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THE LABOR WEDGE AND BUSINESS CYCLE IN CHILE*

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Abstract

Recent studies have documented the importance of the labor wedge in accounting for the level of business cycle fluctuations in Chile. None of these papers, however, extensively studies the labor wedge fluctuations and its possible sources. This paper takes a closer look at the labor wedge in Chile, with special emphasis on its cyclicality. We use a flexible model to implicitly derive the Frisch elasticity of labor, and construct a set of labor wedges. We find that the labor wedge in Chile is counter-cyclical. Finally, we show that the labor wedge can be written as the sum of two components: the firm's and the household's. We find that household component is the main driver of Chilean labor market fluctuations.

Resumen

Estudios recientes han documentado la importancia de las brechas laborales en la contabilidad de las fluctuaciones de los ciclos económicos en Chile. Sin embargo, ninguno de estos artículos estudia extensivamente las fluctuaciones de las brechas laborales y sus posibles fuentes. Este documento estudia más de cerca las brechas laborales en Chile, enfatizando sus propiedades cíclicas. Para tal efecto, usamos un modelo suficientemente flexible para derivar implicitamente la elasticidad Frisch del trabajo, para luego construir un conjunto de brechas laborales. Encontramos que estas brechas son contracíclicas en Chile. Finalmente, mostramos que las brechas laborales pueden ser escritas como la suma de dos componentes: el de la firma y el de los hogares. Encontramos evidencia que el componente de los hogares es el principal responsable de las fluctuaciones laborales en Chile.

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1 Introduction

During the last decade there has been a growing amount of literature investigating the so-called *labor wedge* - the difference between the marginal rate of substitution (MRS) and the marginal productivity of labor (MPL)- and how it moves through time[1]. According to the neoclassical model, this difference should be zero, or at least constant at business cycle frequencies. This conclusion follows from the equilibrium condition, in which the MRS and the MPL should be equal to the real wages. Empirically, though, this hypothesis has been largely rejected by the literature. In particular, it has been shown that the labor wedge is counter-cyclical for the United States, and some European and Latin American countries (Shimer (2009), Ohanian and Raffo (2012), Lama (2011)).

The study of the labor wedge is important because it provides information about labor market frictions during business cycles. Consider a frictionless setting, such as the neoclassical model. In this economy, variations of the activity should be immediately compensated by a reduction in real wages, followed by an adjustment in employment. In particular, labor hours should decrease, reflecting the unwillingness to work from households that substitute away from labor hours towards leisure. In reality, however, this reduction in hours is strikingly larger than what this model would predict, for a reasonable set of parameterizations. This labor wedge *puzzle* has still not been entirely explained by taxes, subsidies, elasticities of labor, or utility and production function misspecifications. The existing literature has provided ways to account for the business cycle contributions to activity, using the labor wedge as one of its main drivers. The purpose of this paper is to focus uniquely on the labor wedge and its cyclical properties for the Chilean economy.

Labor market rigidities may be driving these findings. And Chilean labor market is not absent in these type of analyses. Cowan et. al (2004), for example, show evidence that the Chilean labor market is rigid. Analyzing a large increase in minimum wages, which were set *before* the Asian crisis, the authors show that this predetermined indexation contributed to a lower growth of employment in the years that followed it. In addition, Medina and Naudon (2012) show that salaries in Chile are among the less volatile countries among emerging economies, while Castex and Ricaurte (2011) show that labor market rigidities may explain the difference in employment between the two crises: Asian and Great Recession.

This paper studies these issues indirectly, by estimating labor wedges for Chile, placing more emphasis on its cyclical properties. This is not the first paper that calculates the labor wedge for Chile. Following closely on the work of Chari, Kehoe and McGrattan (2007), Simonovska and Söderling (2014) calculate efficiency, labor, investment, and government/trade wedges for Chile. They find that the labor wedge has a great relevance in accounting for business cycles. Also, Lama (2011), who presents an expanded version of the same paper, studies a set of Latin American countries, Chile among them, and arrives to the same conclusion. No other study addressing business cycle accounting has been done in Chile since then.

[1] See for example Chari, Kehoe and McGrattan (2002), Hall (2009), Justiniano, Primiceri, and Tambalotti (2010). For an extensive literature review, see Shimer (2009).

These papers focus on the relevance of the different sources of business cycle variations, not showing a particular interest on any of those wedges. Although the contributions of these papers are important for the business cycle literature in Chile, a systematic study solely on the labor wedge is still missing. For example, Simonovska and Söderling (2014) document that the labor wedge is one of the most important wedges that is responsible for the business cycle variation in Chile. Since their study does not investigate deeply the labor wedge, they do not provide a range of plausible Frisch elasticity of labor, which is crucial in this type of analysis. In fact, their specification for the utility function, although very standard, it is restrictive, which is why it does not allow them to estimate this parameter.[2] Given the relevance of the topic, we think it is important to study the business cycle in Chile, focusing exclusively on the labor wedge. We fill in this gap, by presenting estimates of the labor wedge for Chile, for a relatively flexible set of assumptions.

Our paper makes three important contributions. First, we provide a range of estimates for the Frisch elasticity of labor (ε). We find that this elasticity is relatively low compared to international standards[3]. This result is not only surprising for a macroeconomic study, but consistent with rigidities in the labor market. Second, we use this range of estimates to calculate labor wedges for Chile. Even though the responses of this variable to business cycle shocks are affected, the qualitative cyclical pattern of the labor wedge remains unaltered. In particular, we find that using a wide range of parameterizations, labor wedges are negatively correlated with activity, and statistically significant. In fact, all estimated labor wedges increase during recessions. Third, using the methodology proposed by Karabarbounis (2014), we show that this cyclical pattern is mostly explained by the household component of the labor wedge, not so much by the firm's. This means that the discrepancy between the marginal rate of substitution and real wages better explains the labor wedge, vis-a-vis differences between marginal product of labor and real wages. In other words, successful attempts to explain the cyclical fashion of the labor wedge, will focus more on frictions coming from the household side of the model.

The structure of the paper is as follows. Section 2 presents a standard representative-agent neoclassical model, and derives the labor wedge for a very flexible specification of the utility function. Section 3 shows data sources and treatment we applied to it. Section 4 presents the estimation of Frisch elasticities of labor, calculates the labor wedge for a wide set of parameterizations, studies the labor wedge cyclicality, and presents a decomposition of the labor wedge into household and firm components. Conclusions are presented in Section 5.

[2]The specification they use is the following: $u(c,h) = \log c + \gamma \log(1-h)$, where c represents consumption and h stands for hours of work. Since total time is normalized to 1, a worker who works 45 hours a week has an h equal to $45/168 \approx 0.27$. The Frisch elasticity of labor for this utility specification is $\frac{1}{h} - 1 \approx 2.7$, which, as we will see in Section 4, is well above the plausible range we found in this study.

[3]Our exercise in section 4.1 indicates that Chilean Frisch elasticity of labor is most of the time lower than one, around 0.5. A similar exercise performed by Shimer (2009) for France and Germany found a Frisch elasticity of labor close to four.

2 Derivation of the Labor Wedge

Households

In the macroeconomics literature it is usual to see utility specifications in which consumption and leisure are additively separable.[4] These specifications restrict the response of the household in the sense that for any amount of hours the household decides to work, the marginal utility of consumption is constant. In this economy, however, we decide to relax this assumption and allow for a different marginal utility of consumption for different levels of labor hours. This is relevant for our analysis, because the cyclical response of labor hours may differ greatly with respect to standard utility specifications. Following the specification shown in Shimer (2009), we postulate that the representative household possesses the following preferences:

$$U(c,h) = \frac{c^{1-\sigma}\left[1+(\sigma-1)\frac{\gamma\varepsilon}{1+\varepsilon}h^{\frac{1+\varepsilon}{\varepsilon}}\right]^{\sigma}-1}{1-\sigma}, \tag{1}$$

where γ denotes the *disutility of working*, $\frac{1}{\sigma}$ is the (constant) elasticity of substitution, c_t is consumption, h_t represents hours worked. This specification is more flexible than standard business cycle accounting models. It is particularly important for our purposes, because it allows us to estimate the Frisch elasticity of labor, ε, along with relaxing the usual additive separability between consumption and leisure. That is, it will permit us to calculate the labor wedge, using different coefficients of relative risk aversion (σ). We need $\gamma > 0$ and $\sigma > 0$, in order to have an increasing utility, and decreasing marginal utility in consumption; and decreasing and concave utility in labor hours. Notice as well that when $\sigma \to 1$, this specification converges to

$$U(c,h) = \log c - \gamma\left(\frac{\varepsilon}{1+\varepsilon}\right)h^{\frac{1+\varepsilon}{\varepsilon}},$$

which is another usual additively separable utility function specification.

In addition, the household faces the following intertemporal budget constraint:

$$a_t + (1-\tau_h)w_t h_t + T_t = (1+\tau_c)c_t + (1+\tau_k)q_{t+1}a_{t+1}, \tag{2}$$

where τ_h, τ_c, τ_k are labor, consumption and capital tax rates, respectively; T_t is a lump-sum transfer; w_t is the hourly wage; a_t are bond holdings; and q_{t+1} is the before-tax price of a bond at time $t+1$.

[4] A utility function $u(c,h)$ is additively separable if it can be written as $u(c,h) = f(c) + g(h)$ where $f(\cdot)$ and $g(\cdot)$ are both single-variable functions. For example, the utility function $u(c,h) = \log c + \gamma\log(1-h)$ is very common in the business cycle literature. Additively separable specifications have the advantage, in addition to simplicity, that ensures the existence of a balance growth path, which is an important feature of most macroeconomic models.

The problem of the household is to maximize equation (1) subject to (2). The first-order condition of interest, the marginal rate of substitution equal to the real wage is:

$$w_t = \underbrace{\left(\frac{\gamma}{1-\tau}\right) \frac{c_t h_t^{\frac{1}{\varepsilon}}}{\left[1 + (\sigma - 1)\frac{\gamma\varepsilon}{1+\varepsilon} h^{\frac{1+\varepsilon}{\varepsilon}}\right]^{\sigma}}}_{MRS}, \tag{3}$$

where $\tau \equiv \frac{\tau_c + \tau_h}{1+\tau_c}$ is defined as the *relevant* tax rate. Notice that τ, not exclusively represents taxes, but any labor market distortion that makes this wedge to increase. Condition (3) reflects the (inverse) labor supply of the household. Notice that regardless of the other first-order conditions, the marginal rate of substitution (MRS) remains unchanged.

Firms

In this economy, all firms are equal and exhibit a standard Cobb-Douglas production function: $y_t = A_t k_t^{\alpha} n_t^{1-\alpha}$. This representative firm solves the following problem:

$$\max_{\{k,n\}} \left[A_t k_t^{\alpha} n_t^{1-\alpha} - (\delta + r_t)k_t - w_t n_t\right],$$

where A_t is an exogenous productivity shock, k_t represents capital stock of the firm, δ is a constant depreciation rate, and r_t is the real interest rate. The standard first-order condition for labor demand (n_t) is:

$$w_t = \underbrace{(1-\alpha)\frac{y_t}{n_t}}_{MPL}. \tag{4}$$

The right-hand side of equation (4) is the Marginal Product of Labor (MPL). In order for this economy to be in equilibrium, we know that MRS should be equal to MPL. Using the labor market clearing condition: $h_t = n_t$, and equations (4) and (3), we obtain the labor wedge:

$$\tau = 1 - \frac{\left(\frac{\sigma\gamma}{1-\alpha}\right) h_t^{\frac{1+\varepsilon}{\varepsilon}} \left(\frac{c_t}{y_t}\right)}{\left[1 + (\sigma - 1)\frac{\gamma\varepsilon}{1+\varepsilon} h^{\frac{1+\varepsilon}{\varepsilon}}\right]} \tag{5}$$

This equation presents the relationship between the labor wedge on the left-hand side; with the consumption to income ratio and labor hours on the right-hand side. Its value depends also on parameters γ, α, σ, and ε. From this set of parameters, the most crucial ones are the last two. On the other hand, the *cyclical* behavior of the labor wedge will finally depend on the interaction between labor hours, the consumption-to-income ratio and both, the relative risk aversion (σ), and the Frisch elasticity of labor (ε).

3 Data

In this section, we show the sources of data used in this study. Our data set starts from 1986. *Hours* is defined as the average hours worked by employees as a share of working-age population. *Average hours worked* were taken from Total Economy Database (https://www.conference-board.org/data/economydatabase/). Work force and unemployment data were collected from National Bureau of Statistics (INE) directly. Households' real consumption and output are from National Accounts (Central Bank of Chile). Real output and consumption are 1996-chained prices. In order to have a longer series (1986 onwards), we spliced the series to fixed base year 2008. We alternatively used nominal-price consumption and output data, in order to provide robustness to our estimates.

As for taxes, we used taxes over labor income (second category and global complementary taxes) and consumption taxes (VAT, specific taxes, legal acts taxes, international trade taxes and others). All this data were collected from Servicio de Impuestos internos (SII). Even though contributions to pension funds and health insurance are not collected through the tax system, we performed additionally an alternative exercise in which these were included as taxes. Prescott (2004) includes them in his seminal paper in which compares labor market patterns between the United States and selected European countries. Even for those countries in which these contributions were collected in individual saving accounts, he points out, act in practice as taxes, given its mandatory nature for most workers in the labor force. Appendix A shows more details on how we constructed this alternative definition of taxes. For pension funds and health insurance, we collected data from Superintendence of AFP (Asociación de Fondos de Pensiones - Pension Fund Associations), Superintendence of ISAPREs (Instituciónes de Salud Previsional - Health Contingency Funds), and FONASA (Fondo Nacional de Salud - National Health Fund). For some missing values for medical insurance, we estimated them using Health Services activity. Finally, labor share of income was obtained from National Accounts (line (nominal) *Remuneraciones* from Table 1.51, divided by (nominal) gross domestic product).

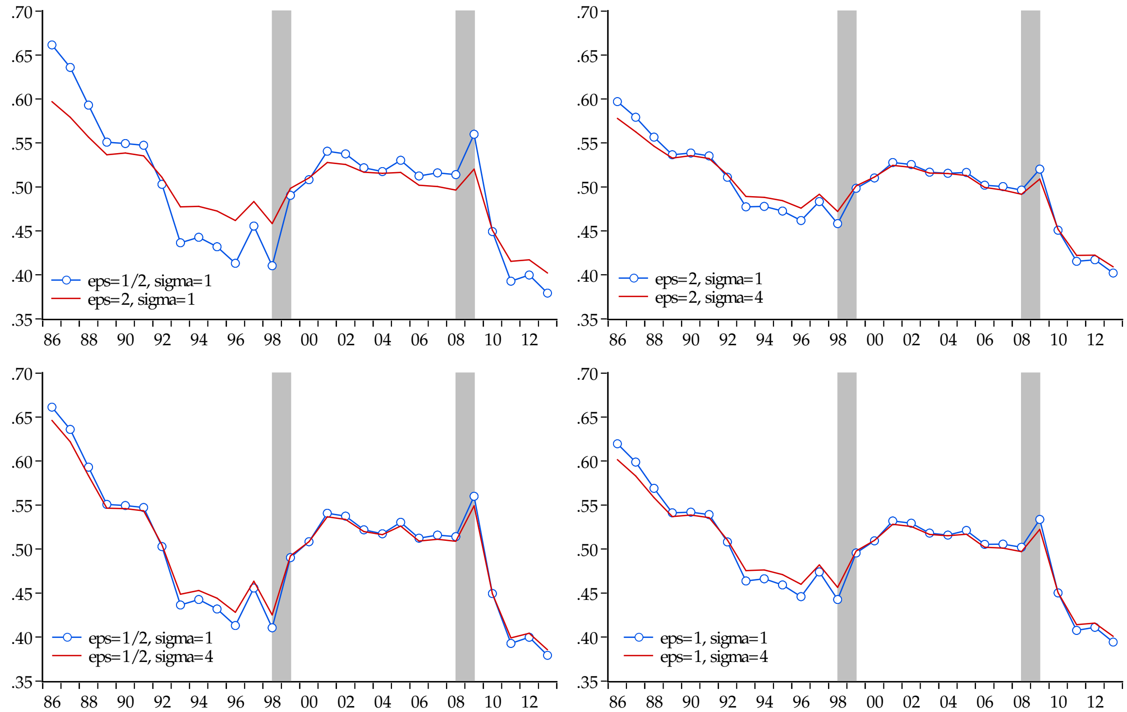
4 The Labor Wedge in Chile

4.1 Estimation of the Frisch-Elasticity of Labor

The empirical construction of the labor wedge, as shown in equation (5) relies on the calibration of parameters γ, α, σ, and ε. In this paper we are particularly interested in the last two. We set $\alpha = 0.3$ (Bergoeing et al. (2001)) and calibrate γ in order to have a labor wedge sample average of $\frac{1}{2}$ (1986-2013). We visually inspect labor wedges for Chile, for a wide range of parameters for σ and ε. Figure 1 shows the results of this exercise.

We document several observations. First, the general pattern of the labor wedge is relatively unchanged even if we introduce extreme values for ε and σ. Second, most of the difference between these labor wedges is not accounted for differences in σ, but in the Frisch elasticity, ε. The upper left graph in Figure 1, in which we hold σ constant and equal to one,

Figure 1: Chile: The Labor Wedge in Chile



Source: Authors calculations. Shaded areas represent recession periods. All series are normalized to have an average of 0.5 in the whole sample 1986-2013.

shows that the labor wedge movements along the cycle are greater, the lower is ε. When we hold ε constant, on the other hand, differences in labor wedges seem to be negligible. Third, the labor wedge increases during recessions. Observe both recession episodes in our sample. Each time there is a recession, the labor wedge increases for any value of ε and σ. Some authors have documented this stylized fact for the United States and Europe (Shimer (2009), Galí and Rabanal (2005), Hall (2009)). This finding is consistent with Lama (2011) and Simonovska and Söderling (2014), who find the same in their business accounting exercises. In particular, they show that the labor wedge is strongly decreasing after 2004, which would be coherent with structural policy improvements in the Chilean labor market.

The visual inspection of the labor wedge leaves us with a starting point to further restrict the set of parameters. In particular, we can confidently fix parameter σ to one, which lead us to a logarithmic additively separable utility function:

$$U(c,h) = \log(c) - \gamma h^{\frac{1+\varepsilon}{\varepsilon}}.$$

Next, we are interested in the estimation of the Frisch elasticity of labor, ε. In order to do this exercise we inspire on Shimer (2009) (see Table 1). With a parameter $\sigma = 1$, the labor wedge boils down to:

$$\tau = 1 - \left(\frac{\gamma}{1-\alpha}\right) h_t^{\frac{1+\varepsilon}{\varepsilon}} \left(\frac{c_t}{y_t}\right). \tag{6}$$

Solving the above equation for h_t we find:

$$h_t = \left[\left(\frac{1-\tau}{c_t/y_t}\right)\left(\frac{1-\alpha}{\gamma}\right)\right]^{\frac{\varepsilon}{1+\varepsilon}}. \tag{7}$$

Equation (7) represents the theoretical labor hours worked for a representative worker whose consumption to income ratio is c_t/y_t, and relevant tax rate is τ. We reproduce h_t assuming a wide set of values for ε. As robustness check, we include several sources and definitions for c/y and τ. We include these different versions of c/y, because there is a notable difference between them, especially between the constant- and current-price series. Chile is a particular case in which consumption-to-income ratios have to be observed with caution. Chile is the world's biggest producer of copper along with related mining resources. Taking at-face-value current-price series may mislead economists to think that this ratio has remained relatively unchanged between 1996 and 2013. In fact, the GDP deflator in Chile is strongly driven by international copper prices, and therefore it does not represent actual domestic representative bundle prices. A more insightful exercise should consider the real GDP variations of these series. In order to show a complete exercise, we include it in our estimates (version 2).

We construct the relevant tax rate defined previously, τ, as:[5]

$$\tau = \frac{\tau_c + \tau_h}{1 + \tau_c}.$$

Two different versions for labor taxes (τ) are presented. In Chile, the social security system is fully funded. This means that each working individual contributes to their own pension saving account, which is mandatory for contractual workers (who represent about 70% of total employment). This is different than the social security system in the United States, and most European countries, in which working individuals are taxed to fund *current* pensioned individuals. Even though contributions to the Chilean pension system are not a tax per-se, the mandatory fashion of the system makes it functionally be seen as a tax.[6] We opted to show both cases. The results of this exercise are shown in Table 1.

Estimates for the Frisch elasticity of labor are in all cases in the low range. Considering contributions to social security and medical insurance does not change the quantitative and qualitative results. For all cases, except for c/y version 2, ε is between 1/2 and 1. This finding contrasts with what is usual in the macroeconomic literature. Shimer (2009) for example, estimates this number is closer to four, not only in the United States but also in France and Germany. In the case of version 2, even though we miss the sign of the change in

[5] For a detailed description of the construction of taxes τ, please see Appendix A.

[6] In fact, Prescott (2004) considers these savings as taxes for the European countries with similar systems as the Chilean one.

Table 1: Chile: Implicit Estimation of the Frisch Elasticity of Labor

Including contributions to pension and medical insurance systems

				theoretical h				
	$1-\tau$	$\frac{c}{y}$ (version 1)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.736	0.55	1,146					
2009-2013	0.785	0.65	1,112					
log change	0.06	0.16	-0.03	0	-0.03	-0.05	-0.06	-0.07
	$1-\tau$	$\frac{c}{y}$ (version 2)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.736	0.64	1,146					
2009-2013	0.785	0.61	1,112					
log change	0.06	-0.04	-0.03	0	0.04	0.05	0.07	0.09
	$1-\tau$	$\frac{c}{y}$ (version 3)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.736	0.68	1,146					
2009-2013	0.785	0.77	1,112					
log change	0.06	0.13	-0.03	0	-0.02	-0.03	-0.04	-0.05
	$1-\tau$	$\frac{c}{y}$ (version 4)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.736	0.57	1,146					
2009-2013	0.785	0.65	1,112					
log change	0.06	0.12	-0.03	0	-0.02	-0.03	-0.04	-0.04

Without Including contributions to pension and medical insurance systems

				theoretical h				
	$1-\tau$	$\frac{c}{y}$ (version 1)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.802	0.55	1,146					
2009-2013	0.828	0.65	1,112					
log change	0.03	0.16	-0.03	0	-0.04	-0.06	-0.08	-0.10
	$1-\tau$	$\frac{c}{y}$ (version 2)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.802	0.64	1,146					
2009-2013	0.828	0.61	1,112					
log change	0.03	-0.04	-0.03	0	0.03	0.04	0.05	0.06
	$1-\tau$	$\frac{c}{y}$ (version 3)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.802	0.68	1,146					
2009-2013	0.828	0.77	1,112					
log change	0.03	0.13	-0.03	0	-0.03	-0.05	-0.06	-0.08
	$1-\tau$	$\frac{c}{y}$ (version 4)	h	$\varepsilon=0$	$\varepsilon=\frac{1}{2}$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
1996-2000	0.802	0.57	1,146					
2009-2013	0.828	0.65	1,112					
log change	0.03	0.12	-0.03	0	-0.03	-0.04	-0.06	-0.07

Source: Authors calculations. Data for τ were obtained from Servicios de Impuestos Internos, Superintendencia de Pensiones, Superintendencia de Isapres, and Fondo Nacional de Salud. The upper panel assumes contributions to social security and medical insurance is not a tax. The lower panel assumes these contributions are part of τ. Data for c/y was obtained from National Accounts using several versions. Version 1 denotes the private consumption to GDP ratio using real variables, chained, reference year 2008. Version 2 uses nominal series. Version 3 defines consumption includes government consumption, household consumption and inventories, fixed base 2008. Version 4 uses private consumption using fixed base 2008. Variable h represents the number of working hours per active worker per year in the working-age population.

labor hours, the estimate is consistent with an *even lower* ε. Although the estimates are low compared to international standards, it is consistent with what other authors have found for the Chilean economy.[7]

4.2 Cyclical pattern of the Labor Wedge

We have mentioned earlier that previous research papers have found that the labor wedge in Chile is a relevant part of the story to account for business cycle contributions. We add to this literature by taking a closer look at the cyclical pattern of the labor wedge, not only its level. Using the flexible specification in equation (5), we present the cyclical pattern of the labor wedge in comparison to the GDP. The end of this exercise is to check whether activity and labor wedge are negatively correlated. Figure 2 shows the results. It results visually clear that the cyclical component of the labor wedge negatively comoves with the cyclical component of the GDP, for $\varepsilon = \{1/2, 1, 2\}$ and $\sigma = \{1, 4\}$. This is confirmed by the correlations shown in Table 2, using additionally a different filtering method. The correlation is close to between -0.39 and -0.45, all statistically significant at usual confidence levels.

Table 2: Chile: Correlations between the Labor Wedge and Gross Domestic Product, for different specifications, and filtering methods.

Hodrick-Prescott Filter					
$\sigma = 1$			$\sigma = 4$		
$\varepsilon = 1/2$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 1/2$	$\varepsilon = 1$	$\varepsilon = 2$
-0.43446	-0.43311	-0.43671	-0.43821	-0.42499	-0.43518
[-2.46**]	[-2.45**]	[-2.475**]	[-2.486**]	[-2.394**]	[-2.465**]

Christiano-Fitzgerald Band Pass Filter					
$\sigma = 1$			$\sigma = 4$		
$\varepsilon = 1/2$	$\varepsilon = 1$	$\varepsilon = 2$	$\varepsilon = 1/2$	$\varepsilon = 1$	$\varepsilon = 2$
-0.39182	-0.40424	-0.40425	-0.4029	-0.3997	-0.40857
[-2.172**]	[-2.254**]	[-2.254**]	[-2.245**]	[-2.223**]	[-2.282**]

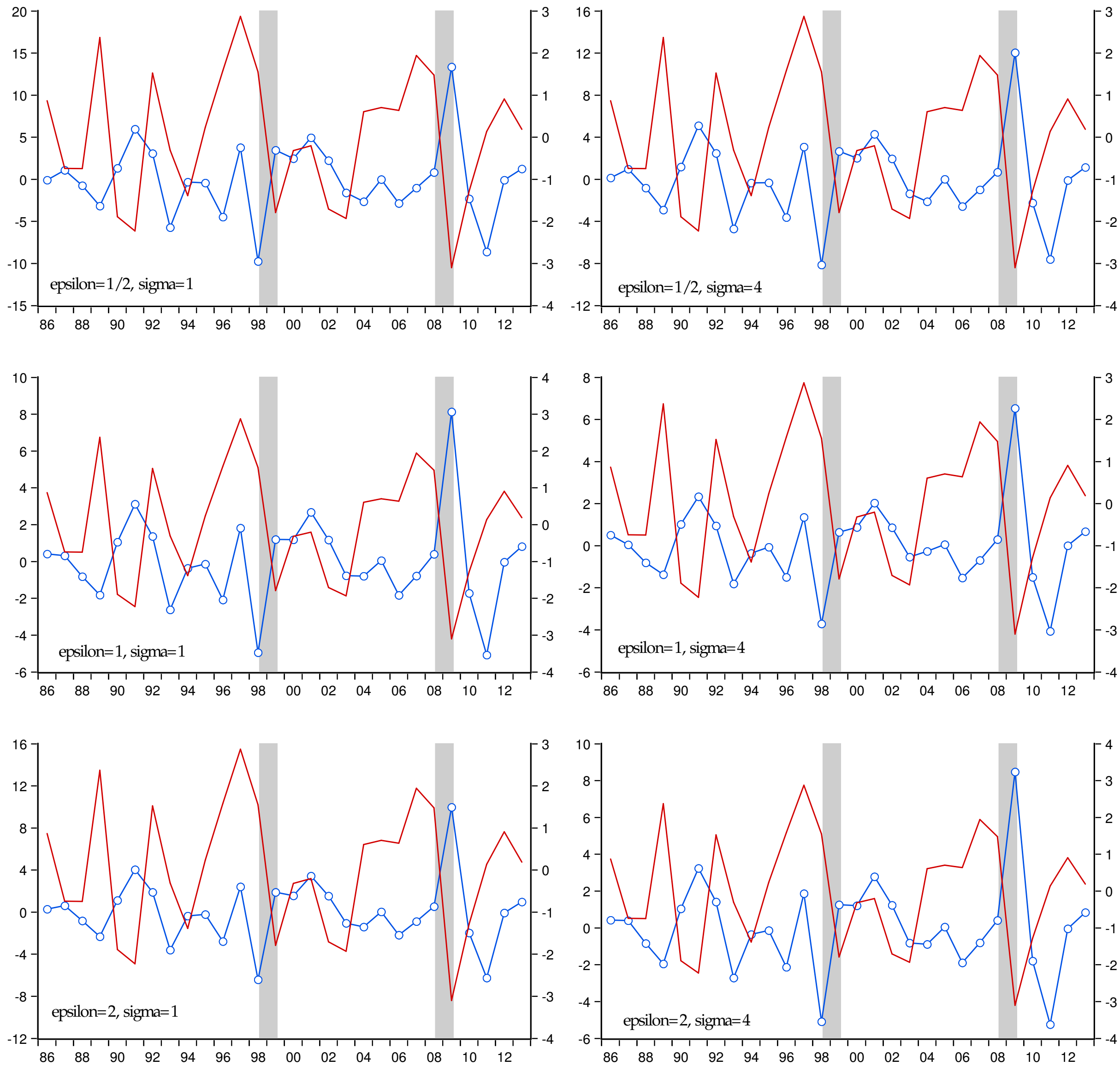
Source: Authors calculations. Annual data from 1986 to 2013. *, **, and ***, denote statistical significance at 10%, 5% and 1% confidence level, respectively. Standard errors in brackets. Both GDP and Labor Wedge are measured in deviations from trend. For the Hodrick-Prescott filter we used parameter 6.25.

We also performed the following regression, which we call Specification (1):

$$\widehat{\tau}_t = \beta_0 + \beta_1 \widehat{y}_t, \tag{8}$$

[7] Medina and Soto (2007), for example, estimate $\varepsilon = 1.2$, while Edwards and Cox (2002) calibrated it at 0.3. Mizala et al. (1998) estimates that ε is about 1.1 for men, and 1.9 for women .

Figure 2: Chile: Negative Correlation Between the Labor Wedge and Gross Domestic Product



Source: Authors calculations. Annual data from 1986 to 2013. Blue, dotted line represents Labor Wedge (left axis). Red, solid line represents the GDP (right axis). Shaded areas represent recession periods. Both GDP and Labor Wedge are measured in deviations from trend, using Hodrick-Prescott filter with parameter 6.25.

where the sign $\widehat{\ }$ reflects deviations from trends. Results are shown in the left panel of Table 3. Unsurprisingly, we find that all estimated parameters β_1 are negative and significant at usual confidence levels. The elasticity lies between -0.54 and -1.28, depending on the values for ε and σ. We complement this set of regressions by presenting results for the following regression (Specification (2)):

$$\widehat{\tau}_t = \pi_0 + \pi_1 d, \tag{9}$$

where $d = 1$ if $\widehat{y}_t > 0$. In this case, parameter π_1 represents the average response of the labor wedge, when the GDP is above its tendency. As before, we find that labor wedge and activity negatively comove, and their estimated impacts are large, negative and statistically significant. With this analysis we conform what other authors have observed for other countries. Labor wedges and GDP move in opposite directions. The big question in all this literature is why.

Table 3: Chile: Regression Analysis. Dependent variable Labor Wedge derived for different parameters for ε and σ

		Specification (1)			Specification (2)		
		GDP	R-squared	Adj. R-squared	dummy	R-squared	Adj. R-squared
$\varepsilon = 1/2$	$\sigma = 1$	-1.28**	18.90	15.78	-3.47**	15.33	12.08
	$\sigma = 4$	-1.12**	19.24	16.13	-2.99**	15.08	11.82
$\varepsilon = 1$	$\sigma = 1$	-0.71**	18.76	15.64	-1.81*	13.52	10.19
	$\sigma = 4$	-0.54**	18.10	14.95	-1.34*	12.22	8.84
$\varepsilon = 2$	$\sigma = 1$	-0.90**	19.11	16.00	-2.36**	14.45	11.16
	$\sigma = 4$	-0.74**	19.00	15.89	-1.89*	13.69	10.38

Source: Authors calculations. Annual data from 1986 to 2013. Regression estimates of equations (8) and (9). *, **, and ***, denote statistical significance at 10%, 5% and 1% confidence level, respectively. All regressions are done with 28 observations (annual data from 1986 to 2013). Both GDP and Labor Wedge are measured in deviations from trend, using the Hodrick-Prescott filter with parameter 6.25.

As mentioned before, in the neoclassical theory the MRS and MPL should be equal, or at most their distance should be constant explained only by the variation in taxes. There is a growing amount of evidence that this condition is violated empirically, including this paper. In fact, the labor wedge is counter-cyclical, as shown in Figure 1 and 2. Lately, some papers have arisen in the literature in order to explain this behavior.

The first intuitive and obvious hypothesis to test empirically is that taxes increase during recessions. McGrattan and Prescott (2010) for example, show that when variation in taxes is included in the labor wedge dynamics, the model fits better to the data. However, the improvement is marginal (Romer and Romer (2009) show that the variation explains at most 18% of the US business cycle variance). Still, most economists do not share this explanation as the main driver of the labor wedge pattern. The present work supports this finding by isolating the effect of taxes. The tax-adjusted labor wedge is still observed to increase during recessions, and basically follows the same pattern as the rest of the labor wedges.

Other authors claim that this pattern may be explained because utility functions are misspecified. In order to test this hypothesis, we intentionally use a flexible specification for the utility function, as in Shimer (2009). As showed in Figures 1 and 2, and Tables 2 and 3; many different and flexible specifications lead to labor wedges with essentially the same cyclical behavior than an additively separable CRRA specification. In all specifications, which combine different parameters for σ and ε, the labor wedge and the GDP gap are negatively correlated. There are two other observations we can make. First, the higher the risk aversion parameter (σ), the lower is the impact of GDP fluctuations on the labor wedge. Second, the lower the Frisch elasticity of substitution (ε) the higher is the impact of GDP fluctuations on the labor wedge. This is intuitive, as a relatively insensitive labor supply to changes in wages, would exacerbate labor market frictions, which leads rigidities to adjust to new equilibria.

A third wave of papers suggest that disutility of working is counter-cyclical. In other words, either there is some kind of chronic laziness in recessions or workers acquire monopoly power during recessions, which makes them work *less* in order to drive up wages (see for example Galí and Rabanal (2005), Smets and Wouters (2007)). Even though these papers show that their models fit better the data, the explanation is still not convincing. What these models really do is to force tastes of leisure relative to consumption to increase in recessions and decrease during booms. This exogenously imposed cyclical pattern explains most of the movement of the labor wedge along the business cycle, which makes the results of these studies not very fascinating.

4.3 Contributions of the MRS and MPL to the Cyclical Pattern of the Labor Wedge

The counter-cyclical fashion of the labor wedge is still a puzzle in the academic world. In this paper, rather than trying to explain this fact for the Chilean economy, we will contribute with a small step ahead towards the answer. Karabarbounis (2014) develops an interesting and simple way to disentangle the labor wedge into two components: the household and the firm component. In the theoretical section above we showed that the labor wedge is the difference between the MRS and the MPL. The former is derived from the first-order conditions of the household, while the latter corresponds to the firms' optimal condition. In this section, we will present briefly the proposed methodology, and calculate the contributions of each of these elements to the variation of the labor wedge in Chile exploiting business cycle frequencies.

Assume the contribution of each component enters exponentially in the optimality conditions of the agents:

$$\begin{aligned} MRS_t \times \exp(\tau_t^h) &= w_t && (10) \\ MPL_t \times \exp(-\tau_t^f) &= w_t. && (11) \end{aligned}$$

Using equations (3) and (4), assuming $\varepsilon = 1$ and $\sigma = 1$, and solving for τ_t^h and τ_t^f, we obtain the following expressions:

$$\begin{aligned}\tau_t^h &= \log(s_t) + \log(y_t/c_t) + \log(1-T) - \log(\gamma) \\ \tau_t^f &= -\log(s_t) + \log(1-\alpha),\end{aligned}$$

where s_t is the labor share of income: $s_t \equiv \frac{w_t h_t}{y_t}$.[8] Also, $T \equiv \frac{\tau_c+\tau_h}{1+\tau_c}$, we changed notation for the relevant tax rate, avoiding confusion. Notice that by construction, the labor wedge satisfies:

$$\tau_t = \tau_t^h + \tau_t^f \equiv \log(MRS_t) - \log(MPL_t).$$

This simple exercise allows us to measure the relevance of each component in the variation of the labor wedge in Chile. Intuitively, it is straightforward to see that the labor share, s_t, is relevant in the distinction of both components.[9] For instance, if we want to say that the firm component mostly explain the labor wedge variation, then we should expect a strongly procyclical s_t . In reality, this is hardly the case. As shown in Figure 3, the labor share of income is heavily counter-cyclical. Each time there is a recession, the labor share is increasing. This behavior is consistent with the model of Gomme and Greenwood (1995), who explain that the observed counter-cyclical behavior of the labor share of income may be part of an optimal risk-sharing arrangement between firms and workers. This observation should make us suspect a priori that the household component plays a more important role in the determination of the labor wedge.

Since we are interested in the cyclical movements of the labor wedge, we use the Hodrick-Prescott filter to de-trend household and firms components: $\widehat{\tau}_t^h$, and $\widehat{\tau}_t^f$. Again, by construction we verify that $\widehat{\tau}_t = \widehat{\tau}_t^h + \widehat{\tau}_t^f$.

We take s_t from National Accounts. Taxes are taken from Servicio de Impuestos Internos (SII). As mentioned before, even though social security and medical insurance in Chile are not collected by SII, we use alternatively two definitions for taxes: one including the contributions to social security and medical insurance (which are taken from Superintendencia de AFP, FONASA, and Superintendencia de Isapres.[10]), and the other without including them. For the consumption to output ratio, we use private consumption, and real GDP, from the fixed base series, base year 2008.

In order to determine the variation of each component on the total labor wedge, we run the following set of regressions:

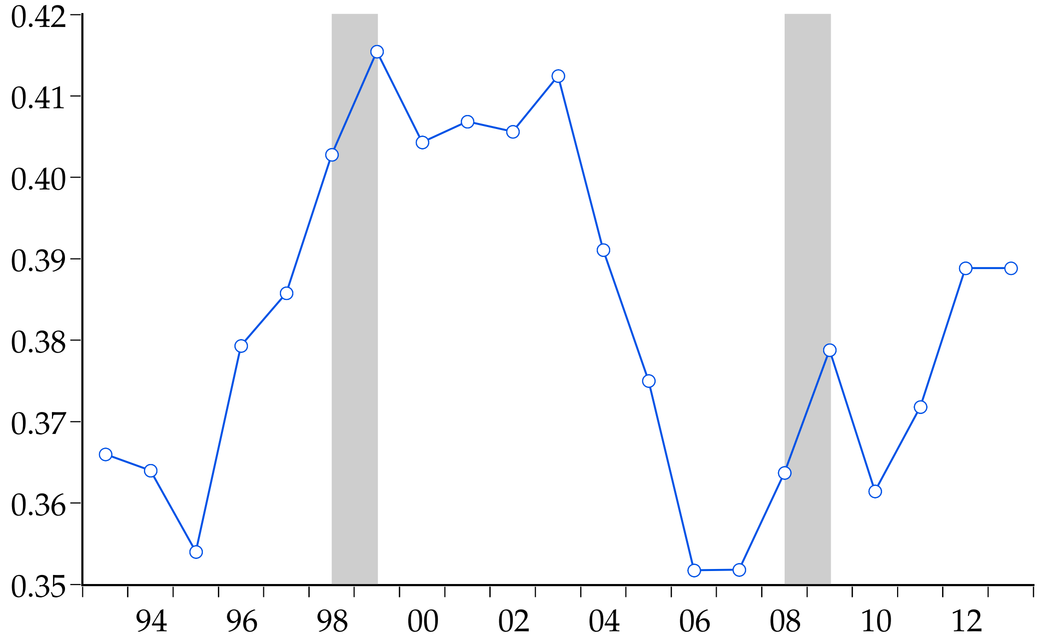
$$\widehat{\tau}_t = \delta_0 + \delta_1 \widehat{\tau}_t^h + \upsilon_h \tag{12}$$
$$\widehat{\tau}_t = \delta_0 + \delta_1 \widehat{\tau}_t^f + \upsilon_f \tag{13}$$

[8] Strictly speaking this corresponds to the ratio between compensation of employees to gross domestic product, which does *not* include self-employment, in nominal terms. This may be problematic, as it misses the variation of the informal sector. Unfortunately, we are unable to include this missing part of the labor share due to lack of reliable data. Nonetheless, since the formal sector accounts for the majority of the wage mass variation (between 75% and 80% on average), this issue would be somewhat modest.

[9] It is important to notice, though, that our measure for s_t does not control for labor efficiency.

[10] See Appendix A for more details.

Figure 3: Labor Share of Income (s_t) and Recession Periods in Chile



Source: Central Bank of Chile. Shaded areas represent recession periods.

We are not interested in the value of the estimated parameters, because they are by construction equal to one. This is not the same as saying that both are equally important in the determination of the labor wedge. For example, the variation of the firm component ($\widehat{\tau}_t^f$) may be very different than the variation of the labor wedge as a whole. Statistically speaking, this would mean that the firm component does not explain much of the variation of the labor wedge. Similarly, if the variation of the household component ($\widehat{\tau}_t^h$) resembles the variation of the labor wedge as a whole, we would say that the household side of the model better explains the variation in the labor wedge. Consequently, we would like to find a measure of the goodness of fit that each component exerts on the labor wedge. In order to do this, we follow the same thought experiment performed by Karabarbounis (2014), and calculate the R-squared for the regressions shown above. Notice, though, that this measure is by no means perfect, since for example, the R-squared of each component need not sum up to 100. However, it is still a useful and simple statistical tool, which allows us to obtain the relative importance of each component on the labor wedge. Unfortunately, since we observe annual tax data from 1993-2013, we only count with 21 observations. Despite this shortcoming, the lessons learned from this exercise are useful, especially for future research projects. The results are shown in Table 4.

The upper panel of Table 4, shows the contribution of the household component of the labor wedge, while the lower panel shows the firms component. Each of these numbers was

Table 4: Chile: The Labor Wedge explained by the Firm and Household Components

Household Component	R-squared	Adjusted R-squared
Including contributions to pension and medical insurance systems	40.75	37.63
Without contributions to pension and medical insurance systems	38.99	35.78
Firm Component		
Including contributions to pension and medical insurance systems	17.41	13.06
Without contributions to pension and medical insurance systems	15.5	11.05

Note: This table shows R-squared and Adjusted R-squared from regressions (12) and (13).

calculated using the two definitions of taxes explained in previous sections. Since we count with few observations, we include the *adjusted* R-squared of these contributions.

As we suspected from the visual inspection of Figure 3, Table 4 shows us that the household component is the main driver of the variation in the labor wedge in Chile. In other words, the wedge between the MRS and the real wedge w_t is better explained by the cyclical variation of the household component. On average, we find that roughly 40% of the variation in the labor wedge for Chile is explained by differences in the household's optimal conditions with respect to what we actually observe in data. On the other hand, variation in the firm's component of the labor wedge (the difference between MPL and w_t) does not contribute more than 17% of the variance of the total labor wedge. Even though 40% does not seem to be a big contribution, it is still true that the household component is the main driver of the labor wedge in Chile.[11]

The conclusion of this section is as follows. In order to better understand the Chilean labor market fluctuations, we need to focus more on the household side of the model. In other words, models that generate endogenous and cyclical differences between marginal rates of substitution and real wages will be most likely not rejected by the data.

5 Concluding Remarks

This paper studies takes a closer look at the labor wedge for the Chilean economy. Unlike other studies, we focus more on the cyclical fashion on the labor wedge. Using a flexible specification, which allows us to use a wide range of assumptions on parameters, we derive and estimate a set of labor wedges for Chile. Our findings indicate that the Frisch elasticity of labor is relatively low in Chile compared to international standards (between 1/2 and 1), which is robust to different definitions and data sources. We also corroborate what has

[11] Forty percent is relatively low in comparison with international standards. For example, Karabarbounis (2014) shows that for the United States the household component contributes about 80% of the labor wedge variation, while for a set of industrial countries this number was about 70%.

been found in other countries: the labor wedge is counter-cyclical. Using a flexible set of parameterizations we find that the correlation between the labor wedge and GDP is between -0.39 and -0.43, and statistically significant. In particular, we find that for all specifications the labor wedge increases during recessions. Finally, we decompose the labor wedge into two elements: the household and the firm components. The results indicate that the bulk of the variation of the labor wedge can be explained by the household component. This finding is useful for future research, as it helps to understand where we should focus to better analyze the Chilean labor market fluctuations.

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A Definition of Taxes

In this appendix, we explain in detail the definitions for the tax rates τ_c, and τ_h used in this study. Following Prescott (2004), we define τ_c, and τ_h as follows:

$$\tau_c = \frac{VAT + T_{spec} + T_{acts} + T_{comex} + T_{others}}{\text{Private Consumption} - (VAT + T_{spec} + T_{acts} + T_{comex} + T_{others})}$$

$$\tau_h^{(1)} = \frac{T_{sc} + T_{gc}}{GDP - (T_{sc} + T_{gc})}$$

The definitions of these taxes are as follows:

- VAT: Value Added Tax (source www.sii.cl)
- T_spec: Specific Products Taxes (source www.sii.cl)
- T_{acts}: Juridic Taxes (source www.sii.cl)
- T_{comex}: International Trade Taxes (source www.sii.cl)
- T_{others}: Other consumption taxes (source www.sii.cl)
- T_{sc}: Second Category Tax (source www.sii.cl)
- T_{gc}: Global Complementary Tax (source www.sii.cl)

In addition, we present an alternative labor tax definition, where we include social security and medical insurance contributions ($\tau_h^{(2)}$).

$$\tau_h^{(2)} = \frac{T_{sc} + T_{gc} + AFP + FONASA + ISAPRES}{GDP - (T_{sc} + T_{gc} + AFP + FONASA + ISAPRES)},$$

where

- AFP: Mandatory contributions to Pension Funds (Superintendency of AFPs, www.safp.cl)
- $FONASA$: Mandatory contributions to National Health Fund (Fondo Nacional de Salud, www.fonasa.cl)
- $ISAPRES$: Mandatory contributions to Private Medical Insurance (Superintendency of ISAPREs, www.supersalud.gob.cl)

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