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"On Tyranny of Numbers"
CAUSES OF LABOR PRODUCTIVITY IN ARGENTINA, 1993-2004

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ABSTRACT JEL: O4-O3-E2

The main purpose of the paper is to show some evidence that the main cause of labor productivity growth in Argentina during 1993-2001 would have been capital intensity growth, instead of the Solow´s residual or Total Factor Productivity (TFP).

This result is analogous to the findings of Alwyn Young (1992) (1994) (1995) (1997) and Timmer and Van Ark (2000), spread by Krugman (1994) for the Southeast Asian countries, but are different from other previous results on the Argentine experience, for example Kydland and Zarazaga (2002), which found that TFP was the principal cause of GDP growth during the 1990s based on the calibration of a real business cycle model.

The discrepancies arise as a result of the methodological approach and the macroeconomic consistency analyses of the series, that in the case of this paper belong to National Accounts System of Argentina.

According to the recommendations of the economic literature on productivity measurement, the sources of economic growth are analyzed through the economic theory of index numbers. This allows the extraction of substitution and composition effects in production, labor input and capital services from the residual TFP.

The paper evaluates the possible main causes of labor productivity growth: capital intensity (capital-labor ratio) vs. TFP. Following the OECD Productivity Manual, this paper analyzes the main components of TFP; not all TFP is technological change and not all technological change is TFP. The paper discusses the possible wrong identification of residual TFP –or the so call Solow's Residual– as exclusively shifts in the production function.

It is also considered the main problems of measurement of the capital stock and their possible impact on TFP growth, due to: biases due to the assumptions of the Perpetual Inventory Method on the level and performance of the capital stock; changes in the quality of capital assets; econometric estimation of the functional form of depreciation; and other measurement problems in the capital stock figures, partially corrected by the author in recent estimations of the capital stock series in National Accounts of Argentina.

As a result of the application of this methodology, taking into account the National Accounts series and their macroeconomic consistency, the paper shows that labor productivity growth and TFP growth had a remarkable procyclical behavior during the 1993-2004 period, being its trend significantly reduced for both indicators, after subtracting the changes in capacity utilization and substitution and composition effects in production and factors from the Solow Residual.

During 1993-2001, there was an important increase of the capital intensity of the Argentine economy as a result of the high labor cost due to the low real exchange rate and high openness of the Argentine economy to external trade during the Convertibility Plan. One of the main results is that during 1993-2001, capital intensity reacts to changes of factors' relative costs (fall of relative price of capital goods), showing a high elasticity of factors' substitution in the Argentine economy.

During the post devaluation period (2002-2004), Argentina reduces the capital intensity as a result of the increase in the labor-GDP elasticity associated to increases in the capacity utilization, and some influence of the reduction of its relative cost originated in the 2002 devaluation, displaying cyclical increases in labor productivity and the residual TFP. The apparent cyclical increase of the residual TFP (and its trend) would be reduced remarkably as a result of the discount of the Solow Residual by capacity utilization.

The main conclusion is that the Argentine economy during the 1993-2001 period would present an extensive growth profile, based on factor accumulation rather than positive shifts in the production function (similar to the case of Southeast Asian NICs in the 80's). Technological change would have been of an embodied type, stimulated by the fall in the relative price of capital goods as a result of the appreciation of the domestic currency and the increase in the openness to external trade during the 1990's, but without having a substantial positive effect on the organization of the argentine economy in the long run.

During the post mega devaluation and crises period (2002-2004), GDP growth would have been explained by the reduction of capital intensity originated in a higher relative labor demand, as a consequence of increases in the capacity utilization previously underused during five years of deep economic depression (1999-2001) and some influence of the high decrease of unit labor costs due to the high increase of real exchange rate. It is possible to ask if the deep changes of factor prices stemming from the 2002 devaluation will produce higher labor-GDP elasticity sustainable in the long term.

As a consequence of these stylized facts, some doubts arise about the capacity of the Argentine economy to generate the necessary gains in strictly TFP (regardless of the changes in relative prices of goods and factors) that allow sustainable growth in the long run.

"The Tyranny of Numbers"
CAUSES OF LABOR PRODUCTIVITY
IN ARGENTINA, 1993-2004*

Ariel Alberto Coremberg

1. Introduction

This paper attempts to detect the causes behind the performance of labor productivity in the Argentine economy for the 1993-2004 period.

It proposes a methodology to identify the main causes of labor productivity growth:

1. Increases in capital intensity (capital-labor ratio)
2. Improvements in productive organization independent of factors and production re-allocations due to changes in relative prices or cyclical effects (strict Total Factor Productivity (TFP))
3. Substitution, Reallocation and Cyclical Effects in factors utilization and in production

Case one refers to an increase of the potential output of a firm, an industry, or the economy as a whole, due to increases in capital intensity. This case includes a capital intensity increase produced by employment reduction, even though there is an improvement in productive efficiency, this has undoubtedly negative social consequences because this can cause increases in the unemployment rate in the short run. Capital intensity could be increase also in the case of an increase in the embodied technology of the capital stock, but this improves work efficiency if only if there is an appropriate organization and/or management of the production process (case 2).

While in case one changes in capital intensity produce movements through the production function, in case two the production function shifts positively (strict TFP) as a consequence of an improvement in the organization of the production process (due to changes in layout, soft technologies, scale returns), regardless of the factor allocation and changes in relative prices.

Case three refers to changes in the allocation of factors and production between and within industry and types due to changes in relative prices (substitution-quality and reallocation - composition effects) can result in productive efficiency gains. But this efficiency gains are not shifts in the production function in the sense of case two, these are movements from inside the production possibilities set to its frontier, and not necessarily increases in the productivity in the long run if there is not a better management or improvements in productive organization that allows them to occur. This case also includes cyclical effects, changes in factors utilization, for example changes in capacity utilization, that is another example of temporary effects, cost reduction that are not necessarily sustainable in the long run.

In this last case, it is relevant –in order to identify the strict TFP– to analyze the consequences of the process of reallocation of production and primary inputs towards tradable industries of the Argentine economy , as a consequence of the new structure of relative prices after the mega devaluation of the argentine currency in 2002.

In order to identify the main source of labor productivity growth, this paper takes into account the most recent economic literature, specially the index number approach and the methodology discussion in the OECD Productivity Manual.

Argentina case set up a challenge to economists and statisticians in order to correctly identify its strict TFP performance, considering the high instability of argentine economy that shows a high volatility behavior of its economic cycle and in its relative price structure. Most of

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all, during the 1990 decade, it is accepted by the profession that Argentine economic growth profile was intensive in TFP, as Kydland and Zarazaga (2002) and other authors have proposed. This paper show some evidence, that support that the Argentine economy would have shown an extensive growth profile based on capital accumulation and cyclical effects instead of strict TFP.

Identifying possible causes of changes in labor productivity allows to recommend appropriate public policies to achieve a sustainable growth profile, based on improvements in the organization of the productive process, and not only on the incorporation of productive factors subject to decreasing returns to scale or efficiency productive gains or cyclical behavior that have temporary but not permanent effect in the long run growth. Labor productivity growth based on this kind of profile would avoid the dilemma between two desirable social and economic goals: a better income distribution and employment creation, and a higher productive efficiency through productivity gains causing a higher current and future growth of the economy.

The subsequent sections of this paper analyze the problem of identifying the main causes of productivity growth, and also discuss methodological recommendations of recent economic literature to measure it.

2. Sources of Labor Productivity Growth

Taking into account the standard economic growth theory, the increase of productivity in the economy means an increase in production due to improvements in the organization of the productive process (management, layout, etc.), regardless the accumulation of production factors: capital, work and inputs.

According to this approach, the shifts in production possibilities frontier of the economy, is determined by the increase in the variable called "exogenous or disembodied technical progress", "total factor productivity (TFP)" or "Solow's residual".

The approach of growth accounting supposes that the TFP is a residual emerging from subtracting the weighted growth of the productive factors from the output growth. The standard approach assumes constant scale returns and profit maximization, but this assumptions are not necessarily in the sense of measuring in practice, accounting does not get rid of the possible positive effects on the output growth of other important determinants, like improvements in efficiency, scale economies, costs of adjustment in the incorporation of factors to the productive process, technical progress incorporated to capital goods or the characteristics of employment, specially human capital, etc[1].

The equation of growth accounting would be the following:

$$\boxed{\frac{d\ln y}{dt} = s_K \frac{d\ln k}{dt} + \frac{d\ln A}{dt}} \quad (1)^{2}$$

Where y is labor productivity; k are the services of capital stock- labor ratio; A is Solow's residual or TFP; and s_k is participation of capital in income.

2.1 The Capital Intensity (capital-labor ratio)

According to equation (1), the growth of labor productivity depends on two main variables: capital stock per job position and Solow's residual or TFP.

[1] This approach does not get rid of the possible positive effects on the output growth of other important determinants, like improvements in efficiency, scale economies, costs of adjustement in the incorporation of factors to the productive process, technical progress incorporated to capital goods or the characteristics of employment, specially human capital, etc., or possible cause-effect relationships between the TFP and the productive factors here mentioned. A detailed analysis of causes of economic growth could be found in Barro and Sala-I-Martin (1995).

[2] Where $dlnX/dt$ expresses the rate of growth, proportional to the variable X.

Changes in capital labor ratio or capital intensity express changes in labor productivity due to changes in the allocation of productive factors along the production function.

Increasing capital intensity causes higher levels of labor productivity. Changes in capital intensity can be caused by changes in factor relative prices. For instance, a higher relative price of capital goods would be an incentive to a reallocation of primary inputs reducing the capital intensity; ceteris paribus the residual TFP, it will generate a decrease in labor productivity[3].

Besides, improvements in capital intensity could be achieved not only through a quantity increase of the capital intensity but also in factors quality.

Capital intensity can be increased as a consequence of improvements of factor "quality"-efficiency: education and work experience, or human capital, and the technological change incorporated in the capital goods.

It is central to point out that improvements in factor "quality" represent improvements in efficiency within the same production possibilities frontier; therefore, they impact on capital intensity, i.e., on movements along the production function, but not necessarily on shits of it.

According to the standard economic growth theory, an increase in capital intensity is a necessary, but not sufficient, condition to long term economic growth; because capital accumulation is subject to the law of decreasing returns. For this reason, it is fundamental, in order to achieve long term economic growth, that gains in labor productivity are due mainly to the dynamics of the strict TFP, i. e., to shifts in the production function over time.

To achieve this, it is necessary to add improvements in the strict TFP, that stay over time and that are not subject –in principle– to cyclical variations, like changes in capital intensity causes by changes in relative costs or changes in their utilization.

But, in fact, TFP is usually estimated (as in the case in Argentina) as a residual between data of labor productivity growth and variations in capital intensity without discounting cyclical changes or substitution and composition effects. Therefore, the residual TFP does not express strictly the shifts in the production function that standard theory points out as a necessary and sufficient condition to long term sustainable economic growth.

Next sections deal with the concepts embedded in the residual TFP, in order to identify which one is the strict TFP.

2.2 Not Every Technological Change is TFP

In OECD (2001a), there is a synthesis of the implications of the TFP. Here, we present a brief and non-exhaustive summary on this subject.

2.2.1 Strict TFP: Disembodied Technological Change

The standard approach points out that TFP expresses the output growth originated in neutral technical progress, regardless factor accumulation. According to what Solow (1965) originally said, TFP would have to strictly express the shifts in the production function originated in improvements in the organization of the productive process, not in movements along the production function due to changes in capital intensity.

The strict TFP has been identified as disembodied technological change, since it is produced regardless the amount and the quality of the productive factors Embodied to the productive process. This component has been identified with several phenomena: scientific advances, implied competences, soft technologies, learning by doing, management improvements, organizational changes, etc.

This component reflects increases in the output without incorporating (or deducting) additional resources in the production. For instance, if labor productivity increases because

[3] Although Leontief functions of production in the firm are assumed, changes in industry composition of output could result in a Cobb-Douglas behavior in the aggregate production function.

more capital is added or because the employment allocation is reduced, improvements in labor productivity are caused by an increase in capital intensity and not by strict TFP.

2.2.2 Embodied Technological Change

Technological change can be embodied to new products emerging in the economy, as a consequence of improvements in design, quality and rendering in the new vintages both of capital goods and intermediate inputs, originated by expenditures in investment and development of the domestic sector that produces capital goods of, or by imported advanced capital goods.

It is significant to point out that the spread of embodied technical change implies necessarily a market transaction, because one can only acquire it by purchasing the technologically advanced good. Instead, the spread of implied knowledge or disembodied technical change (if there are no exogenous restrictions) would not imply necessarily a market transaction because ex-ante it hast the characteristic of a public good.

2.2.3 Quality Change in Primary Inputs

Of course, it is possible to sustain that the technological change incorporated in capital goods and intermediate inputs provokes more than proportional increases in production. However, this can be a wrong general conclusion, since the "disorganization" of productive process or the lack of management can produce the so called Solow's Paradox: more machines do not necessarily translate into higher TFP.

Empirically, since TFP is a residual concept, if the productive factors contribution to growth is correctly measured, adjusting by improvements in their quality, the effect of the incorporated technological change on production is included in the residual TFP. Therefore, the measurement of the effect of embodied technological change on total productivity would not present more difficulties, apart from the right identification of the quality change in the right side of the equation of growth accounting.

Therefore, in order to know the impact of the embodied technical progress on the measurement of TFP, it is necessary to identify:

- Capital stock: changes of quantity and quality by type, model and vintage.
- Employment: changes of quantity and quality by attribute: education, gender, industry, etc.

The relevance of the adjustment of factors growth by quality is correlated to its degree of heterogeneity, typical characteristic of durable goods like capital goods.

According to the recommendations of the System of National Accounts (Sistema de Cuentas Nacionales, 1993 (ISWGNA (1993)))[4], the price should be corrected by quality changes, to incorporate them in the physical volume index. For instance, computers prices can increase intertemporally, but this fact reflects improvements in their quality and not variations of supply and demand. The traditional fixed-based index does not capture changes of composition due to changes in attributes of goods.

The correction per quality of goods is done, in general, through econometric techniques, called hedonic prices. This adjustment consists in detecting the influence of changes of quality of goods on prices, to measure the changes in prices with homogeneous quality.

But the contribution of factors to growth does not necessarily change if there is a quality adjustment or not. Let's assume now that, because of statistical and technical difficulties, it is impossible to correct productive factors by "quality". Its effects will be included in the price of the productive factor and, therefore, in its value. The contribution of the factor to the output increase in the equation of growth accounting is not modified: the correction by hedonic prices gives part

[4] See ISWGNA (1993).

of the contribution to the component of variation of quantities. On the other hand, the non-correction gives the quality effect to price index, which is indirectly captured in the factor's weights. In sum, the contribution of the factor to the output growth is not modified by the correction of quality, provided that the factor contributions are corrected by composition changes originated by changes in the relative prices of its subaggregates, as we will see in the next section.

Thus, if the volume index and weights are corrected by changes in the composition of output and factors, updating changes in the contribution of the subaggregates to the output growth by changes of relative prices, quality changes would not have an effect on the residual TFP.

Therefore, regardless the correction by quality changes, it is very important to detect if the Embodied technical change effectively produced any effect on production. This will be a key question in the section where the interpretation of TFP in Argentine economy is analyzed.

2.3 Not Every TFP Is Technological Change

a. Externalities: these are factor contribution to output growth that are not captured in their factor retributions or weights, for instance, human capital, fixed capital and specialized intermediate inputs.

b. Adjustment Costs: the transaction costs of contracting specific labor and the costs of installation of fixed capital could not be included in the valuation of respective factors.

c. Increasing Scale Returns and Non Competitive Markets: the effects of the optimal minimum size of the plant in some sectors could produce the optimality of non competitive configurations of the market and increasing returns that would be included in the TFP, if the effect is not explicitly measured.

d. Cyclical effects: the lack of adjustment of factors contribution by their effective utilization can produce a procyclical behavior of the TFP, taking into account that effect does not reflect shifts of production possibilities frontier but cyclical movements in the aggregate demand.

e. Productive Efficiency: improvements in efficiency at the firm or industry level, as a result of reallocations of resources to the paretian optimum due to changes in relative prices included in the residual. This kind of efficiency gains are not shifts in the production possibilities frontier, but movements inwards:

Production and Primary Inputs Substitution and Reallocations (or composition) Effects

> **i. Production reallocation effects between industries:** the aggregate residual TFP can improve as a result of changes in the contribution of different industries to growth through changes of relative prices and not through shifts of the production function.
> **ii. Production reallocation effects within the same industry:** as a consequence of production redistributions among firms with different sizes and efficiencies.
> **iii. Factor reallocation and substitution effects by industry and typology:** the changes in goods and factor relative prices and by typology can originate substitution effects between factors and composition effects within them, which could not be correctly captured in the measurement of factors contribution.

f. Measurement Problems in GDP: for example: in Latin American economies it is relevant to know if an estimation of non registered economy by industry in the estimate is included in the GDP, if it is not, its effects could be included in the residual TFP.

g. Measurement Problems in Capital Stock: perpetual inventory method (PIM) is used as a usual practice in capital estimation when there is not exhaustive data from Census and Registers records on quantities and prices by type of capital stock. However, the lack of empirical corroboration of the main assumptions of the PIM (average useful life, retirement patterns, and age efficiency profile), as well as the measurement of high aggregation levels,

would generate a high degree of uncertainty over the level and dynamics of the capital stock[5]. The economic literature of capital stock measurement recommends the exhaustive estimation of the value of the stock at maximum level of disaggregation through the econometric verfication of the main assumptions of the PIM. This question was partially solved in recent official capital stock estimates by the author in National Accounts in Argentina –used in this paper– whose level and performance were consistent with the rest of the macroeconomic aggregates of the National Accounts in Argentina[6] (see section 3.3).

h. Human capital: this factor would reflect the effects of education and experience on the "quality" of labor. If it is not measured explicitly, its effect will be included in the residual TFP.

i. Intangibles Assets: software, patents, R&D investment. Their contribution to economic growth can be higher than their valuation at production cost or even at market price, which can result in an externality effect that is included in the TFP.

In summary, every bias measurement in GDP, capital stock and employment can be included in the residual TFP[7].

If the residual TFP is null or negative, there is no X efficiency at macroeconomic level; therefore, the spillover effects or the increasing yields –probably existing in some sectors or productive factors of economy– are not profitably employed.

The purpose of this paper is to identify TFP strictly as positive shifts of production possibilities frontier (or positive shifts in production function) considering substitution, reallocation and changes in utilization effects of factors as part of the factorial contributions but not in the strict TFP.

In order to correctly identify the causes of labor productivity of an economy, it is necessary to know how the GDP and the productive factors are measured a question to be analyzed in the case of the argentine economy in the following section.

3. The Measurement of Labor Productivity Components

As seen before, in order to estimate labor productivity, it is necessary to know how both factor and output growth is measured, so that it is possible to determine their contribution to growth.

It has to be taken into account that both capital and labor input are heterogeneous factors. Therefore, their aggregate contribution to output growth can be determined not only by changes at aggregate level, but also by variations in their components.

If the effects of changes in the composition of the factor aggregate or the GDP were not determined, these effects would be included in the TFP, the identification of the strict TFP as positive shifts in production function could be biased.

Next subsections will present briefly the emerging problems when we try to measure the main causes of labor productivity growth.

3.1 Optimal Measurement of GDP Contribution

According to the recommendations in economic literature[8], the optimal measurement of GDP, relevant to estimations of productivity, both to the calculus of its evolution as well as the estimation of factors shares in the GDP, correspond to the valuation of the value

[5] For a criticism to PIM, see Miller (1983), and Coremberg (2002).
[6] See INDEC (2004).
[7] The distortions that we try to correct in this paper are in bold letter. Therefore, the rest of the determinants, and the partial comprehension of the one mentioned before, besides the contribution of non produced resources not estimated explicitly in this document are included in this paper in the TFP.
[8] See Young (1995) and Ahmavaara (2004).

added by industry and GDP from the producer point of view. According to ISWGNA (1993), this criterion correspond to the value added at basic prices, calculating the value of production at factory exit prices without indirect taxes and transport and trade margins[9].

The measurement of the physical volume of GDP assumes the solution of a problem of heterogeneous goods aggregation. In general, in Latin America –like in Argentina–, the physical evolution of the product is estimated through a Laspeyres physical volume index.

This type of indexes estimate the physical volume index of GDP through the aggregation of every industry value added, taking into account its weighting in a base year. This assumes to freeze the structure of relative prices of the base year to the whole series, so that the contribution of the value added of each industry to GDP growth does not take into account the changes of relative prices that could have been produced between the base year and the measurement period. This problem –called *production substitution bias* or *production reallocation effect*– generates distortions in the measurement of GDP, if the structure of relative prices is not updated[10][11].

According to Diewert (1995), the fixed base physical volume indexes, like Laspeyres, have a tendency to overweight the goods whose prices have fallen, and to underweight the goods whose relative prices have risen.

The effects of reallocation of production between industries can be of considerable size in economies with a high instability of relative prices like Argentina. For instance, if due to a devaluation produced in a year distant from the base one, relative prices of tradable goods increase, the tradable sector contribution to GDP growth will be underestimated and also the the aggregate GDP growth, because its growth will be calculated at base year price, whose relative prices are lower than the ones at the current period.

The use of fixed base physical volume index does not allow to capture the contribution of changes in industry distribution of value added to growth, generating a bias on the GDP growth and, therefore, in the productivity of the economy as a whole.

More important, this effect should not be understood as strict TFP, since it does not reflect a positive shifts in the production possibilities frontier, but rather than an improvement in the productive efficiency, as a consequence of reallocation of production between industries due to changes in relative prices.

In this sense, the logical reallocation of resources from less efficient sectors to efficient sectors according to the new set of relative prices is a productive efficiency effect, a movement from inwards the possibilities production set to its frontier but not a positive shift in the same frontier.

The economic literature on index numbers proposes to eliminate these problems by superlative index, like Tornqvist's, Fischer's, or Chain index. These allow capturing the production substitution and reallocation effects, updating relative prices and current weights, relevant to the firm's production decision making. In this paper, we adopt the following chain index as the optimal index that allows us to update the sector contributions according to current weighting[12]:

$$\dot{Q}_t^{\,O} = \sum_{i=1}^{N} \left(p_{i,0} Q_{i,0} \,/\, p_{i,0} Q_{i,t-1} \right) v_{i,t}^{Q}, \qquad v_{i,t}^{Q} = \frac{p_{i,t-1} Q_{i,t-1}}{\sum_{i=A}^{O} p_{i,t-1} Q_{i,t-1}}$$

i = 1, ..., N sectors according to CIIU rev.3

[9] On the other hand, the value of primary inputs should be calculated at incorporation to the productive process prices, i.e., at purchase prices, a criterion similar to the estimation of intermediate inputs.

[10] See Jorgenson, Gollop y Fraumeni (1987).

[11] See Aulin-Ahmavaara (2004).

[12] To avoid to smoothing the change of relative prices implied in indexes like Tornqvist's, see ISWGNA (1993). But the results present here are similar of taking into account the rest of superlative index.

$p_{i,}Q_{i,t}$: value added by industry of the GDP

3.2The Optimal Measurement of the Contribution of Labor

In general, it is advisable to measure the labor factor contribution to output growth, in terms of hours worked, not numbers of persons employee, to avoid the effects on the measurement of labor of double jobs, part time jobs and the changes in average hours worked per week[13].

Nevertheless, measuring labor input based on the simple aggregation of hours worked implies an undifferentiated measurement. The labor input presents important heterogeneities; for instance, gender, age, education, occupational category, industry, that can impact on the bias of its contribution to aggregate labor input and of course on productivity growth.

The differences in labor force skills could be caused by some characteristics mentioned before, and they result in differences in relative wages for each group. If this differentiation is not captured, the TFP measurement would be biased.

The economic literature approximates the skills of labor that could be attributed to these characteristics, assuming that relative wages by attribute are a good proxy variable for skills or productivity differentials by kind of work.

This means weighting the labor input groups in which is subdivided (industry, education, etc.), taking into account their relative wages at least in the base year.

Being the undifferentiated index of labor:

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

Note that, in the example, labor input is group or kind of education and industry is disaggregated; if more characteristics are taken into account, new groups will be defined for each one, increasing the defined groups' amount.

The Lasypeyres fixed base index results:

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

i=(1....E) education levels, for instance
j=(1....n) economy sector
w_{ii}: hourly wages per education group
$L_{i,j}$: hours worked, according to typology i belonging to sector j

The difference between the undifferentiated labor index and the fixed base index, weighted by relative wages, will allow disaggregating the substitution effect:

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

Where substitution or "quality" changes mean changes in the aggregate labor growth, as a consequence of changes in composition by attribute: education, gender, age, etc.

But the fixed base weighting of the subaggregates implies also a bias in the aggregate rate of labor growth, similar to the one described in the case of production, because it does not capture for each subaggregate changes of labor composition that may be produced during the

[13] See OECD (2001a) and ISWGNA (1993)

series. Taking into account labor desegregations by industry, the fixed base employment index would not be considering either the effect of the changes of relative wages in the contribution of the subaggregates on total labor growth.

This reallocation effect would be captured estimating an optimal index, similar to the one mentioned for GDP. For instance, if a devaluation causes an increase in the relative demand of labor in the tradable sector, and an increase of its relative wage, it will cause a reallocation of labor to this sector over time; the increase of the relative wage in tradable sector will increase in its contribution to the aggregate labor growth that is not captured in the undifferentiated index or in the fixed base index.

The difference between the factor physical evolution measured by a traditional fixed base index, like Laspeyres, and by an optimal index will reflect the effect of reallocation on the analyzed factor.

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

O: optimal index
L: fixed base index
r: intersectorial substitution effect

The optimal labor input index results:

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

i=(1....E) education level, for instance
j=(1....n) economy sector
w_{ii}: hourly wage by group
$L_{i,j}$: hours worked, according to typology i belonging to sector j

For this study, there is only available labor differentiation by industry; nevertheless, OECD (2001a) points out that the differentiation of labor by industry implies an implicit differentiation in the other non observed characteristics, because there is a correlation between relative wages in the sector and the other attributes of workers.

Finally, it is important to point out that, in labor factor includes no only salaried workers but also an estimation of unregistered salaried workers and proprietors (noncorporate business). This last type of employment category has a heterogeneous series of typologies of people: relatives, owners, self-employed people, etc. The income of this kind of workers is called mixed income because their income includes part of the surplus of their own capital. To discount this surplus from the mixed income of proprietors, the labor income of proprietors was calculated at the industry level based on the wages of the salaried workers.

3.3. The Optimal Measurement of Capital Stock Contribution

In this section we briefly analyzed the main problems of measurement of capital stock and its possible effect on TFP: the assumptions of the Perpetual Inventory Method (PIM), changes in the quality of capital goods, empirical verification of the functional form of depreciation, etc; problems partially corrected in the last estimation of capital stock series by the author published by National Accounts in Argentina[14].

As we pointed out in last section, the lack of availability of exhaustive data of quantities and prices per type of capital stock from exhaustive census and/or detailed records encourages the use of the PIM to estimate capital stock.

[14] See INDEC (2004).

This method consist of calculating indirectly the level of capital stock from the capitalization of historic investment series with different base years, usually without methodological homogeneity by linking in historical series, making assumptions about the average life of capital goods, the functional form of depreciation, and retirement patterns. However, the lack of empirical corroboration of these assumptions, as well as the measurement at high levels of aggregation, generates a high degree of uncertainty about the stock level and its dynamics[15].

In order to estimate accurately the capital stock, it is recommended that the physical stock should come from exhaustive, detailed and consistent data from census and/or records stratified by typology and attributes, in order to avoid the bias introduced by the capitalization of aggregate historic investment series implied by the PIM, as it is detailed ahead.

Most recent economic literature about capital stock measurement and the ISWGNA (1993) recommends the detailed estimation of the stock value at maximum level of differentiation through the econometric corroboration of the assumptions.

In general, the recommendation is to estimate the capital stock following the Hedonic Valuation Method (HV) in the base or reference year. This method consists of taking into account price data from the used durable goods market, in order to verify the age price profile of capital goods, and with that, the real functional form of depreciation.

Once obtained the vector of hedonic prices, it is recommended to value the stock disaggregated by attribute (age, quality, model, etc.). Then the series could be estimated by matching model or in defect by benchmarking the estimation by hedonic valuation in the reference years.

Besides the considerations of the impact of the PIM assumptions, usually pointed out in the literature, the PIM estimates with aggregated series at a base year prices can result in even more important biases in the estimates.

Note that the PIM estimates by fixed base index, as usual in Argentina and other Latin-American countries would not capture the changes in the age price profile in the used capital goods market. In other terms, the structure of relative prices of base or reference year is assigned to the whole series.

The degree of aggregation generates a bias in the series, both in the level and in its performance; therefore, the general approach of this study is to address the estimate with the highest possible degree of disaggregation, according to the available statistical information. The PIM estimates, based on an investment series at high aggregation level, assume that there were no changes of relative prices among typologies of capital goods composing the aggregate.

Moreover, if the set of capital stock were estimated by the PIM, by linking in historical investment series flows at constant prices of sub aggregates with Laspeyres physical volume indexes, we would face the problem of applying the structure of relative prices of a base year to data that are very distant in the series. The longer the series, the bigger could be the distortion. A longer average life of the capital goods included in the stock will generate also a bigger distortion. This distortion is unavoidable in the stock aggregate estimates by the PIM with fixed base index, due to the inclusion of goods like buildings and other construction works that force to incorporate long investment series with vectors of relative prices distant from the base year.

According to ISWGNA (1993), the quality changes of capital goods should be captured in the estimate at constant prices. The PIM estimate implies that the changes of capital goods are not captured explicitly in the series at constant prices, leaving them implicitly in the estimate at current prices.

Another additional biased is that if there are no annual update of user matrix in the national accounts, the PIM method and investment series estimation implicitly assumes that the demand utilization by industry (consumption, capital, intermediate use) is constant between different base years.

[15] For a criticism of PIM, see Miller (1983), (1990), and Coremberg (2002).

These questions are partially solved in recent estimates of capital stock, held by the author in National Accounts in Argentina, used in this estimate, whose level and performance are, at the same time, consistent with the rest of the macroeconomic aggregates of Argentina[16].

The official estimations of capital stock in Argentina are based on data from census and/or official records that assure the exhaustive comprehension of the physical magnitude and the characteristics of the stock to the highest possible degree of differentiation: more than 100 different categories, without counting the different models (in the case of automotive transport equipment: more than 7,000), by taking into account a matching model or in defect benchmarking of the reference years estimated by hedonic valuation as mentioned before. Its appraisal was made with market prices data of second hand capital goods by model, vintage and other attributes.

Besides, an econometric study was held to determine the functional form of the depreciation and the life span of capital goods estimated by HV. This study verifies a convex price age profile for capital goods in Argentina, justifying its use in the PIM procedure.

Besides the estimation problems of capital stock series, it is important to take into account that the contribution to output and labor productivity growth should be analyzed as a productive factor, i.e., in terms of the services it generates.

This would imply to have available statistics on machine/hours by type and user. In general, the assumption is that the stock evolution per type of good is proportional to the use of its services, being this proportion constant for each kind of asset[17].

In any case, in order to determine the aggregate contribution of capital stock in terms of services, it is necessary to estimate the flows of services generated by essentially heterogeneous capital goods.

Therefore, two main problems emerge in the estimate of the contribution of capital services: the problem of aggregation or index numbers, and the problem of weights or prices of the individual categories services.

The aggregation problem is solved by the application of index numbers. This discussion is similar to the one presented in sections 3.1 and 3.2 for output and labor input. It is necessary to estimate capital services evolution in terms of optimal indexes, similar to those presented before.

The weights of capital services by category are the result of estimating their prices in terms of user cost. This concept represents the rent price of the use of capital stock as a productive factor. The user cost by type of capital good should come from statistics of the rent or leasing market of capital goods. However, not all the capital goods have a rent, leasing or even selling market, most of them are use by its owner. According to this last point, it is necessary to make an estimation of the user cost, independent who is the asset owner.

Literature on productivity measurement recommends estimating the use cost applying this formula to each kind of good:

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

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

[16] See INDEC (2004).
[17] See Hill (1999), (2000); Hulten (1990).

Therefore, the factor growth rate will have three components: one that captures "quality" changes, another one that captures effects of the factors reallocation on the aggregate, and finally an undifferentiated component:

$$\frac{d \ln X}{dt} = \left(\frac{d \ln X^{q}}{dt} + \frac{d \ln X^{r}}{dt} + \frac{d \ln X^{u}}{dt} \right)$$

Where each term represents the aggregate growth component of X factor: q ("quality"); r (sector reallocation); u (undifferentiated growth).

As pointed out in OECD (2001), the right interpretation of the TFP demands the exhaustive knowledge of the estimation methodologies of each productive factor series, as they are presented in the following section.

4. The Estimation of the Components of Labor Productivity in Argentina

The goal of this section is to analyze the methodology and the estimates of the components of labor productivity for Argentina during the 1993-2004 period, according to the recommendations presented in sections 2 and 3.

4.1 The GDP growth

The series of the Gross Domestic Product (GDP) are the official ones, made by the National Bureau of National Accounts (DNCN) of the National Institute of Statistics and Census ((INDEC) of Argentina. These estimates belong to the base year 1993 for the 1993-2004 period[18].We can add that the official GDP data from the DNCN include sector estimates of the non registered economy. The available sector aggregate values correspond to their valuation at producer prices.

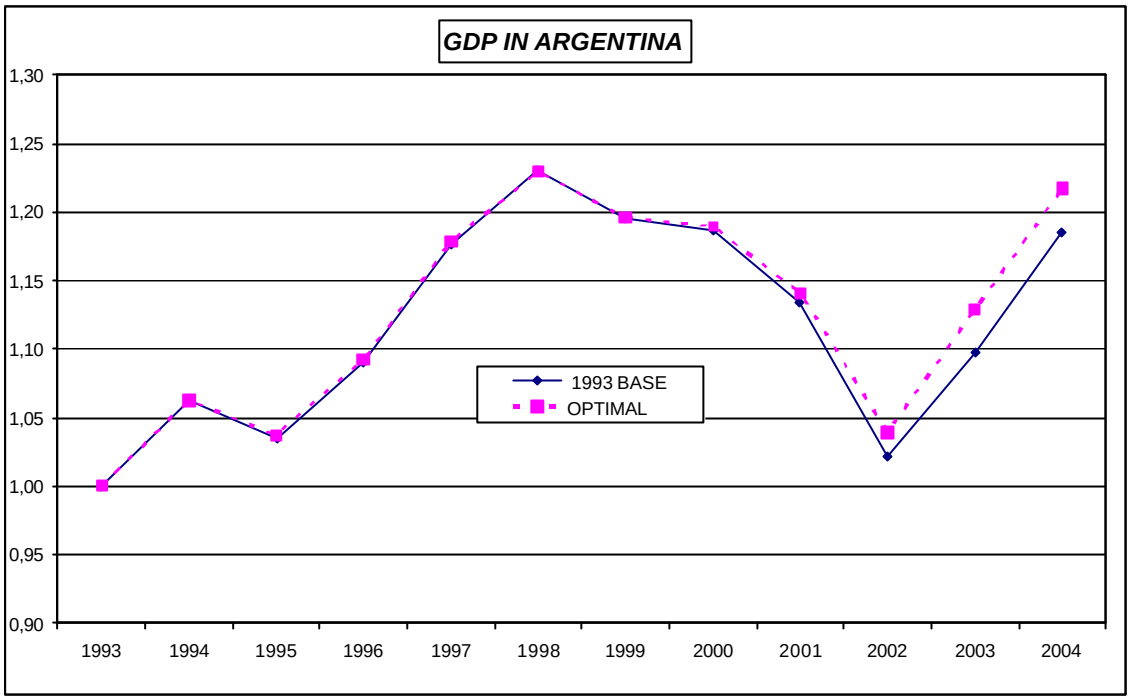
As explained before, the GDP series was estimated through chain index, as explained in section 3.1[19].

In the following figure, the GDP series is presented according to 1993 base and chain index:

[18] Estimates for the 1990-1992 period are not included for two reasons: first, there are no consistent series for those years (labor series data present the same problem), where the GDP was estimated taking 1986 as base year. It is possible to make a simple linking in of the series of different base years, however, it would imply a distortion in the measurement of physical volume growth, because it would mix the structure of relative prices for both base years for the same series. Besides, there is a problem of lack of methodological homogeneity, that produces spurious effects in the annual growth rates estimation through simple linking in method.

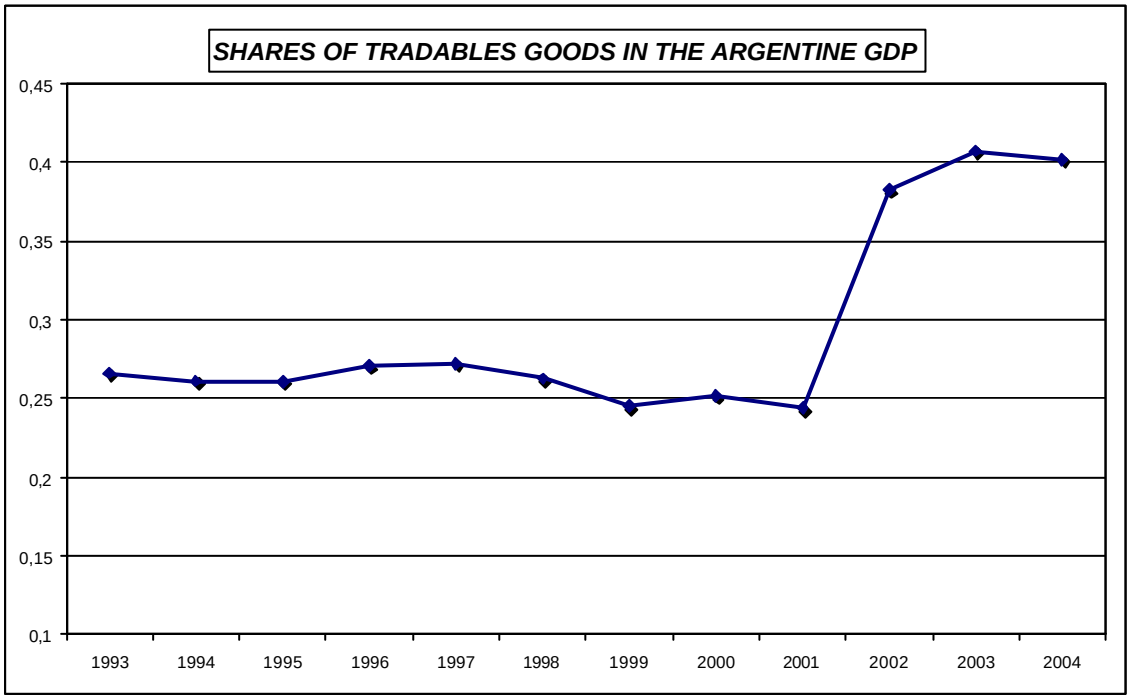
[19] For the concept and methodology of ideal or optimal index, see, for instance, OECD (2001b) and ISWGNA (1993). The estimate presented for Argentina is also explained in Coremberg (2002).

FIGURE 1



The behavior of GDP during the last decade was not different for both series[20]. However, from 2001, in particular from 2002, the output physical evolution starts to be higher for the case of the optimal index in comparison to the fixed base index. The consequence is that tradable sectors have a higher participation in the GDP after the mega devaluation in 2002, increasing their contribution to output growth, an increase not reflected in the fixed base index with lower participation of tradable goods.

FIGURE 2



If this bias was not taken into account, the output growth would be underestimated and, therefore, productivity gains would also be underestimated.

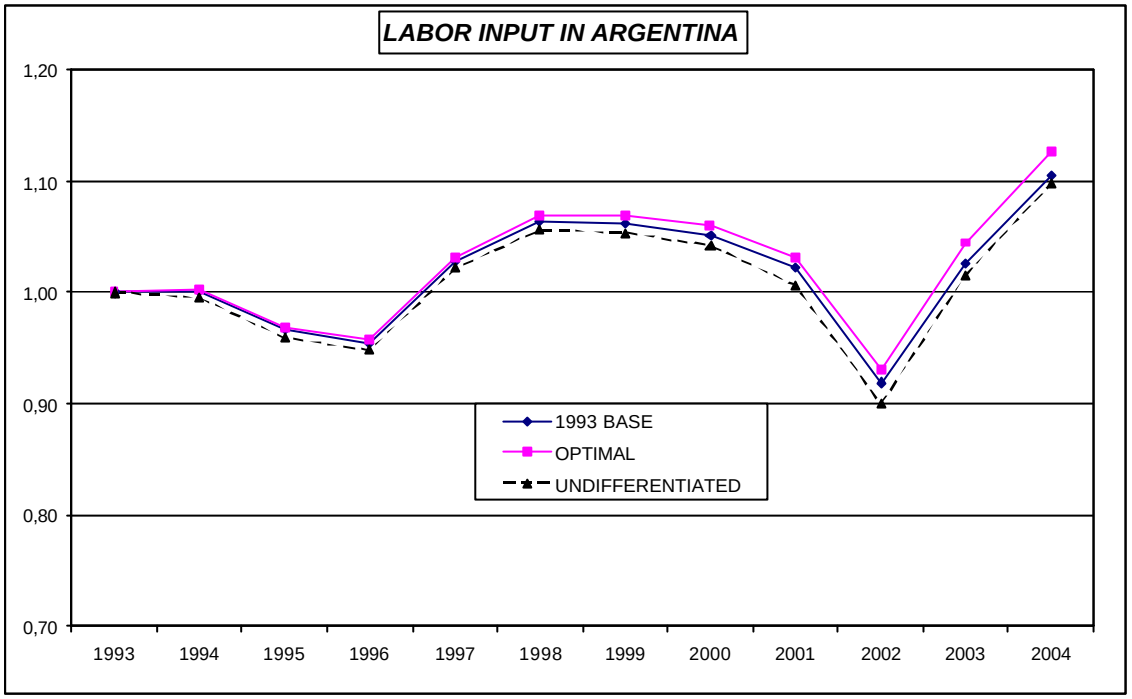
[20] See Table 4.

4.2 Labor Input Growth

The data correspond to labor input for all occupational categories, including registered and non-registered employment in terms of hours worked, taking into account the relative wage by industry at one digit of the CIIU rev. 3 in the case of fixed base index and optimal index.

The following figure shows the important procyclical behavior of labor input series during the analyzed period, independent of the index type adopted:

FIGURE 3



The difference of labor input growth between undifferentiated and fixed base index is a consequence of capturing the labor input performance taking into account the fixed weights in the base year. The optimal index reflects the changes in relative wage structure, produced along the series, biased to non-tradable sectors during the Convertibility period and to tradable sectors in the post devaluation period, following the same profile of structural change in the case of changes in relative prices structure of the GDP.

Since the optimal index reflects a higher labor dynamic than the undifferentiated and the fixed base ones, it is possible to infer that labor productivity and TFP would be underestimated if substitution and reallocation effects in GDP are not included.

4.3 Capital Services growth

The capital stock corresponds to recent estimates of the author in the National Bureau of National Accounts in Argentina[21], taking into account more than 100 different asset types, whose method of estimation was presented in section 3.3. The user cost for each type was estimated to express the capital stock in terms of annual services[22].

According to the statistical data available for Argentina, the capital stock was estimated for the supply side; because there are no consistent data from the demand side.

In this sense, the effects of reallocation of capital, as well as changes in capacity utilization by industry in Argentine economy in this paper would be embodied in the residual

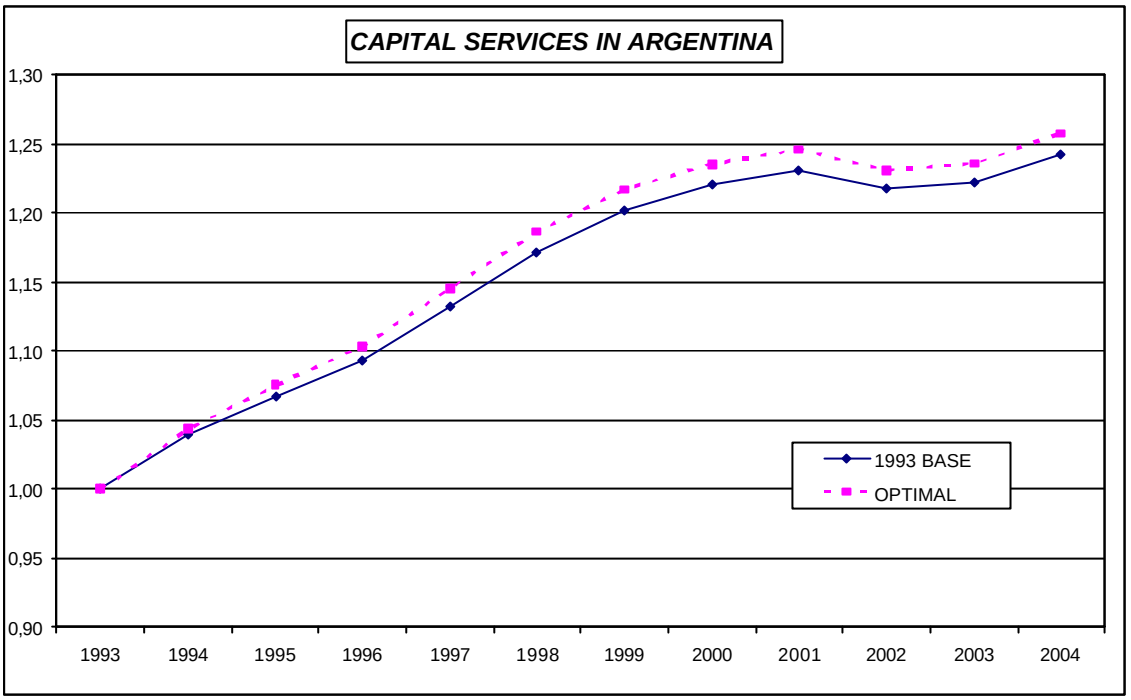
[21] See INDEC (2004). An important antecedent of estimate of capital stock in Latin America can be found in Hofman (1991).

[22] The estimate of capital stock used here corresponds to the so called productive capital stock in terms of services, a concept that is relevant for productivity studies. See OECD (2001a).

TFP. The composition effects captured in the optimal index correspond to changes in the contribution of the different types of capital goods due to changes by type or model.

The following figure illustrate the impact of these adjustments in the capital services series:

FIGURE 4



The capital services series present small but persistent differences in their two versions.

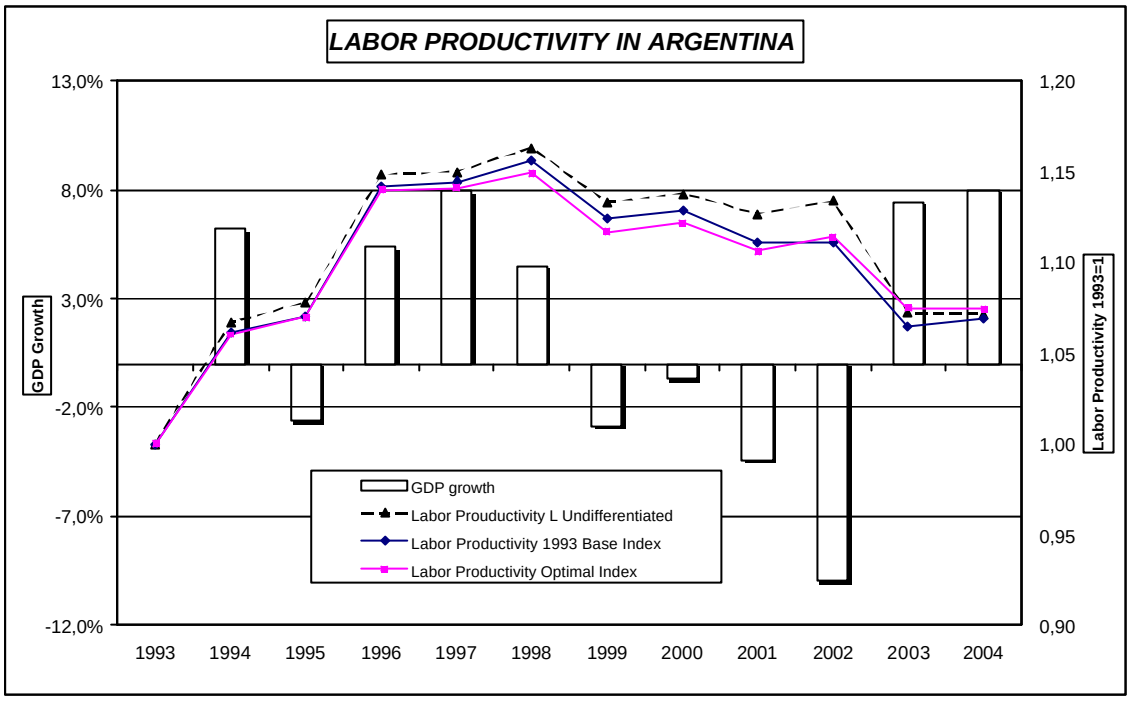
In the following section, we addressed the impact of different measurements of productive factors and output growth in the analysis of the causes of productivity evolution in Argentine economy during the 1993-2004 period.

5. Causes of Labor Productivity Growth in Argentina, 1993-2004

5.1 Labor Productivity

In the following figure, the performance of labor productivity for Argentine economy as a whole is presented according to the three methodologies employed[23]:

FIGURE 5



Labor productivity –measured as production by hours worked for the Argentine economy demonstrate a particular behavior over the business cycle. Four periods clearly defined, according to the phases of the Argentine GDP business cycle: 1993-1998 (labor productivity growth); 1998-2001 (labor productivity decrease); the 2002 crisis; and 2003-2004 (a slight increase of labor productivity).

Nevertheless, the procyclical behavior of labor productivity of Argentine economy hides a reality of stagnation of the labor productivity trend for the 1993-2004 period.

Taking into account the generally used indicator (undifferentiated method), even though between 1993 and 1998 labor productivity increased 15.3%, at a pace of an annual average 3%, the later economic depression and the ulterior crises of 2002 determined that the level of labor productivity achieved in 2004 is only 7% higher than the 1993 levels and a –5% lower than the 2001 levels. For the whole 1993-2004 period, the rate of labor productivity growth was only an annual average 0, 6%.

[23] Elías (1992) is an important antecedent of the exhaustive methodology of growth accounting applied to seven Latin American economies, including Argentina's, for periods previous to the one analyzed here.

TABLE 1			
LABOR PRODUCTIVITY IN ARGENTINA			
annual average growth			
Period/indexes	**L UNDIF**	**BASE 1993**	**OPTIMAL**
1993-2001	1.50%	1.32%	1.27%
1993-1998	3.07%	2.94%	2.82%
1998-2001	-1.06%	-1.32%	-1.26%
2002-2004	-2.79%	-1.95%	-1.81%
1993-2004	0.63%	0.60%	0.65%

The performance of labor productivity for the post devaluation period is particularly outstanding: while during the positive phase of the Convertibility Plan the undifferentiated index of labor productivity grew at an annual average 3.07% and during the negative phase 1998-2001 grews -1%; for the 2002-2004 period, labor productivity decreased to an average annual pace of -2.79%, in spite of a positive the positive GDP growth.

Taking into account that the reverse of labor productivity growth is the labor-output elasticity, the important dynamism of labor input since the second semester of 2002 implied an important structural change in the labor-output elasticity, reaching levels close to the unit for the 2002-2004 period, in comparison to the years of the Convertibility cycle (average close to 0.4).

The scarce dynamism of labor productivity since the end of Convertibility due to a high increase in labor demand could be a consequence of the growth of capacity utilization, associated to growth of the aggregate demand and the important decrease of the relative price of labor due to the peso devaluation in 2002.

The economic recovery initiated at the middle of 2002 year, after almost five years of economic depression, implied an important production growth, first as the result of import substitution, and then as a consequence of the important growth of domestic demand.

Regardless changes of relative prices of productive goods and factors, the need to respond to the growth of the aggregate demand during 2003 and 2004 were fulfilled by an increase in the utilization of preexisting installed capacity of production[24]. The increase in the utilization of machines and equipments generated an important increase of labor demand, first in terms of hours worked and then in numbers of employee, given the complementarity between labor demand and capacity utilization.

While there are no reliable statistical data of capacity utilization for the Argentine economy as a whole, the indicator of capacity utilization of the Monthly Industrial Survey (EMI) of the National Statistics Institute (INDEC) reports an important growth in the capacity utilization of manufacturing sector. During the 2002-2004 period, the capacity utilization in manufacturing industry grew almost 14 percentage points, while in 2002, the indicator was 55.7%, in 2004 it would have achieved levels close to 70% for the whole manufacturing industry[25].

Another possible cause of the increment in the labor-output elasticity during Post Convertibility is the result of the fall in the relative price of labor input as a consequence of mega devaluation of domestic currency in 2002. This could have been an incentive to some substitution between capital and labor factors in every industry of the Argentine economy. This substitution in favor of labor surely would be higher in those sectors that, being labor intensive, were beneficiated by the remarkable decrease of labor costs in a context of an high increase of aggregate demand[26].

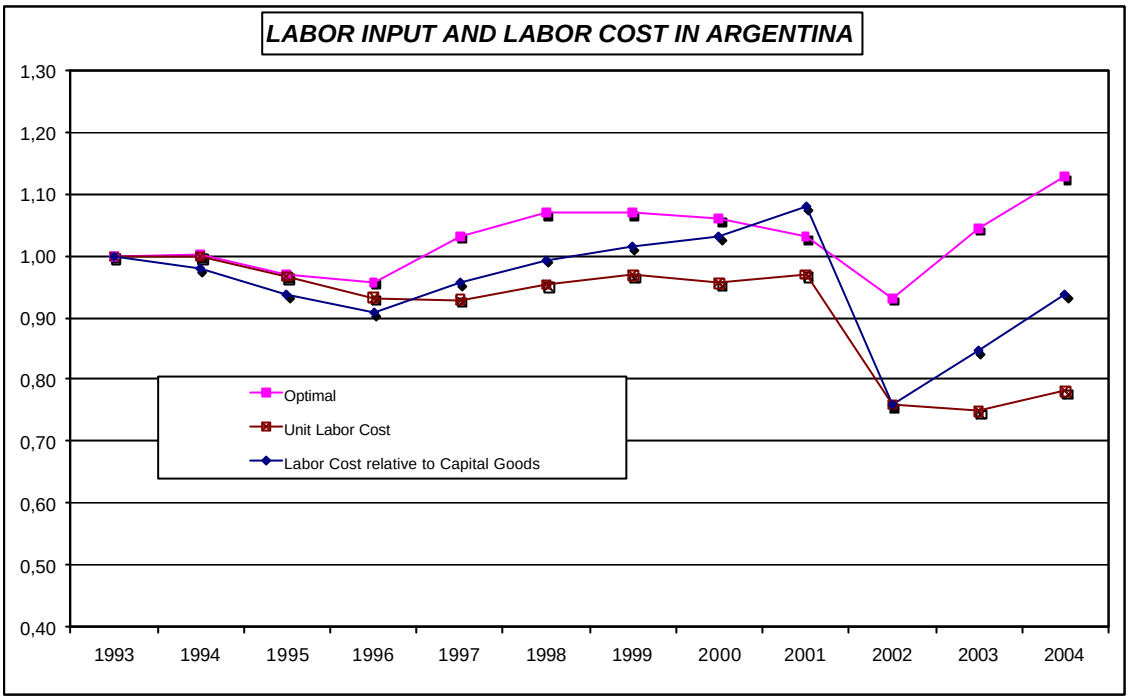
[24] The same situation would have been produced during 1991-1992, at the beginning of the positive phase of the business cycle in Argentina, since the implementation of the Convertibility Plan.

[25] We should take into account that these figures reflect the average in the manufacturing industry but the situation in the rest of the industries of the economy could be heterogeneous. Also, the possibility of "bottle-necks" due to insufficient supply of specialized labor force or other reasons can produce a saturation of the previous installed capacity before the maximum level of theorical capacity utilization.

[26] However, this hypothesis should be verified even more. According to the comments of Luis Beccaria, the beginnings of positive phases of the cycle, preceded by long term economic depressions can produce an important

Unit labor costs (compensation paid to labor from a producer's point of view) was fallen strongly in 2002 (-20.8%) for the whole Argentine economy. As we will see in the next section, the fall in the relative price of labor compared to capital goods was also important (-30%), and in terms of imported capital goods, the fall was even bigger (-62%), explaining in part the important decrease in the capital intensity during post devaluation years.

FIGURE 6



This reality of labor productivity stagnation in Argentine economy during the 90's reflects a trend similar to the one of the 80's, an unusual result for other studies focused exclusively in the manufacturing sector.

According to Figure 5, the dynamics of labor productivity measured by the traditional indicator is clearly biased. The optimal indicator is always below the traditional and the fixed base ones for the period 1993-2001, especially since 1997. As of 2002, the optimal index exceeds both indexes because it incorporates the influence of price and relative wages changes on industry contributions to production and labor growth, since that year devaluation.

According to Table 1, labor productivity measured by the undifferentiated index was reduced an annual average -2.79% between 2002 and 2004, in terms of the fixed base index, labor productivity decreased an annual average -1.95, while in the case of the optimal index, labor productivity would have fallen even less –an annual average -1.81%– clearly revealing the estimation biases of the traditional indicator of labor productivity.

increase of employment, as a consequence of covering the growth of the aggregate demand with an extensive capacity utilization, until now underused, through the incorporation of more labor force, first in hours and then per job positions, regardless the level of the real exchange rate and factorial relative prices. We agree in these terms for the 2002-2004 period. Nevertheless, at the beginning of the Convertibility Plan, we can assume that this effect was, in part, compensated by the reduction of employment due to the public sector reform and the economic deregulation. Note that the increase in capital intensity was similar both in the positive and the negative phase of the cycle of the Convertibility, with an average tendency to the fall of the relative price of capital goods.

5.2 Capital Intensity of the Argentine Economy 1993-2004

The moderate trend of labor productivity growth during the Convertibility period (1993-2001) is contrasted with an important increase in the capital intensity as presented in the following table:

TABLE 2			
CAPITAL INTENSITY IN ARGENTINA			
Annual Average Rates of Growth			
Period/indexes	**L UNDIFF**	**1993 BASE**	**OPTIMAL**
1993-2001	2.45%	2.36%	2.40%
1993-1998	1.98%	1.96%	2.10%
1998-2001	3.25%	3.03%	2.88%
2002-2004	-9.55%	-7.89%	-8.13%
1993-2004	0.77%	1.07%	1.00%

According to the optimal index, capital intensity grew an annual average of 2.40% during between 1993 and 2001.

The important increase in capital intensity during this period is produced by different reasons: between 1993-1998, the ratio is increased (2.10%) as a consequence of higher relative increases of capital stock (annual average 3.48%) than labor (annual average 1.35%), while during the 1998-2001 period, capital intensity grows 2.88% as a consequence of the increases in capital stock (annual average 1.64%) and net falls in labor (annual average -1.21%)[27].

The 2002-2004 period is particularly relevant, because a structural change in capital intensity toward a lower level than in the previous decade. Since the devaluation and the 2002 crisis, the capital labor ratio decreased at an annual average –8.13%.

This could be a consequence of a change in the dynamic of labor input: since the 2002 devaluation, the labor dynamic is higher than capital, while the capital stock increased an annual average 1%, labor increased an annual average 10%[28].

As cited before, the main cause of this labor performance during the 2002-2004 period would have been the increase in hours worked demanded as a consequence of the increase in the capacity utilization of equipments to attend the increase of the aggregate demand associated to a new phase of the post devaluation business cycle.

Nevertheless, probably the fall of relative price of labor as a consequence of a higher real exchange rate has some positive effect on the labor demand and the consequent lower capital intensity in the current post devaluation phase.

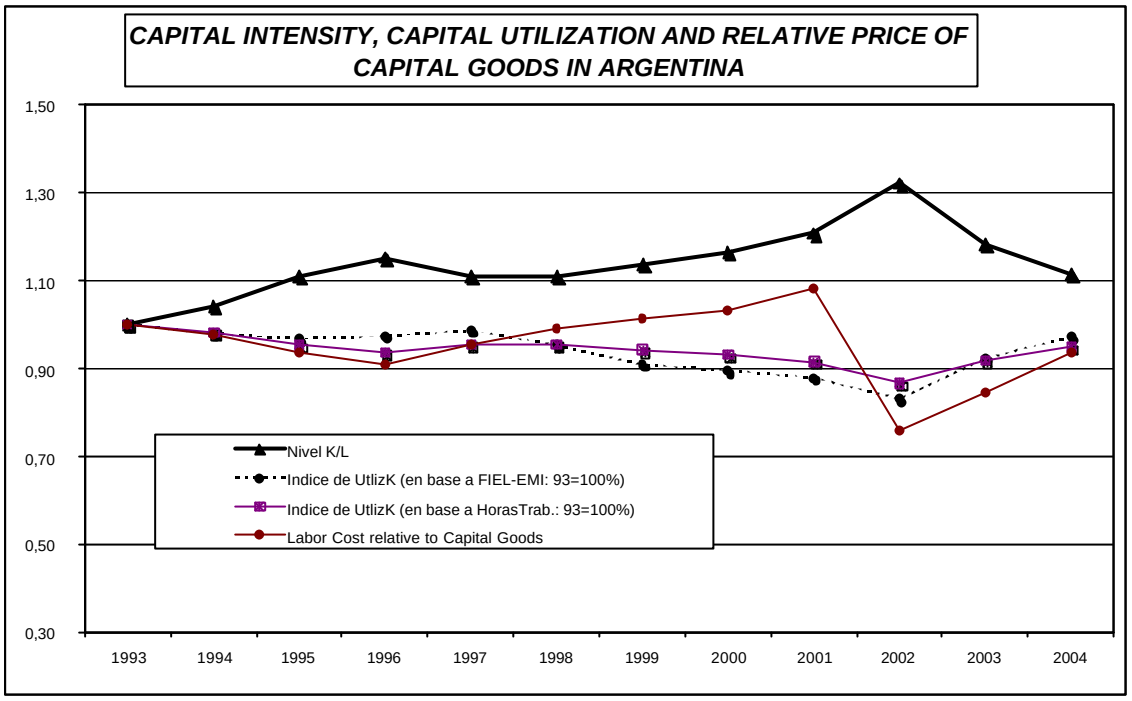
The fall of relative price of labor compared to machinery was even bigger than the reduction of unit labor costs. While unit labor costs was fallen strongly in 2002 (-20.8%) for the whole Argentine economy, the fall in the relative price of labor compared to capital goods was also important (-30%), and in terms of imported capital goods, the fall was even bigger (-62%).

[27] See also table 7

[28] See also table 7

In the following figure it is clearly stated that the previous annual changes of the relative cost of the machineries have an influence on the capital intensity in the subsequent period.

FIGURE 7



Therefore, there would be evidences that labor productivity gains during the 1993-2004 period are explained by the changes in capacity utilization and certain dynamism in the substitution of primary inputs associated to variations in their relative costs, as presented in the following table:

TABLE 3

FACTORS ELASTICITY OF SUBSTITUTION IN ARGENTINA

Annual Average Rates of Growth

Period/indexes	K/L	Pk/w*	Changes in Capacity Utilization (93=100%) ***		$s_{K,L}$
			Hours Worked	Manufacturing Indicator	
1993-2001	2.40%	-1.18%	-8.4%	-12.0%	-2.03
2002-2004	-8.13%	13.42%**	8.1%	14.0%	-0.61

*Corresponds to the variation of relative prices of capital goods in relation to average wage (including employer contributions)

** 2004-2001

*** Increases in the capacity utilization, assuming that in 1993 (base year for National Accounts) it was 100%.

The above table shows how the increase of the capacity utilization and the decrease of the relative labor cost, due to the 2002 devaluation, would have been an incentive to later reduction in the capital intensity of Argentine economy. Changes in capital intensity had lower absolute value compared to the previous decade, producing a considerable reduction in the elasticity of factors substitution, evidence that would incline us in favor of the increases of the capacity utilization as the main cause of the reduction of the capital intensity, associated to the higher level of labor-output elasticity.

The amount of the adjustments in capital intensity related to the dynamics of labor productivity described before has important implications to the residual estimation of TFP, as we will see in next section.

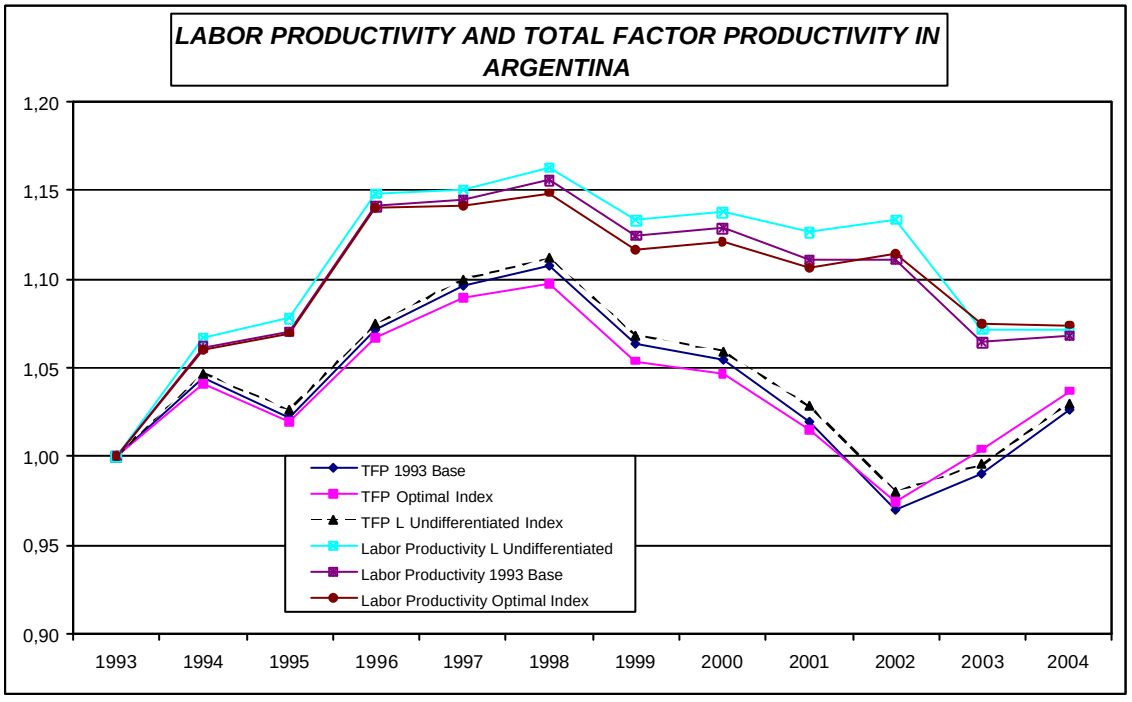
5.3 Total Factor Productivity in Argentina 1993-2004

Since the estimate of the factors contribution to growth in Argentina is restricted by the statistical information available; up to here, the following non-accounted effects would be included in Solow's residual or TPF:

- Embodied technological change, would not be partially captured in the correction by quality and composition of productive factors[29].
- Capital reallocation by industry, because there are no available data about capital stock per user sector.
- Changes in capacity utilization both at aggregate level and by sector, because there are no sufficiently reliable available data about use of capital stock per user sector and at aggregate level.
- Scale Returns Economies.
- Human Capital: as the result of not differentiating employment by education and experience. However, if we assume a correlation between these attributes and the industry sector where employment is generated (as the implicit differentiation approach assumes), then the contribution of human capital would be already captured in the estimated optimal index for labor input.
- Measurement errors.

In the following figure, we can observe that TFP has a clear cyclical behavior. For the 1993-2004 period, it presents a lower net tendency than the labor productivity. In 2002, labor productivity was 11% higher than in 1993, TFP were at the end of 2002, -2,02 lower than in 1993.

FIGURE 8



[29] As Carlos Zarazaga comments, the correction by "quality" or hedonic correction should also be applied to the rest of the components of the GDP, not only to investment; for instance, durable consumption goods. Thus, the effect of quality changes on durable consumption goods is also included implicitly in the TFP.

5.3.1 TFP in 1993-2001 Period

According to the results previously presented in Table 2 and in Table 1: relative higher growth of capital intensity than labor productivity growth, the TFP had a vegetative behavior during the 1993-2001 period.

In Table 4 the output and labor productivity growth accounting is described, while in Table 5 a summary of the main effects of index numbers correction on TFP is presented. In Table 6 the TFP and factors contribution to output growth is presented.

TABLE 4
SOURCES OF GROWTH 1993-2001

Annual Average Growth

	L UNDIF.	1993 BASE	CHAINED
Q	**1.59%**	**1.59%**	**1.66%**
K	2.64%	2.64%	2.79%
L	0.08%	0.27%	0.38%
Y	**1.50%**	**1.32%**	**1.27%**
K/L	**2.45%**	**2.40%**	**2.40%**
TFP	**0.30%**	**0.20%**	**0.14%**

TABLE 5
QUALITY AND REALLOCATION EFFECTS 1993-2001

Annual Average Growth

	L Undif.	Quality	Reallocation	Total
Q	1.59%		0.07%	1.66%
K	2.64%		0.15%	2.79%
L	0.08%	0.19%	0.12%	0.38%

TABLE 6
SOURCES OF GROWTH 1993-2001-SHARES

	L UNDIF.	1993 BASE	OPTIMAL
Q	100.00%	100.00%	100.00%
K	78.41%	78.41%	79.52%
L	2.70%	8.86%	12.18%
TFP	**18.90%**	**12.73%**	**8.30%**

a. The average TFP growth in Argentina during the Convertibility Plan was very low according to the three methodologies.

b. Capital accumulation was the main factor that contributes to economic growth, so that an accurate measurement of capital stock has a methodological and an explanatory significance as well.

c. Changes in factor composition, as well as corrections by factor quality, are more important than composition effect in production[30].

d. The TFP contribution to growth is significantly small, and its contribution is additionally reduced when the optimal index is adopted. ***TFP explains 18.9% of average growth in the case of undifferentiated labor input, to 12.7% in the case of fixed base indexes (with "quality" change corrections), and only 8.3% in the case of optimal methodology.***

The low TFP contribution to economic growth in Argentina during the "90's miracle" is similar to the findings for Southeast Asian countries case by Young (1992), (1994), (1995)[31] and

[30] Probably the statistical procedure underestimates quality changes. As we pointed out in the previous note, durable consumer goods are not corrected by quality either. However, if the quality correction underestimates it, it would not be captured in the residual either!

[31] Thanks to Saul Keifman for his comments in this sense.

by Timmer and Van Ark (2000) –spread by Krugman (1994)-. For the same technical reasons (the use of National Accounts data, measurement through optimal indexes, macroeconomic consistency), these authors consider that the Nic's economic miracles were based on capital accumulation and not on strict TFP gains in the sense of positive shifts in production function.

However, there are important antecedents presenting opposite conclusions, in favor of a higher TFP contribution to growth for the Convertibility period in Argentina

Kydland and Zarazaga (2002) sustain that, according to a calibration of a real equilibrium cycle model, Argentina generated an important TFP growth rate. On the contrary, the improvements in capital-labor ratio, generated by the performance of gross fixed investment during the last decade, were not enough, compared to the theoretical model. In the papers by Meloni-SPEyR-MECON (1999) and Nicholson-Maia-DNCPM-MECON (2001), a similar conclusion is reached.

The main differences with these studies are the followings, synthetically based on methodological, data base and macroeconomic consistency.

In first place, this paper tries to measure factors contribution to growth following the criteria of consistence, exhaustiveness and detail of System of National Accounts 1993 (SNA93). In second place, this document presents a correction of the problem of index numbers that could create biases in the factors contributions to output growth. Finally, the evidence in this paper, as well as in its antecedents, is macroeconomic consistent, both in terms of National Accounts data and regarding to the standard theory of economic growth.

The three papers cited above estimate capital stock using the PIM method mentioned before, with data of investment flows with a high level of aggregation, without any kind of empirical corroboration of the assumptions used for the estimation. This implies, according to what was said in section 3.3, to assign the same aggregate price to the subaggregates, linking in series of different base years without a methodological criterion for the treatment relative price structure changes among base years; leaving, in sum, a high degree of uncertainty regarding the level and evolution of capital stock.

In the papers mentioned before, capital-output and capital-labor ratios are higher than the ones in the United States and other developed countries, contradicting the standard theory of economic growth.

The higher levels of capital stock estimated by the PIM method, have been used by the above mentioned authors without taking into account census or register data of some important types of capital goods and also without empirical verification of the main assumptions of the PIM. This type of estimation impacts in a positive bias in the level of the stock. Ceteris paribus the performance of gross investment, this generates a reduced dynamism during the 90's, not matching the basic statistics of census and records in Argentina about the stock of dwellings units, infrastructures works, private non residential constructions, automotive transportation equipment, farm tractors and other agricultural equipment, cultivated assets, cattle, etc.[32]

These questions have been partially solved in the capital stock series of National Accounts in Argentina, as pointed out in section 3.3, in Coremberg (2002), and INDEC (2004), taking into account exhaustive data of records or census valued hedonically by industry at 5 digits level of CIIU, by vintage and specific model for the more important types of capital goods.

This proceedings result not only on a series of capital stock with homogeneous methodology regarding the investment series, because it comes from the same statistical source, but also in a higher macroeconomic consistency, because the capital-output and capital-labor ratios implied in the series of National Accounts of Argentina are lower than the ones in developed countries, confirming the theory of economic growth.

On the other hand, in the empirical literature above argentine experience cited above, capital stock is not estimated in terms of services. This has an impact on that the estimated

[32] For instance, the estimate of dwelling stock by the PIM method would result in a level of dwelling stock estimation a lot higher than the one registered in the 1991 National Census of Population and Housing in Argentina, being this last record exhaustive and consistent. See this and other considerations in INDEC (2004).

stock series grows at lower pace, as construction contributions are overestimated, because when it is measured in terms of services its contribution to the total stock is lower in comparison to equipment[33].

Given the trends of these subaggregates in Argentina, besides the overestimation of the aggregate stock level, this would have repercussion on a lower dynamism of total stock and, therefore, on the reduction of its contribution to growth.

The papers mentioned before estimate labor input in terms of numbers of employees instead of hours worked, as it is recommended in the economic literature on productivity measurement. These last proceedings does not capture the labor hoarding phenomena or changes in labor intensity, generating a sub estimation of the labor performance and overestimation of TFP and labor productivity gains during the changes of economic cycle. Besides, these estimations proceeds through simple linking in series based on the Gran Buenos Aires data, being their behavior clearly inconsistent with the evidence at national level of the INDEC series, used here.

The lack of use of optimal indexes both for output and factors generates the distortions mentioned before, that, in average, create an overestimation of labor productivity and TFP growth.

However, the evidence presented here is similar to a recent work by FIEL (2002). It has a TFP measurement based on data of the Big Firms National Survey (Encuesta Nacional a Grandes Empresas) by INDEC and the PyMES Observatory of the Unión Industrial Argentina, whose capital data correspond to the statement of real assets annex of the balance sheets of surveyed firms.

FIEL (2002) estimates that TFP explains only 30% of the value added growth of the private sector firms for the 1993-1998 TFP, similar percentage to the one pointed out in the mentioned papers. In this document, the (optimal) contribution of TFP during the same 1993-1998 period was 44%, although it decreased to 18.9% for the 1993-2001 period (8% with correction of index numbers).

In the case of big firms, according to FIEL (2002), the value added growth is explained by the capital factor, while in the case of industrial PyMES, labor is the factor that contributes the most to value added growth.

However, in the case of firms that quote in Stock Market Exchange, FIEL (2002) estimates that TFP contributes only to 8% of the value added growth.

It is worthy to mention that, even though these estimations have a different methodology[34], the results are in line with Coremberg (2002), (2004) and this paper, taking into account that the period measured by FIEL –1993/1998– corresponds to a positive phase of the cycle and the TFP is not corrected by changes in capacity utilization.

In other terms, there would be an obvious heterogeneity of the TFP indicator at firm level, whose lower aggregate level for TFP would be the outcome of the compensations of positive and negative stories at industry levels.

None of these papers analyze the reasons of the procyclical behavior of TFP and labor productivity and the possible association to changes in capacity utilization.

[33] Construction usually has a lower user cost than equipment, because its lower annual depreciation rate.

[34] In FIEL (2002) the factor contribution to growth is estimated based on accounting estimations of capital stock, without correcting the factor growth by "quality" and intersectorial "relocation" effect. Note that in the case of Coremberg (2002), (2004) and this document, the estimated contribution of TFP is similar to FIEL's estimation (2002) for the ENGE and the survey Pymis when it is not corrected by those effects. In other words, the estimation of the mentioned effects, based on the surveys would result in an even higher reduction of the contribution of the TFP, as shown in Coremberg (2004).

5.3.2 TFP in 2002-2004 Period

In the following tables, an analysis of growth accounting for the 2002-2004 period is presented:

TABLE 7 SOURCES OF GROWHT IN ARGENTINA 2002-2004			
Annual Average Growth Rates			
	L UNDIF	**1993 BASE**	**CHAINED**
Q	**7.73%**	**7.73%**	**8.25%**
K	0.99%	0.99%	1.08%
L	10.46%	9.64%	10.02%
Y	**-2.79%**	**-1.32%**	**-1.81%**
K/L	**-9.55%**	**-7.89%**	**-8.13%**
TFP	**2.48%**	**2.86%**	**3.15%**

TABLE 8 QUALITY AND REALLOCATION EFFECTS 1993-2001				
Annual Average Growth Rates				
	L Undiff.	**Quality**	**Reallocation**	**Total**
Q	7.73%		0.52%	8.25%
K	0.99%		0.09%	1.08%
L	10.46%	-0.83%	0.38%	10.02%

TABLE 9 SOURCES OF GROWTH 2002-2004-SHARES			
	L UNDIF	**1993 BASE**	**OPTIMAL**
Q	100.00%	100.00%	100.00%
K	7.03%	7.03%	7.17%
L	60.84%	56.04%	54.61%
TFP	32.13%	36.93%	38.22%

a. TFP in Argentina grew at important rates during the post devaluation years.

b. Labor is the main productive factor that contributes to economic growth during the 2002-2004 period. Its contribution decrease in the fixed base methodology and in the optimal methodology.

c. Quality and composition changes correction of GDP and labor growth are relatively more relevant than during the 1993-2001 period, as a consequence of the change in relative prices in 2002 due to mega devaluation and the consequently obsolescence of 1993 as base year .

d. The TFP contribution to growth is significant. Its effect increases with optimal methodology.

However, it should be taken into account that the residual TFP growth could be part of a cyclical movement and not strict TFP in the sense of positive shifts in possibilities production frontier in the long run.

According to the following figure, TFP grew at an important pace between 2002 and 2004, as a consequence of the beginning of the positive phase of the cycle[35] [36].

In order to get the strict TFP, it is necessary to adjust it by changes in capacity utilization. While there are no reliable indicators of the capacity utilization by industry for the

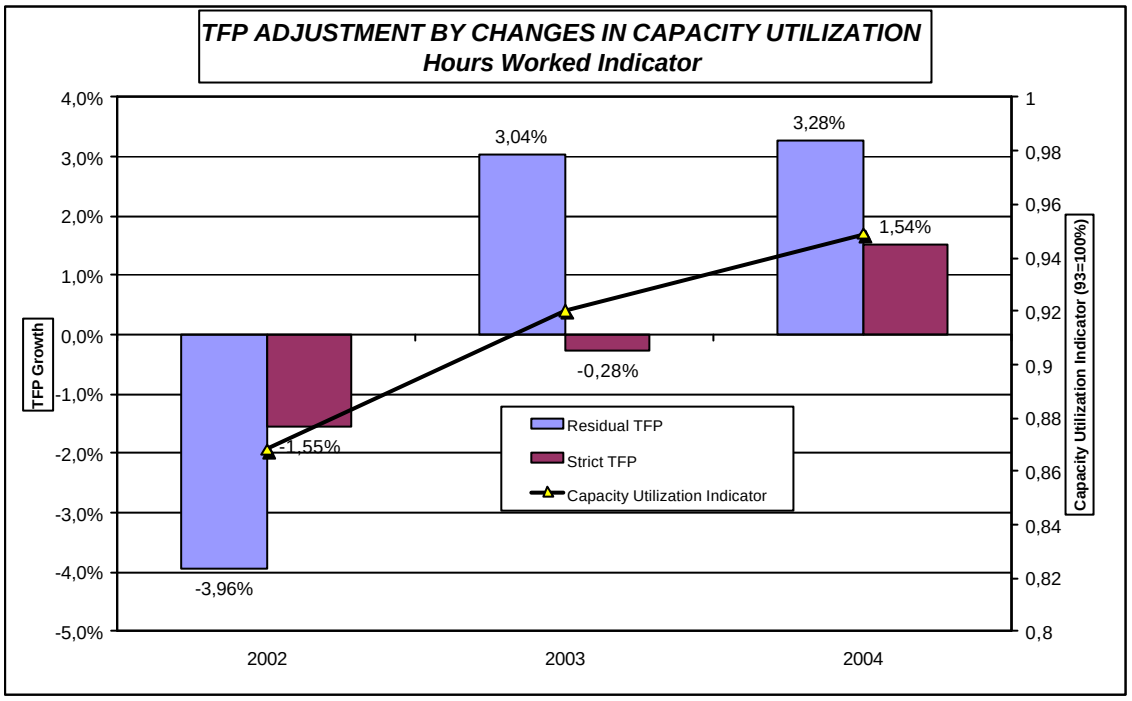
[35] The TFP would have shown the same behavior at the beginning of the Convertibility Plan (1991-1993). At the moment of writing this paper, there were no reliable data to include this period.
[36] The analysis of TFP variations as a consequence of the short term cycle was suggested by Daniel Heymann.

whole economy, and capital stock series by user sector, we present a correction of capital services contribution to growth by changes in capacity utilization.

It should be considered that the indicator of capacity utilization of the Industrial Survey of INDEC (EMI) corresponds to manufacturing industry which represents only 25% of the GDP. In the case of hours worked, reliability is gained by higher sector coverage; however, it is a questionable indicator in the case of economies with high instability of relative factor prices as Argentina's[37]; because of these problems, the following results are necessarily tentative.

The following figures present how the short term dynamics of the TFP would be affected by the adjustment of capital services contribution by changes in its capacity utilization for the 2002-2004 period:

FIGURE 9



[37] Besides, to use this indicator as proxy could be questionable in the negative phases of the cycle because hours worked can be subject to labor hoarding effect. When the output falls, capacity utilization can be reduced, but more than the use of labor as a consequence of the increase of labor intensity due to retention of highly qualified workers in a context of cyclical recession.

FIGURE 10

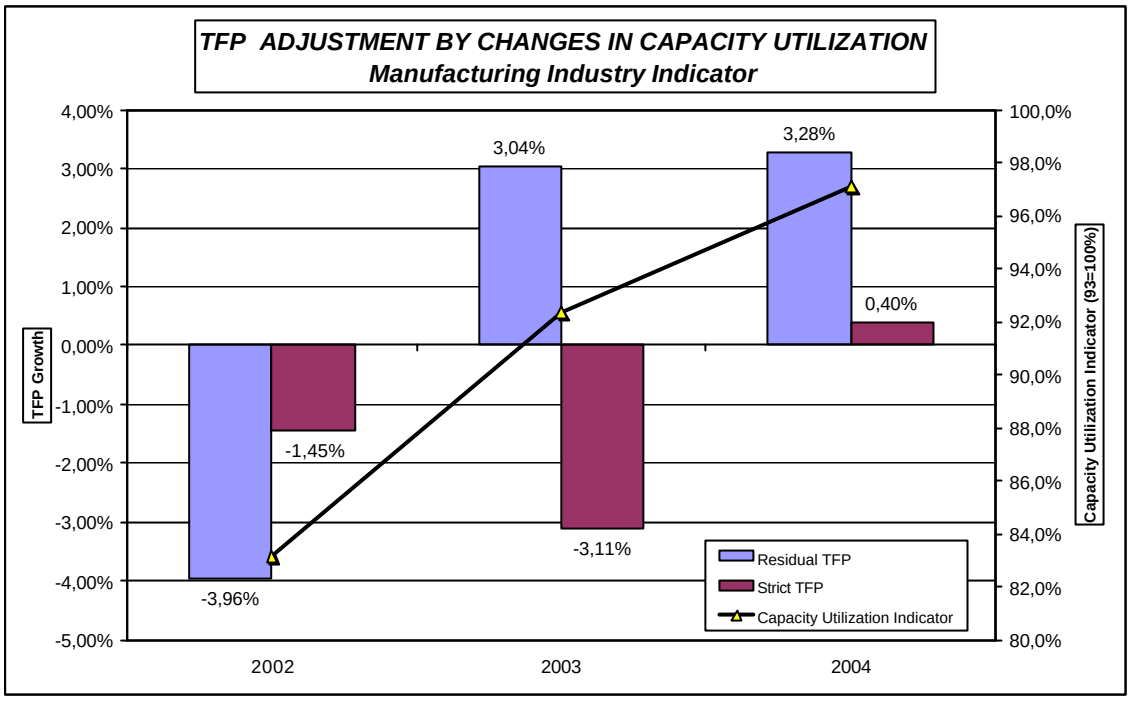


TABLE 10 EFFECT OF CHANGES IN CAPACITY UTILIZATION ON TFP 2002-2004		
	Hours Worked	**Manufacturing Indicator**
RESIDUAL TFP	**3.15%**	**3.15%**
STRICT TFP	**0.62%**	**-1.37%**

According to the previous figures, and Table 11, the adjustment by changes in capacity utilization would considerably reduce the performance of the residual TFP for the post devaluation period. The output growth in this period would be explained mainly by factors utilization because the increases in capacity utilization, underused during the recent negative phase of the business cycle in Argentina which last five years (1998-2002).

Labor productivity and residual TFP performance in Argentina could be mainly the result of a procyclical phenomenon originated in the changes in capacity utilization and also logical reallocation of production and factors due to changes in relative prices instead of improvements in the organization of the Argentine economy as a whole.

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CONCLUSIONS

This paper shows that the main cause of labor productivity growth in Argentina during the 1993-2004 period seems to have been the increase of the capital-labor ratio, instead of the so called total factor productivity (TFP).

After the exhaustive analyses of the causes of labor productivity growth and the concepts implicitly included in the TFP, this paper discusses in detail the measurement of the components of labor productivity. Through recommendations of recent economic literature about the comprehensive and consistent estimation of the factors' contribution to economic growth and the use of optimal index that allow to capture the effect of changes in relative prices on factors and GDP contribution, the paper estimates the performance of labor productivity and its main components for the Argentine economy between 1993 and 2004 according to different methodologies.

The series of labor and capital, as well as GDP data from the National Accounts provides methodological and macroeconomic consistency to the main aggregates composing the source of growth in Argentina.

As a consequence of the application of this methodology, the study shows that labor productivity and residual TFP growth had a marked procyclical behavior during the 1993-2004 period, being their average trend really low according to both indicators.

During the 1993-2001 period, an important increase in capital intensity took place in Argentine economy as a consequence of the impact of high relative labor costs and lower capital goods prices on lower dynamism of labor demand and high performance of investment.

One of the main results is that capital intensity reacts to changes of factors' relative costs, showing a high elasticity of factor substitution at the aggregate level for the Argentine economy.

During the 2002-2004 period, capital intensity of the Argentine economy was reduced, as a consequence of the higher dynamism of labor demand, associated to increases in capacity utilization after a long time of economic depression, and to some influence of the reduction of its relative cost, originated by the 2002 devaluation, showing cyclical increases of labor productivity and non strict TFP.

The provisional correction by capacity utilization notably reduces the non strict TFP gains during the post devaluation period. Given the lack of reliable data, the same methodology could not be applied to the beginning of the Convertibility Plan (1991-1993), but intuition and knowledge of the developments taking place during that period would indicate that the correction of capital services' contribution to growth by capacity utilization would have similar effects for the early 1990s.

The higher relative labor cost, due to the appreciation of the domestic currency during the 1990s was not sustainable because the non strict TFP gains were reduced in the medium term.

This evidence would be consistent with the ex post overinvestment "status" after the 2002 economic crisis. The economic depression after the Brazilian devaluation in 1999, and the 2002 Argentine devaluation did not allow for the long term persistence of the TFP gains and the higher level of capital intensity presumably achieved during the early 1990s.

The evidence of embodied technological change during the 1990s in big companies or in the firms that received foreign direct investment is compatible with these results, once the following characteristics features of Argentine economy are taking into account: high degree of productive heterogeneity, the scarce survival of the PyMES sector, and the non- integrated nature of the industry after the openness of the economy to external trade. In other words, there would have been a Solow´s paradox in the Argentine economy: "more computers could not have an impact in the strict TFP".

The main conclusion of this paper is that the Argentine economy seems to have displayed extensive growth during the period 1993-2001, based on capital accumulation, rather than on improvements in the organization of the production processes (similar to the Asian NIC´s experience during the 1970s and 1980s).

Technological change may have been the embodied type through the investment in new equipment allowed by the fall of the relative prices of capital goods, as a consequence of the appreciation of the domestic currency and the increase in the openness of the economy to external trade during the 1990s.

During the 2002-2004 period, output and labor productivity growth can be explained by the reduction of capital intensity originated in a higher relative labor demand as a consequence of increases in capacity utilization --previously underused during five years of deep economic depression-- and the fall in the relative price of labor that followed the 2002 mega devaluation.

The strict TFP in the sense of positive shifts in production function would not have grown after taking into account the adjustment by quality and reallocation effects due to changes in relative prices and cyclical changes in capacity utilization.

Finally, there are doubts about the ability of the Argentine economy to generate the necessary strict TFP gains that allow a sustainable economic growth in the long-run.

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