Competition, Bargaining and Income Distribution in Argentina and the United States [*]

by Germán Coloma [#]

Abstract

This paper presents a model of capital accumulation and income distribution that comes from the dynamic interaction between capitalists and workers in an economy. The model is later applied to fit data from the Argentine and the US economies, and to test if they are closer to the implications of a competitive or a bargaining solution. The first one is associated to a Walrasian equilibrium of the theoretical model, while the second is computed as a Nash cooperative solution. The empirical results obtained seem to confirm our original intuitions that the United States exhibits a greater degree of competitive behavior and bargaining forces have been more important in Argentina, but no single behavioral hypothesis is able to explain income distribution in any of the two countries.

Resumen

Este trabajo presenta un modelo de acumulación de capital y distribución del ingreso que surge de la interacción dinámica entre los capitalistas y los trabajadores de una economía. El modelo se aplica a sendas bases de datos correspondientes a las economías argentina y estadounidense, a fin de verificar si las mismas siguen un comportamiento ligado a la competencia o a la negociación colectiva. A la primera de tales hipótesis se la asocia con un equilibrio walrasiano del modelo teórico, en tanto que a la segunda se la computa como una solución cooperativa de Nash. Los resultados empíricos parecen confirmar la intuición original de que los Estados Unidos exhiben un nivel mayor de comportamiento competitivo y de que la negociación colectiva ha jugado un papel más importante en la Argentina, pero ninguna de las dos hipótesis puras es capaz de explicar totalmente la distribución del ingreso en ninguno de los dos países.

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In previous work of ours (Coloma, 1996) we saw that alternative behavioral assumptions about capitalists and workers in an economy, together with changes in the rules which govern their interaction, were able to generate different equilibrium patterns of capital accumulation and income distribution. These alternative patterns can be used to calibrate macroeconomic models and to test hypotheses about the characteristics of the economy and the behavior of its agents of production.

In this paper we show an example of application of the ideas described before to the cases of Argentina and the United States. To do that, we use aggregate data from the National Income and Product Accounts and from other related sources. With those data we estimate the basic parameters of the utility and production functions of representative capitalists and workers in the two economies. That information is later used to test if the income distributions in the Argentine and the US cases are closer to the implications of a competitive or a bargaining solution.

The paper is organized as follows. In section 1 we explain some basic macroeconomic characteristics of Argentina and the United States during the periods of time considered, and in section 2 we summarize the basic theoretical model that underlies our work. In section 3 we describe the functional forms and the estimation strategy that we use to proceed with our empirical exercise, while in section 4 we analyze the basic results that we obtain. Finally, section 5 presents the conclusions drawn from the analysis.

1. Characteristics of the economies

Although both nations share some common geographical and historical elements, Argentina and the United States are essentially two very different countries. The former is a mid-size, mid-income Latin American country, while the latter has a much larger area, population and income per capita, and its gross domestic product is by far the largest in the world. Therefore, the choice of these two examples does not pretend to compare the basic macroeconomic dimensions of two clearly distinct examples, but relies on the fact that these are the two economies whose data are more readily available to us.

There is, however, an important intuition that make the Argentine and the US economies interesting examples of cases which are *ex-ante* close to two types of intertemporal equilibria. The United States is one of the countries where markets have always been more developed and competition has been an explicit goal of its policy-makers. On the contrary, Argentina has a long history of protectionism and intervention and, especially after 1945, a tradition of large-scale bargaining between its economic actors. This may imply that the US is likely to be a relatively pure example of an economy whose dynamic equilibrium follows a Walrasian path, while Argentina's long-term position may probably be closer to a bargaining outcome such as the Nash solution.

In order to test if those ideas are correct, we first need to collect some data for the two economies. In both cases, we construct databases of 38 annual observations, which contain information about 12 variables. Those variables are output (q), labor (h), capital stock (k), workers' consumption (c_L), capitalists' net income (yn_K), investment (inv), capitalists' consumption (c_K), depreciation of the capital stock (dep), per-capita labor productivity (γ), wage rate (w), depreciation rate (δ) and population (pop).

For the case of the United States, our data cover the years between 1954 and 1991, while for Argentina the observations correspond to the period 1943-1980. For the US economy our basic source is the *Citibase* data bank, produced by Citicorp (1994), but the data on capital stocks is taken from Musgrave (1992). For Argentina, all the data come from a work by the Instituto de Estudios Económicos sobre la Realidad Argentina y Latinoamericana (IEERAL, 1986), which compiles statistics on the economic evolution of Argentina. Where possible, the series whose expression is in monetary units are constructed using nominal data deflated by an index of implicit GDP prices.

Due to discrepancies in our statistical sources, we sometimes had to use different methodologies to measure the same phenomena in each country. Probably the most noticeable difference appears in the measurement of labor, which for the United States consists of an estimation of the total number of hours worked, and for Argentina is a series of the total number of employed people. Population is also measured differently, since for the US economy we use a series of potentially active population defined as the total number of inhabitants older than 17 years of age, while for Argentina we use an estimation of the total population in the country. For the United States, workers' consumption is defined as equal to the total remuneration of labor in the economy, and the wage rate (per hour) is obtained by dividing that remuneration by the number of hours worked. Conversely, for Argentina we have a series of annual wages per capita, and we obtain the total workers' consumption by multiplying that series by the one referred to total employment.

For both countries, however, the net income of the capitalists is defined as the sum of the rewards received in the economy in concept of interests, rents and profits, and the depreciation rate is the ratio between the total depreciation and the capital stock at the beginning of each year. The capitalists' consumption is obtained by adding up their net income and the total depreciation and subtracting the investment, which is defined as equal to the internal gross investment. Total output is obtained as the sum of workers' consumption, capitalists' consumption and investment, and it does not include the portions of income whose distribution is ambiguous. Finally, the level of per-capita labor productivity is measured as an index of the evolution of output per capita.

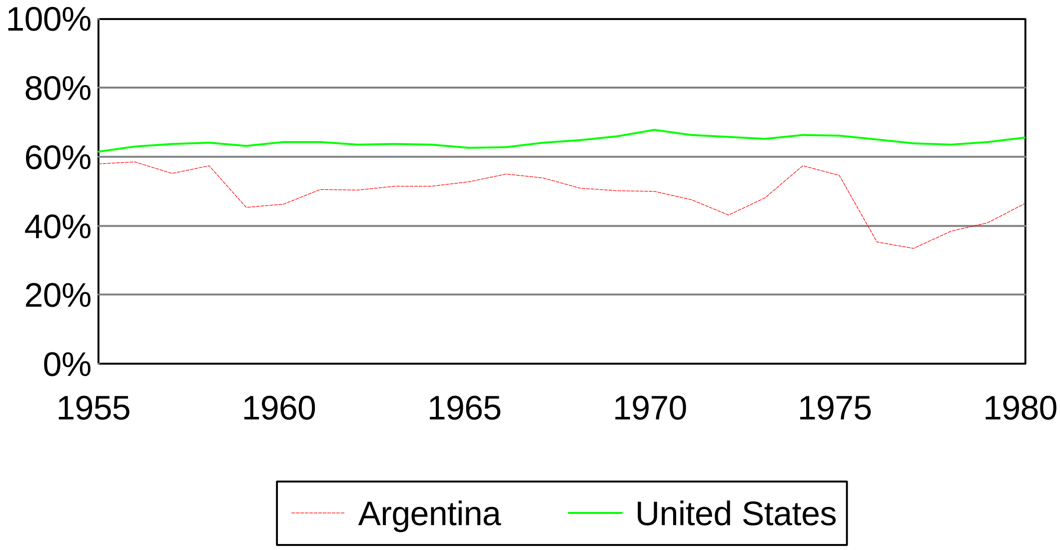
Although the variables chosen to calibrate our economies are the same in both cases, the different methodologies used and the fact that the data comes from different sources and is expressed in different units (dollars of 1987 for the United States, and pesos of 1960 for Argentina) make some absolute comparisons meaningless or even impossible. However, we are still able to calculate some comparable rates and indices for the two economies, like the ones which appear on table 1. Due to the differences in the periods covered in our series of observations, the numbers for Argentina have been divided into two sub-periods: the first eleven years (1943-1953), and the last twenty-six (1954-1980). The same criterion is followed for the case of the United States, where the two sub-periods are 1954-1980 and 1981-1991.

1. Basic Macroeconomic Indicators

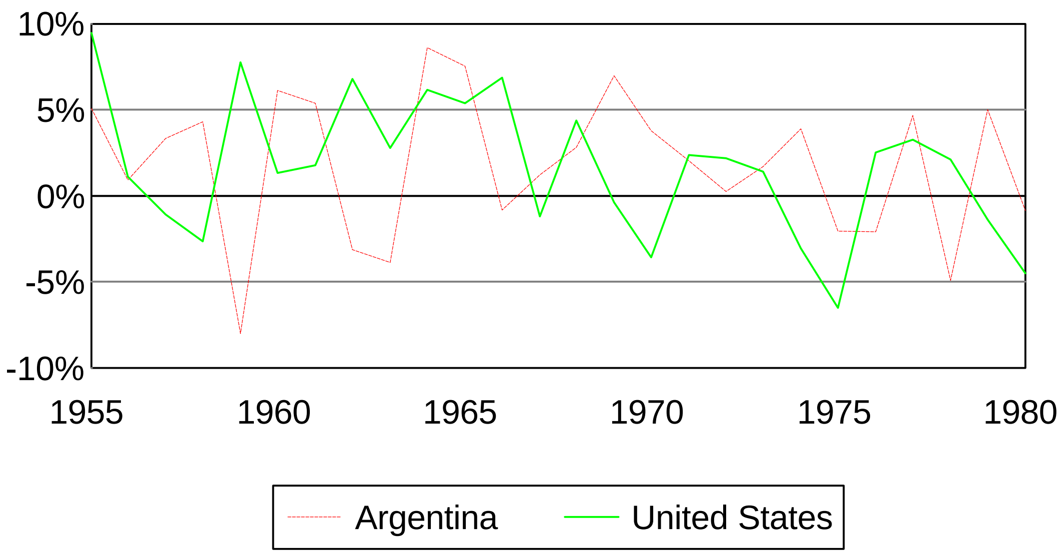
Concept	W / Y	K / Y	I / Y	R / K	Growth
Argentina					
1943-1953	0,5569	2,2037	0,1407	0,1632	0,0152
1954-1980	0,4860	2,1787	0,2063	0,1842	0,0177
1943-1980	0,4983	2,1831	0,1950	0,1805	0,0169
United States					
1954-1980	0,6462	1,7499	0,1804	0,1364	0,0163
1981-1991	0,6418	1,9759	0,1753	0,1152	0,0191
1954-1991	0,6445	1,8390	0,1784	0,1275	0,0172

The figures on table 1 show important structural differences between both countries in all the indicators that have to do with the distribution of income and the use of capital. If we look at the period that goes from 1954 to 1980, for example, the participation of wages in total income (W/Y) averages almost 65% in the United States and is smaller than 49% in Argentina. Conversely, the rate of return of capital (R/K), measured as the ratio between "yn_K" and "k", is almost five points higher in Argentina than in the US. The ratio of capital to income (K/Y) is also considerably higher in Argentina.

1. Participation of Wages
(as a percentage of income)



2. Rate of Per Capita Growth
(% with respect to previous year)



Contrary to what one would expect, the rate of per-capita income growth that both economies exhibit during the period 1954-1980 is almost the same (between 1.6% and 1.8% per year), and the ratio of investment to income (I/Y) is even higher in Argentina than in the United States[1]. Moreover, the movements of the growth rate in both countries are considerably erratic along time, although in general the US seems to exhibit a slightly smaller dispersion, as figure 2 shows. What really strikes as extremely different between the two countries, however, is the evolution of their wage shares in total income. In this item, the figure for the US follows a relatively stable pattern which is never below 60% and never above 70%, while Argentina begins with a share above 55% in the late fifties which falls below 40% in the late seventies (see figure 1).

2. Theoretical model [2]

In order to model capital accumulation and income distribution along time, let us define an economy with one worker and one capitalist. Both agents are infinitely lived and have strictly concave, twice differentiable utility functions that depend positively on their own consumptions. The worker's utility also depends negatively on the amount of labor that he supplies. The two utility functions are additively separable along time, and exhibit constant discount factors. No uncertainty is considered. The capitalist is the one who owns the capital in the economy, and is also the owner of the means of production (firms). He is the only one who saves (through capital accumulation) but does not work. The worker, conversely, works but does not save.

The worker's economic problem can be represented as a maximization of an

[1] These numbers are deceiving in one important aspect, related to the moment in which we end the series for Argentina. If we continued those series for two more years (until 1982), the Argentine output per capita would reflect an additional decrease of 14.34%. However, we preferred to stop our statistics in 1980 due to problems in the quality of the information, which would considerably distort the parameters to be estimated.

[2] This section draws heavily on Coloma (1996).

average intertemporal utility function (V_L) subject to a series of budget constraints:

$$V_L = (1-\beta)\cdot\sum_{t=0}^{\infty}\beta^t\cdot u_L(c_{Lt}, 1-h_t) \qquad \text{s.t. } c_{Lt} \leq w_t.h_t \qquad ;$$

where "c_{Lt}" is the worker's consumption in period "t", "h_t" is his supply of labor (expressed as a fraction of his total endowment of available time), "β" is the common discount factor and "w_t" is the wage rate.

The capitalist's problem, in turn, can be described as a maximization of another average intertemporal utility function (V_K) subject to a law of motion for capital accumulation:

$$V_K = (1-\beta)\cdot\sum_{t=0}^{\infty}\beta^t\cdot u_K(c_{Kt}) \qquad \text{s.t. } k_{t+1} \leq k_t.(1-\delta) + f(k_t, h_t) - w_t.h_t - c_{Kt} \qquad ;$$

where "c_{Kt}" is the capitalist's consumption in period "t", "k_t" is his stock of capital at the beginning of that period, "δ" is the rate of depreciation of capital, and "f" is the (strictly concave, twice differentiable) aggregate production function of the economy.

The agents of this economy trade two goods in each period: output (which is used for consumption and capital accumulation by the capitalist, and only for consumption by the worker) and labor. The directions of those trades are also unique: the capitalist sells part of his output to the worker, and the worker sells his labor (which he extracts from a fixed supply of time) to the capitalist. Having normalized the price of output as equal to one in every period, the only relative price to be determined is the real wage (w_t).

Two kinds of equilibria are going to be defined for this economy: a Walrasian equilibrium and a bargaining equilibrium based on the so called "Nash cooperative solution". To define a Walrasian equilibrium, we must find sequences of equilibrium levels of employment (amounts of labor traded in each period), capital stocks and equilibrium wages, such that both agents maximize their average intertemporal utility functions and both markets (output and labor) clear. The other variables (total output, worker's consumption, capitalist's consumption) can be determined by directly substituting the three mentioned sequences in the production function and in the corresponding budget constraints, which always hold as equalities.

The conditions for such an equilibrium can be written as a system of four equations for each period of time:

$$w_t = \frac{\left(\partial u_L / \partial l_t\right)}{\left(\partial u_L / \partial c_{Lt}\right)} \quad ;$$

$$w_t = \frac{\partial f}{\partial h_t} \quad ;$$

$$r_t = \frac{\partial f}{\partial k_t} = \frac{\left(\partial u_K / \partial c_{K(t-1)}\right)}{\beta \cdot \left(\partial u_K / \partial c_{Kt}\right)} - 1 + \delta \quad ;$$

$$k_{t+1} = k_t.(1-\delta) + f(k_t, h_t) - w_t.h_t - c_{Kt} \quad ;$$

where "l_t" is the worker's leisure (equal to "1 - h_t") and "r_t" is the implicit rental rate that the capitalist receives. These equations generate sequences of wages and implicit rental rates, which contain values that follow the same recursive conditions in each period. These imply the equality between the marginal product of labor and the worker's marginal rate of substitution between leisure and consumption, and the equality between the marginal product of capital and an expression which depends on the capitalist's marginal utility of consumption in consecutive periods, the discount factor and the rate of depreciation.

The concept of Walrasian equilibrium that we have developed is a suitable one to represent the behavior of a competitive economy. As we see, income distribution is strictly determined by a marginal productivity theory, and is the same one that we could have obtained using a model with a single representative agent. An alternative concept to contrast with the Walrasian equilibrium is the Nash cooperative solution, which considers that the equilibrium levels of capital accumulation and income distribution come from bargaining and not from competition. Applied to an economy, this concept can be used as a stylization of a situation in which resource allocation is the result of a process of negotiation between the main economic forces (for example, between the capitalists' associations and the workers' unions).

The definition of the Nash cooperative solution is independent from any particular assumption about the bargaining process between the agents of production. In general, this solution is axiomatically defined by four conditions: individual rationality, symmetry of treatment, invariance to positive affine utility transformations, and independence of irrelevant alternatives. Applied to any bargaining problem in which the players have Von Neumann-Morgenstern utility functions the fulfillment of these four conditions is satisfied by a unique outcome, which also turns out to be efficient. This outcome is the one that maximizes a certain function, known as the Nash product (N), which in our case can be written as follows:

$$N = [V_L - V_L(M)]\cdot[V_K - V_K(M)] \quad ;$$

where "$V_L(M)$" and "$V_K(M)$" are the minmax values for the worker's and the capitalist's average intertemporal utility functions. These values are defined in the following way:

$$V_L(M) = \min_{w_t, k_{t+1}} \left\{ \max_{h_t} \left[V_L \right] \right\} = \min_{h_t, k_{t+1}} \left\{ \max_{w_t} \left[V_L \right] \right\} \quad ;$$

$$V_K(M) = \min_{h_t} \left\{ \max_{w_t, k_{t+1}} \left[V_K \right] \right\} = \min_{w_t} \left\{ \max_{h_t, k_{t+1}} \left[V_K \right] \right\} \quad ;$$

and correspond to a situation where the worker does not work and does not consume, while the capitalist does not produce. In this situation, provided that the discount factor "β" tends to one, the worker gets all his utility from a stationary (maximum) level of leisure and the capitalist's utility level converges asymptotically to a point where he runs out of capital and gets zero consumption.

The equilibrium conditions under a Nash cooperative solution for our economy can be expressed through the following system of four equations:

$$\frac{\partial f}{\partial h_t} = \frac{(\partial u_L / \partial l_t)}{(\partial u_L / \partial c_{Lt})} \quad ;$$

$$\frac{\partial f}{\partial k_t} = \frac{(\partial u_K / \partial c_{K(t-1)})}{\beta \cdot (\partial u_K / \partial c_{Kt})} - 1 + \delta \quad ;$$

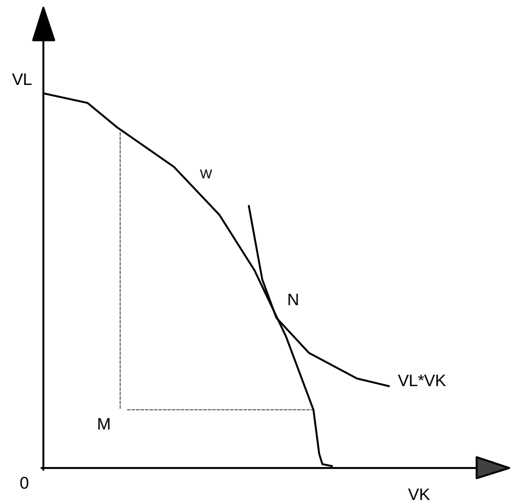
$$k_{t+1} = k_t.(1-\delta) + f(k_t, h_t) - w_t.h_t - c_{Kt} \quad ;$$

$$\frac{V_L - V_L(M)}{V_K - V_K(M)} = \frac{\left[\left(u_L^L - u_C^L \cdot \overline{w}\right) \cdot \left(d\overline{h}/d\overline{w}\right) - u_C^L \cdot \overline{h}\right]}{u_C^K \cdot \left[\left(f_h - \overline{w}\right) \cdot \left(d\overline{h}/d\overline{w}\right) + \left(f_k - \delta\right) \cdot \left(d\overline{k}/d\overline{w}\right) - \overline{h}\right]} \quad ;$$

where “$\overline{h}$”, “$\overline{k}$” and “$\overline{w}$” are the steady-state levels of employment, capital and wages. This solution typically implies departures from the Walrasian equilibrium conditions that connect wage and depreciation rates with marginal products and utilities.

The outcome actually chosen by the Nash cooperative solution basically depends on two elements, which typify the problem that we are analyzing. One is the level of the minmax reservation utilities of the capitalist and the worker. The other is the shape of their utility functions and, in particular, their concavity. This last feature is related with the concept of the players’ risk-aversion and, as a result of it, the less risk-averse player (i.e, the one whose utility function is “less concave”) ends up receiving a relatively higher utility than the more risk-averse one.

The adjoint diagram is a representation of the concepts that we have seen in the space of average intertemporal utilities. The utility possibility frontier is drawn as a downward-sloping curve that relates the different capitalist’s utility levels (VK) with the maximum possible worker’s utility (VL). The minmax point (M) is also located in the diagram, so we are able to define the area of individually rational solutions by using the horizontal and vertical lines that have M as the origin. One of



its efficient points (N) corresponds to the Nash cooperative solution, where the frontier is tangent to the highest utility isoproduct curve (VL*VK). Another one (W) corresponds to the Walrasian equilibrium allocation.

3. Estimation specifications

Following the general approach described in the previous section, our empirical exercise consists of a series of regressions that try to capture the relationships among variables decided by capitalists and workers. These are basically given by an aggregate production function that relates output to capital and labor, a series of equilibrium conditions that come from the existence of utility functions for our two representative agents of production, and a wage equation whose shape depends on the kind of equilibrium that we assume for the economy.

As both the Walrasian equilibrium allocation and the Nash bargaining solution share the characteristic that they are located in the utility possibility frontier of the economy, we can assume that in both cases output is determined by the same aggregate production function and that the marginal products of labor and capital are equated to expressions which depend on the same utility parameters. Therefore, if the economy is somewhere between the Walrasian equilibrium and the Nash bargaining solution, we can first estimate its production function and efficiency conditions, and then regress a wage equation that tells us how close it is to one or the other alternative positions.

Given that estimation strategy, we first postulate specific functional forms for the economy's aggregate production function and for the representative capitalist's and worker's utility functions. As a matter of convenience, we choose a Cobb-Douglas production function with constant returns to scale, a Cobb-Douglas utility function for the capitalist, and a separable utility function for the worker which is also linear in leisure[3]. Those three functions are therefore the following:

$$f(k_t, h_t) = A.k_t^{\theta}.h_t^{(1-\theta)}.\gamma_t^{(1-\theta)} \quad ;$$

$$u_K(c_{Kt}) = c_{Kt}^{\sigma} \quad ;$$

$$u_L(c_{Lt}, 1\text{-}h_t) = c_{Lt}^{\alpha} - B.h_t \quad ;$$

where "γ_t" is the level of per-capita labor productivity (in a context of labor-augmenting technical progress)[4] and "A", "B", "θ", "σ" and "α" are parameters to be estimated, together with the discount factor "β".

To find the values of the parameters for our production and utility functions, we observe the following procedure. First of all, we estimate the aggregate production function by running a regression under this logarithmic specification:

$$\ln(q_t) = \ln(A) + \theta.\ln(k_t) + (1-\theta).\ln(h_t.\gamma_t) \quad .$$

[3] This last assumption is relatively common in the literature on business cycles, since it provides a highly effective way of matching the observed variance of hours worked in US data. See Hansen (1985).

[4] The inclusion of an assumption of labor-augmenting technical progress has a consequence on the dynamics of the system, since it implies that the equilibrium converges to a "balanced growth path" instead of a steady state. This is consistent with the existence of growth in per-capita income.

Once we know the value for "θ", we use it to build series of marginal products of labor and capital, respectively defined as "$mpl = (1-\theta).q/h$" and "$mpk = \theta.q/k$". This last concept is then modified by the effect of depreciation, and re-expressed as an "adjusted marginal product of capital" ($ampk = \theta.q/k + 1 - \delta$).

After constructing our series of marginal products, we run a regression of a system of equations formed by the efficiency conditions, which postulate that "mpl" must be equal to the ratio of marginal utilities of workers' leisure and consumption, and that "ampk" must be equal to the ratio of discounted marginal utilities of capitalists' consumption in two consecutive years. This allows to estimate the relevant parameters of our model without defining the type of economy that we are dealing with, provided that we are at some point in the utility possibility frontier. Set in logarithmic form, the system of efficiency conditions gives the following regression equations:

$$\ln(mpl_t) = \ln(B/\alpha) + (1-\alpha).\ln(c_{Lt}) \quad ;$$

$$\ln(ampk_t) = \ln(1/\beta) + (1-\sigma).\ln(c_{Kt}) + (\sigma-1).\ln(c_{Kt-1}) \quad .$$

After estimating the basic parameters of the model, our last task is to compare the relative effect of competitive and bargaining elements on the determination of the wage rate. The first step of this process consists of calculating two series of limit wages ($wmax_t$, $wmin_t$), which represent the wage rates that prevail in the points of the utility possibility frontier where the capitalists and the workers respectively get their minmax payoffs. Next, we use this information to estimate a series of Nash solution wages (wns_t), defined as the ones for which the Nash product of the capitalist's and the worker's utilities is maximized. Once we have that, we run a regression for the actual wage rate on "mpl" and "wns", whose aim is to measure the relative degree of competitiveness of the economy (λ). As an additional information, we also estimate a bargaining power coefficient (μ), which comes from regressing "w" on "wmin" and "wmax". The regression equations are in this case linear, and they are written as:

$w_t = \lambda.mpl_t + (1-\lambda).wns_t$;

$w_t = \mu.wmin_t + (1-\mu).wmax_t$.

An interesting by-product of this specification is the actual estimation of a utility possibility frontier, together with series of implicit variables related to the Nash bargaining solution. One important assumption that we make to calculate those series is that the economy is always on a balanced growth path[5]. Given this, we can write the following relationships between the efficient levels of employment (h_{EF}), capital (k_{EF}) and wages (w_{EF}):

$$mpl = \frac{B}{\alpha} \cdot (h_{EF} \cdot w_{EF})^{1-\alpha} \quad ; \quad mpk = \frac{1}{\beta} - 1 + \delta \quad ; \quad \frac{mpl}{mpk} = \frac{k_{EF} \cdot (1-\theta)}{h_{EF} \cdot \theta} \quad ;$$

which imply that:

$$h_{EF} = \left(\frac{\alpha \cdot mpl}{B}\right)^{\frac{1}{1-\alpha}} \cdot \frac{1}{w_{EF}} \quad ; \quad k_{EF} = \left(\frac{mpl \cdot \theta}{mpk \cdot (1-\theta)}\right) \cdot h_{EF} \quad .$$

Given this, the annual payoffs that capitalists and workers get when they are at a point of the utility possibility frontier ($V_K(EF)$, $V_L(EF)$) can be written as the following functions of the efficient wage rate:

$$V_K(EF) = \left(\frac{\alpha \cdot mpl}{B}\right)^{\frac{\sigma}{1-\alpha}} \cdot \left\{ \left[A \cdot \left(\frac{mpl \cdot \theta}{mpk \cdot (1-\theta)}\right)^{\theta} \cdot \gamma^{(1-\theta)} - \left(\frac{\delta \cdot mpl \cdot \theta}{mpk \cdot (1-\theta)}\right) \right] \cdot \frac{1}{w_{EF}} - 1 \right\}^{\sigma} \quad ;$$

$$V_L(EF) = \left(\frac{\alpha \cdot mpl}{B}\right)^{\frac{\alpha}{1-\alpha}} - B \cdot \left(\frac{\alpha \cdot mpl}{B}\right)^{\frac{1}{1-\alpha}} \cdot \frac{1}{w_{EF}} \quad .$$

[5] This assumption is consistent with a situation where capitalists are risk-neutral.

Let us now define the feasible bargaining region of the utility possibility frontier as the set of combinations of capitalist's and worker's utilities where both agents get more than their minmax values. Due to the form of the utility functions that we are using, these minmax values are equal to zero in a stationary situation, so the minimum and maximum efficient wages (wmin, wmax) that both capitalists and workers accept are given by:

$$w\min = \alpha \cdot mpl \qquad ; \qquad w\max = A \cdot \left(\frac{mpl \cdot \theta}{mpk \cdot (1-\theta)}\right)^{\theta} \cdot \gamma^{(1-\theta)} - \left(\frac{\delta \cdot mpl \cdot \theta}{mpk \cdot (1-\theta)}\right) \quad .$$

To find a bargaining wage rate, finally, we maximize the product of "$V_L(EF)$" and "$V_K(EF)$" with respect to the efficient wage. What we get is the following expression:

$$wns = \frac{(1+\sigma) \cdot w\min \cdot w\max}{w\min + \sigma \cdot w\max} \quad .$$

As we see, this wage rate under the Nash bargaining solution depends positively on the two limit wages that we have already defined, and negatively on the value of "σ". Indirectly, it also increases when "mpl" or "α" grow. All this is consistent with the assumption that bargaining is more favorable to the relatively less risk-averse agent.

4. Empirical results

As we mentioned in the last section, the empirical implementation of our model for the cases of Argentina and the United States must be performed in three steps, associated to the estimation of the production function, the efficiency conditions and the wage equations. Due to the type of functions that we postulate, all regressions are run using linear least square methodologies.

For the aggregate production function regression, we use ordinary least squares. To deal with possible heteroscedasticity effects, we correct the variance-covariance matrix using White's method, and we also control for first-order autocorrelation by applying the Prais-Winsten algorithm. With the results of this regression we calculate the series of "mpl" and "ampk", and then regress the system of efficiency conditions by using three-stage least squares. This consists of replacing the workers' and the capitalists' consumptions by instrumental variables, and then use those instruments as independent variables in a seemingly unrelated regression of the efficiency conditions. To solve the endogeneity problems that "c_L" and "c_K" may exhibit, we substitute them by fitted values of previous regressions run on lagged versions of those variables and on all the exogenous variables in our data sets (k, dep, pop, γ, year). This takes into consideration possible correlations between the residuals of the two efficiency condition equations and, since we also use the Prais-Winsten algorithm, it allows for first-order autocorrelation among each equation's residuals.

Using the parameters estimated in the two previous rounds of regressions, we calculate the series of maximum, minimum and Nash solution wages that we need for our wage equation regressions. Once we have them, we perform those regressions by running ordinary least squares with the same heteroscedasticity correction made for the aggregate production function. These regressions are complemented by a series of tests that attempt to contrast competitive and bargaining hypotheses, looking for the effect of alternative restrictions on the goodness of fit of the models. These tests are F-tests on the joint significance of the restrictions and Cox tests on the relative power of one hypothesis against the other.

The results of our procedures are summarized in table 2, both for Argentina and the United States. In it we observe that the distribution parameters "θ" are relatively small for both countries (0.3002 for the US and 0.1838 for Argentina), especially if we compare them with the average shares of capitalists in total income (which are 0.3555 and 0.5017, respectively). This comparison tells us that in the two cases the capitalists get a larger fraction of income than the one expected under a purely competitive distribution rule, but we also see that the gap between "R/Y" and "θ" is considerably wider in Argentina than in the United States.

2. Empirical Results

Country	Argentina		United States	
Parameter	**Coeff**	**%Signif**	**Coeff**	**%Signif**
Theta	0,1838	0,01	0,3002	0,00
Alfa	0,4478	0,00	0,4966	0,00
Beta	0,9503	0,15	0,9005	0,00
Sigma	0,9967	0,00	0,9998	0,00
Lambda	-0,0574	21,70	0,7175	0,00
Mu	0,7393	0,00	0,4629	0,00
R^2 Prod funct	0,9944		0,9838	
R^2 Effic condit	0,9835		0,9867	
R^2 Wage equat 1	0,3694		0,9820	
R^2 Wage equat 2	0,3755		0,9062	
F-tests				
Walrasian Equil	283,57	0,00	685,96	0,00
Nash Solution	1,2746	29,19	4413,5	0,00
Cox tests				
WE vs NS	-3,5351	99,98	0,6120	27,03
NS vs WE	0,8160	20,73	-1,6211	94,75

The estimates for "σ" are almost identical in the two economies (0.9967 and 0.9998) and imply that capitalists exhibit a risk-neutral behavior, since none of those coefficients is significantly different from one. Conversely, workers seem to be considerably risk-averse, since the estimated values for "α" (0.4478 for Argentina, and 0.4966 for the US) are both significantly different from one. The implicit rate of time preference, however, seems to be larger in the United States than in Argentina, whose discount factor "β" is almost 5% higher than the US one. All the parameters estimated in the first two steps of our procedure are statistically different from zero at all possible levels of significance for the two countries, and the coefficients of determination of the regressions (R^2) are always greater than 0.98.

The two equations run to determine the relative influence of the marginal product of labor, the Nash solution wage and the limit wages on the actual income distribution give very different results for the Argentine and the US cases. In the latter, the parameter which measures competitiveness (λ) is able to explain more than 70% of the observed wages, while in the former its impact is not significantly different from zero. If we look at the results of the regressions of actual wages on maximum and minimum rates, moreover, our measure of the capitalists' relative market power (μ) is noticeably greater in Argentina (0.7393) than in the United States (0.4629). This last country also gives a much better fit in the regressions, since its R^2 coefficients are both larger than 0.9 while the Argentine ones are both smaller than 0.4.

Two additional regressions are performed in order to test for the relative importance of competitive and bargaining elements on the determination of wages in the two economies. They also regress "w" on "mpl" and "wns", but alternatively restrict the values of the coefficients to be zero or one. This implies that only Walrasian or Nash solution forces enter in the models, so that we can contrast them through a series of F-tests that check the validity of those assumptions. The results of those tests seem to indicate that for the case of the United States none of the two hypotheses alone explains the observed series of wages, since both F-statistics are extremely high and consequently their degree of significance is very low. Conversely, in the Argentine case the Nash bargaining hypothesis reduces the goodness of fit only slightly, and therefore the corresponding F-statistic is much smaller and its significance is much higher.

An alternative testing methodology is given by the use of Cox tests, which compare the ability of each alternative specification (Walrasian equilibrium or Nash solution) to explain the residuals of the wage equation run under the other hypothesis. This is done by regressing those residuals on the regressors and the restrictions of the alternative model, and by constructing a normally distributed statistic using the estimated variance of this new dependent variable together with the ones obtained in the two original regressions[6]. The results obtained show that the hypothesis of a Walrasian equilibrium is clearly rejected for Argentina while the one of a Nash bargaining solution is clearly rejected for the United States, since their corresponding Cox statistics are very small (-3.5351 and -1.6211). The inverse hypotheses, however, are also rejected for both countries, although their respective statistics are higher and their margins of rejection are considerably smaller. No single explanation, therefore, seems to be possible for any of the two economies, although the income distribution in the US is clearly more competitive while the one that we observe in Argentina seems to be more strongly guided by bargaining forces.

Figures 3 and 4 plot the evolution of the average wage in Argentina and the United States during the periods covered by our data sets. The diagrams also depict our estimations for the marginal product of labor (mpl), the Nash solution wage (wns), and the upper and lower wage limits under an efficient and individually rational solution (wmin, wmax). What we first observe is that the path of US wages is clearly smoother, while the Argentine one exhibits very sharp movements whose amplitude increases during the 1970's. For both economies the marginal product of labor is always higher than the Nash solution wage, and the two of them always lie between the upper and lower wage limits.

However, figures 3 and 4 also show that "mpl" is much closer to "wmax" in Argentina than in the United States, probably because of the smaller value that we have found for the parameter "θ" in the first of those countries. Finally, we observe that while the actual US wage is always between the "mpl" and "wns" lines (and closer to the first of them), the Argentine one moves around the Nash solution wage and even drops below the "wmin" line in 1976 and 1977. These differences in the behavior of the series are related to the way in which our wage regressions fit the actual data, which is clearly better for the United States than for Argentina.

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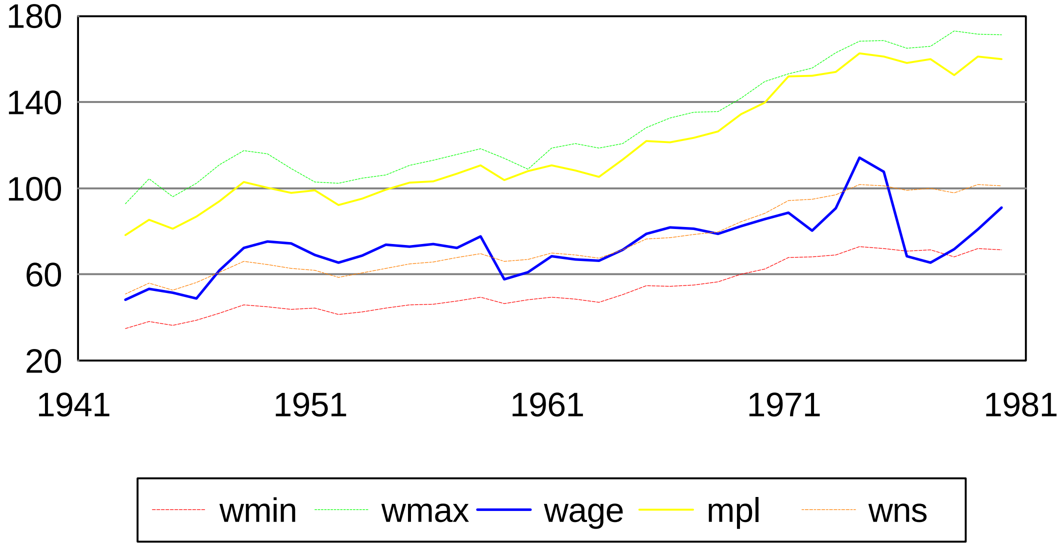
[6] The test performed here is in fact a variation of the original one proposed by Cox (1961) and developed by Pesaran and Hall (1988). The exact procedure used is reproduced in the appendix.

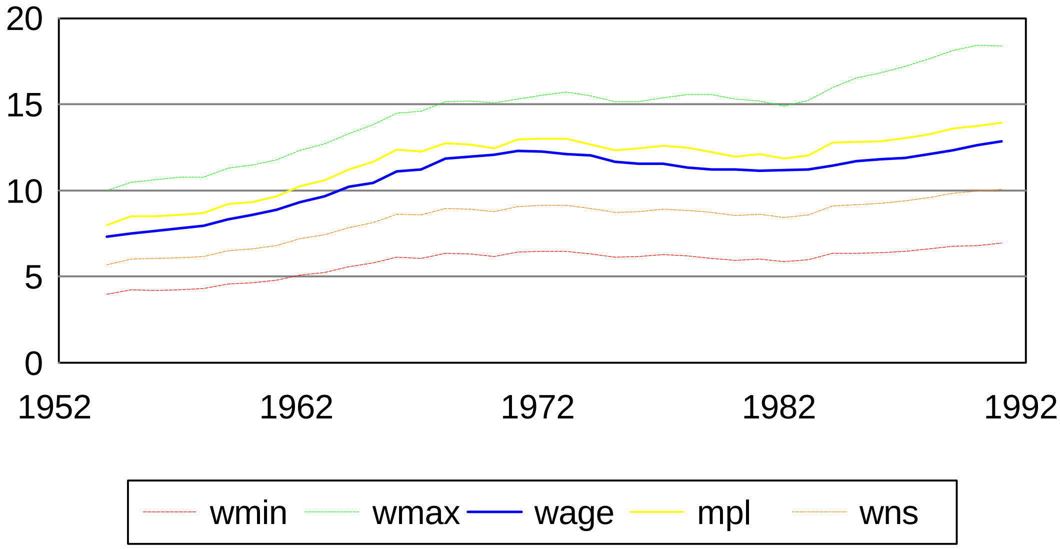
3. Argentina: Average Wages

(in thousands of 1960 Arg$ per year)



4. United States: Average Wages

(in 1987 US$ per hour)



5. Conclusions

The basic conclusion of this empirical application of our model of capital accumulation and income distribution is probably that the model itself provides a suitable way of contrasting dynamic equilibrium hypotheses when applied to actual data. Our particular examples compare two alternative explanations (perfect competition versus "perfect bargaining") and estimate the degree of mixture of the two that we find in the Argentine and the US economies during a relatively long period of time.

The main empirical results that we obtain seem to confirm our original intuitions that the United States exhibits a greater degree of competitive behavior, while bargaining forces seem to be more important in Argentina. Due to the difference in risk aversion between capitalists and workers, this outcome also implies that the relative market power of capitalists is considerably higher in Argentina.

However, no single behavioral hypothesis is able to explain income distribution in any of the two countries, although in the United States the Walrasian equilibrium model captures almost 72% of the observed wage rates while in Argentina the coefficient of competitive behavior is not significantly different from zero. The very good fit of the wage equation regressions for the American case, moreover, seem to indicate that perceiving the US economy as a relatively stable mix of competitive and bargaining elements may be a reasonable way to study its process of accumulation and distribution. Conversely, the results for the Argentine case suggest that there are other factors that influence the apportioning of income, and that the relative weight of those factors has probably changed during the period under consideration.

Appendix: Programming procedures

The following program, written in Limdep 6.0, describes the procedures used in our empirical estimation for both the Argentine and the US databases. For additional details on these procedures, see Greene (1992).

```
? Read in the data
READ ; Nobs=38 ; Nvar=7 ; File=data1.txt ;
Names=year,q,h,k,cl,ynk,inv $
READ ; Nobs=38 ; Nvar=7 ; File=data2.txt ;
Names=ck,dep,gr,w,d,r,pop $
OPEN ; OUTPUT=chapter4.out $
DSTAT ; Rhs=q,h,k,cl,inv,ck,gr,w,d,pop $

? Production function
CREATE ; lq=log(q) ; lk=log(k) ; hgr=h*gr ; lhgr=log(hgr) $
SAMPLE ; All $
REGRESS ; Lhs=lq ; Rhs=one,lk,lhgr ; Hetero ; AR1 ; Cls: B(2) + B(3) = 1 $
MATRIX ; BP=B ; VP=VARB $
CALC ; A1=exp(BP(1)) $
CREATE ; mpl=BP(3)*q/h ; mpk=BP(2)*q/k ; ampk=mpk+1-d ;
wmax=A1*(BP(2)*mpl/mpk/BP(3))^BP(2)*gr^BP(3)-d*mpl*BP(2)/mpk/BP(3) ;
lmpl=log(mpl) ; lampk=log(ampk) $

? Efficiency conditions
CREATE ; lcl=log(cl) ; lck=log(ck) ;
ldep=log(dep) ; lpop=log(pop) ; lgr=log(gr) $
SAMPLE ; 2-38 $
REGRESS ; Lhs=lcl ; Rhs=one,year,lk,lgr,lpop,ldep,lcl[-1],lck[-1] ; Keep=lclf $
REGRESS ; Lhs=lck ; Rhs=one,year,lk,lgr,lpop,ldep,lcl[-1],lck[-1] ; Keep=lckf $
SAMPLE ; 2-38 $
SURE ; Lhs=lmpl,lampk ; Eq1=one,lclf ; Eq2=one,lckf,lckf[-1] ;
Model=1 ; Maxit=1 ; Cls: B(4)+B(5)=0 $
MATRIX ; BE=B ; VE=VARB $
CALC ; alfa=1-BE(2); sig=1-BE(4); beta=1/exp(BE(3)); A2=exp(BE(1))*alfa $

? Wage equations
SAMPLE ; All $
CREATE ; wmin=alfa*mpl ; wns=(1+sig)/(sig/wmin+1/wmax) $
REGRESS ; Lhs=w ; Rhs=mpl,wns ; Hetero ; Cls: B(1)+B(2)=1 $
MATRIX ; BW1=B ; VW1=VARB $
REGRESS ; Lhs=w ; Rhs=wmin,wmax ; Hetero ; Cls: B(1)+B(2)=1 $
MATRIX ; BW2=B ; VW2=VARB $
```

```
CALC ; lambda= BW1(1) ; mu=BW2(1) $

? Alternative hypotheses
SAMPLE ; All $
? Walrasian equilibrium (WE)
REGRESS ; Lhs=w ; Rhs=mpl,wns ; Hetero ; Cls: B(1)=1, B(2)=0 ; Res=rw $
CALC ; sw=ssqrd $
? Nash bargaining solution (NS)
REGRESS ; Lhs=w ; Rhs=mpl,wns ; Hetero ; Cls: B(1)=0, B(2)=1 ; Res=rn $
CALC ; sn=ssqrd $

? Cox tests
SAMPLE ; All $
? WE vs NS
REGRESS ; Lhs=rn ; Rhs=mpl ; Hetero ; Cls: B(1)=1 $
CALC ; swn=ssqrd ; twn=38*log(sn/sw)/2/sqr(38*swn/sw) ; pwn=1-phi(twn) $
? NS vs WE
REGRESS ; Lhs=rw ; Rhs=wns ; Hetero ; Cls: B(1)=1 $
CALC ; snw=ssqrd ; tnw=38*log(sw/sn)/2/sqr(38*snw/sn) ; pnw=1-phi(tnw) $
```

References

Citicorp Database Services. *Citibase*, updated 1/1994.

Coloma, Germán. "Acumulación de capital y distribución del ingreso en un juego dinámico infinito" [Capital Accumulation and Income Distribution as the Outcome of a Dynamic Game]; Serie Seminarios 32/96. Buenos Aires, Instituto y Universidad Torcuato Di Tella, 1996. (There is an improved English version of this paper in the *Journal of Economic Dynamics and Control*, forthcoming).

Cox, D. "Tests of Separate Families of Hypotheses"; *Proceedings of the Fourth Berkeley Symposium on Mathematical Statistics and Probability*. Berkeley, University of California Press, 1961.

Greene, William. *Limdep 6.0: User's Manual and Reference Guide*. Bellport, Econometric Software, 1992.

Hansen, Gary. "Indivisible Labor and the Business Cycle"; *Journal of Monetary Economics*, vol 16, pgs 309-327, 1985.

Instituto de Estudios Económicos sobre la Realidad Argentina y Latinoamericana (IEERAL). "Estadísticas de la evolución económica de Argentina, 1913-1984" [Statistics on the Economic Evolution of Argentina, 1913-1984]; *Estudios*, vol 9, pgs 103-184, 1986.

Musgrave, J. C. "Fixed Reproducible Tangible Wealth in the United States: Revised Estimates"; *Survey of Current Business*, vol 72, pgs 106-107, 1992.

Pesaran, M. and Hall, A. "Tests of Non-Nested Linear Regression Models Subject to Linear Restrictions"; *Economic Letters*, vol 27, pgs 341-348, 1988.