

The first order conditions for the households (who, in period t, choose c_t, h_t, k_{t+1}, and μ_t) are

$$\begin{aligned}
\frac{u_h(c_t,h_t)}{u_c(c_t,h_t)} &= -\left(1-\tau_t^h\right)w_t \\
\left(1-\tau_t^k\right)r_t &= a\overline{\delta}\exp\left(a\left(\mu_t-\overline{\mu}\right)\right) \\
u_c(c_t,h_t) &= \beta E_t u_c\left(c_{t+1},h_{t+1}\right)\left(\left(1-\overline{\delta}\exp\left(a\left(\mu_{t+1}-\overline{\mu}\right)\right)\right)-\left(1-\tau_{t+1}^k\right)r_{t+1}\mu_{t+1}\right)
\end{aligned}$$

Three period t shocks (or wedges, are they are called in the literature), τ_t^h, τ_t^k, and A_t, can be found in terms of period t observations on the data from the first two of these first order condition and the production function as

$$\frac{u_h(C_t,H_t)}{u_c(C_t,H_t)} = -\left(1-\tau_t^h\right)(1-\theta)\gamma^t A_t\left(\mu_t K_t\right)^{\theta}\left(\gamma^t H_t\right)^{-\theta}, \quad (1)$$

$$a\overline{\delta}\exp\left(a\left(\mu_t-\overline{\mu}\right)\right) = \left(1-\tau_t^k\right)\theta A_t\left(\mu_t K_t\right)^{\theta-1}\left(\gamma^t H_t\right)^{1-\theta}, \quad (2)$$

and

$$A_t = \frac{Y_t}{\left(\mu_t K_t\right)^{\theta}\left(\gamma^t H_t\right)^{1-\theta}}. \quad (3)$$

In addition, A resource constraint that must hold is

$$C_t + K_{t+1} + G_t = Y_t + \left(1-\overline{\delta}\exp\left(a\left(\mu_t-\overline{\mu}\right)\right)\right)K_t.$$

Notice that with the extra choice variable of capital utilization, it is possible to extract all four of the time t shocks using just time t data on C_t, H_t, K_t, G_t, and μ_t. G_t come directly from the data on government expenditures and net exports. A_t is calculated given output, the production function and the data on the capital stock, capital utilization and labor (along with labor productivity growth). The wedges, τ_t^h and τ_t^k, are then calculated from the two remaining first order conditions.

In the actual implementation, we take K_0 as given and use the data on gross investment, I_t, and capital utilization to calculate the sequence of capital stock from

$$K_{t+1} = \left(1-\overline{\delta}\exp\left(a\left(\mu_t-\overline{\mu}\right)\right)\right)K_t + I_t.$$

Note that the capital stock path depends crucially on the parameter a of the depreciation function.

The sub-utility function[3] used for implementation is

$$u(C_t,H_t) = \log C_t + \psi\log(\overline{H}-H_t)$$

[3]The subutility function used in Kydland and Zarazaga [11] is

$$\frac{\left(c_t^{\alpha}\left(\overline{h}-h_t\right)^{1-\alpha}\right)^{1-\sigma}}{1-\sigma},$$

which give exactly the same marginal conditions when $\psi = \frac{1-\alpha}{\alpha}$.

so

$$\frac{u_h\left(C_t, H_t\right)}{u_c\left(C_t, H_t\right)} = -\frac{\psi C_t}{\overline{H} - H_t}.$$

With this Cobb-Douglas type utility function, we find the four wedges.

To find the impact of each of the wedges independently, we fix the values of three of wedges at their average value, use the time series for the capital stock that we found above, and use a nonlinear system solver in Matlab to find the values of C_t, H_t, μ_t, and Y_t as the zeros for the system

$$\begin{aligned}
0 &= -\frac{\psi C_t}{\overline{H} - H_t} + \left(1 - \tau_t^h\right)(1-\theta)\gamma^t A_t \left(\mu_t K_t\right)^{\theta} \left(\gamma^t H_t\right)^{-\theta} \\
0 &= a\overline{\delta}\exp\left(a\left(\mu_t - \overline{\mu}\right)\right) - \left(1 - \tau_t^k\right)\theta A_t \left(\mu_t K_t\right)^{\theta-1} \left(\gamma^t H_t\right)^{1-\theta}
\end{aligned}$$

$$0 = A_t - \frac{Y_t}{\left(\mu_t K_t\right)^{\theta}\left(\gamma^t H_t\right)^{1-\theta}}$$

$$0 = Y_t + \left(1 - \overline{\delta}\exp\left(a\left(\mu_t - \overline{\mu}\right)\right)\right) K_t - C_t - K_{t+1} - G_t.$$

In addition, we calculate the time path for output that comes from using the total factor productivity wedge and the capital tax wedge together, keeping the other two wedges at their average value.

3 The data and the wedges

The data are quarterly and run from 1972.1 to 2006.4, a relatively long period of time for studies of Argentina. The data for the four macroeconomic variables are quarterly, expressed in per capita terms in prices of 1993, and are shown in Figure 1 and those for utilization and labor (calculated from hours worked per capita) are given in Figure 2. The period has been characterized as one of economic and political turbulence in Baer, Elosegui and Gallo [1]. The first decade, from 1972 until 1982, has been characterized as a series of so called "stop and go" policies and the "plata dulce" period, with a seriously overvalued exchange rate, that ended in a debt crisis. The lost decade of the 80s can be characterized by systemic growing inflation and a final hyperinflation period mixed with a number of failed attempts to introduce stabilization programs. The problem of inflation was only dominated in 1991, with the introduction of the "Convertibility Plan", a currency board system that characterized the decade until its collapse at the end of 2001. Since 2003, the economy has been recovering from that crisis. The data encompass a number of policy regimes, substantial variation over business cycles and a virtually flat long run trend. The construction of the wedges should be able to help us to analyze each of these periods and the impact of their policies on capital, labor and productivity.

We use series on the real, per capita value of output, consumption (in this case, the combined private and public consumption), net exports, investment,

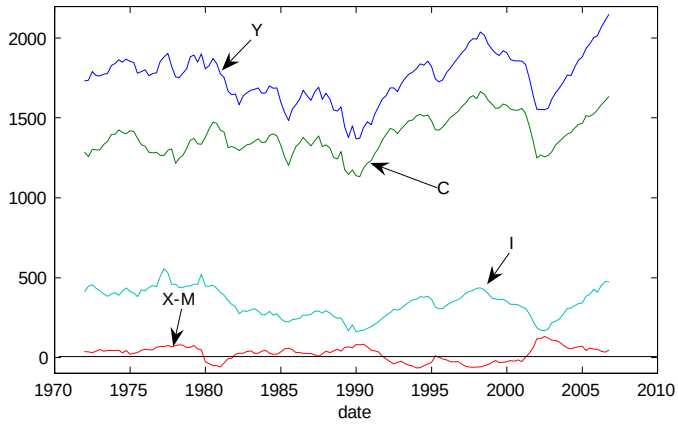

Figure 1: Deseasonalized macro data: Y, C, $X - M$, and I

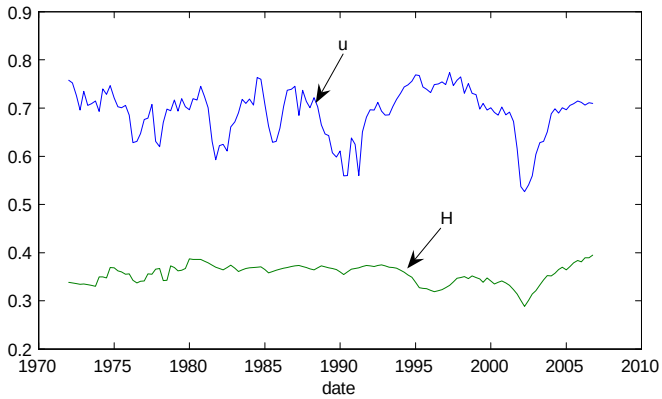

Figure 2: Data for utilization and labor

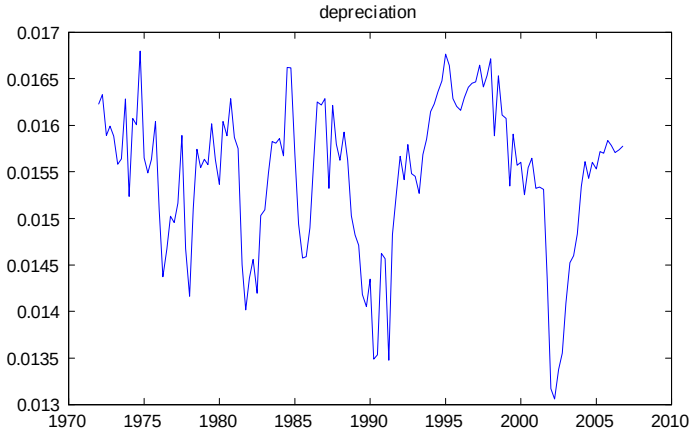

Figure 3: Depreciation

normalized hours worked, and an index for capital utilization[4]. The pre-1993 data do not come with private and public consumption separated, so we assume that government consumption enters the utility function mixed together with private consumption. Since government consumption is not available for the whole period, the variable G_t in the above equations only contains net exports. The series for the capital stock is constructed using

$$K_{t+1} = Y_t + \left(1 - \overline{\delta} \exp\left(a\left(\mu_t - \overline{\mu}\right)\right)\right) K_t - C_t - G_t,$$

using a value of 21490 for the 1980.1 value of the per capita capital stock, calculating backwards to 1972.1 and forward to 2006.4. In the calculations we used $\theta = .57$, $\overline{\delta} = .06174/4$, $\gamma^t = 1$, $\overline{\mu} = 0.6878$, $\psi = .75$, and $a = 1$. The depreciation series that comes from the function (in quarterly terms) is shown in Figure 3. The time series for capital (measured in quarterly, per capita, in prices of 1993 terms) that we get from these calculations is shown in Figure 4. For the years where the two studies overlap, our time path for the capital stock is generally similar to the one in Kydland and Zarazaga [10].

Using this data, we find A_t using equation 3, τ_t^h, using equation 1, and τ_t^k from equation 2. The net export wedge, G_t, comes directly from the data and are per capita, measured in prices of 1993. The wedges that result from these calculations are shown in Figure 5. The labor and capital wedges are measured as the fraction of income from each source paid as implicit taxes.

[4]The index on capital utilizaton comes from FIEL (Fundación de Investigaciones Económicas Latinoamericanas). The other data comes from INDEC (Argentina's Instituto Nacional de Estadística y Censos) except that output is defined from the national income accounting identity, $Y = C + I + G + netX$. Real variables are in terms of 1993 prices and were linked to earlier real series by averaging over overlapping dates.

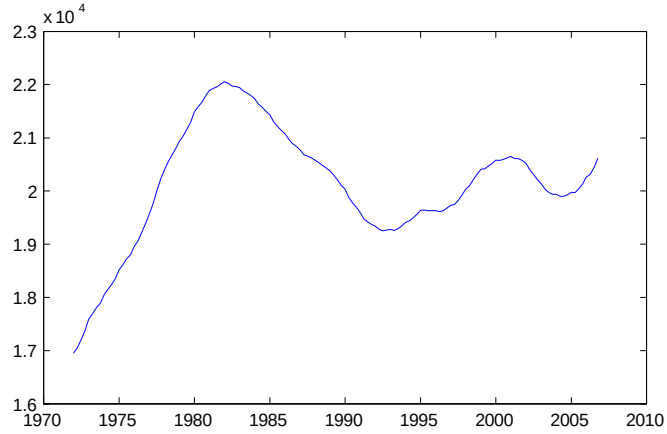

Figure 4: Calculated capital stock

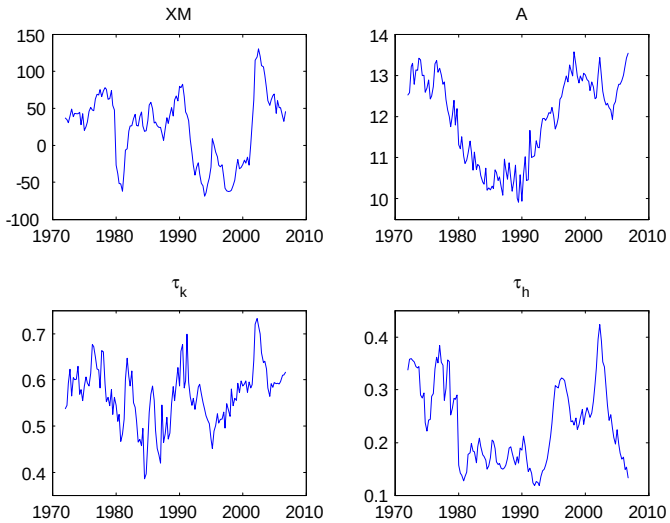

Figure 5: Four wedges for Argentina

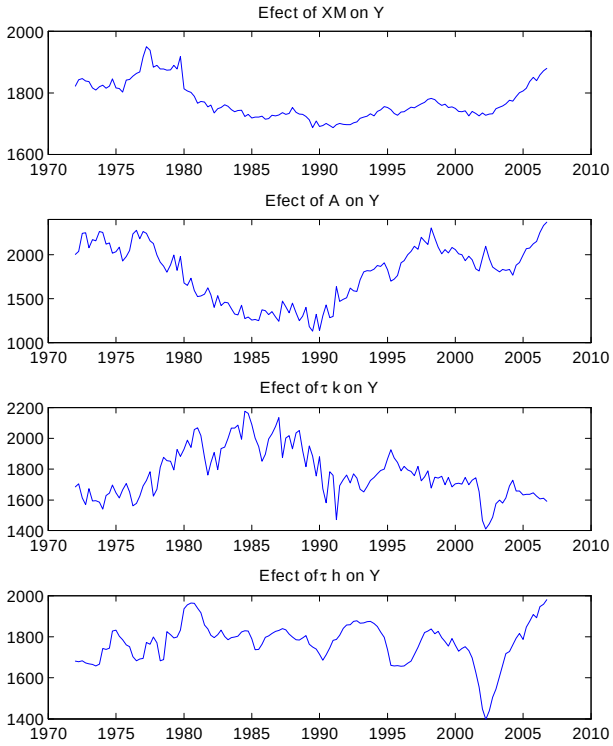

Figure 6: Effects of the four wedges on output

Taking each of these wedges separately and using the mean value for the remaining three, we calculate the importance each of the wedges has had in producing cycles in the Argentine economy. The contribution to Argentine output of each of the four wedges over the last 35 years are shown in Figure 6 and are quarterly, per capita, in prices of 1993.

In Figure 6, one can see that total factor productivity wedge, A_t, captures much of the long term cycle that is comprised of the decline of the 1980's, the growth of the 1990's and some of the crash and recovery of the 2000's.[5] It is interesting to note that there is a peak in the total factor productivity factor in 2002, since the decline in labor and capital utilization meant that the factors

[5] Using this method on data with the seasonals left in puts most of the seasonal variation in total factor productivity. The biggest seasonal variation for Argentina is a sharp fall in output caused by vacations during the first quarter of each year. Net exports explain a bit of the seasonals caused by primary product exports.

still being used were highly productive. Total factor productivity "explains" a deeper cycle than is seen in the data and is mostly compensated by the effects of the capital tax.

The part of the business cycle explained by net exports is quite small, although it does capture a slow decline until around 1993 and a gradual rise thereafter. The relatively small contribution that net exports makes in explaining the cycles is at odds with claims that real international shocks are important for explaining the Argentine business cycle.

The bottom two graphs in Figure 6 show the effects of τ_t^k and τ_t^h. Neither of these explains much of the long term cycle and the part of output that is explained by the capital wedge is negatively correlated with that cycle for most of the period. The capital wedge captures a number of important events in Argentine economic history. Capital clearly suffered from the hyperinflations of 1989 and 1991 as well as the inflation leading up to the Austral Plan in 1985 and the debt crisis of 1981-2. Interestingly, capital did not seem to suffer during the Tequila crisis around 1995, where most of the changes seem to be reflected through the labor wedge. Capital also suffered from the 2002 crisis but recovered to a level similar to that before the crisis. This last suggests that the output growth in the last few years of the period under study does not seem to have come from policies that benefit capital. The labor wedge indicates that the part of output explained by labor had a long slow decline during the 1980's, although it was much less sensitive to business cycles than capital, suffered in the hyperinflations at the beginning of the 1990's, recovered a bit after that only to be heavily hit by the Tequila crisis of 1995. This is consistent with the big jump in unemployment observed in Argentina in the mid-1990's. The $2001-2$ crisis initially had as big an impact on labor as it did on capital but the output effects of the labor wedge continue to show improvement up to the last observations available.

Figure 7 shows how well the combined effects of the total factor productivity wedge, A_t, and the capital tax wedge, τ_t^k, explain output. As can be seen in the center two graphs of Figure 6, the effects of total factor productivity alone is a very large long cycle and that of the capital tax alone is a similar long cycle but going in the opposite direction. When the two wedges are taken together, they capture a very large fraction of the movement in output. Given how our accounting method is constructed, the little that is left to explain must be captured by the other two wedges.

A second way of studying how well each wedge explains output is to look at the correlation coefficient between output and the part of the business cycle explained by each wedge separately. Table 1 shows these correlations coefficients. The upper number in each box give the correlation coefficient between the variable to the left and that above from the data in levels. Since we cannot reject the hypothesis that output in Argentina has a unit root[6], the lower number in each box shows the correlation coefficients for the first differences of the same variables.

[6] Using an augumented Dickey-Fuller unit root test.

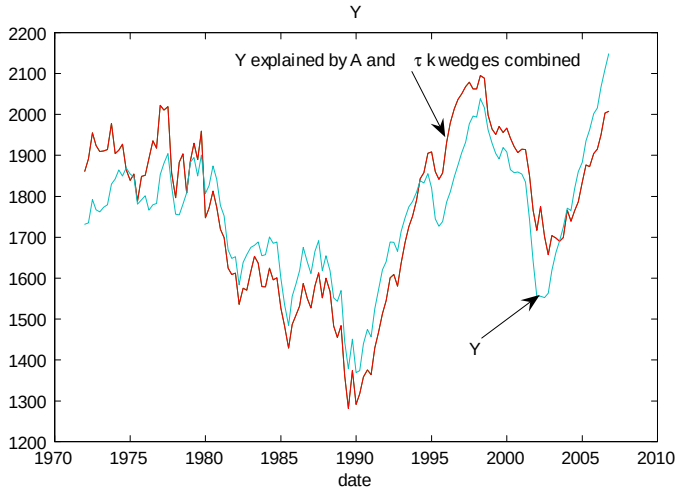

Figure 7: The combined effects of the total factor productivity wedge and the capital tax wedge

	Y	Y_{XM}	Y_A	Y_{τ^k}	Y_{τ^h}
Y	1.0000 1.0000	0.6111 0.5288	0.7971 0.5641	−0.2439 −0.0946	0.3282 0.4616
Y_{XM}	0.6111 0.5288	1.0000 1.0000	0.6663 0.4685	−0.2582 −0.0796	0.0941 0.0138
Y_A	0.7971 0.5641	0.6663 0.4685	1.0000 1.0000	−0.7052 −0.7729	−0.1702 −0.0483
Y_{τ^k}	−0.2439 −0.0946	−0.2582 −0.0796	−0.7052 −0.7729	1.0000 1.0000	0.4088 0.0794
Y_{τ^h}	0.3282 0.4616	0.0941 0.0138	−0.1702 −0.0483	0.4088 0.0794	1.0000 1.0000

Table 1: Correlations of output and the part explained by each wedge

One of the most interesting features of Table 1 is the correlation between the part of output explained by total factor productivity and that explained by the capital tax. This is strongly negative, whether measured in levels or in first differences. As we showed above, these two wedges combined explain a large fraction of the movement in output. The path of output that results from the combined effects of the total factor productivity wedge and the capital tax wedge has a 90.17% correlation with the output data when measured in levels and a 81.04% correlation when measured in first differences. This result in the table suggests that in Argentina, whenever there is an increase in total factor productivity, it is met with increase in policies that operate as a tax on capital[7]. Looking at the wedges themselves in Figure 5, the tax on capital moves very much like total factor productivity except during the hyperinflations of 1989 and 1991 when the tax on capital rises without a compensating rise in total factor productivity and in the Tequila crisis of 1995 when the tax on capital falls dramatically with only a small decline in total factor productivity.

The effects of each of the wedges on C, μ, and H are shown in Figure 8. As one might expect, given the importance of output in determining consumption, the effect of each wedge on explaining consumption is very similar to its effect on explaining output. The effect of net exports, the unlabeled line in each graph, is small in all cases, although it is a bit more important, and seasonal, in explaining labor movements. In explaining capital utilization, it is not surprising that the capital wedge captures some important movements, especially the drop in 2002. Technology, A, captures long trends in the capital utilization as well as some seasonals. The labor tax wedge does not explain much of utilization, although it does reinforce the decline in the 2002 crisis.

Most of the movement in employment is explained by the labor tax wedge. The net export wedge provides a bit of a seasonal and a bit of long term movement, however, this is small. The impact of the technology (A) wedge and the capital wedge on labor are very similar, so much so that they cannot be very well separated in the graphs.

4 More detailed historical analysis of the growth accounting exercise for Argentina

Major crises have occurred with certain regularity in the period under consideration. A serious inflation in 1975-6 was followed by a military coup (a potential regime change[8]). A period of an overvalued peso (known as the Tablita) was followed by a foreign exchange crisis. The return to democracy witnessed high and rising inflation that in 1985 was met with the Austral plan. The transition from the 1980s to the 1990s suffered two hyperinflations. A banking crisis in 1995 resulted in the closing or consolidation of much of the banking system.

[7] An alternative hypothesis is that whenever policies go against capital, firms respond by increasing total factor productivity.

[8] Zablotsky [14] looks at military coups in Argentina as regime changes with democratic periods raising taxes on land and military regimes lowering them.

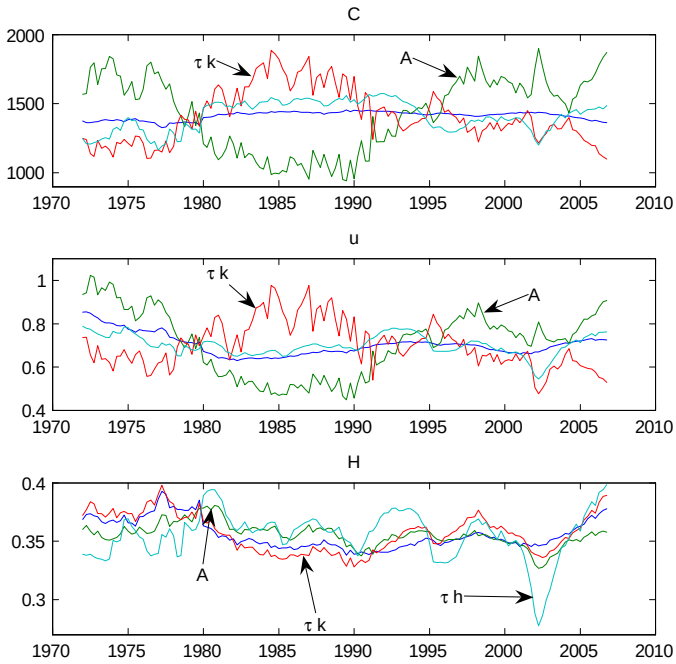

Figure 8: Effect of each wedge separately on C, μ, and H

The recession that began in late 1998 became a full blown banking and exchange crisis in 2002. Each of these crisis events can be noted in Figure 6, with greater or lesser short term impact on output. What is of interest is how these crisis differed and what our wedges can tell us about how they were different.

The return of Peron to power in 1973 is marked by a sharp decline in the labor tax and a relatively small decline in total factor productivity as seen in Figure 5. The labor tax returns to its original level with the military coup of 1976 and stays high for most of the time the military is in government (it falls at the end of the period as the military is leaving government). There is a steady fall in the capital tax over the military period that is accompanied by a secular decline in total factor productivity. The overvalued peso of the Tablita permitted capital accumulation and is observed in the positive effect of net exports on output in the period just prior to 1980. This capital accumulation is also indicated in the increase in output from the capital tax but does not show up in total factor productivity.

The low level of the tax on labor continues throughout all of the Alfonsin presidency. During the first part of this period, total factor productivity continues to fall and then stays low for the second half of the 1980's (the so called "lost decade"). The tax on capital rises for most of this period, although with substantial variation. The effects of net exports on output are relatively constant over the Alfonsin period. The hyperinflation of 1989 generates rises in net exports (as imports fall) and increases in the capital tax, but has little effects on the labor tax or on total factor productivity.

The hyperinflation in 1991, at the beginning of the Menem period, was somewhat different from that of 1989. The effects of both the capital and labor wedge on output are negative and the tax on capital was particularly high. It is also one of the peaks of the net export wedge. The beginning of the convertibility period[9] is marked by a fall in the tax on labor (and a increase in output from the labor wedge) and a secular rise in total factor productivity. The Tequila crisis of 1995 hit labor hard but had almost no effect on the other wedges. This is consistent with the large increases in unemployment that accompanied and followed that crisis.

The general trend of the recession of 1999 to 2002 and the recuperation after is captured in the net export wedge. The crisis of 2002 hits both the labor and capital wedges hard, with sharp increases in the wedges and sharp declines in the part of the business cycle explained by these wedges. These two effects are so sharp that total factor productivity actually rises during this crisis. The recovery during the Kirchner years comes from a large reduction in the tax on labor, an increase in total factor productivity, and a decline in net exports. The tax on capital increases to a level similar to the Peron period at the beginning of the sample (the mid-1970's). In Figure 6, the effect of both the labor wedge and factor productivity are the highest over the sample and the effect of net exports is close to the maximum. The effect of the capital wedge is a small decline after the initial recuperation from the 2002 crisis. These results are

[9] See Baer, Elosegui and Gallo [1] for a detailed explanation of the convertibility plan.

consistent with the perception that the Kirchner government looks to benefit workers with policies that tend to increase wages, promote labor formalization and increase labor union powers while imposing increased tax pressures on the owners of capital and land. In a model as simple as this one, what we call the capital stock is comprised of physical capital and land.

5 On the importance of the capital stock path

The calculation of the time path for capital is one of the more difficult aspects of this analysis. The capital path is important in determining two of the wedges, that of total factor productivity and the capital tax, and is important in determining the time path of output that comes from each of the wedges. Data on the capital stock is not good and capital stock series are created from the investment series, an estimate for some initial capital stock, the average depreciation rate, and the function of the capital utilization rate.

The time path for capital that comes from the investment series is sensitive to the choice of an average depreciation rate and to the initial capital stock, although the importance of the initial capital stock diminishes with time. Figure 9 shows the calculated time paths for capital for three values of δ and of K/Y_{1980}. The top-most graph uses a depreciation rate of 6.17% per year and a capital stock for 1980 of 2.85 times output. This series for capital is consistent with a literature that gives estimates of the capital stock for Argentina that are high by international standards and where this capital stock is attributed to a mix of protectionism and government regulations that make labor expensive and difficult to change. In a regulatory environment in which labor dismissal costs go up with length of service and can become quite large, optimizing firms tend to keep their labor force small and use relatively high quantities of capital. The second and third graphs use depreciation rates and output capital ratios more in keeping with world averages. The second graph uses the values from Kydland and Zarazaga [10]. What is very different in this graph is the first decade of the period: there is much less growth in the capital stock during the 1970s. The third shows how a slightly lower depreciation rate and initial capital stock result in a time path not much different from the first, although at a lower output-capital ratio.

The set of wedges that come from using the first capital series are shown in Figure 10, those from the second capital series in Figure 11, and those from the third capital series in Figure 12. Notice that the capital stock has no effect on the wedges related to net exports and the labor tax. The only effects are on the total factor productivity (A), and the tax on capital. For the first and third capital series, the changes are very minor. The relative fall in total factor productivity during the period from 1970 through 1990 is somewhat large with the third capital stock and the rise in TFP in the 1990's is somewhat smaller. The capital tax series is very similar for these two as well.

For the second capital series (the one that is closest to that of Kydland and Zarazaga [10]), the fall in TFP during the first 20 years is smaller and the

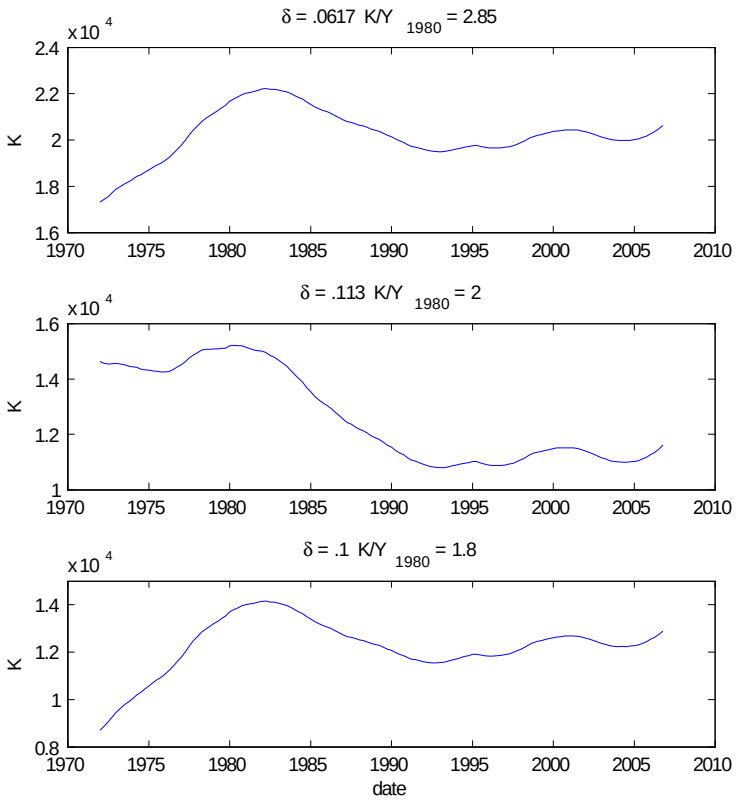

Figure 9: Three different calculations of the capital stock

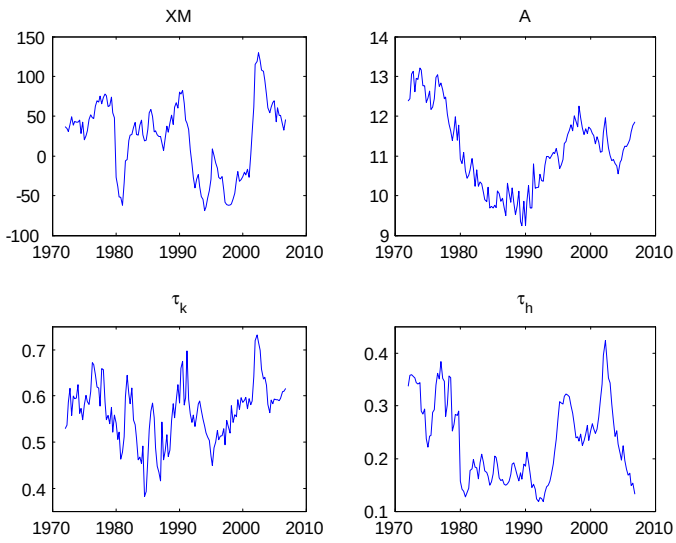

Figure 10: Wedges when $\delta = .0617$ and $K/Y_{1980} = 2.85$

growth during the 1990's is substantially larger than those that result from the other two capital stock series. The capital tax associated with this capital stock series implies a small drop in the tax in the 1980's and a more secular upward trend thereafter (with similar variations, however).

All three of the capital stock series shown here produce what Kydland and Zarazaga [11] refer to as Argentina's capital shallowing. They note that there was relatively little recovery in the capital stock in the boom of the 1990s after the long period of capital stock rundown that was the 1980's. Their model predicts a capital stock at least 20% higher than the observed one. The output boom of the 1990s seems to have been more motivated by increases in total factor productivity and by early declines in the capital tax than by capital accumulation. There was substantial new startup activity in the first half of the 1990s, concentrated mostly in service and commercial sectors, and many of the older import substituting manufacturing plants were closed (see Escudé, et al [7]). Since the service and commercial sectors tend to be less capital intensive than manufacturing, this shift in production away from manufacturing may explain at least part of the capital shallowing observed.

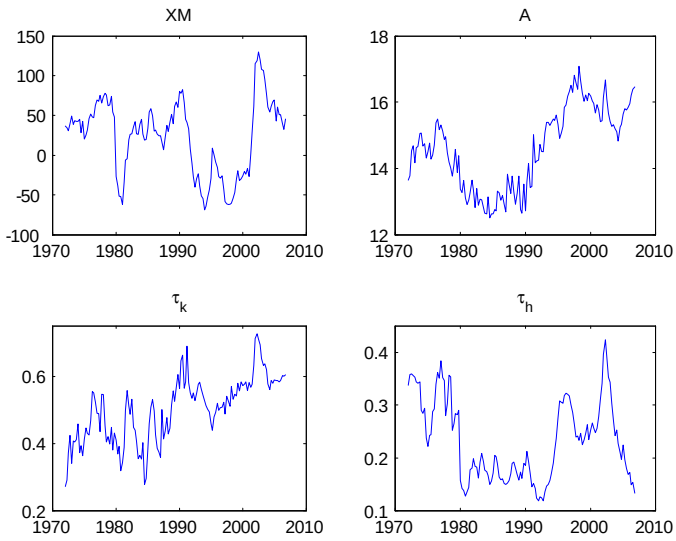

Figure 11: Wedges when $\delta = .113$ and $K/Y_{1980} = 2$

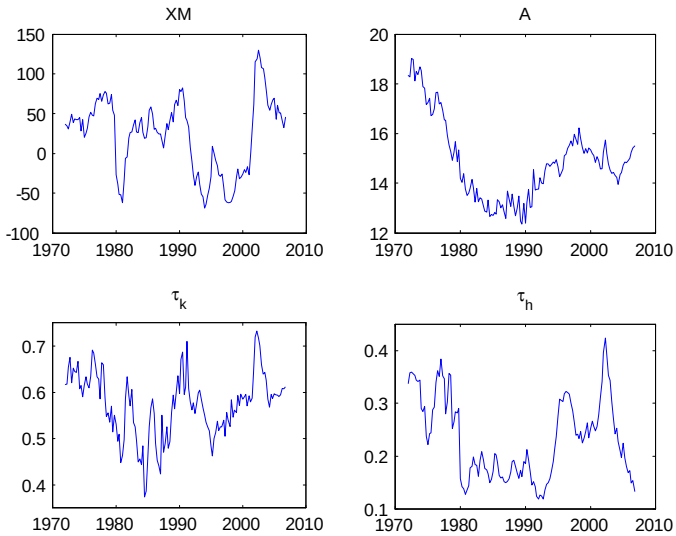

Figure 12: Wedges when $\delta = .1$ and $K/Y_{1980} = 1.8$

6 Conclusions

The growth accounting technology provides another window through which we can decompose the economic history of a country. The narrative of economic history frequently points out that particular policies were favorable to one or another factor or that much of the evolution of the period was based on Solow residuals or total factor productivity[10]. The growth accounting technique allows us to decompose the business cycle and growth of Argentina into a net export component, a total factor productivity component, and components that functions as taxes on labor and on capital.

This paper makes two contributions to the literature. First, we provide a method for extracting the wedge that functions as a capital tax by adding to the model capital utilization as a household decision variable and then applying the data on capital utilization to the wedge extraction process. With this method, the wedge for the tax on capital makes a substantial contribution in the explaining the business cycle of Argentina (while the earlier method resulted in very little explanatory power for the capital wedge for the United States). This result may come from the method or may come from the greater importance that the capital wedge has in Argentina. Notable is the large negative correlation between total factor productivity wedge and the capital tax wedge. Further, cross-country studies on the importance of taxes on capital over the business cycle and its relationship to growth is suggested. The second contribution is applying this method to Argentina and comparing the results of the growth accounting technique to the narrative history.

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