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Growth in Uruguay: Factor Accumulation or Productivity Gains?

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During the last five decades, the Uruguayan economy faced a changing macroeconomic environment and had to adjust to a variable set of economic policies. They range from high controls to capital flows, exchange rates and interest rates to the introduction of a high degree of financial liberalization; from periods of high inflation to recurrent efforts to stabilise price movements; from heavy intervention of the public sector in a variety of economic activities including price controls to deregulation of many of those activities; and from high restrictions to international trade to the implementation of unilateral reductions of barriers to trade and to the effort to create a custom union with the neighbours countries.

Something went wrong with economic policy in Uruguay during that period. After being one of the most developed nations in the world by the middle of the century, both in terms of per capita income and other social indicators, five decades of very low growth carried Uruguay to be part of a less selected club, that of the less prosperous nations between the middle-income countries.

According with the data from the Penn World Table (Summers and Heston, 1991), in 1955 Uruguay's annual Gross Domestic Product (GDP) per capita was US$ 4.285 (in 1985 international prices), a 44% from United States' GDP per habitant, not too distant from that of France (US$ 4.770 per capita) and higher than that of Austria and Italy. In 1998, according with the same source, Uruguay's GDP per capita grew to US$ 6.058, falling to 29% from that of United States, while France, Austria and Italy almost double this figure. Uruguay's rate of growth between 1955 and 1998 is one of the lowest in the world, considering 60 countries where data is available for both years.

Most of this poor growth performance must be imputed to the stagnation that characterized the Uruguayan economy in the 1955-1973 period, when GDP per capita actually decreased at a cumulative annual average rate of 0.2%. That period coincides with an environment of oppressive governmental intervention, remarkably in external trade but also ruling the financial sector and influencing the economy through the determination of critical prices like wages and exchange rates or the imposition of limitations to free-entry in certain markets.

This environment changed substantially during the next decade, and successive governments have been coherent in the application of policies that promoted the development of a market-oriented economy during the last twenty five years. At first glance, those efforts were successful: GDP per capita growth averaged 1.7% in the 1973-2000 period, a significant better figure than that of the previous eighteen years. Nevertheless, it is still too far below the records of other developing countries which also introduced market-oriented economic reforms during the last two decades.

This paper will show that the better performance in terms of economic growth since the liberalization efforts took place is the consequence of an improvement in the allocation of resources, which in turn promoted an increase in human capital accumulation. But no significant changes are observed in the pattern of physical capital accumulation or the evolution of Total Factor Productivity (TFP).

The first section provides an overview of economic policies in Uruguay, where a characterization of different periods in the recent Uruguayan economic history is made. In the second, the stylized facts relevant for understanding the economic growth results are composed with the help of a growth accounting exercise. The sources of growth analysis will reveal the little importance of increments in Total Factor Productivity (TFP) to explain growth in this country. This evidence is complemented with an analysis of the time series properties of the variables of interest, which will permit to address the empirical regularities that must be explained to understand economic growth in Uruguay.

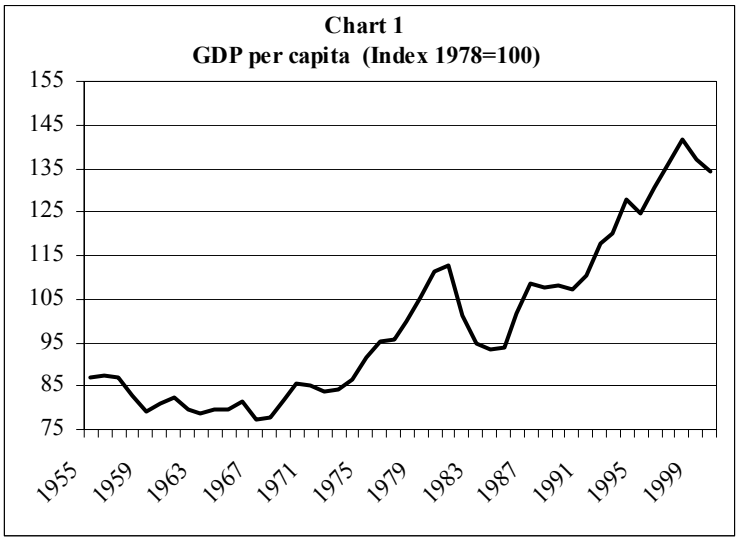
Next, a model consistent with the stylized facts documented is formulated. Given the absence of observed changes in TFP, the dynamic of growth will not be driven by innovation and technological progress. Instead, the idea of an "imbalance effect", along the lines of Barro and Sala-i-Martin (1995, Chapter 5) or Stokey (1996) will be followed, but in a model of a small open economy in which three goods are produced (two of them tradables and the other non-traded) with the use of three factors of production: skilled and unskilled labor and physical capital. A change in commercial policy will modify the initial relative factor intensities and the economy will face a transition to the new equilibrium, during which output growth will be higher than in steady-state.

This model is empirically implemented and tested in the fourth section. The importance of the more competitive environment that Uruguayan firms faced after the implementation of the Mercosur in the nineties is addressed, being reflected in turn in a higher accumulation of human capital and a progressive reduction of the physical to human capital ratio during the nineties. The fifth section concludes.

1 Overview of economic policies

The evolution of GDP per capita in Uruguay is a clear image of the economic policies implemented in this country and their results. Two distinct periods are immediately noticed with a first look at the series (see Chart 1): the 1955-1973 one, characterized by stagnation, and the 1974 to the present, in which growth resumed.

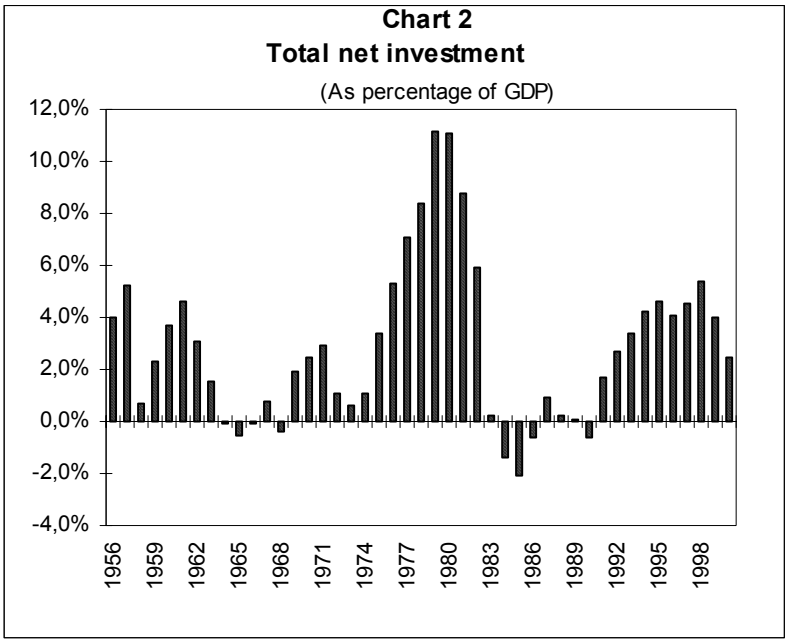
As noted before, the first period is stamped by significant intervention of the government in economic activity and high macroeconomic instability. After the world crisis in 1930, Uruguay put in practice, as many other countries, a set of measures aimed to control external commerce and equilibrate the balance of trade. Those measures included increment of tariffs, imposition of quotas and exchange rate controls, as the most noticeable. The reduction of imports helped local industry to develop, and that

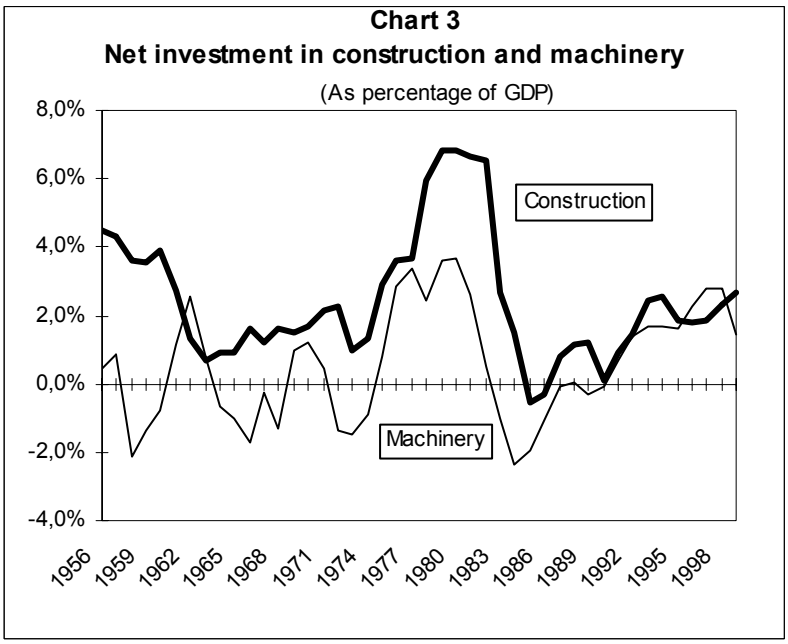


tendency was reinforced during the Second World War, when great part of international trade collapsed. The manufacturing sector experienced high growth rates during the forties, and the government decided to consolidate its "import substitution" strategy and continued protecting the local industry from competition from abroad, in spite of the change in international conditions after the War.

By the end of the fifties, the possibilities of the Uruguayan economy to continue growing based on the domestic market were depleted. At that moment, a new phenomenon came to the scene: the surging of inflation. A first attempt to stabilise the economy and to dismantle the administrative controls to trade and to exchange rate transactions was the 1959 stabilization plan and the package of reforms that were passed by the Congress at the end of that year. That plan finally failed in 1963 and a period of recurrent exchange rate and balance-of-payments crises, accompanied by persistent fiscal deficits, came after that. Those external crises discouraged the government to put in practice the legal reforms approved in 1959. By the contrary, the answer to the successive balance-of-payments crises was systematically the introduction of new barriers to trade and the adoption of exchange rate controls.

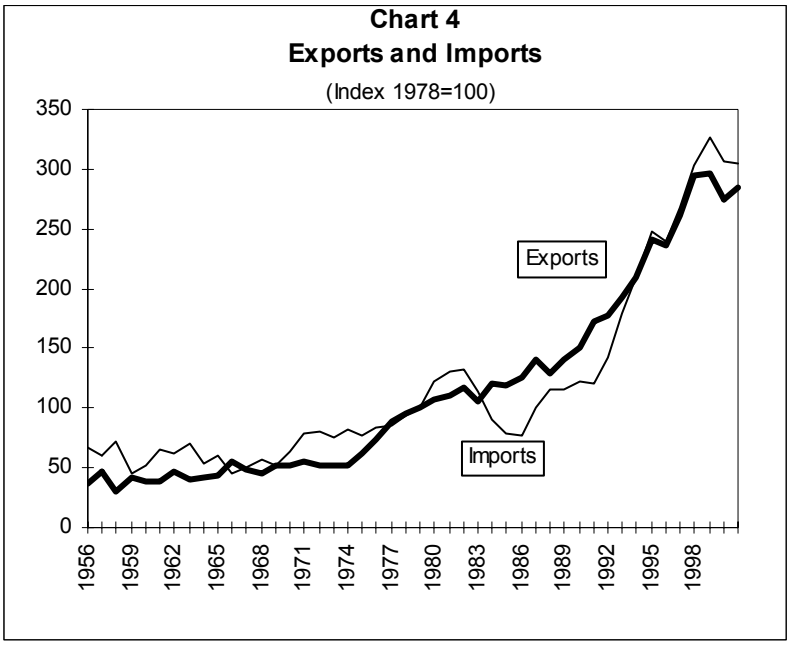
The combination of exchange rate crises and fiscal deficits gave strength to the inflation process and, at the edge of falling into hyperinflation, the government implemented a second stabilization plan in 1968, which was finally abandoned in 1972. The initial phase of this stabilization plan induce an expansion of domestic consumption and the economy experienced the higher rates of GDP growth since the early fifties. But that was merely a business-cycle associated with the stabilization effort. It was not until 1973, when under the pressure of the oil crisis and its negative impact on the trade balance, the government decided to put in practice a set of economic measures aimed to promote export growth, liberalizing, at the same time, most of the non-tariff barriers to imports. The exchange rate policy was also changed, establishing the total convertibility of the capital account of the balance-of-payments. A fiscal reform, that included the introduction of the Value-Added Tax (VAT), help to bring down the fiscal deficit and reduce the bias against exports that the former tax system had.





A change in the trend of the GDP is clearly visualised in Chart 1, after the economic reforms of 1974-1975. GDP growth averaged 3.9% between 1973 and 1978, with a significant increment in net investment, both in construction and machinery and equipment, as seen in Charts 2 and 3. Exports also grew very rapidly in response to the new incentives, and accompanied the growth of imports in 1973-1978 (Chart 4).

The priorities of the government turn again to the problem of inflation in the second half of the seventies, and in 1978 a third effort to stabilise the inflation rate was launched. This program used the pre-announcement of the exchange rate as the nominal

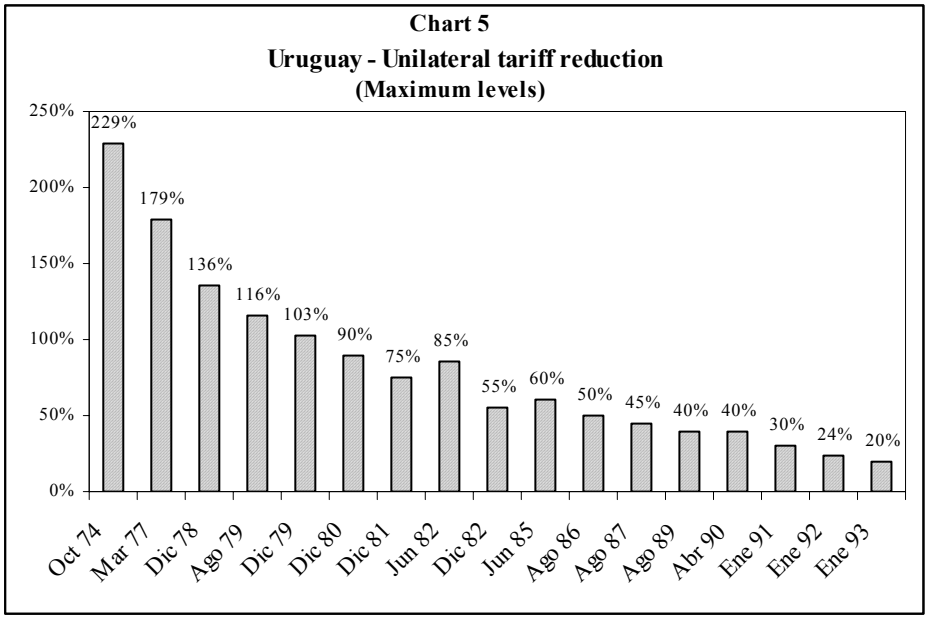


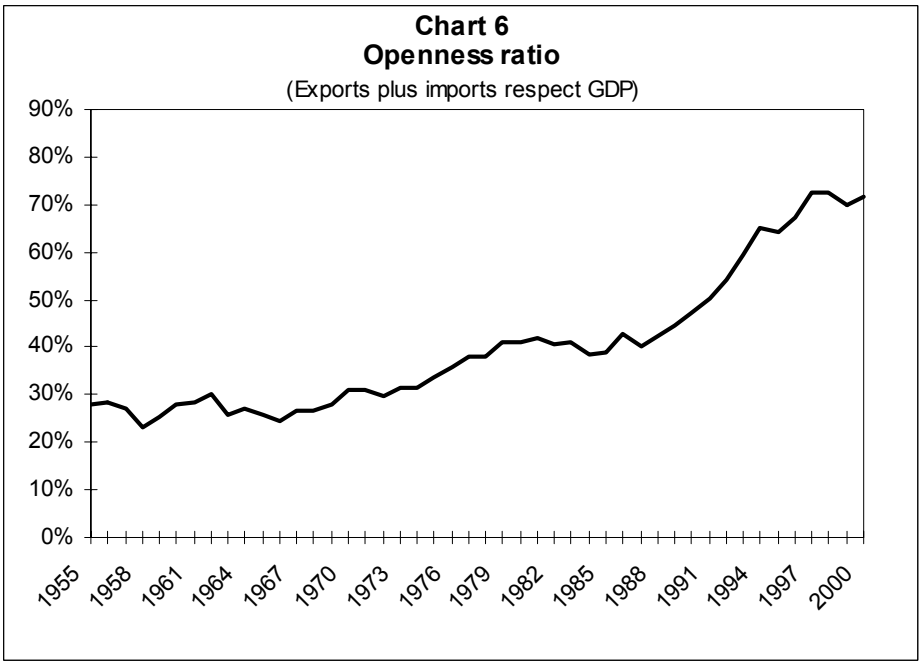
anchor (the "Tablita") and tried to make the domestic inflation converge gradually to international inflation. Several macroeconomic inconsistencies of the Plan, combined with the currency crisis of Argentina in 1981 and the precipitation of the international debt problem, with the consequent interruption in the flow of capital to the region, point to the abandonment of the program in 1982.

The exit from the "Tablita" Plan had as a consequence a deep crisis in the local financial market. The adverse domestic and external environment drove the Uruguayan economy to a huge recession, maybe the most profound in its history. GDP per capita was reduced 17.2% between 1981 and 1984, and return to the level it had before 1976.

From then on, the Uruguayan business-cycle is extremely related with economic outcomes in the vicinity. In the middle-seventies, bilateral trade agreements were signed between Uruguay and Argentina and Brazil (agreements known as CAUCE and PEC respectively), and in 1985 they were widened in scope. These preferential trade agreements deepened the natural dependency of the Uruguayan economy to what happen in the region, and the culmination of that process of strengthening ties with Argentina and Brazil was the Mercosur agreement, launched by the Asunción Treaty in 1991.

The influence of the region in the domestic business-cycle can be detected particularly in relation with the stabilization plans in Argentina and Brazil. The expansion of domestic demand in those countries after the implementation of the Austral and Cruzado Plan was precisely an important drag that helped Uruguay to escape from the economic recession in 1986-1987. Again in 1991, the Convertibility Plan of Argentina induced a strong push to domestic demand there, that in part spill-over to Uruguay. Something similar happened in 1994 with the Plan Real in Brazil. On the other side, the domestic crises that Argentina and Brazil suffered in 1995 after the





Tequila effect and in 1999 after the Brazilian devaluation affected negatively the Uruguayan economy.

Economic policies during the nineties were oriented to consolidate the market-oriented reforms initiated in the middle-seventies. Before the implementation of the Mercosur agreement, Uruguay culminated the process of reduction of tariffs that began in 1978, as well as the elimination of most non-tariff barriers to import that survived the initial abolition (see Chart 5). As a result of the unilateral reduction of trade barriers and the progresses made in the expansion of trade in the Mercosur, the openness ratio of the Uruguayan economy has had a steady increment during the last twenty-five years (see Chart 6).

There has also been some attempts to promote reforms in the public sector, introducing new regulatory frameworks that enable the private sector to participate in the financing and operation of public sector projects, like in telecommunications and energy. In the same way the reform of the Social Security system introduced the possibility that private sector firms operate like pension funds.

2 Growth accounting and time series evidence

After reviewing the principal facts and policies in the Uruguayan economy during the last five decades, it is the time to analyze the determinants of economic growth in this country. The previous analysis has emphasised the change in the behaviour of the economy after the reforms that took place in the seventies, and now the attention will be focused in what are the factors behind the growth performance.

First, a decomposition of the sources of growth will be made, that will help to understand to what extent the variation in the GDP per capita must be addressed to changes in factor accumulation or improvements in productivity due to innovation and technological progress.

Second, a closer look at the variables of interest will be taken. It is of special interest here to ascertain what variables have effectively changed its behaviour after the introduction of economic reforms.

2.1 Growth accounting

Assume that the production function of the economy can be characterized as

$$Y_t = A_t F\left(L_t h_t, K_t\right)$$

where Y is aggregate output or GDP, K is physical capital, L is labor, h is a correction for quality of the labor force (which in this paper will be always interpreted as an index of human capital) and A is an index of productivity or technological change that evolves over time.

Totally differencing this production function, the rate of growth is determined by:

$$\hat{Y}_t = \hat{A}_t + \frac{\left(\frac{\partial F}{\partial Lh} L_t h_t\right)}{Y_t}\left(\hat{L}_t + \hat{h}_t\right) + \frac{\left(\frac{\partial F}{\partial K} K_t\right)}{Y_t}\hat{K}_t$$

Table 1
Sources of growth in the Uruguayan economy
1957 - 1999

Period	GDP growth	Incidence of labor			Incidence of capital	Total factor productivity
		Employment	Quality	Total		
Percentages of change						
1957 - 1999	1,8%	0,5%	0,9%	1,4%	1,1%	-0,69%
1957 - 1973	0,7%	0,6%	0,4%	1,0%	0,8%	-1,07%
1974 - 1999	2,6%	0,5%	1,1%	1,6%	1,4%	-0,45%
1974 - 1990	2,1%	0,4%	0,5%	0,9%	0,9%	0,28%
1991 - 1999	3,5%	0,7%	2,5%	3,2%	2,2%	-1,86%
Contribution to GDP growth						
1957 - 1999	100,0%	29,3%	46,6%	76,3%	61,6%	-37,8%
1957 - 1973	100,0%	88,5%	52,7%	141,7%	104,4%	-146,2%
1974 - 1999	100,0%	18,3%	44,6%	63,3%	54,2%	-17,5%
1974 - 1990	100,0%	18,5%	25,2%	43,9%	42,4%	13,7%
1991 - 1999	100,0%	18,7%	71,6%	91,1%	61,7%	-52,8%

Sources: Own calculations

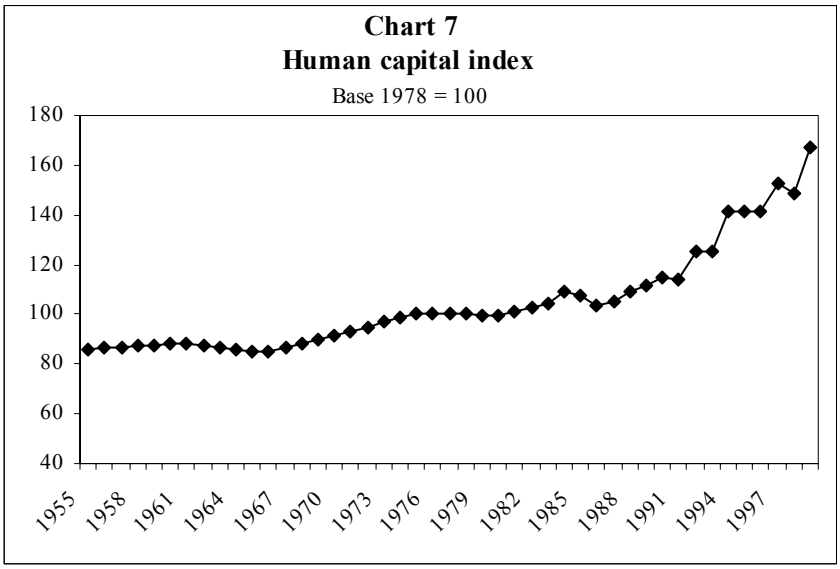
If factors of production are paid their marginal product, then the elasticities $\frac{\left(\frac{\partial F}{\partial Lh} L_t h_t\right)}{Y_t}$ and $\frac{\left(\frac{\partial F}{\partial K} K_t\right)}{Y_t}$ are, respectively, the share of labor and capital in total product. Assuming constant returns to scale, $\frac{\left(\frac{\partial F}{\partial Lh} L_t h_t\right)}{Y_t} + \frac{\left(\frac{\partial F}{\partial K} K_t\right)}{Y_t} = 1$.

Given the data on GDP growth, factor shares, labor force and estimations of physical and human capital, the changes in Total Factor Productivity $\hat{A}_t$ are estimated as a residual. GDP growth and factor shares are taken from the National Accounts. Labor force is defined here as labor employed, and its data is taken from the National Institute of Statistics.

To construct the series for physical capital, an update of a previous work by Elias(1996) was updated. The series of human capital is constructed using the labor-income based measure suggested by Mulligan and Sala-i-Martin (1995)[1]. The evolution of this variable is showed in Chart 7.

[1] Mincer regressions of labor income on a constant, years of education, years of labor experience and its square and a dummy for sex where run for each year, since 1982 to 1999, using data from the Households Survey. The constant term represents the estimated labor income for the non-educated, without-experience male, and can be interpreted as the unskilled worker wage. The human capital index is defined, for each year in the sample, as the ratio of the average labor income in the sample to the constant term in the regression.

For the period previous to 1982, the evolution of the human capital index was estimated through the years of schooling variable included in the Barro-Lee dataset.



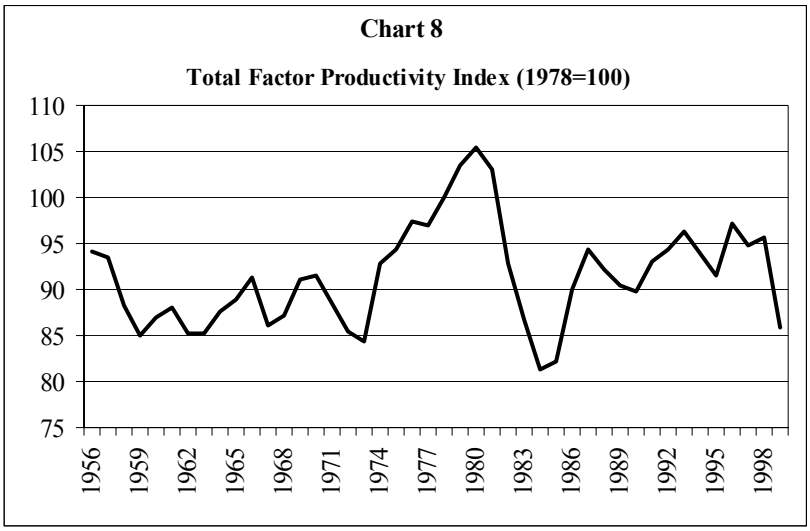
The results are presented in Table 1. Aggregate output growth averaged 1.8% a year in the period under consideration. Prior to 1973, the average rate of growth was 0.7%, while during 1974-1999 GDP growth averaged 2.6%. It is specially remarkable the behaviour of growth during the Mercosur era: 3.5% a year.

During the period of low growth (1957-1973), almost all the increment in production was explained by employment, as GDP per worker remain constant in that years. Increments in the quality of labor, measured as an index of human capital, explained near 50% of GDP growth during all the period. In the nineties, this human capital concept explained more than two thirds of output growth. Its lower incidence was after 1974, where its contribution for output growth was 25%.

Accumulation of capital also played an important role in output growth. Its higher rates of growth was achieved in the nineties, but in that period human capital accumulation grew even faster.

An unexpected result is that Total Factor Productivity showed negative rates of growth in almost all sub-periods (an in the whole period also, an average decrease of 0.7% a year), except in 1974-1990. The calculations were used to compute a series for TFP, that is presented in Chart 8. It looks as having no changes in trend or level during all the period, a result that would be confirmed in the time series analysis.

The growth accounting exercise suggests that factor accumulation have dominated the contributions to economic growth in Uruguay. The rate of growth in factor accumulation seems to be related with the major changes in the economic environment during the last five decades: the set of economic reforms in the middle seventies and the implementation of Mercosur in the nineties. A closer look at the series involved will shed more light to this analysis.



2.2 Time series evidence

An important issue in relation with the impact of economic policies on growth is if the changes in the variables under control of the government provoke a change in the *level* or in the *differences* of the aggregate output. The first result is the usually found in comparative-static analyses of changes in trade policy, factor endowments or other shocks. In this case, the change in policy affect the level of output and, transitory, its rate of growth. But at the end, the rate of growth returns to the initial values. This is also the conclusion of neoclassical models of growth, in which a change in the variables that determine a steady-state induces an increment of the level of output per worker in the long run, but no change in the steady-state rate of growth.

In endogenous growth models, the typical result is that a change in a policy variable affects permanently the rate of growth or the difference of the series. In this section, it will be addressed what is the outcome that can be expected to have happened in Uruguay after the economic reforms, according to the characteristics of the series under analysis.

The evolution of the level of TFP in Chart 8 suggests that there has been no changes in the mean of this variable during the period under analysis. But it seems to be also the case for the net investment variables in Charts 2 and 3. If these variables are indeed stationary around some mean, then the change in policies would have modified the level of the physical capital, but with no changes in the long run for the rate of change of this variable.

To address this issue, unit root tests for the variables of interest were performed. In Table 2 are showed augmented Dickey-Fuller tests of the form:

$$\Delta Y_t = \beta_0 + \beta_1 t + (\alpha - 1) Y_{t-1} + \sum_{i=1}^{k} \Delta Y_{t-i}$$

Table 2
Augmented Dickey-Fuller tests

Variable	Differences	Constant	Trend	ADF t-test	Lags
GDP per worker	0			1,2633	0
	1	0,00764		-5,5308 ***	0
		(1,0896)			
Human capital index	0	-0,2119	0,0080	0,6132	1
		(-0,6457)	(0,8156)		
	1			-0,3183	4
Machinery and	0			0,5114	1
equipment per worker	1			-4,0815 ***	0
Private fixed capital	0			0,1350	0
	1	0,0008		-6,1171 ***	0
		(0,1343)			
Public construction	0			2,1708	0
	1	0,0118		-5,3357 ***	0
		(1,7547)			
Total factor productivity	0	1,6321		-3,4226 **	1
		(3,4179)			

Notes: *** Significative at 1%; ** Significative at 5%

With the exception of Total Factor Productivity and the index of human capital, all the series in levels under analysis have unit roots. The index for TFP is stationary around a non-zero mean, while the index of human capital looks, at least, as integrated of order two.

In particular, GDP in levels is integrated of order one, and so its differences or GDP growth is a stationary series around a mean. This implies that the mean of output growth is not significantly different before and after the reforms initiated in the seventies. Those reforms induced an increment in the level of output, but not in the steady-state growth rate.

A similar conclusion can be arrived respect of the various measures of physical capital. The stock of total fixed private capital is integrated of order one, but its differences, the net investment in those items, is stationary. So, it can be concluded that the reforms did not affect the equilibrium investment rate, but increased it temporary while the steady-state value of the capital stock was obtained.

A special mention is deserved for the series of human capital. It is the only variable of all that are considered here, with the exception of TFP, which rate of change is not stationary. To check if the non-stationarity of changes in human capital results from a structural time-break, the Perron test unit roots under structural breaks was performed, and its results presented in Table 3.

After an analysis of the data not reported here, it was found that the only significant structural change in the series for the index of human capital was in 1991, after the introduction of the Mercosur. When a change in trend is introduced to capture the effect of a deterministic movement in the series, the null hypothesis of a unit root in the series in levels is not rejected at a significance level of 5%. But the change in trend

Table 3
Perron tests for structural breaks

Variable	Differences	Model	Perron t-test	Lags
GDP per worker	0	AO	-3,196	0
Human capital index	0	AO	-3,759 *	0
	1	IO	9,472 ***	0
Machinery and equipment per worker	0	AO	-2,479	1
Private fixed capital	0	AO	-3,395	0

Note: Model AO refers to the "additive outlier model" of Perron, in which there is a change in slope but no changes in the intercept. IO refers to the"innovative outlier" model, in which there is a change in the intercep but no changes in slope.
*** Significative at 1%; * Significative at 5%

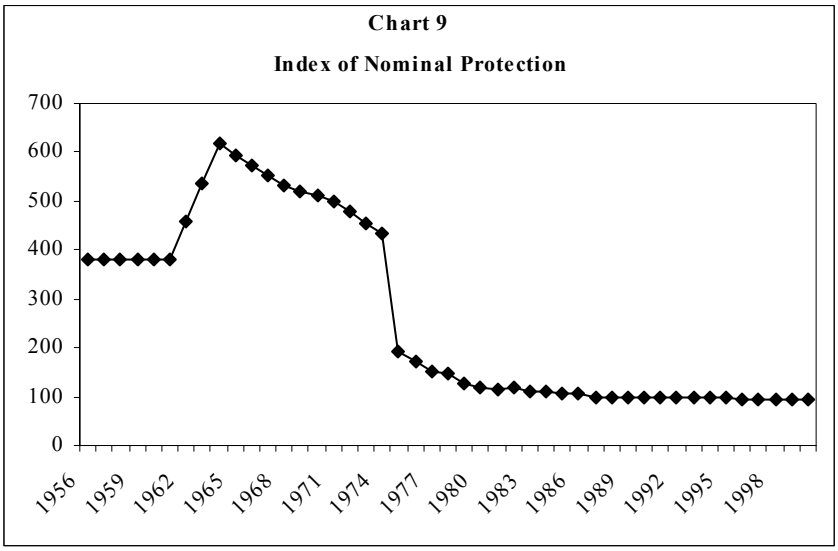
from 1991 is significant enough to make the differenced series stationary when that change is taken into account.

As a conclusion, with the exception of the series of TFP, which is stationary in levels, all the series under analysis are integrated of order one, and so its first differences are stationary. In the case of the index of human capital, the stationarity of the series in differences is obtained after a correction is made for a jump of the series in differences (a change in trend in the series in levels) since the year 1991.

Given this behaviour of the series, the increment in the rate of output growth after the episodes of liberalization, like the reforms of the middle seventies or the implementation of the Mercosur is a transitory phenomenon that tend to be reversed unless new shocks are received.

The story that these variables tell is in the tradition of the neoclassical growth model with a steady-state with invariant growth rate in spite of the changes introduced in the parameters of the model. The evolution of the human and physical capital can be interpreted as the response of one factor to a change in relative prices which favoured him. If the more skilled workers are attracted to sectors in expansion, maybe due to better relative prices or technology improvements, there will be a transformation from unskilled to skilled workers through better education, and the equilibrium ratio between capital and labor will be modify. In the case of Uruguay, a hypothesis that surges from the reading of the time series information is that during the nineties, the more competitive environment after the introduction of Mercosur induced a change in the relative demand of factors, as sectors that produced commodities with high intensities of unskilled workers and physical capital begin to slowdown. This change in demand would be reflected in the wages differential between skilled and unskilled workers, attracting a higher offer of well educated people.

As the ratio of skilled workers respect the other factors is low in comparison with equilibrium values, the return to human capital will be higher, as is happening in Uruguay, and will be decreasing as the economy approach the equilibrium. During that



transition, as capital and labor are reallocated to the sectors with higher productivity, the aggregate product will also be rising.

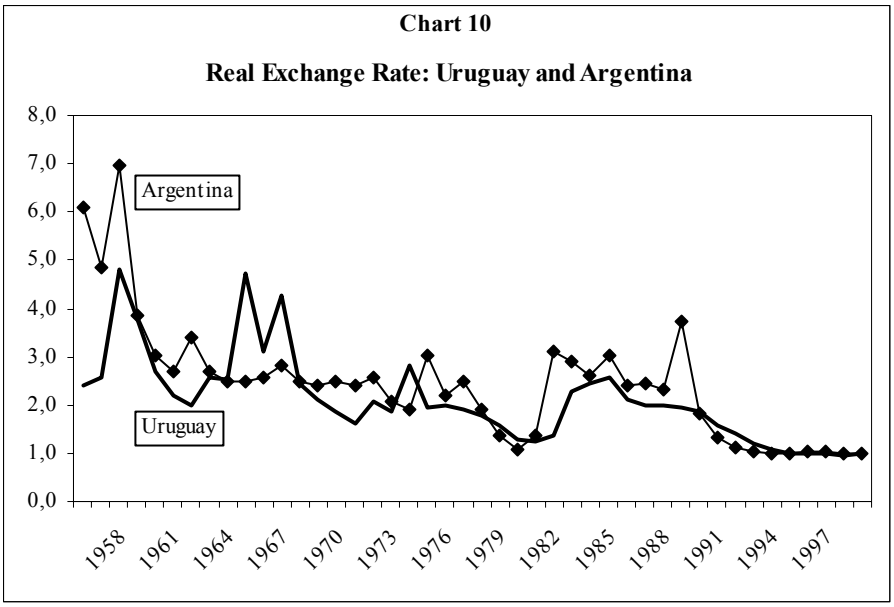
To analyze the extent to which the changes in the factors demand is related with the new economic environment that the Uruguayan economy faced after the seventies, a measure of the policy variables that characterize the liberalization process is needed. An index of nominal protection for the period under analysis was constructed, and the results are presented in Chart 9[2].

The index of nominal protection gives an indicator of the evolution of the relative price of importables during the period under consideration. But in an economy with three goods (exportable, importable and non-tradable) other important relative price is the real-exchange-rate, defined as the relative price of tradables to non-tradables. In the case of Uruguay, the real-exchange-rate supplies the channel through

[2] For the period 1988-2000, an excellent measure is given by the indexes of prices of imported products calculated by the Instituto Nacional de Estadística (INE). This office calculate two indexes of prices of imported products: an index of CIF (Cost, Insurance and Freight) prices and an index of prices at the importer deposit. Both indexed are calculated for the same basket of goods, so the ratio of the index of prices at deposit to the index of prices CIF gives the evolution of the costs incurred to nationalise the merchandise, including tariffs. This kind of measure permits to avoid the problem of representing the trade policy through the nominal tariff during the nineties, when almost fifty percent of the international trade of Uruguay had a preferential treatment in terms of tariff due to the Mercosur agreement.

The evolution of tariffs is a better descriptor of the Uruguayan commercial policies prior to the nineties. After the trade reform in the late seventies, there are good measures of average nominal protection (which includes tariffs and other non-tariff policy instruments), extensively documented in Rama (1982), CINVE (1987), Macadar (1988) and De Brun and Michelin (1993). For the period before the trade liberalization, measures of nominal protection are more difficult to obtain because the multiplicity of non-tariff barriers to trade, like quotas, prohibitions to import, multiple exchange rate mechanisms and exchange rate controls, among others. Favaro and Spiller (1990) made estimates of protection for that period based on the ratio of import to export prices for a sample of goods, which were used to compute an index of trade policy for that period.

After obtaining measures of nominal protection under the period of consideration, the index of tariff policy was calculated adding one to the nominal protection percent in year XX and assigning the value 100 to the year 1988.



which the macroeconomic shocks in the region, specially those coming from Argentina, affect the Uruguayan business-cycle. It is clear from Chart 10 that there is a strong relationship between the real-exchange-rate of Argentina and Uruguay, which was formally addressed to a cointegration analysis not reported here. As the domestic markets of both countries are highly integrated due to the intense movement of persons between them (tourism, business, family), most goods and services usually considered as non-tradables face competition from close substitutes in the other country. This explains the tendency of the real-exchange-rate of both countries to move together in the long run.

The appreciation of the real-exchange-rate in Argentina after the Convertibility Plan of 1991 induced a relative increment of the price of non-tradables in Uruguay during the last decade. This change in relative prices was added to the one generated by the trade liberalization process, which under certain conditions of factors demand can result in the shift of the human to physical capital ratio observed in the last ten years and a temporary acceleration of the rate of growth during the transition. The next section develops a model that reasonably encompass these stylised facts. After that, the model is tested empirically to assess if it can capture adequately the dynamics of the variables related with economic growth.

3 The model

Consider a small open economy, for which both the world price of traded goods and the world interest rate are taken as given. The economy produces three types of goods and services: traded goods (exportable and importable) are produced for consumption, investment in human and physical capital or export, while non-traded goods are produced for domestic consumption and formation of human capital.

Three factors of production are used to produce those goods and services: skilled labor *S*, unskilled labor *U* and physical capital *K*. Total labor force *L*, given by $L_t = S_t + U_t$, grows at the exogenous rate *n*. As in Stokey (1996), the distinction between skilled and unskilled workers tries to capture two kinds of productive services provided by labor, which are physical and mental effort.

3.1 Consumption and human capital formation

Households are the direct owners of physical capital, which they rent to firms at a rate *r*, equal to the world interest rate. They can also receive loans from foreign residents with no restrictions to foreign debt besides the intertemporal budget constraint. Then, net assets per capita in this economy are represented by $a_t = k_t - d_t$, where *d* is net debt to foreigners (in per capita terms) and $k_t = \frac{K_t}{L_t}$. They also supply labor inelastically, but they choose the resources dedicated to human capital formation and, in this way, the amount of skilled and unskilled labor available.

The household's problem, given the initial endowments of assets and human capital and given the paths for factor and final products prices, is to choose paths for investment in physical and human capital, total expenditure and its allocation among the different goods and services, to maximize discounted utility:

$$U_0 = \int_0^{\infty} e^{-(\rho - n)t} \log u\left(c_{N,t}, c_{X,t}, c_{M,t}\right) dt \qquad (1)$$

$$\text{s.t. } \dot{a}_t = W_{U,t} + z_t\left(W_{S,t} - W_{U,t}\right) + (r - n)a_t - \varepsilon_t + v_t - i_{z,t}$$

where ρ is the rate of time preference, W_j, $j = S, U$ are skilled and unskilled wages, c_i, $i = N, X, M$ are per capita consumption of non-tradables, exportables and importables, ε is nominal expenditure in consumption goods per capita, *v* are transfers from the government, financed through the commercial policy, $z = \frac{S}{L}$ and i_z is nominal expenditure in human capital formation.

Let assume that the world interest rate is $r = \rho$, the one that would apply in steady-state if the economy were closed. The representative household can borrow and lend at world interest rate *r*, so its investment and consumption decisions can be analyzed separately, and it will be done in three stages. First, the path for human capital formation is determined to maximize the present discounted value of its labor income flow, net of investment costs. Second, given the optimal supply of skilled and unskilled labor, the aggregate expenditure on consumption goods path is chosen, to maximize lifetime utility. Third, given the prices of final goods, expenditure is allocated among non-tradable, exportable and importable goods.

3.1.1 Investment in human capital and consumption path

The optimal path of expenditure in human capital formation is the one that maximize, given z_0, v, W_S and W_U

$$V_0 = \int_0^{\infty} e^{-(r-n)t}\left[W_{U,t} + z\left(W_{S,t} - W_{U,t}\right) + v_t - i_{z,t}\right]dt \tag{2}$$

$$\text{s.t. } \dot{z}_t = Bi_{z,t}^{\phi} - \eta z_t$$

where $B > 0$, $0 < \eta < 1$ (depreciation rate) and $0 < \phi < 1$ are constants. The law of motion for z indicates the rate at which labor is transformed from unskilled to skilled. As in Stokey (1996), the parameter ϕ represents the adjustment cost.

We can analyze this optimization problem by setting up the current-value Hamiltonian

$$J = e^{-(r-n)t}\left[W_U + z\left(W_S - W_U\right) + v_t - i_z + q\left(Bi_z^{\phi} - \eta z\right)\right]$$

where q is the current-value shadow price of the proportion of skilled workers in total labor force. The first-order conditions of this optimization problem give the following laws of motion for human capital and its shadow price:

$$\dot{z} = \left[B\left(\phi q\right)^{\phi}\right]^{\frac{1}{1-\phi}} - \eta z \tag{3a}$$

$$\dot{q} = \left(r - n + \eta\right)q - \left(W_S - W_U\right) \tag{3b}$$

The steady-state values of z, i_z and q satisfy

$$\tilde{z} = \frac{1}{\eta}\left[B\left(\phi\tilde{q}\right)^{\phi}\right]^{\frac{1}{1-\phi}} \tag{4a}$$

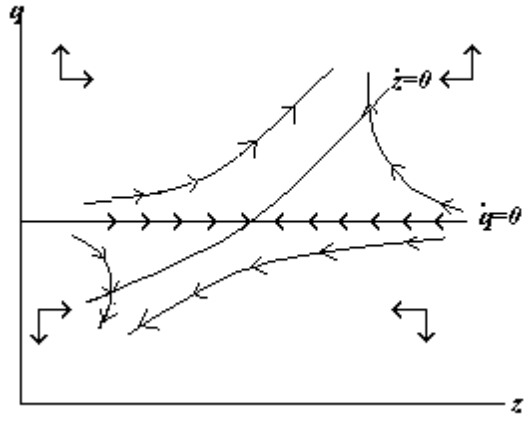
$$\tilde{i}_z = \left[B\phi\tilde{q}\right]^{\frac{1}{1-\phi}} \tag{4b}$$

$$\tilde{q} = \frac{W_S - W_U}{r - n + \eta} \tag{4c}$$

The phase diagram in Figure 1 shows that the only stable path goes through the $\dot{q} = 0$ locus, so the shadow price of human capital remains constant during the transition to a steady-state. Its means that if there is a change in relative wages, the shadow price q will jump on impact to its new steady-state value, and then z will increase or decrease gradually to its new equilibrium.

We can now proceed to the determination of the optimal consumption path. Define the consumption index $c = \left[\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}\right]^{-1} c_N^{\alpha} c_X^{\beta} c_M^{1-\alpha-\beta}$ and the instantaneous utility function as $u\left(c_N, c_X, c_M\right) = c$. If we replace $u\left(c_N, c_X, c_M\right)$ by the indirect utility given by $v\left(P_N, P_X, P_M; \varepsilon\right) = \frac{\varepsilon}{P}$, where P is the perfect price index $P = P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}$, the optimization problem (1) can be expressed as

Figure 1



$$U_0 = \int_0^{\infty} e^{-(\rho-n)t}\left(\log\varepsilon - \log P\right)dt \tag{5}$$

$$\text{s.t. } \dot{a}_t = W_{U,t} + z_t\left(W_{S,t} - W_{U,t}\right) + (r-n)a_t - \varepsilon_t + v_t - i_{z,t}$$

where a_0 and the path of z, $i_{z,t}$, P_i, $i = N, X, M$, W_S and W_U are taken as given. The first-order conditions of this problem determine that the optimal path for spending satisfy

$$\frac{\dot{\varepsilon}}{\varepsilon} = r - \rho \tag{6}$$

Given the assumption that $r = \rho$, the solution to this problem is a constant consumption spending, which level is determined by integrating the differential equation in (5), assuming a non-Ponzi game condition and using the optimal value of V_0 found in the first stage.

$$\tilde{\varepsilon} = (r-n)\left(V_0 + a_0\right) \tag{7}$$

3.1.2 Allocation of consumption

Having obtained the optimal path for per capita spending, the constant level $\tilde{\varepsilon}$ in (7), the allocation of consumption to non-tradable, exportable and importable goods can be determined maximizing the instantaneous utility function

$$u(\cdots) = \left[\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}\right]^{-1} c_N^{\alpha} c_X^{\beta} c_M^{1-\alpha-\beta} \tag{8}$$
$$\text{s.t. } P_N c_N + P_X c_X + P_M c_M = \tilde{\varepsilon}$$

The first-order conditions of this problem determine the sectoral demands, as follows:

$$c_N = \alpha \frac{\tilde{\varepsilon}}{P_N} \tag{9a}$$

$$c_X = \beta \frac{\tilde{\varepsilon}}{P_X} \tag{9b}$$

$$c_M = \left(1-\alpha-\beta\right) \frac{\tilde{\varepsilon}}{P_M} \tag{9c}$$

Finally, define the index of consumption of the tradables composite and the perfect price index for tradable goods as

$$c_T = \left[\frac{\beta^{\frac{\beta}{1-\alpha}}\left(1-\alpha-\beta\right)^{\frac{1-\alpha-\beta}{1-\alpha}}}{1-\alpha}\right]^{-1} c_X^{\frac{\beta}{1-\alpha}} c_M^{\frac{1-\alpha-\beta}{1-\alpha}}$$

$$P_T = P_X^{\frac{\beta}{1-\alpha}} P_M^{\frac{1-\alpha-\beta}{1-\alpha}}$$

3.2 Production and equilibrium

The sector that produces non-traded goods employs skilled labor as the only input, while the exportable good is produced combining skilled labor and physical capital and the importable good is produced combining unskilled labor and physical capital. As in Baldwin and Seghezza (1996), physical capital formation requires the tradable composite c_T, while human capital formation requires the aggregate composite c. That is, spending in physical capital combines the use of the exportable and importable good in proportions $\frac{\beta}{1-\alpha}$ and $\frac{1-\alpha-\beta}{1-\alpha}$ respectively, while spending in human capital combines the three products in proportions α for non-traded goods, β for exportables and $1-\alpha-\beta$ for importables.

This specification seeks to capture the general fact that non-traded goods like services are, in general, relatively intensive in human capital, while manufactured goods (usually traded goods) are more capital intensive than non-traded goods. Each of the two sectors manufacturing tradable goods makes intensive use of a different type of labor, which will be reflected in the pattern of trade of this economy. To highlight the role played by cross-sectoral differences in factor intensities on the pattern of trade, the differences were make as extreme as possible, and each tradable sector employs only one type of labor. Changes in the relative price of the traded goods will influence the formation of human capital.

All markets are competitive. All goods and services are produced with constant returns to scale technologies. The production functions for the non-tradable, exportable and importable goods are, respectively:

$$Y_N = A_N S_N \tag{10a}$$
$$Y_X = A_X K_X^{\gamma} S_X^{\gamma} \tag{10b}$$
$$Y_M = A_M K_M^{\gamma} U_M^{\gamma} \tag{10c}$$

where $Y_i,\ i = N, X, M$ represent physical quantities of production on each sector, $A_i,\ i = N, X, M$ are constants, $U_M = U$, $S_X + S_N = S$ and $K_X + K_M = K$. There is no technological change in this economy, as our main interest is to capture the effect on the dynamics of growth of a change in the allocation of resources.

Given the world interest rate *r*, the depreciation rate of physical capital δ, the world prices of the tradable goods $P_i,\ i = N, X, M$, and the skilled and unskilled wages $W_j, j = S, U$, the first order conditions for the allocation of resources in the three sectors are the following:

$$P_N A_N = W_S \tag{11a}$$
$$P_X A_X \gamma \left(\frac{z_X}{k_X}\right)^{1-\gamma} = P_T(r+\delta) \tag{11b}$$
$$P_X A_X (1-\gamma)\left(\frac{k_X}{z_X}\right)^{\gamma} = W_S \tag{11c}$$
$$P_M A_M \gamma \left(\frac{1-z}{k_M}\right)^{1-\gamma} = P_T(r+\delta) \tag{11d}$$
$$P_M A_M (1-\gamma)\left(\frac{k_M}{1-z}\right)^{\gamma} = W_U \tag{11e}$$

In equations (13c) and (13e) the price of a unit of physical capital is the tradable composite index. All stocks are expressed in per capita terms, so $z_X = \frac{S_X}{L}$, $z_N = \frac{S_N}{L}$, $1 - z = \frac{U}{L}$, $z_X + z_N = z$, $k_X = \frac{K_X}{L}$, $k_M = \frac{K_M}{L}$ y $k_X + k_N = k = \frac{K}{L}$.

The first-order conditions for optimal factors demand (11), the sectoral production functions (11) and the aggregate demand functions for final goods derived from (9) determine the equilibrium price of the non-traded good P_N, nominal skilled and unskilled wages W_j, $j = S,U$, sectoral allocation of skilled labor z_i, $i = N,X$ and unskilled labor $1-z$, and sectoral allocation of physical capital k_i, $i = X,M$, given world prices of traded goods P_i, $i = X,M$ and the path for expenditure in consumption goods $\widetilde{E} = \widetilde{\varepsilon} L$.

Equilibrium in the market of non-traded goods requires the following condition:

$$P_N Y_N = P_N C_N + \alpha I_Z \tag{12}$$

where $C_N = c_N L$ and $I_Z = i_z L$. Using equation (9a) and the production function (10a) the aggregate demand of labor in the non-tradable sector is obtained:

$$S_N = \alpha \frac{E + I_Z}{A_N}$$

or in per capita terms,

$$\widetilde{z}_N = \alpha \frac{\widetilde{\varepsilon} + \widetilde{i}_z}{A_N} \tag{13}$$

where $\widetilde{\varepsilon}$ and $\widetilde{i}_z$ come from (4b) and (7).

Wage equations for skilled and unskilled labor result from first-order conditions (11b) to (11e). Combining equations (11b) and (11c) the skilled wage is obtained:

$$\widetilde{W}_S = P_X \left[\gamma^{\gamma} (1-\gamma)^{1-\gamma} A_X \left(\frac{P_X}{P_M} \right)^{\frac{(1-\alpha-\beta)\gamma}{1-\alpha}} \left(\frac{1}{r+\delta} \right)^{\gamma} \right]^{\frac{1}{1-\gamma}} \tag{14a}$$

The unskilled wage equation is obtained in a similar way from conditions (11d) and (11e):

$$\widetilde{W}_U = P_M \left[\gamma^{\gamma} (1-\gamma)^{1-\gamma} A_M \left(\frac{P_M}{P_X} \right)^{\frac{\beta\gamma}{1-\alpha}} \left(\frac{1}{r+\delta} \right)^{\gamma} \right]^{\frac{1}{1-\gamma}} \tag{14b}$$

The equilibrium ratio $\frac{\widetilde{W}_S}{\widetilde{W}_U}$ results from dividing (14a) and (14b) and equals:

$$\frac{\widetilde{W}_S}{\widetilde{W}_U} = \left(\frac{A_X P_X}{A_M P_M} \right)^{\frac{1}{1-\gamma}} \tag{14c}$$

From equation (11a), the price of the non-traded good is immediately obtained using the result for the skilled wage in (14a):

$$\widetilde{P}_N = \frac{\widetilde{W}_S}{A_N} \tag{15}$$

Equilibrium ratios of capital to labor in the exportable and the importable sector can be expressed, using equations (11c), (11e) and (14) as

$$\left(\frac{\widetilde{k}_X}{\widetilde{z}_X} \right) = \left(\frac{1}{A_X (1-\gamma)} \frac{\widetilde{W}_S}{P_X} \right)^{\frac{1}{\gamma}} \tag{16a}$$

$$\left(\frac{\widetilde{k}_M}{1-\widetilde{z}} \right) = \left(\frac{1}{A_M (1-\gamma)} \frac{\widetilde{W}_U}{P_M} \right)^{\frac{1}{\gamma}} \tag{16b}$$

From conditions (11b) and (11d), and taking into account the value of $\frac{\widetilde{W}_S}{\widetilde{W}_U}$ in (14c), the following relation between relative factor intensities result:

$$\left(\frac{\widetilde{k}_X}{\widetilde{z}_X} \right) = \frac{\widetilde{W}_S}{\widetilde{W}_U} \left(\frac{\widetilde{k}_M}{1-\widetilde{z}} \right) \tag{17}$$

This means that if we assume that skilled wages must be higher than unskilled wages, then the exportable sector will have a higher capital to labor ratio than the importable sector.

3.3 Effects of changes in trade policy

The model analyzed here has the well-known properties of neoclassical growth models in which the economy converges to a steady-state with zero growth in per capita terms. The interest here is to analyze the dynamic of the economy after a change in the predetermined variables, due for example to a modification in trade policy that affect the relative price of the exportable to the importable good, $\frac{P_X}{P_M}$, where if we represent with an asterisk the variables at international prices and if τ is the tariff for imports, then $P_X = P_X^*$ and $P_M = P_M^*(1+\tau)$. We will assume that $\hat{P}_X - \hat{P}_M$ is positive, for example because a reduction in trade barriers. A "^" over a variable denote the rate of change of that variable, that is $\hat{X} = \frac{dX}{X}$.

3.3.1 Changes in relative prices

The impact of a change in the relative price of the exportable good on factor retributions, taken the world interest rate as given, resembles the well-known results of the Stolper-Samuelson theorem. The relative change of the skilled wage in terms of exportables and the unskilled wage in terms of importables can be expressed as:

$$\hat{W}_S - \hat{P}_X = \frac{(1-\alpha-\beta)}{1-\alpha}\frac{\gamma}{1-\gamma}\left(\hat{P}_X - \hat{P}_M\right) > 0 \tag{18a}$$

$$\hat{W}_U - \hat{P}_M = -\frac{\beta}{1-\alpha}\frac{\gamma}{1-\gamma}\left(\hat{P}_X - \hat{P}_M\right) < 0 \tag{18b}$$

As in the Stolper-Samuelson theorem, if $\hat{P}_M = -\frac{d\tau}{(1+\tau)} < 0$ because the government reduces the import tariff, keeping P_X constant, then it can be shown from (18a) and (18b) that $\hat{W}_X > \hat{P}_X > \hat{P}_M > \hat{W}_U$, with $\hat{W}_U < 0$

It will be useful to find an expression for the rate of change of the ratio of skilled wage to unskilled wage, $\frac{\widetilde{W}_S}{\widetilde{W}_U}$. From (18a) and (18b) the following expression is obtained:

$$\hat{W}_S - \hat{W}_U = \frac{\hat{P}_X - \hat{P}_M}{1-\gamma} > 0 \tag{19}$$

As $0 < \gamma < 1$, the change in the ratio of wages due to a change in final goods prices is magnified and $\hat{W}_S - \hat{W}_U > \hat{P}_X - \hat{P}_M$.

The change in the price of the non-traded good results from equation (15), and is equal to the rate of change of skilled wages,.

$$\hat{P}_N = \hat{W}_S \tag{20}$$

3.3.2 Changes in skilled labor and its allocation

Having determined the effect of trade policy on wages and prices of domestic goods, its impact on factor demand can be analyzed. Beginning with the effect of a change in the relative price of exportables on human capital accumulation, equations (4a) and (4c) give the following expression for the rate of change in the participation of skilled workers in total labor force, *z*:

$$\hat{z} = \frac{\phi}{1-\phi}\frac{dW_S - dW_U}{W_S - W_U} = \frac{\phi}{1-\phi}\left[\hat{W}_S + \frac{W_U}{W_S - W_U}\left(\hat{W}_S - \hat{W}_U\right)\right] > 0 \tag{21}$$

as long as $\hat{W}_S > 0$ and $\hat{W}_S - \hat{W}_U > 0$ according to equations (18a) and (19) and the assumption that $W_S > \hat{W}_U$.

But even that the positive impact of the relative increment in the price of the exportable good on human capital accumulation comes directly from the assumptions made about the production functions, the allocation of the more skilled workers to the production of the non-traded and the exportable good is more intriguing. As can be seen from equation (13), the participation of skilled workers in the non-tradable sector, $\tilde{z}_N$, depends on the equilibrium values of expenditure per capita $\tilde{\varepsilon}$ and investment in human capital $\tilde{i}_z$. The latter is obtained from (4b), and depends on the shadow price *q* that, as results from Figure 1, jumps to its new steady-state value after a change in relative prices and remains constant thereafter. So, $\tilde{i}_z$ will also jump to its new steady-state value and will remains constant during the transition.

But $\tilde{\varepsilon}$ results from (7) and its change depends on the derivative of the integral (2). Define the present discounted value of the labor income stream plus transfers, Ψ_0, as follows:

$$\Psi_0 = \int_0^{\infty} e^{-(r-n)t}\left[W_{U,t} + z\left(W_{S,t} - W_{U,t}\right) + v_t\right]dt \tag{22}$$

If $\tilde{i}_z$ remains constant during the transition to the new steady-state, the integral (2) can be expressed as

$$V_0 = \Psi_0 - \frac{\tilde{i}_z}{r-n} \tag{23}$$

The nominal expenditure per capita in consumption goods given by (7) is now

$$\tilde{\varepsilon} = (r-n)\left(\Psi_0 + a_0\right) - \tilde{i}_z \tag{24}$$

and the equilibrium value of the proportion of skilled workers allocated to the non-tradable good sector is

$$\tilde{z}_N = \alpha\frac{(r-n)\left(\Psi_0 + a_0\right)}{A_N} \tag{25}$$

The problem is now to find the derivative of the integral (22) to a change in wages, due to an increment in the relative price of the exportable good. Define the "average" wage as $W_t = W_{U,t} + z\left(W_{S,t} - W_{U,t}\right)$ and let $d\Psi_0 = \int_0^{\infty} e^{-(r-n)t}\left(dW_t + dv_t\right)dt$, where dv_t is the change in transfers that corresponds to the change in revenues for the

government when the import tariff is modified. If $dW_t > 0$ and $dv_t > 0$ for all $t \in [0,\infty]$, then $d\Psi_0 > 0$ unambiguously and $\tilde{z}_N$ will increase. In the following discussion, it will be assumed that tariffs are high enough to promote an increase in revenues on impact, immediately after the reduction in tariffs levels. During the transition, as z increases, production of importables will decrease and imports will grow, and so $dv_t > 0$ for all $t \in [0,\infty]$. We will now consider the effect on dW.

On impact, at time 0, z remains constant and so $dW_0 = dW_U + z(dW_S - dW_U)$. Given that $dW_S - dW_U > 0$ from (19) and (21), this expression will be always positive if $dW_U > 0$. But we will consider the stringent condition $dW_U < 0$, in the extreme case where $\hat{P}_X = 0$ and $\hat{P}_M < 0$. This would be the case of a reduction in import tariffs, without affecting the price received by the producers of the exportable good. Define the unskilled wage component proportion in the average wage as $m_U = \frac{W_U}{W}$ and the skilled premium as $m_S = 1 - m_U = \frac{z(W_S - W_U)}{W}$. Then

$$\frac{dW_0}{W_0} = m_U \hat{W}_U + m_S \frac{dW_S - dW_U}{W_S - W_U}$$

Remembering that, from equation (21), $\frac{dW_S - dW_U}{W_S - W_U} = \hat{W}_S + \frac{W_U}{W_S - W_U}(\hat{W}_S - \hat{W}_U) > 0$ and using equations (18) under the hypotheses $\hat{P}_X = 0$ and $\hat{P}_M < 0$, $\frac{dW_0}{W_0}$ will be positive if

$$\frac{m_S}{1 - m_S} > \frac{1 - \gamma \frac{1-\alpha-\beta}{1-\alpha}}{\frac{W_U}{W_S - W_U} + \gamma \frac{1-\alpha-\beta}{1-\alpha}} \tag{26}$$

The right hand expression depends on the value of $\gamma \frac{1-\alpha-\beta}{1-\alpha}$. Its presence in this equation comes from the assumption that investment in physical capital is a composite of the tradable goods, being $\frac{1-\alpha-\beta}{1-\alpha}$ the participation of the importable good in the formation of investment. As most of the investment in physical capital comes from the importable good, the right hand side of (26) will decrease and less participation of the skilled labor premium in average wage will be required to verify (26).

After the initial impact, during the time interval $t \in (0,\infty]$, z will be growing along the stable saddlepath in Figure 1. As the skilled and unskilled wages remain

constant after the initial change, $dW_t > 0 \;\; \forall t \in (0,\infty]$ from the initial value W_0. The change from the initial steady-state value of W to the new one is given by

$$\frac{d\widetilde{W}}{\widetilde{W}} = m_U \hat{W}_U + m_S \frac{d\widetilde{W}_S - d\widetilde{W}_U}{\widetilde{W}_S - \widetilde{W}_U} + m_S \frac{\phi}{1-\phi} \frac{d\widetilde{W}_S - d\widetilde{W}_U}{\widetilde{W}_S - \widetilde{W}_U}$$

where the last term is obtained from the expression for $\hat{z}$ in (21). The condition for $\frac{d\widetilde{W}}{\widetilde{W}} > 0$ is given by

$$\frac{m_S}{(1-m_S)(1-\phi)} > \frac{1-\gamma\frac{1-\alpha-\beta}{1-\alpha}}{\frac{W_U}{W_S - W_U} + \gamma\frac{1-\alpha-\beta}{1-\alpha}} \tag{27}$$

The condition (27) is less restrictive than (26), so if the latter is met the same will happen with the former.

If the initial value of m_S is high enough to satisfy condition (26), the entire path of W_t will be above the initial steady-state values and the sign of the derivative of Ψ_0 will be unambiguously positive, and the participation of skilled labor allocated in the non-tradable good sector, z_N, will rise. If the initial value of m_S is not high enough to meet condition (27), the path of W_t will be below the initial equilibrium values for all $t \in [0,\infty]$ and the derivative of the integral (22) will be unambiguously negative. In this case, the participation of the non-traded good in the allocation of skilled labor will decrease, in spite of the increase in z. If m_S satisfy condition (27) but not (26), the path of W_t will be below the initial equilibrium values for some interval $t \in [0,T]$, with T finite, and above them for $t \in [T,\infty]$. In this case, the sign of the derivative of Ψ_0 will be ambiguous and so will happen with z_N.

Other question is, admitting that m_S satisfy the condition for an increase in Ψ_0 and z_N, whether the rate of change in z_N is higher, equal or lower than z, because this result will affect the relative allocation of skilled workers among the non-traded and exportable goods. Again, the condition for a rate of change of W_0 higher than $\hat{z}$ is, using the result in (21),

$$\frac{m_S(1-\phi)-\phi}{(1-m_S)(1-\phi)} > \frac{1-\gamma\frac{1-\alpha-\beta}{1-\alpha}}{\frac{W_U}{W_S - W_U} + \gamma\frac{1-\alpha-\beta}{1-\alpha}} \tag{28}$$

This condition requires much larger values of m_S to be satisfied than in (26). If this condition is met, $\frac{dW_0}{W_0} > \hat{z}$ on impact, and as W_t continues growing for $t \in (0,\infty]$, the rate of growth of Ψ_0 and of z_N will become larger than $\hat{z}$, promoting a reallocation of skilled workers toward the non-traded good sector.

Consider finally the condition to be met to allow for $\frac{d\widetilde{W}}{\widetilde{W}} > \hat{z}$. Proceeding in an analogous form than previously, we obtain the following:

$$\frac{m_S - \phi}{(1-m_S)(1-\phi)} > \frac{1-\gamma\frac{1-\alpha-\beta}{1-\alpha}}{\frac{W_U}{W_S - W_U} + \gamma\frac{1-\alpha-\beta}{1-\alpha}} \tag{29}$$

As can be easily seen, (29) is less restringing than (28) (but not than (26)). If this condition is satisfied, the values of W_t in the new steady-state will show an increment with respect to the initial steady-state of $\hat{z}$ or more, but as the path for W_t has lower rates of growth than $\hat{z}$ during some interval in the transition, so it is not secured that Ψ_0 and z_N will grow more than $\hat{z}$ between the new and the old steady-state.

Given reasonable values for the parameters involved, conditions (28) and (29) are hardly to be met, but values for m_S that satisfy (27) and even (26) fall into reasonable ranges. Then, it will be assumed that $0 < \hat{z}_N < \hat{z}$. This implies that $\hat{z}_X$, the rate of change of the participation of skilled workers in the exportable good sector with respect to total labor force is higher than $\hat{z}$.

As a closed-form solution to the rate of change of z_N cannot be derived, the following representation will be adopted to simplify the calculations:

$$\hat{z}_X = \hat{z} + \theta_X > 0 \tag{30a}$$
$$\hat{z}_N = \hat{z} - \theta_N > 0 \tag{30b}$$
$$\theta_X, \theta_N > 0$$

3.3.3 Changes in physical capital

The effects of trade policy on physical capital demand and its allocation among the tradable goods can be derived differencing equations (16a) and (16b). Using the results in (18) and (30) the following relations are obtained:

$$\hat{k}_X = \hat{z} + \theta_X + \frac{1}{1-\gamma}\frac{1-\alpha-\beta}{1-\alpha}\left(\hat{P}_X - \hat{P}_M\right) > 0 \tag{31a}$$

$$\hat{k}_M = -\frac{z}{1-z}\hat{z} - \frac{1}{1-\gamma}\frac{\beta}{1-\alpha}\left(\hat{P}_X - \hat{P}_M\right) < 0 \tag{31b}$$

To obtain the change in aggregate physical capital, $k = k_X + k_M$, we obtain the following relation:

$$\hat{k} = \frac{k_X}{k}\hat{k}_X + \frac{k_M}{k}\hat{k}_M = \frac{k_X}{k}\left(\hat{k}_X - \hat{k}_M\right) + \hat{k}_M$$

Using (31a) and (31b), $\hat{k}$ is given by

$$\hat{k} = \left(\frac{k_X}{k} - z\right)\frac{\hat{z}}{1-z} + \left(\frac{k_X}{k} - \frac{\beta}{1-\alpha}\right)\frac{\hat{P}_X - \hat{P}_M}{1-\gamma} + \frac{k_x}{k}\theta_X \tag{32}$$

As equations (31) show, physical capital is expanding in the exportable good sector and is contracting in the importable good. The net effect is positive if the exportable good sector is capital intensive, been its demand of capital in terms of total physical capital higher than the participation of skilled workers over total labor force, and higher than the participation of the exportable good in the product of tradables.

3.3.4 Sectoral and aggregate growth

Differentiating the sectoral outputs in equations (10) using the results obtained previously on factor demands, give the following:

$$\hat{y}_N = \hat{z}_N = \hat{z} - \theta_N > 0 \tag{33a}$$

$$\hat{y}_X = \gamma\hat{k}_X + (1-\gamma)(\hat{z} + \theta_X) > 0 \tag{33b}$$

$$\hat{y}_M = \gamma\hat{k}_M - (1-\gamma)\frac{z}{1-z}\hat{z} < 0 \tag{33b}$$

where $\hat{y}_i$, $i = N, X, M$ is $\hat{y}_i = \frac{dy_i}{y_i}$, and y_i, $i = N, X, M$ is $y_i = \frac{Y_i}{L}$

To find an expression for the aggregate product in this economy, weighting factors must be determined to put together the rates of changes in sectoral products. It will be assumed that initially, not only trade balance is in equilibrium, but also all sectoral outputs equal their respective demand, as in a closed economy. This permits to equalize sectoral participations in aggregate product with the same parameters of consumption.

Total demand for the exportable good is given by, using (9b) and the assumptions made about the origin of expenses in physical and human capital,

$$P_X C_X + \frac{\beta}{1-\alpha} I_K + \beta I_Z = \alpha\left(E + I_Z\right)$$

The assumption of trade balance in equilibrium implies that $YN = E + I_K + I_Z$, where YN is nominal aggregate product. Define the initial investment ratios as $\kappa_\kappa = \frac{I_K}{YN}$ and let $\Lambda_X = \beta\left(1 + \frac{\alpha}{1-\alpha}\kappa_K\right)$. The aggregate demand for the exportable good is:

$$P_X C_X + \frac{\beta}{1-\alpha} I_K + \beta I_Z = \Lambda_X YN \tag{34a}$$

Proceeding in analogous form in the importable sector, we get

$$P_M C_M + \frac{1-\alpha-\beta}{1-\alpha} I_K + (1-\alpha-\beta) I_Z = \Lambda_M YN \tag{34b}$$

where $\Lambda_M = (1-\alpha-\beta)\left(1 + \frac{\alpha}{1-\alpha}\kappa_K\right)$.

Finally, total demand for the non-traded good is given by

$$P_N C_N + \alpha I_Z = (1 - \Lambda_X - \Lambda_M) YN \tag{34c}$$

Equilibrium in the three markets (which implies no trade at the initial equilibrium) requires that the value of production must be equal to total expenditure in each type of good. Given equations (34), the conditions for equilibrium are

$$P_X Y_X = \Lambda_X YN \tag{35a}$$
$$P_M Y_M = \Lambda_M YN \tag{35b}$$
$$P_N Y_N = (1 - \Lambda_X - \Lambda_M) YN \tag{35c}$$

From the equilibrium equations (35), expressing all the product variables in per capita terms (dividing all magnitudes by total labor force, L), the implicit price index for the different products are obtained.

$$P_X = \Lambda_X \frac{yn}{y_X} \tag{35a}$$
$$P_M = \Lambda_M \frac{yn}{y_M} \tag{35b}$$
$$P_N = (1 - \Lambda_X - \Lambda_M) \frac{yn}{y_N} \tag{35c}$$

where $yn = \frac{YN}{L}$. Define the "real" aggregate product as the nominal product divided by the aggregate perfect price index $P = P_N^\alpha P_X^\beta P_M^{1-\alpha-\beta}$, that is

$$Y = \frac{YN}{P} = \frac{YN}{P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}} \tag{36a}$$

or in per capita terms,

$$y = \frac{yn}{P_N^{\alpha} P_X^{\beta} P_M^{1-\alpha-\beta}} \tag{36b}$$

Substituting the price indexes (35) in (36b), the following expression for the aggregate "real" product results:

$$\begin{aligned} y &= \frac{yn}{\left[\left(1-\Lambda_X-\Lambda_M\right)\frac{yn}{y_N}\right]^{\alpha}\left(\Lambda_X\frac{yn}{y_X}\right)^{\beta}\left(\Lambda_M\frac{yn}{y_M}\right)^{1-\alpha-\beta}} \\ &= \frac{y_N^{\alpha} y_X^{\beta} y_M^{1-\alpha-\beta}}{\left(1-\Lambda_X-\Lambda_M\right)^{\alpha}\Lambda_X^{\beta}\Lambda_M^{1-\alpha-\beta}} \end{aligned} \tag{37}$$

Totally differencing equation (37), the rate of growth of aggregate product is given by:

$$\hat{y} = \alpha\hat{y}_N + \beta\hat{y}_X + \left(1-\alpha-\beta\right)\hat{y}_M \tag{38}$$

Substituting equations (33) in (38) and using the expressions for factor accumulation in (21) and (31), an expression for the rate of growth of this economy is found:

$$\hat{y} = \frac{\phi}{1-\phi}\left(\frac{\alpha+\beta}{z}-1\right)\frac{z}{1-z}\frac{dW_S - dW_U}{W_S - W_U} - \alpha\theta_N + \beta\theta_X \tag{39}$$

Ignoring the effect of the term $-\alpha\theta_N + \beta\theta_X$, which measures the impact on aggregate growth of the change in the allocation of skilled labor on the non-traded and the exportable good, the change in trade policy analyzed in this section will have positive impact on aggregate output if the participation of the sectors that use skilled labor (non-traded and exportable, given by $\alpha+\beta$), is high with respect to the ratio of skilled labor on total labor force.

It can be seen from equations (31) that there are two effects that impact on the allocation of physical capital among sectors. One is the "equilibrium capital-labor ratio" effect, that drives the demand of physical capital accordingly with changes in the use of labor. The other is a substitution effect, that modifies that capital-labor ratio because of changes in relative prices. This substitution effect increment the demand for physical capital in the exportable sector and reduces it in the importable sector. In the derivation of equation (39), those movements are compensated, because the assumptions made

about the relative participations of all sectors in output implicate that the incidence in aggregate growth of the expansion of the exportable sector due to higher demand of physical capital (that in turn obey to a change in relative prices) is exactly matched by the incidence of the contraction of the importable sector due to analogous reasons.

As a consequence, the only effect that influence aggregate growth is the change in the composition of labor. As a higher percentage of total labor force is skilled labor, the output of the non-traded and the exportable good will be expanded, while the output of the importable good will be in contraction. The net effect is an increment in aggregate output if the incidence of the sectors that are increasing production, $\alpha + \beta$, is high enough to compensate the reduction in the production of the importable good.

The condition $\frac{\alpha + \beta}{z} > 1$ for positive aggregate output growth implies that the participation of the sectors that are expanding on total output is higher than the participation of the labor resources that they use as input on total labor force. This condition is consistent with the conclusion that can be drawn from (17), that is, the relative higher capital intensity of the exportable good with respect to the importable good.

4 Estimation

4.1 Implementation of the system

The model to be estimated is the production function (37), after substituting the sectoral outputs by the production functions (10), and the dynamic equations for *z* and *k*, (21) and (32). Beginning from the production function the following is obtained:

$$y = \frac{A_N^{\alpha} A_X^{\beta} A_M^{1-\alpha-\beta}}{\left(1-\Lambda_X-\Lambda_M\right)^{\alpha} \Lambda_X^{\beta} \Lambda_M^{1-\alpha-\beta}} \left[\left(\frac{z_n}{z}\right)^{\alpha} \left(1-\frac{z_n}{z}\right)^{\gamma\beta} \right] z^{\alpha+\beta\gamma} \left(1-z\right)^{\gamma(1-\alpha-\beta)} k_X^{(1-\gamma)\beta} k_M^{(1-\gamma)(1-\alpha-\beta)}$$

The expression $\left[\left(\frac{z_n}{z}\right)^{\alpha} \left(1-\frac{z_n}{z}\right)^{\gamma\beta} \right] z^{\alpha+\beta\gamma} \left(1-z\right)^{\gamma(1-\alpha-\beta)}$ is a weighted average of the skilled and unskilled labor in various sectors. Assuming the initial participations as given, and the same for the investment ratios in Λ_X, Λ_M, the production function can be presented in a estimable form as

$$
\begin{aligned}
y &= Mh^{1-\sigma}k^{\sigma} \\
M &= \frac{A_N^{\alpha}A_X^{\beta}A_M^{1-\alpha-\beta}}{\left(1-\Lambda_X-\Lambda_M\right)^{\alpha}\Lambda_X^{\beta}\Lambda_M^{1-\alpha-\beta}}\left[\left(\frac{z_n}{z}\right)^{\alpha}\left(1-\frac{z_n}{z}\right)^{\gamma\beta}\right] \\
h^{1-\sigma} &= z^{\alpha+\beta\gamma}\left(1-z\right)^{\gamma\left(1-\alpha-\beta\right)} \\
k^{\sigma} &= k_X^{(1-\gamma)\beta}k_M^{(1-\gamma)(1-\alpha-\beta)} \\
\sigma &= \left(1-\alpha\right)\left(1-\gamma\right)
\end{aligned}
\tag{40}
$$

where h is an index of skilled to unskilled workers and M will be assumed constant. Finally, in logarithmic form:

$$\ln y_t = \ln M + \left(1-\sigma\right)\ln h_t + \sigma \ln k_t \tag{41}$$

To transform (41) in a dynamic version, it must be taken into account that, as the analysis in section 2 revealed, the TFP, which is the residual of an expression like (41), is stationary. But being the aggregate output, the index of human capital and all measures of physical capital non-stationary, there must be a cointegration relationship in (41) that transform variables I(1) into one I(0). We will interpret the cointegration relation precisely as the production function.

But if exists a cointegration relationship between y, h, and k, the dynamic version of (41) is not just its first differences. Suppose the following partial adjustment mechanism for the equilibrium relationship (41), where the constant term is drop for simplicity:

$$\ln y_t = a\ln y_{t-1} + b_0 \ln h_t + b_1 \ln h_{t-1} + c_0 \ln k_t + c_1 \ln k_{t-1}$$

Deducing $\ln y_{t-1}$ from each side and making the appropriate adjustments in the other variables, we get:

$$\Delta \ln y_t = b_0 \Delta \ln h_t + c_0 \Delta \ln k_t - \left(1-a\right)\left(\ln y_{t-1} - \frac{b_0+b_1}{1-a}\ln h_{t-1} - \frac{c_0+c_1}{1-a}\ln k_{t-1}\right)$$

The term in brackets in the right-hand side is the residual of a regression of $\ln y$ on the factors of production, that is, is the residual of the production function lagged once.

To conclude, the estimable version of equation (41) is

$$\Delta \ln y_t = b_0 \Delta \ln h_t + c_0 \Delta \ln k_t - \left(1-a\right)\left(\ln y_{t-1} - \left(1-\sigma\right)\ln h_{t-1} - \sigma \ln k_{t-1}\right) + u_t \tag{42}$$

Taken into account that from (40) we can obtain a linear relationship between the rates of growth of z and h, the equation (21) can be expressed as:

$$\Delta \ln h_t = d_1 \Delta \ln h_{t-1} + e_0 \Omega_t + v_t \tag{43}$$

where Ω_t represent exogenous variables that drive the dynamics of *h*. This variables maybe well include the error-correction mechanism in (42). Finally, the estimable version of (32) is

$$\Delta \ln k_t = f_1 \Delta \ln k_{t-1} + g_0 \Delta \ln h_t + g_1 \Delta \ln h_{t-1} + m_0 \Phi_t + w_t \qquad (44)$$

where Φ_t represent exogenous variables that determine *k*. The system (42) - (44) permit to estimate simultaneously *z*, *h* and *k*. To avoid problems of simultaneity bias, an Instrumental Variable (IV) estimation procedure was implemented.

4.2 Estimation

In the first stage, the production function (41) was estimated in levels to test for the stationarity of its residuals and the appropriateness of the error-correction mechanism in (42). The dependent variable is the GDP per capita (in logs, LPBIPC). Besides the index of human capital (LICAPHUM) and the fixed capital of the private sector (LCAPPRFIJPC) as explanatory variables, the infrastructure of the public sector (LCONSTPUBPC) was also included in the production function as a predetermined variable. The equation was estimated subject to the restriction that the sum of the parameters must add to one.

Dependent Variable LPBIPC - Estimation by Least Squares
Annual Data From 1956:01 To 1999:01

Usable Observations	44	Degrees of Freedom	41
Centered R**2	0.857185	R Bar **2	0.850219
Uncentered R**2	0.999718	T x R**2	43.988
Mean of Dependent Variable		3.4609368881	
Std Error of Dependent Variable		0.1558115876	
Standard Error of Estimate		0.0603015626	
Sum of Squared Residuals		0.1490874166	
Durbin-Watson Statistic		0.526782	
Q(11-0)		50.822967	
Significance Level of Q		0.00000044	

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-0.672390949	0.112347976	-5.98490	0.00000045
2. LICAPHUM	0.550113591	0.079953129	6.88045	0.00000002
3. LCAPPRFIJPC	0.271501257	0.049270817	5.51039	0.00000214
4. LCONSTPUBPC	0.178385152	0.057706498	3.09125	0.00357601

The system (42)-(44) was then estimated using IV. The variable RESPBI represents the residuals of the production function in levels. The equation for the change in the product per capita is:

Dependent Variable DLPBIPC - Estimation by Instrumental Variables
Annual Data From 1958:01 To 1999:01

Usable Observations	42	Degrees of Freedom	35
Centered R**2	0.284836	R Bar **2	0.162237
Uncentered R**2	0.312682	T x R**2	13.133
Mean of Dependent Variable		0.0088209873	
Std Error of Dependent Variable		0.0443554178	
Standard Error of Estimate		0.0405982512	
Sum of Squared Residuals		0.0576876301	
Durbin-Watson Statistic		1.977265	
Q(10-0)		8.581087	
Significance Level of Q		0.57226649	

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-0.027479337	0.010694329	-2.56952	0.01460210
2. RESPBI{1}	-0.578027927	0.140097172	-4.12591	0.00021656
3. DLPBIPC{1}	0.599602492	0.184303211	3.25335	0.00252931
4. DLICAPHUM	0.868074854	0.336669443	2.57842	0.01429110
5. DLCAPPRFIJPC{1}	-0.848211579	0.412490257	-2.05632	0.04726802
6. DLCONSTPUBPC	0.700121550	0.184484964	3.79501	0.00056242

As resulted from the analysis of the unit root tests, the difference in human capital admits a dummy that reflects its change of the intercept since 1991 (DUMMERC). The real-exchange-rate of Argentina (in differences, DLARGTCR) was included as an explanatory variable, as a source of changes in the relative price of non-tradables in Uruguay. The impact of changes in relative prices of tradables due to shifts in the commercial policy is captured by the variable DLPROTEC, which measures the changes in logs of the indicator of nominal protection defined before. Both variables have the expected signs, but neither is significant when the dummy for Mercosur is introduced. The endogenous variable proved to be exogenous to the others of the system, as the F-test for the current value and lags of GPD, private and public capital were not significant.

Dependent Variable DLICAPHUM - Estimation by Instrumental Variables
Annual Data From 1958:01 To 1999:01

Usable Observations	42	Degrees of Freedom	36
Centered R**2	0.415820	R Bar **2	0.334683
Uncentered R**2	0.524436	T x R**2	22.026
Mean of Dependent Variable		0.0155816041	
Std Error of Dependent Variable		0.0329991359	
Standard Error of Estimate		0.0269163842	
Sum of Squared Residuals		0.0260817026	
Durbin-Watson Statistic		1.797690	
Q(10-0)		11.503665	
Significance Level of Q		0.31964585	

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	0.011685787	0.00496612	2.35310	0.02419982
2. DUMMERC	0.052465483	0.011444220	4.58445	0.00005309
3. RESPBI{1}	0.031907903	0.074238001	0.42981	0.66989894
4. DLICAPHUM{1}	-0.497135204	0.154882019	-3.20977	0.00279278
5. DLPROTEC	-0.021037592	0.031430590	-0.66933	0.50755212
6. DLARGTCR{1}	0.008198138	0.015702784	0.52208	0.60481123

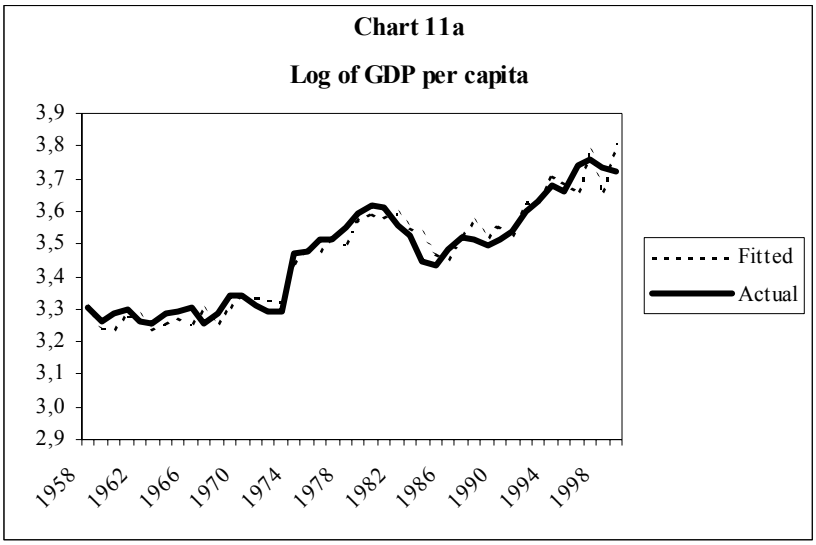
Finally, the equation for the private fixed capital is given by the following:

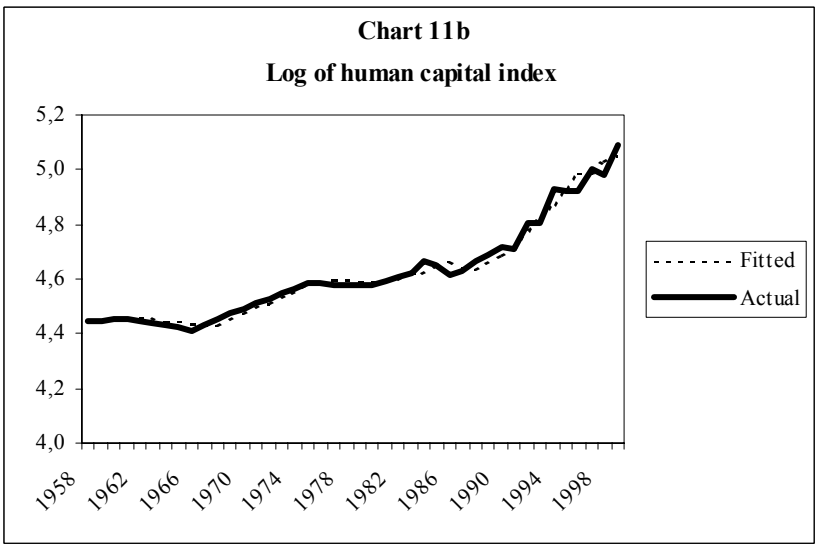
Dependent Variable DLCAPPRFIJPC - Estimation by Instrumental Variables
Annual Data From 1958:01 To 1999:01

Usable Observations	42	Degrees of Freedom	35
Centered R**2	0.914935	R Bar **2	0.900352
Uncentered R**2	0.914973	T x R**2	38.429
Mean of Dependent Variable		0.0007657228	
Std Error of Dependent Variable		0.0366186168	
Standard Error of Estimate		0.0115594249	
Sum of Squared Residuals		0.0046767107	
Durbin-Watson Statistic		2.028367	
Q(10-0)		10.887220	
Significance Level of Q		0.36637189	

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-0.002107887	0.002234960	-0.94314	0.35207301
2. RESPBI{1}	-0.001071961	0.034461885	-0.03111	0.97536196
3. DLCAPPRFIJPC{1}	0.768456622	0.109617754	7.01033	0.00000004
4. DLCONSTPUBPC	0.892469036	0.050213791	17.77338	0.00000000
5. DLCONSTPUBPC{1}	-0.665248124	0.101290128	-6.56775	0.00000014
6. DLARGTCR{1}	-0.018211174	0.006988933	-2.60572	0.01337432
7. DLPROTEC	0.040729584	0.016297503	2.49913	0.01729157

As can be seen, this variable is also exogenous respect the other dependent variables, human capital and growth. It is interesting to note the significance of the construction in the public sector as an explanatory variable for the dynamics of the investment in the private sector. Shocks to relative prices, through the real-exchange-rate and through the

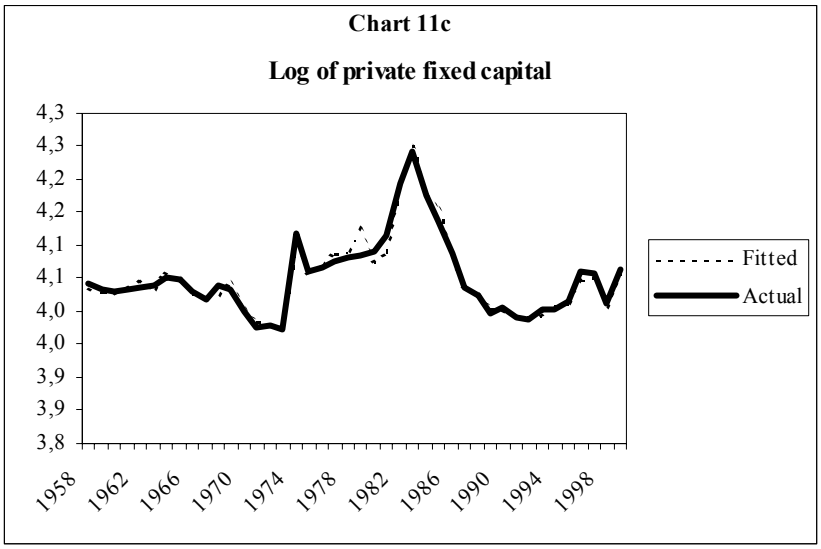




nominal protection were significant to explain movements in private investment. The comparative static in equation (32) gives no clear guide of the direction of change in investment after shifts in relative prices. As the estimation suggests, the appreciation of the real-exchange-rate induces private investment (mainly through construction), while the reduction of the nominal protection has a negative impact on the demand for private investment, which suggests that import substitution activities are more physical capital intensive than export-oriented ones.

5 Conclusions

This paper studied the dynamics of economic growth in Uruguay during the last five decades. The most relevant empirical regularities to be explained are:



- The actual acceleration of economic growth, measured as the rate of variation of the GDP per capita, after the economic reforms toward a market-oriented economy began to be implemented.
- The high contribution of human capital accumulation to the growth of GDP per worker, over all the period under consideration but specially in the decade of the nineties.
- The absence of change in Total Factor Productivity, which during most of the time became even negative, according to growth accounting calculations.
- The stability of the net investment in physical capital before and after the implementation of the reforms, notwithstanding some periods of temporary acceleration.

A model that explains most of this facts was formulated, and an estimation of its empirical consequences was performed. Essentially, the behaviour of the Uruguayan economy fits into the characteristics of a neoclassical model of economic growth, in which changes in policy have transitory impacts on investment and growth, until the economy reach a new steady-state, with higher output per capita but with the same equilibrium rate as before.

The model suggests that changes in policy had benefited the development of sectors relatively intensive in the use of skilled labor. What can be expected from the model, and it is confirmed by the facts, is that if the economy received a shock that favoured the relative retribution of the skilled work, then the wage differential will rise, promoting the formation of human capital.

The model predicts an ambiguous effect of the changes that favour human capital formation on physical capital formation. It will depend on the relative intensity of physical and human capital in sectors where both factors are demanded and on the origin of the goods that composed the physical capital accumulation: exportable or importable goods. The model estimated suggests that while real appreciation of the exchange rate favours investment in physical capital (mainly through construction), the

reduction in the nominal protection affected negatively the investment in physical capital. This result suggests the presence of more capital intensive technologies in the sector of importables.

The model predicts a transitory higher rate of growth of final output than the initial equilibrium, and the rate of growth will decrease as the economy approach its new steady-state, clearly a neoclassical result.

The model estimated, which structure is suggested by the theoretical model formulated, represents quite well the dynamics of growth and factors accumulation during the period under study. A clear conclusion from the empirical evidence is that economic growth in Uruguay has been supported by the accumulation of physical and human capital, with little or no contribution from changes in TFP.

References

Baldwin, Richard E. and Elena Seghezza (1996): *Testing for Trade-Induced Investment-Led Economic Growth*. CEPR Discussion Paper Nº 1331, February.

Barro, Robert and Xavier Sala-i-Martin (1995): *Economic Growth.* McGraw-Hill.

CINVE (1987): *La Industria frente a la Competencia Extranjera*. Ediciones de la Banda Oriental, Montevideo, Uruguay.

De Brun, Julio and Gustavo Michelin (1993): *Trade Policy, Regional Trade Agreement and Macroeconomic Environment: 1985-1992*. Mimeo, CERES, August.

Elias, Victor (1996): *El Capital Físico y Humano en Uruguay*, mimeo.

Favaro, Edgardo and Pablo Spiller (1990): "Uruguay", in A. Choksy, M. Michaely and D. Papageorgiou, eds., *The Timing and Sequencing of Trade Liberalization*. London, Basil Blackwell.

Macadar, Luis (1988): "Protección, Ventajas Comparadas y Eficiencia Industrial", *Suma* 3, 5, 7-59, CINVE.

Mulligan, Casey B. and Xavier Sala-i-Martin (1995): *A Labour-Income-Based Measure of the Value of Human Capital: An Application to the States of the United States"*, CEPR Discussion Paper Nº 1146.

Rama, Martín (1982): *Protección y Crecimiento Industrial: 1975-1980*. CINVE, Ediciones de la Banda Oriental.

Stokey, Nancy L. (1996): "Free Trade, Factor Returns and Factor Accumulation", *Journal of Economic Growth*, 1, 421-447.

Summers, Robert y Allan Heston (1991): "The Penn World Tables (Mark V): An Expanded Set of International Comparisons, 1950-1988". *Quarterly Journal of Economics*, 106, 327-368.