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Evelina Gavrilova-Zoutman, Floris Zoutman, Arnt-Ove Hopland, and Jarle Møen

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Evelina Gavrilova, Floris Zoutman, Arnt-Ove Hopland, Jarle Møen,

NHH Norwegian School of Economics and
Norwegian Center for Taxation

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Abstract

Zoutman, Gavrilova and Hopland (2018) develop a method that allows to estimate structural demand and supply elasticities using variation in a single tax rate. In this paper, we apply this methodology to papers in the payroll tax literature. We use reduced-form estimates from the literature on payroll taxation to retrospectively estimate structural labor demand and supply elasticities. We extend the methodology to other areas of the labor economics literature. Therefore, we create an overview on the structural estimates of the labor supply and demand. We discuss implications.

JEL Codes: H20, H3, J
Keywords: elasticities, instrument, reduced-form, structural, payroll tax

1 Introduction

In a recent contribution Zoutman et al. (2018) show that a simple assumption from taxation theory allows the identification of both the supply and demand elasticities using a single instrument. In this paper we focus on the payroll tax, as an instrument for identifying both the supply and demand elasticities.

The payroll tax is a tax imposed on the employer, based on the wage paid to employees. In the hiring decision the employer considers the wage gross of the payroll tax, while the employee perceives the wage net of taxes. Following that, it is straightforward to assume that exogeneous variation in the payroll tax can be used as an instrument to identify the elasticity of labor supply, as workers do not generally take into account the payroll tax.[1] Zoutman et al. (2018) define the Ramsey Exclusion Restriction (RER). In the context of the payroll tax, the RER would say that the employers perceive changes in the payroll tax in the same way as they would perceive changes in the wage rate, as employers base their decisions on the gross wage, inclusive of the payroll tax. The RER serves as an extra exclusion restriction, allowing the payroll tax to serve as an instrument for the labor demand elasticity.

Papers in the previous literature have focused on estimating reduced form elasticities, rather than structural ones. [2] Structural supply and demand elasticities have several advantages over reduced form elasticities. First, structural elasticities can be a used in a wide range of welfare analyses as a sufficient statistic. Second, they allow for comparison between estimates in the, e.g., payroll tax literature and the labor literature. Third, they allow for a decomposition of the reduced form elasticities into a supply and demand response. Finally, they allow for a finer analysis of the heterogeneity of responses to a change in the policy, where for e.g. one group might have a higher or lower demand elasticity than another group.

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[1]In Zoutman et al. (2018) this is referred to as the Standard Exclusion Restriction (SER)

[2]See Section ?? for more detail.

In this paper, we provide a review of the literature on the payroll tax where we impose the RER and calculate supply and demand elasticities for a variety of policies and countries. We generally find labor supply elasticities in the range of -1 to 2, and demand elasticities in the range of -0.5 to 1.

Taking into account the variability in the data, we find strong identification for the supply elasticity in Gruber (1997), Stokke (2017) and Bosch et al. (2018). In all three cases the supply elasticity is not significantly different than zero. Similarly, the demand elasticity is also not significantly different than zero in all applications except Kugler & Kugler (2009). There we find for Columbia a demand elasticity of -0.5. Overall, labor supply is not very elastic and the demand elasticity is in line with recent estimates in the minimum wage literature.

The remainder of the article is organized as follows. In Table 1 we present estimates of the supply and demand elasticities from papers, where a payroll tax reform has served as a source of exogeneous variation. The next section provides an introduction into the methodology of this paper, which is derived from Zoutman et al. (2018). In subsection 2.4 we explain the methodology of converting the estimates in different paper to comparable elasticities. In subsection 3 we present the results.

2 Methodology

We adapt the methodology from Zoutman et al. (2018). In the following subsections we will first detail the intuition behind the methodology. In the second subsection we will present the estimating equations, and in the third subsection we will discuss the necessary conditions for obtaining supply and demand elasticities for the Norwegian labor market.

2.1 Intuition

Zoutman et al. (2018) show how to estimate the supply and the demand elasticity using exogenous variation in only one tax rate, thus overcoming the standard result that estimating a supply and demand elasticity requires at least two instruments. In this paper we apply the methodology by estimating the supply and demand elasticity in the Norwegian labor market, using exogenous variation in the payroll tax rate. To understand our methodology consider the following demand-supply model for the labor of a plant i in sector s in municipality m at time t:

$$E_{ismt} = \varepsilon^S w_{ismt} + \gamma^S x_{ismt} + \nu^S_{ismt}, , \quad (1)$$

$$E_{ismt} = \varepsilon^D w^\tau_{ismt} + \gamma^D x_{ismt} + \nu^D_{ismt}, \quad (2)$$

where E_{ismt} denotes the log of the number of employees at the plant. w_{ismt} denotes the log of the average net wage rate at the plant. w^τ_{it} is the log of the gross wage rate including the payroll tax.[3] Hence, w^τ_{ismt} is the sum of the log of the net wage rate and the log of the gross-of-payroll-tax rate $1+\tau_{ismt}$. x_{ismt} is a vector of control variables including fixed effects. The coefficients ε^S and ε^D denote the supply and demand elasticity. Standard economic theory would imply that $\varepsilon^S, -\varepsilon^D > 0$.

To understand the effect of payroll taxation on this labor market consider Figure 1. The left panel shows the (exaggerated) effect of an infinitesimal increase in the payroll tax rate by $d\tau$ on employment E_{ismt} and the net wage rate w_{ismt}. As can be seen by totally differentiating (2) the increase in the payroll tax shifts labor demand left by $\varepsilon^D d\tau$. The resulting effect of the shift on equilibrium labor demand and the wage rate is given by the standard incidence equations:

$$\frac{dE_{ismt}}{d\log(1+\tau_{ismt})} = \frac{\varepsilon^D \varepsilon^S}{\varepsilon^S - \varepsilon^D} \equiv \pi^E, \quad (3)$$

$$\frac{dw_{ismt}}{d\log(1+\tau_{ismt})} = \frac{\varepsilon^D}{\varepsilon^S - \varepsilon^D} \equiv \pi^w, \quad (4)$$

where $\pi^E < 0$ denotes the reduced-form elasticity between employment and the gross-of-payroll-tax rate. π^w measures the reduced-form elasticity between the wage rate and the gross-of-payroll-tax rate.

[3]Formally, $w^\tau_{ismt} = \log(W_{ismt}(1+\tau_{ismt})) = w_{ismt} + \log(1+\tau_{ismt})$, where W_{ismt} is the (unlogged) net wage rate and τ_{ismt} denotes the payroll tax rate.

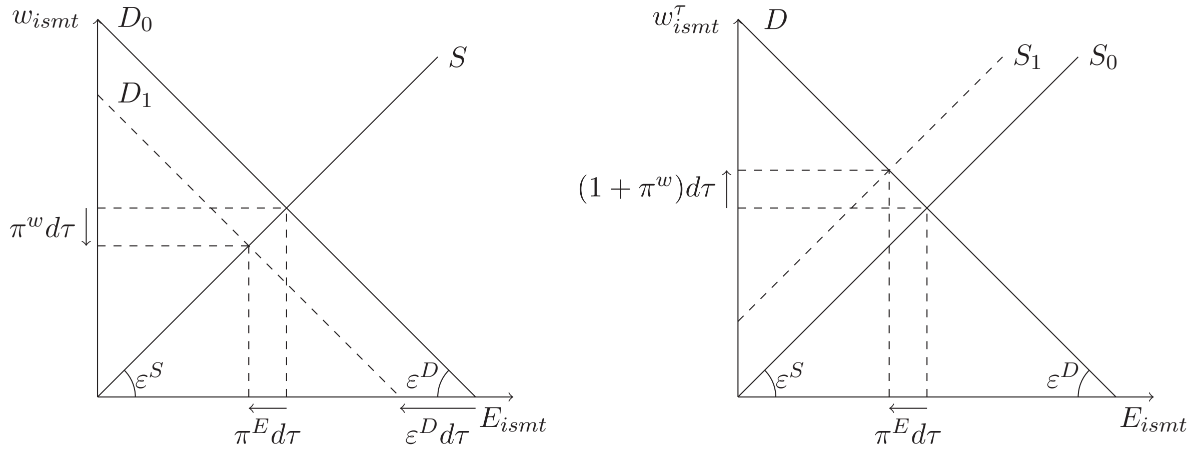

Figure 1: The Effect of an Increase in the Gross-of-payroll-tax Rate by $d\tau$

Under standard assumptions π^w ranges between -1 implying that the full incidence of the tax resides with workers, and 0 implying that the incidence of the tax resides with employers.

Equation (1,2) cannot be estimated using OLS, because the wage rate w_{ismt} is endogenous. However, Zoutman et al. (2018) show that they can both be estimated using an IV-approach. To understand the approach, again consider Figure 1. As discussed before, an increase in the payroll tax shifts demand along the supply curve in the left-hand panel. Hence, it follows that variation in the payroll tax allows for identification of the coefficients in the supply equation (1).

The right panel of Figure 1 shows the exact same tax reform, but now expressed in the gross wage rate w^τ_{ismt}. Expressed this way, the tax rate does not independently appear in the demand equation, and hence, the demand equation does not shift. Instead, the tax variable appears in the supply equation, and therefore, shifts the supply equation inwards. The intuition is that for any given gross wage rate w^τ_{ismt} a tax increase lowers the net wage rate w_{ismt}, thereby making it less attractive to supply labor. Because supply shifts along the demand curve, the same reform can also identify the demand elasticity.

2.2 Estimating Equations

Figure 1 naturally gives rise to the couple of 2SLS equation, necessary to identify the supply and demand elasticity.

The left panel of Figure 1 can be represented by the following 2SLS model that allows for identification of the supply elasticity:

$$w_{ismt} = \pi^w \log(1+\tau_{ismt}) + \gamma^w x_{ismt} + \nu^w_{ismt}, \quad (5)$$
$$E_{ismt} = \varepsilon^S \hat{w}_{ismt} + \gamma^S x_{ismt} + \nu^S_{ismt}, \quad (6)$$

where $\hat{w}_{ismt}$ denotes the net wage rate instrumented by equation (5).

The right panel of Figure 1 gives rise to the following 2SLS approach to estimate the demand elasticity:

$$w^\tau_{ismt} = \pi^{w^\tau} \log(1+\tau_{ismt}) + \gamma^w x_{ismt} + \nu^w_{ismt}, \quad (7)$$
$$E_{ismt} = \varepsilon^D \hat{w}^\tau_{ismt} + \gamma^S x_{ismt} + \nu^S_{ismt}, \quad (8)$$

where $\hat{w}^\tau_{ismt}$ denotes the gross wage rate instrumented by equation (7).

Zoutman et al. (2018) show that the 2SLS equations (5,6) and (7,8) provide consistent estimates for the supply and demand elasticity, provided the following three conditions hold: i.) the null hypotheses that $\pi^w = 0$ and $\pi^{w^\tau} = 1 + \pi^w = 0$ can both be rejected, ii.) the tax rate does not directly appear in (1) when expressed in net wages, and in (2) when expressed in gross wages, and iii.) variation in τ_{ismt} must be exogenous after controlling for x_{ismt}.

2.3 Required Conditions

2.3.1 Strength and Incidence

In order for the demand and supply elasticities to be identified it is necessary that the incidence of the tax is shared. In intuitive terms, one needs to observe a reaction to the tax both from the employer and the employee. If one of the two does not react, then we can't estimate their elasticity and responsiveness.

Formally, the instrument in the two first stages (7,5) should be significantly different than zero, which can be directly tested with the F-test, whose result is reported in the F-statistic from the first stage. A weak instrument can be interpreted as evidence that the incidence of the payroll tax is not shared. Note that the coefficient $\pi^{w^{\tau}} = 1 + \pi^{w}$ mechanically. [4]

If $\pi^{w} = 0$, then $\pi^{w^{\tau}} = 1$ and one can estimate only the demand elasticity. Intuitively, in the left panel of Figure 1 the wage faced by employees will not change, the demand curve would not shift and there would be no identifying variation for the supply elasticity. In the right panel of Figure 1 the gross wage paid by employers would change as a result of the payroll tax. This would lead to shift in the supply curve and enough variation to identify the demand elasticity.

Conversely, if $\pi^{w^{\tau}} = 0$, then $\pi^{w} = 1$ and one can estimate only the supply elasticity. Therefore, in order to estimate both supply and demand elasticities it is necessary for the incidence of the payroll tax to be shared.

2.3.2 Exclusion Restriction

The two 2SLS require two exclusion restrictions.

First, following (1) labor supply is a function of the net wage rate workers receive, w_{ismt}, and thus, does not directly depend on the payroll tax τ_{ismt}. Therefore, τ_{ismt} can be excluded from the supply equation (6) and serve as an instrument in the first stage (5).

Second, demand only depends on the gross wage rate w^{τ}_{ismt} because this is the wage rate employers pay for hiring a worker. In other words, the employer reacts in the same way to a change in wage rate as he does to a change in the tax rate. Hence, after controlling for w^{τ}_{ismt}, the tax rate τ_{ismt} can be excluded from the demand equation. This is the Ramsey Exclusion Restriction (RER), see for detailed derivation Zoutman et al. (2018).

2.4 Comparison with the Literature

Most papers in the literature attempt to estimate the reduced-form elasticity by estimating the following two regression specifications:

$$
\begin{aligned}
E_{ismt} &= \pi^{E} \log(1+\tau_{ismt}) + \gamma^{E} x_{ismt} + \nu^{E}_{ismt}, &(9)\\
w_{ismt} &= \pi^{w} \log(1+\tau_{ismt}) + \gamma^{w} x_{ismt} + \nu^{w}_{ismt}. &(10)
\end{aligned}
$$

If variation in the payroll tax rate is exogenous (after controlling for x_{ismt}) both (9) and (10) can be estimated using OLS. The estimates provide useful information for policy makers as they measure the wage and employment effects of payroll taxation. Moreover, they provide information on who carries the burden of the tax, and they can under some conditions serve as sufficient statistics for welfare analysis of the payroll tax (see the Online Appendix of Zoutman et al., 2018 for a further discussion of these conditions). However, they do not offer insights in the optimal design of other labor-market policies such as minimum wages, unionization and other tax instruments. Moreover, the estimates from (10,9) can be compared to other estimates from the empirical payroll literature, but they cannot be compared to estimates using different instruments from other areas of the labor literature.

In order to facilitate comparison with other strands of the labor market literature, and inform policy-makers on the effectiveness of a large range of policy instruments we instead estimate the underlying supply and demand equation (1,2). We take the RER explicitly, and use the provided estimates in

[4] This follows from the fact that the dependent variable in (7) equals $w^{\tau}_{ismt} = w_{ismt} + \log(1+\tau_{ismt})$ i.e the dependent variable in (5) plus the log of the gross-of-tax rate.

past papers to derive the supply and demand elasticities. For this, we use the following re-arranging of equations (3, 4) and an indirect least squares estimator:

$$\varepsilon^S = \frac{\pi^E}{\pi^w} \quad (11)$$

$$\varepsilon^D = \frac{\pi^E}{1+\pi^w}, \quad (12)$$

The standard errors for the elasticities have been calculated by using reported standard errors in the source tables and the Delta method applied to the formulas above. In order to jointly estimate both elasticities we need to assume that $cov(\pi^E, \pi^w) = 0$, since the covariance between the two estimates is usually not reported. From the first stage estimates we are able to compute F-statistics, which allow us to determine the strength of the instrument.

The supply elasticity is strongly identified when $\pi^w = 0$ can be rejected. The F-statistics is calculated as: $F_S = (\frac{\pi^w}{se(\pi^w)})^2$. When $\pi^w = -1$ can be rejected, then the demand elasticitiy will be strongly identified. The F-statistics is calculated as $F_S = (\frac{\pi^w+1}{se(\pi^w)})^2$.

3 Results

Table 1 is organized in the following way. In the first column we present the reference article and the table,from which we source the main estimates. In column two we highlight the country for which elasticities have been estimated. In the next two columns we present estimates for π_{zw} and π_{ze}, and in the last two columns we present estimates for the elasticities. In round parenthesis we present standard error estimates. In square parenthesis we present F-statistics for the first stage. We have selected articles in which we can observe both estimates π^w and π^E. This excludes contributions by Anderson and Meyer, 1997, Korkeamäki and Uusitalo (2009), Elias (2015), Dale-Olsen (2017) and Saez et al. 2017.

Looking at the estimated F-stiatics we find strong identification for the supply elasticity in Gruber (1997), Stokke (2017) and Bosch et al. (2018). In all three cases the supply elasticity is not significantly different than zero. Similarly, the demand elasticity is also not significantly different than zero in all applications except Kugler & Kugler (2009). There we find for Columbia a demand elasticity of -0.5. Overall, labor supply is not very elastic and the demand elasticity is in line with recent estimates in the minimum wage literature.

4 Conclusion

In this paper we have applied the methodology of Zoutman et al. (2018). We create a meta summary of the structural estimates of the labor supply and demand elasticities.

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Table 1: Comparison with the Literature

Authors	Country	Estimates			
		π^w	π^e	$\varepsilon^S \equiv \frac{\pi^E}{\pi^w}$	$\varepsilon^D \equiv \frac{\pi^E}{1+\pi^w}$
Gruber (1994)	US	-1.049 (0.561)	1.195 (0.537)	-1.139 (0.667) [3.496]	-24.39 (195.832) [0.008]
Gruber (1997)	Chile	-1.022 (0.180)	-0.113 (0.165)	0.111 (0.163) [32.26]	5.136 (42.69) [0.015]
Anderson & Meyer (1997)	US	-0.715 (0.292)	0.298 (0.732)	-0.417 (1.037) [5.95]	1.05 (1.719) [0.953]
Kugler & Kugler (2009)	Colombia	-0.2346 (0.0883)	-0.3841 (0.1572)	1.637 (0.911) [7.08]	-0.502 (0.213) [75.14]
Cruces et al. (2010) Table 4	Argentina	-0.501 (0.192)	0.270 (0.482)	-0.539 (0.984) [6.81]	0.541 (0.988) [6.75]
Bennmarker et al. (2012) Table 4	Sweden	-0.0023 (0.0008)	0.0001 (0.0010)	-0.043 (0.435) [8.27]	0.0001 (0.010) [1,555,321]
Stokke (2017) Tables 3/4	Norway	-0.167 (0.043)	-0.286 (0.207)	1.713 (1.316) [15.08]	-0.343 (0.211) [375.28]
Bosch et al. (2018)	Netherlands	-0.608 (0.181)	-0.055 (0.048)	0.09 (0.084) [11.28]	-0.14 (0.138) [4.69]