

The Measurement of TFP in Argentina, 1990-2004: A Case of the Tyranny of Numbers, Economic Cycles and Methodology

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ABSTRACT

The aim of this study is to examine the main sources of growth in Argentina for the period 1990-2004 in order to identify the dominant growth profile: either extensive, which is associated with factor accumulation and utilisation, or intensive, which is based on productivity gains. The study proposes a methodology for identifying gains in total factor productivity (TFP) net of short-run fluctuations in relative prices and cyclical changes in factor utilisation. When applying this methodology to Argentina in the period 1990-2004, we find that economic growth appears to be extensive during the whole period, biased towards capital accumulation and utilisation during the 1990s and biased towards labour input after the 2002 devaluation. These results raise doubts as to whether the Argentine economy is able to generate long-run productivity gains independent of composition and quality effects and cyclical changes in factors utilisation, gains that are needed to achieve sustainable long-run growth.

DURING THE 1990S, LABOUR productivity grew at a robust pace in Argentina. It is widely believed that much of the labour productivity growth was due to the growth of total factor productivity (TFP), i.e. associated exclusively with positive shifts in the production function,

or in other words with improvements in the organization of the production process that were independent from the accumulation and utilisation of labour and capital.

However, as will be shown in this article, the interpretation of TFP as a production function

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shift may be incorrect if measured TFP (a necessarily residual variable) includes the impact of short-run economic phenomena that are not necessarily related to shifts in the production function. The most important short-run phenomena are cyclical changes in factor utilisation (labour intensity and capital utilisation), intersectoral reallocation of factors and substitution effects in production reflecting normal adjustments to changes in relative prices and changes in input quality that are not related to improvements in the organization of the productive process. These factors seem to have been particularly important over the 1990–2004 period.

As pointed out by Galiani, Heymann and Tomassi (2003), the accurate identification of the sources of economic growth can help to determine the long-term sustainability of the growth process and the magnitude of permanent income or wealth perceived by economic agents on which investment decisions depend. Canavese and Gerchunoff (1996) have highlighted the central role of TFP in long-term sustainability, not only for growth but also for the real exchange rate.

This study investigates the sources of economic growth in Argentina during the period 1990–2004. Following the recommendations of the literature on productivity measurement, sources of growth are analysed by means of index number theory. This allows filtering TFP from the so-called intersectoral substitution effects in production and quality and composition effects in inputs. In addition, TFP is disaggregated to identify procyclical changes in input utilisation as a consequence of the business cycle: changes in labour intensity and in capital utilisation.

The article is divided into five parts. The first section provides a brief qualitative review of economic developments in Argentina over the 1990–2004 period. The second section proposes a methodology for identifying gains in TFP net

of short-run fluctuations in relative prices and cyclical changes in factor utilisation. The third section presents the main results of the use of this methodology and analyses the different sources of growth in Argentina between 1990 and 2004. The fourth section analyses the results in terms of labour productivity and TFP (strict and apparent) growth and identifies the growth profile of the Argentine economy for the period 1990–2004. In the fifth and final section, conclusions are drawn.

A Review of Economic Development in Argentina between 1990 and 2004

During the last fifty years, the Argentine economy exhibited very slow trend growth (3 per cent annually), with high volatility relative to other emerging economies. Significant political and macroeconomic instability is the most common explanation among economists for Argentina's poor long-term growth.

It is notable that Argentina has experienced periods where the investment share has exceeded 20 per cent of GDP, a proportion close to that observed in major developed countries. While Argentina's investment as a share of GDP has been similar to other Latin American economies, it has been lower than in the newly industrialised countries of East Asia. In Argentina, these periods of a high investment share coincided with the implementation of successful stabilization plans that resulted in notable improvements in macroeconomic stability, export performance, and economic growth. Unfortunately, none of these positive developments could be sustained in the long run.

One of the periods characterized by these short-term positive developments was the era of the Convertibility Plan, from 1991 to 2001, which saw significant economic growth. Growing international liquidity for emerging economies, macroeconomic stability, and a set of structural

reforms fostered significant capital inflows that allowed for an increase in credit for the public and private sectors, leading to higher domestic investment, consumption and public expenditure.

At the beginning of the 1990s Argentina privatized public utilities and introduced reforms favouring greater deregulation of markets and improved trade and financial openness. These reforms appeared to have produced an increase in the productivity of the Argentine economy in spite of a large real appreciation of the domestic currency.² Productivity gains allowed for significant cost savings, partially compensating for the competitive disadvantage created by the real appreciation. Evidence of this effect can be found in the notable growth of the tradables sector, especially the manufacturing industry, which translated into higher domestic output and, in particular, higher exports.

However, over time the real appreciation of the domestic currency became unsustainable, in large part because productivity gains were based on short-term fluctuations rather than underlying technological change. After overcoming the external "tequila" shock in 1995, the Argentine economy did not recover rapidly from the shock produced by the Brazilian devaluation of mid 1998. The Argentine economy could not internally generate the necessary increase in both domestic savings and productivity to compensate for the negative effects of the external shocks. The extent of the exchange and financial imbalances accumulated by the end of the 1990s led to the inevitable collapse of the convertibility regime in the early 2000s. The collapse of the convertibility regime resulted in significant capital flight, a major devaluation, and a deep external and financial crisis with effects that can still be felt today.

At the beginning of 2002, the domestic currency experienced a significant devaluation. However, due to the freezing of all bank accounts

— the so-called "corralito" — and the recession, the pass-through of devaluation to prices was very limited initially, avoiding hyperinflation. The doubling of the real exchange rate (\$Argentinos/\$US) fostered import substitution and exports. Growth in aggregate demand, together with reduced labour costs and excess installed capacity, allowed employment to recover to pre-devaluation levels. The unemployment rate declined almost ten percentage points. The substantial underutilisation of installed capacity, after an almost five-year depression, meant that growing aggregate demand could be met without spiralling inflation.

Accounting for Growth in Argentina

Because Argentina is a developing country with an unstable economy, an investigation of the sources of growth raises a number of analytical and statistical challenges. To surmount these challenges, this article proposes a methodology for disaggregating economic growth into its main sources by adapting the most recent development or innovation in the economic literature on the subject.

The identification of a country's economic growth profile consists of estimating the contributions to economic growth from the factors of production (movements along the production function) and from TFP (positive shifts of the production function). The standard approach estimates TFP by subtracting the weighted growth of factors of production (labour and capital) from overall economic growth.

But the standard approach does not take into account other important economic phenomena that can affect economic growth and labour productivity. Accounting for these phenomena is especially important in an economy characterized by deep structural changes

2 The real appreciation of the currency resulted from the adoption of the convertibility exchange regime and the growing inflow of external savings.

and considerable volatility in relative prices and aggregate demand. Changes in the composition or quality of key macroeconomic aggregates (output, labour or capital) as a result of changes in relative prices may have considerable effects on the measurement of economic growth. Moreover, cyclical changes in aggregate demand may induce changes in the use of productive factors. Thus, an ideal measure of TFP (i.e. one measuring positive shifts of the production function) should account for changes in the composition of output; changes in labour and capital; quality changes in primary factors; and cyclical changes in factor utilisation as captured by labour intensity (hours worked per job) and capital utilisation.

Changes in the composition and quality of macroeconomic aggregates may be of considerable magnitude in Latin American countries, including Argentina, where the instability of relative prices has been the rule over the last 30 years. For example, changes in the real exchange rate may lead to large substitution effects in production across the tradables and non-tradables sectors, affecting their contributions to GDP growth. Something similar happens with labour and capital inputs, not only by industry but also by types or attributes: qualification, age, etc.

Changes in labour intensity and in capital utilisation may also have a certain effect along the business cycle. In general, if we consider labour input as a quasi-fixed factor, its skill composition may be affected by the business cycle (through labour hoarding), and cycles may also produce changes in labour intensity (hours worked per job). Moreover, the existence of adjustment and transaction costs, as well as sunk costs, mean that the quantity of

capital input cannot be easily adjusted to reflect changes in aggregate demand, leading to changes in capital utilisation. Thus, taking into account the considerable fluctuations in aggregate demand in Latin America (especially in Argentina during the period analysed in this study), adjusting for factor utilisation is of critical importance when investigating the growth profile of the Argentine economy.

Failure to adjust TFP for changes in capital utilisation and labour intensity generates a strongly procyclical behaviour that could be incorrectly attributed to shifts in the production function. Given that in this study TFP gains are understood as technological progress (positive shifts in the production function), the adjustment of labour and capital for changes in their use becomes essential.

We propose a methodology for estimating TFP which disentangles the influence of changes in relative prices (quality and composition effects) and cyclical changes in factor utilisation to obtain a measure we hereafter call "strict TFP," which represents a positive shift in the production possibilities frontier.³ Our methodology accounts for economic growth as follows:⁴

$$1) \quad \Delta Y^O = \bar{s}_K \Delta K^O + \bar{s}_L \Delta L^O + \Delta A^S$$

Where the main variables are measured as follows:

ΔY^O = Optimal output growth measured by Tornqvist index

\bar{s}_i = average share of primary input in GDP using period beginning and end point

ΔA^S = "strict TFP" growth

$$2) \quad \Delta L^O = (\Delta L^U + \Delta L^Q + \Delta L^C + \Delta L^{ul})$$

where the optimal labour input growth measured by Tornqvist index (L^O) is defined as the sum of the following effects: hours or undifferentiated labour growth (L^U); the quality effect

3 Hulten (1986) distinguishes TFP in even stronger terms: true TFP and false TFP (without adjusting for capital utilisation).

4 For more details, see the unabridged version posted at www.csls.ca.

(L^Q) expressed as the difference between labour input growth by Laspeyres index and hours growth; the composition effect (L^C) expressed as the difference between the Laspeyres and Tornqvist index of labour input growth; and the utilisation or labour intensity effect (L^{ul}) expressed as the difference between hours and jobs growth.⁵

3) $\Delta K_P^O = (\Delta K_W^B + \Delta K^Q + \Delta K^C + \Delta K^{uk})$
 where capital services growth measured by Tornqvist index (K_P^O) can be decomposed into capital stock growth measured by the Laspeyres index of wealth stock (asset prices as weights of types of capital) (K_W^B); the quality effect (K^Q) expressed as the difference between the Laspeyres index of wealth stock and the Laspeyres index of capital services (taking user cost as weights by type of asset); the composition effect (K^C) expressed as the difference between the Laspeyres index of capital services and the measurement by Tornqvist index; and the utilisation effect (K^{uk}) expressed as the difference between the measurement of original or "potential" capital services and capital services adjusted by utilisation.⁶

It thus follows that for labour productivity:

y = labour productivity

k = capital/labour ratio

$$4) \Delta y = S_K \Delta k + \Delta A^S$$

where all its components are measured optimally.

The traditional methodology consists of the measurement of apparent TFP without identifi-

cation of quality, composition and adjustment effects in the input contribution side.

$$5) \Delta Y^B = \bar{S}_K \Delta K_W^B + \bar{S}_L \Delta L^U + \Delta A^A$$

where ΔA^A = apparent TFP growth

And from it follows the traditional version of labour productivity:

$$6) \Delta y = S_K \Delta k + \Delta A^A$$

where output growth is measured by Laspeyres or another fixed-base index, capital input growth represents the growth of wealth stock measured by Laspeyres, and labour input growth is measured using unadjusted hours growth.

The Measurement of the Sources of Growth in Argentina, 1990-2004

The purpose of this section is to briefly present the methodology, sources and results of the estimates of the components of productivity growth for Argentina during the period 1990-2004, following the recommendations of section two.⁷ Our analysis of the productivity drivers and productivity performance of Argentina over the 1990-2004 period focuses on the following sub-periods: 1990-1994, the initial boom of the Convertibility Plan; 1995, the tequila effect which was characterized by significant capital flight triggered by a widespread loss of confidence of foreign investors after the collapse of the Mexican peso; 1995-1998, the second positive phase of the Convertibility Plan; 1998-2001, the negative phase and the end of the currency board; the

5 It is worth mentioning that self-employed and unpaid family workers are included in labour input, in addition to employees. Income for these types of workers is called mixed income given that it includes compensation for both labour and capital. In order to identify labour remuneration, returns to labour of this type were imputed at the industry level based on the wages of employees as recommended by OECD (2001b).

6 The adjustment of capital services by their effective utilisation in productivity measurement has been discussed extensively in the economic literature. There is agreement that this phenomena has to be taken into account in growth accounting and productivity studies but there is no agreement about how to make the adjustment. Taking into account the volatility of the economic cycle in Argentina, we follow the methodology of Basu *et al.* (2001) in the explicit tradition of Solow (1957), Jorgenson and Griliches (1967), and Denison (1969), but with specific utilisation indicators by factor in a growth accounting context.

7 The impact on productivity of each variable and the growth profile are analyzed in the following section.

2002 crisis (default, "corralito", devaluation); and 2002-2004, the new positive phase of the business cycle.

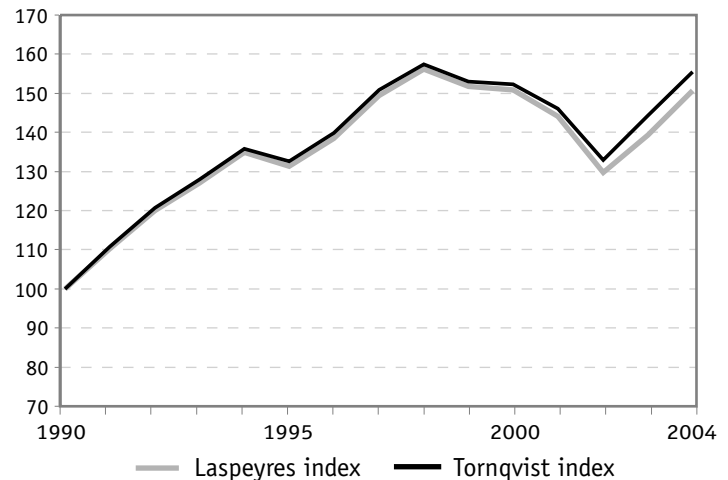
Gross Domestic Product

Gross domestic product (GDP) estimates in this article are from the National Accounts Area (DNCN) of the National Statistical and Census Bureau (INDEC).⁸ Official GDP estimates include non-registered activity by industry in the base year. Sectoral value added is estimated at producer prices, that is, excluding non-deductible value-added tax as well as import taxes and intermediation margins.⁹ The GDP series was calculated using a Tornqvist index, which accounts for the large changes in relative prices since 2000.¹⁰

Chart 1 presents the GDP series by index type. In 1990s both indices exhibit a near identical trend. However, since 2000, and especially after the 2002 crisis, the two series have diverged (Table 1). As a consequence of the substantial devaluation of the domestic currency in 2002, the tradable goods producing sectors (agriculture, mining and manufacturing) increased their share of GDP (from 25 per cent to 40 per cent) and their contribution to GDP growth (Chart 2). This important change in relative prices is captured in the Tornqvist physical volume index, representing a substitution effect in production of approximately one percentage

Chart 1

Real Gross Domestic Product in Argentina, 1990-2004
(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

point for 2002 and of 0.4 percentage points on average for the following years (Table 1).

On the other hand, differences between the two indices were substantially smaller at the beginning of the period. Prior to adopting the Convertibility Plan, devaluation was almost neutral with respect to relative prices as nominal devaluation was entirely passed through to prices (even more than proportionally). After the adoption of the Convertibility Plan in April 1991, currency appreciation resulted only in a small reduction in the share of the tradables sector, slightly increasing the gap between the indexes.¹¹

8 For the period 1993-2004, the base year is 1993. For the period 1990-1993, the series at the one-digit level of ISIC 3rd rev. were linked with the series of the former base year, 1986. This match is provisional given that it was not carried out standardizing the methodology used to calculate the physical volume indexes of the industries that form GDP.

9 A more accurate measurement of productivity should use the basic prices valuation criterion. This criterion provides a superior estimate of the price at the exit of the factory, because it removes direct taxes, income tax and exports taxes; however, these estimates at current and constant prices by industry are not officially available.

10 For the definition and methodology of ideal or optimal indexes, see Diewert (1976, 1978 and 1995), OECD (2001b) and ISWGNA (1993). The estimates for Argentina are explained in Coremberg (2002 and 2004a); results using different types of ideal index are similar to the one presented here.

11 The impact 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 deflators of value added of the tradables and non-tradables sectors. Between 1990 and 2001, the relative prices of tradable goods in terms of non-tradable goods decreased 17.5 per cent, whereas after devaluation relative prices of tradable goods increased 92 per cent (2001-2004).

Table 1**Real Gross Domestic Product in Argentina, Selected Periods, 1990-2004**

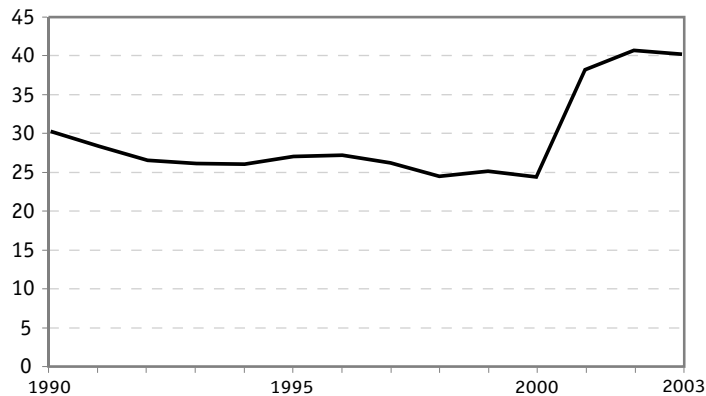
(annual or average annual growth rates)

Type of Index	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
Laspeyres93	7.78	-2.62	5.94	-2.65	3.38	-10.02	7.77	2.97
Tornqvist	7.96	-2.36	5.86	-2.46	3.50	-8.96	8.15	3.20
Substitution Effect	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.

Chart 2**Share of Tradables Industries in the Argentine GDP, 1990-2004**

(current prices)



Source: Author's estimation based on National Accounts, INDEC.

If this production substitution bias were not taken into account, GDP growth would have been underestimated by an average of 0.23 percentage points annually in the 1990-2004 period. As noted earlier, after the 2002 devaluation, the difference would have been an average of 0.4 percentage points annually. These differences are not minor. If this bias were not taken into account, GDP growth and, therefore productivity gains, would have been significantly underestimated.

Labour Input

Output, wages and labour input (captured by hours and jobs series) by industry during the 1993-2004 period, come from the National Accounts (DNCN-INDEC, 2006). The functional distribution of income estimated in the National Accounts is based on information from a variety of sources in order to achieve exhaustive estimates by industry consistent with the ISWGNA (1993) recommendations.¹²

The availability of data from a single statistical source ensures the necessary methodological consistency of employment and GDP data by industry, which is especially important given that production and labour data include a sectoral adjustment for the 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, and includes an adjustment for under-declaration of factor income consistent with the rest of the National Accounts.¹³

The quality of labour by sector was determined using the implicit differentiation approach proposed by OECD (2001a), which assumes a correlation between the sectoral characteristics of labour and the rest of the

12 As noted earlier, the labour input also includes the contribution of self-employed and non-paid family workers, using wages similar to those of the industry where they are employed as recommended by OECD (2001b).

13 The National Accounts labour and wage series for the period 1993-2004 are available at the one-digit level of ISIC 3rd rev. (16 sectors), and are compatible with the disaggregation of the GDP accounts and an own estimate based on the Household Permanent Survey (EPH) of INDEC for 1990-1993.

Table 2
Labour Input in Argentina*, Selected Periods, 1990-2004
 (annual or average annual growth rates)

Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1991-2001	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.

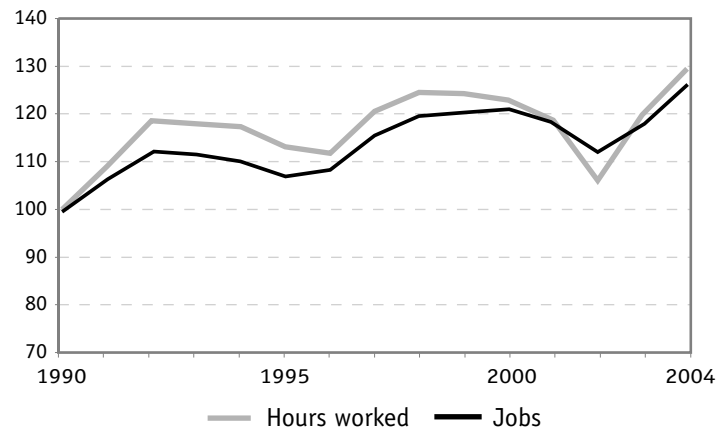
* Labour input in terms of undifferentiated positions or hours worked.

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

According to Table 2, in Argentina during the 1990-2004 period, the rate of growth of hours worked was slightly faster than the rate of growth of jobs. Trends in labour input showed procyclical behaviour over this period. These cyclical movements were independent of the indicator used (Chart 3) and occurred in spite of both variables being stock rather than flows. This cyclicity was more pronounced for hours worked than for jobs, a difference that may be attributed to the greater flexibility of hours worked than jobs or to labour hoarding.

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 average 0.18 per cent and -0.83 per cent respectively as a consequence of the changes in relative wages generated by the important appreciation of the domestic cur-

Chart 3
Labour Input in Argentina by Indicator, 1990-2004
 (1990=100)



Source: Author's estimation based on National Accounts, INDEC.

rency at the beginning of the 1990s and the devaluation in 2002.

To sum up, adjusting for labour utilisation is crucial in the measurement of the contribution of the labour input to economic growth. The Tornqvist series of hours worked exhibited highly procyclical behaviour, as well as more volatility than jobs.

Capital Services

The capital stock series used corresponds to the author's recent estimates at National Bureau of National Accounts-INDEC (National Statistics Institute).¹⁴

Table 3**Hours Worked in Argentina, Selected Periods, 1990-2004**

(annual or average annual growth rates)

Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1991-2001	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
Laspeyres93	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
Tornqvist	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.

Composition and Quality Effects on Capital Services in Argentina

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 in terms of annual capital services. To identify the different effects of changes in relative prices on capital services, the composition effect on the net capital stock was first identified, and then adjusted by changing the weights to obtain the quality effect, in line with OECD (2001b). Table 4 summarizes the main results.

The following conclusions can be drawn from an analysis of the results:

- The composition effect is positive for the aggregate stock and its two components. This effect, expressed as the difference between the Laspeyres and Tornqvist volume indexes of net

capital stock, was almost one percentage point per year on average. This represented the weighted effect of durable equipment (0.41 percentage points) and construction (1.03 percentage points). In other words, the growth of the wealth capital stock is underestimated by traditional indexes.

- The quality effect, the difference between net capital stock and capital services (both measured by Tornqvist indexes), was negative for the aggregate stock, -0.50 percentage points. The quality effect represents the weighted sum of a positive effect for durable equipment (0.76 points) and a negative effect for construction (-1.05 points). The weighting by user cost is proportionally higher for durable equipment since, in having a shorter average service life, it provides a relatively greater share of annual services.

14 The estimation methodology is explained in Coremberg (2002 and 2004b), following the methodological recommendations of the literature on capital measurement, and in particular 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 and Uriel (2005). The main characteristics of the Capital Stock and Capital Services estimation are the following: (i) perpetual inventory method (PIM) adjusted by (a) 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 Wyckoff (1981), (b) benchmarking of census data and (c) 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 ISIC 5-digit level of disaggregation; (iv) macroeconomic consistency; and (v) Capital services are measured through endogenous approach taking user costs as weights as recommended in Jorgenson, Gollop and Fraumeni (1997) and OECD (2001a) (estimations through exogenous approach provided similar results). Hofman (1991, 2000) presents standardized purchasing power parity (PPP) Perpetual Inventory Method (PIM) estimates of capital stock disaggregated in three types for seven Latin American economies, including Argentina for the 1950-1994 period with similar capital-output ratios as our series for the period 1990-2004.

Table 4
Real Capital Stock Services in Argentina, 1990-2004
 Annual Average Growth Rates

	Total	Durable Equipment	Construction*
Laspeyres Capital Stock	2.03	1.84	2.09
Composition Effect	0.93	0.41	1.03
Tornqvist Capital Stock	2.96	2.25	3.11
Quality Effect	-0.50	0.76	-1.05
Tornqvist Capital Services	2.46	3.01	2.06
Total Effect	0.43	1.16	-0.03

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

However, although the quality effect on durable equipment stock is positive, it is outweighed by the negative effect from construction given the much larger weight of construction in the aggregate capital stock (both net and productive), even when weighted by user cost.

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

Chart 4 shows the alternative capital series for the period 1990-2004. The total effect of adjusting for the quality and composition of the capital stock is significant and growing. Using the most common measure of net capital stock, the Laspeyres volume index, underestimates the contribution of capital to economic growth and leads to an overestimation of TFP growth.¹⁵

Capital Utilisation in Argentina

Empirically, there are a number of alternatives methods of adjusting the productive capital stock for effective utilisation: (i) the output gap as proposed by Okun (1962); (ii)

the employment rate; (iii) hours worked; (iv) energy consumption; and (v) surveys on installed capacity use. All of these variables present theoretical and statistical problems summarized in Table 5.

Potential output can be econometrically estimated, implicitly assuming that there exists a potential product upon which the output gap can be estimated. This usually assumes (but not necessarily) the existence of a natural unemployment rate, the measurement of which is inevitably controversial.¹⁶

The following three alternatives require the assumption that both factors of production are used in constant proportion over time, in other words, that there exists complementarity in the production process between the use of capital and labour. This assumption may be questionable in a context of important changes in relative factor prices or productive restructuring, both of which could involve factor substitution and, therefore, that both factors of production are not being used in constant proportion. However, substitution between factors could be less important in the short run as a consequence of technological rigidities, sunk costs and transaction costs; thus in the aggregate, substitution

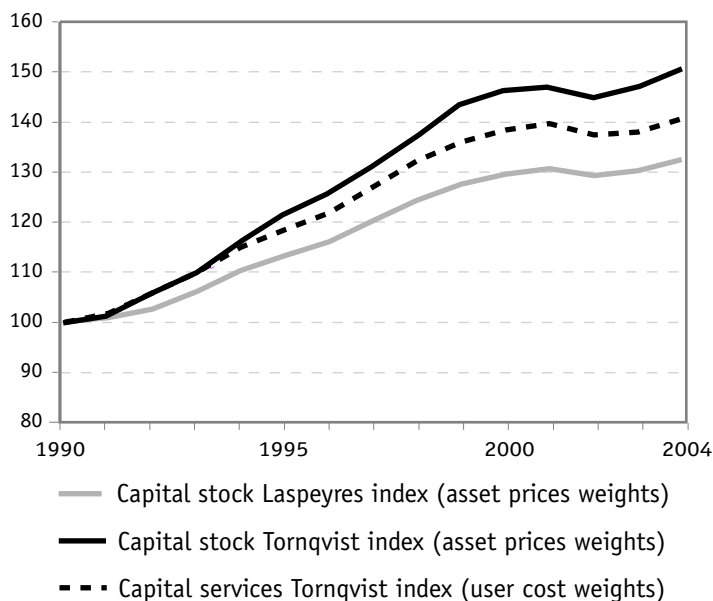
15 Similar measurement problems are studied by Schreyer (2001) for a set of OECD countries and by Mas, Perez and Uriel (2005) for Spain.

16 The output gap can also be estimated using the growth accounting approach, but the potential growth 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.

Table 5
Proxy Indicators of Capital Utilisation

	Assumption	Statistical Coverage in Argentina
Output Gap	Usual interpretation of Okun: Natural Unemployment Rate	Reflects the analyst's subjectivity, econometric estimations
Employment Rate	Complementarity	By household surveys in urban areas
Hours Worked	Complementarity	
Energy Consumption	Complementarity	Energy Demand
Surveys	Representativity	Indicators usually limited to Manufacturing Industry

Chart 4
Capital Services in Argentina, 1990-2004
(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

may result from the birth and death process of firms or due to intersectoral output reallocations rather than to factor substitutions within them.

The employment rate should not be used as an indicator of the contribution of labour and capital growth to GDP growth, because the appropriate indicator when measuring the sources of economic growth is hours worked and not the num-

ber of jobs or workers.¹⁷ Indeed, hours worked is more appropriate as it efficiently captures part-time employment, extra hours, and persons holding multiple jobs in the labour input.

Using hours worked as a proxy for capital utilisation is also problematic, because over the period analysed the Argentine economy experienced important changes of relative factor prices. This may have induced factor substitution, invalidating the assumption that labour hours and machine hours are complementary.

The use of electricity as a proxy for capital utilisation, as in Foss (1963) or Jorgenson and Griliches (1967), has been criticised by Denison (1969) and other authors. Indeed, firms can adopt production processes that substitute energy for other factors. Moreover, the relationship between machine hours used and energy is not stable, given that the productivity of capital with respect to energy is inversely correlated with energy costs.

Econometric techniques or proxy indicators such as those just discussed should only be used in the absence of extensive surveys that capture changes in capital utilisation by industry. But the problem of statistical coverage is important in Argentina. In fact, the only available survey of capital utilisation for the period 1990-2004 corresponds to the capital utilisation index in the manufacturing industry prepared by FIEL (2002).¹⁸

17 Using the employment rate as a proxy of capital use introduces a distortion as changes in the condition of activity of the population would now be reflected as changes in capital use.

18 Fundación de Investigaciones Económicas Latinoamericanas.

Table 6**Capital Services Utilisation in Argentina, Selected Periods, 1990-2004**

(annual or average annual growth rates)

Indicator	1990-1994	1995	1995-1998	1998-2001	1990-2001	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 Services, 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.

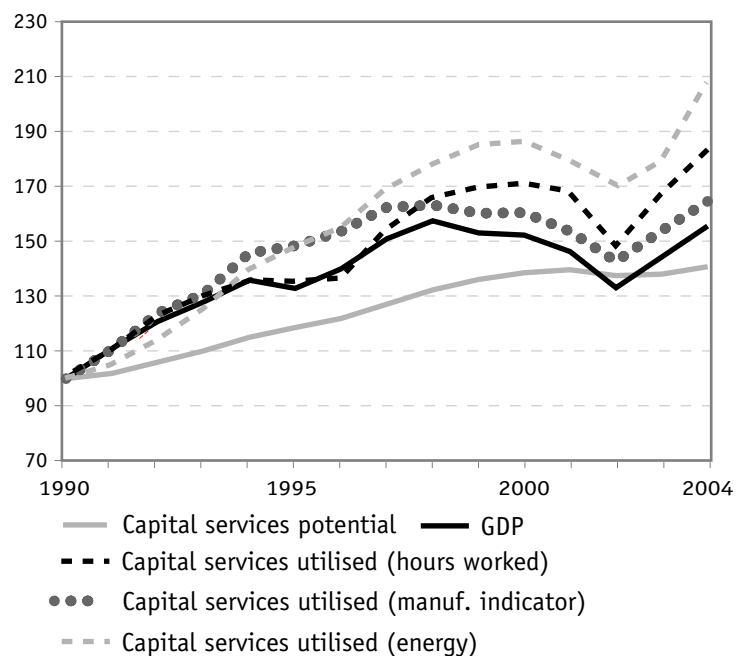
Comparatively, the latter indicator exhibits the greatest correlation with changes in aggregate demand (Chart 5) and for that reason is used in this article. The use of the other indicators would have led to an over-adjustment of capital services and would have significantly changed its trend.

The results of the adjustment of productive capital stock by utilisation are presented in Table 6. The series on capital services effectively used presents clear procyclical behaviour. The adjustment for utilisation has a stronger effect in the changes of phase of the business cycle, and the absolute value of the adjustment peaks at the beginning of the two important cycles of the Argentine economy: the beginning of the Convertibility Plan (1990-1994) and the growth cycle that started after devaluation (2002-2004). In both cases, adjusting for capital utilisation increases capital services growth by 6.3 percentage points.

The adjustment for capital utilisation shows that if unadjusted potential capital services were used for the growth analysis, the contribution of capital input to GDP growth during positive phases of the business cycle would be underestimated and inversely in the recessive stages. Therefore, TFP would be overesti-

Chart 5**Capital Services: Adjustment by Utilisation Indicators, 1990-2004**

(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

mated at the beginning of the positive phase of the business cycle and underestimated in the negative phases.

Table 7**Labour Productivity in Argentina* by Type of Labour Input Indicator, Selected Periods, 1990-2004**

(annual or average annual growth rates)

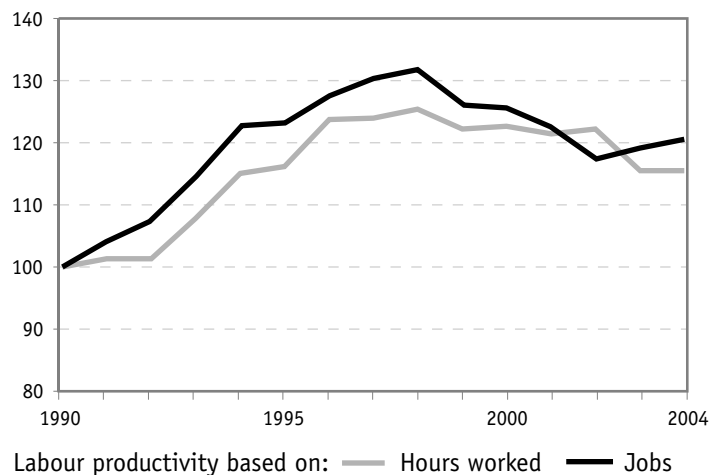
Labour Input Indicator	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
Jobs	5.28	0.25	2.17	-2.31	1.86	-4.34	1.44	1.34
Hours Worked	3.56	1.02	2.58	-1.06	1.78	0.58	-2.76	1.04
Labour Intensity Effect	-1.72	0.77	0.41	1.25	-0.07	4.92	-4.20	-0.31

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

* Labour productivity based on labour input measured in terms of jobs or undifferentiated hours worked

Chart 6**Labour Productivity in Argentina, 1990-2004**

(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

Productivity in the Argentine Economy, 1990-2004

Labour Productivity

This section analyses trends in labour productivity during the period 1990-2004.¹⁹ First, in order to assess the effect of adjusting for labour intensity (hours worked per job) we discuss the differences between trends in labour productivity measured by GDP per job (job labour productivity) and GDP per hour worked (hour labour productivity). Second, we analyse the quality and intersectoral composition effects

mentioned earlier using the Tornqvist index to measure hour labour productivity.

The Adjustment by Labour Intensity

According to Chart 6, for the period 1990-2004 labour productivity exhibited a positive trend whether measured as job labour productivity or hour labour productivity. By 2004, job labour productivity had increased 20.5 per cent over the level of 1990, while hour labour productivity had increased by 15.5 per cent.

According to Table 7, between 1990 and 2004, job labour productivity grew on average at a rate somewhat higher than hour labour productivity, 1.34 per cent and 1.04 per cent respectively.

Both indicators of labour productivity exhibited procyclical behaviour. In general, in periods of economic recovery, changes in labour productivity become positive while in recessionary periods they present null or negative values. Yet, although long-term trends in labour productivity for the period 1990-2004 and the signs of annual growth are similar for both job and hour labour productivity, there were substantial differences in the magnitude of the rates of change in the short run (Chart 7).

The large differences in the short-run growth rates of both series were due to changes in labour intensity. Changes in labour

19 One of the main earlier analysis on Latin America is Elías (1992), where traditional growth accounting was applied to Argentina for the 1944-1985 period.

intensity are a result of either the greater adjustment flexibility of hours compared to jobs or to labour hoarding. According to Chart 6, 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: the Convertibility Plan (1990-1994) and the "Post devaluation" (2002-2004).

The Adjustment by Quality and Composition of the Labour Input

Other important effects to take into account in analysing labour productivity trends are the impact of sectoral composition and quality on labour input. Using undifferentiated hour labour productivity instead of adjusted hour labour productivity produces different biases over the period 1990-2004 (Table 8). The magnitude of these biases becomes relevant only for the period 2001-2004, mainly as a consequence of the impact of changes in relative prices and wages on the sectoral composition of GDP and labour input. For this period, the Tornqvist indicator of labour productivity suggests faster growth than the traditional indicator, indicating a potential understatement of labour productivity during this period.

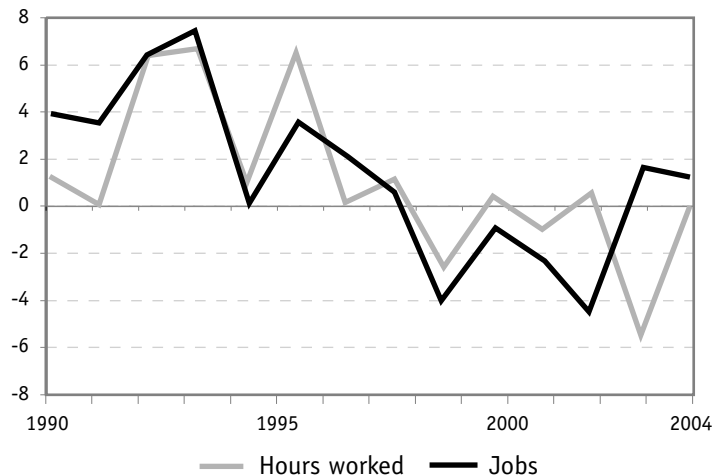
Capital Intensity

One of the main sources of labour productivity growth is capital intensity growth (equation 1). All else equal, when capital intensity grows faster, it explains a larger share of economic growth, and the importance of TFP as an explanation of economic growth falls. Chart 8 presents capital intensity in Argentina between 1990 and 2004 using five different methodologies.

A visual analysis suggests that the five capital intensity indicators can be separated into two groups. The four series using potential capital

Chart 7

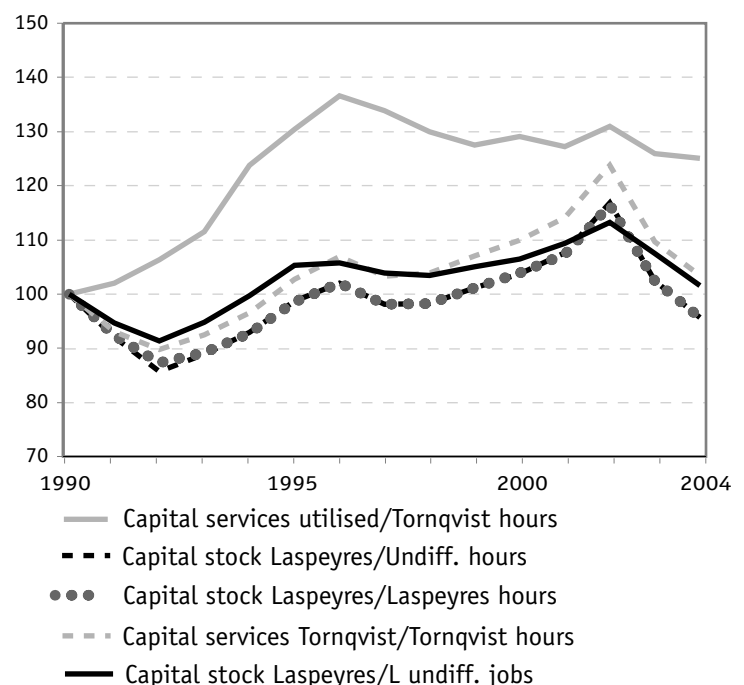
Labour Productivity Growth in Argentina, 1990-2004
(annual growth rate, per cent)



Source: Author's estimation based on National Accounts, INDEC.

Chart 8

Capital Intensity in Argentina by Index and Indicator, 1990-2004
(1990=100)



Source: Author's estimation based on National Accounts, INDEC.

Table 8**Labour Productivity in Argentina by Methodology, Selected Periods, 1990-2004**

(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	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 Tornqvist/LTornqvist	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.

Table 9**Capital Intensity in Argentina by Methodology, Selected Periods, 1990-2004**

(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	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 ^{Serv} Tornqvist/ Tornqvist Hours	-0.89	6.44	0.39	3.16	1.20	8.44	-8.56	0.24
K ^{Serv} utilised/ Tornqvist 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 stock or wealth. K^{Serv}: potential capital services except for the last row corresponding to the adjustment by installed capacity utilisation.

services declined between 1990 and 1993, increased until 2002, and then declined again. In contrast, capital intensity with effective factor utilisation grew between 1990 and 1996, and then slowly declined until 2004, down to the level achieved in 1994.

The main difference between the two groups is the adjustment for factor utilisation. As seen earlier, failure to adjust an input series for utilisation leads to growth being underestimated at the beginning of the positive phases of the cycle and overestimated in the negative phases. These biases are reflected most clearly in capital intensity, because the adjustment to capital is on average larger than the adjustment to labour.

According to Table 9, during the 1990s the adjustment of both capital and labour for

changes in relative prices and quality of labour, leads to a significant increase in the average growth rate of capital intensity: from an annual average of 0.81 per cent to 1.20 per cent. The adjustment for capital utilisation increases the procyclicality of the series, especially at the beginning of the 1990s, and translates into an increase in capital intensity growth to an average of 2.21 per cent annually between 1990 and 2001.

From 1990 to 2004, the trend in the capital intensity using utilised factor services can be explained by faster growth in capital services (3.62 per cent per year) than hours worked (1.92 per cent per year) (Chart 9 and Table 10).

However, factors that explain the trends in capital intensity differ significantly over the business cycle. According to Table 10, growth in

Table 10**Components of the Capital Intensity Growth*, Selected Periods, 1990-2004**

Factor	1990-1994	1995	1995-1998	1998-2001	1990-2001	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 Tornqvist indexes for the capital services effectively utilised and labour input in hours worked.

capital intensity during the 1990s was due mainly to faster growth in capital than labour. On the other hand, the capital-labour ratio appears to have decreased during the positive phase following the 2001-2002 crisis, with labour input growing slightly faster than utilised capital services.

Total Factor Productivity (TFP)

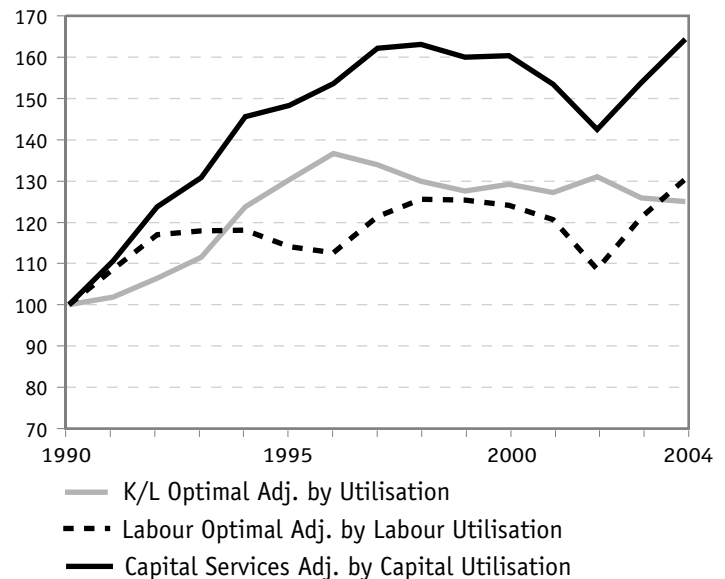
This section presents TFP estimates using the methodology outlined in Section two, which correctly measures the contributions of factor inputs to economic growth. This methodology allows us to interpret TFP as a shift in the production function as it accounts for several effects that cannot be attributed to the performance of strict TFP, such as: (i) the composition or substitution effect in output; (ii) the sectoral composition effect in labour input; (iii) the quality effect in labour input; (iv) the quality effect in capital input; (v) the composition effect by types in capital input; and (vi) 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.²⁰ Moreover, our measures of factor inputs account for their effective utilisation:

- Labour input is measured as hours worked

20 It is worth noting that the measurement of TFP must also use a Tornqvist index if its measurement is to remain consistent with that of 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.

Chart 9**Capital Intensity and Factor Input in Argentina by Components, 1990-2004**

(1990=100)



Source: Author's estimates based on National Accounts, INDEC.

- Capital input is measured as capital services effectively utilised in production

In this way, the impact of fluctuations in factor costs and demand as a result of the business cycle are incorporated in the input contributions rather than attributed to TFP.

The traditional methodology generally used in Latin America, especially in Argentina, is the TFP1 (Table 11), which measures the apparent

Table 11
Optimal Measurement Methodology for TFP in Argentina

Index Type	GDP	Capital	Labour	Income Shares
TFP1 (traditional Latinamerican research)	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated workers	fixed in the base year
TFP2	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	fixed in the base year
TFP3	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ undifferentiated hours worked	Tornqvist
TFP4	Laspeyres	Laspeyres/ wealth capital	Laspeyres/ differentiated hours worked	Tornqvist
TFP5	Tornqvist	Tornqvist/ productive capital services (potential)	Tornqvist/ differentiated hours worked	Tornqvist
TFP6 (Optimal method.)	Tornqvist	Tornqvist/ utilised productive capital services	Tornqvist/ differentiated	Tornqvist

TFP in a very basic way: all physical volume indexes of GDP and inputs by Laspeyres index, capital input measured by net capital or wealth and labour input by worker. The following analysis compares the optimal measurement methodology of strict TFP with different methodological alternatives, including the traditional indicator which is most commonly used in Argentina.

Intermediate methodologies incorporate some of the adjustments mentioned in the economic literature, while the best-practice methodology of strict TFP (TFP6) includes all of them: all physical volume indexes of GDP and inputs by Tornqvist 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. Chart 10 presents estimates of TFP produced using the alternative methodologies. Clearly, the results of using

strict TFP in Argentina during the period 1990-2004 suggest much less growth than other methodologies.²¹

Table 12 presents average annual growth rates of TFP by sub-period using the six different methodologies. All methods that do not adjust input contribution for effective factor utilisation (all but TFP6) exhibit clear procyclical behaviour that is notably reduced when this adjustment is included. 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 (TFP1 versus TFP2) reduces average annual TFP growth by one percentage point in the first cycle (beginning of the Convertibility Plan) and by 2.5 percentage points in the post-devaluation cycle. The adjustment for the utilisation of capital services reduces TFP growth further,

21 Examples of TFP estimations for Argentina with the traditional measurement may be found in Kydland and Zarazaga (2002), SPEyR-MECON (1999) and DNCMP-MECON (2001). Generally in these studies an important contribution of TFP to economic growth, similar to the traditional calculation replicated herein for the 1990s, is detected. As explained in this study, the differences are the consequence of not only the type of index number used, but also of the adjustment of primary inputs for utilisation, as well as of the use of self estimations of wealth capital instead of productive capital (different from the figures of INDEC used here), and of the use of labor input in terms of workers instead of hours worked, generally using non exhaustive labour series corresponding to the Greater Buenos Aires and not all the country.

Table 12**Total Factor Productivity in Argentina by Methodology, Selected Periods, 1990-2004**
(annual or average annual growth rates)

Method	1990-1994	1995	1995-1998	1998-2001	1990-2001	2002	2002-2004	1990-2004
TFP1	5.3	-2.1	2.4	-3.1	1.5	-5.9	3.7	1.2
TFP2	4.3	-1.7	2.7	-2.4	1.5	-3.0	1.3	1.1
TFP3	4.6	-2.0	2.7	-2.5	1.5	-4.2	2.5	1.2
TFP4	4.6	-2.0	2.7	-2.6	1.5	-4.3	2.5	1.2
TFP5	4.2	-2.0	2.3	-2.6	1.2	-3.7	3.2	1.1
TFP6	1.1	-1.5	2.6	-0.8	0.7	-0.6	-0.3	0.5

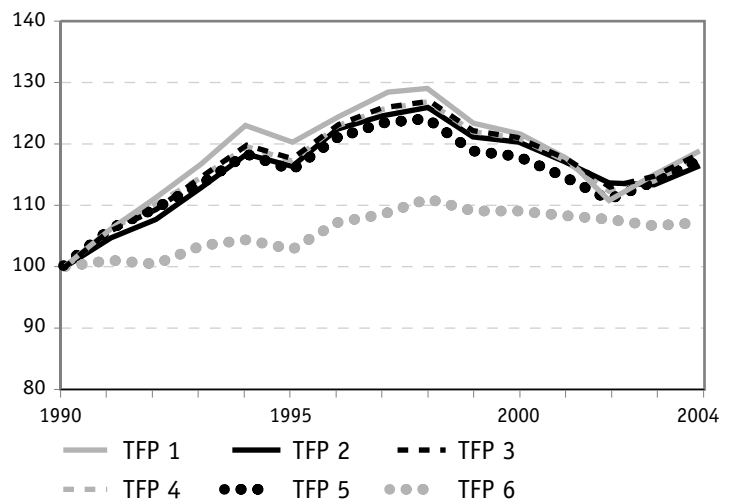
Source: Author's estimation based on National Accounts-INDEC.

by an average of 3.1 percentage points in the first phase and 3.5 percentage points in the second phase.

Composition and quality effects become particularly important in the 2001-2004 period. Adjusting for composition and quality (TFP2 versus TFP5) decreases TFP growth 0.7 percentage points during the 2002 crisis and increases it almost two percentage points in the 2002-2004 cycle as a result of the effect of devaluation on relative input and output prices.

As noted earlier, the most important adjustment is for capital utilisation. Interestingly, if other indicators of capital utilisation had been used, strict TFP, that is TFP6, would grow even more slowly for the whole period 1990-2004, including for the 1990s.²²

Strict TFP increased in the 1990s, stabilized, and then fell slowly during the economic depression that began in 1998. In the initial phase of the Convertibility Plan (after the economic depression and hyperinflation of the previous decade), strict TFP grew on average one per cent per year between 1990 and 1994, substantially more slowly than

Chart 10**Total Factor Productivity in Argentina, 1990-2004**
(1990=100)

Source: Author's estimation based on National Accounts, INDEC.

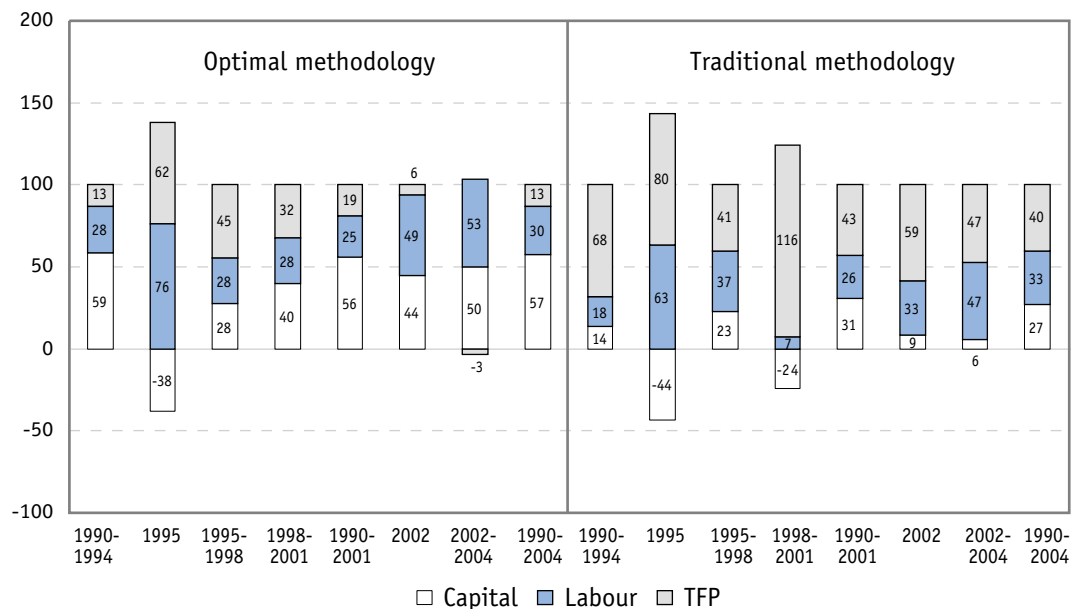
apparent TFP of 5.3 per cent. The less procyclical behaviour of strict TFP is also evident during the years of economic depression (except for 1995). Both during the period 1998-2001, as well as during the 2002 crisis, the fall of strict TFP was smaller than TFP estimated using other methodologies.

22 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 per cent average; in the case of energy and hours worked, strict TFP is reduced to a 0.5 per cent and 0.8 per cent average annual growth respectively.

Chart 11

Sources of Economic Growth in Argentina, Selected Periods, 1990-2004

(contribution to average annual GDP growth, per cent)



Source: Author's estimation based on National Accounts, INDEC.

Strict TFP grew again only in 2004, by 0.5 per cent,²³ although apparent TFP (with Tornqvist index) grew in 2003 (3.16 per cent) and 2004 (3.15 per cent).²⁴ The slower growth in strict TFP during the post-devaluation period is a result of the significant growth of labour demand provoked by the effects of devaluation on labour costs. This was more important in terms of hours than jobs. Nonetheless, the level of both strict and apparent TFP in 2004 was below that of 1998.

To sum up, between 1990 and 2004, strict TFP in Argentina was less procyclical and grew more slowly than apparent TFP, mainly as a consequence of including cyclical variations in the use of primary inputs.

The Growth Profile in Argentina 1990-2004

The results presented so far allow us to estimate the contributions of labour, capital, and TFP to economic growth, and help us to understand the type of growth experienced in Argentina between 1990 and 2004. Chart 11 presents the contributions to growth of labour, capital and TFP and compares the growth profiles generated by the optimal methodology and the traditional methodology. Using the optimal methodology, the Argentine economy has an extensive profile based on factor accumulation and utilisation rather than on a positive shift in the production function. Strict TFP (optimal methodology) accounts for only 13 per cent of economic growth over the period 1990-2004,

23 If the demand for energy or hours worked would have been used as proxy variables for capacity utilisation, strict TFP in 2004 would have been -0.35 per cent and nil respectively.

24 Preliminary data for 2005-2006 obtained after this paper was written, would confirm the recovery of the strict TFP growth cycle but at a slow performance.

while apparent TFP (traditional methodology) accounts for 40 per cent.

The 1990s present an extensive economic growth profile based on capital accumulation and utilisation, with capital contributing 56 per cent, labour 25 per cent and strict TFP explaining the remaining 19 per cent. In contrast, over the same period, apparent TFP contributed 43 per cent.

The period after devaluation, 2002-2004, also presents an extensive growth profile but more focused on labour demand. Labour contributed 53 per cent, capital 50 per cent and strict TFP contributed negatively (-3 per cent). During this period, apparent TFP represented an important positive contribution, 47 per cent, labour another 47 per cent and capital only 6 per cent.

If we had used the traditional methodology, the growth profile would have been wrongly diagnosed as intensive, that is, based mainly on the TFP contribution, both in the Convertibility cycle and after devaluation. As seen before, this diagnosis follows mainly from the fact that the traditional methodology fails to adjust for effective utilisation of labour and capital. In other words, it does not take into account either hours worked or changes in capital utilisation. But in fact, the positive shock to GDP growth at the beginning of the positive phase of the business cycle was the result of the procyclical contribution of the increments in labour intensity and capital utilisation and not from growth in strict TFP.

In terms of labour productivity, the extensive growth profile is also confirmed. During the whole period 1990-2004, the growth of labour productivity, according to the optimal methodology, was generated by growth in capital intensity (65 per cent). Instead, in the case of the traditional methodology, apparent TFP explained almost all of the growth in output per hour worked during the 1990-2004

period, with similar conclusions for both the 1990s and after the 2002 devaluation.

It can be concluded from this analysis that the growth profile presented by the Argentine economy from 1990 onwards is of the extensive type, based on factor accumulation and utilisation: capital during the 1990s and capital utilisation and labour for the period after the 2002 devaluation. This finding is consistent with the important growth of apparent TFP in the 1990s, which reflected a phenomenon of average cost reduction associated with cyclical factors and normal adjustments to changes in relative prices rather than genuine technological progress.

Conclusion

The purpose of this study was to investigate the sources of economic growth in Argentina during the period 1990-2004, and to identify the prevalent growth profile: extensive, associated with trends in productive factors, or intensive, linked to productivity gains.

Taking into account the important changes in relative prices and the amplitude and volatility of the business cycle of the Argentine economy, the study proposed a methodology for disentangling from residual TFP the effects of changes in relative prices and of cyclical utilisation of productive factors. In this way, the study sought to identify strict TFP, i.e. TFP which more closely represents a long-run shift in the production function linked to technology, independent of short-run phenomena. It was distinguished from apparent TFP, which expresses a cost reduction phenomenon but is not necessarily linked to long-term changes in the growth path of the economy.

The main results of the application of this methodology were the following.

- The usual fixed-base indexes used for measuring GDP growth at constant prices

underestimate economic growth and productivity gains.

- The quality and composition effects on GDP (substitution in output) and on inputs had a moderate magnitude during the whole period 1990–2004, being especially important in the period after the 2002 devaluation. Not taking them into account would produce a slight underestimation of TFP in the strict sense.
- The traditional use of a Laspeyres index net capital stock would underestimate the contribution of capital services to economic growth in Argentina, thus producing an overestimate of TFP growth over the period as a whole.
- 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 hours worked series is strongly procyclical. Were these effects not corrected for, TFP and labour productivity would be overestimated in expansionary periods of the business cycle and underestimated in contractionary periods.
- Similarly, the lack of adjustment for capital utilisation would generate an underestimate of the contribution of capital to growth during expansions and an overestimate in contractions. Therefore, strict TFP would be overestimated at the beginning of positive phases and underestimated in negative phases of the business cycle.
- During the period 1990–2004, strict TFP grew substantially more slowly and was less procyclical than apparent TFP, mainly as a result of adjustments in the cyclical variations in factor utilisation. Similar conclusions are derived for labour productivity adjusted by labour intensity. Moreover, the adjustment by cyclical factor utilisation

reduces significantly residual TFP gains, both during the 1990s as well as after the 2002 devaluation.

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

The importance of short-run competitive gains of the Argentine economy revealed through improvements in apparent cyclical TFP, generated both during the 1990s and after the 2002 devaluation, is unquestionable. However, doubts arise about the ability of the Argentine economy to generate productivity gains in the long-run independent of composition and quality effects and cyclical variations in factor utilisation, gains necessary to maintain sustainable long-run growth.

In 2004, both TFP and labour productivity were below 1998 levels. While this article focuses primarily on measurement issues, we could affirm that the poor performance in terms of TFP growth in Argentina was due to the inconsistent macro policies and the instability of the business cycle. The extensive growth profile exhibited by the Argentine economy, especially during the 1990s, contrasts with assessments of other authors and institutions based on the traditional methodology which does not adjust for relative price effects and factor utilisation. On the contrary, our results are analogous to the evidence found by Young (1995), Krugman (1994) and Timmer and Van Ark (2000) for newly industrialised countries.

This conclusion is based not only on 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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