THE LABOR WEDGE AND BUSINESS CYCLES IN CHILE[*]

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I. INTRODUCTION

Between the years of 2005 and 2014, there was a growing body of literature investigating the so-called labor wedge—the (log) 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).

Studying 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, a decrease in 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 by households that substitute away from labor hours towards leisure. Actually, 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 only provided ways to account for the business cycle's 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 the Chilean labor market is not absent in these types of analyses. For example, Cowan et al.

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1   *See for example Chari et al. (2002), Hall (2009), Justiniano et al. (2010). For an extensive literature review, see Shimer (2009).*

(2004) show evidence that the Chilean labor market is rigid. Analyzing a large increase in minimum wages, which were set *before* the Asian crisis, they show that this predetermined indexation contributed to a deceleration of employment in the years that followed. In addition, Medina and Naudon (2012) show that salaries in Chile are among the less volatile among emerging economies, while Castex and Ricaurte (2011) show that labor market rigidities may explain the difference in employment between the two episodes: the Asian crisis and the Great Recession.

In this paper, we study 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 et al. (2007), Simonovska and Söderling (2015) calculate efficiency, labor, investment, and trade wedges for Chile. They find that the labor wedge has extraordinary 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.

These papers focus on the relevance of the different sources of business cycle variations, showing no particular interest in any of those wedges. Although their contributions are important for the business cycle literature in Chile, a systematic study solely of the labor wedge is still missing. For example, Simonovska and Söderling (2015) document that the labor wedge is one of the most important wedges responsible for the business cycle variation in Chile. Since their study does not investigate the labor wedge in depth, they do not provide a range of plausible Frisch elasticities of labor, which is crucial in this type of analysis. In fact, their specification for the utility function, although very standard, is restrictive, which is why it does not allow them to estimate this parameter.[2] Given the relevance of the topic, we consider it relevant 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 under a relatively flexible set of assumptions.

We make 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 by 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

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2   *The specification they use is the following: u(c,h) = log c+γlog(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≈0.27. The Frisch elasticity of labor for this utility specification is 1/h–1≈2.7 which, as will be shown in section IV, is well above the plausible range we found in this study.*

3   *Our exercise in section IV.1 indicates that Chilean Frisch elasticity of labor is most of the time lower than 1, around 0.5. A similar exercise performed by Shimer (2009) for France and Germany found a Frisch elasticity of labor close to 4.*

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 component. This means that the discrepancy between the marginal rate of substitution and real wages better explains the labor wedge, *vis-à-vis* differences between the 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. In section II we present a standard representative-agent neoclassical model, and derive the labor wedge for a flexible specification of the utility function. In section III we show data sources and treatments applied to it. In section IV we present the estimation of Frisch elasticities of labor, calculate the labor wedge for a wide set of parameterizations, study the labor wedge cyclicality, and present a decomposition of the labor wedge into household and firm components. Finally, in section V we present conclusions drawn from this study.

II. DERIVATION OF THE LABOR WEDGE

1. The representative household

In the macroeconomics literature it is common 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 number of hours the household decides to work, the marginal utility of consumption is constant. In this economy, however, we 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 has the following preferences:

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

(1)

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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(.) and g(.) are both single-variable functions. For example, the utility function u(c,h) = log c + γlog(1–h) is very common in the business cycle literature. Additively separable specifications have the advantage, in addition to simplicity, that it ensures the existence of a balance growth path, which is an important feature of most macroeconomic models.*

where γ denotes the disutility of working, $1/\sigma$ 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 both an increasing utility and a decreasing marginal utility of consumption, as well as a decreasing and concave utility of 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_{hc}, and 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 is bond holdings; and q_{t+1} is the before-tax price of a bond at time $t+1$.

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 as follows:

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

where $\tau \equiv (\tau_c + \tau_h)/(1+\tau_c)$ is defined as the *relevant tax rate*. Notice that τ does not exclusively represent taxes, but any labor market distortion that drives 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.

2. The representative firm

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 the firm's capital stock, 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 have 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:

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

Equation (5) represents 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 also depends on parameters γ, α, σ, and ε. From this set of parameters, the most important 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).

III. THE DATA

In this section, we present the sources of data used in this study. This data set starts in 1986. Hours are defined as the average hours worked by employees as a share of the working-age population. *Average hours worked* were taken from Total Economy Database (*https://www.conference-board.org/data/economydatabase*), since official published series provided by the national statistics institute *Instituto Nacional de Estadísticas* (INE) are available only from 2009 onwards. Work force and unemployment data were collected from INE. Households' real consumption and output are from the 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 the 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 ("*segunda categoría*" and "*global complementario*" taxes[5]) and consumption taxes (VAT, specific taxes, legal acts taxes, international trade taxes and others). All this data were collected from the internal revenue service *Servicio de Impuestos Internos* (*SII*). Even though contributions to pension funds and health insurance are not collected through the tax system, we additionally performed an alternative exercise in which these were included as taxes. Prescott (2004) includes them in his seminal paper in which he 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, they act in practice as taxes given their mandatory nature for most workers in the labor force. The appendix shows more details on how we constructed this alternative definition of taxes. For pension funds and health insurance, we collected data from the Superintendence of *AFPs* (*Administradoras de Fondos de Pensiones* - Pension Fund Administrators), the Superintendence of *Isapres* (*Instituciones de Salud Previsional* - Health Contingency Funds), and Fonasa (*Fondo Nacional de Salud* - National Health Fund). In place of some missing values for medical insurance, we compiled estimates using Health Services activity. Finally, labor share of income was obtained from the National Accounts (line (nominal) *Remuneraciones* from table 1.51, divided by (nominal) gross domestic product).

IV. THE LABOR WEDGE IN CHILE

1. Estimating 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., 2002) and calibrate γ in order to have a labor wedge sample average of 0.5 (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.

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5 *The "segunda categoria" tax (monthly) applies to income from salaried work, including wages, pensions and ancillary or supplementary workers' fees. The "global complementario" tax (annual) is a progressive tax levied on natural persons residing in Chile on rents received from dividends, interests and capital gains (such as stocks and mutual funds), as well as salaries and fees over a certain amount (see www.sii.cl).*

Figure 1

The labor wedge in Chile
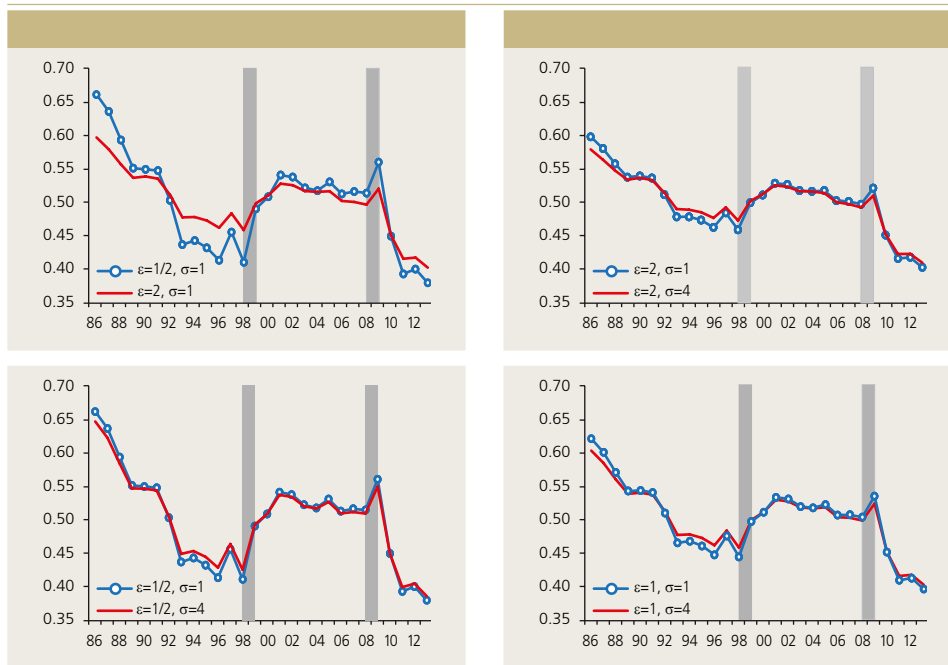
Source: Authors' calculations.

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

We have documented 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 by differences in σ, but by the Frisch elasticity, ε.

The upper left graph in figure 1, in which we hold σ constant and equal to one, shows that the labor wedge movements along the cycle are greater, the lower ε is. 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 this 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 sharply 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 leads 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 go to Shimer (2009) (table 1). With a parameter σ =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 by a representative worker whose consumption-to-income ratio is c_t/y_t, and whose relevant tax rate is τ. We reproduce h_t assuming a wide set of values for ε. As a 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 current-price series at face value 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 previously defined relevant tax rate, τ, as:[6]

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

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 savings account, which is mandatory for contractual workers (who represent about 70% of total employment). This is different from the social security system in the United States and most European countries, in which working individuals are taxed to fund current pensioned

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6 *For a detailed description of the construction of taxes τ, please see the appendix.*

individuals. Even though contributions to the Chilean pension system are not a tax per-se, the mandatory fashion of the system makes it functionally tantamount to a tax.[7] We opted to show both cases. The results of this exercise are shown in table 1.

Table 1

Implicit estimation of the Frisch elasticity of labor

	Including contributions to pension and medical insurance systems							
					Theoretical h			
	$1-\tau$	c/y (Versión 1)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 2)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 3)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 4)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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			
	$1-\tau$	c/y (Versión 1)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 2)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 3)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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
	$1-\tau$	c/y (Versión 4)	h	$\varepsilon=0$	$\varepsilon=1/2$	$\varepsilon=1$	$\varepsilon=2$	$\varepsilon=4$
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.

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

2. Cyclical pattern of the labor wedge

We have mentioned earlier that previous research papers have found the labor wedge in the Chilean economy to be a relevant part of the story accounting 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 objective of this exercise is to check whether activity and the labor wedge are negatively correlated. Figure 2 shows the results.

Figure 2

Negative correlation between the labor wedge and gross domestic product
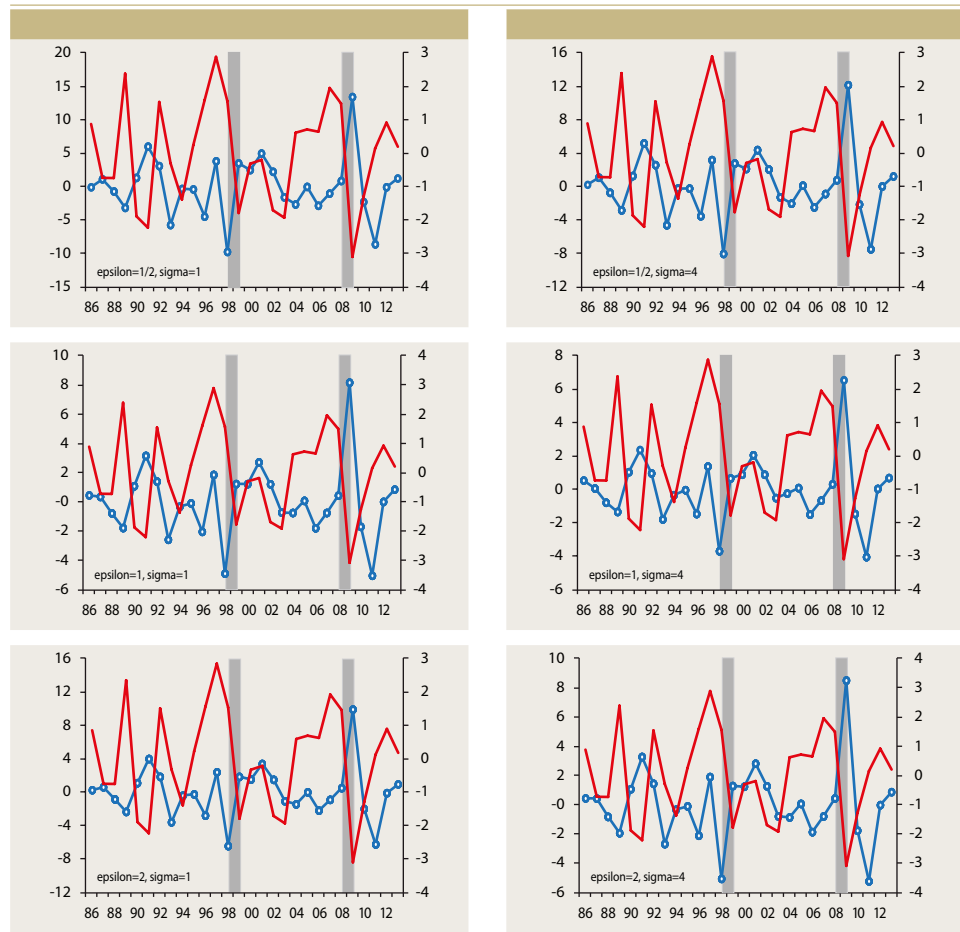
Note: Annual data from 1986 to 2013. Blue and dotted line represents Labor Wedge (left axis). Red and solid line represents the GDP (right axis). Shaded areas represent recession periods. Both GDP and labor wedge are measured in deviations from trend, using Hodrick-Prescott filter with parameter 6.25. The results are 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 1, using additionally a different filtering method. The correlation is approximately between -0.39 and -0.45, all statistically significant at usual confidence levels.

Table 2

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):

$$\hat{\tau}_t = \beta_0 + \beta_1 \hat{y}_t, \qquad (8)$$

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

$$\hat{\tau}_t = \pi_0 + \pi_1 d, \qquad (9)$$

where $d=1$ if $\hat{y}_t > 0$. 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 the labor wedge and labor activity negatively comove, and their estimated impacts are large, negative and statistically significant. With this analysis we confirm what other authors have observed for other countries. Labor wedges and GDP move in opposite directions. The lingering question in all this literature is why.

The first intuitive and obvious hypothesis to test empirically is that taxes increase during recessions. For example, McGrattan and Prescott (2010) 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 (2007) show that the variation explains at most 18% of the U.S. business cycle variance). Still, most economists do not share the belief that this explanation is 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.

Table 3

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
ε=1/2	σ=1	-1.28**	18.90	15.78	-3.47**	15.33	12.08
	σ=4	-1.12**	19.24	16.13	-2.99**	15.08	11.82
ε=1	σ=1	-0.71**	18.76	15.64	-1.81**	13.52	10.19
	σ=4	-0.54**	18.10	14.95	-1.34**	12.22	8.84
ε=2	σ=1	-0.90**	19.11	16.00	-2.36**	14.45	11.16
	σ=4	-0.74**	19.00	15.86	-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.

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 shown in figures 1 and 2, and tables 1 and 2, many different and flexible specifications lead to labor wedges with essentially the same cyclical behavior as 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 the impact of GDP fluctuations on the labor wedge. This is intuitive, as labor supply that is relatively insensitive to changes in wages would exacerbate labor market frictions, leading 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 (for example, Galí and Rabanal, 2005; Smets and Wouters, 2007). Even though these papers show that their models fit the data better, the explanation is still not convincing. What these models really do is 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 fairly uninteresting.

3. CONTRIBUTIONS OF THE MRS AND MPL TO THE CYCLICAL PATTERN OF THE LABOR WEDGE

The counter-cyclical fashion of the labor wedge still puzzles the academic world. In this paper, rather than trying to explain this fact for the Chilean economy, we contribute with a small step towards the answer. Karabarbounis

(2014) develops an interesting and simple way to disentangle the labor wedge into two components: the household component 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 briefly present 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 that the contribution of each component enters exponentially in the optimality conditions of the agents:

$$MRS_t \times exp(\tau_t^h) = w_t \tag{10}$$

$$MPL_t \times exp(-\tau_t^f) = w_t. \tag{11}$$

Using equations (3) and (4), assuming ε=1 and σ=1, and solving for τ_h^t and τ_t^f, we obtain the following expressions:

$$\tau_t^h = log(s_t) + log(y_t / c_t) + log(1 - T) - log(\gamma)$$

$$\tau_t^f = -log(s_t) + log(1 - \alpha),$$

where s_t is the labor share of income: $s_t \equiv w_t h_t / y_t$.[8] Also, $T \equiv (\tau_c + \tau_h)/(1 + \tau_c)$, we changed notation for the relevant tax rate, to avoid 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 easy 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 explains 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.

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8 *Strictly speaking, this corresponds to the ratio of employee compensation 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 most 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 this measure for s_t does not control for labor efficiency.*

Figure 3

Labor share of income (s_t) and recession periods in Chile
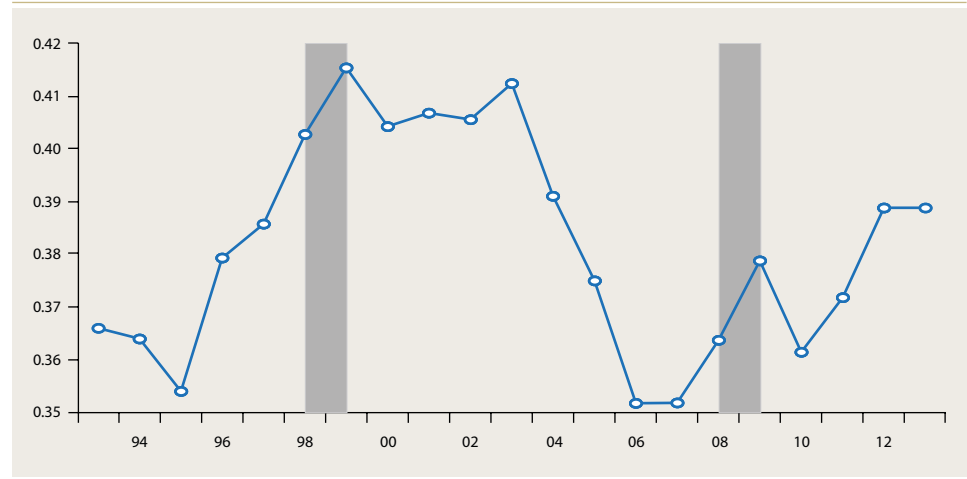
Source: Central Bank of Chile.

Note: Shaded areas represent recession periods.

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: $\hat{\tau}_t^h$, and $\hat{\tau}_t^f$. Again, by construction, we verify that $\hat{\tau}_t = \hat{\tau}_t^h + \hat{\tau}_t^f$.

We take st from the National Accounts. Taxes are taken from *Servicio de Impuestos Internos* (*SII*). As mentioned before, although social security and medical insurance in Chile are not collected by *SII*, we alternatively use 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 not 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 of the total labor wedge, we run the following set of regressions:

$$\hat{\tau}_t = \delta_0 + \delta_1 \hat{\tau}_t^h + \upsilon_h \tag{12}$$

$$\hat{\tau}_t = \delta_0 + \delta_1 \hat{\tau}_t^f + \upsilon_f \tag{13}$$

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

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10　*See the appendix for more details.*

equally important in the determination of the labor wedge. For example, the variation of the firm component $(\hat{\tau}_t^f)$ may be very different from 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 $(\hat{\tau}_t^h)$ resembles the variation of the labor wedge as a whole, we can see 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 fit that each component exerts on the labor wedge. 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 both components 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 in the labor wedge. Unfortunately, since we can only observe annual tax data from 1993-2013, we can only calculate 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 3.

As we suspected from the visual inspection of figure 3, table 3 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 households' optimal conditions with respect to what we actually observe in the data. On the other hand, variation in the firms' 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. While 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]

Table 4

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	15.50	11.05

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

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11   *Forty percent is relatively low by 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%.*

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 supported by the data.

V. CONCLUDING REMARKS

This paper takes a closer look at the labor wedge for the Chilean economy. Unlike other studies, we have focused more on the cyclical fashion on the labor wedge. Using a flexible specification, which has allowed us to use a wide range of assumptions on the parameters, we have derived and estimated 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. Our findings also corroborate what has 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 have decomposed the labor wedge into two elements: the household component and the firm component. The results indicate that the bulk of the variation in 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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APPENDIX

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:

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

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

The definitions of these taxes are as follows (from *www.sii.cl*):

- *VAT*: Value Added Tax
- T_{spec}: Specific Products Taxes
- T_{acts}: Juridical Taxes
- T_{comex}: International Trade Taxes
- T_{others}: Other Consumption Taxes
- T_{sc}: *Segunda Categoría* Tax
- T_{gc}: *Global Complementario* Tax

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 (Superintendence 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 (Superintendence of Isapres, *www.supersalud.gob.cl*)