LABOR DEMAND: CHILE 1986-2001

Rodrigo A. Cerda

1. INTRODUCTION

Since the recovery of the 1982 crisis, the Chilean labor market evolved very favorably. Employment and real wages of the Chilean population increased steadily since the mid 1980s until 1998. However, since 1998, unemployment rose as the creation of jobs (and therefore net employment) showed a much smaller growth rate compared to the period 1982-1998. The are several alternative explanations for this phenomenon. In the one hand, the irruption of the 1998 Asian crisis must surely had played an important role by affecting overall economic activity. In fact, the GDP growth rate decreased from an average of 7% between 1986 and 1997 to an average of 2.8% between 1998 and 2001. On the other hand, there is also a set of internal factors that might also had impacted the labor market. One of these internal factors is the abrupt increase in the minimum wage from $65,500 in May 1997 to $100,000 in June 2000, while the IPC\(^1\) rose only 13% during the same period. A second internal shock in this period is the discussion and promulgation of the reform to the labor market code. This labor reform could have caused greater inflexibility in the labor market and therefore, impacted real wages and employment.

This papers looks for empirically determining the factors that might have produced movements in the labor demand of the Chilean economy. The methodology follows Murphy and Welch (1992) by determining the factors that allow a system of labor demand by economic sectors to fulfill the basic restrictions emanated from the economic theory. The study is developed as follows. Section 2 explains the methodology, while section 3 presents the results and section 4 concludes.

2. MODELING CHANGES IN LABOR DEMAND

The INE\(^2\) publishes monthly nominal data of employment and wages by economic activity from February of 1986 to the present\(^3\). The sectors of economic activity are: (1) agriculture, fisheries and hunting, (2) mining, (3) manufacturing

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* Department of Economics, Catholic University of Chile. Email: rcerda@faceapuc.cl. Fernando Coloma provided helpful comments. Many of the data used in this paper were obtained from the CIEF, of the UNAB. Any error is my own responsibility.

1 Chilean consumption price index.

2 Chilean National Bureau of Statistics.

3 The data concerning wages in agriculture, fisheries and hunting is not published. We construct a wage index of this sector using information of average wages of the economy and wages in other sectors.
industry, (4) electricity, gas and water, (5) construction, (6) commerce, restaurant and hotel, (7) transport and telecommunications, (8) financial services and (9) communal, social and personal services. This is an interesting information because it allows us to think about a system of labor demand by economic activities. In fact if we assumed linearity in the labor demand functions, the labor demand system can be written as in:

\[ H_t = \Phi W_t + \Gamma Z_t + U_t \]

Where \( H_t, W_t \) are matrices of dimension 9x1 that contains the logarithm of employment and the logarithm of the real wages of each one of the economic sectors, whereas \( Z_t \) is a matrix of dimensions 9xk that contains an intercept and variables that shifts. The labor demand functions and \( U_t \) is a 9x1 matrix that reflects measurement errors. These matrices are indexed by t, indicating that they vary through time. The matrix \( \Phi \) is a 9x9 matrix including the effects of wages on labor demand. It is important to notice that in this system, the economic theory imposes as restriction that \( \Phi \) be negative semi-definite (like in any Hicksian demand system). Thus, this is a system of labor demand by economic activities conditional on \( Z_t \).

After taking deviations with respect to means, the system (1) can be written as in:

\[ \bar{W}_t^T (\bar{H}_t - \bar{\Gamma} \bar{Z}_t) = \bar{W}_t^T \Phi \bar{W}_t + \bar{W}_t^T U_t \]

Where the bars indicate deviations with respect to the averages and \( T \) indicates transposition. Since \( \Phi \) is negative semi-definite, if we are able to find the \( Z_t \) variables that produce the shifts in labor demand, the left hand side of (2) must be negative semi-definite up to measurement error. This result is quite intuitive, because it is based on correcting the matrix \( H_t \), to obtain the variation on employment orthogonal to the shifts in the labor demand functions (which are summarized in the \( Z \) matrix). Finally, it is useful for the later discussion, to remember that a negative semi-definite matrix has only negative eigenvalues. If there are positive eigenvalues, our data reject the hypothesis of negative semi-definiteness in the \( \Phi \) matrix. To proceed with the argument, the following matrix is defined:

\[ M_Z = I - Z(Z^T Z)^{-1} Z^T \]

This matrix has the property of projection in the orthogonal space to \( Z \), reason why pre multiplying (1) by \( M_Z \) we get:

\[ M_Z H_t = \Phi M_Z W_t + M_Z U_t \]

Since \( M_Z Z = 0 \). This last expression indicates that pre multiplication by \( M_Z \) allows to eliminate the effects of the shifts in labor demand and concentrate in the substitution effects among economic sectors.
Let the variation in our variables of interest and orthogonal to Z be $M_Z H_t = H_t^*$, $M_Z W_t = W_t^*$ and $M_Z U_t = U_t^*$, then the analog to (2) is:

$$W^* H^* = W^* \Phi W^* + W^* U^*$$

Where the t index was eliminated by simplicity. As in (2), the matrix in the left hand side must be negative semi-definite which is equivalent to negative semi-definiteness in the matrix $1/2(W^* H^* + H^* W^*)$. We will focus on this symmetric matrix. The procedure to identify the Zs' variables will consist on (1) choosing candidates variables to be included on the Z matrix and (2) testing the negative semi-definiteness in $1/2(W^* H^* + H^* W^*)$

3. **Empirical Results**

In this section we follow the procedure explained in section 2. The sample ranges from February 1986 to January of the 2001 (we were able to obtain some of the Zs variables only until January of 2001).

The Table 1 presents the results using the complete sample. It shows the 2 biggest and the 2 smallest eigenvalues of the $1/2(W^* H^* + H^* W^*)$ matrix. Also, in parenthesis, we present the associated standard errors for each eigenvalue which were obtained by the method of the Bootstrap, using 10000 iterations.

Columns 1, 4 and 7 of Table 1 presents the results when all the economic sectors are considered in the analysis. We also include the results when we divide the sample between tradable and non tradable economic sectors. Initially, when we do not include any Z variable as control, there are positive and highly significant eigenvalues. The magnitude of these eigenvalues is 9 to 10 times larger than the magnitude of the negative eigenvalues. When we include the index of monthly economic activity (denoted as GDP in the table) in the Z matrix, the magnitude of the positive eigenvalues considerably diminishes. Nevertheless, even after correcting by the economic activity, the positive eigenvalues are significant and larger in magnitude than the negative eigenvalues. This result indicates that the effect of the economic activity only partially controls the shifts in the demand functions. We follow Martínez, Morales and Valdés (2001) and we control in addition by the relative price of non labor inputs. To do so, we include the average interest rate (TIP) on 90-365 day deposits indexed to the UF (IPC) as a proxy of the cost of capital, the price of petroleum and the relative price of the importable goods (measured in terms of the IPC). These last variables help to correct somehow the magnitudes of the eigenvalues, but only in the non tradable sectors. Therefore the

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4 The tradable sector is composed by sectors 1, 2, 3 and 7 while non tradable is composed by the rest. Even though the usual definition of the tradable sector only includes sectors 1 to 3, we include also sector 7 to be able of reporting 4 eigenvalues. We chose sector 7 because it includes transports which have an important tradable component.
Φ matrix is far from being considered negative semi-definite. Due to the unsatisfactory results we decide to include the following additional control variables: (1) ratio of minimum wage to average wage, (2) the total number of workers affiliated to unions and (3) a trend.

TABLE 1

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Tradable</th>
<th>Non Tradable</th>
<th>Sectors</th>
<th>Tradable</th>
<th>Non Tradable</th>
<th>Sectors</th>
<th>Tradable</th>
<th>Non Tradable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GDP</td>
<td>GDP, Prices</td>
<td>Union</td>
<td>GDP, Prices</td>
<td>Union, Trend</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ₁</td>
<td>-4.57</td>
<td>0.11</td>
<td>0.29</td>
<td>-0.22</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.07)</td>
<td>(0.13)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ₂</td>
<td>-0.31</td>
<td>-0.38</td>
<td>-0.20</td>
<td>-0.20</td>
<td>-0.20</td>
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<tr>
<td></td>
<td>(0.04)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.04)</td>
<td>(0.01)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>λ₃</td>
<td>1.85</td>
<td>0.18</td>
<td>1.05</td>
<td>0.18</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
<td>(0.02)</td>
<td>(0.12)</td>
<td>(0.02)</td>
<td>(0.02)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>λ₄</td>
<td>36.93</td>
<td>1.98</td>
<td>2.28</td>
<td>1.47</td>
<td>1.47</td>
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<tr>
<td></td>
<td>(2.56)</td>
<td>(0.20)</td>
<td>(1.71)</td>
<td>(0.14)</td>
<td>(0.10)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The eigenvalues are denoted as λ, their standard errors are in parenthesis. In order to calculate the standard errors we use the method of Bootstrap with 10000 iterations. The variables GDP, Prices and MINW denote IMACEC (index of monthly economic activity), relative prices (cost of capital and price of importable goods, as well as price of petroleum) and the ratio minimum wage to average wage of the economy. The variables Union and Trend denote number of individuals affiliated to a union and a time trend respectively. All the variables (with the exception of the trend) are measured in logarithms and seasonal adjusted.

The theory indicates different effects of the minimum wage on the labor market. Brown (1999) provides a revision of these effects. If we consider an economy with homogenous labor, a competitive market and binding minimum wage, a variation on the minimum wage causes a direct influence on real wages and, without affecting the labor demand function, determines employment. Conversely, if there is heterogeneity on labor supply, an increase in the minimum wage might impact the employment of low skilled workers and, provided substitution with non labor inputs, might also depress total labor demand, for any level of wages. This second effect implies that the minimum wage could be included in our set of Zs variables.

Graph 1 presents the evolution of this variable from January of 1983 to the present, showing its remarkable increase on the beginning of 1998 (nearly 18% on May of the 2003). The results (see Table 1), when we include this variable in the Z...
set, indicate that it does not allow to correct the demand functions, which continue to reject negative semi-definiteness in the $\Phi$ matrix.

**FIGURE 1**
RATIO MINIMUM WAGE-AVERAGE WAGE  
(January 1983 = 100)

Next, we include the total number of individuals affiliated to a union (UNION) as a proxy of a measure of labor inflexibility and expected cost of firing workers. The results in Table 1 show that the inclusion of this variable allows to significantly correct the magnitude and the significance of the positive eigenvalues in the $\Phi$ matrix. In fact in the tradable sector, the largest negative eigenvalue has a magnitude two times larger than the magnitude of the largest positive eigenvalue. The results in the non tradable sector, although better to the previous, do not allow to totally correct the shifts in the labor demand function, indicating that some other factors different from the one considered here have affected these sectors. Finally, including the trend in the $Z$ matrix, as a way of measuring changes in the demand function due to technological progress or some others exogenous change, is not significant for each of the three cases.

Table 2 provides the results considering only the last 60 months of the sample. The effect of the economic activity, as well as the effect of relative prices, are important, but not sufficient to correct the shifts in the demand functions. The effect of the minimum wage and the effect of the total number of individuals affiliated to a union appears very significant in this last period. The contributions of these variables allow to correct the problem in the tradable sectors, but not in the non tradable sectors. Further, the evidence of Table 2 shows an important break in the non tradable sectors, since the negative eigenvalues, although significant, have low magnitudes, whereas the largest positive eigenvalue is significant and its magnitude is approximately 2 times larger compared to the magnitude of the negative eigenvalue. This evidence indicates that there exists important changes in the non tradable sectors (or in some of them), that have not been caught by the variables.
considered here. Also, the fact that the minimum wage appears important in the correction, can probably indicate that in this period the minimum wage is very restrictive, due to the large increase occurred in 1998. However, its contribution is smaller than the one of the economic activity and relative prices.

**TABLE 2**

February 1996 to February 2001

<table>
<thead>
<tr>
<th>Sectors all</th>
<th>Tradable</th>
<th>Non tradable</th>
<th>Sectors all</th>
<th>Tradable</th>
<th>Non tradable</th>
<th>Sectors all</th>
<th>Tradable</th>
<th>Non tradable</th>
</tr>
</thead>
<tbody>
<tr>
<td>No correction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| $\lambda_1$ | -0.44 (0.04) | -0.29 (0.02) | -0.14 (0.03) | -0.17 (0.02) | -0.14 (0.09) | -0.04 (0.02) | -0.12 (0.02) | -0.09 (0.01) | -0.03 (0.00)
| $\lambda_2$ | -0.04 (0.009) | -0.005 (0.003) | -0.01 (0.006) | -0.02 (0.007) | -0.02 (0.001) | -0.02 (0.001) | -0.01 (0.005) | -0.03 (0.001) | -0.02 (0.001)
| $\lambda_3$ | 0.05 (0.01) | 0.007 (0.004) | 0.03 (0.009) | 0.01 (0.004) | 0.01 (0.001) | 0.011 (0.001) | 0.01 (0.005) | -0.001 (0.001) | 0.014 (0.001)
| $\lambda_4$ | 0.69 (0.05) | 0.17 (0.01) | 0.52 (0.04) | 0.32 (0.04) | 0.06 (0.01) | 0.26 (0.03) | 0.19 (0.03) | 0.04 (0.009) | 0.14 (0.002)

<table>
<thead>
<tr>
<th>GDP, prices, minW</th>
<th>GDP, prices, minW, union</th>
<th>GDP, prices, minW, union, trend</th>
</tr>
</thead>
</table>
| 1 | -0.05 (0.01) | -0.03 (0.007) | -0.016 (0.006) | -0.05 (0.01) | -0.028 (0.006) | -0.026 (0.009) | -0.05 (0.01) | -0.028 (0.005) | -0.026 (0.009)
| 2 | -0.01 (0.008) | -0.002 (0.001) | -0.0017 (0.002) | -0.007 (0.002) | -0.02 (3.16-4) | -0.001 (0.001) | -0.007 (0.002) | -0.02 (3.16-4) | -0.001 (0.001)
| 3 | 0.015 (0.004) | -0.001 (0.001) | 0.014 (0.004) | 0.01 (0.002) | 0.02 (0.001) | 0.006 (0.003) | 0.01 (0.002) | 0.002 (0.001) | 0.006 (0.003)
| 4 | 0.018 (0.003) | 0.02 (0.003) | 0.069 (0.012) | 0.05 (0.001) | 0.016 (0.003) | 0.04 (0.003) | 0.05 (0.001) | 0.016 (0.003) | 0.04 (0.008)

The eigenvalues are denoted as $\lambda$, their standard errors are in parenthesis. In order to calculate the standard errors we use the method of Bootstrap with 10000 iterations. The variables GDP, Prices and MINW denote IMACEC, relative prices (cost of capital and price of importable goods, as well as price of petroleum) and the ratio minimum wage to average wage of the economy. The variables Union and Trend denote number of individuals affiliated to a union and a time trend respectively. All the variables (with the exception of the trend) are measured in logarithms and seasonal adjusted.

4. **LIMITATIONS AND CONCLUSIONS**

The analysis relies on two assumptions. The first of them is the stability of demand functions conditional in the $Zs$ factors, e.g. the matrix $\Phi$ is stable. The second assumption relies on the fact that we interpret the $Zs$ factors as the factors that shifts labor demand functions. Nevertheless, it must be noticed that although these variables show explanatory power concerning the shifts in labor demand, it could be other variables with common trend the ones which truly produce the shift on labor demand. In our behalf, the inclusion of the $Zs$ variables chosen in this paper depends upon recommendations obtained from the economic theory.

The conclusions of this paper are twofold. Firstly, there are clearly identifiable factors determining shifts in labor demand. These variables are the level of economic activity, relative prices of substitutes, the total number of
individuals affiliated to unions and in addition, but only during the last period, the minimum wage. Secondly, it seems that it exists some factors not accounted in the structure of labor demand on the non tradable sectors. As those sectors are related to services which are intensive on high-skilled labor, the evidence suggests either a structural break or either the omission of a relevant variable shifting demand for high skilled-labor. A possible factor which might explain the phenomenon is the reform of the labor code, however no evidence for this hypothesis is provided and therefore must be source of further research.

REFERENCES