New Estimates for Labor Supply Elasticity of Korean Married Female Workers: Evidence from Recent Korean Tax Reform

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This paper is still in progress, thus very preliminary.

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1. Introduction

One of the empirical challenges in estimation of elasticity of labor supply using tax reform is that an after-tax wage rate can be possibly endogenous in labor supply equation. The usual suspects are correlation between taste for work and wage rate for the following reasons. First, it is possible that the workers who have strong preference for work is likely to accumulate more human capital and, as a consequence, end up with higher wage rate. Second, wage rate is usually not observed, rather obtained by dividing earnings by hours of work. The constructed wage rate must be endogenous with respect to the error term in labor supply equation.

Korea experienced modest tax reforms recently. From 2009 to 2010, the marginal tax rates were lowered by 2 percentage point for every income bracket in a sequential fashion except the highest one. Income deduction amounts were also changed. For example, the income deduction for dependent children had been doubled. This type of tax reforms (or changes) provides a chance to recover the elasticity of labor supply due to its nature of exogeneity.

A sequence of tax reforms in Korea generates exogenous variations which help identifying the wage elasticity of labor supply since the change in marginal tax rates had a differential impact on different demographic groups. Chetty (2012) points out that with large changes in marginal tax rates can generate fairly large intensive margin elasticity.

A goal of this paper is to estimate the labor supply elasticities of married female workers of Korea using the recent tax reforms. We focused on prime-age female workers, rather than male workers because they were the ones who were mostly likely to be influenced by the tax reforms. In addition, in order to encourage more labor supply of female workers, we need to understand more on their behavior. To our knowledge, however, it is rarely known how responsive the Korean female workers are to their wage rates.

This paper contributes to the literature of estimating labor supply elasticity of Korean workers and the one of the general literature of labor supply. First, we used the National Survey of Tax and Benefit (NaSTaB, henceafter) which contains information on detailed individual tax return including incomes

from various sources, income deduction amounts, tax credits, assets, and consumption as well as demographic information. Most tax-related information is reported based upon official tax documentations. Thus the measurement error in computing the marginal tax rate which each individual faced could be minimized. Other previous papers (Blundell et al.(1998) and Bosch and Jongen (2012)) used the tax simulator based upon the income level. But the actual marginal tax depends upon not only the before-tax earnings but also the consumption and demographic patterns of the households. From that aspect, the Tax-Benefit panel has an advantage. Second, to our knowledge, our paper is the first one which considers the female workers of Korea in a dynamic setting. Previous works focused on prime-aged male workers with a static framework (Na et al., 2002; Sim, 2006; Nam, 2007; Jeon and Hong, 2009). The estimates for labor supply elasticity ignoring dynamic implications can be biased. Our estimate improves upon the literature by allowing the female workers to save with or without liquidity constraints.

The organization of the paper is as follows. In section 2, we explained the recent tax reforms in Korea. In section 3, we introduced our empirical model and identification strategies. The data and summary statistics of our sample were described in section 4. Section 5 presents the main estimation results as well as some preliminary analyses. Section 6 discusses the conclusions of the paper.

2. Recent tax reforms in Korea

The recent tax reform in terms of personal income tax for earnings since 2009 includes two components. First, the marginal tax rate was decreased by 1 or 2 percentage point for all the income bracket except the highest one. There were four income brackets for taxable income until 2008; 8 percent for the taxable income less than 12 mil. won, 17 percent between 12 mil. won and 46 mil. won, 26 percent between 46 mil. won and 88 mil. won, 35 percent for greater than 88 mil. won. In 2009, the marginal tax rate for the first income bracket decreased by 2 percentage point and became 6\%. The marginal tax rates for the second and third brackets decreased by 1 percentage point. In 2010, the

tax rates for the second and third brackets were additionally decreased by 1 percentage point. In sum, by 2010 the marginal tax rates were decreased by 2 percentage point except the one for the highest bracket. It was planned to be decreased by 2 percentage point in 2010. However, after fierce debates between the ruling Grand National Party and the opposing Democratic Party, the decrease for the highest income bracket was postponed and eventually cancelled. The tax reform in marginal tax rate is summarized in [Table 1] and [Figure 1].

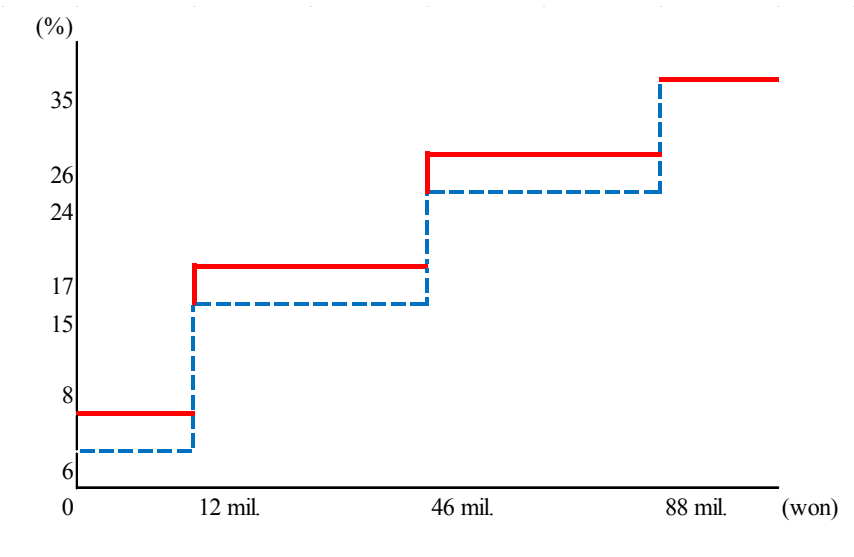
The second component of the tax reform is about the increase of the income deduction amount. Especially the change targeted for the family with children. The standard deduction amount for the family with children depends upon the number of children, and it increases as the number of dependent children. Before 2011, the deduction amount for the first two children was 0.5 mil. won per child. The amount for the third child or beyond was 1 mil. won per child. From 2011, the deduction amount was doubled to 1 mil. won for the first two children and 2 mil. won for the beyond.

These two reforms are expected to have an impact on the after-tax hourly wage rate. The change in marginal tax rate has a direct effect, and the change in taxable income has an indirect effect on the marginal tax rate that a tax-paying individual should face. However, considering that the female workers in Korea are mostly second bread-earners, the indirect effect might be minimal because most income deductions were picked up by husband with higher marginal tax rate (Woo and Song, 2012).

Table 1 Change of marginal tax rates in recent tax reform in Korea

	Year		
Taxable income	~2008	2009	2010~
~12 mil. won	8%	6%	6%
12 mil. won~46 mil. won	17%	16%	15%
46 mil. won~88 mil. won	26%	25%	24%
88 mil. won~	35%	35%	35%

Figure 1 Change of marginal tax rates in recent tax reform in Korea



Note: The red solid line is for 2008 and the blue dotted line is for 2010. The X-axis is taxable income net of income deductions.

3. Empirical specification and identification strategy

Our benchmark empirical model follows the one in Blundell, Duncan, and Meghir (1998). Basically it takes the form of equation (1).

$$h_t = \beta_0 + \beta_w \log(\tilde{w}_t) + \beta_\mu \log \mu_t + \beta_X{}' X_t + e_t \qquad (1)$$

$$\widetilde{w}_t = w_t (1 - \tau_t)$$

where w is a pre-tax hourly wage rate, τ is marginal tax rate, $\widetilde{w}$ is a post-tax hourly wage rate, μ is other income, and e is an unobserved heterogeneity representing the taste for work (or leisure).

Depending on how we define the other income, the labor supply specification in equation (1) can be consistent with either static model or dynamic model. Suppressing the subscripts for the convenience of explanation, if μ is just non-labor income, equation (1) estimates the conventional static labor supply model. The non-labor income can be defined to include the household income except wife's earned income, such as the incomes from financial or real estate assets. If $\mu = c - wh$, where C is consumption, the model is consistent with inter-temporal two-stage budgeting in the absence of liquidity constraints and with the presence of liquidity constraints (MaCurdy, 1983; Blundell and Walker, 1986; Arellano and Meghir, 1992). That is, if the other income is property defined, one can recover the labor supply elasticity in a dynamic environment although we still need to assume weak separability of the life-time utility function over time.

In order to incorporate the endogeneity problem, e_t is allowed to be potentially correlated with the after-tax wage rate $\widetilde{w}_t$. We assumed the following restrictions on the unobserved heterogeneity to identify the model.

$$E[e_t \mid P_t = 1, g, t] = \beta_g + \beta_t + \beta_{gt} \qquad (2)$$

where P_t is an indicator for supplying labor in the market, g represents a demographic group, and t represents a time. The assumption above is equivalent to the set-up for difference-in-differences estimation if there are only two periods considered, where there is a group fixed effect and an additive time effect.

As long as the recent tax reform had a differential effect on the differential groups over time, the assumption in equation (2) provides an identification strategy. From equation (2), one can construct

the reduced-form equation as below.

$$\log(\widetilde{w}_t) = \alpha_g + \alpha_t + \alpha_{gt} + \alpha_X{}' X_t + u_t \quad (3)$$

Since we are dealing with the labor supply of female workers in couple, selection into labor market must be considered in estimating equation (1). Otherwise, we are likely to have an inconsistent estimate for β_w due to selection bias. We basically follow the control function approach by including the inverse Mills' ratio. In other words, we estimated the probit model to explain the participation decision of the married female workers.

$$\Pr(P_t = 1) = \Phi\left(\gamma_g + \gamma_t + \gamma_{gt} + \gamma_X' X_t\right) \quad (4)$$

Then we computed the inverse Mills' ratio $\hat{\lambda}_t = \phi\left(\hat{\gamma}_g + \hat{\gamma}_t + \hat{\gamma}_{gt} + \hat{\gamma}_X' X_t\right) / \Phi\left(\hat{\gamma}_g + \hat{\gamma}_t + \hat{\gamma}_{gt} + \hat{\gamma}_X' X_t\right)$ and included it in the labor supply equation.

Finally we estimated the 2SLS model with the control function from equation (4) as below.

$$h_t = \beta_g + \beta_t + \beta_w \log(\widetilde{w}_t) + \beta_\mu \log \mu_t + \beta_X{}' X_t + \beta_\lambda \hat{\lambda}_t + \varepsilon_t \quad (5)$$

4. Data

We used the 2nd-5th waves of the NaSTsB panel collected by Korea Institute of Public Finance. The data has an advantage for our research over other data set because it contains very detailed information regarding individual income tax information as well as other social-economic variables. It contains information on yearly income from various sources, pension, insurance, income deduction amounts, and overall tax burdens. Most of all, the income tax information was collected reported upon official individual tax filing documentations. Therefore, this data can minimize the measurement

errors in identifying the exact marginal tax rates, in turn, and after-tax wage rate which the female workers in our sample were facing. Most previous research suffers from the measurement errors in obtaining the marginal tax rate and frequently used the tax calculator suck as the TAXSIM of the NBER. For example, Bosch and Jongen (2013) obtained the marginal tax rate by increasing the income by 3 percent and computing the marginal increase of tax burden. In contrast, our data helps us to overcome this shortcoming because it provides rather precise information on the deduction amounts and taxable income of each respondent even though we had to make some assumptions for the convenience of analysis.

We focused on the married female workers in our analysis because they are the ones who were most likely to be affected by the current tax reforms. Labor force participation is defined if they provided at least one hour paid work for a week. We restricted our attention to the women aged ranged between 20 and 60. Since our focus group is married couple, we ruled out those who are neither head of household nor spouse. We ruled out the self-employed or non-paid workers in family business from estimation. After cleaning the data set, finally we have 1,947 married females and 4,402 observations (person×time). Every current value was converted into real term by using the consumer price index. The summary statistics are given in [Table 2].

The labor force participation rate in our sample is around 77 percent, which seems to be high compared to general perception. This is due to our definition of labor force participation. This definition is different from the official definition of labor force participation; yes for the question for seeking jobs. The annual before-tax earned income is around 18 million KRW and the income tax is 0.80 million KRW, so the effective average income tax rate is around 4.2 percent. This number is roughly commensurate with the effective average tax rates from other studies. The before-tax hourly wage rate for the married female workers is 8,800 KRW and the after-tax hourly wage rate is 7,900 KRW. When it comes to employment type, the permanent workers accounts for around 68 percent conditioning upon labor force participation while the temporary or daily employed is 32 percent.

Table 2 Summary statistics I

	No.	mean	s.d.
labor force participation	4042	0.77	0.42
hours of work[a]	3114	43.70	12.42
pre-tax earnings (10,000 KRW)	3060	1884.07	1539.22
income tax	3059	79.88	197.08
pre-tax wage rate (10,000 KRW)	3060	0.88	0.79
post-tax wage rate (10,000 KRW)	3060	0.79	0.63
Employment type (%)	3114		
permanent	2,109	67.68	
temporary	617	19.8	
daily	390	12.52	

Data: wave 2-wave 5 from the Tax-Benefit panel of Korea Institute of Public Finance.
a: The unit of measurement is week.

[Table 3] presents the education achievements and birth cohorts. A majority of females, 45 percent, achieved high school or college level education. When it comes to birth cohort, 74 percent of our samples were born in 1970s and 1980s. That is, the females seem to be rather young, compared to the ones in the KLIPS. The young cohorts partially explains why we had high labor force participation rate.

Table 3 Summary statistics II

	no.	%
year of education	4,034	
primary school	174	4.31
middle school	353	8.75
high school	1,821	45.14
2 or 4 year college	1,519	37.65
graduate	167	4.14
cohort by birth year	4,042	
≤ 1960	777	19.22
≤ 1970	1,478	36.57
≤ 1980	1,500	37.11
> 1980	287	7.1

Data: wave 2-wave 5 from the Tax-Benefit panel of Korea Institute of Public Finance.

5. Empirical analysis

A. Preliminary analysis

In this section, we presented how the hourly wage rate and the hour of work had changed before and after the income tax reform. In addition, we graphically investigated how the hours of work were correlated with the after-tax wage rates.

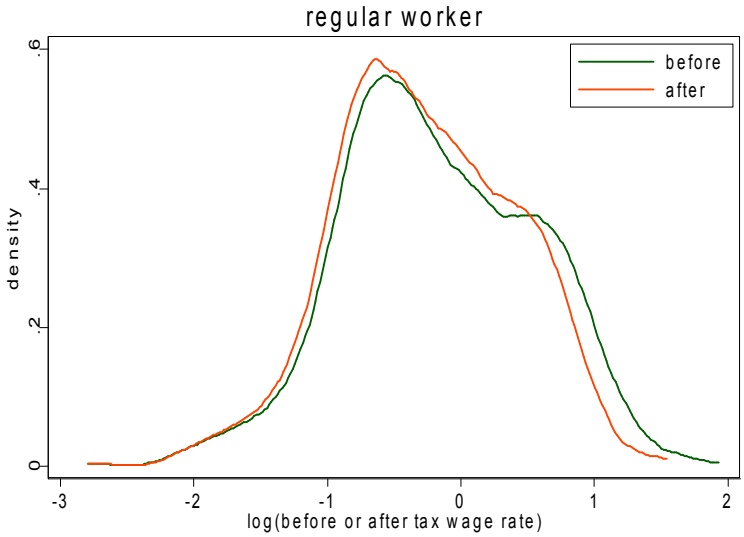
[Figure 2] shows the distributions of the logarithm of before- and after-tax wage rates of the regular workers for the wave 2, before reform, and the wave 5, after reform. Compared to the wave 2, the after-tax wage rate decreased to a smaller extent. That is, the tax reforms seem to have decreased the income tax burden even though the change also seems to be small.

[Figure 3] presents the distributions of the logarithm of after-tax wage rates for the wave 2 and the wave 5 of regular workers and contingent workers, respectively. For regular workers, the proportion of high wage rate workers had decreased and moved down to the middle. This might be due to the global financial crisis which hit Korea over the periods between 2008 and 2010. For contingent workers, on the other hand, the after-tax wage rate has increased.

The changes in hours of work before and after tax reform are presented in [Figure 4]. For both regular and contingent workers, the hours of work seem to have decreased visually. The regular female workers concentrated on 40 hours of work in the wave 5. The contingent workers moderately decreased the hours of work as well. The overall decrease of the hour of work in wave 5 might be due to the recessions from the global financial crisis.

[Figure 5] shows the scatter plots of the weekly hours of work and the logarithm of the after-tax wage rates. As expected from the above analysis, the correlation between two variables for both regular workers and contingent workers seems to be negative. That is, the workers with higher wage rate are likely to end up with lower hours of work. This phenomenon might imply the negative uncompensated wage elasticity. However, it should be noted that the negative relations might be spurious because the wage rate was obtained by dividing the earned income by the hours of work reported. Thus, the wage rate might be endogenous with the hours of work by construction. So, we need a set of instruments to identify the effect of the wage rate on the labor supply.

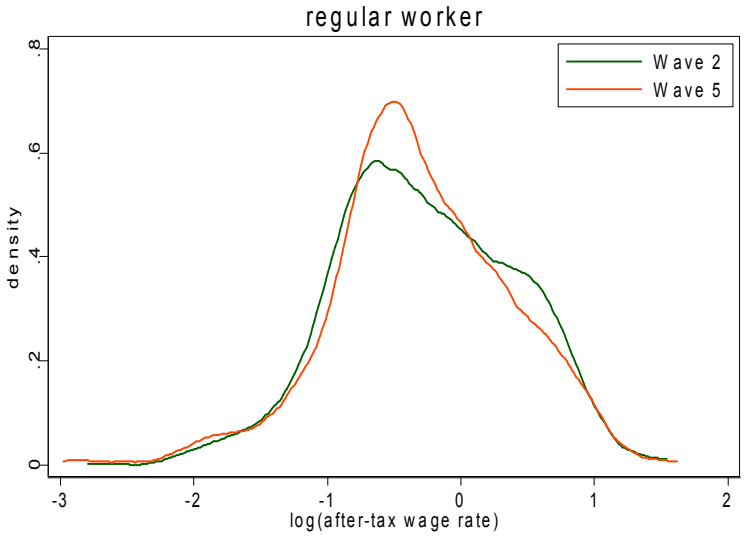
Figure 2 Before- and after-tax wage rate before and after tax reform



(a) wave 2

(b) wave 5

Figure 3 Distribution of log(after-tax wage rate) before and after tax reform



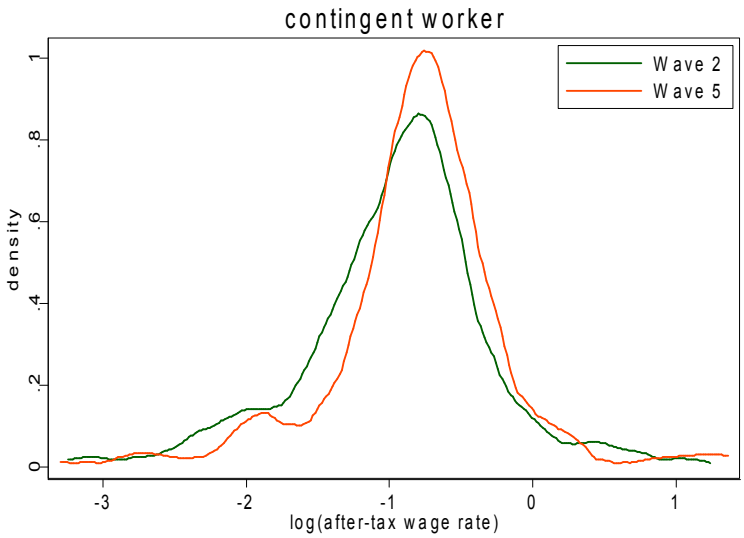
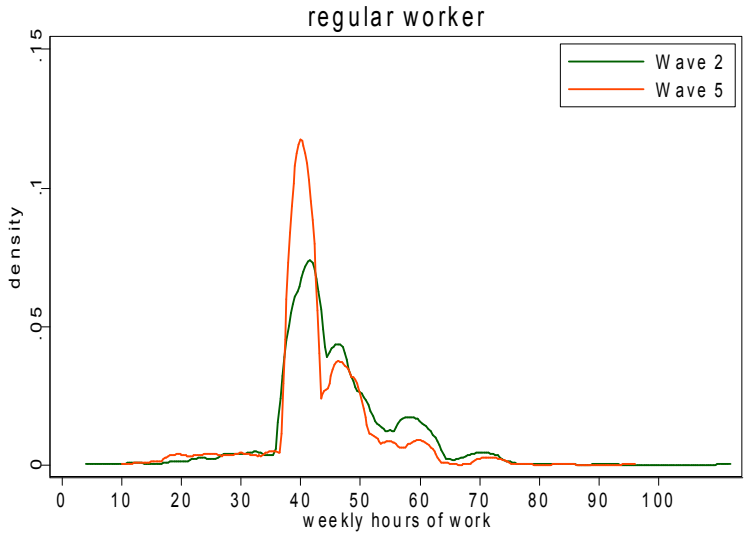


Figure 4 Change in hours of work before and after tax reform



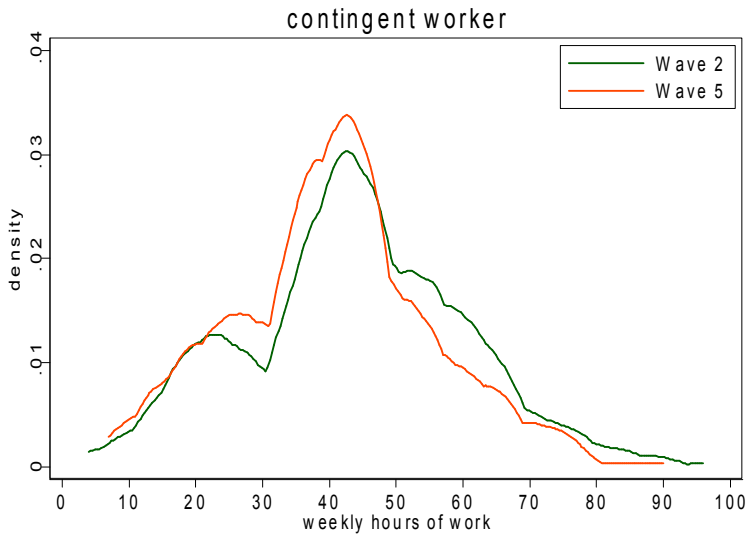
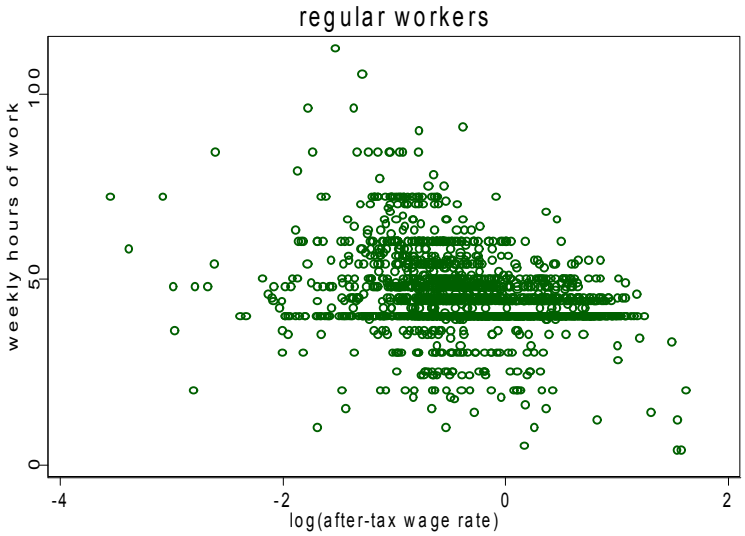
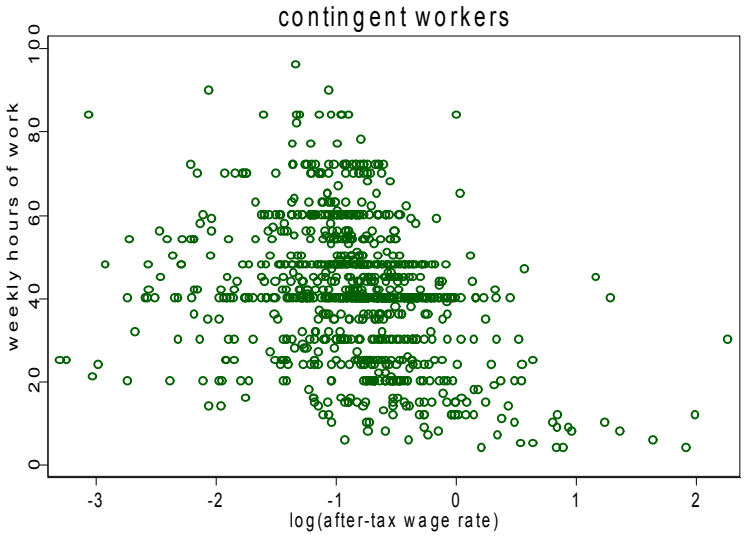


Figure 5 Scatter plots of hours of work against log(after-tax wage rate)





B. Estimation results

As mentioned in previous section, our major identification strategy is to use the cohort-education based instrumental variables. The idea is that the recent tax reforms, which changed the marginal tax rates, had differential effects on the different cohort-education groups. The idea is from Blundell et al. (1998) and Burns and Ziliak (2013).

Using the simple OLS estimation, we estimated four different specifications. Model (1) includes only the logarithm of the after-tax wage rate, model (2) controls for a set of observed characteristics such as dummies for regular worker, head of household, number of kids aged equal or less than 6 years old, and time dummies. Model (3) includes the other income to estimate equation (1), and model (4) allows the wage rate to interact with the job status such as temporary or daily work.

[Table 4] presents the estimation results for the above four specifications. The coefficient of the logarithm of after-tax wage rate ranges from -4.2 to -8.6 depending on the specifications. The uncompensated wage elasticity can be obtained by dividing the coefficient by the average hours of work. The uncompensated wage elasticity from model (1) is around -0.094, and the one from model (3) is -0.128 in [Table 5]. The signs of the estimated uncompensated elasticities are negative. That is, from model (3), 10 percent increase of the wage rate would decrease the labor supply by 1.3 percent. The estimated income elasticity is positive, which is against to the casual assumption that leisure is normal goods. The Hicksian elasticity is negative which is also against the assumption of convex preference. It is quite rare to find the negative compensated elasticity, so we doubt that the OLS estimates might be biased due to endogeneity problem.[1]

[Table 6] presents the estimation results for IV estimation including the inverse Mills ratio in the estimation equations. Model (1) estimates the basic model similar to model (3) in [

[1] To our knowledge, Kuismanen (1997) is the only paper which finds negative uncompensated elasticity and positive income elasticity

Table 4]. Model (2)-(4) additionally include the inverse Mills ratio in order to control for self-selection into labor market. Model (3) and (4) include the interactions with work type.

First of all, the coefficients of the logarithm of after-tax wage rate are positive and range from 1.8 to 2.8 except model (4) in which the coefficient is negative but statistically insignificant. The uncompensated elasticity reported in [Table 7] ranges from -0.028 to 0.0527 depending upon work status. More specifically, for model (3), the uncompensated elasticity is 0.064, the income elasticity is around -0.055, so the compensated elasticity is 0.12. The estimated elasticities are statistically significant but its magnitude is small. If we break down into work status, the permanent workers' compensated elasticity is very small and not different from zero to a statistical margin. However, the temporary workers' uncompensated elasticity is 0.308 and their compensated elasticity is 0.549. Both are large in terms of magnitude and statistically significant as well. We can find similar phenomenon for daily workers. In summary, the permanent female worker whose job is stable does not respond to the change in wage rate while the temporary or daily workers are very responsive to the change in wage rates.

C. Discussions

The elasticities estimated in this paper are different from the previous works in the following aspects. First, we considered the dynamic model rather than the static labor supply model which most previous literature on Korean workers used. Second, we focused on the female workers who are believed to be more responsive to the change in wage rate as a second bread earner. They are the ones whom the tax reform was targeting on in terms of labor supply. We have more variations in the changes of marginal tax rates, which helped us to identify more precise estimates for labor supply elasticities.

Na et al. (2002) reported negative compensated elasticity, -0.46, as well as negative uncompensated elasticity. Sim (2006) seemed to find out a significant effect of tax change on labor supply due to lack of variations of marginal tax rate. The findings of Nam (2007) are close to other estimates from western literature (Blundell and MaCurdy, 1998). He reported that the uncompensated elasticity is

around 0.1 while the compensated elasticity is 0.0015. On the other hand, Jeon and Hong (2009) finds that the compensated and uncompensated elasticity is around 1.3. Considering that the sample of Nam (2007) and Jeon and Hong (2009) is the head of household, mostly male, their estimates seem to exaggerate or underestimate the realities due to lack of precise tax information or dynamic aspects.

Our estimates improve on the previous works because we have more information and dynamic model. As a result, we provide more reliable estimates for female workers which are close to the literature. The uncompensated elasticity of the female workers in regular jobs are statistically close to zero while the one of temporary workers are around 0.3 with relatively large income effect. For daily workers, the uncompensated elasticity was roughly 0.5 while the income elasticity is close to zero. For both types, the compensated elasticity is above 0.5.

6. Conclusions

This paper estimated the labor supply elasticities for married female workers in Korea. In order to identify the wage effect in terms of intensive margin, we took advantage of a series of recent tax reforms. Our finding is two folds. First, the compensated elasticity for the workers with job security is around 0.1 while the ones with less stable work status is slightly over 0.5. Second, the income effect is very small and not different from zero statistically in most cases.

These findings provide some policy implications for tax and benefit policies. First, the increase of marginal tax rates would distort the decisions of female workers in unstable status mostly in terms of efficiency. So the recent tax reform, in contrast, which lowered marginal tax rates for low income brackets only, would encourage the labor supply of married female workers. There must be an improvement in efficiency. Second, the income subsidy such as child benefit would not discourage the labor supply of female workers at least in intensive margins as many policy makers are worried about.

References

Arellano, M. and C. Meghir, 1992, Female labor supply and on-the-job search: an empirical model estimated using complementary data sets, *The Review of Economic Studies*, 59, 537-559.

Blundell, R., A. Duncan and C. Meghir, 1998, Estimating labor supply responses using tax reforms, *Econometrica*, 827-861.

Blundell, R. and I. Walker, 1986, A life-cycle consistent empirical model of family labour supply using cross-section data, *The Review of Economic Studies*, 53, 539-558.

Bosch, N. and E. Jongen, 2012, Intensive Margin Responses when Workers are Free to Choose: Evidence from a Dutch Tax Reform, mimeo.

Burns, S.K. and J.P. Ziliak, 2012, Identifying the elasticity of taxable income, Unpublished manuscript .

Chetty, R., 2012, Bounds on elasticities with optimization frictions: A synthesis of micro and macro evidence on labor supply, *Econometrica*, 80, 969-1018.

Jeon, S. and I. Hong, 2009, A Microeconometric Analysis of the Differential Effects of Changes in Personal Income Tax Rates and Deductions on Labor Supply Using the KLIPS, *Quarterly Journal of Labor Policy*, 9, 55-98.

MaCurdy, T.E., 1983, A simple scheme for estimating an intertemporal model of labor supply and consumption in the presence of taxes and uncertainty, *International Economic Review*, 24, 265-289.

Na, S., J. Nam and C. Moon, 2007, Effect of Taxation on Labor Supply, *Korean Journal of Public Economics*, 12(2), 3-25.

Sim, U., 2006, An Analysis of Labor Supply Elasticity Using 2002 Tax Rate Changes, Proceedings of the 7th conference of the KLIPS, Korea Labor Institute.

Table 4 Estimation results (simple OLS)

	OLS (dependent variable: hours of work)			
	(1)	(2)	(3)	(4)
log(after-tax wage rate)	-4.118***	-5.362***	-5.588***	-4.509***
	[0.312]	[0.323]	[0.340]	[0.408]
× temporary				-4.097***
				[0.839]
× daily				-2.701***
				[0.906]
other income			0.000332**	0.000267
			[0.000156]	[0.000178]
× temporary				-1.00E-05
				[0.000357]
× daily				0.000317
				[0.000478]
work status[a]		6.757***	6.680***	9.314***
		[0.480]	[0.481]	[1.236]
head of household		4.201***	4.505***	4.560***
		[0.613]	[0.629]	[0.633]
no. kids (0,6)		-1.390***	-1.337***	-1.443***
		[0.353]	[0.354]	[0.353]
time dummy		Yes	Yes	Yes
Constant	41.71***	37.40***	36.32***	34.13***
	[0.263]	[0.607]	[0.789]	[1.159]
Observations	3,060	3,060	3,060	3,060
R-squared	0.054	0.131	0.133	0.14

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
a: work status is a dummy variable representing

Table 5 Labor supply elasticities from OLS estimation

	Model			
	(1)	(2)	(3)	(4)
uncompensated elasticity				
permanent worker	-0.094	-0.123	-0.128	-0.103
temporary worker				-0.197
daily worker				-0.165
income elasticity				
permanent worker			0.021	0.017
temporary worker				0.017
daily worker				0.038
compensated elasticity				
permanent worker			-0.149	-0.121
temporary worker				-0.214
daily worker				-0.203

Data: authors' calculation

Table 6 Estimation results (IV & selection correction)

	IV & self-selection (dependent variable: hours of work)			
	(1)	(2)	(3)	(4)
log(after-tax wage rate)	1.820***	1.855***	2.783***	-1.209
	[0.472]	[0.474]	[0.525]	[0.817]
× temporary				14.66***
				[3.693]
× daily				24.25***
				[4.213]
other income			-0.000850***	-0.00024
			[0.000180]	[0.000243]
× temporary				-0.00347***
				[0.000716]
× daily				0.000479
				[0.00137]
work status[a]	3.094***	3.055***	3.083***	-16.22***
	[0.542]	[0.544]	[0.552]	[3.003]
head of household	4.927***	4.765***	4.138***	4.053***
	[0.661]	[0.694]	[0.716]	[0.877]
no. kids (0,6)	-2.107***	-2.402***	-2.368***	-1.994***
	[0.381]	[0.540]	[0.548]	[0.636]
time dummy	Yes	Yes	Yes	Yes
inverse Mills ratio		1.415	0.418	-0.277
		[1.841]	[1.878]	[2.187]
Constant	43.45***	43.34***	46.49***	63.12***
	[0.706]	[0.721]	[0.999]	[2.763]
Observations	3,054	3,054	3,054	3,054
Chi2	176.6	177	193	196.6

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.
a: work status is a dummy variable representing. The instrumental variables are cohort-education-wave dummies, income-bracket dummies, and other characteristics included in the main equation.

Table 7 Labor supply elasticities from IV estimation

	Uncompensated		Income		Compensated	
	Elasticity	S.E.	Elasticity	S.E.	Elasticity	S.E.
(1)	0.042***	(0.011)				
(2)	0.042***	(0.011)				
(3)	0.064***	(0.012)	-0.055***	(0.012)	0.119***	(0.020)
(4)	-0.028	(0.019)	-0.016	(0.016)	-0.012	(0.030)
temporary	0.308***	(0.076)	-0.241***	(0.043)	0.549***	(0.077)
daily	0.527***	(0.092)	0.015	(0.087)	0.512***	(0.069)

Data: authors' calculation from [Table 6]