The wage elasticity of labour demand in the Uruguayan manufacturing sector after re-unionisation: new results

Adriana Cassoni*
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Abstract

This paper provides new evidence on the magnitude of the elasticity of substitution between labour and capital for the Uruguayan manufacturing sector. Labour demand is derived using a right-to-manage model estimated for the period 1985-1997 using data for six industries. The evidence found suggests that the elasticity is generally less than 1. Differences by industry and in time are also found. The latter result may be linked both to the integration process underwent by Uruguay in the nineties and to the changes in the bargaining framework that took place in that same period. As a nested CES production function is used to derive the labour demand, the partial elasticity of substitution between production and non-production workers is also calculated, being its magnitude quite low. Finally, the model was estimated using data from industrial surveys (gathered from firms) and from household surveys. The comparison of results shows that when using industrial surveys data the estimated elasticities are higher than when using household surveys data. The result is probably related to the different coverage of both sources, as well as to the different accuracy reached in measuring wages.

Resumen

Este artículo brinda nueva evidencia sobre el valor de la elasticidad de sustitución entre capital y trabajo, para la industria manufacturera uruguaya. La función de demanda de trabajo se deriva a partir de un modelo de negociación salarial de tipo right-to-manage, estimado durante el período 1985-1997, usando datos de seis industrias manufactureras. La evidencia sugiere que la elasticidad de sustitución es generalmente menor que 1. Se encuentran diferencias por industria y en el tiempo. Este último resultado puede asociarse tanto al proceso de integración del país, iniciado en los noventa, como al cambio en el marco de negociación salarial que tuvo lugar en el mismo período. Dado que la demanda derivada de trabajo se obtiene a partir de una función producción CES anidada, el modelo también permite calcular la elasticidad parcial de sustitución entre obreros y empleados, siendo su magnitud bastante baja. Finalmente, el modelo se estimó usando datos provenientes de encuestas industriales (en las que se entrevista a los establecimientos) y encuestas de hogares. La comparación de los resultados obtenidos muestra que las elasticidades estimadas son más altas cuando se usa el primer tipo de encuestas. Esto es probablemente explicable tanto por la diferente cobertura de ambas encuestas como por la diferente precisión en la medición de los salarios.

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1. Introduction

In 1985, when democracy was reinstated in Uruguay after a 12 years military regime, the institutional setting in which labour relations took place changed drastically. Unions were reorganised and started bargaining wage increases together with employers associations. The government participated in these negotiations until 1991. Further, public workers regained the right not to be fired (except for certain causes specified by law), while the Ministry of Labour was again the main authority solving possible conflicts between employers and employees. Previous work (Cassoni, 1999a; Cassoni, Allen and Labadie, 1999; 1996) has shown that all these changes did have an impact on the manufacturing sector labour demand. Unions, among other factors, have pushed wages up. The evidence on which is the suitable bargaining model, however, is mixed. The results obtained in Cassoni et al. (1996) pointed at an efficiency contracts model, or at least at a model in which employment would not be on the labour demand function of firms. However, the analysis of all contracts signed since 1985 supports the idea that the employers have retained their right to adjust employment given the wage bargained in the so called Wage Councils, as they do not include any clauses relative to the level of employment or to firing practices. Under these assumptions, the effects of the new setting would have been reflected in a change in the underlying production function, lowering both the wage and the output elasticities of labour demand (Cassoni, 1999a and Cassoni et al., 1999). This result was obtained estimating a right-to-manage model for the period 1985-1997, and comparing it with those of a competitive model estimated for 1975-1984. Although the direction of the changes found in the relevant parameters are robust, their magnitude is quite small. A possible explanation could be linked to the existence of simultaneity bias. A 3-equations system derived from a CES production function was postulated, reflecting the demand for capital services, production and non-production workers, but only the demand for production workers was estimated\(^1\).

A first aim of this paper is to estimate the elasticity of substitution and hence the wage elasticity of labour demand, using data on production and non-production workers, so as to obtain new evidence on the magnitude of this parameter. The model to be used follows that specified in Cassoni (1999a), that is, a right-to-manage bargaining model, with a technology defined by a CES production function. However, instead of assuming there are three distinct factors of production, a nested CES will be used (Sato, 1967), in which two inputs - capital and labour – are considered, but the latter is classified in two categories, and aggregated according to a CES function itself. Further, the partial elasticity of substitution among both types of labour will be also derived.

A second objective here pursued relates to the sensitivity of results to the information set used. In Uruguay the only source of information on employment by economic sector with a

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\(^1\) Theoretically, the elasticity of substitution between both types of labour and capital is the same, if a multi-factor CES production function is assumed. However, if when estimating the demand for production workers this restriction is not imposed, biases, of unknown sign, arise.
quarterly or monthly frequency is the Household Survey. Hence, recent work in Uruguay that has attempted to estimate the parameters of a production function has used this source of information. However, it is well known that income measures obtained from household surveys are not the best approximations of wages. Further, being the individual the unit of observation, employment levels calculated from household surveys are not equal to those obtained from establishment surveys in Uruguay. The former would cover a greater number of firms than the latter, in which only establishments with 5 or more workers are interviewed. If small firms use technologies that imply a different elasticity of substitution, then the estimated value of this parameter might be different depending on the source of information used.

2. The model

Firms are assumed to use a CES technology with two inputs, capital and labour. Labour, in turn, may be classified in two categories: according to the worker being directly involved in production or not (production and non-production workers). Labour is hence not homogenous. It is assumed that both types of workers are combined according to a CES function, following Sato (1967):

\[ Q^{1/\lambda} = \{[\forall L_{np}\lambda K \times (1-\forall) L_p \lambda K + \exists K^{\lambda}]^{1/\lambda} + \} \]

where Q is value added; \( L_{np} \) refers to non-production workers; \( L_p \) refers to production workers; and \( K \) accounts for capital services. The parameter \( : \) allows for increasing or decreasing returns to scale \( (>:1; <1) \); while \( \Delta \) and \( \Lambda \) determine the elasticities of substitution between \( L_{np} \) and \( L_p \) (\( \Phi_{npp} \)) and between labour and capital (\( \Phi_{KL} \)), according to the following formulae:

\[ \Phi_{KL} = 1/(1-\Lambda) \]
\[ \Phi_{npp} = \Phi_{KL} + (\Phi_{KL} - \Phi_{KL}) / s_L \]

with \( \Phi_{KL} = 1/(1-\kappa) \) and \( s_L \) labour share in value added

The partial elasticity of substitution between the two types of workers - \( \Phi_{KL} \) - reflects substitution within the subprocess generating labour but it does not take into account technical restrictions as summarised by the elasticity of substitution between subprocesses. On the other hand, \( \Phi_{npp} \) does account for the latter effect. The nested (two-levels) CES production function thus imposes the restriction that the elasticity of substitution between capital and both categories of workers is the same but it allows for a different elasticity of substitution between the two types of labour. Further, it is possible that production and non-production workers are complementary factors depending on the value of \( \Phi_{KL} \) (Anderson and Moroney, 1994).

If firms maximise profits, subject to given prices of inputs, the system of derived demands for the three inputs is:
\[ K = (o(p_c/p)^{-1} Q^2_2 \] (2)
\[ L_{np} = (3(w_{np}/p)^{-1} Q^3_3[\forall L_{np}^\kappa + (1-\forall)L_p^\kappa] \] (3)
\[ L_p = (7(w_p/p)^{-1} Q^2_2[\forall L_{np}^\kappa + (1-\forall)L_p^\kappa] \] (4)

Where \( p_c/p, w_{np}/p \) and \( w_p/p \) are the prices of capital services, non-production and production workers, respectively, relative to the product price, \( p \). The coefficients labelled \((0, (3 \text{ and } (7 \text{ are constants; and the other parameters are defined as:}

\[ (1 = 1/(1-\Lambda) \] (3)
\[ (2 = (1-\Lambda/\gamma)1/(1-\Lambda) \] (4)
\[ (5 = (1-\Lambda/\gamma)1/(1-\Lambda) \] (6)
\[ (6 = (\Lambda-\Delta)/[\Delta^*(1-\Delta)] \]

An alternative way to specify the above model is to assume maximisation takes place over the average wage (w) so as to determine the aggregate labour input (L) and capital services, subject to the distinction among production and non-production workers in a second stage. This would yield the following model:

\[ K = \exists_0(p_c/p)^{-1} Q^2_2 \] (5)
\[ L = \exists_3(w/p)^{-1} Q^2_2 \] (6)

where \( \exists_0 \) and \( \exists_3 \) are constants; \( \exists_1 = 1/(1-\Lambda) \); and \( \exists_2 = (1-\Lambda/\gamma)1/(1-\Lambda) \)

The parameter \( \Delta \), needed to calculate the elasticity of substitution among both types of workers, can be obtained by estimating the equation resulting from dividing equation (3) by equation (4):

\[ L_{np} / L_p = N_0(w_{np}/w_p)^{-1} \] (7)

Following Cassoni (1999a), wages are not exogenous but determined after a bargaining between employers and unions takes place, taking into account that the employers retain their right to manage. Assuming the utility function of unions is derived from a median voter framework and that they maximise a surplus over an alternative income \( w^a \), the generalised Nash bargain can be stated as:

\[ \text{Max } Y = (\Gamma-\Gamma_0)^\beta (\Pi-\Pi_0)^{1-\beta} \]

s. t.
\[ L = L^* \]

where \( \Gamma \) and \( \Pi \) are the utility functions of unions and employers, respectively:

\[ \Pi(p, Q, K, L, p_c, w) = pQ - wL - p_cK \]
\( \Gamma(w, w^a, L) = (w - w^a)L^\phi \)

\( \Gamma_0 \) and \( \Pi_0 \) are the fall-back positions of each player, which are assumed to be zero (Binmore, Rubinstein and Wolinsky, 1986) \(^2\); \( L^* \) is employment as determined in a second stage when firms maximise profits subject to the negotiated wage level; \( \exists \) is the bargaining power of unions; and \( \phi \) is a parameter reflecting the weight given to employment in the union utility function.

Subject to the assumption that the capital level is given, once bargaining over the wage and labour demand occur, the solution to the Nash bargain yields an equation for the wage level as follows:

\[
\frac{w}{p} = 0(S,O)^*\frac{w^a}{p} \tag{8}
\]

where 0 is the mark-up over \( w^a/p \) and depends on union density (S) and the degree of competitiveness the firm is subject to (O), as proxies of the bargaining power of unions. The model to be estimated would be the 4-equations system (5)-(8). However, as no data on capital services is available, equation (5) will be omitted. The exclusion of one or more equations would thus generate simultaneity biases in the estimates of the parameters. The appropriate method of estimation is the Seemingly Unrelated Regressions method, proposed by Zellner (1962).

3. Data

The units of observation are the 2-digit manufacturing industries. Only six out of eight are used, due to data availability in the period 1985-1997: food, beverage and tobacco; textiles and apparel; paper; chemicals and oil products; non-metallic minerals; and metallic products.

The first model estimated uses data on output, number of workers and wages that stem from the Quarterly and Annual Industrial Surveys (National Institute of Statistics-INE). The Quarterly Survey publishes indexes while yearly the Annual Survey reports values. Both sources were used to build quarterly time series of values for the above variables. In the second model, employment and wages are calculated using data from the Household Survey (INE) on a quarterly basis, taking into account only formal workers. Formality is defined in terms of the individual having the legally stipulated health care coverage (public or private depending on the sector).

Information relative to non-production workers, as well as to wages of both types of workers, is not published on a quarterly basis since 1992. In order to get quarterly data for number of workers it is assumed that the 1991 seasonal pattern remains for the period

\(^2\) In the event of no agreement there would be a strike. Then the firm will have no operating profits and union members will have zero earnings, as there are no legal provisions assuring any income to strikers in Uruguay.
1992-1997. Regarding wages, the within year evolution is assumed to be identical to that reported by the Wage Survey, that is also carried out by the INE.

Apart from having a different unit of observation (the establishment and the worker), the Industrial Survey gathers information relative only to firms with 5 or more workers. Further, declared earnings are known to be less accurate when obtained from individuals than from firms. Those differences have to be taken into account when comparing the estimated elasticities of substitution using both sources.

The cost of labour is built adding to the wage variable all costs related to social security; taxes; annual premia and other bargained costs, as described in Cassoni (1999a).

The degree of openness is used as a proxy to the competitiveness of the industry. It is calculated as the ratio of exports plus imports (as reported by the Republic Bank of Uruguay and the Customs Office) to value added.

Union density is defined as the affiliation rate, by industry. The time series is built using data on membership reported by the central union (PIT-CNT) in each congress and of total employment. These congresses took place in 1985, 1987, 1990, 1993 and 1997.

Figure 1 depicts the evolution of the main variables for the whole manufacturing sector. Table 1 reports descriptive statistics for each industry and for the whole manufacturing sector.

Union density declined all along the period, with the strongest decline registered after 1993. Simultaneously, the degree of openness of the economy has steadily increased, being the consolidation of the integration process a further accelerator of the process. The path of the manufacturing product reveals there is a period of stagnation between 1989 and 1994. The level of employment has declined continuously since 1989, although the speed with which this is recorded by the Industrial Survey is faster than that stemming from the Household Survey data. This might reflect the fact that bigger firms adjusted the level of employment more than smaller ones. Wages have increased in the period, although at a lower pace after 1993, specially according to the Household Survey data. This date could be related to the new setting for bargaining operating since 1991 and with all contracts that had been signed before, having expired. Finally, the ratio of non-production to production workers has increased in the sub-period 1992-1996, being this pattern matched by a decrease in relative wages. On average, relative employment is equal to 0.3, but it differs greatly among industries. While only 65% of workers are directly involved in the production process in chemicals and oil products, 85% of employees in textiles are production workers. Regarding the relative wage, there are also differences among industries, but not as sharp as in the composition of employment. On average, non-production workers are paid twice the wage of production workers.
Figure 1: Evolution of main variables – Manufacturing sector 1985-1997

Note: L is employment in logs; RW is real labour cost in logs; Q is value added in logs; LNPP is the ratio of non-production to production workers; RWNPP is the ratio of non-production to production workers real wage; UNION is the affiliation rate; OPEN is the degree of openness. IS and HS mean the data stem from the Industrial Survey and the Household Survey, respectively.

Sources: Quarterly and Annual Industrial Surveys (INE); Household Survey (INE); Republic Bank of Uruguay (BROU); Central Bank of Uruguay (BCU); Customs Office; National Accounts (BCU); different newspapers for union membership, as reported by the Central Union (PIT-CNT).
Table 1: Descriptive Statistics - Manufacturing Industries 1985-1997

<table>
<thead>
<tr>
<th>Employment</th>
<th>IS</th>
<th>HS</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>I31</td>
<td>I32</td>
<td>I34</td>
</tr>
<tr>
<td>IS</td>
<td>45615</td>
<td>35702</td>
<td>9066</td>
</tr>
<tr>
<td>HS</td>
<td>53437</td>
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<td>9487</td>
</tr>
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<td>Standard Deviation</td>
<td>IS</td>
<td>HS</td>
<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>I31</td>
<td>I32</td>
<td>I34</td>
</tr>
<tr>
<td>IS</td>
<td>5529</td>
<td>9360</td>
<td>1261</td>
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<td>Real labour cost</td>
<td>IS</td>
<td>HS</td>
<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>I31</td>
<td>I32</td>
<td>I34</td>
</tr>
<tr>
<td>IS</td>
<td>158</td>
<td>163</td>
<td>201</td>
</tr>
<tr>
<td>HS</td>
<td>140</td>
<td>138</td>
<td>1321</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>IS</td>
<td>HS</td>
<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
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<td>I32</td>
<td>I34</td>
</tr>
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<td>IS</td>
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<td>41.13</td>
</tr>
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<td>Other variables</td>
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<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>I31</td>
<td>I32</td>
<td>I34</td>
</tr>
<tr>
<td>LNPP</td>
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<td>0.47</td>
</tr>
<tr>
<td>RWNPP</td>
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<td>2.33</td>
<td>1.73</td>
</tr>
<tr>
<td>Q</td>
<td>20.34</td>
<td>10.59</td>
<td>3.26</td>
</tr>
<tr>
<td>UNION</td>
<td>47.34</td>
<td>43.35</td>
<td>48.17</td>
</tr>
<tr>
<td>OPEN</td>
<td>24.76</td>
<td>60.87</td>
<td>22.69</td>
</tr>
<tr>
<td>RAW</td>
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<td>95.88</td>
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<td>Standard Deviation</td>
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<td>HS</td>
<td>Mean</td>
</tr>
<tr>
<td>Mean</td>
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<td>I32</td>
<td>I34</td>
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<td>0.04</td>
</tr>
<tr>
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<td>0.24</td>
</tr>
<tr>
<td>Q</td>
<td>2.29</td>
<td>1.66</td>
<td>0.33</td>
</tr>
<tr>
<td>OPEN</td>
<td>3.55</td>
<td>11.59</td>
<td>10.35</td>
</tr>
<tr>
<td>RAW</td>
<td>12.98</td>
<td>23.20</td>
<td>25.23</td>
</tr>
</tbody>
</table>

Note: Employment refers to total number of workers; Real labour costs per worker are monthly pesos of 1988; LNPP is the ratio of non-production to production workers; RWNPP is the relative wage of non-production and production workers; Q is monthly value added in 1988 million pesos; UNION is the affiliation rate; OPEN is the degree of openness; and RAW is the monthly alternative real wage in pesos of 1988. IS means data come from the Industrial Survey while HS refers to information stemming from the Household Survey.

Finally, the comparison of the data relative to employment and wages using the Industrial and the Household Surveys shows that employment is generally higher and wages are lower when stemming from the latter source. This could be linked to the omission of the smallest establishments in the Industrial Survey, as already mentioned, and to the fact that in those firms workers are paid less than in bigger establishments.
4. Results

The model to be estimated is the system (6)-(8) that is reproduced in logs here below:

\[
\ln L = \exists_0 + \exists_1 \ln(w/p) + \exists_2 \ln Q \\
\ln(L_{np}/L_p) = N_0 + N_1 \ln(w_{np}/w_p) \\
\ln(w/p) = 0_0 + 0_1 S + 0_2 O + 0_3 \ln(w^a/p) 
\]

The analysis of the order of integration of the series involved results in all being either integrated of order one or stationary\(^3\). The non-stationarity of the ratio of production to non-production workers would imply that exogenous shocks that have led to a re-structuring of the manufacturing sector have had a permanent effect on the mix of employment in most industries. A possible explanation could be related to the need of firms to reduce their labour force, partly due to the increase in non-wage costs. This has resulted in many firms promoting that some of their production workers –those linked to a specific part of the production process- create an independent firm that sells its services to the original one. Another fact worth considering is that increased competitiveness has also forced firms to emphasise processes related to quality control, commercialisation practices and strategies aiming to get new customers. Further, a possible effect of unionisation is a reduction in wage differentials and this might also have had a permanent effect in the wage structure. Co-integration tests, following Engle and Granger (1987) procedure, do not reject the existence of an equilibrium relationship between labour, wages and output, if labour costs are instrumented using the alternative wage, openness and union density as instruments. Relative employment and relative wages are also found to be co-integrated.

Given these results, the associated dynamic form is specified as a distributed lag model, starting with four lags of every variable. Output is instrumented using its own lags to avoid endogeneity biases. Fixed effects are allowed for to account for specific characteristics of the different industries.

In Cassoni (1999a) evidence was found suggesting both the labour demand function and the wage equation shifted at some point at the beginning of the nineties. This was linked to the change in the structure of bargaining that took place in 1991. The data pointed at 1993 as the time period in which the shift would have occurred. Hence, dummy variables for the post-1993 period are included here also, in all equations, and their significance tested for.

Finally, using a pooled cross section – time series dataset could result in some or all parameters being different by industry. Hence, the stability in the cross section of every coefficient was also analysed.

\(^3\) To study the order of integration of the individual series, Augmented Dickey-Fuller tests (Dickey and Fuller, 1979) were done by industry, using PCGive and PCFiml 9.0. Results are available upon request.
Thus, the econometric strategy followed was one of specifying very general models that were sequentially reduced. The starting and final forms of these models are reported in the appendix. The final dynamic form of the equations never includes more than two lags. There is evidence supporting that some parameters are unstable in the nineties, while differences by industry cannot always be rejected. Moreover, in some cases a combination of both effects is also supported by the data. Regarding the wage and employment equations, the existence of so many sources of variation makes it difficult to arrive at a unique model, as some of these effects cannot be properly differentiated. Misspecification tests were performed to all equation individually and to the system. Normality is generally rejected, but given the sample size, the results of hypothesis tests should be still robust (Spanos, 1986). As heteroskedasticity is also found, reported standard errors are corrected following White (1980). Autocorrelation is always rejected.

4.1 Results using industrial surveys data

The final form of the equation describing the relative demand of blue and white-collar workers allows for one lag in the dependent variable and none in the relative wage. There are differences by industry in the speed of adjustment to equilibrium, as indicated by the coefficient of lagged relative labour demand (see Table 2). Thus, it could be argued that the long run partial elasticity of substitution between production and non-production workers ($1/(1-\rho)=\Phi\kappa$) is greater in paper; chemicals and oil products; and non-metallic minerals than in food, beverage and tobacco; textiles; and metallic products, the estimated values being 0.5 and 0.2, respectively. Although these figures seem a bit low, estimates for developed countries are between 0 and 3.7, with a mean value of 1 (Wood, 1994, pp132).

Finally, there is also evidence suggesting the curve shifted out in the nineties, so that the same relative wage would yield a higher ratio of non-production to production workers after 1993 (between 7% and 14%, depending on the industry, in the long run). The result could be linked to the processes already described by which firms have increased the number of white-collar workers and reduced that of blue-collars.

The final form of the wage equation includes two lags of the wage and one of the alternative income (Table 3). The long run estimator of the coefficient multiplying the alternative wage is statistically equal to one. On the other hand, the effect of openness on the mark-up is statistically zero when including these lags. In spite of this, the value of the coefficient in the long run is of the same order than when estimating the model with no lags of the alternative wage and one lag of the real wage, in which case the estimator is significant\(^4\). Although the fact that increased openness would set a bound to the wage inflation is very appealing, the order of the effect is very small, as doubling the degree of openness would only generate a 2.5% reduction in the real wage, in the long run.

\(^4\) This specification was also tried in order to compare results with Cassoni (1999a). The long run values of the estimators multiplying the three variables are very similar (-0.039 and -0.037 for OPEN; 1.22 and 1.08 for RAW, both statistically equal to 1; 0.22 and 0.17 for UNION, although the latter would have fallen after 1993 for three of the six industries).
Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
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</tr>
<tr>
<td>I31</td>
<td>0.21550</td>
<td>0.11827</td>
</tr>
<tr>
<td>I32</td>
<td>-0.14898</td>
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</tr>
<tr>
<td>I34</td>
<td>0.35074</td>
<td>0.14536</td>
</tr>
<tr>
<td>I35</td>
<td>0.37876</td>
<td>0.12643</td>
</tr>
<tr>
<td>I36</td>
<td>0.24257</td>
<td>0.12132</td>
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<tr>
<td>DUMMY93</td>
<td>0.031821</td>
<td>0.00936</td>
</tr>
<tr>
<td>RWNPP</td>
<td>-0.10057</td>
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<tr>
<td>LNPP_1</td>
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<td>LNPP31_1</td>
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<td>LNPP36_1</td>
<td>0.24469</td>
<td>0.11827</td>
</tr>
</tbody>
</table>

Note: LNPP is the relative employment of non-production to production workers. qr1, qr2 and qr3 denote dummy variables for quarters 1 to 3, respectively. I31 to I36 are dummy variables related to the industry (31 is food, beverage and tobacco; 32 is textiles; 34 is paper; 35 is chemicals and oil products; 36 is non-metallic minerals). Dummy93 is equal to 1 after 1992. RWNPP is the relative cost of non-production to production labour. LNPP_1 is LNPP lagged one quarter. LNPP31_1 to LNPP36_1 are LNPP_1 multiplied by I31 to I36.

Regarding the effect of union density on the mark-up, it is not possible to arrive at a unique specification. Some of the tests performed to analyse temporal stability point at a change in the nineties, lowering the effect of unions on the mark-up over the alternative wage. However, the result is quite sensitive to the inclusion or exclusion of other variables, as well as to the combination of changes in the parameters in time and among industries (see the appendix). Thus, the final specification chosen was a simple one, in which the parameter multiplying union density is imposed to be the same for all industries and stable in time (column (1) of Table 3). Its estimated effect is such that a 10% increase in the affiliation rate - calculated at its mean value – would imply a 1% increase in the real wage. All these three effects are consistent with the ones obtained in previous work using data only on production workers. The result can be read as supporting the hypothesis that trade unions bargain disregarding the specific occupation of their members at the firm. However, in 1993 the wage equation would have shifted, so that for equal values of the alternative income, union density and openness, real wages would be 11% higher than before (in the long run). This last finding might be linked to the change in the composition of labour, increasing the relative share of non-production workers, whose wage is twice that of
production workers. This, in turn is consistent with some recent evidence on increased wage dispersion and increased returns to schooling since 1992 (Gradín and Rossi, 1999; Miles and Rossi, 1999).

Table 3
Dependent variable: RW

<table>
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<tr>
<th>Variable</th>
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<th>(2)</th>
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<td>Std.Error</td>
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</table>

Note: RW is the real cost of labour. qr1, qr2 and qr3 denote dummy variables for quarters 1 to 3, respectively. I31 to I36 are dummy variables related to the industry (31 is food, beverage and tobacco; 32 is textiles; 34 is paper; 35 is chemicals and oil products; 36 is non-metallic minerals; 38 is metallic products). DUMMY93 is equal to 1 after 1992, 0 elsewhere. UNION is union density; OPEN is degree of openness; RAW is the alternative wage. Variables ending in "_1" indicate that the original variable is lagged one period. UNION9331 to UNION9338 refer to UNION multiplied by DUMMY93 and by I31 to I38, respectively.

Finally, three specifications are reported for the labour demand equation. As in the wage equation, temporal and cross-section instability was supported by the data, but the results are too sensitive to the inclusion and exclusion of variables.

The final models reported reflect quite different situations. In column (1) of Table 4 the elasticity of substitution between labour and capital is allowed to vary per industry as well as in time. Before 1993, the value of the parameter would have ranged from 0 (reflecting a
Leontief technology) to 0.74, which is not a surprising result, given the heterogeneous nature of the activities involved. After that date, all industries would have changed technology, towards one with a greater elasticity of substitution (that is equal to 1 in four of them). However, the temporal change would have been accompanied by an outward shift of the labour demand function, so that the final result would depend on the wage level (see Figure 2).

### Table 4

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<th>Dependent variable: L</th>
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<th>Std.Error</th>
<th>Coefficient</th>
<th>Std.Error</th>
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</tr>
<tr>
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<td>L_1</td>
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<td>0.87618</td>
<td>0.02208</td>
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</table>

Note: L is total employment. qr1, qr2 and qr3 denote dummy variables for quarters 1 to 3, respectively. I31 to I36 are dummy variables related to the industry (31 is food, beverage and tobacco; 32 is textiles; 34 is paper; 35 is chemicals and oil products; 36 is non-metallic minerals; 38 is metallic products). Dummy93 is equal to 1 after 1992, 0 elsewhere; PROD is production; PROD35 is PROD by I35. RW is the real cost of labour. RW31 to RW36 are RW by I31 to I36. RW93 is RW by DUMMY93. RW3193 to RW36 are RW93 multiplied by I31 to I36.

The second model, summarised in column (2) of the same table, thus allows for a different elasticity of substitution by industry but that is stable in time. However, only that of textiles is statistically different from the rest (the elasticity of substitution would be equal to 0.42 for all industries, while that of textiles would be 0.77 and statistically equal to 1).
The last model imposes a common elasticity of substitution for all industries and that does not vary in time\(^5\). Its estimated long run value is 0.36, quite similar to that obtained using the previous model, although in the short run it is smaller than that resulting from model 2 (0.048 versus 0.067 for all industries except textiles). In Figure 2 a simulation is done in order to show the modelled change in the labour demand function in 1993. It is there assumed that all industries have the same initial wage level and that production is constant. The values used for the wage (in logs) are not the actual ones but just a simulated series. The picture that emerges from the graphs is that, if the models were correctly predicting labour demand, then at least at high wage levels employment would be lower today than before 1993, in all industries.

**Figure 2**

The above results suggest that, although it is not possible to obtain a robust specification, differences by industry and in time do exist and their omission might be biasing the results obtained when imposing common coefficients. An alternative strategy would have been to estimate a multivariate model in which the labour demand of each industry was estimated separately. However, and probably due to the level of aggregation of the data, this

\(^5\) When a common parameter for all industries is imposed, temporal instability is rejected.
methodology proved to be ineffective. Thus, future work should be directed to obtain data at the level of the firm.

Considering all the evidence found, it could be argued that the elasticity of substitution between capital and labour in the manufacturing industries should range between 0.3 and 1. There is also some evidence suggesting an increase of the parameter in the nineties, but this result is not robust enough at this stage. In Cassoni (1999a) an elasticity equal to 1 was found before 1985. So a first question would be: is it sensible that firms could have changed technology twice in 23 years, towards one with less/more possibilities of substitution between the two main production factors when relative prices change? An affirmative answer can be proposed if one looks at the economic and institutional environment in which manufacturing firms operated along the period. First, in 1985-1992 unions were not only active but very influential. Membership was at its top and bargaining was very synchronised and co-ordinated. On the other hand, in the pre-1985 period unions were illegal while after 1992 they started losing members and bargaining power, negotiations at the firm level started to generalise and contracts were no more enforceable. One could think then that during 1985-1992 the institutional framework could have promoted technologies in which substitution between labour and capital was more difficult than in others, due to the explicit and/or implicit pressure of strong unions. Together with this institutional setting, the economic policies instrumented in the sub-periods have promoted or discouraged investment. In the mid-seventies the first steps towards liberalisation were taken. This, together with the exchange rate policy (pre-announced exchange rate and overvalued local currency) did impulse firms to invest in new technology. However, with the 100% devaluation of the peso at the end of 1982 and the increase in interest rates, a lot of highly indebted firms were forced to close. On the other hand, in the nineties, the consolidation of the integration process in the MERCOSUR, plus a new exchange rate policy leading to an overvaluation of the local currency promoted investment in new technology once again. Thus, the economic environment, with more competitive pressure for firms and a relatively low exchange rate, could also have resulted in firms using technologies with higher elasticities of substitution in the pre-1985 period and in the nineties than those used in the 1985-1992 period.

In spite of the heterogeneity of the reported results, their comparison with those stemming from other recent research for Uruguay shows they are quite sensible. Cassoni (1999a), using quarterly data only on production workers for 2-digit manufacturing industries along the same period, obtained an estimated value of 0.4, rejecting differences by industry and in time. Cassoni (1999b), using the same dataset than in this paper and a model similar to that in column (2), estimated an elasticity of substitution that is equal to 1 for textiles; non-metallic minerals; and metallic products and around 0.5 for the other three industries. On the other hand, Tansini and Triunfo (1998), used establishment data for a sub-sample of manufacturing firms (those that have survived all along the period 1988-1994) and a translog cost function. The reported elasticity of substitution is 1.78, but its standard deviation is 1.2. Finally, regarding international studies on this topic, Wood (1994, pp 132-133) argues that developed economies show an elasticity of substitution between 0.5 and 1.5 for the industrial sector while that for developing economies is between 0.5 and 1.2.
Further, Hamermesh (1993, pp 92) argues that given the empirical work surveyed in the book, a simple mean of the elasticity of substitution would be 0.75.

The calculated elasticities of substitution between capital and labour imply that the wage elasticity of labour demand would be, on average, \(-0.3\), varying between \(-0.1\) and \(-1\) depending on the industry and the time period, increasing in all industries in since 1993 (see Table 5).

A last comment relates to the values of the elasticity of substitution between non-production and production workers (\(\Phi_{npp}\)), given the estimated values for \(\Phi_{KL}\) and \(\Phi_{K}\), and the share of labour costs in value added (\(s_L\)). The latter varies from 18% to 55% depending on the industry, being on average 30%. If the whole period is split in two, 1985-1992 and 1993-1997, these shares slightly increase in the latter, for all industries except chemicals and oil products. Blue and white-collar workers are substitutes in paper; chemicals and oil products; and non-metallic minerals when using models in columns (2) and (3) of Table 4. If results in column (1) are used, they are substitutes also in textiles in the first subperiod. However, after 1992, the elasticity of substitution significantly decreases in paper and in non-metallic minerals, while production and non-production workers become complements in textiles and in chemicals and oil products. This is the consequence of the increase in the possibilities of substituting labour by capital (Table 5).

### Table 5

<table>
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<tr>
<th>Industry</th>
<th>(\sigma_{KL})</th>
<th>(\eta_{LL})</th>
<th>(\sigma_{\rho})</th>
</tr>
</thead>
<tbody>
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<td>Food, bev. &amp; tobacco</td>
<td>0.68 1.25 0.37 0.38 0.56 1.02 0.30 0.26</td>
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<tr>
<td>Textiles</td>
<td>0.11 0.76 0.82 0.38 0.09 0.57 0.64 0.26</td>
<td></td>
<td></td>
</tr>
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<td>Paper</td>
<td>0.28 0.84 0.29 0.38 0.17 0.49 0.17 0.26</td>
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<td>0.23 0.74 0.32 0.38 0.18 0.57 0.25 0.26</td>
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<td>Non-metallic min.</td>
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<td>Metallic prods.</td>
<td>0.75 1.29 0.52 0.38 0.56 0.89 0.38 0.26</td>
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<td></td>
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<tr>
<td>Food, bev. &amp; tobacco</td>
<td>0.22 1.90 4.39 0.42 0.12</td>
<td></td>
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<tr>
<td>Textiles</td>
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<td>Paper</td>
<td>0.51 0.86 0.05 0.83 0.82</td>
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<td>Chemicals</td>
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<td>Non-metallic min.</td>
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<tr>
<td>Metallic prods.</td>
<td>0.22 1.32 2.18 0.55 0.12</td>
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</table>

Note: M1 to M3 refer to models in columns (1) to (3) in Table 4. \(\sigma_{KL}\) is the elasticity of substitution between labour and capital. \(\sigma_{\rho}\) is the partial elasticity of substitution between non-production and production workers. \(\sigma_{npp}\) is the elasticity of substitution between production and non-production workers (\(\sigma_{KL} + (\sigma_{\rho} - \sigma_{KL})/s_L\), with \(s_L\) the labour share in value added). \(\eta_{LL}\) is the wage elasticity of labour demand (\((-1-s_L)*\sigma_{KL}\))
4.2 Results using household surveys data

The Household Survey does not differentiate between white and blue-collar workers. Hence, the equation for relative employment cannot be estimated. Results for the wage and labour demand equations are summarised in Table 6. The final specification reported is slightly different from those reported in the previous sub-section. Regarding the dynamic structure, more lags are needed in the labour demand equation. Regarding the stability of parameters, no temporal instability is detected while no differences among industries are supported by the data.

A second comment relates to the significance of the parameters in the wage equation. The union variable, having the opposite sign to that expected, is not significant. Openness, on the other hand, has the expected negative effect on wages, but its magnitude is twice that of the previous model. How could one reconcile these findings with previous results? A first hypothesis must be related to the coverage of the Household Survey. If these data refer to all firms, the result poses a question on union coverage of individuals working at small firms. If workers of small firms are not union members and/or they have little or no access to the channels leading to effective wage claims, then this sample would include a lot of outsiders. Their wage might have gone down given the increase in unemployment resulting from unions rising wages in the more organised strata.

Table 6

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<th>Std.Error</th>
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<th>Coefficient</th>
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Note: L is total employment; RW is the real cost of labour; qr1, qr2 and qr3 denote dummy variables for quarters 1 to 3, respectively. I31 to I36 are dummy variables related to the industry (31 is food, beverage and tobacco; 32 is textiles; 34 is paper; 35 is chemicals and oil products; 36 is non-metallic minerals; 38 is metallic products). PROD is production. “-_1” and “-_2” besides a variable means the variable is lagged one and two periods, respectively. Dummy93 is equal to 1 after 1992, 0 elsewhere. OPEN is the degree of openness. UNION is the affiliation rate. RAW is the real alternative income.
Elasticities resulting from the labour demand function are smaller than those calculated using establishment data. The output-employment elasticity is 0.20 (vis vis a value of around 0.6, according to Table 4) while the capital-labour elasticity of substitution is 0.15 (vis vis a value ranging from 0.4 to 1). In this case, it is sensible to think that establishments using less than 5 workers have technologies in which substitution between capital and labour is more difficult, given their relatively restricted access to capital markets. Thus, their inclusion in the sample would bias downwards the average elasticity. Accordingly, the wage elasticity of labour demand is only –0.1 on average, and varying very little among industries (between –0.07 and –0.12). Finally, the elasticity of substitution between non-production and production workers indicates they are substitutable factors (σnpp is between 0.4 and 1.7 depending on the industry), which is no surprise given the low possibilities of substitution between labour and capital.

5. Conclusions

New evidence regarding the magnitude of the elasticity of substitution between capital and labour in the Uruguayan manufacturing industry is here reported. Results point to this parameter being less than or equal to 1. This result, in turn, is quite consistent with other research performed for Uruguay. It also implies a quite low wage elasticity of labour demand, although still within international ranges. Regarding the magnitude of the elasticity of substitution among production and non-production workers, when keeping the level of the labour input fixed, the evidence found points at a low value. Further, once substitution with capital is allowed for, both categories of labour result in being complements.

The analyses performed, however, also suggest that the elasticity of substitution between capital and labour has changed in the nineties, increasing its value. Is this linked to the integration process the economy is undergoing? Which is the role of the new bargaining framework in this process? Is the death of small firms, possibly as a consequence of increased competitiveness, in the root of the econometric result? The answers to these questions need further research.

On the one side, decentralised relative to sectoral bargaining would imply lower wage inflation, as it was demonstrated in Calmfors and Driffill (1988), despite there are other issues to be taken into account when an open economy such as the Uruguayan is analysed (Rama, 1994; Forteza, 1998). Hence, one interesting line of future work should be one developing a model that incorporates the new bargaining setting. Related to this, a gap to be filled is that of a possible change in the objective function of trade unions, once synchronisation and co-ordination are broken.

A completely different but nonetheless necessary research goal should be to develop a model that explicitly considers the death and birth of firms, as a result of the re-structuring
of the manufacturing sector. This should be accounted for by specifying an equation in which the probability of surviving or dying is modelled.

On the other hand, the analysis done has shown that using data aggregated by industry might be inconclusive, at least in the Uruguayan case. Shocks to the industrial sector, as well as changes in the institutional setting in which labour relations take place, are so many and so diverse, that the individual analysis of each industry seems inevitable. Hence, data at the level of the firm must be used to better conclude on these issues.

Finally, a warning has emerged from the paper as a side exercise regarding the use of household or establishment data. Both sources are not exchangeable and work should be done previous to any analysis in order to be sure that we are measuring the appropriate theoretical concepts.
References


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\[ \sigma = 0.0599442 \quad \sigma = 0.0584916 \]

\[ \loglik = 3635.5 \quad \loglik = 3590.1 \]