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DETERMINANTS OF LABOR DEMAND IN ARGENTINA: ESTIMATING THE BENEFITS OF LABOR POLICY REFORM

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Setiembre 1996
Nº 114

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Comments are Solicited

* This paper was prepared under the immediate supervision of Dr. Jose Luis Guasch, Principal Economist, LATAD, and the general guidance of Dr. Danny Leipziger, Lead Economist, LA1DR, and Dr. Jane Armitage, Manager, Labor Markets Group, PSP. We are grateful to Dr. Osvaldo Giordano, Subsecretario, Ministerio de Trabajo, and Dr. Juan Luis Bour, Director, FIEL for invaluable help, and to Luis Andres for excellent research assistance. All errors remain ours.

DETERMINANTS OF LABOR DEMAND IN ARGENTINA

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DETERMINANTS OF LABOR DEMAND IN ARGENTINA

I. INTRODUCTION AND APPROACH

A. Background and Overview

Recent Developments. Since the economic reforms at the end of the last decade, Argentine employment grew by more than 2 percent annually while the economy grew at a sustained rate of about 8 percent annually between 1990 and 1993. In 1994, in spite of GDP growth of about 6 percent, employment stagnated or even declined. A likely explanation for the relatively slow employment growth despite healthy GDP growth is that the costs of labor have remained high, prompting the adoption of capital-intensive methods of production. This argument is supported by evidence, often anecdotal, of the downward rigidity of real wages as well as low productivity growth that contributes to high unit costs of labor. More reliable evidence on the effects of the Convertibility Plan, the introduction of subsidies for domestic capital, and a fall in interest rates indicates that the price of capital relative to labor has fallen by between 26 to 40 percent between 1990 and 1994 (Bour, 1995).[1]

Government responses. Thus, countering the "output effect" on employment since the reforms was the "substitution effect" of increases in the price of labor relative to that of capital. A number of government-sponsored programs to encourage private employment growth have been introduced, but data from 1995 indicate that employment growth in Argentina remains sluggish and - with a steady increase in the labor force - unemployment has risen to alarming levels. The government has, appropriately, responded with measures to lower labor costs through reduction of payroll taxes and make adjustments smoother by reforming wage-setting and employment regulations. Public programs to help displaced workers and new entrants to a labor market in transition - from a system in which real wage changes, facilitated by high inflation, bore the brunt of adjustment to one in which both real wages and employment must adjust - have also been initiated.

Informing the policy debate. Based upon a well-developed literature that considers output, the price of labor relative to other factors such as capital, and technology as the main determinants of labor demand (see Hamermesh, 1993, for a survey), this paper provides quantitative estimates of the likely payoff (in terms of greater employment) to the government's initiatives to streamline labor market functioning and lower the burden of payroll taxes. This allows for comparisons between strategies that rely only on economic growth to reduce open unemployment, and those that combine these strategies with labor reforms. With more work, the costs and benefits of these strategies can be compared with those that rely solely upon assisting unemployed workers with labor market interventions such as unemployment insurance, retraining programs, employment subsidies, and public works.

B. The Basic Approach and its Usefulness

Labor market and the macroeconomy. Following Barro (1992), the Argentine economy can be characterized as consisting of four markets: the real goods market, the money market, the capital market,

[1] Kritz (1994) correctly points out that a better comparison would require the consideration of relative unit costs (nominal costs of each factor adjusted by productivity): all evidence points to the productivity of capital growing faster than that of labor, so this trend appears to be even stronger when unit costs are considered.

and the labor market. For the sake of simplicity, assume that real goods and capital market conditions influence but are not in turn influenced by the equilibrium in the labor market. Then - given long-run neutrality of money - the main determinants of labor demand can be identified as: *output* (GDP) since the demand for labor is derived from the demand for commodities and services; and the *relative price of labor* to the prices of capital and other factors, which determines the cost of using labor in production. The prices of these other factors, e.g., intermediate inputs such as energy and raw materials can in part be captured by changes in the real exchange rate which influences the cost of these inputs. In the case of Argentina, given the revolutionary change in the exchange rate regime due to the adoption of the Convertibility Plan in 1991, these changes may be quite important.

Labor demand and unemployment. As discussed above, GDP grew steadily between 1990 (the end of hyperinflation) and 1994, so that employment grew as well. With a steady increase in labor supply due to population growth and increased participation of women, the measured unemployment rate rose steadily over this period, from about 5 percent in October 1990 to about 10 percent in October 1993, and to 11 percent in May, 1994. With the fall-off in GDP growth in 1995, and a continued rise in the relative price of labor due to slow progress in the reform of labor markets, employment growth fell; by some estimates, total employment declined. The unemployment rate rose sharply to almost 20 percent in May 1995, triggering a heightened interest in labor market issues.

Quantifying responses to labor policy changes. Of course, changes in unemployment and wages - the two variables of current interest in Argentina - depend both on changes in labor demand and on changes in labor supply. We defer issues related to labor supply and unemployment in two companion papers. In this paper, using the approach described above, we examine the determinants of labor demand from a policy perspective. In particular, we compute the own-wage and output elasticities of labor demand. Simply put, estimates of the output elasticity of labor demand, holding wages and other labor costs constant, provide quantitative estimates of how much renewed output growth can reasonably be expected to result in increases in employment if labor market functioning is left unaltered. The own-wage elasticity of labor demand provides a numerical guide to the "payoff" to labor market reforms - which will lower the cost of labor - in terms of an increase in employment.[2] We believe that quantitative estimates of the responsiveness of employment to, alternatively, higher growth and to labor policy reform, will enrich the policy debate in Argentina.

C. Data sources

Employment data. In this paper, we use all available data for the period 1974-1995 from all sources to estimate labor demand elasticities. The main sources are the Ministerio de Economia, the INDEC-EPH household surveys, and national accounts published by the Secretaria de Programacion Economica (Ministerio de Economia). ***Employment*** data are from two main sources: INDEC household surveys, and the Ministerio de Economia's Informe Economico. Generally speaking, when coverage is taken into account, all the series show very similar patterns. The main difference between Ministerio de Economia and INDEC numbers is for 1994 and 1995: INDEC-EPH numbers show a larger decrease in employment than do Ministerio de Economia numbers. In our estimations, we use both series to ensure that results are not sensitive to the choice of series.

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[2]Cox Edwards (1995) and Grigoon (1995) provide estimates of the influence of different policy measures on labor costs. These estimates can be combined with our results to impute the employment effects of these policy reforms.

Output data. GDP and industrial production data used to proxy output are from the Ministerio de Economia, the Central Bank and the Fundacion de Investigaciones Economicas Latinoamericanas (FIEL). The three series - real per capita GDP, real GDP, and industrial production - show very similar patterns over the sample period.

Relative price of labor. To calculate the price of labor, we use nominal wage data and price indices from the Ministerio de Economia, FIEL and INDEC-EPH. The different categories used by the three sources make the nominal wage series less than satisfactory, which implies that the real wage series are rather unreliable. However, different series for real labor costs - wages adjusted for payroll taxes and deflated by the wholesale price index - exhibit a much closer relationship, and different series on labor costs in dollars -nominal wages divided by the nominal exchange rate - track one another closely. We also faced difficulties in constructing a reliable series for the price of capital. Reassuringly, however, there is considerable consensus among the different series for the price of labor relative to capital, which is most relevant for our estimation of labor demand.

D. Summary of Findings

Different estimation techniques. Labor demand functions were estimated using a range of assumptions regarding technology, from relatively restrictive forms such as a Cobb-Douglas specification to the "flexible" transcendental logarithmic (translog) characterization of technology. Given differences in the coverage of data (e.g., total employment versus wage employment only in manufacturing), incompleteness of the data (e.g., we did not have a reliable series for capital price, and lacked any data on other inputs such as raw materials), and the differing parametric restrictions (e.g., restricting the elasticity of substitution between labor and capital to one or a constant, versus allowing it to change every year), we get a range of estimates for own-wage and output elasticities of employment. Our approach yields estimates of constant-output demand elasticities, which is appropriate given that the theory is based on long-run equilibrium for the entire economy, which implies in turn that output is fixed.

Main results. The main findings are: First, own-wage elasticities range between -0.3 to -0.8 for the specifications that we prefer, though we do obtain an estimate which is as high (in absolute terms) as -1.5. Based on these results, the own-wage elasticity of employment - as a simple mean at the aggregate level - can reasonably be regarded as about -0.5, implying that a ten percent fall in labor costs will, *ceteris paribus*, raise employment by five percent. Second, output elasticities range from 0.1 to 0.4 for the specifications where the value is determined by the data. Based on these results and those from an enterprise survey by FIEL (see Box 1), the output elasticity of employment can reasonably be regarded as about 0.25, implying that a 10 percent growth rate of GDP will result in a 2.5 percent increase in employment. Third, considerably better data are required to narrow down these ranges, but these estimates are in the general neighborhood of elasticity estimates using US data.

Implications. Based on these results, the importance of labor reforms that lower labor costs - e.g., reduction of payroll taxes and changes in collective bargaining practices - as an employment-enhancing device can be contrasted with simply relying on higher output growth to generate additional employment. With forecasts of GDP growth for 1996 of about 1-2 percent, and the economy's medium-term prospects being only marginally better, Argentina has little choice other than continue along the path that it has chosen over the last two years, and perhaps even accelerate the process of labor market reform.

II. METHODOLOGY AND DATA

A. Methodology

The parameters of interest. The two parameters of interest for policy purposes in Argentina are the own-wage elasticity and the output elasticity of employment. At the risk of oversimplification, the output-elasticity -- holding the wage or unit labor costs constant, and with an initial condition of high unemployment -- helps in obtaining numerical estimates of employment growth that would occur solely due to GDP growth, i.e., without any labor policy reforms which raise or lower labor costs. The constant-output own-wage elasticity estimate can be used to quantify the effects of labor policy reforms on employment growth and hence on unemployment.

Assuming two factors of production labor (L) and capital (K), a constant returns to scale (CRS) production function and profit maximization, the own-wage elasticity of labor demand -- at a constant output and constant price of capital, r, (i.e., without considering scale effects) -- is:

$$\epsilon_{LL} = -[1-s]\sigma < 0 \qquad 1.1$$

$s = wL/pY$, the share of labor in total revenue of the firm, w is the price of labor, p is the price of output Y and σ is the elasticity of substitution between labor and capital..

"For an entire economy, in which output may be assumed constant at full employment, (these equations) are the correct measures of the long-run effect of changes in the wage rate on labor demand." Hamermesh (1986). In the case of Argentina, since output should not be assumed constant and the economy is not at full employment, the production function approach is not used. The alternative approach, which we use here, makes use of cost minimization subject to an output constraint. Total cost is:

$$C = C(w, r, Y); \quad C_i > 0, C_{ij} > 0, \quad i, j = w, r \qquad 1.3$$

since the profit maximizing input demands were themselves functions of input prices, the level of output, and technology.

By Shephard's lemma (See Varian, 199?), conditional labor demand can be written as a function of the prices of labor and capital, output, and technology:

$$dC/dw = L^d = L(w, r, Y) \qquad 1.4$$

where the form of 'L' embodies the technology. Capital demand is derived similarly. The elasticities are similar to equations 1.1 and 1.2 above, except that s represents the share of labor in total costs -- wL/C -- not revenues.

B. Labor demand under different technologies

Since the form of technology is not known, labor demand equations under specific technologies have to be derived. The equations estimated use, alternatively, the Cobb-Douglas, CES, generalized Leontief, and translog representations of technology. Note that all these representations of technology assume that the output (Y) is separable from factor prices.

(a) *Cobb-Douglas technology*

$$C = C(w, r, Y) = w^{\alpha}.r^{\beta}.Y^{\delta} \tag{1.5}$$

Using Shephard's lemma, the labor demand equation is:

$$L^d = \alpha.w^{\alpha-1}.r^{\beta}.Y^{\delta} \tag{1.6}$$

$$\ln L = \ln\alpha + (\alpha-1)\ln w + \beta\ln r + \delta\ln Y \tag{1.7}$$

$\delta=1$ implies constant returns to scale; σ, the elasticity of substitution between L and K is restricted to equal 1.

(b) *Constant Elasticity of Substitution (CES) technology*

$$C = Y[\alpha^{\sigma}.w^{1-\sigma} + (1-\alpha)^{\sigma}.r^{1-\sigma}]^{1/(1-\sigma)} \tag{1.8}$$

Using Shephard's lemma, the labor demand equation is:

$$L^d = \alpha^{\sigma}w^{-\sigma}Y \tag{1.9}$$

$$\ln L = \sigma\ln\alpha - \sigma\ln w + \ln Y \tag{1.10}$$

σ is the elasticity of substitution and is a constant, but not necessarily 1.

(c) *Generalized Leontief technology*

$$C = Y[a_{11}w + 2a_{12}w^{0.5}r^{0.5} + a_{22}r] \tag{1.11}$$

Using Shephard's lemma, the labor demand equation is:

$$L^d = a_{11}Y + a_{12}Y(w/r)^{-0.5} \tag{1.12}$$

(d) ***Transcendental logarithmic technology (Translog)***

$$\ln C = \ln a_0 + a_1 \ln w + 0.5a_2[\ln w]^2 + a_3 \ln w.\ln r + 0.5b_1.[\ln r]^2 + b_2 \ln r + b_3 \ln Y + b_4 \ln Y.\ln r + a_4 \ln Y.\ln w \qquad 1.14$$

Using Shephard's lemma, we arrive at the following "labor demand" function:

$$wL/C = a_1 + a_2 \ln w + a_3 \ln r + a_4 \ln Y \qquad 1.15$$

In our estimations, the dependent variable will be approximated by the ratio of salaries to GDP, both in real terms. The main advantage of the translog form is that the elasticity of substitution, σ, is not a constant but depends on all parameters and all factor prices.

C. Data and econometric problems

Main sources. The only available data to estimate labor demand elasticities in Argentina are aggregate time-series data from 1974 until 1995. The lack of reliable industry- and enterprise-level surveys is a serious shortcoming for purposes of quantification of the effects of policy initiatives. In Argentina, complete National Accounts have not been published since 1975 on the extent of quantity of factors and its remuneration, hence, homogeneous and consistent aggregate data is not available. At the same time, the Survey on Manufacturing elaborated by INDEC was interrupted in 1990. Hence, most of the data used in this study comes from different private and public sources and most of it had to be reconstructed using one or more sources to cover the whole period analyzed.

Data frequency. The frequency of the data is annual and covers the period 1974-1995. There is some biannual data available for the same period, but only for some variables. Since not all the variables could be included in estimations, and there were other measurement and time aggregation problems, estimators tended to be less efficient using the biannual data, even after correcting for AR1 and AR2 specifications, including seasonal dummies and/or deseasonalizing the time series. More work remains to be done; here we present results with annual data only.

In this paper, we use all available data for the period 1974 to 1995 from all sources to estimate labor demand elasticities. The main sources of information are the Ministerio de Economia, the INDEC-EPH household surveys, and national accounts published first by the Central Bank, and then by Ministerio de Economia. The details of the construction and sources of all the series used are in the Annex, which also plots all the series. This information is summarized here.

(a) ***Labor demand.*** Employment data (for the Greater Buenos Aires region, for manufacturing workers, and for wage workers or combinations thereof) are from two main sources: INDEC-EPH surveys, and the Ministerio de Economia's Informe Economico. Generally speaking, when coverage is taken into account, all the series show very similar patterns (See Figure A1). The main difference between Ministerio de Economia and INDEC numbers and is for 1994 and 1995: INDEC-EPH numbers show a larger decrease in employment than do Ministerio de Economia numbers. In our estimations, therefore, we use both series to make sure that our results are not sensitive to the choice of series.

(d) Transcendental logarithmic technology (Translog)

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(b) ***Output.*** GDP series are from the Ministerio de Economia. Indices of industrial production are from Central Bank (1974-1980) and FIEL (1980-1995). The three series - real per capita GDP, real GDP, and industrial production - show very similar patterns over the sample period. (See Figure A2).

(c) ***Price of labor.*** 1970-1979 nominal wage data are from FIEL (manufacturing sector only); 1980-1995 data are from the Ministerio de Economia, FIEL, or INDEC-EPH (all sectors). The different categories used by the three sources make the nominal wage series less than satisfactory, which implies that the real wage series (i.e., nominal wages deflated by the consumer price index) are rather unreliable. Upto the mid-1980s the two series are similar; in 1987 they begin to diverge in the magnitude of variation, and by 1990 in the direction of change (See Figure A3). However, different series for real labor costs - wages adjusted for payroll taxes and deflated by the wholesale price index - exhibit a much closer relationship (See Figure A4). And different series on labor costs in dollars - nominal wages divided by the nominal exchange rate - track one another closely (see Figure A5), the only exception being that when contributions to payroll taxes are adjusted for likely adherence to payroll tax laws, labor costs in dollars do not rise as rapidly after 1991 as they do in cases where this correction is not made.

(d) ***Price of capital.*** We had the most trouble constructing a reliable series on the price of capital. One solution was to simply use the implicit price of Gross Domestic Investment from the national accounts, and deflate it either by the wholesale price index (WPI) or implicit prices in GDP. Another was to use the price of domestic and imported machinery deflated by the WPI. Figure A6 plots three capital price series, and shows low correlation between them.

(e) ***Relative price of labor.*** More reassuringly, though, there is considerable consensus in the series for the price of labor relative to capital, which is most relevant for our estimation of labor demand. (See Figure A7). The exception is for 1995: three series show a decline, while two show a moderate increase. The divergence is again caused by the difference between labor costs that include an adjustment for compliance rate changes for payroll taxes, and those that don't, and because of different deflators in the wage and capital series.

In Argentina, as elsewhere, we have the problems of estimation - aggregation, measurement error autocorrelation and simultaneity bias - reported in the literature on estimation of labor demand. In addition, we have a problem of data scarcity. In an economy beset by high inflation and concerns of macroeconomic stability until the late 1980s, labor market issues were a secondary concern. But since the economic reforms, employment, unemployment and wage policies have assumed importance. The paucity of labor-related data will increasingly hamper informed decision-making on critical issues. But empirical labor economics has some unexpected help: variation in time-series data in Argentina is more pronounced than in most developed countries, so that identification issues are more secured. In principle, therefore, though the construction of appropriate labor series is difficult and application of econometric techniques to available labor-related data in Argentina is troublesome, there is no *a priori* reason to expect worse or better estimates than in other countries. We hope that this paper will illustrate the benefits of such exercises, and the value of reliable data that facilitate informed decision-making.

III. ECONOMETRIC SPECIFICATION AND RESULTS

The implications of aggregate data. As noted in the literature (e.g., Hamermesh (1993)), there are several methodological concerns in the use of aggregate data instead of cross-section data at the establishment level. In particular, microeconomic theory posits that the firm is the cost-minimizing and/or profit maximizing unit which responds to variation in product and input prices. At the aggregate level, parameters estimates do not usually correspond to elasticities at the firm level since it is the net effect of all the firms considered together. Hence, while some firms might respond positively and others negatively, say to the change in some parameter, we only capture the net effect at this level. Usually, therefore, aggregate elasticities tend to be lower than estimates found at the micro level. Hence, we should regard our estimates of labor demand elasticities as lower bounds.

The need for instrumental variables techniques. Another important concern is whether to take quantities or prices as exogenous for the econometric implementation. Ideally, in any set of data, both the price and quantity of labor may be treated as exogenous. This is not always done in studies on the demand for homogeneous labor because of the difficulty of specifying a labor-supply relation in the aggregate data on which most studies of labor demand are based; hence a good set of instrumental variables is hard to obtain. Therefore, one must be able to argue that supply of labor is either completely inelastic or completely elastic in response to exogenous changes in demand. So, as noted above, the choice usually boils down to whether price or quantity is viewed as exogenous. With aggregate data, if the supply of labor is relatively inelastic in the long run, demand parameters are best estimated using specifications that treat the quantity of labor as exogenous. Hence -- since labor supply has responded to price changes -- the need for instrumental variable techniques in Argentina.

Parameters of interest. The own-wage and output elasticity of employment can be estimated relying on the production function directly, or by using the cost function approach and estimating factor demand functions (using Shephard's Lemma). In the case of the Cobb-Douglas function this produces the shares of capital and labor directly. Estimating more complex forms (such as those assuming a constant elasticity of substitution between factors, or transcendental logarithmic technology) using this approach is not easy. For that, little work has relied on this approach.

A. Cobb-Douglas Technology

Deriving an estimable form. The Cobb-Douglas production function is:

$$Y = A.\ K^{\beta}.\ L^{\alpha} \qquad 1.16$$

from which one can derive, through cost-minimization, the cost function:

$$C = C(w, r, Y) = Z.\ w^{\alpha}.r^{\beta}.Y^{\delta} \qquad 1.17$$

where Z is a constant.

Using Shephard's lemma, the labor demand equation is:

$$L^{d} = \alpha^{1}.w^{\alpha-1}.r^{\beta}.Y^{\delta} \qquad 1.18$$

The own-wage elasticity of demand can be estimated in two ways:

(a) The coefficient for lnw in the following equation - the log-log version of the labor demand function - is the own-wage elasticity of labor demand.

$$\ln L^{d} = \ln\alpha^{1} + (\alpha-1)\ln w + \beta\ln r + \delta\ln Y \qquad 1.19$$

$\delta=1$ implies constant returns to scale; the elasticity of substitution between L and K, σ, is restricted to equal 1.

(b) Estimate the production function directly, using a log-log form of equation 1.16:

$$\ln Y = \ln A + \beta \ln K + \alpha \ln L. \qquad 1.20$$

and estimate the share of labor and/or capital. Assuming constant returns to scale, which implies the parameter restriction $\alpha + \beta = 1$, and rearranging yields an equation relating average labor productivity (Y/L) to the capital/labor ratio (K/L):

$$\ln (Y/L) = \ln A + \beta \ln (K/L) \qquad 1.21$$

Note that an important implication of this specification is that α and β must equal the value shares of inputs in the value of output[3]. With a CRS production function and profit maximization, the own-wage elasticity of labor demand -- at a constant output and constant price of capital, r, is:

$$\epsilon_{LL} = -[1-s_L]\sigma < 0 \qquad 1.22$$

$s_L = wL/pY$, the share of labor in total revenue of the firm[4].

The elasticities are similar to equations 1.22 and 1.23 above, except that s_L represents the share of labor in total costs - wL/C - not revenues.[5] With $\sigma = 1$, $\epsilon_{LL} = -[1-s_L]$, and $\epsilon_{LL}' = -1$.

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[3] In Argentina, there are no current estimates available on shares of labor and capital on value added.

[4] Similarly, the cross-price elasticity is:

$$\epsilon_{LK} = [1-s]\sigma > 0 \qquad 1.23$$

[5] However, to obtain the total demand elasticities for labor, scale effects must be added to equations 1.22 and 1.23:

Estimation results. Using alternative definitions of output (Y), and employment (L), we estimated equation 1.21 arriving at the results reported in Table 1. Diagnostic tests reveal the presence of autocorrelation. Taking into account that there is first order autocorrelation, these estimates imply that for the broader definition of labor (i.e., the whole economy), the share of capital is approximately 0.65. The share of capital in manufacturing is 0.74, and in the manufacturing wage sector it is 0.71. Thus the range of β is from 0.50 to 0.75, consistent with estimates of National Accounts in the 1970s (not updated since), as well as a simple estimate of average wages (900 pesos) multiplied by aggregate employment (12 million employees) divided by the GDP (3 billion pesos), which yields an estimate of 0.35, which is 1 minus the share of labor, i.e., the share of capital.

COBB-DOUGLAS TECHNOLOGY:
ALTERNATIVE ESTIMATES OF β (CAPITAL SHARE)

Number	**L used**	**Y used**	**Specification**	β	T-statistic
C-D.1	EM1	Y2	AR1	0.635	3.19
C-D.2	EM2	Y2	AR1	0.674	2.84
C-D.3	EM4	Y2	OLS	0.628	8.21
C-D.4	EM4	Y3	OLS	0.472	6.04
C-D.5	EM4	Y2	AR1	0.742	6.95
C-D.6	EM4	Y3	AR1	0.493	4.52
C-D.7	EM5	Y2	AR1	0.497	2.31
C-D.8	EM6	Y2	OLS	0.640	8.83
C-D.9	EM6	Y2	AR1	0.713	7.25

Notes: EM1 = Employment in GBA (15-64 years), from INDEC-EPH; EM2 = Employment in GBA (all ages), from Ministerio de Economia *Informe Economico*; EM4 = Manufacturing employment, from INDEC-EPH and Ministerio de Economia; EM5 = Total wage employment, from INDEC-EPH and Ministerio de Economia; EM6 = Wage employment in manufacturing, from INDEC-EPH and Ministerio de Economia. Y2 = Real GDP Index, from Ministerio de Economia (1980-95) and Central Bank (1974-80). Y3 = Industrial Production Index, from FIEL and Central Bank.

See Annex for details.

Table 1

$$\epsilon_{LL}' = -[1-s]\sigma - s\eta < 0 \tag{1.26}$$

and

$$\epsilon_{LK}' = [1-s][\sigma-\eta] > 0 \tag{1.27}$$

where η is the elasticity of product demand.

These numbers imply a share of labor, α, of approximately 0.35. This is consistent with earlier estimates. According to Delfino (1984), the share of labor in manufacturing was approximately 0.40 in 1973. Elías (1988) reports a series on the share of capital income in GDP, whose average in the period 1950-1980 is 59.8; the source of these data is the National Accounts from BCRA.

B. Constant Elasticity of Substitution (CES) technology

Deriving an estimable form. The CES production and cost function are, respectively:

$$Y = [\alpha L^{\rho} + (1-\alpha).K^{\rho}]^{1/\rho} \qquad 1.28$$

$$C = Y[\alpha^{\sigma}.w^{1-\sigma} + (1-\alpha)^{\sigma}.r^{1-\sigma}]^{1/(1-\sigma)} \qquad 1.29$$

where $\sigma = 1/[1-\rho]$; σ is the elasticity of substitution and is a constant, but not necessarily 1. . The CES is sufficiently general that σ is free to fluctuate between 0 and ∞, so one can infer its size and indirectly that of ϵ_{LL}.

Using Shephard's lemma, the labor demand equation is:

$$L^{d} = \alpha^{\sigma} w^{-\sigma} Y \qquad 1.30$$

so

$$\ln L = \alpha'' - \sigma \ln w + \ln Y \qquad 1.31$$

A form of equation 1.31 is very useful for estimation. This produces estimates of the degree of homogeneity of the production function along with the estimate of σ. Together with information on s_L, the estimate of σ generates ϵ_{LL}. This approach to estimating σ is what Hamermesh (1993) calls the estimate of the marginal productivity condition:

$$\ln L = \alpha'' - \sigma_1 \ln w + \beta \ln Y \qquad 1.32$$

Results. We use instrumental variables estimation, with the instruments being the logs of TRC2, log of Y2 or Y3, log of PBLURB2 and INFL1. These instruments account for the fact that input prices can be endogenous variables (and also measured with error). Hence we need to specify variables correlated with input prices, but not with labor demand. Specially, we seek variables affecting the supply of labor, but not its demand.

Specifications using the more aggregate categories of labor, such as EM1, EM2 and EM3, did not produce tight estimates of the parameters of interest. The reason may be that the trend captures most of the movements in these series, and the movements between formal and informal sectors, and the manufacturing and services sectors mask the true elasticities in each sector of the economy. To finesse this problem, most subsequent estimates rely on employment <u>in the manufacturing sector</u>.

Note that the wage elasticity of labor demand is higher the narrow the sector considered, such as -0.37 and for the whole manufacturing (formal and informal) sector is -0.31. And the more precise estimates of β, the elasticity with respect to industrial production, are between 0.4 and 0.5. The estimates are sensitive to the use of GDP or industrial production, and tend to be higher (but of lower statistical significance) with GDP measures. Note also that β is statistically different from 1, which the CES form restricts it to; at this level of aggregation there is no reason to expect $\beta = 1$.

CONSTANT ELASTICITY OF SUBSTITUTION TECHNOLOGY: ESTIMATION OF σ

Number	L used	Y used	Specification	σ	ϵ_{LL}	β
CES.1	LEM4	Y3	OLS W3	0.16 (2.19)	-0.10 (-2.20)	0.08 (0.36)
CES.2	LEM4	Y3	IV* AR1 W3	0.35 (3.28)	-0.21 (-3.24)	0.34 (1.49)
CES.3	LEM4	Y2	IV* AR1 W3	0.51 (1.77)	-0.31 (-1.76)	0.52 (0.86)
CES.4	LEM6	Y3	OLS W3	0.19 (2.38)	-0.11 (-2.32)	0.13 (0.52)
CES.5	LEM6	Y3	IV* AR1 W3	0.41 (3.70)	-0.25 (-3.65)	0.45 (1.91)
CES.6	LEM6	Y2	IV* AR1 W3	0.62 (2.03)	-0.37 (-2.00)	0.72 (1.11)

* Instruments used were LTRC2, LY2 or LY3, LPBLURB2 and INFL1.
To calculate ϵ_{LL} it was assumed that $s_L = 0.6$.

Table 2

To corroborate these findings, we used yet another way of generating estimates of σ, using the ratio of factor inputs. This requires a measure of the capital input and the price of its services which are usually measured with error, as it is surely the case for Argentina. However, for sensitivity analysis, we choose to do a complete analysis. These estimates are based again in the CES production function, on the marginal products relations, assuming that firms make zero profits and operate in competitive markets. Hence from, the production function, equation 1.28:

$$\partial Y/\partial L = \alpha\,(Y/L)^{1-\rho} \qquad 1.33$$

$$\partial Y/\partial K = [1-\alpha](Y/K)^{1-\rho} \qquad 1.34$$

When equating these to w/p and r/p and adding an error term, one obtains the estimable equations:

$$\ln(Y/L) = \alpha_1 + \sigma_1 \ln(w/p) + u_1 \qquad 1.35$$

and

$$\ln(Y/K) = \alpha_2 + \sigma_2 \ln(r/p) + u_2 \qquad 1.36$$

where σ_1 and σ_2 are alternative estimates of σ (see Berndt (1991) for a discussion on these alternative estimates of σ). Now letting the ratio of 1.35 and 1.36 equal to the factor price ratio (only need cost-minimization), taking logs and differentiating with respect to ln(w/r) yields:

$$-\partial \ln(K/L)/\partial \ln(w/r) = \sigma \qquad 1.37$$

Hence an estimable form of this equation is:

$$\ln(K/L) = \alpha_3 + \sigma_3 \ln(w/r) + u_3 \qquad 1.38$$

Table 3 presents various estimates of 1.35, 1.36 and 1.38.

CONSTANT ELASTICITY OF SUBSITUTION: CORRECTED ESTIMATES OF σ
(Instrumental variable* estimates, AR1 corrected)

Variables used for Output and Employment	Equation		
	ln(Y/L)	ln(Y/K)	ln(K/L)
Real GDP Index (Y2), Employment in Manufacturing (EM4)	0.67 (5.73)	0.32 (2.08)	1.15 (7.55)
Industrial production (Y3), Manuf. employment (EM4)	0.48 (3.90)	0.28 (0.93)	-
Real GDP Index (Y2), Manuf. wage employment (EM6)	0.70 (5.95)	-	1.21 (7.75)
Industrial Production (Y3), Manuf. wage employment (EM6)	0.51 (4.29)	-	-

Notes: t-statistics in parentheses.
* Instruments used were: log of the real exchange rate (LTRC2), log of real GDP or industrial production (LY2 or LY3), urban population in GBA (LPBLURB2), December-to-December % change in the CPI (INFL1). See annex for details of construction and sources.

Table 3

There is, as usual, a measurement error problem in r and hence the estimates using r should be more biased and inconsistent. Hence, in principle, best estimates should be those of column ln(Y/L) that narrow elasticities of substitution between 0.5 and 0.7, and hence -- using equation 1.?? -- <u>an own-wage labor demand elasticity of between -0.3 and -0.5</u>.

Hence, usual conclusion is that the difficulties for inferring ϵ_{LL} of including an imperfectly measured price of capital can be overcome in a labor-demand equation by specifying w and r separately. Therefore, we turn now to estimates based on factor-demand equations.

C. Estimation of single factor demand equations

Equation (1.10), the Shephard condition, can be written in logarithmic form for easy estimation as a log-linear equation. In such a form it yields the constant-output elasticity of demand for labor ϵ_{LL}, the cross-elasticity of demand for labor ϵ_{LK} and the employment-output elasticity. Hence, one obtains:

$$\ln L = \alpha' + \epsilon_{LL} \ln w + \epsilon_{LK} \ln r + \epsilon_{Ly} \ln y + u \qquad 1.39$$

The results of this estimation are presented in Table 4.

SINGLE FACTOR DEMAND EQUATIONS:
Instrumental variable estimates, AR1 correction

Variables used for Employment, Wages, and Output:	ϵ_{LL}	ϵ_{LK}	ϵ_{Ly}	F (LR)
Manuf. Employment (EM4), Nominal Wages (W3), Industrial prod. (Y3)	-0.396 (-4.03)	0.580 (2.42)	0.080 (0.35)	0.58
Manuf. wage emplt. (EM6), Nominal Wages (W3), Industrial prod. (Y3)	-0.472 (-4.88)	0.718 (3.05)	0.127 (0.57)	1.09
Manuf. Employment (EM4), Nominal Wages (W3), Industrial prod. (Y3) Restricted	-0.412 (-4.30)	0.412 (4.30)	0.189 (1.05)	
Manuf. wage emplt. (EM6), Nominal Wages (W3), Industrial prod. (Y3) Restricted	-0.493 (-5.19)	0.493 (5.19)	0.272 (1.57)	

Notes: The instruments used were: log of the real exchange rate (LTRC2), log of industrial production (LY3), urban population in GBA (LPBLURB2), December-to-December % change in the CPI (INFL1). See annex for details of construction and source of these series.

Table 4

Note that again we find ϵ_{LL} consistent with the estimates of σ and the labor share estimated above. However, the estimates of ϵ_{LK} and of ϵ_{Ly} appear to be inconsistent with the previous estimates. Note that the share of labor multiplied by σ should give us an estimate of ϵ_{LK}, and doing that the values of Table 4 are an overestimate of those elasticities. But the estimates of Table 4 do not place restrictions on the production function, such as constant returns to scale which give rise to the formulas 1.22 and 1.23. Rather, without imposing any particular production function form, economic restrictions should be placed on the parameters of the Shephard condition. In particular, the homogeneity restriction implies that $\epsilon_{LL} + \epsilon_{LK} = 0$. An F-test, shown in the fourth column of Table 4, cannot reject the null hypothesis. Hence estimations 3 and 4 are carried out with the restrictions imposed. As expected, the coefficient for lnr decreases, while that for lny increases in size and significance.

We now estimate input demand functions using well-established forms that are second-order approximations to arbitrary cost or production functions: such as the generalized Leontief and the translog form. Each has the advantage over the CES function in the two factor case that σ and the elasticities are not restricted to be constant, but instead depends on the values of the factor inputs or prices.

D. Generalized Leontief (GL) technology

Deriving an estimable form. With constant returns to scale imposed, the GL cost function is:

$$C = Y[a_{11}w + 2a_{12}w^{0.5}r^{0.5} + a_{22}r] \tag{1.40}$$

Using Shephard's lemma, the labor demand equation is:

$$L^d = a_{11}Y + a_{12}Y(w/r)^{-0.5} \tag{1.41}$$

With constant returns to scale, an exact relation should be:

$$L/Y = a_{11} + a_{12}(w/r)^{-0.5} \tag{1.42}$$

$$K/Y = a_{22} + a_{12}(w/r)^{0.5} \tag{1.43}$$

To estimate this model, we use Zellner's seemingly unrelated estimator (SURE) with the cross-equation restriction imposed. Also, as was demonstrated in previous estimates, simultaneous equation bias is present. We employed the three-stage least squares estimation procedure to correct for this bias.

The results of the estimate using EM4 and Y2 were the following:

$$\widehat{L/Y} = \underset{(-1.26)}{-0.0029} + \underset{(4.12)}{0.0098}\,(w/r)^{-0.5} \tag{1.44}$$

$$\widehat{K/Y} = \underset{(2.47)}{0.0063} + \underset{(4.12)}{0.0098}\,(w/r)^{0.5} \tag{1.45}$$

Through these estimates one can get estimated elasticities of substitution and price elasticities [see Berndt (1991)] that vary over the sample interval.

These estimates imply much higher substitution and price elasticities than reported with the other specifications; however still a price elasticity lower than one in absolute value. These estimates appear to be sensitive to the way total costs are computed, and need to be checked further because we do not believe our measures of the actual capital stock to be trustworthy. However, the implied labor share in these estimates is around 0.30, which is in accord with our previous results.

GENERALIZED LEONTIEF TECHNOLOGY: ESTIMATES OF ELASTICITIES

Year	σ_{lk}	ϵ_{LL}	ϵ_{KK}
1974	1.01	-0.71	-0.30
1975	0.99	-0.69	-0.29
1976	0.92	-0.65	-0.27
1977	0.93	-0.66	-0.28
1978	0.96	-0.67	-0.29
1979	0.99	-0.69	-0.30
1980	1.08	-0.76	-0.32
1981	1.08	-0.76	-0.32
1982	1.02	-0.72	-0.31
1983	1.07	-0.75	-0.32
1984	1.13	-0.80	-0.33
1985	1.04	-0.73	-0.31
1986	1.06	-0.74	-0.32
1987	1.04	-0.73	-0.31
1988	1.02	-0.72	-0.31
1989	1.04	-0.73	-0.31
1990	1.03	-0.72	-0.31
1991	1.05	-0.73	-0.31
1992	1.10	-0.77	-0.32
1993	1.11	-0.78	-0.33
1994	1.10	-0.78	-0.33
1995	1.08	-0.76	-0.32
Mean	***1.04***	***-0.73***	***-0.31***

Table 5

Transcendental Logarithmic (Translog) Technology

Cost and share equations. The translog cost function is written as:

$$\ln C = \ln a_0 + a_1 \ln w + 0.5a_2 [\ln w]^2 + a_3 \ln w.\ln r + 0.5b_1 [\ln r]^2 + b_2 \ln r + 0.5b_1 [\ln r]^2 + b_3.\ln Y + b_4 \ln r.\ln Y + a_4 \ln w.\ln Y + 0.5b_5 [\ln Y]^2 \qquad 1.46$$

The "labor demand" function - actually the share equation - derived from the above translog cost function, is:

$$wL/C = a_1 + a_2 \ln w + a_3 \ln r + a_4 \ln Y \qquad 1.47$$

When the full model and the cross-equation restrictions are specified, there is one redundant equation. In our case with only two inputs of data available, only one equation, the share of labor is specified. Moreover, when homogeneity of degree one in input prices is imposed, it amounts to restricting $a_1 + b_2$ to be equal to 1, $b_1 + a_3$ to be equal to 0, $a_2 + a_3$ to be equal to 0, and $b_4 + a_4$ to be equal to 0.

Restrictions and advantages. The main advantage of the translog form is that the elasticity of substitution, σ, is not a constant but depends on all parameters and all factor prices. Usually this form is estimated in a system of factor demands, which is known as KLEM (capital, labor, energy and materials) in the literature.

The translog cost function as specified above is a highly general, nonhomothetic form, which implies that returns to scale (and consequently the output elasticities of input demand) are not restricted a priori. In particular, we have not constrained the cost function to be either homothetic or linearly homogeneous: as is well-known, linear homogeneous functions are a subset of homothetic functions.[6] However, to estimate returns to scale, it is usually necessary to add the translog cost function to the share equation to be estimated, since b_3 and b_5 appear only in the cost function. Christensen and Greene (1976) note that the optimal procedure is to jointly estimate the cost function and the cost share equation as a multivariate regression system. This has the effect of adding additional degrees of freedom and only a few (b_3 and b_5) unrestricted regression coefficients. This will result in more efficient estimates than by estimating either the cost function or the share equation alone when the homotheticity restriction is violated.

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[6] In the general case, nonhomothecity means that the production function cannot be written as $Y = G[F(L, K)]$, where G is monotonic and F is linearly homogeneous. Hence, the cost function is cannot be written as $C (w, r, Y) = H(Y).c(w, r)$. That is, if production is nonhomothetic, output is not separable from factor prices. Instead, the effect of factor prices depends on the scale of output. So the term $b_4 \ln Y.\ln r$ and the term $a_4 \ln Y.\ln w$ in 1.46 allows for nonhomotheticity. In fact, a test for homotheticity is whether a_4 and b_4 are equal to 0. Since the cost function is homogeneous of degree one in prices, in our case this amounts to testing simply that $a_4 = 0$, since $a_4 + b_4 = 0$. Homogeneity of a constant degree in output occurs if, in addition to these homotheticity restrictions, $b_5 = 0$; in this case the degree of homogeneity equals $1/b_3$. Constant returns to scale of the dual production function occurs when, in addition to the above restrictions, $b_3 = 1$. Finally, the translog function reduces to the CRS Cobb-Douglas when, in addition to the above restrictions, $a_3 = 0$.

Following Hanoch (1975), returns to scale μ are computed as the inverse of the elasticity of cost with respect to output. That is

$$\mu = 1/\epsilon_{CY} = \text{Average Cost/Marginal Cost} \tag{1.48}$$

where for the translog cost function

$$\epsilon_{CY} = b_3 + b_4 \ln r + a_4 \ln w + b_5 \ln Y \tag{1.49}$$

Hence, with CRS, MC = AC and both ϵ_{CY} and μ are equal to one. If there are increasing returns (μ > 1), AC > MC and $\epsilon_{CY} < 1$. A more natural way to represent returns to scale is to define ee = $(1-\epsilon_{CY})$, which results in positive numbers for increasing returns to scale and negative numbers otherwise.

Note that unless ϵ_{CY} is constant for all values of Y and independent of factor prices (i.e., homothetic), it will not equal the elasticity of labor demand with respect to output. In the general nonhomothetic case with the cost function C = C(w, r, Y), there is no exact relationship between ϵ_{CY} and ϵ_{LY}. With homotheticity, the two are equal. Only as a local approximation can one use the value of ϵ_{CY} as that of ϵ_{LY} and vice versa..

Estimated equations. For all the above reasons, we estimated the joint system 1.46 and 1.47 using iterated three-stage least squares imposing both the homogeneity and cross-equation restrictions. This is identical to the SURE procedure, but with the fitted values of the endogenous variables regressed on all the instruments and exogenous variables; however, the disturbance covariance matrix is estimated using the original variables, not the fitted ones.

As we imposed the homogeneity restrictions through all the estimated models, 1.46 gets transformed to

$$\begin{aligned} \ln Cr = \ln C - \ln r &= \ln a_0 + a_1(\ln w - \ln r) + 0.5a_2(\ln w - \ln r)^2 + b_3 . \ln Y + a_4 \ln Y (\ln w - \ln r) \\ &+ 0.5b_5 (\ln Y)^2 \end{aligned} \tag{1.50}$$

and the share equation 1.47 to

$$wL/C = a_1 + a_2(\ln w - \ln r) + a_4 \ln Y \tag{1.51}$$

We also imposed the implicit cross-equation restrictions and estimated the model under various levels of generality.

Estimation results. Table 6 presents the estimates: the first colum for the nonhomothetic case, the second for the homothetic, the third for the homogeneous, the fourth for the linear homogeneous, and the fifth for the Cobb-Douglas restriction. The most general model, the nonhomothetic case, gives a good fit. However, the standard errors are somewhat high since we do not correct for autocorrelation (to be done as future work).

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$$\ln Cr = \ln C - \ln r = \ln a_0 + a_1(\ln w - \ln r) + 0.5a_2(\ln w - \ln r)^2 + b_3.\ln Y + a_4 \ln Y (\ln w - \ln r) + 0.5b_5 (\ln Y)^2 \qquad 1.50$$

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$$wL/C = a_1 + a_2(\ln w - \ln r) + a_4 \ln Y \qquad 1.51$$

We also imposed the implicit cross-equation restrictions and estimated the model under various levels of generality.

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Hence, with CRS, MC = AC and both ϵ_{CY} and μ are equal to one. If there are increasing returns (μ > 1), AC > MC and $\epsilon_{CY} < 1$. A more natural way to represent returns to scale is to define ee = ($1-\epsilon_{CY}$), which results in positive numbers for increasing returns to scale and negative numbers otherwise.

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We also imposed the implicit cross-equation restrictions and estimated the model under various levels of generality.

Estimation results. Table 6 presents the estimates: the first colum for the nonhomothetic case, the second for the homothetic, the third for the homogeneous, the fourth for the linear homogeneous, and the fifth for the Cobb-Douglas restriction. The most general model, the nonhomothetic case, gives a good fit. However, the standard errors are somewhat high since we do not correct for autocorrelation (to be done as future work).

Using the likelihood ratio test, the hypothesis of homotheticity cannot be rejected at the 5 percent level.[7] We reject the hypothesis of homogeneity, linear homogeneity, and Cobb-Douglas technology. Under the preferred - homothetic - specification, the estimated average elasticity of labor demand with respect to wages is -0.528, and the elasticity of substitution between L and K (σ_{LK}) is 0.760. The elasticity of total costs with respect to output is 0.828, which would imply that μ = 1.208. The implied output elasticity of labor demand is also 0.828, a considerably higher value than previous estimates. A summary of 42 estimates of this elasticity in the US yields an average of 0.828, exactly the same as our estimate (Hamermesh, 1993)! For other countries, Hamermesh reports a mean of 0.767.

Note that these estimates have high standard errors and hence estimates are less precise than in previous cases. These results for the translog estimation are very preliminary, since as mentioned before, data on actual costs is not available in Argentina. As in the case of the Generalized Leontief technology the resulting estimates are sensitive to the specific indexes of capital and labor used and total costs of production. Without national accounts on payments to factors, the best we could do was to use the "estimated" shares of labor and reindex the data on capital and labor to obtain those shares for 1974. We believe there is still more room for improvement with this data.

Another reason for exercising caution in interpreting these numbers is that there is substantial variation in these elasticities over time. ϵ_{CY} fluctuates between -0.626 and 1.408. During 1974-1990, it has an average value of 1.1 (close to CRS); between 1991-1995 it has an average value of -0.469. A negative value for this elasticity is worrisome, since it would imply that total costs fell with the level of output, and that returns to scale are low for low output levels, and very high for higher levels of output.

F. <u>Translog estimations incorporating nonneutral technical change.</u>

Technical change and ϵ_{CY}. This finding points to the possibility of technical change that was not incorporated in these estimations; that is, the cost function may have shifted down over time. Indeed, Hammermesh (1993) notes that the presence of increasing returns may be due to the fact that econometricians cannot distinguish between the effects of labor-saving technical change and increasing returns. Several studies in the US did model nonneutral technical change - Berndt and Khaled (1979) aggregate data as we do - but they find increasing returns with values of ϵ_{CY} around 0.8 and little technical progress.

Hence, we estimated a translog system adjusting for the effects of biased technological change and total factor productivity growth (TFP). Since we have already rejected the non-homotheticity restriction and do not have enough degrees of freedom to estimate the full model with technical progress, we estimate only two models: the first with homotheticity imposed, and the second which is further restricted to be linearly homogeneous.

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[7]Notice, however, that the parameter a_4 is marginally significant; this is the parameter restricted to be equal to 0 in the homothetic specification. As its asymptotic standard error is equal to the square root of the Wald test statistic corresponding to the null hypothesis that $a_4 = 0$, we contrasted the critical value of χ^2 with 1 degree of freedom (6.63 at the one percent level): the hypothesis cannot be rejected.

Estimated equations. The estimated cost function is

$$\ln Cr = \ln C - \ln r = \ln a_0 + a_1(\ln w - \ln r) + 0.5a_2(\ln w - \ln r)^2 + b_3.\ln Y + 0.5b_5(\ln Y)^2 + b_6 t + b_7.t.(\ln w - \ln r) + b_8 t^2 \qquad 1.52$$

where t is the time trend, and the share equation is

$$wL/C = a_1 + a_2(\ln w - \ln r) + b_7 t \qquad 1.53$$

Estimation results. The results are presented in Table 7. First, the new coefficients are significant in the homothetic specification but the output coefficients lose significance. Second, we cannot reject the hypothesis that technical change is relatively labor saving (and by homogeneity, capital using). Berndt and Khaled (1979) obtain the same result for the US, but of a smaller magnitude. This points to the fact that labor-saving technological change is strong in Argentina, which in turn is likely the result of an increasing price of labor relative to capital. Third, turning to the elasticities, we find that ϵ_{LL}, ϵ_{KK}, and σ_{LK} decrease in value when technical change is allowed for, but they remain greater than zero in absolute value. Finally, we recompute the returns to scale ee. As expected, we obtain smaller changes in returns to scale over time. But the degree of increasing returns to scale is great: we obtain an ϵ_{CY} of 0.161, or an ee of 0.84. Notice that if we use this as a measure of the output elasticity of demand, it is not far from previous estimates with less structured models. For the final part of the sample period (1990-1995), however, the estimated ϵ_{CY} is 0.29.[8]

Previous results. Delfino (1984) estimated a translog KLEM model for the manufacturing sector in Argentina for the period 1950-1973 for which National Accounts data were available, estimating the shares of labor, capital and materials. A lower labor demand elasticity of -0.40 and a capital elasticity of -0.45 resulted. These elasticities are basically in accord with our previous results. However, Delfino (1984) obtains a relatively low estimate of σ_{KL} of about 0.24.

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[8]Total factor productivity results are interpreted as follows. In the context of a production function, it has been traditional to measure TFP by the residual method, viz., the growth of output minus the growth in inputs. Berndt and Jorgenson (1975) related such a measure to biased technical change and to total factor cost diminution, the dual of TFP. They showed that under CRS, $-(\partial \ln C)/\partial t$ is the rate of TFP growth, representing the one-period reduction in costs - with prices and output fixed - due to disembodied technical progress. In the more general case, of nonconstant returns to scale and nonhomotheticity, Berndt and Khaled (1979) showed that $\epsilon_{Yt} = -\epsilon_{Ct}/\epsilon_{CY}$. The value of ϵ_{Ct} turns out to be positive, meaning that on average the period was one of TFP decrease. This is not surprising if the decrease is concentrated in the 1970s and 1980s when Argentina underwent a decrease in GDP and investment and collapsed into hyperinflation. Indeed, the data show that the negative values for TFP are concentrated in the first 10 years until 1984, then is less than 4 percent until the late 1980s, increasing monotonically until reaching almost 9 percent in 1995, which is surprisingly high. With the homothetic model, the behavior of TFP is more in accord with our priors: it has negative values until 1988, is basically zero in 1989, and monotonically increases after that, reaching about 3 percent in 1995.

TRANSCENDENTAL LOGARITHMIC TECHNOLOGY:
THREE-STAGE LEAST SQUARES ESTIMATES, ARGENTINA 1974-1995
(Absolute Value of Ratio of Estimated Parameter to Standard Error in Parentheses)

Parameter & Model	**Nonhomothet.**	**Homothetic** $(a_4 = 0)$	**Homogeneous** $(b_5 = 0)$	**Linear Homog** $(b_3 = 0)$	**Cobb-Douglas** $(a_2 = 0)$
$\ln a_0$	-55.824 (2.01)	-72.021 (2.49)	-1.376 (2.30)	-4.462 (164.77)	-4.462 (271.54)
a_1	1.324 (2.05)	0.300 (27.53)	0.297 (27.40)	0.304 (27.77)	0.302 (33.54)
a_2	0.133 (2.27)	0.051 (1.02)	0.099 (2.34)	-0.029 (0.56)	
b_3	23.346 (1.96)	30.421 (2.46)	0.330 (2.55)		
a_4	-0.223 (1.59)				
b_5	-4.855 (1.91)	-6.404 (2.43)			
Restrictions	0	1	2	3	4
Mean of ϵ_{LL}	-0.256	-0.528	-0.368	-0.793	-0.698
Mean of ϵ_{KK}	-0.114	-0.232	-0.163	-0.343	-0.302
Mean of σ_{LK}	0.369	0.760	0.531	1.136	1
Mean of ee	0.131	0.172	0.670	0	0

Table 6

TRANSLOG: NONNEUTRAL TECHNICAL CHANGE: 3-STAGE LEAST SQUARES ESTIMATES, 1974-1995
(Absolute Value of t-ratios in Parentheses)

Parameter & Model	**Homothetic** ($a_4 = 0$)	**Linear Homogeous** ($b_5 = 0$, $b_3 = 1$)
ln a_0	11.548 (1.66)	-5.3204 (10.46)
a_1	0.374 (13.76)	0.351 (13.57)
a_2	0.153 (2.41)	0.099 (1.70)
b_3	-5.25 (1.75)	
b_5	1.170 (1.82)	
b_6	0.042 (10.38)	0.131 (1.93)
b_5	-0.006 (2.86)	-0.004 (1.99)
b_6	-0.001 (7.76)	-0.004 (1.98)
Restrictions	1	3
Mean of ϵ_{LL}	-0.183	-0.368
Mean of ϵ_{KK}	-0.008	-0.159
Mean of σ_{LK}	0.264	
Mean of ee	0.839	0
Mean of ϵ_{CY}	0.009	0.001

Table 7

THE OUTPUT ELASTICITY OF THE DEMAND FOR LABOR: EVIDENCE FROM A 1995 ENTERPRISE SURVEY

In May 1995, the *Fundacion de Investigaciones Economicas Latinoamericanas* (FIEL) collected information on output, employment, capital and wages in about 400 manufacturing firms in Argentina (Greater Buenos Aires, Rosario, Cordoba, Mendoza, Bahia Blanca and Mar del Plata). While most of the questions in FIEL's Industrial Survey pertained to 1994 levels of these variables, retrospective information was collected for output and employment. Specifically, firms were asked how much output and employment had grown between 1992 and 1994. The following are the relevant findings based on analysis of these data; detailed results can be obtained upon request from the authors:

(a) ***The output elasticity of employment is about 0.5.*** This was measured using regressions that include sector dummies, initial employment size, region dummies, age of the firm, age of capital used, share of working capital in total capital, average hours worked, export orientation, and other variables; estimates varied in a narrow band between 0.49 and 0.52. T-statistics were about 8.00.

(b) ***Firms that had relatively high output growth also had higher average hours worked.*** This indicates that output-elasticity of labor demand measured by examining the increase in the number of employees is likely to be an underestimate of the true elasticity of labor demand.

(c) ***The output-elasticity of employment is somewhat higher outside the Greater Buenos Aires area.*** If this is a robust finding (small sample sizes precluded a definitive investigation), it implies that estimates using information from only the GBA region could under-estimate the output-elasticity of employment.

(d) ***The output elasticity of employment is higher for smaller firms.*** Predictably, the correlation between initial (1992) firm size and output elasticities of employment is negative: firms with 0 to 5 employees had an elasticity of about 4.8, those with 6 to 50 employees had an elasticity of between 0.5 and 0.6, and this fell to between 0 and 0.2 for larger firms.

(e) ***But smaller firms also had higher birth and death rates.*** As in other countries, smaller firms are "younger": in 1994, the average age of firms with 0-5 employees was 23 years, firms with 6-50 employees were about 28 years old, with 51-500 employees were about 39 years, and those with 500+ employees were about 57 years. This implies that a sample of <u>existing</u> firms will overestimate the growth of employment in the small-scale manufacturing sector, since small firms experiencing decreases in employment are more likely to have gone out of business altogether.

Even with enterprise-level data, therefore, output-employment elasticities will be at best measured with some error. Estimates of aggregate output elasticities reported in the text -- between 0 and 0.5 -- are broadly consistent with these estimates from enterprise-level data.

IV. SUMMARY AND POLICY IMPLICATIONS

The main findings using the different series, technological specifications, and econometric techniques:

A. Estimates of Wage Elasticity of Labor Demand

The results show that the constant-output wage elasticity of labor demand is significantly different from zero. In the preferred models estimated it ranges from -0.3 to -0.8, giving a "best-guess" estimate of about -0.5. If we had assumed, at the outset, a Cobb-Douglas specification (i.e., CRS and $\sigma=1$), with the share of labor of approximately 0.4 as indicated by available national accounts (for the 1970s), we would have obtained an elasticity of -0.6, not far from the results of our estimations.

Although low, this estimate of the own-price elasticity is somewhat higher than those reported on average for the US, where Hamermesh (1993) places his "best guess" at -0.3 for the constant-output demand elasticity of labor computed using aggregate data. This would mean that if labor costs are

ESTIMATED ELASTICITIES: OWN-PRICE, OUTPUT AND SUBSTITUTION

Technology Assumption	Wage Elasticity	Output Elasticity	Elasticity of Substitution
Cobb-Douglas	-0.60	1.00 (Restricted)	1.00 (Restricted)
Single Factor Demand	-0.45	0 to 0.10	-
CES	-0.35	0.40	0.50
Generalized Leontief	-0.75	1.00 (Restricted)	1.05
Translog	-0.30	0.30	0.50

Table 8

reduced by 10 percent, *ceteris paribus*, employment would increase by 5 percent. With an employment of about 4 million in Greater Buenos Aires, this will amount to an increase in employment in 200,000. This is greater than the "normal" or trend increase in labor supply (discussed in Pessino and Gill, 1996b), making possible a significant and sustainable decrease in the unemployment rate in a relatively short period.

B. Output Elasticity Estimates

The output elasticity is restricted to equal one under the Cobb-Douglas, CES and generalized Leontief functions. Using the CES formulation - and relaxing the restriction that the elasticity is one - the elasticity of output is estimated to be between 0 and 0.5, depending somewhat upon the series used for employment and output, but more critically upon whether autocorrelation is corrected for, and instrumental variables corrections are applied to correct for the simultaneity bias problem in using wages. Using the single factor demand formulation, the output elasticity is estimated to be 0.2, although not very significant. Enterprise-level data for the manufacturing sector yield an elasticity of 0.5, which is measured with high statistical precision but is likely to be an overestimate of the "true" elasticity due to sample selection bias. The best guess, based on these results, would be an output elasticity of about 0.25.

This estimate of the output elasticity is somewhat lower than estimates in other countries. In the US, Hamermesh (1993) finds an average elasticity (for several studies) of 0.83 while for other countries it is about 0.75. Revenga and Bentolila (1994) obtain lower long-run output elasticities of the employment rate for 11 OECD countries, ranging from 0.21 in Japan to 0.49 for Germany. The estimate for Argentina implies that a 10 percent growth rate of GDP will result in a 2.5 percent increase in employment. With an unemployment rate of about 18 percent of a total labor force of about 500,000 in Greater Buenos Aires, relying solely on output growth to create employment implies - assuming no net growth in the labor supply - that at an unrealistically high GDP growth rate of 10 percent, it would take about 6 years to bring the unemployment rate to 8 percent. Extrapolation for the rest of the country yield similar results. Of course, with a trend rate of labor force growth of 1.5 percent annually (see Pessino and Gill, 1996), the number of years required to reduce unemployment to 8 percent would be more than 14 years (see Table 9).

YEARS NEEDED TO REDUCE THE UNEMPLOYMENT RATE TO 8 PERCENT:
SIMULATIONS USING ALTERNATIVE RATES OF
LABOR FORCE AND EMPLOYMENT GROWTH

Labor Force Growth (percent):		**0.0**	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**
	0.5	28.0					
Employment	**1.0**	14.0	28.2				
Growth	**1.5**	9.4	14.1	28.3			
(percent):	**2.0**	7.1	9.4	14.2	28.4		
	2.5	5.7	7.1	9.5	14.3	28.6	
	3.0	4.7	5.7	7.1	9.5	14.3	28.7

Table 9

C. Elasticity of Substitution Estimates

In the case of Cobb-Douglas technology, the elasticity of substitution between capital and labor is restricted to equal one. In the CES case, it is restricted to a constant, which is estimated at about 0.5. In the generalized Leontief case, where it is allowed to vary over time, the average elasticity is calculated to be more than 1. In the translog case, the estimated elasticity of substitution is about 0.5. In any case, it is clear that the elasticity of substitution between labor and capital in Argentina is significantly greater than zero but less than 1. At the margin, changes in the price of labor relative to capital will be met by proportional changes in the employment of these two factors.

D. Limitations and Noteworthy Econometric Corrections

For other researchers investigating labor demand issues in Argentina, the factors worthy of consideration are:

(a) ***Autocorrelation.*** Aggregate employment and output series display strong serial correlation. The solutions adopted in this paper are to choose output and employment series that are less aggregative, e.g., industrial output, manufacturing sector employment, wage employment, and the other is to apply econometric procedures that adjust for autocorrelation in the data.

(b) ***Simultaneity bias.*** Since wages and employment are determined simultaneously, and employment is used to represent labor demand, using wages as a determinant of labor demand creates problems in estimation, also known as simultaneity bias. The solution adopted in this paper is to use instrumental variable techniques.

(c) ***Omitted or mismeasured variables.*** In estimating the wage and output elasticity of labor demand, and the elasticity of substitution between labor and capital, the unavailability of information on other factors (e.g., inputs such as energy) is a serious handicap. This is especially a problem in estimating labor demand using relatively flexible depictions of technology, such as the translog form. But our estimates of wage elasticity obtained using different specifications appear to provide strong evidence for our main argument, viz., that policy reform which lowers the cost of labor relative to capital is urgently required, and Argentina cannot rely solely on faster output growth to noticeably increase labor demand and employment.

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ANNEX 1: DESCRIPTION OF THE SERIES USED

1. EMPLOYMENT

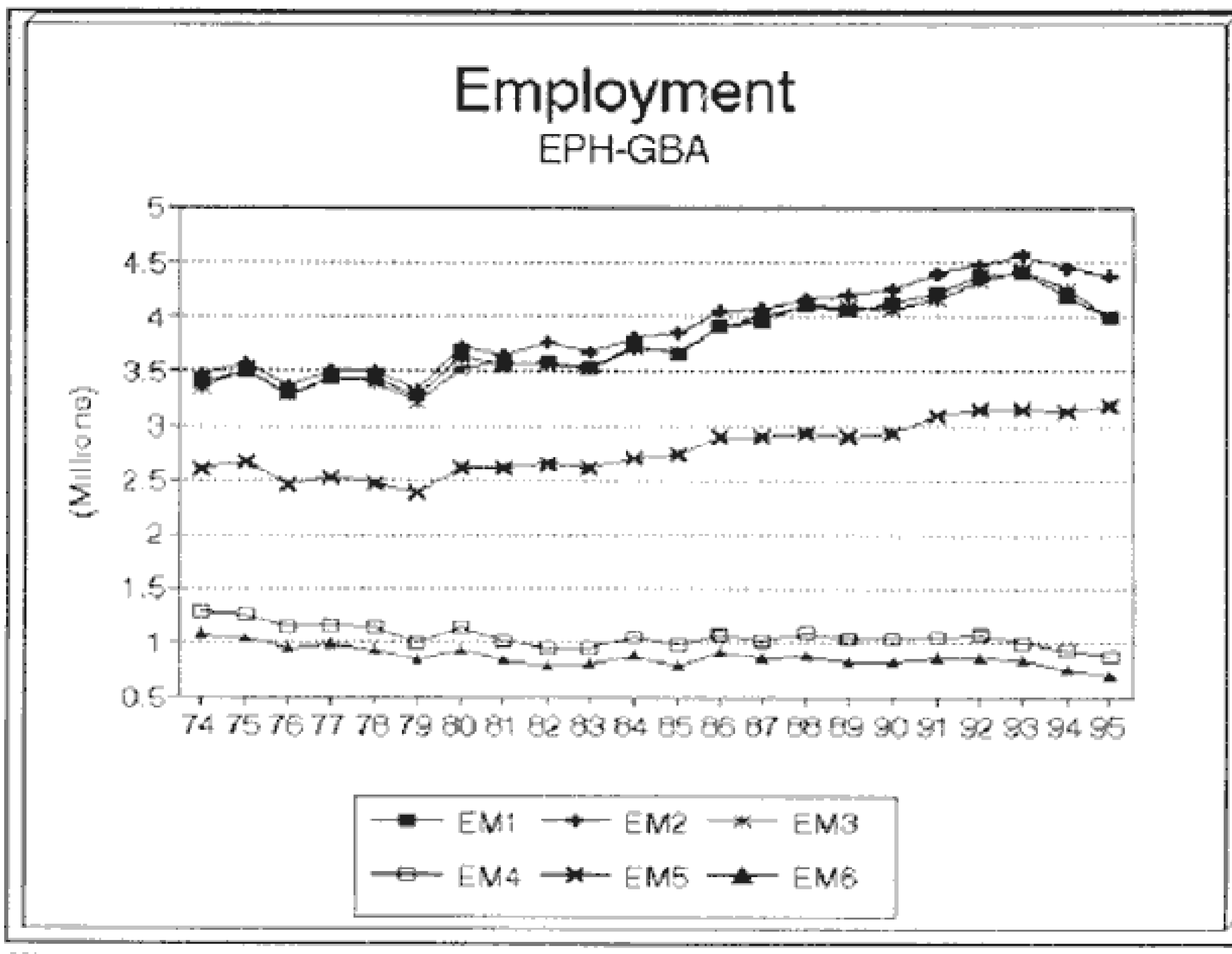

Figure 1

EM1: Employed, 15-64 years, all sectors, Greater Buenos Aires (GBA), October of each year.
Source: Own elaboration, based on direct computation from INDEC-EPH data and recommended expansion factors.

EM2: Employed, all ages, all sectors, GBA, October of each year.
Source: Ministerio de Economia: *Informe Económico*, October 1995. Rates of employment and labor force participation are used and applied to population estimated between censuses.

EM3: Employed, 15-64 years, all sectors, GBA, October and April average.
Source : Own elaboration from direct computation from EPH data and expansion factors.

EM4: Employed in Manufacturing.
Source: Own elaboration on the basis of INDEC-EPH "Informes de Prensa" applied to EM2 (Ministerio de Economia).

EM5: Wage Employed: excludes the self-employed and owners.
Source: Own elaboration on the basis of INDEC-EPH "Informes de Prensa" applied to EM2 (Ministerio de Economia).

EM6: Wage Employed in Manufacturing.
Source: Own elaboration on the basis of INDEC-EPH "Informes de Prensa" applied to EM2 (Ministerio de Economia).

2. OUTPUT

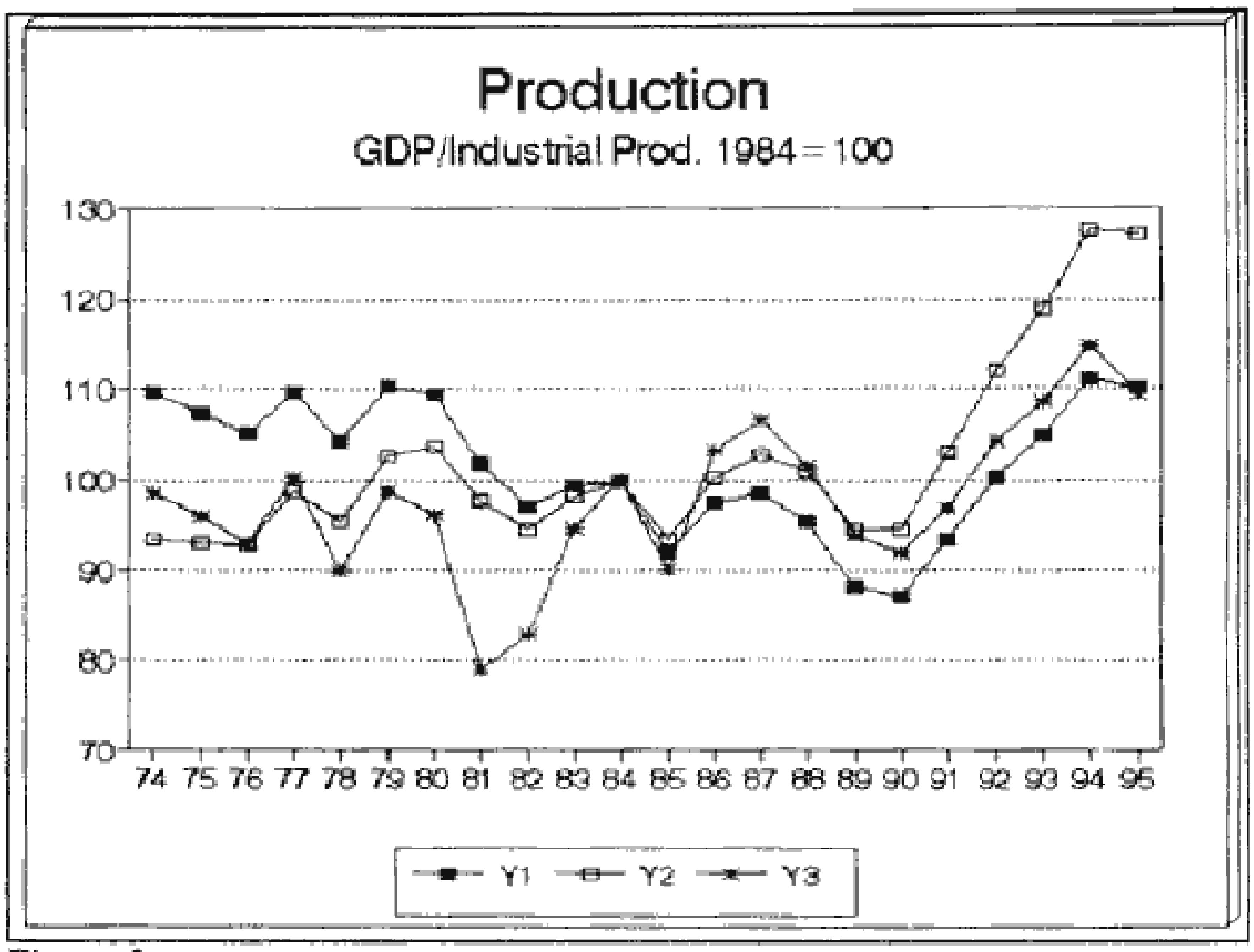

Figure 2

Y1: Real GDP per capita index; 1984=100
Own elaboration on the basis of Ministry of Economy 1980-1995, and chained through variation rates with Central Bank 1974-1980.

Y11: Real GDP per capita; Australes of 1970.
Source: same as Y1

Y2: Real GDP index; 1984=100
Source: Own elaboration on the basis of Ministry of Economy 1980-1995 and chained through variation rates with Central Bank, 1974-1980.

Y21: Real GDP, Prices 1986.
Source: same as Y2

Y3: Industrial production INDEC, 1984=100
Source: 1980-1995, FIEL and 1974-1980 GDP Manufacturing from Central Bank.

3. WAGES AND LABOR COSTS

(a) Nominal Wages

W1: Price of labor elaborated by Economic Ministry 80-95 and before chained with data from FIEL. 1980=100

W2: Nominal wages
1970-79 Data from FIEL, Manufacturing.
1980-95 EPH, October of each year, all Sectors. 1980=100 (not very good, different definition of categories of workers)

W3: Nominal Wages
1970-79 Data from FIEL. 1980-95 EPH-All. Chained through real variation

W4: 1970-95, Nominal Wages FIEL 1980=100.
Annual Average. Includes employee contributions to payroll taxes

W3$: W3 in pesos.

W4$: W4 in pesos.

(b) Nominal wages with payroll taxes included

W2A: W2 including employer contributions during 70-79 (used the formula W2+(0.60*(W2*(1+t)) where 0.60 is the proportion that made contributions to social security according to Censo Económico 1985, in All Sectors. From 1980 onwards, adds both employee and employer contributions. Using data from the Censo Económico we sum during the period 74-86= 60% and from 87-95= 50% of the total contribution (The remaining do not pay payroll taxes) 1980=100.

W3A: W3 including employer and employee contributions 1970-86= 60% and 1987-1995= 50% of total contributions. (Here the data basis W3 is the salaries reported by EPH. net of all kind of taxes) 1980=100

W3$A W3 in actual pesos.

W4A: W4 including in 1970-86 employer contributions using the formulaW4+(0.85*(W4*(1+t))) (85% is approximately the proportion of workers in Manufacturing that contributed to payroll taxes) and since 1987, W4+(0.75*(W4*(1+t))). According to the latest Census the proportion paying payroll taxes decreased). 1980=100

W4$A W4A in actual pesos.

(c) <u>**Real wages deflated by CPI (without payroll taxes, for labor supply)**</u>

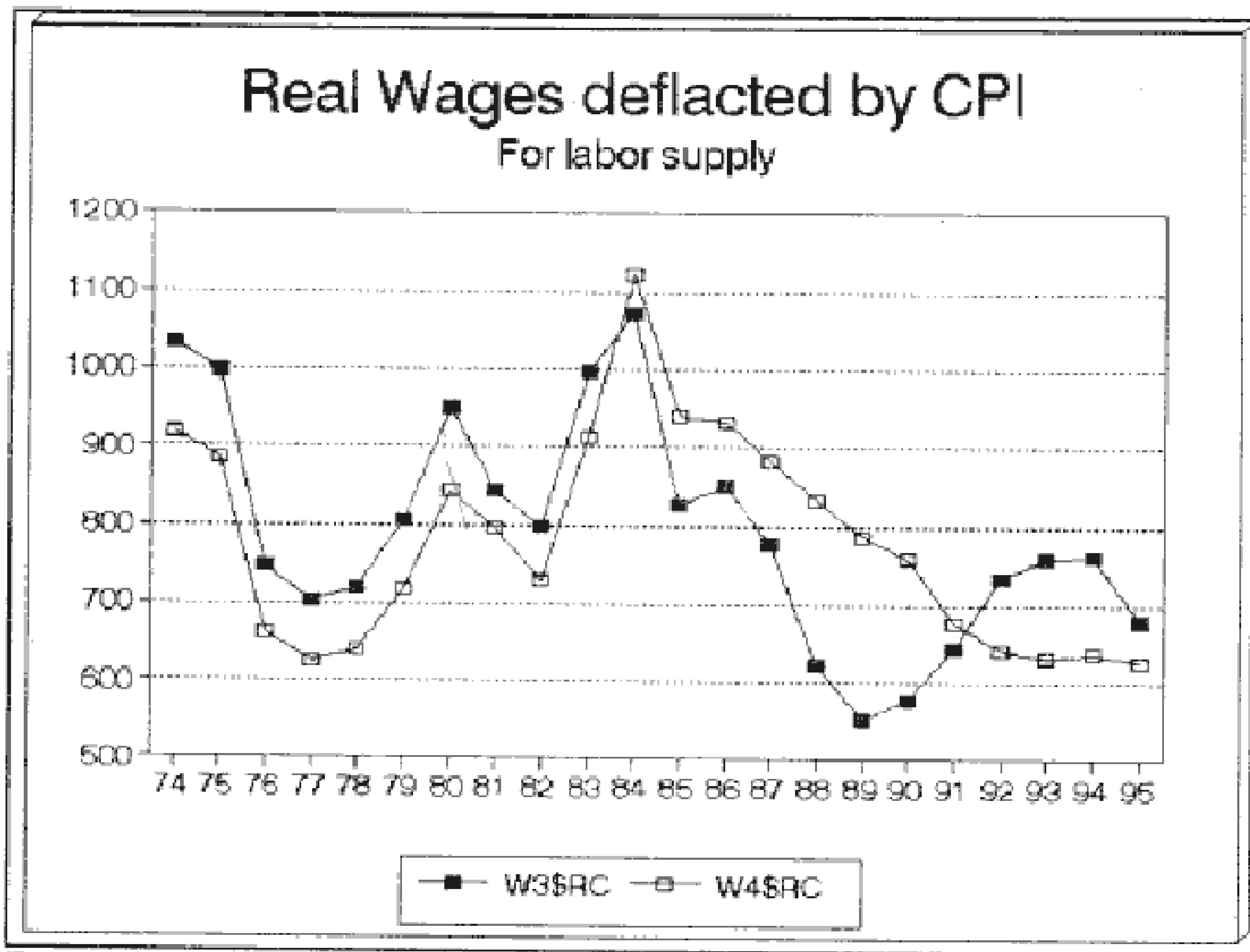

Figure 3

W1RC: W1 deflated by CPI(sept each year). 1980=100

W2RC: W2 deflated by CPI(sept each year). 1980=100

W3$RC: W3$ deflated by CPI. Pesos of 1994.

W4$RC: W4$ deflated by IPC. Pesos of 1994.

(d) Real labor costs deflated by WPI (with payroll taxes, for labor demand)

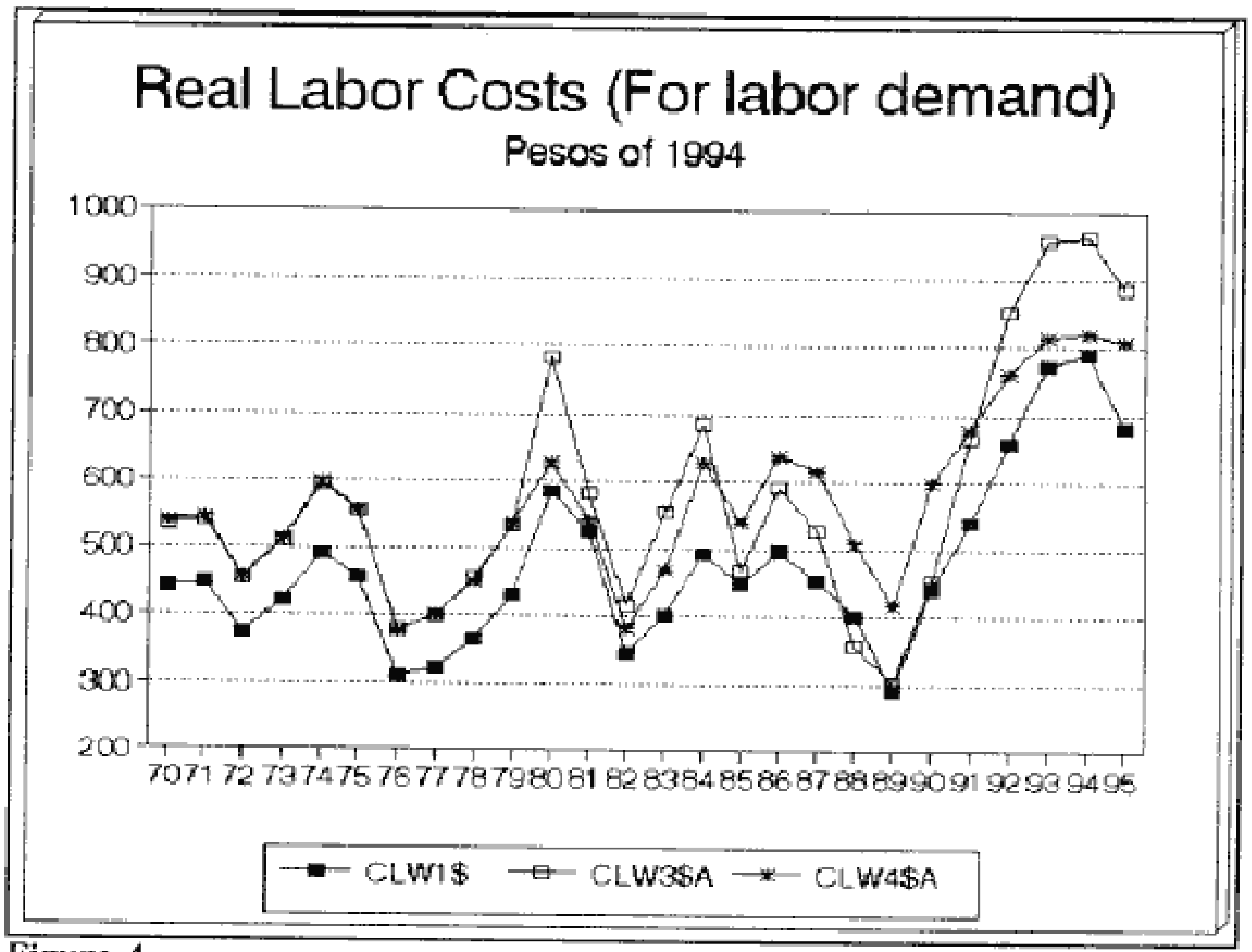

Figure 4

CLW1: W1 deflated by WPI, 1980=100.

CLW3A: W3A deflated by WPI, 1980=100.

CLW4A: W4A deflated by WPI, 1980=100.

CLW1$: W1 deflated by WPI, Pesos of 1994.

CLW3$A: W3A deflated by WPI, Pesos of 1994.

CLW4$A: W4A deflated by WPI, Pesos of 1994.

(e) **Labor costs in dollars**

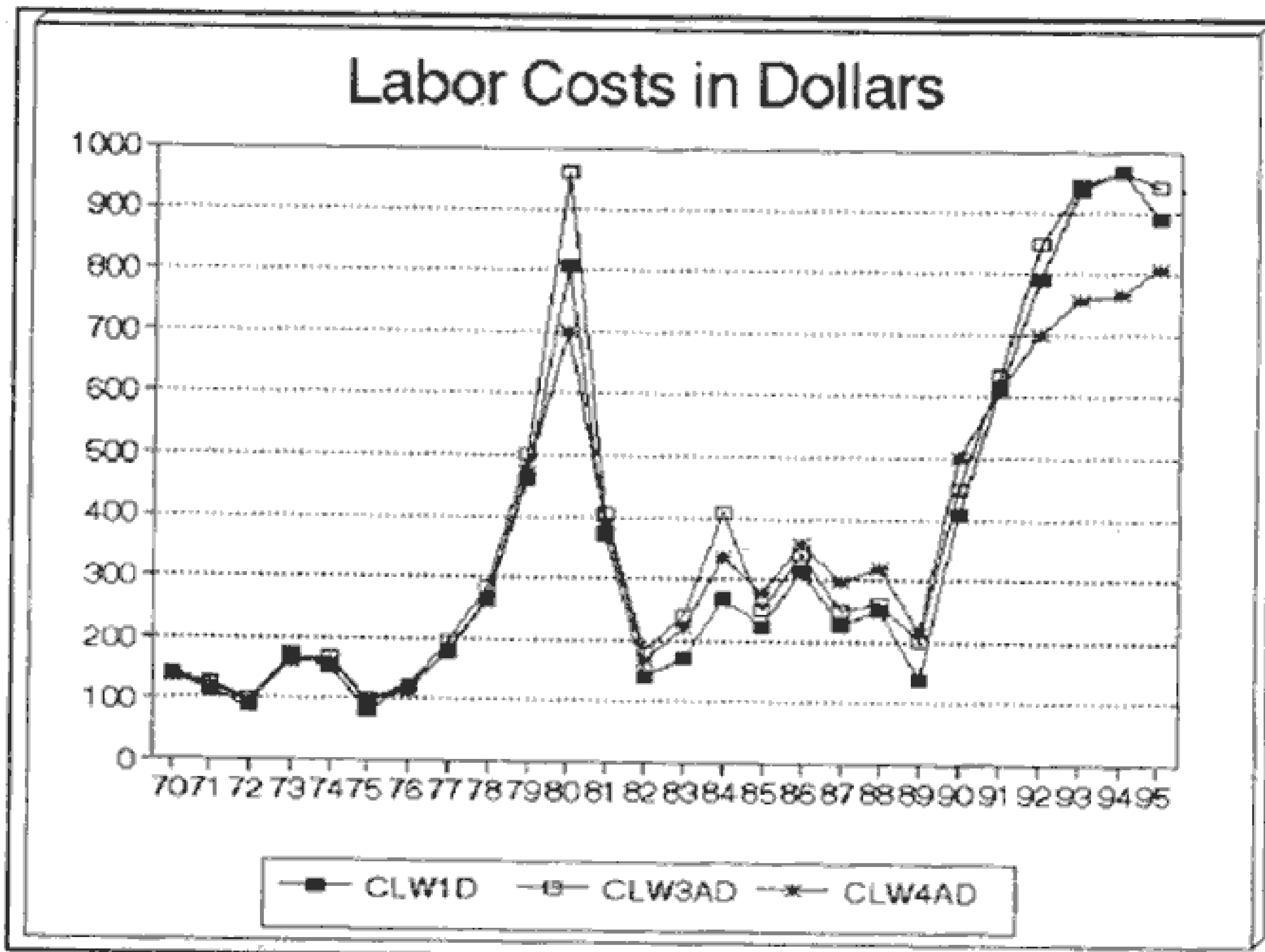

Figure 5

CLW1D: W1$ divided TNC2.

CLW3AD: W3$A divided TNC1 (Prom/sept).

CLW4AD: W4$A divided TNC2.

4. PRICE OF CAPITAL

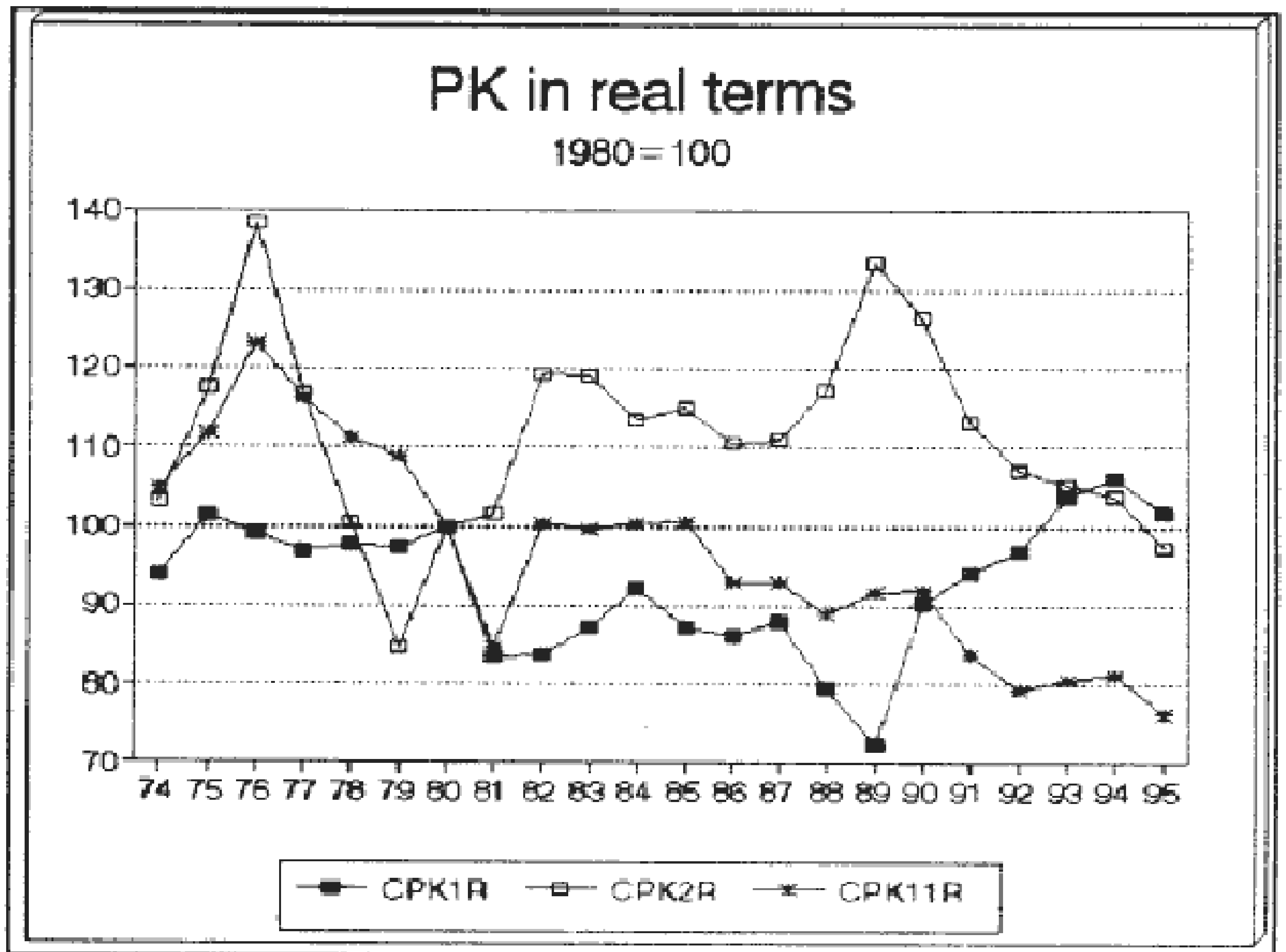

Figure 6

PK1:	Implicit Price of Gross Domestic Investment 1980=100 Source: National Accounts.
PK2:	Weighted average of WPI Machinery National and Importado. 1980=100
CPK1R:	PK1 deflated by WPI, 1980=100.
CPK2R:	PK2 deflated by WPI, 1980=100.
CPK11R:	PK1 deflated by Implicit Prices in GDP, 1980=100.

5. PRICE OF LABOR RELATIVE TO CAPITAL

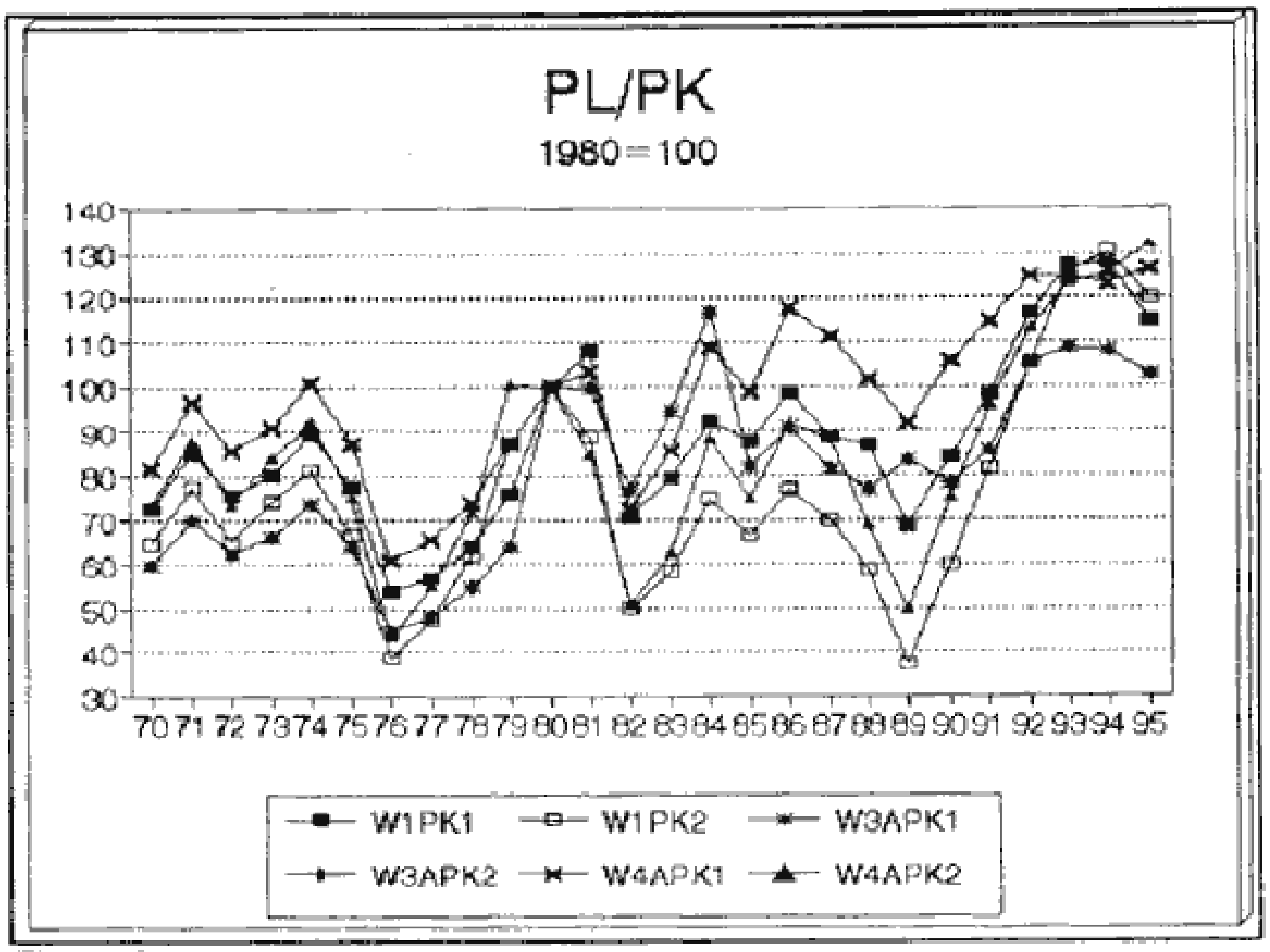

Figure 7

W1PK1: W1 divided PK1. 1980=100.

W1PK2: W1 divided PK2. 1980=100.

W2APK1: W2A divided PK1. 1980=100.

W2APK2: W2A divided PK2. 1980=100.

W3APK1: W3A divided PK1. 1980=100.

W3APK2: W3A divided PK2. 1980=100.

W4APK1: W4A divided PK1. 1980=100.

W4APK2: W4A divided PK2. 1980=100.

6. NOMINAL AND REAL EXCHANGE RATES

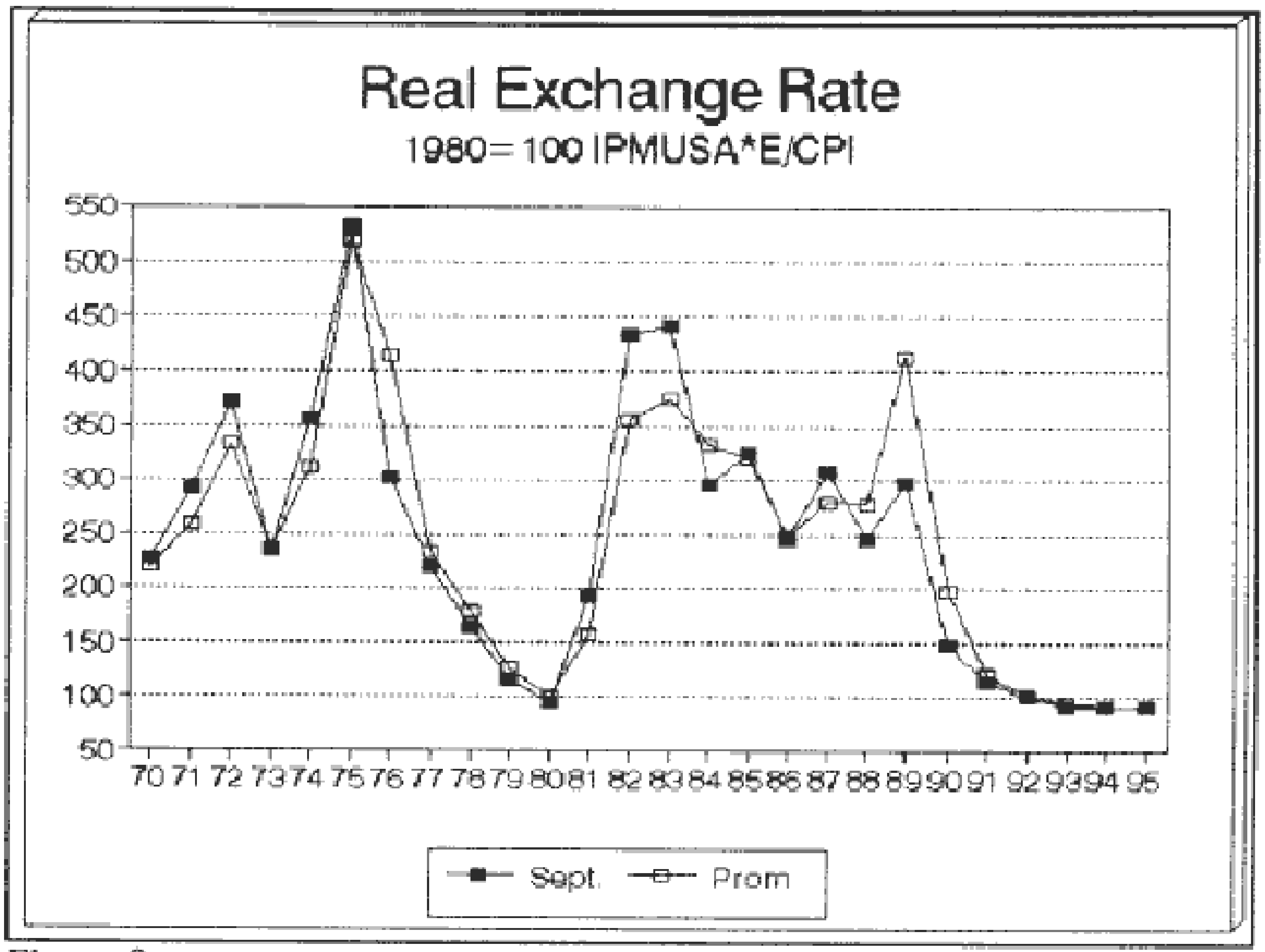

Figure 8

TRC1: September each year, TRC=TNC*WPI(USA)/CPI(ARG)
In 1995 it corresponds to April.

TRC2: Annual Average, TRC=TNC*WPI(USA)/CPI(ARG)
In 1995 corresponds to the first six months' average.

TNC1: September each year. Parallel market.
In 1995 it corresponds to April.

TNC2: Annual average.
In 1995 it corresponds to the first six months' average.

7. URBAN POPULATION

PBLURB1: Total Urban Population
Source: Ministerio de Economia. Actual Census 1970-80-91 and growth rate 1980-91 thereafter.

PBLURB2: Urban Population in Greater Buenos Aires
Source: Ministerio de Economia. Actual Census 1970-80-91 and growth rate 1980-91 thereafter.

8. INFLATION

INFL1: Annual percent change in CPI: December to December.
Source:

INFL2: Annual percent change in CPI: September to September.
Source: