Marginal Tax Rates and Tax-Favoured Pension Savings of the Self-Employed Evidence from Sweden

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Abstract

In recent years, the study of how individuals respond to policies that aim at promoting pension savings has emerged as a vital area of economic research. This paper adds to this literature by estimating the tax price elasticity of contributions to tax-favoured pension savings accounts on a population of self-employed individuals. I exploit a unique total data base over the Swedish population that covers the years 1999 to 2005. Using instrumental variables, I obtain a tax price elasticity estimate of –0.51 and an income elasticity estimate of 0.13, whereas OLS produces estimates that conflict with consumer theory.

JEL-Code: G23, H24, J33, J26.

Keywords: income taxation, fringe benefits, individual pension savings, self-employment.

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I. Introduction

Since the early 1990's, public pension reforms have occupied a prominent place on the international political agenda and several OECD countries have substantially reformed their policies. As documented in a recent overview (OECD 2007), these reforms typically share one crucial feature: In order to preserve system sustainability, today's workers are promised less compensation by the public pension system as compared to past generations. As a consequence, the role of alternatives to public pensions has changed and the study of how individuals respond to policies that aim at promoting pension savings has emerged as a vital area of economic research (Bernheim 2002).

The purpose of this paper is to supply new evidence on this issue by estimating the tax price elasticity and income elasticity of contributions to tax-favoured pension savings accounts on a population of Swedish self-employed individuals. The empirical analysis is complicated by the fact that pension contributions and tax prices are simultaneously determined. When instrumental variables are used to address this endogeneity problem, I find that the self-employed significantly increase their contributions to tax-favoured pension savings accounts when tax prices decrease and virtual income increases. I obtain a tax price elasticity of –0.51 and a virtual income elasticity of 0.13. In contrast, OLS produces estimates with signs that conflict with standard consumer theory.

The study exploits a unique data base that covers the total Swedish population between the years 1999 to 2005. This was a period of calm with respect to income tax reforms. Moreover, the institutional framework governing tax-favoured savings accounts was fixed. I utilise the fact that before-tax profits, and accordingly the tax price facing the self-employed, vary on a year-to-year basis due to factors that are exogenous to the single business owner. The inclusion of a fixed effect, which controls for any time-invariant unobserved factors that

might obscure identification, is therefore a central feature of the empirical model. As a robustness check, I also estimate a selection model that imposes stronger assumptions on the relationship between the fixed effect and the regressors of interest, but relaxes the assumption that selection is strictly exogenous, which is present in the baseline model. These estimations confirm the qualitative results obtained in the baseline fixed effects regressions.

The paper is structured as follows. The next section provides a background and discusses the identification strategy in the light of previous literature. Section III discusses the methodological problems involved in the empirical analysis. Section IV describes the data source, whereas section V presents the regression results. Section VI concludes the paper.

II. Background

General background

Chief among the complements to the public system in Sweden, a country that experienced a profound pension reform in the 1990's, is employer-provided occupational pensions.[1] In several respects, employer contributions to occupational pensions are treated in a tax preferential way in relation to wage compensation and conventional savings. Contributions are deductible both from income and pay-roll taxation, but are still subject to a special wage tax. When pension assets accumulate, the yield is normally taxed at a lower rate than the capital income tax rate that applies to most other kinds of asset income. Furthermore, after withdrawal, pension income is taxed together with taxable earned income. As the income tax schedule is typically progressive – and most people earn more income when they are of working-age than when they have retired – this system is potentially beneficial to the individual taxpayer. However, pension assets are extremely illiquid as they cannot be withdrawn before the age of 55.

[1] See Sundén (2006) for a description of the new Swedish pension system.

The design of the Swedish occupational pension plans is determined at a central level as a bargaining outcome between the employer associations and the unions. A vast majority, approximately 90 % of the Swedish workers, is automatically covered by a negotiated pension plan through collective agreements. In practice, the individual employee or employer lacks power to affect the relation between the tax-deferred amount and money wages. However, this is not true for the self-employed individual, in particular if (s)he runs a business that is taxed at the personal level.[2]

As suggested by the term, the self-employed are, in a sense, both employers and employees and they are not covered by any collective agreement. In contrast to the employee, the self-employed individual is in a position to choose her own optimal mix of wage compensation and pension contributions. Thus, if one is to empirically examine how occupational pensions respond to changes in the tax system in an appropriate manner, one needs to turn to this specific group of taxpayers.[3]

Previous literature

The present paper primarily relates to a rather extensive literature that highlights the effect of marginal tax rates on tax-deductible contributions to individual retirement accounts.[4] I am aware of two previous studies in the literature that focus on the behaviour of the self-employed, namely Long (1993) and Power and Rider (2002). Both studies are carried out on

[2] The population studied in this paper does only include self-employed who are organised as sole proprietors or partnerships. Owners of closely held corporations are not included in the analysis since they have the opportunity to deduct deferrals to pension accounts at the firm level. These deductions are not observed in the individual tax register data.

[3] This is not the first paper to empirically study the provision of fringe benefits and, to this end, exploit a sample of self-employed to overcome problems associated with collective decision mechanisms. With a related argument, Gruber and Poterba (1994) examine purchases of tax-deductible health insurance, which constitutes the main bulk of fringe benefits in the U.S., on a sample self-employed individuals before and after the U.S. tax reform act of 1986.

[4] Basically, the rules for the savings accounts of Swedish self-employed only differ in one essential respect from those applying to individual retirement accounts for employees: In order to compensate the self-employed for their non-eligibility for collectively agreed occupational pensions, the maximum contribution limits are noticeably higher than for employees.

U.S. data. [5] A typical procedure has been to regress the contributed amount – or alternatively the probability to contribute – on the marginal tax rate along with other explanatory variables of interest.

Viewed from a stylised perspective, papers belonging to the literature fall into two groups. The first category, which includes work by Collins and Wyckoff (1988), O'Neill and Thompson (1987) and Long (1990), employs single cross sections and OLS or Tobit techniques. Some authors, e.g. Long (1990), discuss the endogeneity of marginal tax rates and use the 'first-dollar marginal tax rate', i.e. the marginal tax rate that applies to the first dollar of contribution, in place of the endogenous regressor. However, no attempts are made to address a more subtle endogeneity problem: If there is a correlation between unobserved factors that determine the income level and the level of contributions, an omitted variable bias might plague the estimates. Even though the fixed effect approach adopted in this paper has the shortcoming of only controlling for unobserved heterogeneity that is constant over time, this paper attempts to improve on previous studies in this respect.

A second category of papers, Milligan (2002) for Canada, Veall (2001) also for Canada and Power and Rider (2002) for the U.S., exploits income tax reforms, and the fact that different groups of taxpayers are treated differently by such policy changes, as the identifying source of variation. Panel data is used in the two latter studies, whereas Milligan (2002) uses repeated cross sections. The results vary substantially between studies. While this approach has the merit of providing a plausibly exogenous source of variation, there is one remaining concern: Large income tax reforms do not only tend to change present tax rates, but typically also expectations of future rates. Since pension assets in most OECD countries are taxed

[5] As far as I know, nothing has been written about the impact of the Swedish income tax system on fringe benefits or pension savings. From a tax clientele model, Agell and Edin (1990) have studied how Swedish asset portfolios are affected by marginal tax rates. The stock of pension wealth is not included in their study, however. Johannisson (2008) has estimated the relationship between life-cycle variables and savings in tax-deferred individual pension savings accounts on Swedish register data. She restricts her sample to those who have not previously saved in private pension accounts. In addition, Flood (2004), also on longitudinal tax register data, has estimated the stock of pension wealth that relates to these individual retirement accounts for employees.

together with earned income when withdrawn, incentives to save in tax-favoured accounts also depend on future tax rates.[6] Thus, tax price estimates obtained from large income tax reforms can be difficult to interpret for this reason. This paper circumvents this difficulty by utilising rich panel data from a period with no major tax changes.

III. The model framework

The basic model

In this paper, I view the self-employed's decision on how much to contribute to tax-preferred pension savings accounts as a choice between fully taxed in-cash compensation, W, and a fringe benefit, F, that is deductible against business income.[7] Since the income tax function is non-linear – in reality it is piece-wise linear – the price of F in general depends on the consumed amount of F, i.e. its price is endogenous. When expressed as a choice between ordinary taxable consumption, C, and the more leniently taxed fringe benefit, F, a budget constraint that is *linearised* around the optimum point of the individual can be written as $C + P_F F = M$, where P_F is the linear price of F and M is virtual income (Blomquist 1989). In the (C, F)-plane, virtual income is the prolonged intercept of a segment along the C-axis. It differs from exogenous income at zero F, due to the fact that inframarginal contributions to pension schemes are deducted at a different (usually higher) rate than the marginal tax rate that applies at the optimum.

[6]Generally, the incentives to save in tax-favoured accounts depend on the length of the holding period, the tax treatment of the yield from the pension assets while they accumulate as well as the structure of wealth taxation. See Kari and Lyytikäinen (2004) for a proposal of a definition of the effective tax rate for private pension savings. The dilemma that future tax rates are unobservable is not specific to the study of pension savings. As discussed by Poterba (2002), this indeed poses a general methodological difficulty when conducting empirical studies on capital formation and portfolio choice.

[7] Needless to say, there is naturally an important intertemporal dimension present in the choice of how much to contribute to tax-favoured accounts. However, to be able to express an empirical equation in terms of observables in the context of a dynamic model framework, very specific assumptions about the utility functions of the individuals must be made. The bulk of the literature on pension savings does not attempt to couch the analysis in a life-cycle consistent framework. Engelhardt and Kumar (2007, 2009) are exceptions. While studying the effects of employer matching of 401(k) contributions in the U.S., they propose a two-stage budgeting framework.

Suppose that the individual is located on segment k of the piece-wise linear income tax function and on segment l of the piece-wise linear budget constraint in the (C, F)-plane. As discussed by Selin (2009), the tax price on segment l is $P_{F,l} = (1-\tau_k)\frac{(1+q_F)}{(1+q_W)}$, where τ_k is the marginal tax rate on segment k of the income tax function, q_F is a special wage tax levied on the fringe benefit and q_W is a payroll tax. An expression for virtual income is provided in the Appendix.

Empirical model

In the baseline specification, I perform a 2SLS fixed effects regression on the unbalanced sample that contributes to tax-favoured accounts. Let i be an individual index and t a time index. The following empirical equation for all i with $F_{it} > 0$ is posited:

$$\ln F_{it} = \beta_0 + \beta_1 \ln P_{F,it} + \beta_2 \ln M_{it} + \beta_3 Q_{it} + \phi_i + \varepsilon_{it} \qquad (1)$$

where Q_{it} is a vector of control variables, including a full set of year dummies, ϕ_i is an individual level fixed effect and ε_{it} is an idiosyncratic error term. A log-log specification was also used by Power and Rider (2002). This functional form can also be justified on statistical grounds as the distribution of pension contributions is skewed to the right. Note that it is mainly the variation in before tax profits, Y_{it}, that causes both $\ln P_{F,it}$ and $\ln M_{it}$ to vary. The identification of the model therefore rests on the non-linearity of the income tax function.

Let $X_{it} = \{\ln P_{F,it}, \ln M_{it}, Q_{it}\}$ be a vector of endogenous regressors, $Z_{it} = \{\ln P_{F,it}^{instrument}, \ln M_{i\acute{t}}^{instrument}, Q_{it}\}$ a vector of instruments and s_{it} an indicator that takes the value of 1 if individual i makes positive contributions in year t. The choice of instrumental variables for the log tax price and log virtual income regressors will be discussed below. In the baseline model, I impose the assumption that the variables included in the instrument

vector and the selection indicator are strictly exogenous, i.e. $E(\varepsilon_{it}|Z_i, s_i) = 0$. As a robustness check, I will test for and correct for sample selection bias in Section V. The main merit of the baseline model is that ϕ_i is allowed to be arbitrarily correlated with the regressors of interest.

It should be recognised that any time-invariant expectations of future tax rates and permanent life time income will be absorbed by the individual level fixed effect ϕ_i.[8] The coefficients for log tax price and log virtual income are therefore identified by transitory changes in before tax profits.

Whether other sources of income than business income (net-of-tax earnings of the spouse, public transfers and asset income) should enter the virtual income measure in the estimations is a somewhat tricky issue. It is a justified belief that the amount of pension contributions relates differently to one's own business income than to e.g. the income of the spouse. As the individual, and not the household, is the taxable entity in Sweden, individual business income is also a central determinant of the tax price. If not appropriately controlled for, the tax price coefficient might pick up some of the variation that works through the business income of the individual. Therefore, 'other income' will be excluded from the virtual income measure. Instead, it will enter the Q_{it} vector in logarithmic form and its coefficient will be reported separately.

Endogenous regressors

Both key regressors, i.e. log tax price, $\ln P_F$, and log virtual income, $\ln M$, crucially depend on the location of the individual at the income tax schedule. This location, in turn, is a function of the chosen amount of voluntary pension contributions, F. Therefore, if we were

[8] Naturally, expectations of future tax rates can change even in the absence of tax reforms. For instance, expectations of a change in government power can affect such expectations. The time period of study, 1999-2005, contained one national election which was held in 2002. The political (social democratic) regime did not change in conjunction with the 2002 election.

to estimate (1) by OLS, a correlation between $\ln P_F$ and $\ln M$, on the one hand, and the contemporaneous error term, ε_{it}, on the other, is very likely to occur owing to reversed causality. As a consequence, the coefficients would not be consistently estimated.

I will address this problem by constructing instruments that are assumed to be correlated with the endogenous regressors but uncorrelated with the error term. The idea will be to construct a tax price, P_F, and a measure of virtual income, M, that are not functions of the deducted amount of pension savings. The instrumental variables are created in the following way. To the assessed income, I add the deducted amount of pension contributions.[9] I then recompute marginal tax rates and virtual incomes based on the new adjusted measure of assessed income. In spirit, this approach to instrumenting is close to the so-called 'first-dollar marginal tax rate instrument' that has earlier been exploited in the literature on tax-deductible charitable giving.[10] The exclusion restriction is that there should be no effect on F of $\ln P_F^{instrument}$ and $\ln M^{instrument}$ given $\ln P_F$, $\ln M$, Q and the individual-specific effect ϕ_i.

It is worth noting that the instrument is essentially a function of the tax system and before-tax profits. Undeniably, even though profits fluctuate on a year-by-year basis due to factors that are outside the control of the individual, business income is still to some extent a result of work effort. Accordingly, as tastes for work and savings might be expected to be correlated, a concern might be that a simultaneity problem still prevails. If so, the strict exogeneity assumption is violated. A key feature of the model is therefore that $\ln P_F^{instrument}$ and $\ln M^{instrument}$ are assumed to be strictly exogenous, conditional on the individual-specific effect, ϕ_i.

[9] See Appendix E in Selin (2009) for details.

[10] See Feldstein and Taylor (1976) for an early application. One potential problem with the instrument should be recognised. If the investment in pension savings is financed from other financial sources than firm profits, a correlation between F and the adjusted measure of assessed income cannot be completely ruled out.

The remaining threat to instrument validity is transitory shocks in tastes for work that would simultaneously enter both the contemporaneous error ε_{it} and before tax profits. Keep in mind, though, that pension savings are an extremely illiquid form of savings (they cannot be withdrawn before the age of 55). It might be plausible that someone who *temporarily* decides to work very hard in a particular year, for some unobserved reason, wants to accumulate capital in the short run and thereby chooses to invest in liquid assets. It is not clear, however, why (s)he would invest in illiquid pension assets.

IV. Description of data and institutional setting

Data and selection of population

The data material in this study is a unique register data set, especially constructed by Statistics Sweden for the purpose of this project. For the years 1999 to 2005, it contains the total population of Swedish taxpayers.[11] The data set contains very detailed tax register information. Accordingly, marginal tax rates can be computed with a very high degree of precision. Furthermore, a number of demographic variables are included. The dependent variable, the natural log of the contributed amount to tax-favoured pension savings accounts, is based on information from the register of income statements. It mirrors the contributed amount to pension savings reported to the tax authorities by financial institutions in the relevant tax year. [12]

When selecting the population studied, the institutional framework governing deductions for pension savings poses some important constraints. First, the taxpayer should

[11] I also have access to data from 1998 that are used to approximate contribution limits for 1999.

[12] Information on pension contributions is available from two sources. First, the register of income statements contains data on the amount contributed to pension savings, which are reported to the tax authorities by financial institutions (variable label: 'akupens'). Second, in the tax registers, there is also information on the amount that the business owner has deducted and for which (s)he has paid a special wage tax (variable label: 'aslspe'). In most cases, these two variables are identical. However, there is a considerable fraction of business owners with zero 'aslspe' but positive 'akupens', probably because the special wage tax is not levied on all deductions. Therefore, I have chosen to utilise 'akupens' as my dependent variable. I do, however, exploit 'aslspe' when I approximate contribution limits (see Appendix E in Selin (2009)).

report positive income from self-employment. Income from self-employment can either be in the form of income from sole-proprietorships (‘inkomst av enskild näringsverksamhet’) or from partnerships (‘handelsbolag’). Second, the taxpayer is not allowed to report any wage income from employment. This exclusion is made since self-employed who earn a wage income may choose whether to make the deduction against wage income or self-employment income. Including the latter group would therefore complicate the analysis. Third, the age of the individual should fall between 19 and 54. This restriction is made since pension income can be withdrawn from the age of 55.

After these exclusions, a population of around 70,000 to 85,000 individuals for each year remains. This subpopulation corresponds to approximately 2% of the Swedish labour force. This figure is considerably lower than the share of entrepreneurs reported in the labour force surveys of Statistics Sweden, where this share is typically about 10 percent. This is because my studied population does not include individuals who earn wage income in addition to business income. In addition, the selected population excludes corporate owners. These are potentially subject to collective agreements and/or have the opportunity to deduct deferrals to pension accounts at the firm level. This latter kind of deductions is not observed in the individual tax register data.

As a result, the population under study consists of purely self-employed individuals. On average, the individuals in the population studied earn lower incomes than wage earners in the same age categories. The mean assed income in the population studied was SEK 175,000 in 2005 – among those who earned a positive wage income but no positive business income the corresponding figure was SEK 235,000 in 2005. In this respect, the population used in this study differs from the sample examined by Power and Rider (2002), who worked with a similar research question on U.S. data. Their sample consisted of self-employed individuals with mean incomes above the average income level of employees. An examination of the 5-

digit industry classification (NACE) code in the data source used in this study suggests that the largest occupational categories (at a 5-digit level) were hairdressers (5,136 observations in the 2005 sample), restaurant owners (2,442 observations) and carpenters (1,865 observations).

The Swedish income tax system

The basic structure of the Swedish statutory income tax system is rather simple. A proportional local tax rate applies to all earned income. In 2005, the mean local income tax rate was 31.60 %, with a minimum rate of 28.90 and a maximum rate of 34.24.[13] For earned incomes above a certain threshold (SEK 328,600 in 2005), the taxpayer also had to pay a central government income tax. During the period of study, the central government income tax schedule consisted of two brackets; the marginal tax rates in each bracket were 20% and 25%, respectively. There was also a standard deduction in place. This was phased in at lower income levels and phased out at higher income levels with consequences for the marginal tax rate facing the individual in these income intervals.[14] The structure of the standard deduction causes marginal tax rates to be a non-monotonic function of income in income intervals where many self-employed individuals are located. This should be recognised since the identification of the two key estimated parameters of the empirical model relies on the non-linearity of the income tax function.

A look at the data

The population studied is dominated by males (71 % of the studied population) and by relatively elderly persons (the mean age is 42.5). When all observations for the years 1999 to 2005 are pooled, 57 percent of the population make pension contributions. *Figure 1* reveals that this share varies very little during the time period. The mean contributed amount is also

[13] The local income tax rate is the sum of the income taxes set by the two lower tiers of government; the municipalities and the counties. The year-to-year changes in the local income tax rates are typically very small.
[14] The computation of tax prices is described in more detail in Appendix A in Selin (2009).

relatively stable around SEK 16,000, even though a small trend-wise increase in pension contributions can be discerned. However, it cannot be excluded that this trend is due to compositional changes in the underlying population. *Figure 1* also shows that there were no major changes in the mean tax price during the time period.

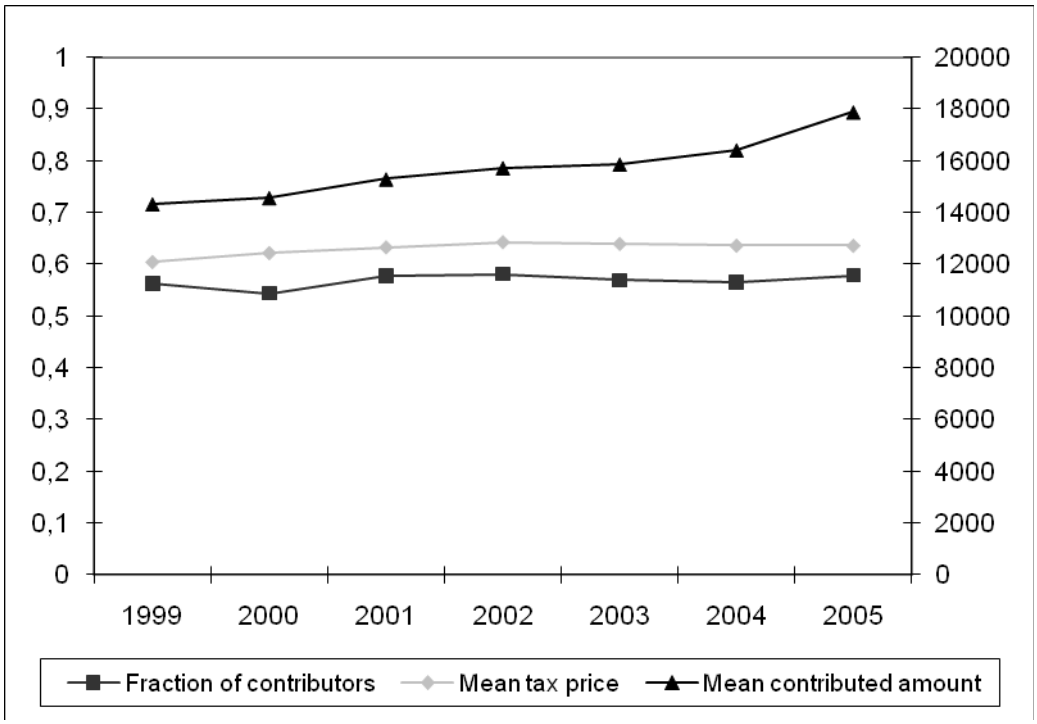

Figure 1. Fraction of contributors, mean tax price and mean contributed amount 1999-2005. Mean contributed amount (right axis) is reported in the price level of 2005.

Table 1 characterises mean tax prices, the mean proportion with contributions and the mean contributed amount conditional on contributing a positive amount by tax bracket in 2005. Since this was a period of calm in the area of income taxation, the tax schedule was quite similar in other years. The population means for each bracket refer to the group of individuals whose actual assessed income falls in that specific interval. It is striking that only a small minority of the population studied is to be found in brackets (7)-(9) where the central government tax rate applies. Conversely, a large majority of taxpayers reside in intervals where the marginal tax rate is affected by the phase out (segment 5) and phase in rates

(segment 3) of the standard deduction. The proportional local tax rate is paid on all segments except segment 1.

Table 1. Summary statistics by tax bracket in 2005.

Bracket	Upper segment limit in SEK	Mean tax price	Share with positive contributions	Mean contributed amount (conditional on contributing)	Observations with actual income in the interval	Observations with adjusted income in the interval	Observations with actual and adjusted income in the interval
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	16700	0.949	0.321	10545	3229	2756	2756
		(0.000)	(0.467)	(14411)			
(2)	46900	0.644	0.375	9556	5980	5697	5247
		(0.009)	(0.484)	(9379)			
(3)	106900	0.704	0.481	10854	14207	13556	12805
		(0.007)	(0.500)	(10933)			
(4)	123200	0.644	0.527	12122	4628	4374	3270
		(0.009)	(0.499)	(11565)			
(5)	249200	0.614	0.618	15408	27407	27275	25614
		(0.010)	(0.486)	(16233)			
(6)	312914	0.644	0.725	22360	8150	7764	6050
		(0.009)	(0.446)	(25668)			
(7)	349431	0.456	0.747	29202	3239	3935	2155
		(0.009)	(0.435)	(34448)			
(8)	465157	0.461	0.743	33698	3137	4075	2665
		(0.009)	(0.437)	(41283)			
(9)	--	0.414	0.751	47472	1777	2322	1777
		(0.009)	(0.433)	(58005)			

Standard deviations are in parenthesis.

Column (6) of *Table 1* reports the distribution of taxpayers when these are sorted by their adjusted business income. The latter income measure is identical to that used in the instrumentation procedure, i.e. I have added pension deductions to actual business income.

Thus, discrepancies between columns (5) to (7) reflect transitions along the tax schedule that are due to pension deductions. It is noteworthy that the three uppermost tax brackets, where tax prices are the lowest, in total contain 2,179 fewer taxpayers when adjusted business income is used to sort taxpayers. It also appears from *Table 1* that both the proportion with contributions and the contributed amount increase with income.

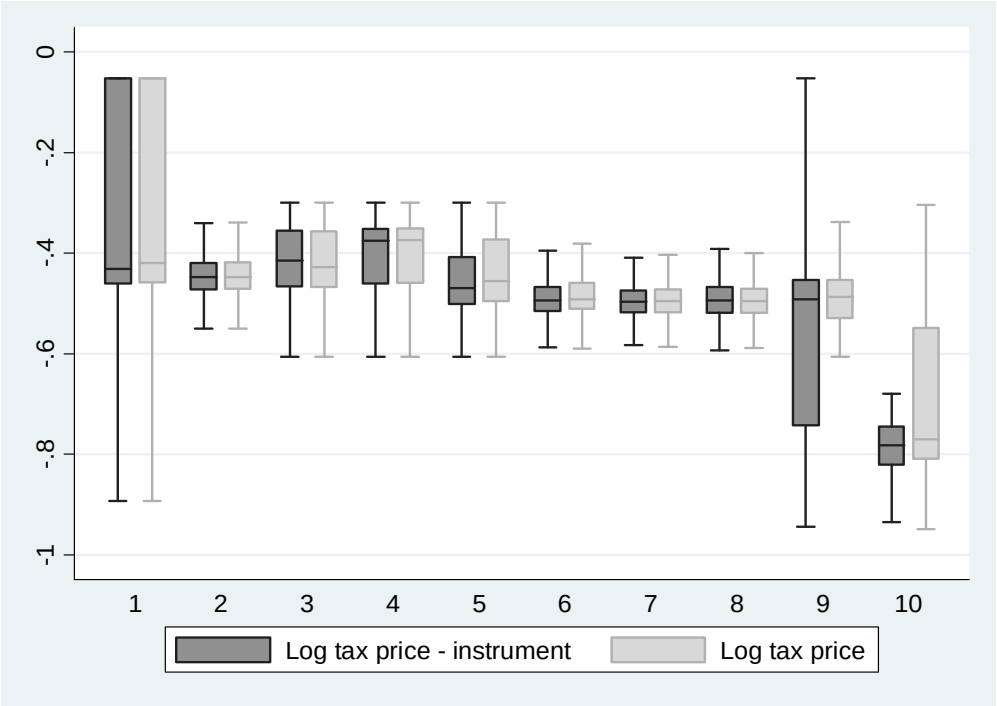

Figure 2. Log tax price instrument and log tax price by decile. Boxes are bordered at the 25th and 75th percentiles. The upper (lower) horizontal line is given by the largest (smallest) value that is less (greater) than or equal to the third (first) quartile plus (minus) 1.5 times the inter quartile range.

Figure 2 displays the distributions of the log tax price instrument and the log tax price by deciles. I have created deciles by ordering all 180,380 unique individuals in the population by their median adjusted business income for the years they participate in the underlying population. The dispersion of tax prices is the highest at the bottom and the top of the income distribution. At the bottom, this is explained by the combined effect of high transitory business incomes and a sizable discrete jump in tax prices between the first and the second tax bracket (see *Table 1*). The large dispersions in tax prices in the two highest deciles are related

to the sharp tax price discrepancy between brackets where central government tax rates are levied (brackets (7)-(9) in *Table 1*) and other intervals of the tax function.

In the two uppermost deciles, there are marked differences in the distributions of the instrumented log tax price and the actual log tax price. This phenomenon is very important and plausibly mirrors behavioural responses. Remember that the instrument is a function of a measure of business income to which pension deductions have been added. In the 9th decile, the distribution of instrumented log tax prices is much wider than that for actual log tax prices. The opposite holds true for the 10th decile. Apparently, self-employed individuals belonging to the 10th decile earn adjusted incomes that place them in the tax brackets where the central government tax applies. However, a large fraction of these claim pension deductions and thereby switch tax brackets. In the 9th decile, unadjusted incomes fall on both sides of the kink point for central government taxation. However, when pension deductions have been made, few taxpayers in the 9th decile remain in the uppermost brackets.

V. Regression results

Baseline results

The baseline regression results are reported in *Table 2*. The first three columns show the fixed effects OLS results with different sets of control variables included in the regressions, whereas the three rightmost columns state the corresponding 2SLS estimates. When income controls are added, in columns (2)-(3), the OLS-estimates of the linear own price elasticity, $\eta_{P_F}{}^{F}$, take on an unexpected positive sign. $\eta_{P_F}{}^{F}$ is estimated to be 0.40. The estimated virtual income elasticity $\eta_M{}^{F}$ is sizable, around 0.32, and suggests that contributions to tax-favoured pension savings accounts are a linear normal good. A remarkable implication of the OLS estimates is that the linear compensated price elasticity, which is given by the Slutsky

relationship $\eta_{P_F}{}^{F,c} = \eta_{P_F}{}^{F} + \eta_M{}^{F} \frac{P_F F}{M}$, is positive.[15] This finding is at odds with standard consumer theory, which predicts that own compensated elasticities should always be non-positive since the substitution matrix is negative semidefinite.

However, the picture is reversed when instrumental variables are used. As described above, the instruments for log tax price and log virtual income are constructed by removing the endogenous component from the assessed business income of the individual and then recomputing these two variables. An appealing property of the instruments is that they explain a considerable part of the variation in the endogenous regressors. The first stage F-statistics of the excluded instruments are extremely high in both first-stage regressions. [16]

The most striking feature of the 2SLS regression results is that the price elasticities now take on signs that are in accordance with consumer theory. The linear uncompensated elasticity, $\eta_{P_F}{}^{F}$, is estimated to be –0.51 when income variables are included in the regressions. The estimate of the (virtual) income elasticity still indicates that contributions are a normal good. There has, however, been a drastic decrease in the magnitude of the elasticity and it is now estimated to be 0.13 when the full set of control variables is added in column (6). It should be recognised that both key elasticities are estimated with great precision: The 99 percent confidence interval ranges from –0.581 to –0.431 for tax price elasticity, whereas the corresponding confidence interval for virtual income elasticity is 0.117 to 0.147. The estimated covariance matrix is robust to heteroskedasticity and arbitrary serial correlation at the individual level.

[15] Here I interpret the results in terms of the static model presented in more detail in Selin (2009). $\eta_{P_F}{}^{F,c}$ denotes the compensated price elasticity, $\eta_{P_F}{}^{F}$ refers to the uncompensated price elasticity and $\eta_M{}^{F}$ is the (virtual) income elasticity.

[16] For the full model, column 6, the values of these F-statistics are 35,531 (first stage for log tax price) and 4,200,000 (log virtual income).

Table 2. Baseline regression results. Dependent variable: Log contributions

	Fixed effects OLS			Fixed effects 2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Log tax price	-0.132 (0.014)***	0.404 (0.015)***	0.404 (0.015)***	-0.841 (0.023)***	-0.506 (0.029)***	-0.507 (0.029)***
Log virtual income		0.323 (0.005)***	0.323 (0.005)***		0.132 (0.006)***	0.132 (0.006)***
Log other income		0.008 (0.002)***	0.005 (0.002)***		0.009 (0.002)***	0.006 (0.002)***
Control variables	No	No	Yes	No	No	Yes

Robust standard errors in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. All specifications include a full set of time dummies. The number of observations in the unbalanced estimation sample is 287,050 and the number of individuals is 73,336. The number of kids aged below 18 in the household and dummy variables for being married, upper secondary schooling, higher education, living in the Stockholm region, Skåne region and Västra Götaland region are control variables.

The sharp discrepancy between the OLS and 2SLS estimates clearly indicates that the reverse causality problem outlined in Section III is severe: By deducting pension contributions the self-employed individual simultaneously alters (usually raises) her own tax price. As made clear by *Figure 2*, the distributions of the endogenous tax price regressor and its instrumental variable differ, in particular at higher income levels. Obviously, when this endogeneity problem is unaddressed, the estimated price and virtual income elasticities are biased upwards.

Table 2 also reveals that it is crucial to control for the income variables. In the OLS case, the sign of the price elasticity estimate is negative when the income variables are excluded (column 1) and in the 2SLS case, the estimated elasticity is considerably larger in absolute terms (column 4). On the other hand, adding a set of control variables makes little difference to the results. To some extent, this might be explained by the fact that most of the control variables are rather time-invariant in nature, thus rendering the variation quite small.

From *Table 2* it can also be seen that the elasticity estimates for 'other income' are much lower than the virtual income elasticities. As a robustness check, I have also estimated analogous models, where 'other income' has been included in the computation of the virtual income measure. For the full model, corresponding to column (6) of *Table 2*, the response in log tax prices is somewhat sharper, the coefficient is –0.74, and the (virtual) income elasticity is considerably lower (0.08).[17] However, in that setting, it cannot be ruled out that the tax price coefficient captures variation that works through own business income.

With some exceptions (Veall 2001 and Venti and Wise 1988), the qualitative results reported here resemble those previously found in the literature on how private pension savings respond to marginal tax rates.[18] Quantitatively, the obtained tax price elasticity estimates are lower than those recently found by Power and Rider (2002). They estimated a tax price elasticity of –2.0 on a sample of self-employed individuals in the U.S.

Testing and correcting for sample selection bias

In the baseline model, we assume selection to be strictly exogenous. Thus, we assume s_{it} to not only be uncorrelated with the contemporaneous error term, ε_{it}, but also with the idiosyncratic error term for all other periods, ε_{ik}, $k \neq t$. To gauge the validity of this assumption, I have performed two testing procedures proposed by Semykina and Wooldridge (2010) in the context of panel data models in the presence of endogeneity and selection. First, I add s_{it-t} or, alternatively, s_{it+t} to (1). Under the null hypothesis of no selection bias, the coefficient for lags and leads of the selection indicator should be 0. However, it turns out that the null hypothesis is rejected. The p-value of the t-statistic – which has been made robust

[17] Full results can be provided upon request.

[18] This also holds true for studies that have included the endogenous marginal tax rate as a regressor, see e.g. Collins and Wyckoff (1988) who study tax-favoured retirement savings on a sample of non-self-employed individuals in the U.S. A probable reason for why the endogeneity problem is much more severe in my study is that the deduction limits are considerably more generous for self-employed.

both to heteroskedasticity and arbitrary serial correlation at the individual level – is 0.000 for the coefficient for s_{it-t} in the regression where it has been added to (1). The corresponding p-value in the regression including s_{it+1} is also 0.000.

Second, I have performed a test for contemporaneous selection bias. Once more, following Semykina and Wooldridge (procedure 3.1), I first estimate the probit equation

$$P(s_{it} = 1 | Z_i) = \Phi(g_t + \delta_t Z_{it} + \zeta_t \overline{Z}_i) \qquad (2)$$

for each year, where Φ refers to the cumulative normal density function, g_t is the year t specific intercept and $\overline{Z}_i = \frac{\sum_{t=1}^{T_i} Z_{it}}{T_i}$, where T_i is the number of time periods individual i appears in the underlying population.[19] From the fitted values, I obtain the inverse Mills ratio, $\hat{\lambda}_{it}$. Finally, I add a set of interactions between $\hat{\lambda}_{it}$ and the time dummies to (1). If the null hypothesis is correct, the joint hypothesis that the coefficients for the interaction terms are zero should hold true. However, the null hypothesis of no selection bias is strongly rejected also in this case. The p-value of the Wald statistic is 0.000.

Since these specification tests indicate that the strict exogeneity assumption does not hold, I implement a two-step procedure suggested by Semykina and Wooldridge as a check of the robustness of the baseline model. Crucially, I now need to assume that the unobserved fixed effect is given by $\phi_i = \eta + \gamma \overline{Z}_i + a_i$, where $a_i | Z_i \sim N(0, \kappa^2)$. This means that ϕ_i is only allowed to be correlated with the instruments through the time averages of the instrumental variables, while the remaining part of the unobserved effect, a_i, is assumed to be independent of the instruments and normally distributed. An advantage, however, as compared to the baseline model, is that the coefficients in this model are consistently estimated when the strict

[19] Note that the underlying population that fulfils the inclusion criteria (no wage income, positive business income and the age restriction) changes from year to year.

exogeneity assumption fails.[20] The following equation is estimated by pooled 2SLS for all *i* with $F_{it} > 0$

$$\ln F_{it} = c_1 X_{it} + c_2 \overline{Z}_i + c_3 \hat{\lambda}_{it} + v_{it}\,, \qquad (3)$$

where $\hat{\lambda}_{it}$ now denotes a vector that contains the estimated inverse Mills ratio and interaction terms between the estimated inverse Mills ratio and the year dummies.[21] The estimated covariance matrix takes into account that the estimated inverse Mills ratio is a generated regressor.[22] *Table 3* reports the regression results from estimating equation (3). Column (1) of *Table 3* corresponds to column 3 of *Table 2* and provides information on the OLS regressions. In coherence with the baseline regression results, the coefficient for the tax price elasticity takes on the 'wrong' sign when the endogenous regressors are assumed to be exogenous – it is estimated to be 0.75, a larger estimate as compared to the baseline model. However, once more, the 2SLS regressions generate elasticity estimates with 'correct' signs. The estimate of the tax price elasticity is –0.37, whereas the estimated (virtual) income elasticity amounts to 0.22. Even though the tax price elasticity is 14 percentage points lower in absolute terms and the income elasticity is 9 percentage points higher than in the baseline model, it is still noteworthy that the observed pattern of results is very similar for this model that rests on another set of assumptions.

[20] To identify the selection model, one would ideally like to have an additional instrument that is assumed to affect selection but that does not affect the continuous decision of how much to contribute. In the absence of a plausible exclusion restriction, I have used the non-linearity of the inverse Mills ratio to identify the selection model. However, I have experimented with a number of arbitrarily chosen exclusion restrictions (number of kids in the household, education variables and region dummies). Throughout, the obtained key estimates are very similar to those reported in *Table 3*.

[21] By necessity, to participate in the estimation sample for the baseline fixed effects regressions, an individual is required to make contributions for at least 2 years. To achieve coherency with the baseline regressions, I have defined the sample selection indicator to be 1 if the individual makes positive contributions for at least 2 years when estimating the inverse Mills ratio.

[22] I am grateful to Anastasia Semykina for providing me with the Stata code for procedure 5.1 in Semykina and Wooldridge (2005).

Table 3. Selection model. Dependent variable: Log contributions.

	OLS	2SLS
	(1)	(2)
Log tax price	0.745	-0.373
	(0.018) ***	(0.032) ***
Log virtual income	0.521	0.221
	(0.007) ***	(.007)***
Log other income	0.014	0.010
	(0.002) ***	(.002) ***

Robust standard errors, corrected for first-step estimation, are in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. All specifications include a full set of time dummies, an estimated inverse Mills ratio and a full set of interactions between the time dummies and the estimated inverse Mills ratio. The number of observations in the unbalanced estimation sample is 287,050 and the number of individuals is 73,336. The regressions include the full set of control variables reported in the footnote of Table 2.

The discrete margin

The theoretical framework describes the choice along the continuous margin. Nonetheless, it is of interest to study how the key independent variables relate to the discrete decision of whether or not to contribute to tax-favoured pension savings accounts. Therefore, I have estimated fixed effects linear probability models on the complete population. The results from this exercise are displayed in *Table 4*. Once more, when the endogenous variables are used to estimate the probability of contributing (column 1), an unexpected positive relationship between the log tax price and the dependent variables arises. If we instead turn our attention to a specification where the probability of contributing is regressed directly on the instruments, the tax price coefficient exhibits the expected sign.

In fact, a comparison of columns (1) and (3) suggests that the coefficients for the log tax price are similar in absolute magnitude for OLS and 2SLS, but that the signs of the two coefficients differ! If we evaluate the implied elasticity at the mean value of the probability of contributing (0.57), we obtain an elasticity of –0.12 when exploiting instrumental variables. In the light of previous literature, this is a modest elasticity estimate.

Table 4. Regression results for the discrete margin. Dependent variable: An indicator variable for making contributions.

	Fixed effects OLS		Fixed effects 2SLS
	(1)	(2)	(3)
Log tax price	0.070		-0.069
	(0.004)***		(0.006)***
Log tax price – instrument		-0.053	
		(0.005)***	
Log virtual income	0.040		0.022
	(0.001)***		(0.001)***
Log virtual income-- Instrument		0.023	
		(0.001)***	
Log other income	0.004	0.004	0.004
	(0.001)***	(0.001)***	(0.001)***

Robust standard errors are in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. The number of observations in the unbalanced estimation sample is 508,377 and the number of individuals is 128,572. All regressions include a full set of time dummies and the control variables reported in the footnote of Table 2.

Comparison with alternative estimators

Table 4 reports results from regressions where a random effects 2SLS estimator and a pooled 2SLS estimator are employed to estimate equation (1). If the unobserved heterogeneity, ϕ_i, is uncorrelated with the covariates random effects and fixed effects estimations should yield similar results. *Table 5* indicates this not to be the case. The estimate of the tax price elasticity is now –0.80, which can be compared to –0.51 for the fixed effects case.[23] The (virtual) income elasticity is estimated to 0.22, which is considerably larger than the fixed effects estimate of 0.13. A Hausman test rejects the null hypothesis that the coefficient parameter vectors generated by the random effects and fixed effects estimator are equal. When

[23] Here I let 'random effects 2SLS' refer to what in the econometrics literature is known as the G2SLS estimator. Similar results are obtained when the alternative estimator, EC2SLS, is employed. See Baltagi and Li (1992) for a description and discussion of these two estimators.

observations from all years are pooled, both the tax price elasticity and the (virtual) income elasticity increase even more in absolute value.

An advantage of the two alternative estimators is that they allow us to obtain a view of the relationship between the time-invariant gender variable and contributions. Interestingly, the coefficient for the male dummy is positive.[24] Moreover, the estimated coefficients for the quadratic in age in *Table 5* suggest that the contributed amount to pension savings increases in age but at a decreasing rate.

Table 5. Results from alternative estimations.
Dependent variable: Log contributions

	Random effects 2SLS	Pooled 2SLS
	(1)	(2)
Log tax price	-0.802	-1.511
	(0.023)***	(0.026)***
Log virtual income	0.222	0.325
	(0.004)***	(0.005)***
Log other income	0.016	0.039
	(0.002)***	(0.002)***
Male	0.081	0.022
	(0.007)***	(0.004)***
Age	0.095	0.056
	(0.003)***	(0.002)***
Age squared	-0.001	-0.000
	(0.000)***	(0.000)***

Standard errors in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. All specifications include a full set of time dummies. The number of observations in the unbalanced estimation sample is 287,050 and the number of individuals is 73,336. All regressions include a full set of time dummies and the control variables reported in the footnote of Table 2.

[24] Conversely, the male dummy takes on the opposite sign when similar (non-reported) estimations are carried out for the discrete margin.

6. Conclusion

The purpose of this paper has been to estimate the tax price elasticity and the (virtual) income elasticity of contributions to tax-favoured pension savings accounts on a population of self-employed individuals. To this end, I have exploited a unique total data base over the Swedish population that covers the years 1999 to 2005. A distinguishing feature of this study, as compared to previous related work, is that I have used several years of panel data from a period when no major tax reforms occurred, which means that expectations of future tax rates were probably held fairly constant. To identify variation in tax prices and virtual incomes, I have exploited the fact that before-tax profits of the self-employed vary due to factors outside the individual's control.

When instrumental variables are used to address the problem of tax prices being endogenous, I find that the self-employed significantly increase their contributions to tax-favoured pension savings accounts when tax prices decrease and virtual income increases. I obtain a tax price elasticity of –0.51 and a virtual income elasticity of 0.13. In contrast, OLS produces estimates with signs that conflict with standard consumer theory. The huge discrepancy between the fixed effects 2SLS and the fixed effects OLS estimates suggests that the self-employed use pension deductions as a means of switching tax brackets owing to transitory increases in before-tax profits.

The precisely estimated tax price elasticity of –0.51 suggests that, at the margin, contributions to tax-favoured accounts increase with around half a percent when the tax price increases with one percent. A caveat, however, when generalising the results is that the estimated parameters are probably not only functions of deep parameters, but also functions of the Swedish tax system. It lies beyond the scope of the present paper to assess whether this price elasticity is too low or too high to make the policy instrument as such welfare improving. In particular, remember that government revenues foregone today must be netted

against revenues collected when the pension income is withdrawn in the future. However, it has been demonstrated in this study that pension deductions do play an important role in Sweden for self-employed persons taxed at the personal level.

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Appendix. Virtual income

Let us define $\tilde{N}$ as the segment of the income tax function into which $\tilde{y} = \frac{Y}{1+q_W}$ falls. When contributions fall into segment l of the budget constraint in the (C,F)-plane taxable business income (net of deductions for contributions), $W = \frac{Y}{1+q_W} - \frac{1+q_F}{1+q_W}F$ falls into segment $\tilde{N}-l+1$ of the income tax function. f_l is the lower kink point of the lth segment of the budget constraint in the (C,F)-plane and b_j is the lower limit of segment j of the income tax function expressed in terms of taxable business income. Following Reece and Zieschang (1985), the segment limits in the (C,F)-plane are defined by

$$f_1 = 0 \qquad \text{(A.1)}$$

$$f_l = \frac{1+q_W}{1+q_F}\left(\tilde{y} - b_{\tilde{N}-l+1},\right) \quad l \in [2,\tilde{N}] \qquad \text{(A.2)},$$

where the segment limit has been multiplied with a factor $\frac{1+q_W}{1+q_F}$ to account for the fact that it is expressed in terms of W. Virtual income on segment 1 is equal to taxable consumption, C, when the individual makes no deductions for contributions:

$$M_1 = \tilde{y} - \sum_{j=1}^{\tilde{N}-1} \tau_j (b_{j+1} - b_j) - \tau_{\tilde{N}}(\tilde{y} - b_{\tilde{N}}) + m \qquad \text{(A.3)}$$

where m is 'other income' and τ_j is the marginal tax rate that applies to taxable business income on segment j. Virtual income on upper segments of the budget constraint is given by the following recursive formula (c.f. Blundell and MaCurdy 1999, p.1619-20):

$$M_l = M_{l-1} + (p_l - p_{l-1}) f_l \qquad \text{(A.4)}.$$

Combining $p_l = \frac{1+q_F}{1+q_W}(1-\tau_{\tilde{N}-l+1})$, (A.2), (A.3) and (A.4) yields

$$M_l = \tilde{y} - \sum_{j=1}^{N-l} \tau_j (b_{j+1} - b_j) - \tau_{N-l+1} (\tilde{y} - b_{N-l+1}) + m .$$

As discussed in Section III, ‘other income’, m, is omitted from the virtual income measure in the empirical analysis and separately estimated in log form.

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