MEASUREMENT PROBLEMS OF TFP PERFORMANCE IN AN UNSTABLE ECONOMY:

ARGENTINA 1990-2004

"A Case of the Tyranny of Methodology"

ARIEL COREMBERG

ECLAC Buenos Aires
CONICET/IDES

acorem@fibertel.com.ar
acoremb@yahoo.com.ar

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SUMMARY JEL: O4-O3-E2

The aim of this study is to examine the main souces of growth in Argentina for the period 1990-2004 in order to identify the prevailing growth profile: either extensive, which is associated to factor acumulation and utilisation, or intensive, based on productivity gains.

The study proposes a methodology for identifying gains in Total Factor Productivity (TFP) in a strict sense which involves the positive shift of the production function; as opposed to the apparent or residual TFP, which involves a real cost changes due to short run fluctuations in relative prices and cyclical changes in factor utilisation but not necessarily linked to changes in the long run growth.

The paper presents a methodology in order to identify the strict TFP in an unstable economy like Argentina, adapting the main recommendations of the recent economic literature on productivity measurement, the experience of OECD, EUKLEMS group and IVIE and others and using consistently a database from Argentina's National Accounts.

The main results of applying this methodology for the Argentine case in the period 1990-2004 are:

The strict TFP performance had less procyclical behaviour and substantially lower trend than the apparent TFP. Similar conclusions are obtained for the labour productivity adjusted by labour intensity.

The growth profile of the Argentine economy appear to be extensive during the whole period 1990-2004, biased to capital accumulation and utilisation during the nineties and biased to the labour input after the 2002 devaluation.

These results for Argentina are analogous to the evidence found by Young (1995) and Timmer and Van Ark (2000) for the NIC´s countries.

Doubts arise on the ability of the Argentine economy to generate the productivity gains in a strict sense (independently of composition and quality effects and cyclical changes in factors utilisation) needed to achieve a sustainable long run growth.

This conclusion is based not only in what Young (1995) called the "tyranny of numbers", by assessing strictly the consistency of the country statistical information, but also a consequence of the "tyranny of the economic cycle, macroeconomic and methodological consistency".

THE MEASUREMENT OF TFP IN AN UNSTABLE ECONOMY: ARGENTINA 1990-2004 "A Case of The Tyranny of Numbers, Economic Cycle and Methodology"*

1. Introduction

During the last fifty years, the Argentine economy displayed a very low growth trend (3% annual), with high volatility if it is compared with other emerging economies.

Strong political and macroeconomic instability come up as one of the most commonly sustained explanations among economists for low long term growth in Argentina.

It is notable however that, apart from the investment rate being more volatile than the rest of the economic variables (which is common in all market economies), Argentina has displayed periods where the investment rate surpassed a 20%, not far away from records of main developed countries and similar to other Latin-American economies; periods which coincide with the implementation of temporarily successful stabilization plans with results that reflect in a notable macroeconomic stability, better performance of exports and an important economic growth that however could not be sustained in the long run.

One of the periods characterized by the mentioned stylized facts corresponds to the Convertibility Plan era, which went on from 1991 to 2001, producing a notable economic growth. Growing international liquidity for emerging economies, a stronger macroeconomic stability and a set of structural reforms fostered an important capital inflow that allowed for an increase in credit for the public and private sector, generating a larger domestic absorption: investment, consumption and public expenditure.

The privatization of public utilities, the deregulation of markets and the trade and financial openness at the beginning of the nineties produced an important apparent increase in the productivity of the Argentine economy in spite of an important real appreciation of the domestic currency as a result of the adoption of the convertibility exchange regime and the growing inflow of external saving.

Productivity gains allowed for an important cost savings, partially compensating the competitive disadvantage of the real appreciation. Proof of this effect can be found

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in the notable growth of the tradable sector, specially the manufacturing industry, not only by means of higher output but also on its exports.

However, the lower real exchange rate became unsustainable in time. Productivity gains seemed ex-post apparent, explaining in a great deal that the exchange convertibility regime became unsustainable in the long run.

After overcoming the external shock known as “tequila” in 1995, the Argentine economy could not recover in the mid term from the shock produced by the Brazilian devaluation of mid 1998. The Argentine economy could not endogenously generate the necessary increase in both domestic savings and productivity so as to compensate the negative effects of the external shocks on the local economy performance.

The extent of the exchange and financial imbalances accrued at the end of the last decade produced the inevitable end of the convertibility regime, generating an important capital flight, a mega devaluation and a deep external and financial crisis with effects that can still be felt at present.

At the beginning of 2002, the domestic currency suffers an important devaluation. However, due to the so-called “corralito” and the recession, the pass-through of devaluation to prices was only very limited initially, avoiding the risk of hyperinflation. This doubled the real exchange rate, fostering import substitution and exports, the latter also helped by an apparently permanent improvement in the terms of trade of Argentina.

Growth in aggregate demand, pushed by the income effect due to the increase in economic activity resulting from both import substitution and exports growth, together with reduced labour costs and excess installed capacity, allowed recovering employment to pre-devaluation levels, reducing the unemployment rate in almost ten percent points.

The important underutilisation of installed capacity, after an almost five-year depression, allowed meeting the growing aggregate demand without spiralyzing inflation.

Labour productivity grew both during the nineties and during the post-convertibility period. An often explanation in the economic profession has been that a large share of economic growth, specially during the nineties, was due mainly to the dynamic performance of total factor productivity (TFP), associated exclusively to positive shifts in the production function, or in other terms with improvements in the organization of the production process that were independent from factors accumulation and utilisation.

However, as will be seen along the study, the identification of the TFP in the strict sense of production function shift may be wrong if the TFP (a necessarily residual variable) is not cleared from a series of short run economic phenomena that not necessarily have to do with its strict interpretation: cyclical changes in factors use (labour intensity and capital utilisation), intersectoral reallocation of factors and substitution effects in production as normal adjustments to changes in relative prices, changes of input quality that are not transferred automatically to improvements in the organization of the productive process, etc.

As pointed out by Galiani, Heymann and Tomassi (2003), the right identification of a country’s growth trend entails important consequences from a macroeconomic viewpoint given its relevance for determining the long term sustainability condition of: the present economic growth process and the magnitude of permanent income or wealth perceived by economic agents on which investment decisions depend.

In this sense, Canavese and Gerchunoff (1996) have highlighted the important role of TFP as a central factor of long term sustainability not only of the growth process but also of the real exchange rate.

Given that strict TFP is the foremost variable that explains an economy's long term growth trend and permanent income, its correct identification is particularly relevant when defining not only the sustainability condition of its present macroeconomic setup but also the economy's growth path.

This study aims to investigate the souces of growth in Argentina during the period 1990-2004.

According to the recommendations of the economic literature on productivity measurement, souces of growth are extensively analysed by means of index numbers economic theory. This allows cleaning the TFP from the so called intersectoral substitution effects in production and quality and composition effects in inputs.

Additionally, the TFP is disaggregated to display procyclical changes in inputs utilisation as a consequence of the economic cycle: changes in labour intensity and in capital utilisation.

The use of National Accounts data on labour and capital inputs, as well as GDP allows for the internal, methodological and macroeconomic consistence of the main aggregates that compose the souces of growth in Argentina.

The second section presents a study of the main sources of growth, analyzing the main sources that originate it: capital intensity, productivity, composition and quality effects as a result of relative price changes, cyclical changes in the use of factors. The third section presents the adaptation of the measurement methodology to factors characteristics. The fourth section presents the main results of the use of the methodology analysed in sections two and three, to the sources of growth in Argentina along the period 1990-2004. The fifth section analyses the results in terms of labour productivity and TFP (strict and apparent) performances and, finally, it identifies the growth profile for the period 1990-2004. To finish, conclusions are derived.

2. Sources of Growth

2.1. Basic Souces of Growth

This study aims to investigate the souces of growth in Argentina during the period 1990-2004 by means of an exhaustive analysis, in order to identify the growth profile for each of the relevant sub periods.

With this purpose, the growth accounting approach is adopted, analyzing extensively the available data of main sources, taking into account the productivity measurement methodological recommendations of the recent economic literature and of the main institutions that care for this topic, specially OECD and EUKLEMS, the practical experience in the Spanish case carried out by IVIE, Basu, Fernald and Shapiro (2001) for the USA case, and others.

The analytical and statistical challenge becomes relevant for a developing country and unstable economy like Argentina. This is specially true taking into account that during the analysed period, the Argentine economic performance was characterized by deep structural changes and considerable volatility of its relative prices and aggregate demand, phenomena that may well distort the right identification of the growth profile of the Argentine economy.

From the viewpoint of the standard approach to economic growth, the economy's productivity growth represents the increase in output as a result of improvements in the organization of the productive process (management, layout, etc.) independently of factor accumulation and utilisation.

The foremost variable to analyse the growth of a country is the output by worker or labour productivity. This is obtained by expressing a standard production function intensively in terms of labour use, thanks to the constant returns to scale assumption. In this way, the growth accounting approach allows analyzing the sources that originate productivity labour performance.

The standard approach allows disaggregating the labour productivity performance into the contribution of productive factors and a residue obtained by subtracting the weighted growth of productive factors from economic growth. Analytically:

$$\boxed{\frac{d\ln y}{dt} = s_K \frac{d\ln k}{dt} + \frac{d\ln A}{dt}} \qquad (1)\,[1]$$

y: labour productivity
k: capital/labour ratio
A: Solow residual or Total Factor Productivity (TFP)
s_k: share of capital in product

This study proposes a methodology for disaggregating the performance of labour productivity into its main sources, that for now we will be calling "basic":

1. –Increase in the capital/labour ratio (capital intensity)

2. –Improvements in productive organization independently of factor endowments (Total Factor Productivity)

[1] Where dlnX/dt expresses the proportional growth rate of variable X: y, k, A

The first case implies an increase in the output of the firm, industry or country as whole as a consequence of the increase in capital intensity, without entailing a better organization of the productive process.

The case of improvements by means of new capital goods also belongs to the first case given that it implies indeed an increase in capital intensity in terms of efficiency capital units.

If the increase in capital intensity is a result of a reduction in employment, undoubtedly this will entail negative social repercussions; there will be an improvement in the productive efficiency or quality of labour and equipment, but it may lead to short term surges in the unemployment rate though not necessarily persistent through time.

In the second case, the production function shifts positively as a consequence of improvements in the organization of the firm, industry or country (technical progress, soft technologies, changes in layout) independently of factors accumulation and utilisation.

Therefore, the identification of a country's economic growth profile consists in the identification of which part of growth responds to the contribution of productive factors (movements along the production function) and which part to the contribution of TFP (positive shifts of the production function).

2.2. Instability of Relative Prices and Aggregate Demand

The basic souces of growth described above (capital intensity and TFP) involve other important economic phenomena that affect the performance of growth and labour productivity.

Changes in the composition or quality of the components of the macroeconomic aggregates that form equation 1 as a result of changes in relative prices may have considerable effects on economic growth measurement.

On the other hand, cyclical changes in aggregate demand may induce changes in the use of productive factors.

Following the former cases enumeration:

3-Changes in the composition of output, labour factor and capital

4–Quality changes in productive factors

5–Cyclical Changes in the Use of Productive Factors: Labour intensity and Capital Utilisation

Both 3 and 4 may be of considerable magnitude especially for Latin-American economies such as Argentina, where instability of relative prices has been the rule during the last 30 years.

The sectoral composition of GDP might change as a consequence of changes in relative prices by industry. For example, changes in the real exchange rate may foster important substitution effects in production among tradable and non-tradable sectors, affecting their contribution to GDP growth.

Something similar happens with labour and capital inputs, not only by industry or types but also to the rest of their main characteristics or attributes: qualification, age, make, etc.

Changes in labour intensity and in capital utilisation may have a certain effect along the economic cycle. Generally, considering the labour input as a quasi-fixed factor, its skill composition may be affected by the economic cycle (through the “labour hoarding” effect), also producing changes in labour intensity.

The existence of adjustment and transaction costs, as well as sunk costs, determines that quantity of capital inputs could not freely adjust to changes in aggregate demand but to its utilisation instead.

In this case, taking into account the considerable fluctuations of aggregate demand in Latin America (especially in Argentina during the period analysed in this study), the identification of the factors utilisation adjustment will be of crucial relevance when investigating the type of growth profile generated by the Argentine economy.

2.2.1 Composition Effects

According to what has just been commented, changes in the composition of aggregates in the growth accounting equation are produced as a result of relative price changes of their types.

In the case of production for instance, a change in the relative price of a given sector may foster a positive substitution effect. The contribution of this sector to GDP growth becomes therefore greater, given that it is valued at higher relative prices.

The same can be said about the labour input; changes in sectoral relative wages may foster an intersectoral reallocation of employment, giving place to a considerable composition effect.

In what respects to capital stock and investment, the composition effect may be produced as a result of changes in relative prices of their main components.

In order to identify composition effects, the index number economic theory suggests taking into account indexes (superlatives and flexible aggregators) that allow to capture the effects of changes in relative prices on the contribution of their correspondent items to the aggregate.

Generally, in Latin America as well as in Argentina, the performance of GDP at constant prices is estimated by means of fixed base physical volume indexes as the Laspeyres type.

For example, in the calculation of the GDP this type of indexes calculate the physical volume of the GDP by aggregating the sectoral value added, using the weight in a certain base year in terms of value. This assumes freezing the relative prices structure of the base year for the whole series, in a way that the contribution of value added to GDP growth does not take into account changes in relative prices that may have been produced between the base year and the period of measurement. According to Diewert (1995), fix base physical volume indexes as Laspeyres tend to overweight those goods whose relative prices have decreased and to underweight those goods whose relative prices have increased with respect to the base year.

This problem, called *production substitution bias,* produces distortions in the measurement of the GDP when the relative prices structure is not updated[2]. A similar problem is produced with productive factors' aggregates.

Since fix base indexes do not allow capturing the contribution to growth of the production substitution effect, this produces a bias on production growth and, therefore, on the whole economy's productivity. Opposite biases would be produced in the case of primary inputs.

The economic literature on index numbers suggests eliminating these problems by using optimal indexes (superlative indexes and flexible aggregators following Diewert terminology) as those of Tornqvist, Fisher or the Chain Indexes. These indexes allow including the production substitution effect not captured in the fix base physical volume indexes by updating the relative prices structure using the relevant weights for the firms' production decision taking process.

In spite of not passing all the statistical axiomatic tests, as in the case of the Fisher index, the economic literature on productivity measurement, generally recommends the Tornqvist index given the analytical advantages of representing a production function with simple aggregation, capturing the influence of relative prices changes of the elements on the growth of the aggregate's physical volume to be measured through substitution or composition effects.

$$\frac{d \ln X^T}{dt} = \sum_{i=1}^{n} 0.5\left[v_{i,t} + v_{i,t-1}\right] \frac{d \ln X_{i,t}}{dt}$$

dlnX/dt: is the rate of change of sub-aggregates
v: is the incidence of the sub/aggregate on the whole value added
i=1….n: elements, attributes or types

Besides, the influence of relative prices changes on the growth of the economic aggregates captured by the Tornqvist indexes allows measuring implicitly changes in consumer preferences or in economic aggregates' technology, in other words, long term relative prices changes that do not necessarily revert.

However, given the time shortness of the series analysed in this document, the use of a symmetrical index may produce an economic bias by unnecessarily softening the relative prices structure changes, which is crucial for the case of an unstable economy, in terms of relative prices volatility as in the case of Argentina analysed herein.

In order to avoid this effect but maintaining the flexible weights property, this study used as an optimal index the so called Contemporaneous Chain index, weighting the rates of change of subgroups according to their weights in the total value at current prices:

$$\frac{d \ln X^O}{dt} = \sum_{i=1}^{n} \frac{d \ln X_{i,t}}{dt} v_{i,t}$$

The composition effect of an aggregate will generally be given by the difference between the constant prices measurement by the optimal index and the traditional measurement by the fix base index (or Laspeyres):

[2] See OECD (2001b), Aulin-Ahmavaara (2004), Jorgenson, Gollop and Fraumeni (1987)

$$\frac{d \ln X^{C}}{dt} = \frac{d \ln X^{O}{}_{i,t}}{dt} - \frac{d \ln X^{B}{}_{i,t}}{dt}$$

O: optimal index
B: fix base Laspeyres index
C: composition effect

2.2.2 Quality Effects

Conversely, the disaggregating of the productive factors into differential qualities (for example, labour skill, groups and models of capital goods –embodied technical progress) may derive efficiency gains in the utilisation of factors.

For instance, in the case of the labour input, the quality effect is given by the difference between considering its growth by aggregating the hours worked taking into account their particular characteristics (sector, education, etc.) and an index that simply aggregates the hours without considering their weighting by attribute.

Thus, the factorial quality effect will be given by the difference between the undifferentiated measurement of the productive factor and its stratified measurement at least with a Laspeyres index. In general, the equation would be:

$$\frac{d \ln X^{Q}}{dt} = \frac{d \ln X^{B}{}_{i,t}}{dt} - \frac{d \ln X^{U}{}_{i,t}}{dt}$$

U: index of undifferentiated factor X, aggregating the elements without differentiating
B: fix base Laspeyres index
Q: quality effect

Note that in these cases, quality improvements could increase primary inputs contribution to growth, but not necessarily the strict TFP.

In sum, quality and composition effects will translate on a positive shift of the production function if and only if these effects generate indeed an improvement in the organization of the productive process.

In other words, the use of more capital goods or more skilled labour does not necessarily produce an improvement in TFP in the strict sense.

2.2.3 Cyclical Changes in Factor Utilisation

Factors utilisation may be subject to cyclical changes, such as changes in labour intensity or capital utilisation[3].

These phenomena may be expressing real cost changes that may affect the residual or apparent TFP. From the viewpoint of price or cost competitiveness analysis, this could be right.

However, if the purpose is to measure strict TFP as shifts in the production function or productive frontier, the lack of identification of this kind of phenomena may bias the sources of growth analysis.

As pointed out by Grilliches (1990) in his analysis of the US economy:

"procyclical fluctuations in 'productivity' do not make sense if we want to interpret them as a measure of the growth in the level of technology or the state of economically valuable knowledge of an economy. The US. Economy did not forget 4% of its technology between 1974 and 1975.Grilliches (1990)"

2.2.3. a Labour Intensity

According to international recommendations, especially ISWGNA (1993) and OECD (2001b), the units of measurement of the labour input must be hours worked.

These series allow including extensively within the labour factor the contribution of double employment, part-time employment and extra hours. Also, the availability of consistent data for hours worked and jobs allow estimating labour productivity in terms of hour-productivity, analysing the change in hours worked in terms of the change in labour intensity and changes in the number of jobs or workers.

However, this is not common practice in Latin America, either because of insufficient statistics or methodological inconsistency. Generally, in sources of growth analysis in that region, it is measured in terms of number of workers, which may end up in distorting the labour productivity indicator and therefore the TFP.

Although it may ex ante be inferred that the trend of employment, in terms of number of workers is similar to the trend displayed by the worked hours series, the cyclical performance of each series may be different.

The staff board may be subject to the labour hoarding effect that is produced during the economic cycle, if labour is considered as a quasi-fixed factor (human capital). When the phase of the economic cycle changes, for example during a cyclical recession, capital utilisation may be reduced faster than the number of workers, due to the hoarding of highly qualified workers, reducing labour intensity and therefore the

[3] The factor utilisation adjustment in productivity measurement has been discuss for a very different point of view in the economic literature, for example Solow (1957), Foss (1963), Denison (1969), Jorgenson and Grilliches (1967), Hulten (1986), Basu, Fernald and Shapiro (2001). Up today, there is aggrement that this phenomena has to be taking into account in growth accounting and productivity studies but there is no aggrement about how to make the adjustment. In that sense, taking into account the volatility behaviour of economic cycle in Argentina, we follow Basu, et.al. (2001) methodology in the explicit tradition of Solow (1957), Jogenson and Grilliches (1967), Denison (1969) but with especific utilisation indicators by factor in a growth accounting context.

total number of hours worked rather than the number of jobs themselves and, conversely, in the case of a change to the positive phase of the cycle[4].

Ceteris paribus the qualification of workers, labour intensity (hours worked by job) is positively correlated with the changes of phases of the economic cycle, given that the number of hours worked is a productive factor relatively more flexible than the employment in terms of jobs or workers. Therefore, as a consequence of the procyclical behaviour of labour intensity, hourly labour productivity (and TFP) will be less procyclical in terms of jobs or number of workers.

2.2.3. b Capital Utilisation

In principle, the production effectively measured should include capital services effectively used, as it occurs with the labour factor.

However, as will be seen in section 3.2, the standard approach to the sources of growth assumes that the services provided to output by capital are proportional to its stock in place. This assumption implies that the services that the capital provide are potential and not the effectively used in production. However, as pointed out by OECD (2001b), the capital services effectively used vary with the economic cycle.

In the absence of frictions, an increase in output may be supplied either with more equipment or with an increase in the use (machinery hours) of the installed equipment. A fall in demand may make certain equipment be retired from production as well as generate a reduction on the utilisation of the stock.

However, given the existence of adjustment and transaction costs as well as sunk costs, the adjustment of the capital stock to cyclical changes of demand (especially in the turning points of the economic cycle when its transitory or permanent condition is doubted), is produced generally by adjusting first the use of existing equipment before the stock itself.

The lack of correction of TFP by changes in capital utilisation, generates a strong procyclical behaviour in it that could be wrongly attributed to a shift in the production function.

Given that in this study TFP gains are understood as technological change or positive shifts in the production function, the adjustment of capital services for changes in their use becomes very important.

The instability of relative prices and aggregate demand may affect economic growth in the short term; not disaggregating the residual TFP may lead to a wrong identification of the growth profile.

In practice, TFP is estimated as a residual variable between the figures of labour productivity growth and capital intensity, or between the GDP and the contribution of productive factors. However, as seen before, this so called residual or apparent TFP, may include the composition and utilisation effects mentioned before. Particularly, in unstable economies as Argentina, these effects may be of an important magnitude, and not disaggregating them from the residual TFP may distort the assessment of the economic growth profile.

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[4] In other words, during a cyclical recession firms dismiss low skilled labor, trying to maintain the labour force with higher skills in terms of skills or human capital.

The aim of this paper is to identify the type of growth profile that predominated in the Argentine economy during the 1990-2004 period. In this purpose, a methodology for approximating TFP as a positive shift in the production possibilities frontier, hereafter "strict TFP", is proposed, discounting the influence of changes in relative prices and cyclical changes in factors utilisation[5].

In order to correctly identify the sources of GDP growth and labour productivity of an economy it is essential to understand how the GDP and productive factors are measured, which is the matter of analysis of the following section.

[5] Hulten (1986) distinguishes the TFP in even stronger terms: true TFP and false TFP (without adjusting for capital utilisation)

3. Main Problems in Factor Contribution Measurement

As seen before, in order to estimate productivity it is necessary to understand how GDP and the contribution of productive factors to growth are measured.

Taking into account that both capital and labour are heterogeneous factors, their contribution to GDP growth may be determined not only by changes at an aggregate level but also changes in its components.

The following subsections present briefly the main problems that arise when trying to measure the contribution of productive factors to GDP growth, taking into account the methodological discussion of the previous section.

3.1. Labour Input

As seen before, the optimal indicator of labour input is the hours worked rather than the number of workers or jobs. Bearing this in mind, the labour intensity effect can be defined as the difference between the growth of the labour factor in terms of hours and that in terms of number of workers:

$$\frac{d \ln L^{ul}}{dt} = \frac{d \ln L^{hs}}{dt} - \frac{d \ln L^{ocup}}{dt}$$

However, measuring the labour factor on the basis of a simple sum of the hours worked implies an undifferentiated measurement. Labour factor presents considerable heterogeneities; for example: gender, age, education, labour skill, industry.

If this differentiation were not captured in the labour factor contribution, the TFP measurement would be distorted.

The economic literature estimate the quality or labour factor differentials assuming that relative salaries by attribute are a good proxy variable of quality or productivity differentials of each of the types of labour. This implies weighting the contribution of groups into which labour is divided (industry, education, etc.) taking into account their relative wages, at least at the base year. The difference between the undifferentiated labour physical performance index and the fix base index weighted by relative wages will allow distinguishing the “quality” effect:

$$\frac{d \ln L^{Q}}{dt} = \frac{d \ln L^{B}}{dt} - \frac{d \ln L^{U}}{dt}$$

where changes in “quality” mean changes in the aggregate labour growth rate as a result of changes in the composition by attribute: education, gender, age, etc.

The Laspeyres fix base index becomes:

$$\frac{d \ln L_t^{\ B}}{dt} = \sum_{j=1}^{N} \sum_{i=1}^{E} \frac{d \ln L_{i,j,t}}{dt} v_{i,j,0}^{L,B} \qquad v_{i,j,0}^{L,B} = \frac{w_{i,j,0} L_{i,j,0}}{\sum_{j=1}^{N} \sum_{i=1}^{E} w_{i,j,0} L_{i,j,0}}$$

i=(1....E) levels of education, for example
j=(1....n) sectors of the economy
w_{ii}: hourly wage by educational group

$L_{i,j}$: hours worked by type i belonging to sector j

Being the undifferentiated labour index:

$$\frac{d \ln L^U}{dt} = \sum_{j=1}^{N} \sum_{i=1}^{E} \frac{d \ln L_t}{dt}$$

Note that in this example labour is opened by group or educational type and industry; if more characteristics are taken into account, it would be necessary to add new sums for each of them, increasing the number of groups defined.

However, the weighting of sub aggregates with a fix base index implies also a bias in the aggregate growth rate of the labour input, similar to the one described in the case of production, by not capturing the changes in composition of labour for each of the sub aggregates that may have been produced during the time between the base year and the observed year.

The fix base index would not be capturing the effect of relative wage changes on the contribution of sub aggregates to total labour growth.

This reallocation or composition effect would be captured estimating an optimal index similar to the one stated for the GDP. For example, if devaluation increases the relative demand of labour in the tradable sector and augments its relative wage, it will produce an intersectoral reallocation of labour towards this sector through time; while the increase in the tradable labour relative wage will increase its contribution to the aggregate labour growth which is not captured by the undifferentiated index or the fix base index.

The difference between the physical growth of the factor measured with a fix base index and the optimal index will reflect the composition effect of the analysed factor.

$$\frac{d \ln L^C}{dt} = \frac{d \ln L^O}{dt} - \frac{d \ln L^B}{dt}$$

O: optimal index
L: fix base index
C: composition or labour intersectoral relocation effect

The optimal index of labour factor becomes:

$$\frac{d \ln L_t^{\ O}}{dt} = \sum_{j=1}^{N} \sum_{i=1}^{E} \frac{d \ln L_{i,j,t}}{dt} v_{i,j,t}^{L,O} \qquad v_{i,j,t}^{L,O} = \frac{w_{i,j,t} L_{i,j,t}}{\sum_{j=1}^{n} \sum_{i=1}^{E} w_{i,j,t} L_{i,j,t}}$$

i=(1....E) levels of education, for example
j=(1....n) sectors of the economy
w_{ii}: hourly wage by group
$L_{i,j}$: hours worked by type i belonging to sector j

The present study in Argentina only covers the labour input divided by industry; however OECD (2001b) highlights that labour differentiation by activity sector involves an implicit differentiation for the rest of the unobservable characteristics, by assuming correlation between relative wages by industry and the rest of the workers' attributes.

Finally, it is worth mentioning that self-employed and un-paid family workers are included in the labour factor, in addition to employees. Income of this type of workers is called *mix income* given that it includes a share of compensation to labour and capital income. In order to indentify their labour remuneration, returns to labour of this type were imputed at an industry level based on the wages of employees as recomended by OECD (2001b).

In this way, the optimal measurement of labour input will be given by a chain index of the hours worked weighted by relative wages by industry. In other words, the optimal index will be the sum of the composition effect, the quality effect and the labour intensity adjustment:

$$\frac{d \ln L^{O}}{dt} = \left(\frac{d \ln L^{U}}{dt} + \frac{d \ln L^{Q}}{dt} + \frac{d \ln L^{C}}{dt} + \frac{d \ln L^{ul}}{dt} \right)$$

3.2. Capital Input Services

The contribution of capital stock to economic growth must be analysed as a productive factor, in other words, in terms of their services generated.

This would imply counting with statistics of used machinery-hours by asset and user industry. Given the lack of this type of statistics, the general assumption is that the stock growth by type of good is proportional to the use of its services, being this proportion constant for each type of asset[6].

Also, the cost of capital services would correspond to the annual cost assumed by the user of the stock for the use of the machinery-hours needed by final output, in other words, the user cost. This concept represents the rental price that corresponds to the annual use of the capital stock as a productive factor, either by a user or by its owner. Therefore, the contribution of capital stock to economic growth should be measured by its user cost and not by its price as an asset.

In the economic literature, the relevant concept of capital stock for productivity estimations has been *productive capital*, whose relevant price is the user cost, in contrast to the net capital stock or wealth, which is valued at asset prices.

The user cost by type of capital good should come from statistics of the rental market of capital goods. However, not all capital goods have a rental market, or leasing or even sale market, making the case for an imputation.

The economic literature on productivity measurement recommends estimating the user cost by means of imputing the following equation for each of the typologies and by user industry:

$$\mu_{k,t} = p_{K,t}\left(r_t + d_t - \frac{\dot{p}_{K,t}}{p_{K,t}}\right)$$

$\mu_{k,t}$: user cost
$p_{K,t}$: price of the asset
r_t: financial cost or opportunity cost
d_t: depreciation rate

There are different alternatives for imputing the user cost to the different components of the capital stock, based on the different criteria concerning how to impute the relevant interest rate or expected inflation in this type of goods, (OECD (2001 a,b)), which may be subject to analytical or statistical criticism due to the instability of the economies being measured[7].

In the present study, the ex-post residual approach of Hall and Jorgenson (1967) and Jorgenson, Gollop and Fraumeni (1987) was adopted, assuming that the value of capital services can be proxied by means of national accounts for the total income of capital ownership (as a residual between the total product and the labour income). The rate of return r arises endogenously from the following equation:

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[6] See Hill (1999) (2000), Hulten (1990), Mas, Pérez and Uriel (2005), Schreyer (2001) and OECD (2001a,b)

[7] For example, the user cost may become negative in a high inflation context with negative real interest rates.

$$PQ - wL = \sum_i p_{K,i,t} K_t^P \left(r_t + d_{i,t} - \frac{\dot{p}_{K,i,t}}{p_{K,i,t}} \right)$$

where the first term represents the gross operating surplus of the National Accounts, and the second term is the value of the capital services provided by the productive capital represented by the third term.

It is worth noting that the weighting by user cost allows bearing in mind that a dollar invested in buildings has a lower annual average return than a dollar invested in machinery, in relative terms, mainly due to the fact that investment in machinery is recovered relatively faster than construction investment, as a result of its lower relative durability.

Some authors, such as Shreyer (2003) or Mas, Pérez and Uriel (2005) consider that the weighting by user cost of the capital stock implies by itself a change in quality. As seen before, equipment with shorter service life, is the one that more services at annual frecuency provide to production and therefore will have a higher weight in *productive capital* than in *wealth capital,* given that their relative weight in terms of asset value is relatively lower.

In analytical terms:

$$\frac{d \ln K^Q}{dt} = \frac{d \ln K_P}{dt} - \frac{d \ln K_W}{dt}$$

where K^P is the productive capital, K^W is wealth capital and K^q represent the quality effect.

The composition effect can be defined, following the discussion of section 2.2.1, as the difference between an optimal physical volume index and a fix base index for the productive capital (or also for the wealth capital).

Finally, the contribution of capital to the GDP growth will have to be adjusted by the capital utilisation indicator, in order to obtain their services effectively used in production (see section 2.2.3):

$$\frac{d \ln K_{uk}^P}{dt} = \frac{d \ln K_P^{ajk}}{dt} - \frac{d \ln K_P^{pot}}{dt}$$

where K^{uk} is the utilisation effect, K^{pot} are the capital services without adjustment (corresponding to the productive capital considered so far) and K^{ajk} represents the capital services adjusted by utilisation.

The adjustment of TFP by capital utilisation in growth accounting and productivity measurement has been discuss for a very different point of view in the economic literature, for example Solow (1957), Foss (1963), Denison (1969), Jorgenson and Grilliches (1967), Hulten (1986), Basu, Fernald and Shapiro (2001). Up today, there is aggrement that this phenomena has to be taking into account in growth accounting and productivity studies but there is no aggrement about how to make the adjustment.

In that sense, taking into account the volatility behaviour of economic cycle in emerging economies like Argentina, as in Basu, et.al. (2001) making an explicit adjustment of capital contribution by utilisation but in the tradition of Solow (1957), Jogenson and Grilliches (1967), Denison (1969) with especific utilisation indicators by factor in a growth accounting context.

In this way, the optimal growth rate of capital services will be given by a chain index of the capital services weighted by user cost, corrected by its effective use in the productive process. In other words, the optimal index will be the sum of the composition, the quality and the utilisation effects:

$$\frac{d \ln K_P^O}{dt} = \left(\frac{d \ln K_W^B}{dt} + \frac{d \ln K^C}{dt} + \frac{d \ln K^Q}{dt} + \frac{d \ln K^{uk}}{dt} \right)$$

4. The Measurement of the Sources of Growth in Argentina 1990-2004

The purpose of this section is to present briefly the methodology, sources and results of the estimations of the components of labour productivity for Argentina during the period 1990-2004, following the recommendations of sections 2 and 3[8].

4.1. Gross Domestic Product

Estimations of the Gross Domestic Product (GDP) are the official ones provided by the National Accounts Area (DNCN) of the National Statistical and Census Bureau (INDEC). These estimations correspond to the 1993 base year for the period 1993-2004. For the period 1990-1993, the series at a 1 digit level of ISIIC 3rd rev. were matched with the series of the former base year 1986[9].

It is worth adding that GDP official figures account for non registered activity by industry in the base year. Available sectoral value added figures are valued at producer prices, that is, excluding non deductible VAT as well as import taxes and intermediation margins[10].

As explained before, the GDP series was calculated by means of ideal or optimal indexes, considering the dynamics of relative prices of the contemporaneous period[11].

Figure 1 presents the GDP series by index type:

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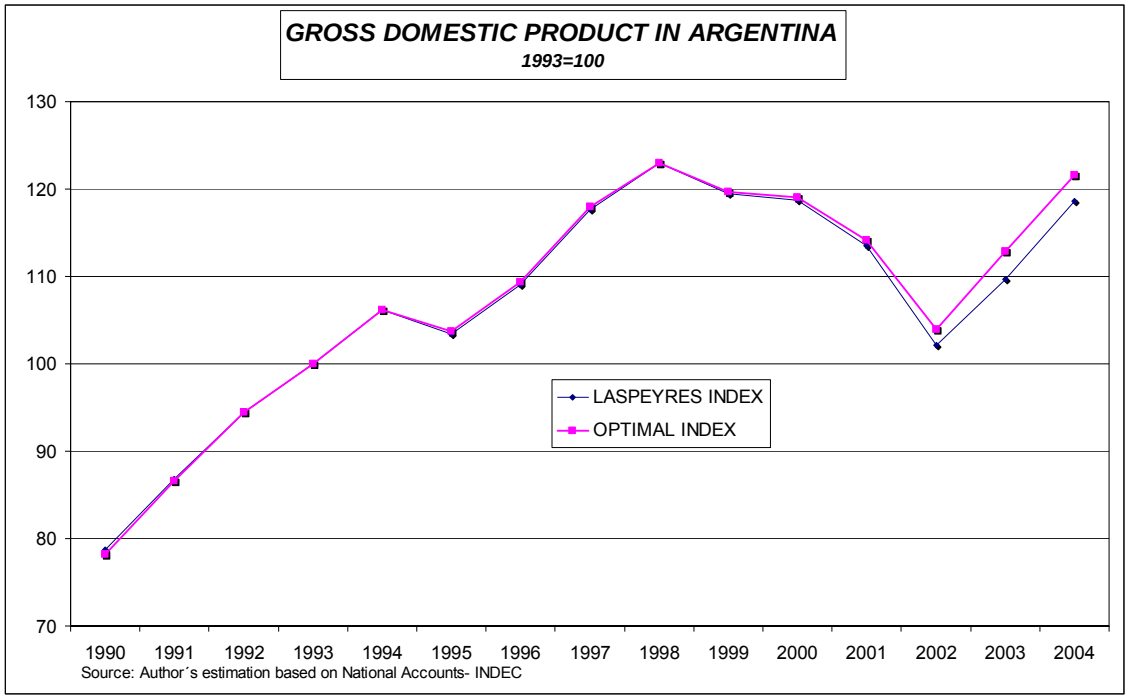
[8] The impact on productivity and the growth profile are analyzed in the following section.

[9] This match is provisional given that it was not carried out homogenizing the calculation methodology of the physical volume indexes of the industries that form the GDP.

[10] A more accurate measurement of productivity should use the basic prices valuation criteria. This criterion allows estimating better the price at the exit of factory, by discounting additionally the direct taxes, income tax and exports taxes; however, this statistics at current and constant prices by industry are not available officially.

[11] For the definition and methodology of ideal or optimal indexes, see for example Diewert (1976) (1978) (1995), OECD (2001b) and ISWGNA (1993). The estimation for Argentina is explained in Coremberg (2002): results for the different type of ideal indexes are similar to the one presented herein.

Figure 1



The performance of GDP during the past decade was not very different between each of the series. However, since 2000 and specially after the 2002 crisis, the physical dynamics of GDP begins being more important for the case of the optimal index than for the fix base or Laspeyres index (Table 1).

As a result of a 250% devaluation of the domestic currency in 2002, tradable goods producing sectors increase their share in GDP (from 25% to 45%), augmenting their contribution to GDP growth (figure 2). It is important to note that the contribution to GDP growth is not reflected in the base 1993 index, with a lower share of tradable goods.

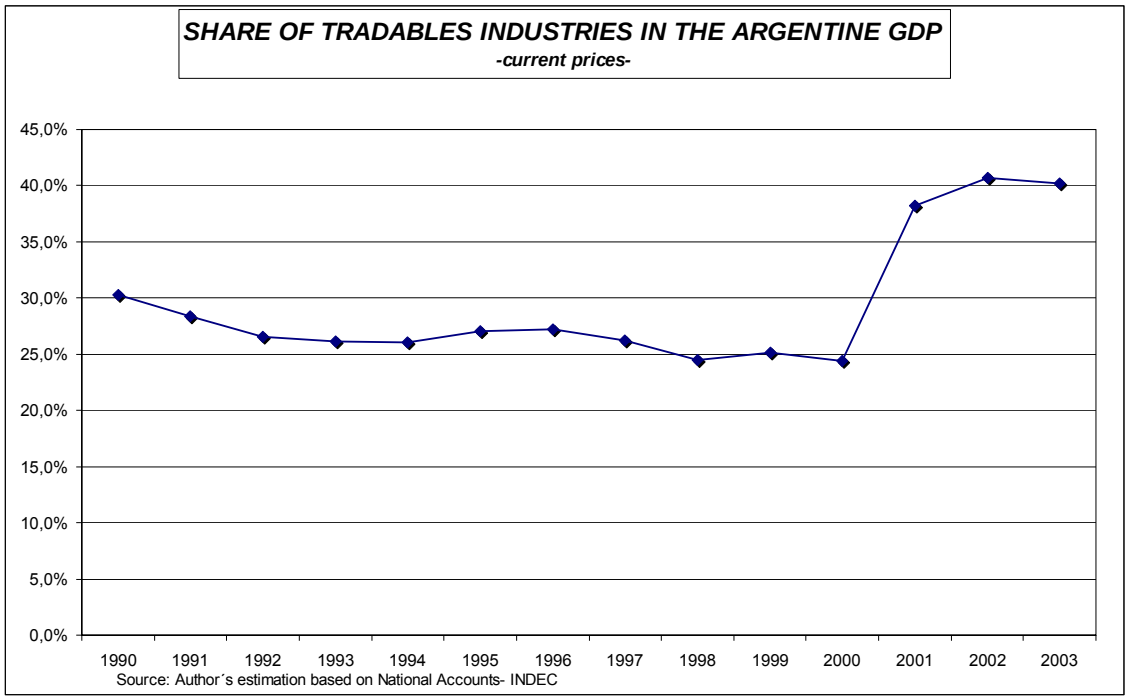
On the other hand, differences are substantially lower at the beginning of the period. Devaluation on years 1988 to 1990, under a hyperinflation period, was completely different since it was almost neutral with respect to relative prices for the average period, as a consequence of the whole pass-through (even more than proportional) of nominal devaluation to prices generated by the 1989-1990 hyperinflation prior to adopting the Convertibility Plan. After the adoption of the Convertibility Plan on April 1991, currency appreciation implied a small reduction in the share of the tradable sector, slightly increasing the gap between both type of indexes[12].

[12] Neutrality of devaluation on relative prices of tradable goods during the hyperinflation period with respect to the post Convertibility devaluation can be demonstrated by analyzing the ratio between the implicit deflactors of value added of the tradable and non-tradable sectors, according to National Accounts. Between 1990 and 2001, relative prices of tradable goods in terms of non-tradable goods are reduced in a 17.5%, whereas after devaluation, relative prices of tradable goods increased in 92% (2001-2004).

TABLE 1 GROSS DOMESTIC PRODUCT IN ARGENTINA								
Average Annual Growth Rates								
Type of Index/ Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1990-2001**	**2001-2002**	**2002-2004**	**1990-2004**
Laspeyres93	7,78%	-2,62%	5,94%	-2,65%	3,38%	-10,02%	7,77%	2,97%
Optimal	7,96%	-2,36%	5,86%	-2,46%	3,50%	-8,96%	8,15%	3,20%
Substitution	0,17%	0,26%	-0,08%	0,19%	0,12%	1,06%	0,38%	0,23%

Source: Author´s estimation based on National Accounts-INDEC

Figure 2



This important change in relative prices is captured in the chain physical volume index mentioned, representing a substitution effect in production of approximately an annual 1% average for 2002 and of 0.4% average for the following years, as presented in Table 1.

In terms of the analysis of sources of growth in Argentina, if this production substitution bias were not taken into account, GDP growth would be underestimated in an annual 0.23% average for the 1990-2004 period, while after the 2002 devaluation the difference would be higher than an annual 0.7% average. This is not a minor difference taking into account the magnitudes in the growth rates of productive factors, as will be seen in the following subsections. If this bias were not considered, GDP growth and therefore productivity gains would be underestimated.

4.2. Labour Input

Output, wages and labour in hours and jobs series by industry during 1993-2004 period comes from National Accounts[13]. The functional distribution of income estimated by National Accounts gather information belonging to different sources in order to achieve an exhaustive estimation by industry consistent with the ISWGNA (1993) recommendations[14].

The availability of data from the same statistical source allows the methodological and consistent homogenization of employment and GDP by industry, whose production and labour data include a sectoral adjustment for non registered economy. This allows a consistent analysis of sectoral and aggregate labour productivity, including employment and wages of primary sectors underestimated in the Household Survey, by means of other exogenous sources, as well as include an adjustment for underdeclaration of factor income consistent with the rest of the National Accounts.

The National Accounts labour and wages series for the period 1993-2004 are presented at a 1 digit level of ISIIC 3rd rev. (16 sectors), which is compatible with the disaggregating of the Gross Domestic Product accounts and an own estimation based on the Household Permanent Survey (EPH) of INDEC for 1990-1993.

The level of disaggregation of the attributes of labour factor was determined on the basis of a study of employment characteristics, following the proposal of Jorgenson et al. (1987) using the EPH, the only source of exhaustive information in Argentina. However, preliminary tabulation did not provide satisfactory results, since the cross-section study of more than two characteristics produced a very sharp reduction in the statistical significance of this survey. For this reason, it was decided to adopt the implicit differentiation approach proposed by OECD (2001a), assuming correlation between the sectoral characteristic of labour and the rest of the workers attributes.

This method implies an inherent differentiation for the rest of the non observable characteristics, by assuming correlation between the sectoral relative wages and the rest of the attributes of the workers, capturing, in part the change in quality of workers. Any change in the workers' attributes not correlated with the sectoral characteristic of the labour input is incorporated in the residual TFP.

Finally, it is worth noting that the labour factor also includes the contribution of self-employed and un-paid family workers taking into account similar wages of the same industry where they belong as recomended by OECD (2001b) (see section 3.1)

According to Table 2, the trend of hours worked in Argentina was slightly higher than that of workers employed during 1990-2004 period:

[13] See DNCN-INDEC (2006)
[14] See ISWGNA (1993)

TABLE 2 LABOUR INPUT IN ARGENTINA*								
Annual Average Growth Rates								
Labour Input Indicator / Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1991-2001**	**2001-2002**	**2002-2004**	**1990-2004**
Jobs	2,44%	-2,87%	3,76%	-0,34%	1,54%	-5,68%	6,33%	1,67%
Hours Worked	4,09%	-3,64%	3,27%	-1,60%	1,57%	-10,60%	10,46%	1,86%
Labour Intensity	1,64%	-0,77%	-0,49%	-1,25%	0,03%	-4,92%	4,13%	0,19%

Source: Author´s estimation based on National Accounts-INDEC
*Labour input in terms of undifferentiated positions or hours worked

On the other hand, the dynamics of the labour input shows an important procyclical behaviour along the period analysed, independently of the indicator used, in spite of being a stock variable. This dynamics is stronger for hours worked than for jobs series, as shown by figure 3, which may be attributed to the greater flexibility of hours worked than jobs or to the labour hoarding phenomenon. The largest fluctuations are observed on the phase change periods of the GDP cycle: 1990-1994, 1998-2001, 2001-2002, 2002-2004.

Figure 3

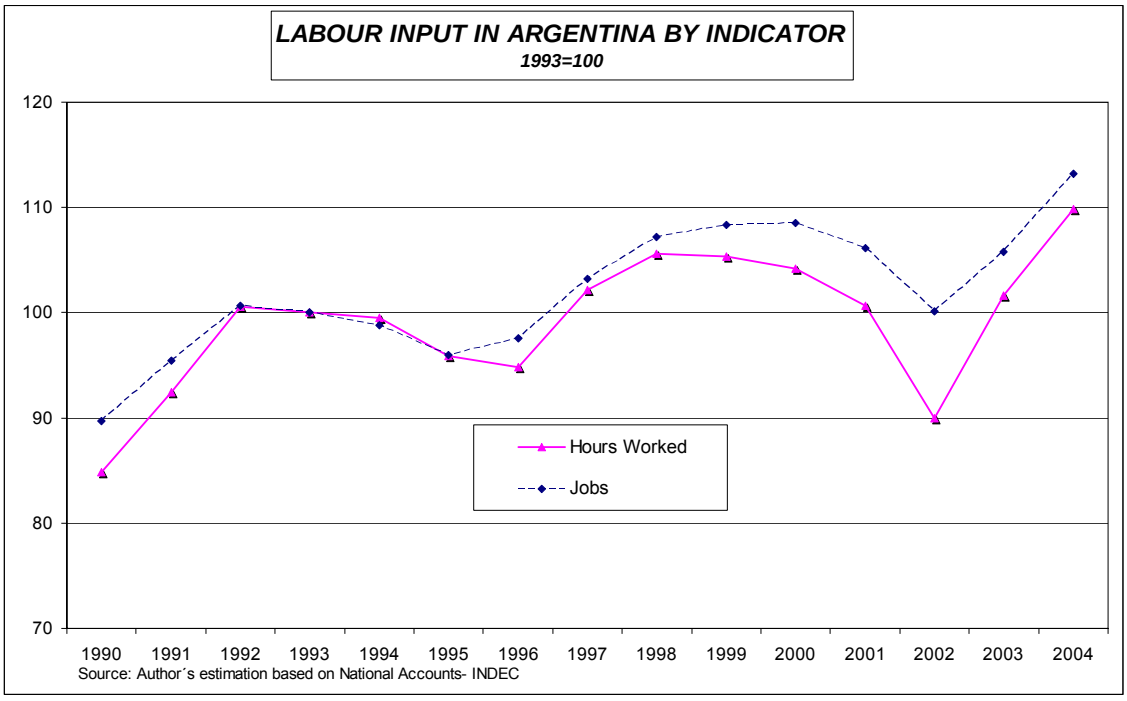
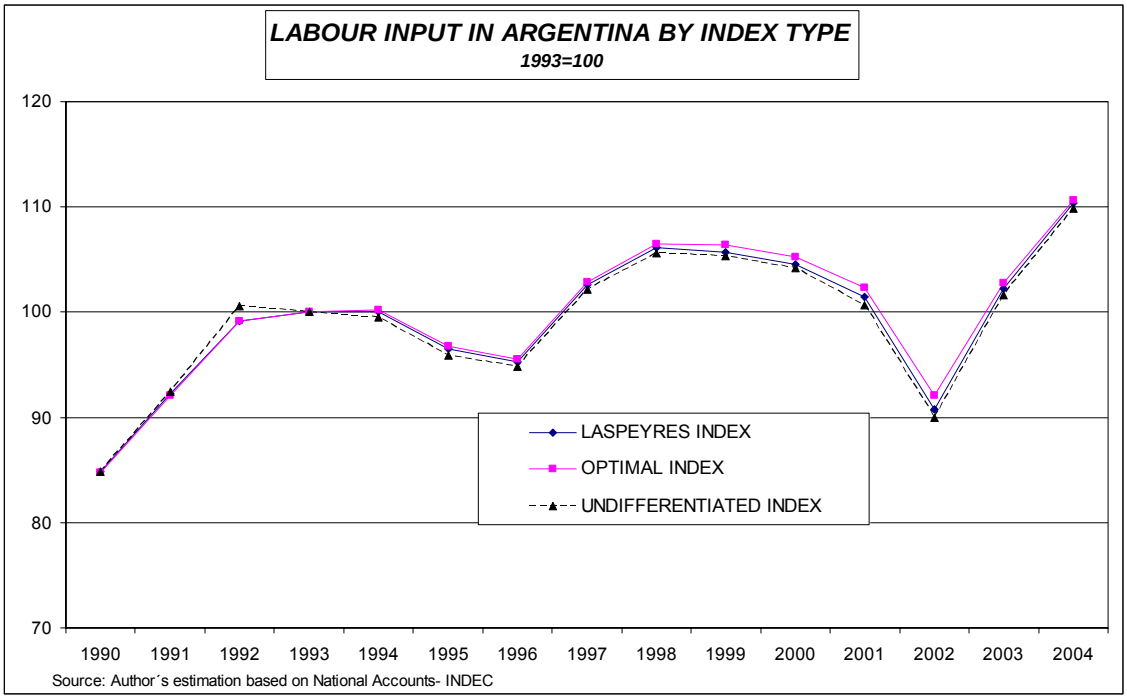


Figure 4 presents the dynamics of labour input measured by index types. The difference between labour growth in terms of the undifferentiated index and the fix base index is produced as a consequence of capturing the dynamics of labour taking into account the differentiation of labour by industry in the base year. In contrast, the optimal index reflects the changes in the structure of relative salaries produced along the series, biased to non tradables for the Convertibility period and to tradables for the post devaluation period, following the same profile of structure change as in the case of relative prices in output.

Figure 4



As shown in Table 3, the most relevant differences appear at the beginning of the positive phases of the economic cycle (1990-1994 and 2002-2004), in which quality and composition effects jointly go up to an average of 0.18% and -0.83% respectively as a consequence of the changes in relative wages generated by the important appreciation of the domestic currency at the beginning of the nineties (positive effect that lasted the whole decade) and the devaluation of year 2002.

TABLE 3
LABOUR INPUT IN ARGENTINA*

Annual Average Growth Rates

Labour Input Indicator / Period	1990-1994	1994-1995	1995-1998	1998-2001	1991-2001	2001-2002	2002-2004	1990-2004
Undifferentiated	4,09%	-3,64%	3,27%	-1,60%	1,57%	-10,60%	10,46%	1,86%
Quality Effect	***0,11%***	***0,06%***	***-0,04%***	***0,10%***	***0,06%***	***0,10%***	***-0,19%***	***0,03%***
Laspeyres	4,19%	-3,58%	3,23%	-1,50%	1,63%	-10,50%	10,28%	1,89%
Composition Effect	***0,07%***	***0,14%***	***0,03%***	***0,17%***	***0,09%***	***0,46%***	***-0,64%***	***0,03%***
Optimal	4,26%	-3,43%	3,26%	-1,33%	1,72%	-10,03%	9,64%	1,92%
Total Effect	***0,18%***	***0,21%***	***-0,01%***	***0,27%***	***0,15%***	***0,57%***	***-0,83%***	***0,06%***

Source: Author´s estimation based on National Accounts-INDEC
*In terms of hours worked

To sum up, the adjustment by utilisation of the labour input due to changes in labour intensity plays a crucial role in the measurement of the contribution of the labour factor to growth, since the optimal series of hours worked presents a very procyclical behaviour as well as a sharper trend for the labour factor which, if not accounted for these effects in labour contribution, would lead to overestimate the TFP and labour productivity.

4.3. Capital Services

4.3.1 Capital Stock Estimation

The capital stock series used herein corresponds to the recent author´s estimations in National Bureau of National Accounts-INDEC (National Statistics Institute). The estimation methodology has been extensively explained in Coremberg (2002) and in Coremberg-DNCN-INDEC (2004), following the methodological recommendations of the literature on capital measurement, especially: the discussions of the OECD Canberra Group for the Measurement of Non Financial Assets, OECD (2001b) and the experience of IVIE in Spain presented in Mas, Perez y Uriel (2005)[15].

Briefly, the main characteristics of that estimation are the following:

i. Perpetual Inventory Method (PIM) adjusted by:

   i.1 Empirical Verification of the Average service life and Depreciation Profile by means of an econometric assessment of the prices of the cohorts in the used capital goods market, similar to Hulten and Wycof (1981).

   i.2 Benchmarking of Census Data

   i.3 Matching-Model in case of availability of information on stock and prices by cohort and model

ii. Disaggregated in more than 100 types

iii. Internal consistency with Investment data of National Accounts by activity with a ISIIC 5 digit level of disaggregating.

iv. Macroeconomic consistency

The price analysis of cohorts in the durable goods market as well as the consistency with census data at the maximum disaggregating level possible allowed verifying and adapting the main assumptions of the Perpetual Inventory Method to the Argentine case.

Also, the high level of disaggregation allowed obtaining physical volume indexes of the stock imputing specific price indexes, consistent in turns with the same criterion applied to investment national accounts.

One of the main results of the macroeconomic consistency, analysed in detail in Coremberg (2002), is that the estimated level of capital stock appears to be relatively low, in terms of the capital-output ratio and capital intensity with respect to other developed countries, verifying one of the main stylised facts in economic growth theory.

[15] Hofman (1991) (2000) presents standardized PPP PIM estimations of capital stock disaggregated in 3 types for seven Latinamerican economies, including Argentina for the previous period 1950-1994 with similar capital-output ratios as our series for the period 1990-2004.

4.3.2 Composition and Quality Effects on Capital Services in Argentina

In order to obtain the (potential) productive capital stock, user costs or rental prices for each of the typologies were estimated so as to express the net capital stock of National Accounts in terms of annual services, following the recommendations of section 3.2.

To identify the different effects of changes in relative prices on the capital services it was firstly identified the composition effect on the net capital stock and then adjusted by changes in the weights to obtain the quality effect, similarly as presented by OECD (2001b).

The following Table presents main results:

TABLE 4
CAPITAL STOCK SERVICES IN ARGENTINA 1990-2004
Annual Average Growth Rates

	Total	Durable Equipment	Construction*
Laspeyres Wealth Capital	2,03%	1,84%	2,09%
Composition Effect	***0,93%***	***0,41%***	***1,03%***
Optimal Wealth Capital	2,96%	2,25%	3,11%
Quality Effect	***-0,50%***	***0,76%***	***-1,05%***
Optimal Capital Services	2,46%	3,01%	2,06%
Total Effect	***0,43%***	***1,16%***	***-0,03%***

Source: Self made based on National Accounts-INDEC.
* Includes cultivated assets (with minimum weight)

The following conclusions can be derived from the analysis of Table 4:

i. Composition effect is positive for the aggregate and all the components of the stock. This effect, obtained as a difference between the net capital stock by Laspeyres volume index and the Chained one is almost an annual 1% average, weighting the respective effects of 0.41% in the case of production durable equipment and of 1.03% in the case of construction. In other words, the dynamics of the wealth capital stock is underestimated by traditional indexes.

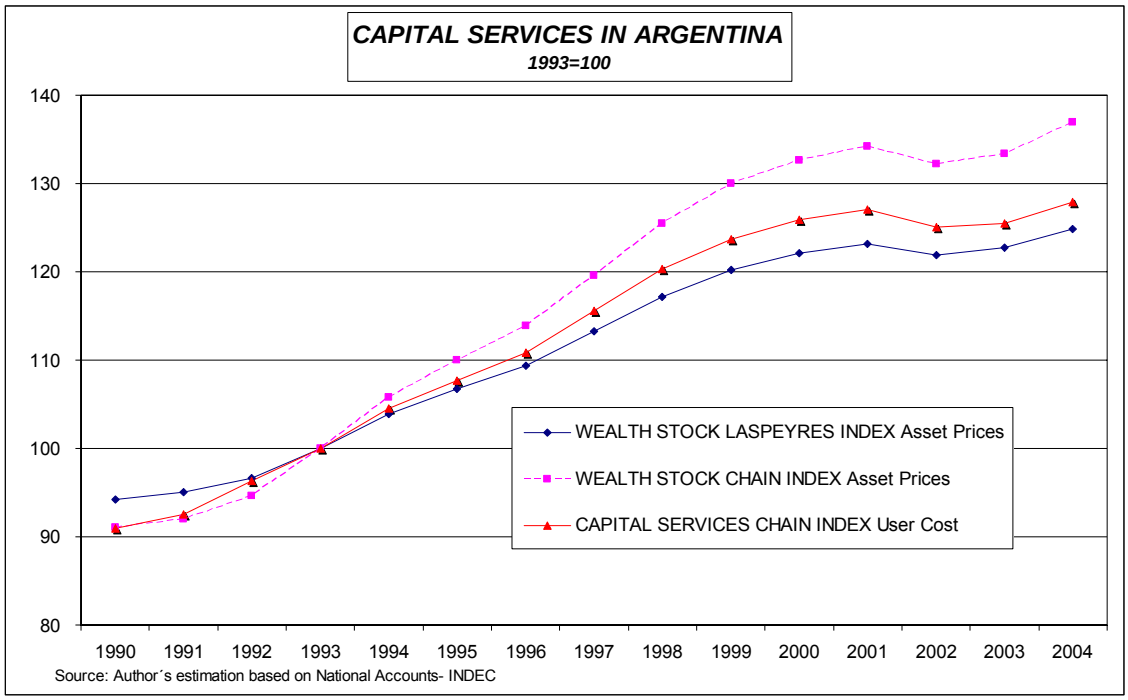
ii. Quality effect, obtained as the difference between wealth or net capital and productive capital (both measured by Chain indexes) is negative for the aggregate stock, -0.5%, as a weighted sum of a positive effect for durable equipment of 0.76% and a negative effect of -1.05% for construction. The weighting by user cost is proportionally higher for durable equipment since, by having a shorter average service life, they provide a relatively greater share of annual services. However, although quality effect on durable equipment stock is positive, the negative effect provided by construction is larger, since the latter has the largest weight in capital stock (both net and productive) even when weighted by user cost.

iii. The total net effect of adjusting for changes in relative prices and weighting by user cost is 0.43% for the aggregate capital stock, 1.16% for the production durable equipment stock and null for the construction stock.

The effects on capital services along the period under analysis can be observed in figure 5. As can be noted, the total net effect of adjustments by quality and composition is relevant and growing for the whole period 1990-2004. The most widespread use of net capital stock by a fix base index would be underestimating the

contribution of capital services to economic growth leading to an overestimation of the TFP growth[16].

Figure 5



[16] Similar results are derived by Schreyer (2001) for a set of OECD countries and in Mas, Perez and Uriel (2005) in recent periods for Spain and at a regional level.

4.3.3 Capital Utilisation in Argentina

Taking into account our explicit approach of capital utilisation adjustment (section 2.2.3 b and 3.2), empirically there are many alternatives for adjusting the productive capital by its effective utilisation:

i. Output Gap as proposed by Okun (1962)
ii. Employment rate
iii. Hours worked
iv. Surveys on Installed Capacity Use
v. Energy Consumption

All these variables present theoretical and statistical problems that are summarized in Table 5:

TABLE 5
PROXY INDICATORS OF INSTALLED CAPACITY USE

	Assumption	**Statistical Coverage in Argentina**
Output Gap	Usual interpretation of Okun: Natural Unemployment Rate	According to the analyst subjectivity, econometric estimations
Employment Rate	Complementarity	By Household Surveys in Urban Conglomerates
Hours Worked	Complementarity	
Energy Consumption	Complementarity	Energy Demand
Surveys	Representativity	Indicators limited to Manufacturing Indust.

The potential output can be econometrically estimated, averaging local maximums, etc. It is worth mentioning that these alternatives assume implicitly that there exists a potential product upon which the output gap can be estimated as in Okun (1962), which can be usually interpreted (but not neccesarily implies) as a natural unemployment rate hypothesis, measurement that is inevitably controversial. It can also be estimated by the growth accounting approach, but the capacity of the economy itself, i.e. the sum of factors at full utilisation plus the contribution of technical progress, is a determinant variable of the indicator that we are estimating.

The first three alternatives imply assuming that the use of both productive factors is the same, in other words, that there exists complementarity in the production process between the use of capital and the services of labour. This assumption may be arguable in a context of important changes in factor relative prices or productive restructuration implying the need of factor substitution and therefore both factors not being used at the same rate. However, the substitution process between factors could be lower in the short run as a consequence of technological rigidities, sunk costs and transaction costs; thus in the aggregate, substitution may be the consequence of the birth and death process of firms or due to production intersectoral substitution rather factorial substitutions within them.

On the other hand, the unemployment rate should be avoided as an indicator of the contribution of labour and capital factors to GDP growth, given that the correct indicator when measuring the sources of growth of effective output is the hours worked and not the number of jobs or workers[17], by capturing part time employment, extra hours, and double employment in the labour input.

[17] Then again, the employment rate indicator as a proxy of capital use implies a distortion in its meaning since it introduces implicitly in this last factor the changes in the condition of activity of the population.

The alternative of using the series of hours worked as a proxy of capital utilisation would be problematic, given that along the period analysed the Argentine economy suffered important changes of factor relative prices[18] that might have induced a mid term factor substitution, invalidating the hours worked-hours machinery complementarity assumption.

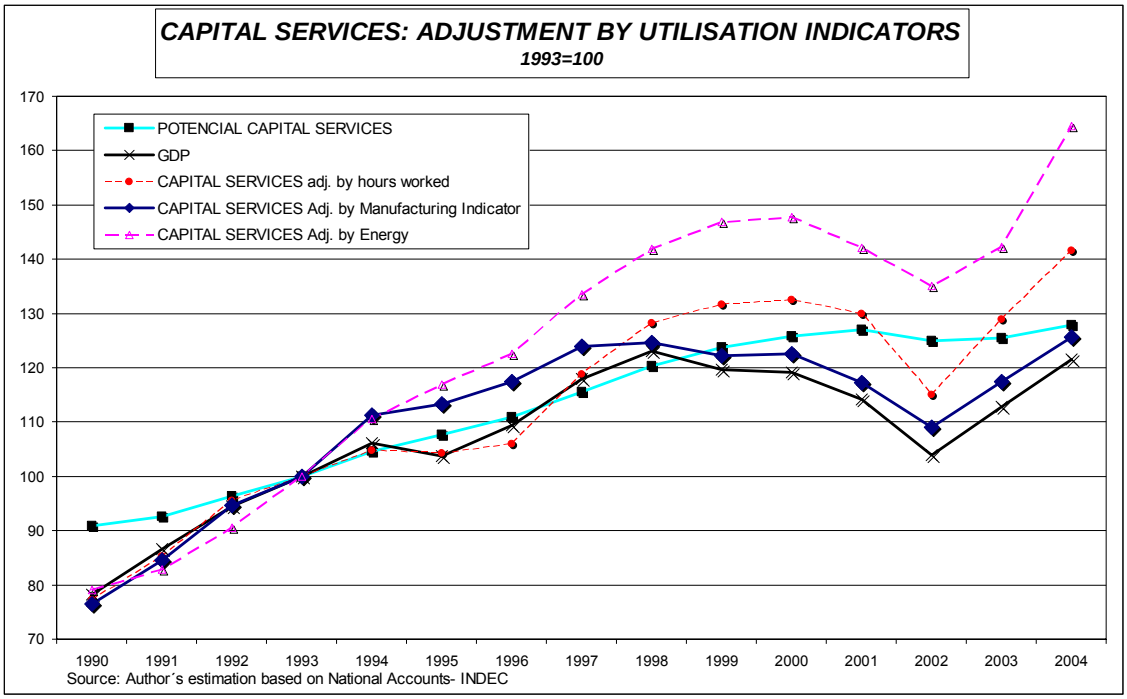
Also, the use of electricity as a proxy of capital utilisation, as in Foss (1963) or in Jorgenson and Grilliches (1967), has been criticized by Denison (1969) and other authors on the grounds of the possibility of substitution of energy sources in production, or for not taking into account the fact that there exists no stable relationship between machine hours used and energy, given that the productivity of capital with respect to energy is inversely correlated with energy costs.

The use of econometric techniques or proxy indicators should only be used in the absence of extensive surveys that allow capturing changes in capital utilisation by user industry. But the problem of statistical coverage is important in Argentina since there are available surveys measure capital utilisation only for the manufacturing industry only.

The only available survey of capital utilisation in Argentina for the period 1990-2004 corresponds to the capital utilisation index in the manufacturing industry prepared by FIEL[19] [20]. Comparatively, the latter indicator is the one that presents the larger correlation with the changes in aggregate demand (see figure 6), and precisely for that reason is the one that is finally used in this study. The use of the other indicators would have led to an over adjustment of the capital services series not only during changes of phase of the economic cycle but also and mostly in its trend.

[18] Due to strong fluctuations in the real exchange rate, appreciation of the domestic currency at the beginnings of the nineties and to the sharp decline in unit labor costs derived from 2002 devaluation.
[19] Fundación de Investigaciones Económicas Latinoamericanas.
[20] There is also the indicator of installed capacity use of the manufacturing industry of the Monthly Industrial Survey (EMI) of INDEC, although only beginning in year 2002, whose path has been similar to that of FIEL.

Figure 6



The results of the adjustment of productive capital stock by utilisation are presented in Table 6:

TABLE 6

CAPITAL SERVICES UTILISATION IN ARGENTINA
Annual Average Growth Rates

Indicator / Period	1990-1994	1994-1995	1995-1998	1998-2001	1990-2001	2001-2002	2002-2004	1990-2004
Potential Capital Services	3,55%	3,01%	3,75%	1,83%	3,08%	-1,59%	1,14%	2,46%
Capital Scies. Adj. By Manuf. Indicator	9,84%	1,89%	3,24%	-2,02%	3,97%	-7,12%	7,40%	3,62%
Utilisation Effect	6,29%	-1,11%	-0,52%	-3,85%	0,89%	-5,52%	6,26%	1,15%

Source: Self made on the basis of data from National Accounts INDEC and FIEL.

The series of capital services effectively used presents a clear procyclical behaviour. The adjustment for utilisation has a stronger effect in the changes of phase of the economic cycle, and its absolute value is maximum at the beginning of the two important cycles of the Argentine economy: during the 1990-2004 period (the beginning of the Convertibility Plan (1990-1994)) and the growth cycle that started after devaluation (2002-2004). Plus, it is worth highlighting that the magnitude of the utilisation effect is similar in both periods, approximately 6.3%.

The adjustment for utilisation determines that if potential capital services were included in the growth analysis, the contribution of capital input to gdp growth during positive phases in economic cycle would be underestimated and inversely in the recessive stages. Therefore, strict TFP would be overestimated at the beginning of the positive phase of the economic cycle and underestimated in the negative phases.

5. The Productivity of the Argentine Economy 1990-2004[21]

5.1. Labour Productivity

This section analyses the dynamics of labour productivity during the period 1990-2004, taking into account the hours worked as the optimal measure. First, we present the differences in trend and in the economic cycle of labour productivity measured by the GDP per job indicator and the GDP by hour worked indicator, in order to assess the effect of the adjustment by labour intensity. In the second place, we analyse the impact on the hour-labour productivity optimal indicator of considering the quality and intersectoral composition effects in labour mentioned in the former chapter.

5.1.1 The Adjustment by Labour Intensity

According to figure 7, labour productivity (undifferentiated labour input) presents a positive trend for both jobs and hours worked, for the whole period 1990-2004. At the end of the period analysed, labour productivity would have reached a level of 20.5% over the year 1990 for the jobs indicator, and 15.5% for the hours worked indicator.

Figure 7

According to Table 7, for the whole period under analysis, labour productivity measured by job grew, on average, at rates somewhat higher than hour labour productivity: 1.34% and 1.04% respectively.

TABLE 7
LABOUR PRODUCTIVITY IN ARGENTINA* BY TYPE OF LABOUR INPUT INDICATOR

[21] One of the main previous analysis on Latinamerica is Elías (1992), where traditional growth accounting was applied to Argentina between 1944-1985.

Average Annual Growth Rates								
Labour Input Indicator / Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1990-2001**	**2001-2002**	**2002-2004**	**1990-2004**
Jobs	5,28%	0,25%	2,17%	-2,31%	1,86%	-4,34%	1,44%	1,34%
Hours Worked	3,56%	1,02%	2,58%	-1,06%	1,78%	0,58%	-2,76%	1,04%
Labour Intensity Effect	-1,72%	0,77%	0,41%	1,25%	-0,07%	4,92%	-4,20%	-0,31%

Source: Author´s estimation based on National Accounts-INDEC
*Labour productivity based on labour input measured in terms of positions or undifferentiated hours worked

On the other hand, labour productivity of the Argentine economy presents a certain procyclical behaviour for both indicators. In general, in periods of economic recovery, changes in labour productivity become positive while in recessive periods they present null or negative values.

However, although the long term paths of labour productivity for the period 1990-2004 and the signs of their annual growth are similar for both types of indicators, there are substantial differences in the short run among the magnitudes of the rates of change, a fact that is presented in figure 8.

Figure 8

The differences in the magnitudes in the growh of both series are important, and due to changes in labour intensity as a result of the larger adjustment flexibility of hours with respect to jobs or as a result of "labour hoarding", as described in section 4.2. According to figure 8, the overstatement of productivity gains that is produced by the jobs indicator becomes notable particularly at the beginning of the positive phases of the cycle of the Convertibility Plan (1990-1994) and the "Post devaluation" (2002-2004).

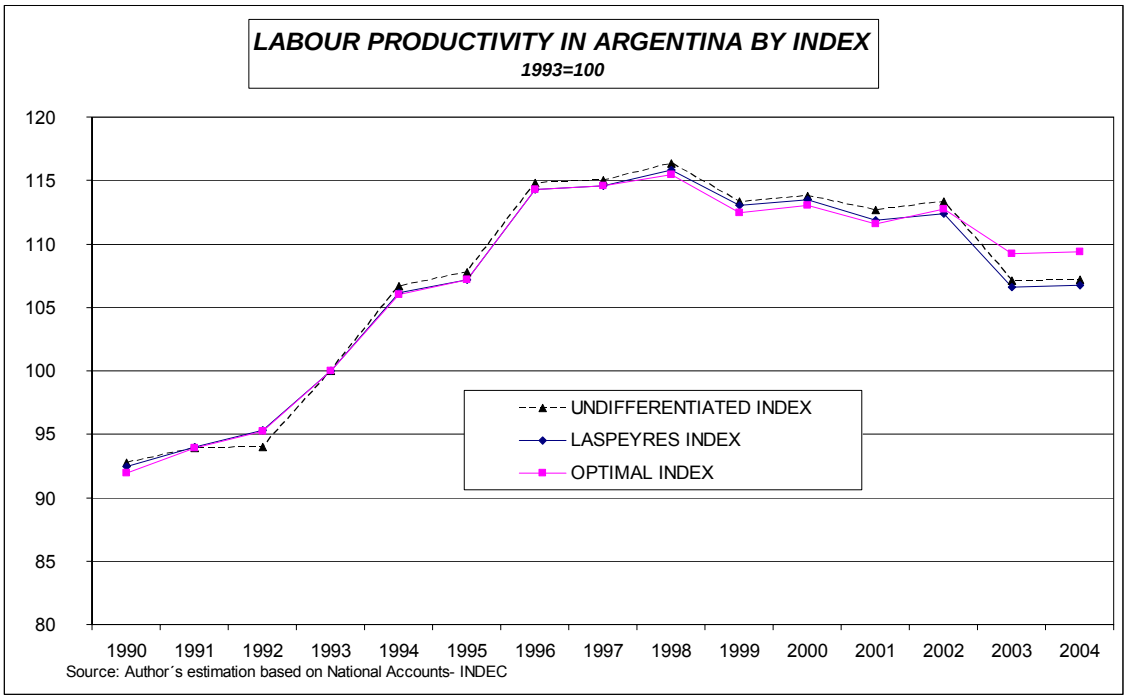
Given these differences for the behaviour of labour productivity with respect to the labour input indicator, the measurement of the labour input by the hours worked indicator becomes crucial for measuring consistently labour productivity and TFP.

5.1.2 The Adjustment by Quality and Composition of the Labour Input

Another important effect to be taken into account in the performance of labour productivity is the impact of sectoral composition and quality effects in labour input presented in the former section.

The following figure presents the performance of labour productivity for the whole Argentine economy under the three index used[22]:

Figure 9



The dynamism of undifferentiated hourly labour productivity would present different biases along the period 1990-2004, according to Table 8. The magnitude of these biases become relevant only for the period 2001-2004, mainly as a consequence of the impact of relative price and wage changes on the sectoral composition of GDP and labour input. In this sense, the optimal indicator is larger than the traditional indicator, suggesting a possible undestatement of labour productivity during this period.

TABLE 8

LABOUR PRODUCTIVITY IN ARGENTINA BY METHODOLOGY
Average Annual Growth Rates

Method/ Period	1990-1994	1994-1995	1995-1998	1998-2001	1990-2001	2001-2002	2002-2004	1990-2004
QLaspeyres/L Undiff.	3,56%	1,02%	2,58%	-1,06%	1,78%	0,58%	-2,76%	1,04%
QLaspeyres/L Laspeyres	3,51%	0,96%	2,61%	-1,15%	1,74%	0,48%	-2,57%	1,03%
Q Optimal/LOptimal	3,62%	1,08%	2,51%	-1,13%	1,77%	1,07%	-1,52%	1,25%
Total Effect	0,06%	0,06%	-0,06%	-0,07%	-0,01%	0,49%	1,24%	0,21%

Source: Author´s estimation based on National Accounts-INDEC.
L: Labour input based on the hours worked indicator. Optimal: chain index. Laspeyres: Laspeyres Volume Index 1993 base.

[22] GDP is measured by a physical volume index with a 1993 base for the undifferentiated labor factor and base 1993 and optimal for a similar adjustment of this primary input.

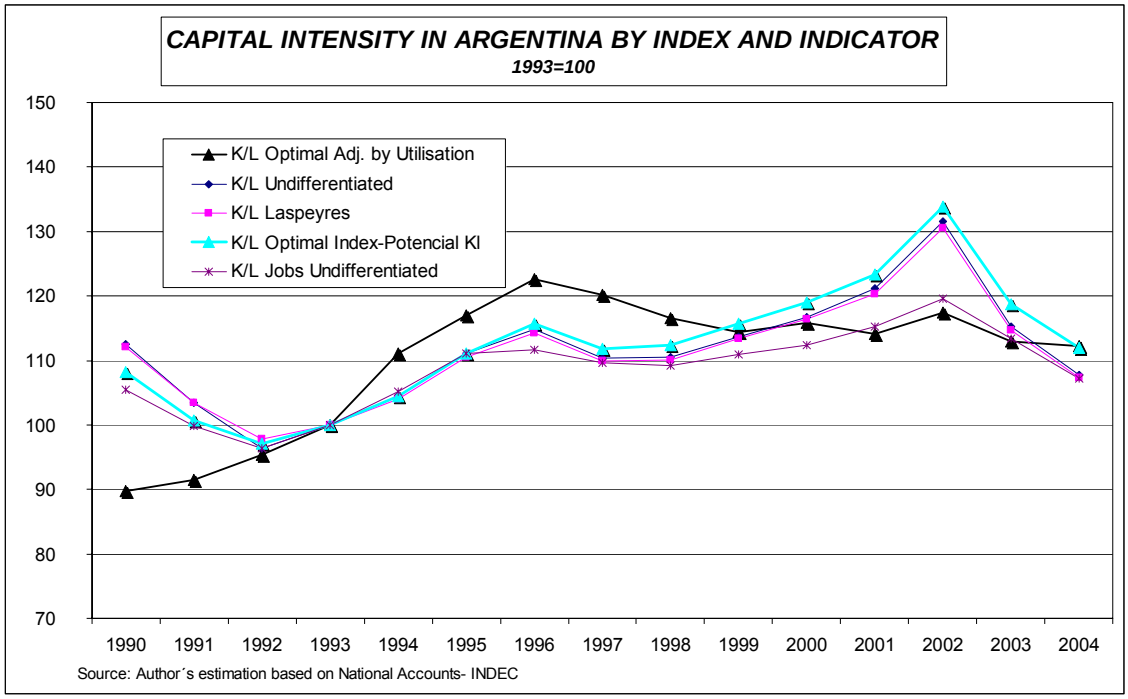
5.2. Capital Intensity

According to equation 1, one of the main source of labour productivity gains is capital intensity. The larger its growth, the lesser the weight of the TFP as an explanation of economic growth.

Figure 10 presents the capital intensity series for the five methodologies used. Their visual analysis shows two clearly differential behaviours among the series of capital intensity.

Series with potential capital services display a decline between 1990 and 1993, followed by an important increase until 2002, after which the series decreases again. In contrast, capital intensity with effectively factor utilisation present a positive dynamic behaviour between 1990 and 1996, then slowly decreasing until 2004 up to the level achieved in 1994.

Figure 10



Clearly, the main differences between both series are produced due to the adjustment by utilisation of primary inputs. As seen before, the input series not adjusted for utilisation intensity produce a clear underestimation of their dynamism at the beginning of the positive phases of the cycle and a clear overestimation in the negative phases. These biases are reflected in the capital intensity as a result of the adjustment in the capital factor being larger on average than in the labour input.

According to Table 9, during the nineties, the adjustment of both primary inputs for changes in relative prices and quality of labour, corrects the series, almost doubling the average growth rate of capital intensity: from an annual average of 0.65% to 1.20%. The utilisation adjustment causes a more procyclical behaviour of the series, especially at the beginning of the nineties, increasing on average the dynamism of capital intensity, 2.21% annual average for the whole decade.

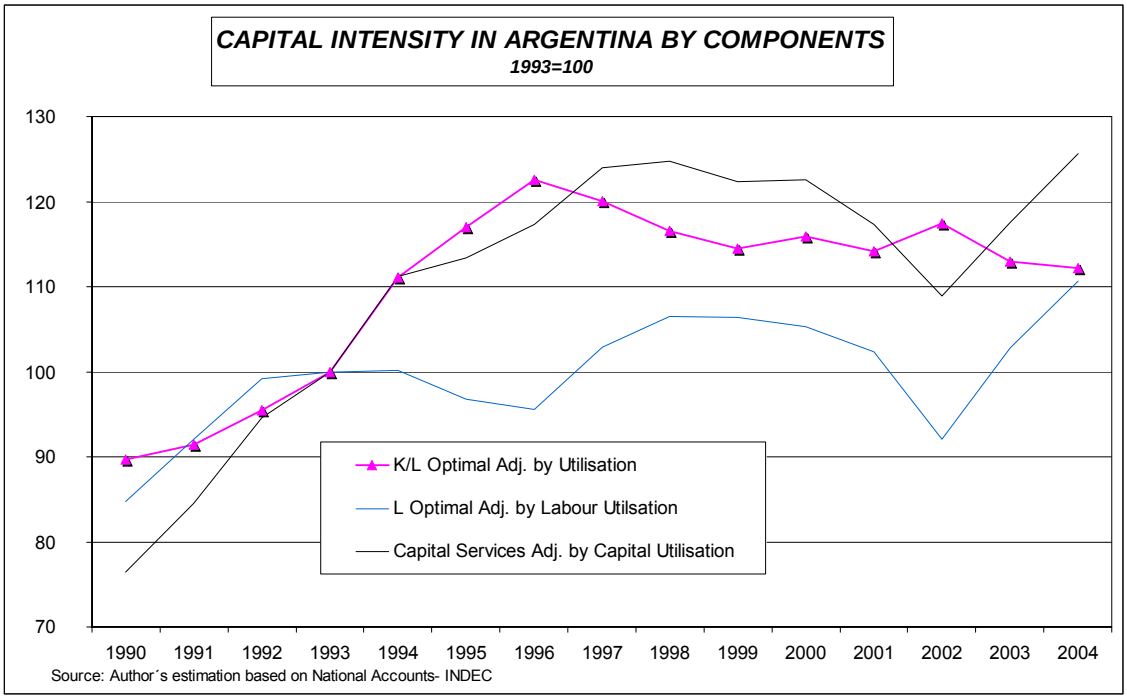
TABLE 9								
CAPITAL INTENSITY IN ARGENTINA BY METHODOLOGY Average Annual Growth Rates								
Method/ Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1990-2001**	**2001-2002**	**2002-2004**	**1990-2004**
K^W Laspeyres/L Undiff. Jobs	-0,08%	5,58%	-0,56%	1,84%	0,81%	3,66%	-5,31%	0,11%
K^W Laspeyres/Undiff. Hours	-1,84%	6,35%	-0,17%	3,09%	0,67%	8,58%	-9,51%	-0,31%
K^W Laspeyres/Laspeyres hours	-1,86%	6,29%	-0,13%	3,00%	0,64%	8,48%	-9,32%	-0,31%
K^P Optimal/ Optimal Hours	-0,89%	6,44%	0,39%	3,16%	1,20%	8,44%	-8,56%	0,24%
K^P utilised/ Optimal Hours	5,48%	5,33%	-0,12%	-0,69%	2,21%	2,92%	-2,27%	1,61%
Total Effect	5,55%	-0,25%	0,44%	-2,53%	1,40%	-0,75%	3,04%	1,50%

Source: Author´s estimation based on National Accounts-INDEC.
K^W: net capital or wealth. K^P: potential capital services except for the last row corresponding to the adjustment by installed capacity utilisation
L: Labour input based on the hours worked indicator. Optimal: chain index. Base 1993: Laspeyres volume index 1993 base.

Besides, capital intensity with potential capital services presented a remarkable negative behaviour during the aftermath of devaluation, but the decrease softens if the installed capacity adjustment is taken into account.

The trend of the capital intensity series for 1990-2004 with utilised factorial services appears to be explained by the greater dynamism of capital services with respect to hours worked, according to figure 11. Indeed, while the first grew at a 3.62% annual average rate, the second one displayed a 1.92% growth trend (Table 10).

Figure 11



However, factors that explain the dynamism of capital intensity are different according to the prevalent time of the economic cycle. According to Table 10, growth in capital intensity during the past decade would be due mainly to a relatively higher growth of the capital input with respect to labour. Meanwhile, the capital-labour relationship appear to have decreased during the positive phase following the 2001-2002 crisis, being its main reason the larger relative dynamism of the labour input series.

TABLE 10
COMPONENTS OF THE CAPITAL INTENSITY GROWTH*

	Average Annual Growth Rates							
Factor/ Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1990-2001**	**2001-2002**	**2002-2004**	**1990-2004**
K	9,84%	1,89%	3,24%	-2,02%	3,97%	-7,12%	7,40%	3,62%
L	4,26%	-3,43%	3,26%	-1,33%	1,72%	-10,03%	9,64%	1,92%
K/L	5,48%	5,33%	-0,12%	-0,69%	2,21%	2,92%	-2,27%	1,61%

Source: Author´s estimation based on National Accounts-INDEC.
*Measured in terms of optimal indexes for the capital services effectively utilised and labour input in hours worked

The magnitude of the adjustments in capital intensity with respect to the dynamism of labour productivity as described earlier, has important consequences for the residual estimation of TFP, as will be seen in the following section.

5.3. Total Factor Productivity (TFP) in Argentina 1990-2004

This section presents TFP results of applying the measurement methodologies to correctly assess the contributions of inputs. According to the economic literature discussion as presented in the previous chapters, the optimal measurement methodology of TFP, adapted to the Argentine case, is as follows:

TABLE 11
TFP OPTIMAL MEASUREMENT METHODOLOGY FOR ARGENTINA

	Index Number	Sectoral Disaggregating	Adjustments
Gross Domestic Product	Chained in t	1 dig ISIIC 3rd rev.	
Labour	Chained in t	1 dig ISIIC 3rd rev.	Hours Worked
Capital	Chained in t	100 typologies	Services adjusted by utilisation
TFP	Chained in t		Weights in t based on the Functional Distribution of Income

This methodology would allow obtaining TFP as a shift in the production function, since it distinguishes and estimates several effects that cannot be attributed to the performance of strict TFP proposed herein, such as:

- Composition or Substitution Effect in Output
- Sectoral Composition Effect in Labour Input
- Quality Effect in Labour Input
- Quality Effect in Capital Input
- Composition Effect by types in Capital Input
- Changes in the Functional Distribution of Income

These effects are derived from productive efficiency gains as a result of normal adjustments of the productive and factorial allocation to changes in relative prices. It is worth noting that the measurement of TFP must also be done by means of a chain index so as to harmonize the methodology with its components. This allows adjusting the contribution itself of the inputs to growth by changes in the functional distribution of income due to changes in inputs' quantities and relative prices.

The measurement of inputs by their effective utilisation allows capturing:

- Measurement of the Labour Input in terms of Hours Worked
- Measurement of the Capital Factor in terms of services effectively utilised in production

In this way, the effects derived from the fluctuations of factor costs and demand as a result of the economic cycle of production and aggregate demand become incorporated in the input contributions.

The following analysis compares the optimal measurement methodology of strict TFP with different methodological alternatives, including the traditional most commonly used in Argentina.

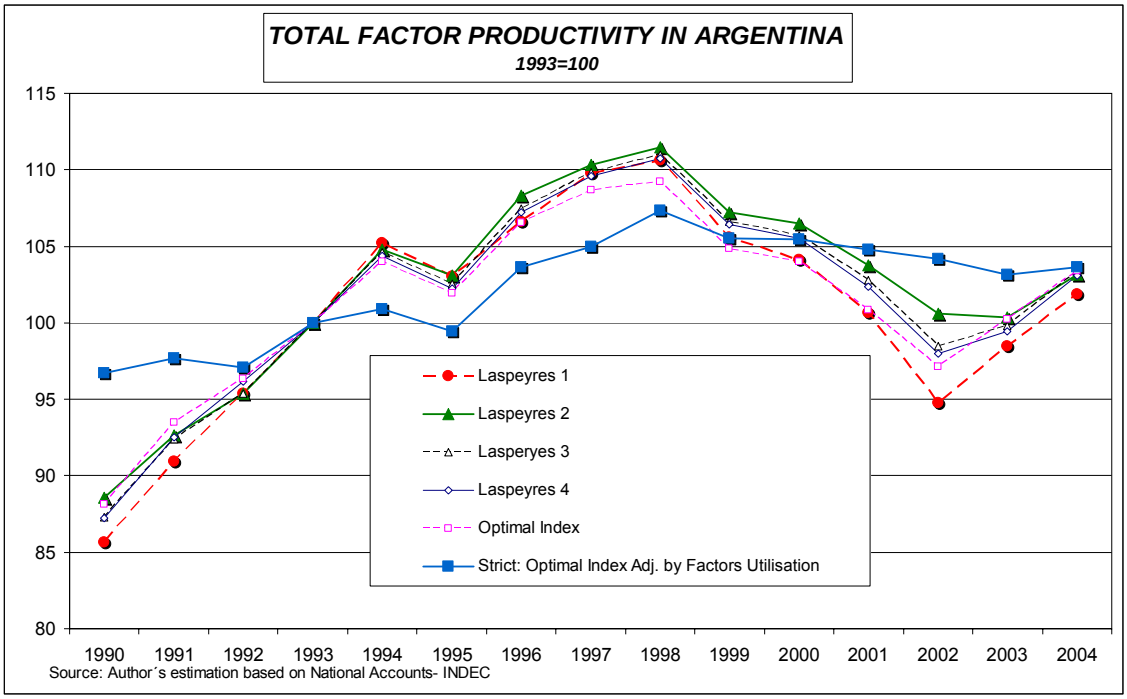
TABLE 12 TFP OPTIMAL MEASUREMENT METHODOLOGY IN ARGENTINA				
Index Type/Variable	**GDP**	**Capital**	**Labour**	**Income Shares**
Laspeyres 1/Traditional	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated workers	constant in the base year
Laspeyres 2	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	constant in the base year
Laspeyres 3	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	chained
Laspeyres 4	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ differentiated hours worked	chained
Chained	Chain	Chain/ productive capital services (potential)	Chain/ differentiated hours worked	chained
Strict	Chain	Chain/ utilised productive capital services	Chain/ differentiated	chained

The traditional methodology generally used in Latinamerica, specially in Argentina, is the Laspeyres1 here presented: all physical volume indexes of GDP and inputs by Laspeyres index base 1993, capital input measured by net capital or wealth and labour input by worker, with the effects formerly mentioned affecting implicitly the residual TFP.

Intermediate methodologies begin incorporating some of the adjustments mentioned in the measurement economic literature until reaching the optimal methodology that includes all of them: all physical volume indexes of GDP and inputs by chained indexes, capital input measured by productive capital services adjusted by the effective utilisation in output and the labour input by hours worked differentiated by industry.

The following figure presents the performance of the different estimations proposed for TFP.

Figure 12



Strict total factor productivity in Argentina, meaning the shift of the production function, during the period 1990-2004, measured by the optimal method would present a lesser dynamism with respect to other methodologies[23].

Table 13 presents average annual growth rates by sub periods of the TFP for the different methodologies.

TABLE 13
TOTAL FACTOR PRODUCTIVITY IN ARGENTINA BY METHODOLOGY

Average Annual Growth Rates								
Method/ Period	**1990-1994**	**1994-1995**	**1995-1998**	**1998-2001**	**1990-2001**	**2001-2002**	**2002-2004**	**1990-2004**
Laspeyres 1	5,3%	-2,1%	2,4%	-3,1%	1,5%	-5,9%	3,7%	1,2%
Laspeyres 2	4,3%	-1,7%	2,7%	-2,4%	1,5%	-3,0%	1,3%	1,1%
Laspeyres 3	4,6%	-2,0%	2,7%	-2,5%	1,5%	-4,2%	2,5%	1,2%
Laspeyres 4	4,6%	-2,0%	2,7%	-2,6%	1,5%	-4,3%	2,5%	1,2%
Optimal Index	4,2%	-2,0%	2,3%	-2,6%	1,2%	-3,7%	3,2%	1,1%
Strict	1,1%	-1,5%	2,6%	-0,8%	0,7%	-0,6%	-0,3%	0,5%

Source: Author´s estimation based on National Accounts-INDEC.

All the series where the input contribution is not adjusted by their effective utilisation present a clear procyclical behaviour that is notably reduced when this adjustment is included.

[23] Examples of TFP estimations for Argentina with the traditional measurement may be found in Kydland and Zarazaga (2002), SPEyR-MECON (1999) and DNCPM-MECON (2001). Generally in these studies an important contribution of TFP, similar to the traditional calculation replicated herein for the nineties, is detected. As explained in this study, the main difference is produced not only by the type of index number but also by the adjustment for primary inputs utilisation, as well as including self estimations of wealth capital instead of productive capital (different from the figures of INDEC used herein), and labor input in terms of number of workers instead of hours worked, generally using non exhaustive labor series corresponding to the Greater Buenos Aires and not all the country.

The effect of softening the cycle of the primary input series when adjusting by factors utilisation is also replicated herein on the apparent TFP series, which is more procyclical than the strict TFP (optimal adjusted serie).

The adjustment is particularly important in the periods of change of phase of the economic cycle: 1990-1994 and 2002-2004. The adjustment of the labour input using hours worked instead of jobs reduces in one percent point the average annual growth rate of TFP in the first cycle (beginning of the Convertibility Plan) and a 2.5% in the post devaluation cycle. The adjustment by utilisation of capital services reduces again TFP growth in an average 3.1% in the first phase and 3.5% in the second phase.

Composition effects through changes in relative prices become particularly important in the period 2001-2004 and similar to the ones found in the case of labour productivity. Apparent TFP with base 1993 underestimates the productivity growth, with respect to the optimal index, in half percent point during the 2001-2002 crisis and increases it in almost 1% in the 2002-2004 cycle as a result of the devaluation effect on the input and output relative prices.

Strict TFP would present a substantially more reduced trend than apparent TFP for the whole period 1990-2004, including for the nineties 1990[24].

Figure 12 shows that TFP displayed an initial once and for all positive shift, then stabilizing and falling slowly since the economic depression that began in 1998, until 2003.

In this sense, in the initial phase of the Convertibility Plan (after the economic depression and hyperinflation of the previous decade), strict TFP grew an annual 1% average between the years 1990 and 1994, a substantially lower rate than the apparent TFP performance: 5.3%.

The less procyclical behaviour of strict TFP is also produced during the years of the economic depression (except for 1995): both during the period 1998-2001, as well as during the 2002 crisis, the fall of TFP was less important than with the rest of the methodologies.

With the post devaluation economic recovery, TFP retakes a positive trend only in 2004, in which strict TFP grows 0.5%[25], although apparent TFP (with chained index) begins growing already in 2003 (3.16%) and 2004 (3.15%). The lower trend in strict TFP during post devaluation is produced as a result of the significant growth of labour demand, more important in terms of hours than jobs.

The effects for relative price changes are particularly important during the period 2002-2004, making the apparent TFP even more important than without these effects, although strict TFP is less important than the apparent.

To sum up, during 1990-2004, strict TFP in Argentina is less procyclical than apparent TFP, mainly as a consequence of including cyclical variations in the use of primary inputs.

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[24] In case of using the adjustment for utilised capital services by the hours worked proxy variable, TFP would have a null trend; and a negative trend in the case of energy. Even for the period 1995-1998 in which the strict TFP series with FIEL's indicator is similar to the apparent TFP growing an annual 2.6% average; in the case of energy and hours worked, strict TFP is reduced to a 0.5% and 0.8% average annual growth respectively.

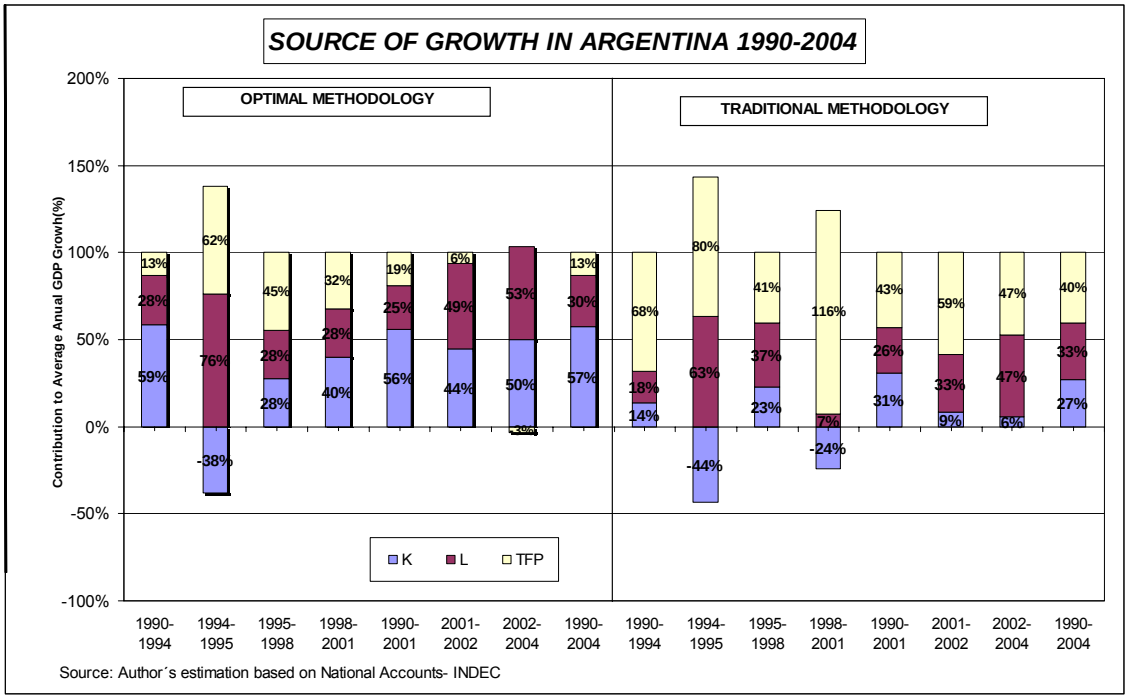
[25] In case of using the demand of energy and hours worked as proxy variables of capacity utilisation, strict TFP in 2004 would have been -0.35% and null respectively. Preliminary data for 2005, would confirm the renovation of the strict TFP growth cycle.

5.4. The Growth Profile in Argentina 1990-2004

The results presented so far allow estimating the contributions of each primary input to economic growth and allow understanding the type of growth generated by the Argentine economy between 1990 and 2004.

The following figure presents the contributions to growth (in terms of their share in the total) of each primary input, comparing the growth profile generated by the optimal methodology versus the traditional methodology.

Figure 13



According to the optimal methodology, the Argentine economy appears to present an extensive profile based on factors accumulation and utilisation rather than on a positive shift in the production function.

Strict TFP (optimal methodology) appears to have contributed with a 13% along the whole period 1990-2004, while apparent TFP (traditional methodology) with a 40.2%.

The nineties also present an extensive economic growth profile based on capital accumulation and utilisation, since it contributes with a 55%, labour with 25% and strict TFP explaining the remaining 20%. In this case, apparent TFP contributes with a 43%.

The period after devaluation, 2002-2004, also presents an extensive growth profile but more focused on labour demand, since this contributes with a 54%, capital with a 50% and strict TFP negatively with a -3.2%, although after 2004 it would be presenting a positive contribution. During this period, in contrast apparent TFP presents an important positive contribution, 47%, labour another 47% and capital the remaining 6%.

As can be noted, according to the traditional methodology, the growth profile would be wrongly diagnosed as intensive that is, based on the TFP contribution, both in the Convertibility cycle and after devaluation. As seen before, this diagnosis would respond mainly to the fact that the traditional methodology does not adjust by effective utilisation of the primary inputs, in other words, it does not take into account neither the hours worked nor changes in capital utilisation. Therefore the initial positive shock on GDP growth at the beginning of the positive phase of the economic cycle could be the result of the procyclical contribution of the increments in labour intensity and capital utilisation and not from strict TFP.

In terms of labour productivity the extensive growth profile is also confirmed. During the whole period 1990-2004, the dynamism of labour productivity according to the optimal methodology would be generated by the great contribution of the growth of capital intensity, 65%. Whereas according to the traditional methodology, apparent TFP would explain almost the whole dynamism of output per hour worked, being the conclusions similar for the nineties and for the period after 2002 devaluation.

Taking into account the contribution of strict TFP, it can be concluded from this analysis that the growth profile presented by the Argentine economy from 1990 up to date is of the extensive type, based on factor accumulation and utilisation: capital during the nineties and capital and labour for the period after the 2002 devaluation.

Also, this is compatible with the important dynamism of apparent TFP, reflecting a phenomenon of average cost reduction associated to cyclical factors and normal adjustments to changes in relative prices.

6. Conclusions

The purpose of this study is to investigate the main souces of growth in Argentina during the period 1990-2004, in order to identify the prevalent growth profile: extensive, associated to the dynamism of productive factors, or intensive, linked to productivity gains.

Also, taking into account the important changes in relative prices and the amplitude and volatility of the economic cycle of the Argentine economy, the study proposes a methodology for discounting from TFP the effects of changes in relative prices and of cyclical utilisation of productive factors.

In this way, the study seeks the identification of a strict TFP as the shift of the production function, independently of current phenomena; distinguishing it from the residual or apparent TFP, that expresses a cost reduction phenomenon but not necessarily linked to trend changes in the long term growth path of the economies.

This required adapting for the Argentine case the main recommendations of the recent economic literature on productivity as in OECD, the EUKLEMS group for the homogeneous measurement of productivity in Europe and United States, the experience of IVIE in Spain, Basu. Fernald and Shapiro (2001) and others.

These recommendations consist basically in applying flexible aggregation index numbers that allow identifying changes in the contributions of the main aggregates on growth (GDP and primary inputs), as a consequence of the quality and composition effects generated by changes in relative prices of the subcomponents of these aggregates.

Furthermore, the study analyses the different methodological alternatives for adjusting the contribution of productive factors by their effective utilisation, specifically the changes in labour intensity and installed capacity utilisation, procedure that aims to estimate the strict TFP, by disaggregating these effects from the apparent or residual TFP.

The use of data of functional distribution of income, labour input and capital stock, as well as GDP from National Accounts of Argentina allows the methodological and macroeconomic consistency of the main aggregates that form the souces of growth in Argentina.

The main results of the application of this methodology to the Argentine case for the period 1990-2004 were the following.

1. The composition effect on GDP (substitution in output) had a moderate magnitude during the whole period 1990-2004, being especially important for the period after 2002 devaluation. The usual fix base indexes used for measuring the performance of GDP at constant prices would underestimate economic growth and productivity gains.

2. Quality and composition effects are relevant for the post devaluation period, reducing the dynamism of the labour input, and therefore not excluding them from the residual TFP would produce an underestimation of TFP in the strict sense.

3. The correction for labour input utilisation due to changes in labour intensity plays a fundamental role in the measurement of the contribution of labour input to growth, since the optimal series of hours worked would present a significant procyclical behaviour. Were these effects not corrected, TFP and labour

productivity would be overestimated in the positive phases of the economic cycle and underestimated in the negative phase.

4. The more traditional use of the net capital stock by a fix base index would underestimate the contribution of capital services to economic growth in Argentina producing an overestimation of TFP growth for the whole period analysed.

5. The lack of adjustment by utilisation of the capital input, similar to the case of the labour input, would generate an underestimation of its contribution to growth during the growth phases of the economic cycle and conversely in the recession phases; therefore, strict TFP would be overestimated at the beginning of the positive phase of the economic cycle and underestimated in the negative phases.

6. During the period 1990-2004, strict TFP was substancially lower and less procyclical than apparent TFP, mainly as a result of not discounting the cyclical variations in factors utilisation. Similar conclusions are derived for labour productivity adjusted by labour intensity. Moreover, the adjustment by cyclical factors utilisation reduces significantly residual TFP gains, both during the nineties as well as after the 2002 devaluation.

7. Relative price effects are particularly important during the 2002-2004 period, making the apparent TFP adjusted by relative prices grow at higher rates than the unadjusted apparent TFP.

8. Both in terms of labour productivity and total productivity, the growth profile of the Argentine economy is extensive during the whole 1990-2004 period, biased towards the utilisation and incorporation of capital during the nineties and biased towards the labour factor in the post devaluation period.

The importance of competitive gains of the Argentine economy through improvements in apparent cyclical TFP, generated both during the nineties and after 2002 devaluation, are unquestionable. However, doubts arise about the ability of the Argentine economy to generate the necessary productivity gains in the strict sense, independently of compostition and quality effects and cyclical variations in factor utilisation, that allow to maintain a sustainable long run growth.

The extensive growth profile diagnosed for the Argentine economy, especially during the nineties, contrasts with assessments of other authors and institutions based on the traditional methodology: without adjusting by relative price effects and factor utilisation. On the contrary, our results are analogous to the evidence found by Young (1995) and Timmer and Van Ark (2000) for Nic´s countries.

This conclusion is based not only in what Young (1995) called the “tyranny of numbers”, by assessing strictly the consistency of the country statistical information, but also a consequence of the “tyranny of the economic cycle, macroeconomic and methodological consistency”.

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