

Price and Wage Inflation in Chile

Carlos Jose García T. & Jorge Enrique Restrepo[†]

Central Bank of Chile

Abstract

Price and wage equations based on a model of imperfect competition were estimated using data from 1986:1 to 2000:4. From the estimations we can conclude: (i) as expected, productivity reduces unit labor costs and inflation and increases real wages; (ii) it is confirmed what was found in other studies in the sense that output gap and unemployment have a small impact on inflation due to widespread indexation; (iii) inflation imposes important costs to firms and workers; (iv) the exchange rate pass-through depends positively on economic activity and the inflation level, explaining why pass-through has been so low in recent years. Since inflation has been stabilized around 3% Pass-through should be permanently lower than in the nineties.

The estimation includes the first difference of the dependent variable following the literature on the estimation of linear quadratic adjustment cost (LQAC) models when the target and some of the driving variables follow I(2) processes. Given that it is a mark-up model, the price index fitted is narrower than the CPI to reflect the fact that these prices are formed where there is monopolistic competition. In order to model wages, we assume that a fraction of wages is negotiated, while the other fraction is adjusted according to past inflation. The nominal wages negotiated are determined following the theory of efficiency wage and bargaining model. The equations are used to generate out-of-sample inflation forecast closer to actual inflation than before.

JEL Classification: F3, F4

Key Words: Exchange rate pass-through, Phillips curve, mark-ups

[†]Senior Economists, Central Bank of Chile

The views expressed in this paper are those of the authors and should not be attributed to the Central Bank of Chile. We would like to thank Pablo García, Esteban Jadresic and seminar participants at the Bank of International Settlements and the Central Bank of Chile, for their comments and suggestions.

Contents

I. Introduction

II. Inflation Stylized Facts and Theoretical Considerations

a. The Phillips Curve

b. Exchange Rate Pass-Through

i. Theory and international evidence

ii. Rolling correlation

iii. Rolling regression and pass-through in a small-structural model

III. A Price Setting Model

a. Optimal price in the long run

b. Short run

IV. Results

a. Unit Roots and Cointegration

b. Price equation

c. Wage equation

d. Pass-Through

V. Conclusions

I. Overview

This article estimates equations for price and wage inflation using quarterly Chilean data from 1986:1 to 2000:4. Several issues crucial for understanding and anticipating the behavior of inflation—which are at stake in the Phillips curve—motivate such estimation. For instance: i) elasticity of inflation to the output gap, ii) the permanent and cyclical movements of mark-ups, iii) effects of labor productivity growth on inflation, iv) credibility, indexation and rationality, and v) the size of the exchange rate pass-through.

Even though we touch all these subjects in this paper, we take a closer look at the effect of exchange-rate changes on domestic inflation because apparently this factor has substantially changed in recent years. Despite the fact that Chile is a small open economy, the exchange rate pass-through has been low recently. In fact, there has been significant peso depreciation since 1997 without having a strong impact on inflation. Why is it? Is a low pass-through a new permanent characteristic of the Chilean economy? Will the depreciation impact on inflation take place as soon as demand takes off again? The answer to these questions is crucial defining monetary policy.

In order to tackle at least part of this research agenda, we present below a model of the Phillips curve based on some microfoundations and time-series econometrics. Thus, we address these issues by estimating a structural equation for price inflation that considers explicitly a model of staggered nominal price setting by imperfect competitive firms. In doing this, we use the quadratic price adjustment cost model of Rotemberg (1982), where the representative firm chooses a sequence of prices for solving its intertemporal problem. As a result, inflation can be represented as an error correction equation (Euler equation), relating this variable to expected inflation as well as to the gap between the “equilibrium” and actual price level.

In addition, an I(2) analysis of inflation and the mark-up is undertaken. We find that the price level is best described as I(2) process. To deal with I(2) processes, we incorporate inflation as an additional component of the “equilibrium” price in the Euler equation (Engsted and Haldrup 1999). Having this variable in the cointegration equation reflects the existence of a long-run relationship between mark-ups and inflation. In the

estimations this relationship is negative, which may be interpreted as the cost to firms of overcoming missing information when adjusting prices in an inflationary environment (Barnerjee, Cockerell and Russell 2001). Different versions of the price equation are estimated (Gruen, Pagan and Thompson 1999) by using a limited-information approach due to McCallum (1976).

Since, there is a clear connection between prices and wages, we also estimated a model to explain wage dynamics. The model assumes that a fraction of wages is negotiated every period, while the other fraction is adjusted according to past inflation (Jadresic 1996). The negotiated nominal wages are determined following the theory of efficiency wage and the bargaining model. Thus, expected real wages depend on labor productivity, unemployment, and past real wages (Blanchard and Katz 1997). In order to incorporate the fact that nominal wages are also I(2), we included the inflation rate as a cost for workers when wages are negotiated. Since indexation is never perfect, the higher the inflation level, the lower real average wage each period.

The results show, as expected, that labor productivity reduces unit labor costs and inflation. In addition, a negative relationship between inflation and both mark-ups and real wages indicates that inflation imposes important costs for firms and workers, fully justifying the stabilization program put in place by the Central Bank since 1990. Moreover, the results confirm what was found in other studies in the sense that output gap and unemployment have a small impact on inflation due to widespread indexation. Therefore, gradual monetary policy is perfectly adequate in this case.

Finally, since pass-through is related to economic activity and the level of inflation, it should be smaller than in the nineties given that the level of inflation has been stabilized around 3%. Taking the estimated price and wage equations simultaneously, the exchange-rate pass-through is analyzed by simulating an exchange rate shock, with and without output gap. Had not existed a negative output gap after 1997 exchange rate pass-through would have been higher.

This article is organized as follows. The second section shows several stylized facts and introduces some imperfect-competition theoretical framework for the Phillips curve and the exchange rate pass-through. The third one presents the mark-up model for prices. The next section has a wage model based on indexation, efficiency wage, and bargaining models. Then, the fourth section presents the estimations for the price and wage equations. Finally there are some conclusions and policy recommendations.

II. Inflation Stylized Facts and Theoretical Considerations

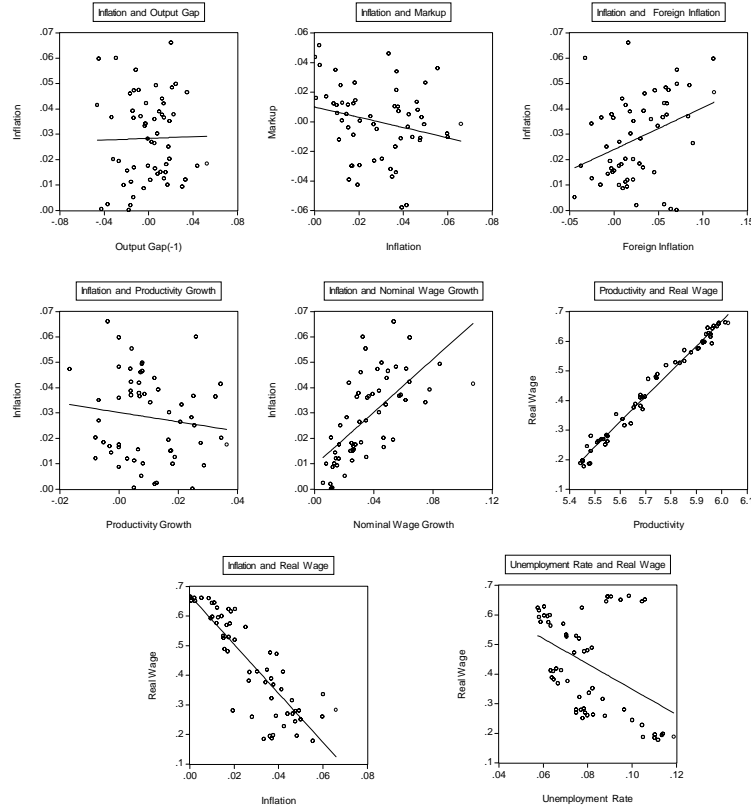
Figure 1 was built with data covering the sample already mentioned. It shows that during this period quarterly inflation has had a positive correlation with output gap and foreign inflation (considering the depreciation rate as well). Where output gap was calculated as the difference between actual output and its Hodrick-Prescott trend. Meanwhile, inflation had a negative correlation with average labor-productivity growth. The strong relation between price and nominal wage inflation indicates the key role indexation plays in the Chilean economy. In addition it is important to point out that there is a negative correlation between inflation and the mark-up¹. This reveals that, contrary to what we initially expected, in periods of higher inflation it is much harder for firms to increase the mark-up.

The negative correlation between real wages and inflation also indicates that workers suffer important costs from the latter expressed in lower real wages. Furthermore, both labor productivity and unemployment are important in wage setting as well. As seen in Figure 1 both variables have a strong correlation with real wages but with different signs.

These graphs seem to indicate there is a Phillips curve with a small slope while other variables, such as labor productivity and foreign inflation, also play an important role explaining inflation.

¹ Mark-up is obtained as the error term of this equation $p_t = a_0 + a_1(w_t - q_t) + a_2 p_t^* + \varepsilon_t$. P_t is price level, w_t is nominal wage, p_t^* is foreign price (adjusted by exchange rate, tariff, and taxes).

Figure 1
Inflation in Chile: Stylized Facts



a. A Phillips curve

A convenient and widely used setup to describe the behavior of the short-run tradeoff between the change in inflation and output is the expectations-augmented Phillips curve, like the one shown in equation 1.

$$\pi_t = \beta_1 * \pi_{t-1} + \beta_2 * E\pi_{t+1} + \beta_3 * \Delta_4 ep^* + \beta_4 * gap + \beta_5 * \Delta mk_t + \beta_6 * R_t + \varepsilon_t \quad (1)$$

Where $E\pi_{t+1}$ = expected inflation, $\Delta_4 ep^*$ = annual imported price inflation, gap = output gap, Δmk = mark-up, R = raw materials, supply shocks or relative price changes (Romer 1996, Ball and Mankiw 1995).

Equation 1 is also useful to summarize some of questions already mentioned above in which we are interested, since the coefficients are associated for instance to: i) β_1 : inertia and β_2 : how much forward looking price formation is; ii) β_3 : the size of the exchange

rate pass-through; iii) β_4 : elasticity of inflation to the output gap; iv) β_5 : the effect of mark-ups on inflation; v) β_6 : effects of raw- material shocks on inflation².

Similar or variations of equation 1 have been estimated for Chile (García, Herrera, and Valdés 2000). Nonetheless it is useful to pursue further research on Phillips curves since there is uncertainty about the β parameters, they do not have a structural interpretation and finally some of those equations have consistently overpredicted Chilean inflation during the recent past.

Furthermore, we will follow a different approach: instead of estimating a reduced form relation between the change in inflation and the unemployment rate we will estimate separate price and wage equations based on a model of imperfect-competitive firms in error-correction form. Thus, the error correction in the price equation ensures that in the steady state the price level is a mark-up on unit labor costs.

Besides the issues cited above, estimating price and wage equations will also allow us to say something about the relationship between labor productivity and inflation, and the effects inflation has on mark-ups and wages. The non-competitive setting is also appropriate to analyze the low exchange-rate passthrough experienced in recent years. Getting the right size of this coefficient is instrumental in implementing an adequate monetary policy. In the next section we introduce the non-competitive theoretical framework by relating the exchange rate pass-through to mark-ups and imperfect competition.

b. Pass-Through from Depreciation to Inflation

i. Theory

Although the exchange rate directly affects the peso price of imported goods, this movement does not necessarily get transferred to the end consumer immediately. When does this transfer occur and to what degree depends on several factors, some of which are described below.

² β_1 and β_2 coefficients are usually restricted to add up to 1.

As above said, the impact of changes in the exchange rate on domestic inflation is known as the “pass-through coefficient”. The direct short-term effect of the exchange rate on inflation is related to the imported part of the basket of goods that make up the CPI. The larger the share of imported goods within the CPI basket, the greater the exchange rate effect on prices. In Chile, about 48% of CPI goods are considered importable. The exchange rate also directly affects the cost structure of companies using imported inputs. Thus, the greater the proportion of imported inputs making up the costs, the more depreciation will affect these companies’ prices.

In a regime based on inflation targets, pass-through ultimately depends on monetary policy and agents’ expectations. Although in the short-term inflation may rise due to depreciation, in the medium- and long-term inflation should fall back to the target level or range defined by the Central Bank.

The behavior of demand determines whether or not companies can transfer to end prices any changes in their costs resulting from fluctuations in the exchange rate. For example, if the economy is in the midst of a recession, companies will find it difficult to transfer to their prices higher costs due to depreciation. Furthermore, movements in the exchange rate can also influence both the level of aggregate demand and wages as well as the composition of demand. For example, depreciation in the exchange rate that tends to produce a contraction in aggregate demand could also end up reducing prices by an amount equivalent to the upward pressures generated by the same depreciation.

Currency devaluation brings with it a change in relative prices. Assuming that income is constant, when the prices of imported goods rise, consumers’ real income falls. If demand for these imported goods is inelastic, the purchase of other goods and services will have to fall and, as a result, so will the prices of the latter, assuming that prices are perfectly flexible. However, prices are often rigid due to market imperfections. In this case, faced with currency depreciation, the CPI inflation rise. This is why many pass-through analyses are based on aspects related to industrial organization (Dornbusch, 1987). This analysis emphasizes, for example, the degree of import penetration, market structure in

terms of greater or lesser concentration, and the differentiation and degree of substitution between domestic and imported products.

A greater concentration in a productive sector increases the producing company's control over price and therefore over profit margins (mark-ups). The same occurs if there is a small degree of substitution between the domestic and imported product. This degree of control over the price could vary with the cycle (Small 1997). In these situations, producers evaluate the costs of modifying their prices and when these are higher than the benefits, they accept transitory fluctuations in their profit margins, causing prices to react less to shifts in the exchange rate.

As a result, in the presence of imperfect competition, aggregate demand movements, combined with fluctuations in the exchange rate, affect importers' mark-ups. More volatile aggregate demand would be associated with a reduced pass-through of exchange rate fluctuations to end prices. In this case, importers will be less willing to raise their prices for fear of losing market share.

The entrance of new firms could have an impact similar to a demand reduction. For instance, during the nineties the retailing sector has gone through a restructuring process in Chile. As a matter of fact, huge superstores and supermarkets distributing a wide variety of products proliferated. These megastores are usually able to reduce costs because of their ability to negotiate with suppliers. At the same time they fight for their market share by introducing sales and different marketing strategies. Some times these sales imply mark-up reduction particularly when demand is weak.

The volatility of the exchange rate is another factor influencing transfers affecting domestic inflation. Thus, the more volatile the exchange rate, the less its impact on domestic prices should be, because importers will be more cautious when it comes to changing prices, especially when the costs of an adjustment are high. As a result, expectations about the duration of currency depreciation affect the speed and size of pass-through of a higher exchange rate to prices.

The level of inflation also affects the pass-through coefficient. In general, the magnitude of the transfer should fall as the annual inflation rate declines. In a low-inflation economy, the price change of a good is more easily perceived as a modification of relative prices, which has more impact on demand for the good and its market share. Thus, the cost of increasing prices could be high for a company, if its market share plays a decisive role in its margins and total profits (Taylor 2000).

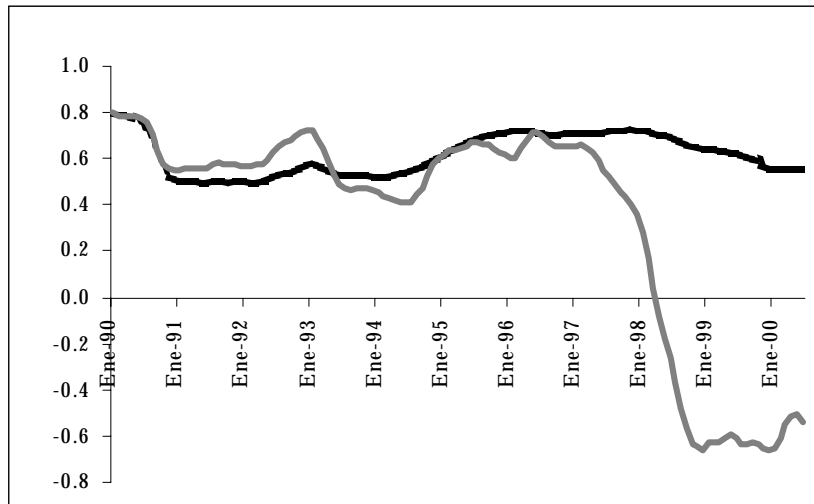
International evidence indicates that the pass-through of the exchange rate to prices is lower in developed countries than in Latin America and Asia³. In one panel estimate with 71 countries, Goldfajn and Werlang (2000) found a depreciation-to-inflation pass-through coefficient of 0.73 at the end of 12 months. When the sample was sorted between OECD members (Organization for Economic Cooperation and Development) and emerging economies, at the end of 12 months, pass-through coefficients of 0.6 and 0.91 respectively appeared. When this sample was sorted by regions, the 18-month coefficient for Europe was 0.46, while in America it was 1.24. Finally, as a result of an exercise based on their estimates, the authors found a bias toward predicting higher inflation than that actually observed in several well-known cases of large depreciation.

ii. Rolling Correlation

The simplest exercise one can do is to compute the correlation between inflation and exchange rate depreciation. In this case two rolling correlation statistics were computed (Figure 2). The first one (black line) has its starting date fixed (1986:1) and the correlation coefficient is calculated each time after adding a new observation starting in 1990. Therefore, each computation has a larger sample than the last one. Even though this coefficient is rather stable, it has some movement. It decreases at the beginning of the nineties, grows again from 1994 to 1996 and is steadily falling since 1998.

³ There has been a great amount of articles written on pass-through over the years. Most of them try to estimate how much exchange rate fluctuations are responsible for the behavior of inflation. Some use CPI inflation others producer price inflation. There is also a wide range of estimation techniques used to obtain a quantitative result. It goes from ordinary least squares (Woo 1984), to panel data (Goldfajn and Werlang 2000), vector auto regression (McCarthy 1999), cointegration analysis and error correction models (Beaumont et al 1994, Kim K. 1998, Kim Y. 1990), and state-space models (Kim Y. 1990).

Figure 2
Rolling Correlation Coefficient between Annual Inflation and Depreciation



The second statistic in Figure 2 (gray line) has a fully moving sample. Thus, both the starting and ending dates move each time the correlation coefficient is computed. In this case the statistics fluctuates much more. This coefficient moves closely to what is happening to the former up to 1996. After that year it falls dramatically to even become negative showing an important change in the relationship between these two variables.

It is worth saying that such a simple exercise shows that decision making based exclusively on the pass-through coefficient used in the small structural model, or based on the first correlation statistics computed, could lead to policy mistakes. That way one could easily overestimate forecasted inflation missing the significant change, that took place from 1997 to 1999, in the relationship between inflation and currency depreciation.

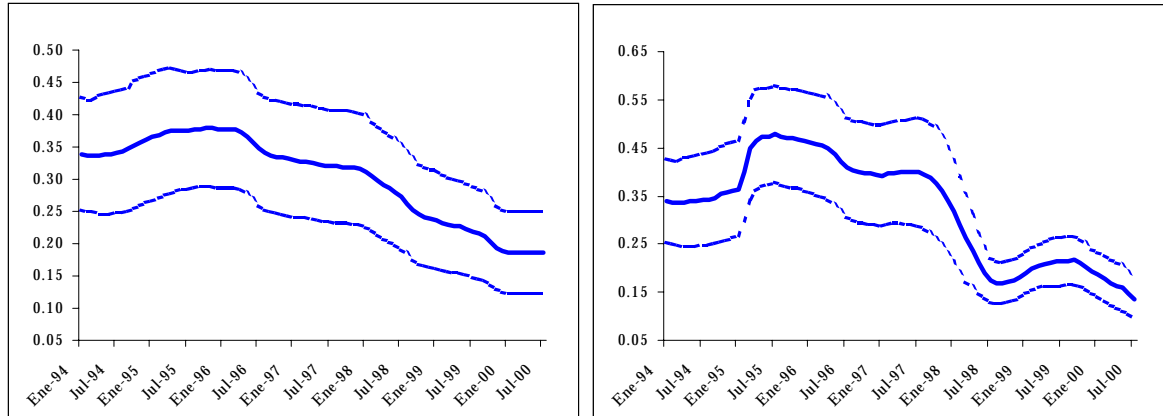
iii. Rolling Regression and Pass-Through in a Small Model

A rolling regression was estimated for annual inflation with exchange rate depreciation and a trend as right hand side variables using monthly data between 1986 and 2000⁴ (Figure 3). Again the two types of rolling samples were used. The left side in Figure 3 shows the regression coefficient obtained when the initial date of the sample does not change. On the contrary, the sample used to estimate the right side in Figure 3 has both initial and last date moving. The left panel of Figure 3 shows that the coefficient fall

⁴ Annual CPI inflation was found to be trend stationary using monthly data.

started earlier in 1996. As one would expect the coefficient is less stable with both dates moving⁵.

Figure 3
Rolling Regression

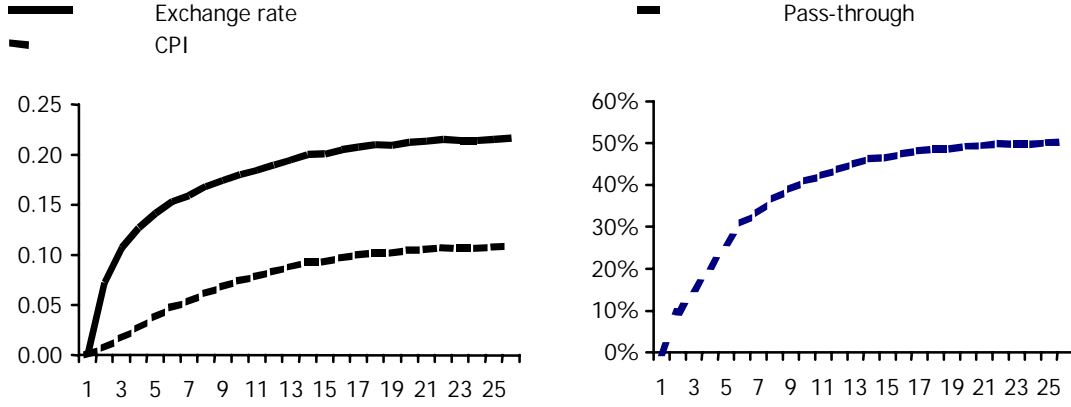


Missing variables such as output gap may cause the instability problem. We also simulated a (five equation) small structural model, similar to the one in García, Herrera and Valdés (2000). The impact of the exchange rate on inflation is controlled by output gap. The pass-through obtained with this simulation amounts to 50% over 5 to 6 years (Figure 4). Meaning that the period over which the full impact of a depreciation is felt is rather long. However, Figure 4 shows that over the first three years most of the effect has already taken place. It is important to point out that this model includes a monetary rule consistent with the behavior of a Central Bank in an inflation-targeting regime. Therefore, it explains why pass-through is never complete in Figure 4⁶.

⁵ As a matter of fact, it matches some stylized facts of the economy during the last decade. It is well known there was a consumption boom between 1995 and 1997 which coincides with a rebound of this coefficient.

⁶ Pass-through never reaches 100% because traded goods represent a share of all inputs and consumer goods.

Figure 4
Pass-Through in a Small Model



III. A Price Setting Model

a. Optimal Price in the Long Run

In this section we derive a Phillips curve from the quadratic price adjustment cost model developed by Rotemberg (1982). Thus, firms weigh the cost of changing prices against the cost of being away from the price that the firm would choose in case there were no adjustment cost (Roberts 1995). The latter price is called the “optimal price” which is found following Beaumont et al (1994) and Layard et al (1991). The firms are identical and get an output (y) by using labor (l) and an imported input (z):

$$y_i = a_1 + a_2 l_i + (1 - a_2) z_i \quad (2)$$

Each firm’s demand is $y_d f$, where f is the log of the number of identical firms. The demand curve faced by each firm would be:

$$y_{di} = -\eta(\tilde{p}_i - p) + y_d - f \quad (3)$$

where p_i is the firm’s price, p is the price level and η is the elasticity of demand. Therefore, the price that maximizes benefits in the long run is given by:

$$\tilde{p}_{di} = -\log\left[\frac{n}{n-1}\right] + MC = m + MC = m + a_1 + a_2 w_t + (1 - a_2) p_t^* \quad (4)$$

where the price (p_{di}) is fixed by charging a margin (m) over the marginal cost (MC)⁷. A pricing model based on a mark-up over costs is inappropriate when applied to markets close to perfect competition like the ones for agricultural products (Woo 1984). Since the

⁷ Note also that w_t can be separated in private (wpr_t) and public wages (wpu_t).

price index to be explained should be the one reflecting monopolistic markets, core or underlying inflation, IPCX2⁸ is used here.

We examine the margin now. It is assumed that in the long term firms desire a constant mark-up, m . However, in the short run firms could postpone price adjustments and accept deviations of their mark-up from the desired level. In doing so, firms could be motivated by both market share and the actual cost of changing prices or menu cost (Ghosh and Wolf 2001). Therefore, demand fluctuations and anything affecting market power could have an impact on the mark-up (Banerjee, Cockerell and Russell 2001). On the other hand, margins and inflation may also be either positively or negatively related because there are two opposite effects. First, one would expect this coefficient to be positive since, as above said, it is harder for employers to pass on to customers cost increases in a low-inflation environment (Taylor 2000). In Taylor words “firms in low inflation economies will appear to have less pricing power than firms in high inflation economies.” Second, one would also expect that inflation imposes costs on firms and therefore the mark-up net of inflation is reduced (Banerjee, Cockerell, and Russell 2001). We rely on the econometric estimation to determine its sign, i.e. which effect is greater.

We follow Banerjee et al (2001), Benabou (1992), Russel et al (1997) and others arguing that high inflation, which usually leads to higher volatility and uncertainty, is associated with lower mark-ups. Therefore we write the mark-up equation as a function of labor productivity, output gap and inflation:

$$m = c_1 + c_2 q_t + c_3 (y_t - \bar{y}_t) + c_4 \Delta p_t \quad (5)$$

Following Beaumont et al (1994), and Banerjee et al (2001) one can approximate equation 4 by this expression:

$$\tilde{p}_{di} = (a_1 + c_1) + a_2 (w_t - q_t) + (1 - a_2) p_t^* + c_3 (y_t - \bar{y}_t) + c_4 \Delta p_t \quad (6)$$

Where p^* is equal to foreign input prices adjusted by nominal exchange rate and taxes and $w_t - q_t$ is wages minus labor productivity (unit labor cost). Here we are imposing $a_2 = -c_2$, which implies that income shares are independent of the level of productivity in the long run. We drop output gap from the long-run price equation (6) on the base that it is a

⁸ IPCX excludes perishable food as well as gas, fuels and regulated services. Throughout the article we

stationary variable with a zero steady-state level. Although in the short run (12), mark-up depends on economic activity. However, economic theory is not conclusive regarding this issue and it could be either pro or counter cyclical. Therefore, this is question should be solved empirically.⁹

b. Short run

The structural equation for inflation is in the spirit of the new Phillips curve literature. It evolves explicitly from a setting of imperfect competitive firms where nominal prices are rigid. In doing this, we propose a (Rotemberg 1982) LQAC model of the representative firm, which minimizes the loss of charging for its product a different price from the optimal one weighted against the cost of changing its price. This intertemporal problem is solved by choosing a sequence of p_t , the decision variable, in order to:

$$\min_{\{p_{t+i}\}} E_t \sum_{i=0}^{\infty} \beta^i \left[\theta (p_{t+i} - \tilde{p}_{t+i})^2 + (p_{t+i} - p_{t+i-1})^2 \right] \quad (7)$$

where E_t is the expectations operator conditional on the full public information set, β is the subjective discount rate, θ is the relative cost parameter, and \tilde{p}_t denotes the optimal price of p_t . After rearrangement, the Euler equation from the minimization problem can be written as:

$$\Delta p_{t+i} = \beta \Delta p_{t+i+1}^e - \theta [p_{t+i} - \tilde{p}_{t+i}] \quad (8)$$

Where Δp_{t+i+1}^e denotes expected inflation. One could think of it as being an error-correction equation relating the rate of inflation to the gap between the equilibrium and actual price levels. In order for this to be a useful theory of inflation, the optimal price level needs to be defined as in (6).

The second step is to reparameterize equation (8) for carrying out the I(2) analysis. Following Haldrup (1995) the optimal price can be parameterized as:

$$\tilde{p}_t = \gamma_1 x_{1,t-1} + \gamma_1 \Delta x_{1,t} + \gamma_2 x_{2,t-1} + \gamma_2 \Delta x_{2,t-1} + \gamma_2 \Delta x_{2,t-1} + \gamma_2 \Delta^2 x_{2,t}$$

also call it core inflation.

where x_1 are the I(1) variables $\{q_t, \Delta p_t\}$ while x_2 are the I(2) ones $\{w_t\}$.

Therefore we transform the optimal price:

$$\tilde{p}_t = (1-a_2)p_{t-1}^* + a_2(w_{t-1} - q_{t-1}) + c_4\Delta p_{t-1} + a_2\Delta w_{t-1} + (1-a_2)\Delta p_t^* + a_2(\Delta^2 w_t - \Delta q_t) + c_4\Delta^2 p_t$$

Now we transform $\theta[p_t - \tilde{p}_t]$ to get the cointegration error correction term.

In order to do that we add and subtract Δp_{t-1} , and we also use two identities

$$p_t \equiv p_{t-1} + \Delta p_t \text{ and } \Delta p_{t-1} \equiv \phi\Delta p_{t-1} + (1-\phi)\Delta p_{t-1} \text{ where } \phi = \frac{\beta}{1+\theta}. \text{ Thus, equation (8) can}$$

be written in acceleration form:

$$\begin{aligned} \Delta^2 p_t &= k_1(\Delta p_{t+1} - \Delta p_{t-1}) + k_2(1-a_2)\Delta p_t^* + k_2a_2(\Delta^2 w_t - \Delta q_t) + \psi(y_{t-1} - \bar{y}_{t-1}) \\ &- k_2 \left(p_{t-1} - \left[(1-a_2)p_{t-1}^* + a_2(w_{t-1} - q_{t-1}) + a_2\Delta w_{t-1} + \left(c_4 + \frac{(1-\phi)(1+\theta)}{\theta} \right) \Delta p_{t-1} \right] \right) + \varepsilon_t \end{aligned} \quad (12)$$

$$\text{Where } k_1 = \frac{\beta}{1+\theta(1-c_4)} \text{ and } k_2 = \frac{\theta}{1+\theta(1-c_4)}$$

Even though the model is over-identified and we need to impose some restrictions to identify all parameters, the parameters β , γ_{12} and θ can be obtained from the same number of equations:

$$\hat{k}_1 = \frac{\beta}{1+\theta(1-c_4)}, \quad \hat{k}_2 = \frac{\theta}{1+\theta(1-c_4)}, \quad \hat{k}_3 = \hat{k}_2^* \left(c_4 + \frac{(1-\phi)(1+\theta)}{\theta} \right) \quad (13)$$

Where k_1 , k_2 , and k_3 are parameters obtained from the unrestricted estimations.

Equation (12) is what we refer to as the price equation. This equation relates inflation to expected inflation, wage growth, output gap, and average cost. In addition, there is an error correction term which ensures that in steady state the price level is set adding a mark-up on unit labor cost and imported-input prices. If one wants to get the expectations-augmented reduced-form Phillips curve, one should substitute $\Delta^2 w_t$ for a wage curve (Blanchard and Katz 1997, Gruen, Pagan and Thompson 1999).

⁹ The theory about the relationship between margins and the cycle is ambiguous. Some models predict procyclical margins (Kreps and Scheinkman 1983). Others, in contrast, predict that they are countercyclical (Rotemberg and Saloner 1986, Rotemberg and Woodford 1991).

Finally, it is important to notice that expected inflation matters because prices are sticky. What happens with prices next period affects current prices. Note that expectations can be rational or adaptive. When expectations are rational, we will have a price curve similar to the New Phillips curve proposed by Galí (2000) and Roberts (1995). Inflation rate can jump. However, usually inflation shows a great amount of inertia¹⁰. This distinction is crucial whenever designing a successful stabilization program. For example, in the case of sticky inflation a more gradual stabilization program is called for, in order to reduce the risk of causing a sharp fall in the rate of output growth.

c. Private Wage Equation

We have assumed that indexation is complete and there is uniform staggering in order to study wage behavior. This implies that a proportion α of the wages is negotiated, while $(1-\alpha-\delta)$ are adjusted according to past inflation (Jadresic 1996). The remainders (δ) cannot adjust their wages with past inflation and suffer a loss with it.

$$\Delta wpr_t = (1 - \alpha - \delta)\Delta p_{t-1} + \alpha\Delta x_t \quad (14)$$

The negotiated wages are set as in Blanchard and Katz (2001):

$$x_t - p_{t+1}^e = \mu b_t + (1 - \mu)q_t - \beta u_t + \varepsilon_t \quad (15)$$

The expected real wage depends on the reservation wage, b_t , labor productivity, q_t , and unemployment rate, u_t , where $0 \leq \mu \leq 1$. The reservation wage is related to non-labor income. However, Blanchard and Katz (2001) argue that labor productivity increases "in the informal and home production sectors are closely related to those in the formal market economy." Therefore the reservation wage depends on past real wage and labor productivity.

$$b_t = a + \sigma(wpr_{t-1} - p_{t-1}) + (1 - \sigma)q_t \quad (16)$$

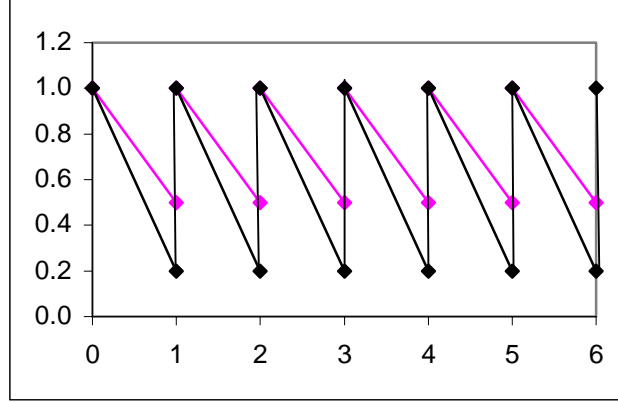
Substituting equation (16) into (15) and doing some algebra one can get equation (17):

¹⁰ In Chile inflation is highly persistent to the extent that it is best described as being an I(1) process.

$$\Delta x_t = [p_{t+1}^e - p_{t-1}] + \mu a - (1 - \sigma\mu)(wpr_{t-1} - p_{t-1} - q_{t-1}) + (1 - \sigma\mu)\Delta q_t - \beta u_t \quad (17)$$

Where p_t is the consumer price level, which includes all goods¹¹, and q_t is labor productivity.

Figure 5
Average Real Wage and Inflation



Replacing equation (17) into equation (14) and doing a reparameterization aggregate wage acceleration is found:

$$\Delta^2 wpr_t = \alpha [\Delta p_{t+1}^e - \Delta p_{t-1}] + (\Delta p_{t-1} - \Delta wpr_{t-1}) + \alpha\mu a - \alpha(1 - \sigma\mu)(wpr_{t-1} - p_{t-1} - q_{t-1}) + \alpha(1 - \sigma\mu)\Delta q_t - \alpha\beta u_t - \delta\Delta p_{t-1} + D_t + Z_t + \varepsilon_t \quad (18)$$

Where α , μ , λ , δ are all greater than zero. D_t represents variables such as seasonal dummies. Variables such as minimum wages and public wages are in Z_t . Thus in absence of adjustment cost, an increase in either the price level or labor productivity will cause an increase in the desired nominal wage. We have also incorporated the rate of inflation to consider the negative effect this variable has on real wages. Since indexation is never perfect, the higher the inflation level, the lower average real wage each period. This loss is equal to $\delta\Delta p$ (Figure 6).

On the other hand, some parameters of interest can be obtained from this specification. For instance, the impact of unemployment on wage acceleration, for workers who are changing their wage contracts can be calculated as $\alpha\beta$.

¹¹ Indexation is based on CPI.

V. Results

We present here the estimation results. Instead of applying the two step method proposed by Engle and Granger (1987) and Haldrup (1995), we estimated the long-run relationship together with the dynamics, as in equation 12, following Harris (1995)¹². As this author puts it, when estimating a long-run equation, superconsistency ensures that it is asymptotically valid to omit the stationary $I(0)$ terms, however the long-run relationship estimates will be biased in finite samples (see also Phillips 1986). Therefore, Harris cites Inder (1993) to conclude that in the case of finite samples, "the unrestricted dynamic model gives... precise estimates (of long-run parameters) and valid t-statistics, even in the presence of endogenous explanatory variables" (Harris op.cit., p.p. 60-61). At the same time it is also possible to test the null hypothesis of no cointegration.

In addition, an $I(2)$ analysis of inflation and the mark-up is done as in Haldrup (1995). We find that the levels of prices and unit labor costs are best described as $I(2)$ processes.

1. Unit Roots and Cointegration

We begin the empirical section testing for unit roots the variables used in the estimations. Table 1 indicates that price level and wage are $I(2)$. This confirms that the price equation can be estimated in acceleration form. In general one can say that Chilean inflation deviates from any given mean in the period here considered. On top of that, Chilean inflation has traditionally been very persistent due to generalized indexation. In addition, variables such as output gap and the nominal exchange rate are instead $I(0)$ and $I(1)$ respectively.

¹² Harris, R. *Cointegration Analysis in Econometric Modeling* pp 60-61. See also Phillips and Loretan (1991) for a comparison among several one-step (uniquational) cointegration methods used to estimate long-run economic equilibria.

Table 1
Unit Root Test

Variables	Level ¹	First differences ²
Price	-0.02	-0.14 ³
Private Wage	1.13	-1.33
Labor Productivity	-2.38	-6.63
Nominal Exchange Rate	-2.16	-3.78
Foreign Price	-1.59	-5.98
Output Gap	-4.26	-7.2
Private Unit Labor Cost	-0.22	--1.35
Public Wage	0.72	-0.65
Unemployment Rate	-2.41	-3.87
1% Critical Value ⁴	-3.56	-3.56
5% Critical Value	-2.92	-2.92
10% Critical Value	-2.6	-2.6

- (1) Test includes a constant and a trend.. (2) Test includes a constant
(3) We also tested inflation including a constant and a trend. In this case the statistic (-2.7) does not allow reject the unit root hypothesis either.
(4) MacKinnon critical value for rejection of a unit root hypothesis.

In order to test for cointegration Phillips-Perron and Dickey-Fuller tests were applied to the residuals obtained in the regression: $p_t = c + \beta_1 w_t + \beta_2 q_t + \beta_3 p^*_t + \beta_4 \Delta p_t + \varepsilon_t$. Unit root is rejected at standard critical values. However when using I(2) variables the appropriate critical values are tabulated in Haldrup (1994). In this case the Phillips-Perron statistic is high enough to reject the null hypothesis. On the other hand the Dickey-Fuller statistic roughly matches the 10% Haldrup critical value (Table 2). We consider that with these results it is possible to reject the null of no cointegration, especially when the Z test is considered.

Table 2
Cointegration Test for Prices^{1,2}

Test	Value	Critical Value	5%	10%
Phillips-Perron	-5.9	PP	-2.6	-1.95
		Haldrup	-4.3	-3.9
ADF	-4.2	ADF	-2.6	-1.95
		Haldrup	-4.3	-3.9

(1)The equation to obtain error term was the following:

$$p_t = c + \beta_1 w_t + \beta_2 q_t + \beta_3 p^*_t + \beta_4 \Delta p_t + \varepsilon_t$$

(2) Each test was estimated with four lags. Serial Correlation LM and ARCH tests do not indicate autocorrelation or heteroskedasticity.

2. Price Equation

As stated in equation (12), price acceleration was run on wage, productivity, output gap, lagged prices, foreign prices and several difference terms¹³. We have estimated two versions of equation (12).

- Model 1

In this estimation we imposed $\beta_6 = -\beta_7$, which implies that we can introduce unit labor costs instead of private wages and labor productivity. Cost homogeneity (the various costs add up to prices) was also imposed: $-\beta_4 = \beta_5 + \beta_6 + \beta_7 + \beta_8 + \beta_9$. Table

$$\Delta^2 p_t = \beta_1 + \beta_2 (\Delta p_{t+1}^e - \Delta p_{t-1}) + \beta_3 (y_{t-1} - \bar{y}_{t-1}) + \beta_4 p_{t-1} + \beta_5 (wpr_{t-1} - q_{t-1}) + \beta_6 (wpu_{t-1} + taxes) + (-\beta_4 - \beta_5 - \beta_6) p_{t-1}^* + \beta_7 \Delta p_{t-1} + \beta_8 \Delta^2 w_{t-1} + \beta_9 \Delta q_t + \beta_{12} \Delta e_{t-1} + \beta_{10} \Delta e_{t-3}$$

where wpr is private wages and wpu corresponds to public wages.

- Model 2

Model 2 includes exchange rate terms multiplied by inflation, besides also having the unit-labor cost restriction.

$$\Delta^2 p_t = \beta_1 + \beta_2 (\Delta p_{t+1}^e - \Delta p_{t-1}) + \beta_3 \frac{1}{2} [(y_{t-1} - \bar{y}_{t-1}) + (y_{t-2} - \bar{y}_{t-2})] + \beta_4 p_{t-1} + \beta_5 (wpr_{t-1} - q_{t-1}) + \beta_6 wpu_{t-1} + [\beta_7 + \beta_8 (p_{t-1} - p_{t-4})/4] p_{t-1}^* + \beta_9 \Delta p_{t-1} + \beta_{10} \Delta^2 wpr_{t-1} + \beta_{11} \Delta^2 wpu_{t-1} + \beta_{12} \Delta q_t + \beta_{13} \Delta e_t + \beta_{14} \Delta p_t \Delta e_t + \beta_{15} D883 + \beta_{16} D911$$

where $p^* = e + p_{ext} + taxes$

The results are presented in Table 3:

¹³ Even though the oil price was included in these regressions to take into account short-run shocks to the system it was not significant. Therefore we dropped it.

Table 3
Price Equation (Dependent Variable: $\Delta^2 p_t$)
Sample 1987.4-2000.4

Variables ¹	Model 1	Variables	Model 2
<i>Const</i>	0.57 (2.8)	<i>Const.</i>	0.58 (3.3)
$\Delta p_{t+1}^e \cdot \Delta p_{t-1}^2$	0.34 (2.3)	$\Delta p_{t+1}^e \cdot \Delta p_{t-1}^2$	0.19 (2.0)
$(y_{t-1} - \bar{y}_{t-1})$	0.08 (3.4)	$(y_{t-1} - \bar{y}_{t-1})$	0.08 (2.6)
p_{t-1}	-0.23 (-5.2)	p_{t-1}	-0.25 (-10.0)
$wpr_{t-1} - q_{t-1}$	0.15 (4.7)	$wpr_{t-1} - q_{t-1}$	0.13 (6.2)
wpu_{t-1}	0.05 (3.4)	wpu_{t-1}	0.08 (8.3)
p_{t-1}^*	0.23-0.15- 0.05=0.03	p_{t-1}^*	0.02 (1.7)
Δp_{t-1}	-0.3 (-1.8)	$p_{t-1}^* \cdot (p_t - p_{t-4})/4$	0.05 (3.6)
$\Delta^2 w_{t-1}$	0.17 (3.9)	Δp_{t-1}	-0.61 (-4.7)
Δq_t	-0.23 (-3.2)	$\Delta^2 wpr_{t-1}$	0.15 (4.3)
Δe_t	0.04 (1.7)	$\Delta^2 wpu_{t-1}$	0.02 (1.8)
Δe_{t-3}	0.04 (2.3)	Δq_t	-0.11 (-2.1)
		Δe_t	-0.05 (-3.1)
		$\Delta e_t \cdot \Delta p_t$	3.1 (3.5)
		D883	-0.012 (-8.7)
		D911	-0.009 (-4.7)
R^2	0.70		0.87
DW	2.06		2.34
ARCH(4) ³	0.6 (66%)		1.2 (32%)
LM(4) ³	0.8 (52%)		4.9 (0%)
Jaque Bera ³	5.4 (6%)		0.4 (82%)
β	1.2		
θ	0.8		
c_4	-2.04		
assuming $\beta=1$			
c_4	[-2.4, -1.8]		
θ	[0.7, 1]		

(1) p_t is core inflation and each variable is in logs.

(2) Δp_{t+1}^e is estimated by instrumental variables. We use as IV contemporaneous and three lags of domestic inflation, external inflation, rate of depreciation, wage growth, labor productivity growth, output gap, and the rate of growth of oil price. We also include seasonal dummies.

(3) Probabilities are reported in brackets.

Table 3 shows the estimation of equation (12)¹⁴. The various diagnostic residual tests indicate that the models have the desired properties for OLS estimation¹⁵. Multivariate tests are satisfactory as seen in the lower part of the table. In general, the econometric fit is satisfactory with high R-squares and highly significant variables. Also, the results presented in Table 3 provide evidence of the existence of I(2) data trends and cointegration because the parameter of Δp_{t-1} is significant and the error terms are stationary.

We tested the two restrictions of model 1 using an unrestricted version of it. First, we tested the hypothesis of the coefficient on private wages being equal to the one on labor productivity, though with opposite signs. If this is the case we can include unit labor cost (w-q) as a variable in the model. As shown in Table 4 the Wald test indicates that we fail to reject the null hypothesis at a 89% of significance. Second, we tested in Model 1 the hypothesis of cost homogeneity or, the same, the various costs add up to prices. We also fail to reject this null hypothesis at a 35% of significance (Table 4). As a result we imposed both restrictions in Model 1. The third estimated model, which generates the best out-of sample inflation forecast, includes only the unit labor cost restriction. This model is also different in the sense that it has two dummy variables and the exchange-rate terms are multiplied by the rate of inflation: $\beta_8 \Delta p_t \cdot p^*_{t-1} \beta_{14} \Delta e_t \cdot \Delta p_t$. The out-of-sample forecast of this model is better as can be seen in the second row of Figure 6.

A major outcome of these econometric estimations is that the parameters have the expected signs and the restrictions of the model hold. The coefficient on output gap ($y_{t-1} - \bar{y}_{t-1}$) is positive but small, indicating that a 10 per cent output gap will accelerate inflation rate in 0.8 per cent. Thus, these results confirm what was found in other studies in the sense that output gap and unemployment have a small impact on inflation due to widespread indexation. Therefore, a gradual monetary policy is perfectly adequate in this case.

¹⁴ Instead of having the contemporaneous acceleration of nominal wages, we included its first lag because the former was not significant and had the wrong sign.

¹⁵ However the second model may have some autocorrelation. Standard errors were obtained with the Newey-West heteroscedasticity and autocorrelation consistent procedure.

Table 4
Restrictions Tests

Wald Test Hypothesis	Model 1
Unit Labor Cost	89%
Linear Homogeneity	35%

The results also show, as expected, that labor productivity reduces unit labor costs and inflation. In addition, a negative relationship between inflation and both mark-ups and real wages indicates that inflation imposes important costs for firms and workers, fully justifying the stabilization program put in place by the Central Bank since 1990¹⁶. On the other hand, expected inflation acceleration $\Delta p_{t+1}^e - \Delta p_{t-1}$ is significant, confirming that expectations matter determining inflation.

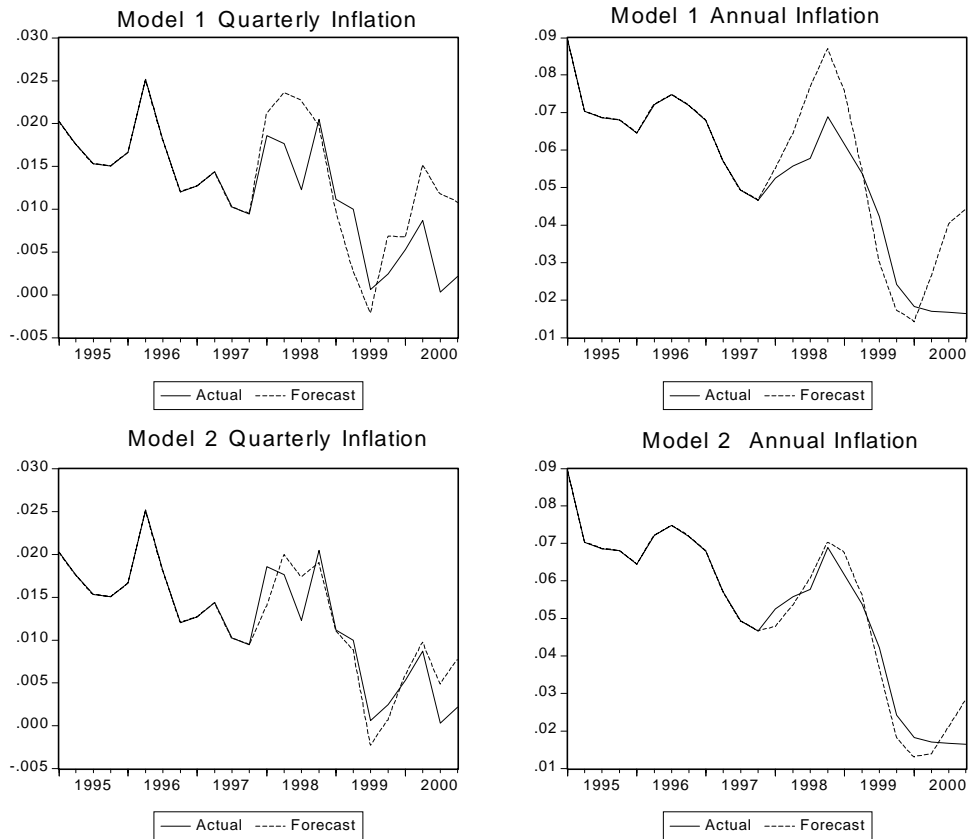
The parameters β , c_{12} and θ can be obtained from equation (13). This implies that the long-run relationship between markup and inflation is negative, i.e., c_{12} is around (-2) . On the other hand, θ is 0.8. This parameter is the weight firms put on costs associated with deviations from the optimal price. Notice that inflation imposes a high cost for firms: one-percentage point increase in annual steady state inflation (0.25) reduces markups in average 0.5 per cent $(0.25 * 2)$ ¹⁷.

In order to compare the models we estimated them until 1997:4 and generated out-of-sample inflation forecast (Figure 6). We find that the restrictions imposed on Model 2 reduce the error when compared to a fully unrestricted estimation (first row in Figure 6). On the other hand, the second model is better forecasting inflation. This confirms that pass-through is positively related to inflation and, at the same time, that inflation overprediction in the recent past is linked to miss-measurement of the pass-through coefficient.

¹⁶ Barnerjee et al (2001) found a similar result for Australia.

¹⁷ One problem with estimation is that β is far above what is theoretically reasonable. In empirical studies it is often common to find imprecise estimates of the discount factor, hence it may be preferable to fix it. Nevertheless, the model is overidentified when β is fixed and it is only possible to obtain a range of values for c_{12} and θ . Fixing $\beta=1$, we obtain a range between 0.7 and 1.0 for the θ coefficient. In the case of the c_{12} parameter, in equation (12), it is negative and similar to the value found without fixing $\beta=1$ (see Table 3).

Figure 6
Out-of-sample Inflation Forecast



3. Wage equation

Regarding wages, Table 5 indicates that using the error term from this regression $w_t = c + \beta_1 p_t + \beta_2 q_t + \beta_3 \Delta p_t + \varepsilon_t$, the Phillips-Perron statistic does not reject the null of no cointegration at a 10% Haldrup critical value. On the other hand, Table 6 shows that the wage model replicates the dynamics of wage inflation remarkably well (out-of-sample forecast confirms this as well, see Figure 7). The regressors explain most of the movements of the dependent variable since the adjusted R squared is around 80%. In addition ARCH test and LM test on the residuals allow us to reject the presence of significant heteroskedasticity and autocorrelation respectively.

Table 5
Cointegration Test for Private Wages^{1 2 3}

Test	Value	Critical Value	5%	10%
Phillips-Perron	-4.15	PP	-2.6	-1.95
		Haldrup	-4.3	-3.9
ADF	-2.7	ADF	-2.6	-1.95
		Haldrup	-4.3	-3.9

(1) The equation to obtain error term was the following $wpr_t = c + \beta_1 p_t + \beta_2 q_t + \beta_3 \Delta p_t + \varepsilon_t$

(2) Each test was estimated with four lags. Serial Correlation LM and Arch tests do not indicate autocorrelation and heteroskedasticity.

(3) Hodrick-Prescott filter is used to calculate productivity.

As shown in Table 6, the data confirms a negative relationship between the acceleration of wage inflation $\Delta^2 w_t$ and unemployment U_t , with a -0.15 parameter. This is a Phillips curve itself. It is worth pointing out that there is a close relation between wage and CPI inflation due to widespread indexation (the term $\Delta p_{t-1} - \Delta w_{t-1}$). Our estimation indicates that a 10% increase in inflation above wages will lead to a 7% acceleration of wage inflation next period¹⁸.

¹⁸ It is worth noting that expected inflation was not significant in the wage equation and hence it was dropped.

Table 6
Private Wage Equation (Dependent Variable: $\Delta^2 w_t$)
Sample 1987.4-2000.4

$$\Delta^2 wpr_t = \beta_1 + \beta_2 \Delta q_t + \beta_3 (\Delta p_{t-1} - \Delta wpr_{t-1}) + \beta_4 w_{t-1} + \beta_5 p_{t-1} + \beta_6 q_{t-1} + \beta_7 \Delta p_{t-1} + \beta_8 U_t + \beta_9 d_2 + \beta_{10} d_3 + \beta_{11} d_4$$

	Variables ¹	Coefficient ² (t-statistic)
β_1	C	-0.8 (-2.8)
β_2	Δq_t	0.1 (1.3)
β_3	$\Delta p_{t-1} - \Delta wpr_{t-1}$	0.68 (7.6)
β_4	wpr_{t-1}	-0.35 (-3.4)
β_5	p_{t-1}	0.37 (3.4)
β_6	Q_HP_{t-1}	0.15 (2.7)
β_7	Δp_{t-1}	-0.33 (-2.7)
β_8	U_t	-0.15 (-1.84)
β_9	Seas_D2	-0.006 (-2.2)
β_{10}	Seas_D3	0.001 (0.5)
β_{11}	Seas_D4	-0.003 (-1.3)
R^2		0.79
DW		2.17
Arch(4) ³		0.67 (61%)
LM(4) ³		0.43 (78%)
Jaque-Bera ³		1.3 (51%)

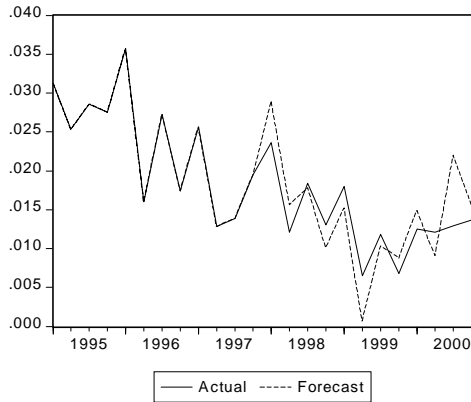
(1) Except unemployment rate, each variable is in log.

(2) Hodrick-Prescott filter is used to calculate the level of productivity. Instead, the first difference is calculated without using this filter.

(3) Probabilities are reported in brackets.

On the other hand, the parameters of productivity confirm it has a positive effect on wages. In addition, the negative parameter of lagged inflation indicates that this variable imposes a cost for workers. Even though the sign of this variable can be derived from the model (inflation is multiplied only for positive parameters), the overidentification does not allow determine its exact magnitude.

Figure 7
Out-of-Sample Forecast for Private Wage Growth



4. Pass-Through

Finally, we analyze in detail the implications of our estimations on exchange rate pass-through. We have incorporated second-round effects of wages on prices. Thus, we have a simultaneous system on prices (Model 2) and wages, which depends on productivity, exchange rate, foreign prices and lagged variables. In the first round, the nominal exchange rate directly hits prices. Following, wages, through indexation, impact prices again. We generated out-of-sample inflation forecast with both equations working simultaneously¹⁹. The results are shown in Figure 8

Figure 8
Simultaneous-Equation Inflation Forecast

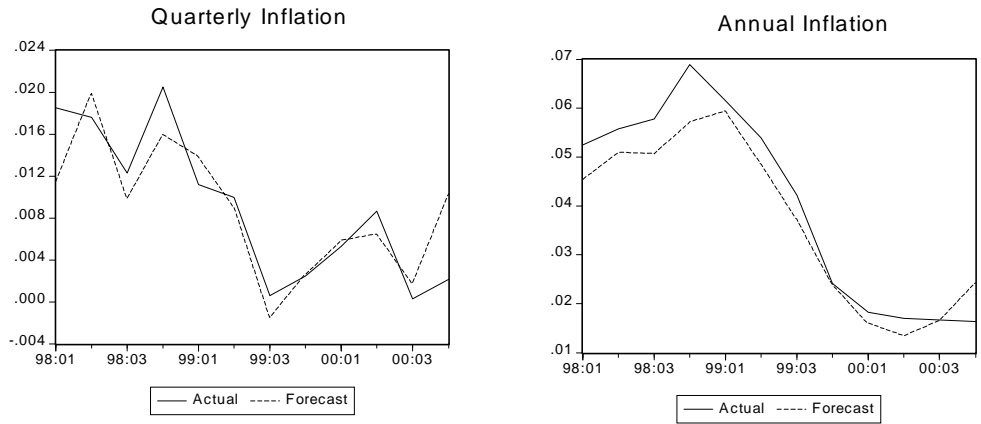
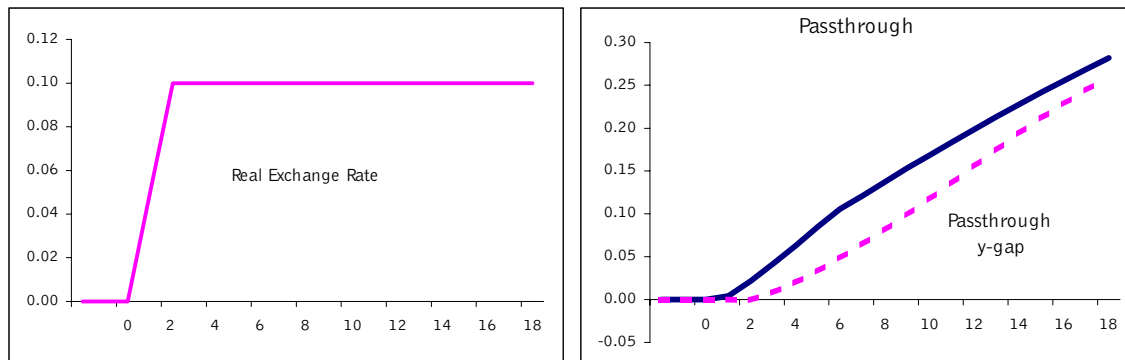


Figure 9 shows pass-through when the nominal exchange rate increases. First we incorporated both equations in the García, Herrera and Valdés (2000) five-equation model –instead of their Phillips curve. Next, given that this model does not have money, ie it is a real model, we hit both real and equilibrium-real exchange rate with a 10% shock. After that we observed the nominal exchange rate and price paths in order to compute the pass-through effect.

Figure 9 indicates that after a 1% rise in the real exchange rate, the nominal exchange rate also increases producing an accumulated impact on prices of around 0.14% in the first two years (8 quarters) which is considered the relevant policy horizon.

Figure 9



Next, we explore how the effect of an exchange-rate shock depends on economic activity. Evidence suggests that there is a pass-through decrease when the economy is in a “recession”. Figure 9 shows what happens in our artificial environment with prices, and the pass-through effect, if we have a temporary increase of 10% in the exchange rate in two alternative scenarios. One with the output gap being endogenous and which starts from zero. The second one has, at the initial point, an exogenous 2 % negative output gap which fades linearly in 3 years. The inflation effect of depreciation is higher when the economy is at potential (zero output gap). A negative output gap tends to compensate the

¹⁹ This exercise was performed with our restricted price index IPCX2, instead of CPI, affecting wages. We consider that this is the origin of the underestimation of the inflation forecast shown in Figure 8.

inflationary effect of depreciation. The negative output gap reduces margins and hence a fraction of the depreciation is not passed on to consumers²⁰.

Finally, Model 2 in Table 3 suggests that the size of exchange rate pass-through is positively related to the inflation level. This effect is captured in the variables where the nominal exchange rate is multiplied by inflation. In both cases the coefficients are positive and strongly significant. Therefore one could conclude that the low pass-through from exchange rate to inflation observed in recent years is permanent since inflation has been stabilized around 3%. It also suggests, as stated above, that inflation overprediction in the recent past is probably related to miss-measurement of the pass-through coefficient.

V. Conclusions

Price and wage equations based on a model of imperfect competition were estimated and used to generate out-of-sample inflation forecast. From the estimations we can conclude:

It is confirmed what was found in previous studies in the sense that output gap and unemployment have a small impact on inflation due to widespread indexation. Therefore gradual monetary policy is called for.

Despite the fact that generalized wage indexation is one of the most important elements explaining price and wage behavior, expectations of future inflation matter. This is a very important variable to be considered in an inflation-targeting regime, since credibility could substantially reduce the sacrifice ratio.

We empirically found that productivity reduces unit labor costs and inflation affecting real wages positively. In addition, a negative relationship between inflation and both mark-ups and real wages indicates that inflation imposes important costs for firms and

²⁰ This exercise was performed assuming a zero unemployment rate because unemployment was not linked to output gap. Considering this second round effect in this particular exercise would probably generate a lower pass-through.

workers. This result emphasizes the benefits of stabilizing the inflation rate. This cost rises even more when the impact of inflation on real wages is considered.

Finally, the exchange rate pass-through depends positively on economic activity and the inflation level, explaining why pass-through has been so low in recent years. Therefore one could conclude that pass-through would be permanently lower than in the nineties given that inflation has been stabilized around 3%.

VII. Bibliography

Ball, L. and G. Mankiw, (1995) "Relative-Price Changes as Aggregate Supply Shocks." *Quarterly Journal of Economics* 110 February: 127-151.

Banerjee A. L. Cockerell and B. Russell (2001), "An I(2) Analysis of Inflation and the Markup" Forthcoming *Journal of Applied Econometrics*.

Beaumont, C. V. Cassino and D. Mayes (1994), "Approaches to Modeling Prices at the Reserve Bank of New Zealand," Reserve Bank of New Zealand Discussion Paper No.3.

Benabou, R. "Inflation and Markups: Theories and Evidence from the Retail Trade Sector" *European Economic Review*.

Blanchard O. and L. Katz (1997), "What we know and do not know about the natural rate of unemployment" *Journal of Economic Perspectives* Vol. 11, pages 51-72, winter.

Blanchard O. and L. Katz (2001), "Wage Dynamics: Reconciling Theory and Evidence" Mimeo, MIT.

Blanchflower D. and A. Oswald (1994), *The Wage Curve*, The MIT press, Cambridge, Massachusetts.

Debelle G. and J. Vickery (1997), "Is the Phillips Curve a Curve? Some Evidence and Implications for Australia," Reserve Bank of Australia Research Discussion Paper No. 9706, October.

Doornik, J. And D.F. Hendry (1992), PC-Give version7, "*An Interactive Econometric Modeling System*," University of Oxford Press.

Dornbusch, R. (1987), "Exchange Rates and Prices," *American Economic Review*, vol. 77, No.1, March.

Engsted and Haldrup (1999) "Estimating the LQAC Model with I(2) variables" *Journal of Applied Econometrics*, 14:155-170.

García, P., L. Herrera, and R. Valdés (2000) "New Frontiers for Monetary Policy in Chile" Mimeo, Central Bank of Chile.

Goldberg, P., and M. Knetter (1997), "Goods Prices and Exchange Rates: What Have We Learned?," *Journal of Economic Literature*, Vol. 35, No.3, September.

Goldfajn, I., and S. Werlang (2000), "The Pass-through from Depreciation to Inflation: A Panel Study," Working Paper of the Central Bank of Brazil, July.

Haldrup N. (1994), "The Asymptotics of Single-Equation Cointegration Regressions with I(1) and I(2) Variables," *Journal of Econometrics* 63 pp 153-181.

Haldrup N. (1995), "An Econometric Analysis of I(2) Variables," *Journal of Economic Surveys* Vol.12, No. 5.

Harris R. (1995), *Using Cointegration Analysis in Econometric Modeling*, Chapter 4, Prentice Hall.

Haskel, J. C., Martin and I. Small (1995), "Price, Marginal cost and the Business Cycle," *Oxford Bulletin of Economics and Statistics*, 57, No.1.

Inder, B. (1993), "Estimating Long-run Relationships in Economics: a Comparison of Different Approaches," *Journal of Econometrics* 57, 53-68.

Kim, K. (1998), US Inflation and the Dollar Exchange Rate a Vector Error Correction Model," *Applied Economics*, 30, pp. 613-619.

Kim, Y. (1990), "Exchange Rates and Import Prices in the United States: A Varying-Parameter Estimation of Exchange-Rate Pass-Through," *Journal of Business & Economic Statistics*, Vol. 8, No. 3, July.

Kreps, D. and J. Scheinkman (1983), "Quantity Pre-Commitment and Bertrand Competition Yield Cournot Outcomes", *Rand Journal of Economics*, vol. 14, pp. 326-337.

McCarthy J. (1999), "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialised Economies," BIS Working Paper No. 79, November.

McCallum, B. (1976) "Rational Expectations and the Natural Rate Hypothesis: Some Consistent Estimates," *Econometrica*, Vol. 44, pp.43-52.

Menon, J. (1995), "Exchange Rate Pass-Through" *Journal of Economic Surveys* Vol. 9, No. 2.

Phillips, P. (1986), "Understanding Spurious regressions in econometrics, *Journal of Econometrics*, 33, 335-346.

Phillips P. And M. Loretan (1991), "Estimating Long-run Economic Equilibria" *Review of Economic Studies* Vol. 58, pp. 407-436.

Romer, D, (1996) *Advanced Macroeconomics* McGraw-Hill Chapters 5 and 6.

Rotemberg, J. (1982) "Sticky Prices in the United States." *Journal of Political Economy* 60, November.

Rotemberg, J. and G. Saloner (1986), "A Supergame Theoretic Model of Price Wars During Booms" *American Economic Review*, vol. 76, pp. 390-407.

Rotemberg, J. and M. Woodford (1991), "Mark-ups and the Business Cycle", *NBER Macroeconomics Annual*, 6.

Russel, B., Evans, J. and B. Preston (1997), "The impact of Inflation and Uncertainty on the Optimum Price Set by Firms" Department of Economic Studies Discussion Papers, No. 84, University of Dundee.

Small, I. (1997), "The Cyclicalities of Mark-ups and Profit Margins: Some Evidence for Manufacturing Services," Working Paper of the Bank of England.

Taylor, J. (2000), "Low Inflation, Pass-Through, and the Pricing Power of Firms," Forthcoming *European Economic Review*

Woo W. (1984), "Exchange Rates and the Prices of Nonfood, Non-fuel Products," *Brookings Papers on Economic Activity* 2.