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Working Paper 2009:4

Marginal tax rates and tax-favoured pension savings of the self-employed
Evidence from Sweden

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Working paper 2009:4
May 2009

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by

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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. When using instrumental variables I obtain a tax price elasticity estimate of -0.53 and a virtual income elasticity estimate of 0.11, whereas OLS produces estimates that conflict with consumer theory.

This version: May 2009

Key words: Income taxation, fringe benefits, individual pension savings, self-employment.
JEL classification: G23; H24; J33; J26.

* This paper has benefited from valuable discussions with Thomas Aronsson, Lennart Berg, Sören Blomquist, Alex Gelber, Per Johansson, Henry Ohlsson, Arthur van Soest and conference participants at the CESifo area conference on public sector economics in Munich as well as seminar participants at Uppsala University. Financial support from the Jan Wallander and Tom Hedelius Foundation and from the Uppsala Center for Fiscal Studies is gratefully acknowledged.
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1. 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 compared with 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 determined simultaneously. 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 -0.53 and a virtual income elasticity of 0.11. On the contrary, OLS produces estimates with signs that conflict with standard consumer theory.

The study exploits a unique data base that covers the total of the Swedish population between the years 1999 to 2005. This was a period of calm with respect to income tax reforms. Also, 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. Comparisons with e.g. random effects IV estimations confirm that this is important.

The paper is structured as follows. The next section provides a background and discusses the identification strategy in the light of previous literature. Section 3 outlines the model framework and the methodological problems involved in the empirical analysis. Section 4 describes the data source, whereas section 5 presents the regression results. Section 6 concludes.

2. Background

2.1 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 tax preferentially 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 typically is progressive -- and most people earn more income when they are working-age than when they have retired – this system is potentially beneficial to the individual tax-payer. However, pension assets are extremely illiquid as they cannot be withdrawn before the age of 55.

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

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

plan through collective agreements. In practice, the individual employee or employer lacks power to affect the relation between the tax-deferred amount and the money wages. However, this is not true for the self-employed individual, in particular not if (s)he runs a business that is taxed at the personal level.[2]

As the term suggests, the self-employed are both in a sense employers and employees and are not covered by any collective agreement. In contrast to the employee, the self-employed individual is in 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 tax payers.[3]

2.2 Previous literature

The present paper primarily relates to a rather extensive literature that highlights the effect from 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 U.S. data. [5] A typical procedure has been to regress the marginal tax rate, along with other

[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 as 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 that empirically studies the provision of fringe benefits and to this end exploits a sample of self-employed to overcome problems associated with collective decision mechanisms. With a related argument Gruber and Poterba (1994) examines purchases of tax-deductible health insurance, which constitutes the main bulk of fringe benefits in the U.S., on a sample self-employed persons before and after the U.S. tax reform act of 1986.

[4] Basically, the rules for the savings accounts of the 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 to collectively agreed occupational pensions, the maximum contribution limits are noticeably higher than for employees.

[5] As far as I know, nothing has been written about the impact of the Swedish income tax system on fringe benefits or on 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, however, not included in their study. 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

explanatory variables of interest, on the contributed amount to individual retirement accounts or alternatively the probability to contribute.

Viewed from a stylised perspective, papers belonging to the literature fall into two groups. The first category, which involves works by Collins and Wyckoff (1988), O'Neill and Thompson (1987) and Long (1990), employ single cross sections and OLS or Tobit techniques. Some authors, e.g. Long (1990), discuss the endogeneity of marginal tax rates and uses 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.

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 tax payers 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 owns the merit of providing a plausibly exogenous source of variation, one worry remains: Large income tax reforms tend not only to change present tax rates, but typically also expectations of future rates. Since pension assets in most OECD countries are taxed together with earned income when withdrawn, incentives to save in tax-favoured accounts also depend on these. [6] Thus, tax price estimates obtained from large income tax reforms can be difficult to

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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.

[6]Generally, 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.

interpret for this reason. This paper circumvents this difficulty by utilising rich panel data from a period with no major tax changes.

3. The model framework

3.1 The basic model

In what follows, I will formalise the self-employed's decision of how much to contribute to tax-preferred pension savings accounts as a choice between fully taxed in-cash compensation and a tax-favoured fringe benefit. Needless to say, of course there is 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 one needs to make very specific assumptions about the utility functions of the individuals.[7]

Suppose that before tax profits of the firm, Y, is given exogenously, but that the individual can choose whether to extract compensation in the form wages or a more leniently taxed fringe benefit. Total compensation can then be expressed as

$$Y = (1 + q_W)W + (1 + q_F)F \qquad (1)$$

where W refers to wage compensation, F denotes the fringe benefit, q_W the 'pay-roll tax rate' applying to wage payments and q_F is a special tax levied on F. At the personal level, W is taxed according to a non-linear income tax function $T(\cdot;\tau)$, where τ is a vector of tax parameters. In the basic theoretical model we can think of $T(\cdot;\tau)$ as a smooth function. If we let C refer to unrestricted consumption the binding budget constraint of the individual has the structure $C = W - T(W;\tau) + m$, where all market prices are normalised to one and m is other

[7] The main bulk of the literature on pension savings does not attempt to couch the analysis in a life-cycle consistent framework. Engelhardt and Kumar (2007,2008) are exceptions. While studying the effects from employer matching of 401(k) contributions in the U.S. they propose a two-stage budgeting framework.

exogenous income. This implies that we are able to define the non-linear budget constraint as a function of C and F :

$$g(C,F) \equiv C + \frac{(1+q_F)}{(1+q_W)} F + T\left\{\frac{Y}{(1+q_W)} - \frac{(1+q_F)}{(1+q_W)} F;\tau\right\} = B \qquad (2)$$

, where $B = \frac{Y}{(1+q_W)} + m$ is total exogenous income. Suppose that the individual maximises the well-behaved utility function $U(C,F)$ subject to $g(C,F) = B$ and that a unique optimum exists. An essential feature of the model is that the price of F in general depends on the consumed amount of F , i.e. its price is endogenous.

We now linearise the budget constraint around the optimum point. Let $\kappa = \{q_F, q_{W,} \tau, Y\}$ be a vector of exogenous parameters and $X = \{C, F\}$ the vector of the endogenous choice variables. Suppose, $\kappa = \kappa^*$, $B = B^*$ and let $X^* = \{C^*, F^*\}$ be the vector of the optimal values for X for these given values of κ and B. As stated by Blomquist (1989), it is then true that

$$X^* = X^m\{\kappa^*, B^*\} = X^{Lm}\{P(\kappa^*, B^*), M\} \qquad (3)$$

at the optimum, where the super scripts m and Lm denote non-linear and linear Marshallian demand functions respectively. P refers to the vector of linear prices and M to exogenous income for the linearised budget constraint (virtual income). Linear prices are given by $P_c = g_C = 1$ and $P_F = g_F = (1-T')\frac{1+q_F}{1+q_W}$. In this paper I will estimate linear uncompensated price elasticities , $\eta_{P_F}{}^F$, and linear income elasticites $\eta_M{}^F$. As usual uncompensated and compensated price elasticities are related by the Slutsky equation in elasticity form, i.e. $\eta_{P_F}{}^{F} = \eta_{P_F}{}^{F,c} - \eta_M{}^{F} \frac{P_F F}{M}$, where $\frac{P_F F}{M}$ is the linear expenditure share of F.[8]

3.3. A piecewise linear budget constraint

In reality the tax function is piece-wise linear and how to describe the budget constraint on this premise is a key issue if one is to arrive at a proper empirical specification. Let τ_i represent the marginal tax rate at the i th segment of the income tax function T. Moreover, let b_i and b_{i+1} denote the lower and upper limits corresponding to segment i. When taxable business income $W = \frac{Y}{(1+q_W)} - \frac{(1+q_F)}{(1+q_W)} F$ falls in the k th bracket of the tax function tax payments T can be written as $T(W;\tau) = \sum_{i=1}^{k-1} \tau_i (b_{i+1} - b_i) + \tau_k (W - b_k)$. The segments of the income tax function, together with $\frac{Y}{1+q_W}$, generate a piece-wise linear budget constraint in the (C,F) -plane.[9]

Suppose that the individual is located at segment l of the budget constraint in the (C,F) -plane and segment k of the income tax function. The budget constraint can then locally be expressed as $C + P_{F,l} F = M_l$ where

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[8] Suppose that we are interested in the effect when an arbitrary element of κ, say κ_i, changes. In this context κ_i could be before-tax profits or a tax parameter. If we differentiate (3) with respect to κ_i we obtain $\frac{\partial F^m\{\kappa^*, B^*\}}{\partial \kappa_i} = \frac{\partial F^{Lm}}{\partial P_F} \frac{\partial P_F}{\partial \kappa_i} + \frac{\partial F^{Lm}}{\partial M} \frac{\partial M}{\partial \kappa_i}$, where $\frac{\partial F^{Lm}}{\partial P_F}$ can be decomposed according to the Slutsky equation. As discussed by Blomquist (1989) it turns out that $\frac{\partial P_F}{\partial \kappa_i}$ and $\frac{\partial M}{\partial \kappa_i}$ do not only depend on the structure of the budget constraint. The derivatives are also affected by the fact that the optimum point changes when κ_i changes. Thus, one should keep in mind that there is no straightforward relationship between the signs of the linear and non-linear demand elasticities.

[9] In the context of tax deductible charitable contributions Reece and Zieschang (1985,p.274) provides a formal description of the budget constraint in the (C,F) -plane. In essential respects, their model is equivalent to the one presented here, even though the empirical approaches differ.

$$P_{F,l} = (1-\tau_k)\frac{(1+q_F)}{(1+q_W)} \tag{4}$$

and

$$M_l = \tilde{y} - \sum_{i=1}^{k-1}\tau_i(b_{i+1}-b_i) - \tau_k(\tilde{y}-b_k) + m \tag{5}$$

and $\tilde{y} = \dfrac{Y}{1+q_W}$. A derivation of M_l is provided in Appendix C. Virtual income, M_l, is the prolonged intercept of the slope of the budget line at segment l at the C-axis. Virtual income differs from exogenous income at zero F owing to the fact that inframarginal contributions to pension schemes are deducted at a different (usually higher) rate than the local rate at segment l. In the empirical application $\tilde{y}$ is computed as assessed business income plus $\dfrac{(1+q_F)}{(1+q_W)}F$. A definition of $P_{F,l}$ is provided in Appendix A.

3.3 Empirical model

Suppose that $F^{Lm}(P_F, M)$ can be represented by the functional form $F^{Lm}(P_F, M) = a_0 P_F^{\,a_1} M^{a_2}$ such that $a_1 = \eta_{P_F}^{\;F}$ and $a_2 = \eta_M^{\;F}$. Of course, when estimating these parameters one must also take individual heterogeneity and randomness into account. Let i be an individual index and t a time index. The following empirical equation for all i with $F_{it} > 0$ is posited:

$$\ln F_{it} = \ln a_0 + a_1 \ln P_{F,it} + a_2 \ln M_{it} + a_3 Q_{it} + \phi_i + \varepsilon_{it} \tag{6}$$

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. I assume that $E(\varepsilon_{it}) = 0$ and that ϕ_i is allowed to be correlated with the regressors. Note 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. Q_{it} is a vector of variables, including a full set of time dummies, which are assumed to be strictly exogenous. I also assume that the selection mechanism is strictly exogenous. Stated in terms of the traditional Heckman two-step procedure: 'the inverse Mills ratio' is assumed to be constant through time and therefore controlled for by the fixed effect ϕ_i.

Whether or not 'other exogenous income', i.e. m in (5), should enter the virtual income measure, M, in the estimations is a somewhat tricky issue. m contains net-of-tax earnings of the spouse, public transfers and asset income. Indeed, it is a justified belief that the amount of pension contributions relates differently to ones 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 exogenous 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 separately reported.

3.4 Endogenous regressors

Both key regressors, i.e. the linear price, P_F, and the virtual income, M, crucially depends on the location of the individual at the income tax schedule. This location, in turn, is a function of the choosen amount of voluntary pension contributions, F. Therefore, if we were to estimate (6) by OLS, a correlation between P_F and 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 is not a function of the deducted amount of pension savings. The new measure is created in the following way. To the assessed income I add back $\frac{(1+q_F)}{(1+q_W)}\tilde{F}$, where $\tilde{F}$ is the amount of pension contributions that have been deducted.[10] 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 tax rate instrument' that earlier has been exploited in the literature on tax-deductible charitable giving. [11] The exclusion restriction is that there should be no effect on F from $P_F^{instrument}$ and $M_F^{instrument}$ given P_F, M, Q and the individual specific effect ϕ_i.

It is worth noting that the instrument essentially is 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 one might expect tastes for work and savings 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 $P_F^{instrument}$ and $M^{instrument}$ are assumed to be strictly exogenous conditioned on the individual specific effect, ϕ_i.

The remaining threat to instrument validity is transitory shocks in tastes for work that simultaneously would enter both the contemporaneous error ε_{it} and before tax profits. Keep in mind though that pension savings is an extremely illiquid form of savings (it cannot be withdrawn before the age of 55). It is perhaps plausible that someone who *temporarily*

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[10] See Appendix E for the computation of $\tilde{F}$.
[11] See Feldstein and Taylor (1976) for an early application. One should recognise one potential problem with the instrument. 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.

decides to work very hard a particular year, due to 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 he/she would invest in illiquid pension assets.

4. Description of data

4.1 Data and selection of population

The data material in this study is a unique register data set, specially constructed by Statistics Sweden for the purpose of this project. For the years 1999 to 2005 it contains the total population of Swedish tax payers.[12] The data set entails 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 during the relevant tax year.[13]

When selecting the studied population the institutional framework governing deductions for pension savings pose some important constraints. First, the tax payer should 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 tax payer is not allowed to report any wage income from employment. This exclusion is made since self-employed who earn wage income may

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

[13] Information on pension contributions is available from two sources. First, the register of income statements entails data on the contributed amount 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. There is, however, a considerable fraction of business owners with zero 'aslspe' but positive 'akupens', probably because 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).

choose whether to make the deduction against wage income or self-employment income. To include 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 then the share of entrepreneurs reported in the labour force surveys of Statistics Sweden, where this share typically is 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.

4.2 A look at the data

Summary statistics, both for the entire selected population and the population conditioned on making positive pension contributions, are reported in Appendix D for all variables appearing in the empirical analysis. It is noticeable that the population is heavily dominated by males and by relatively elderly persons. When all observations for the years 1999 to 2005 are pooled 57 percent of the population makes pension contributions. *Figure 1* reveals that this share varies very little during the time period. The mean contributed amount is also relatively stable around SEK 16,000, even though a small trend wise increase in pension contributions can be discerned. It cannot be excluded, however, that this trend is due to compositional changes in the underlying population. *Figure 2* shows that there were no major changes in the average of marginal tax prices during the period. The computation of tax prices is described in Appendix A.

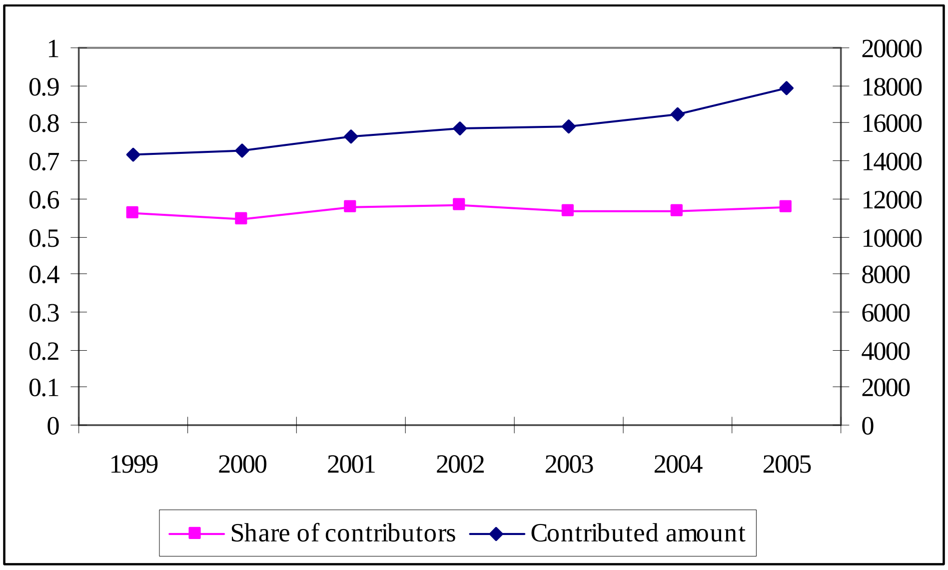

Figure 1. The share of contributors and mean contributed amount by year, expressed in SEK in the price level of 2005.

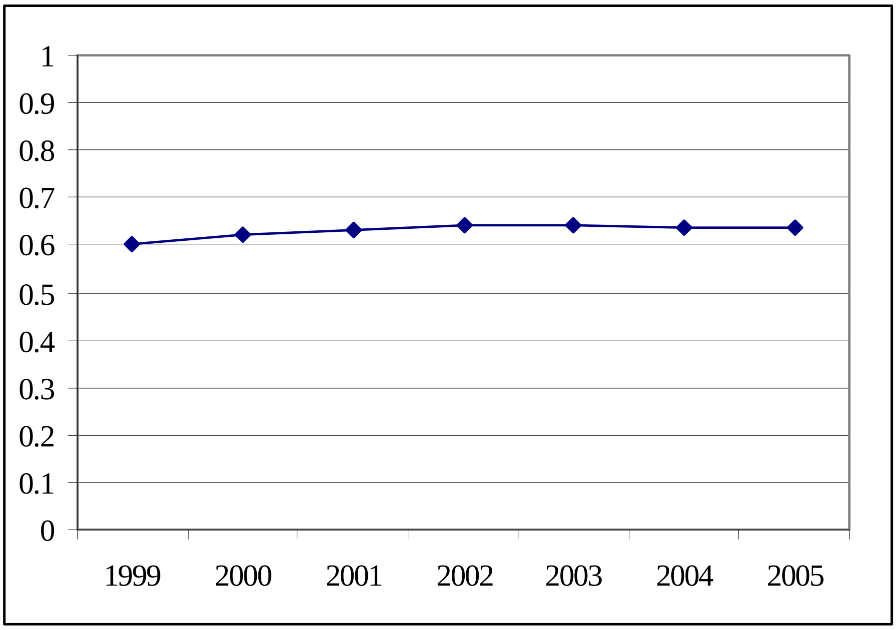

Figure 2. Mean marginal tax price in the selected population by year.

Table 1 characterises mean tax prices, the mean proportion with contributions and the mean contributed amount conditional on contributing with 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 refers to the group of individuals whose actual assessed income falls in that specific interval. It is striking that only a small minority of the studied population is to be found in brackets (7)-(9) where the 'federal' tax rate applies. Conversely, a large majority of tax payers 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 for (1).

The rightmost column of *Table 1* reports the distribution of tax payers 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 back pension deductions to the actual business income. Thus, discrepancies between the two rightmost columns 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 contains 2,179 fewer tax payers when adjusted business income is used to sort tax payers. It is also visible from *Table 1* that both the proportion with contributions and the contributed amount increases with income. A regression analysis is needed to separate the effects from income and tax prices.

The box-plot of *Figure 3*, which visualises the distribution of log contributions by income decile, confirms that contributions tend to increase with income. I have created deciles by ordering all 180,380 unique individuals in the population by their median adjusted business income for the years that they participate in the underlying population.

Figure 4 instead displays the distributions of the log tax price instrument and the log tax price by deciles that are defined in the same way. The dispersion of tax prices is the highest at the bottom and at the top of the income distribution. At the bottom, this is explained by the combined effect from 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 ‘federal’ 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 back. 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 belonging to the 10th decile earn adjusted incomes that place them in the ‘federal’ tax brackets. However, a large fraction of these claim pension deductions and thereby switch tax bracket. In the 9th decile, unadjusted incomes fall on both sides of the kink point for ‘federal’ taxation. However, when pension deductions have been made, few tax payers in the 9th decile are left in the uppermost brackets.

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)	Number of observations with actual business income in the interval	Number of observations with adjusted business income in the interval
(1)	16700	0.949	0.321	10545	3229	2756
		(0.000)	(0.467)	(14411)		
(2)	46900	0.644	0.375	9556	5980	5697
		(0.009)	(0.484)	(9379)		
(3)	106900	0.704	0.481	10854	14207	13556
		(0.007)	(0.500)	(10933)		
(4)	123200	0.644	0.527	12122	4628	4374
		(0.009)	(0.499)	(11565)		
(5)	249200	0.614	0.618	15408	27407	27275
		(0.010)	(0.486)	(16233)		
(6)	312914	0.644	0.725	22360	8150	7764
		(0.009)	(0.446)	(25668)		
(7)	349431	0.456	0.747	29202	3239	3935
		(0.009)	(0.435)	(34448)		
(8)	465157	0.461	0.743	33698	3137	4075
		(0.009)	(0.437)	(41283)		
(9)	--	0.414	0.751	47472	1777	2322
		(0.009)	(0.433)	(58005)		

Standard deviations are in parenthesis.

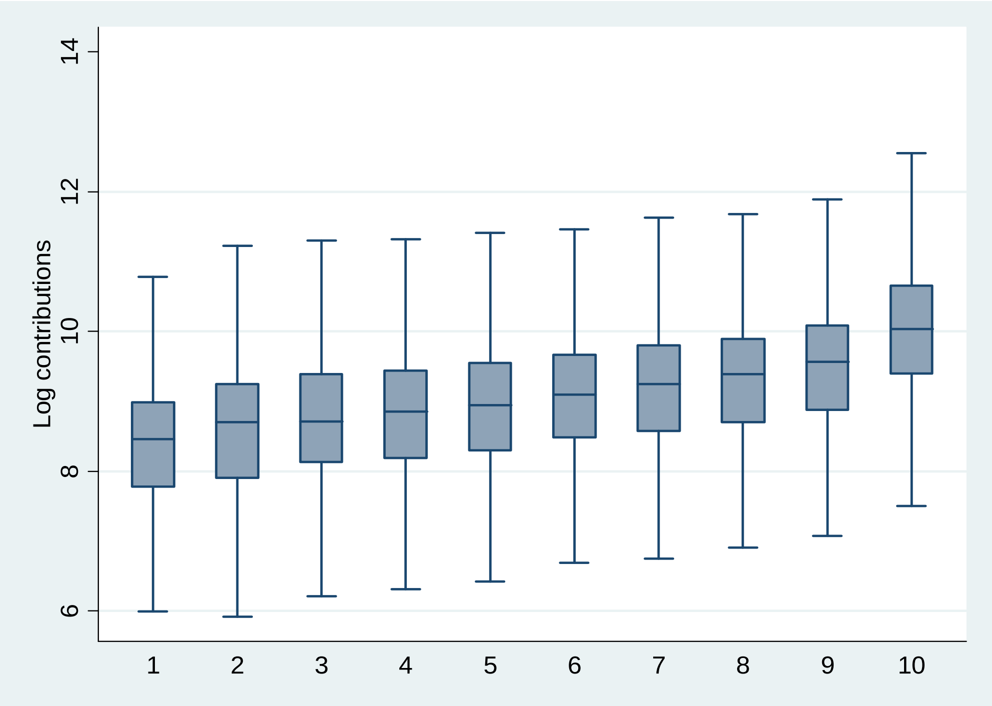

Figure 3. Log contributions to tax-favoured pension savings accounts by decile. Boxes are bordered at the 25th and 75th percentiles. The upper (lower) horizontal line is given by the largest (smallest) value that is less (greater) than or equal to the third (first) quartile plus (minus) 1.5 times the inter quartile range.

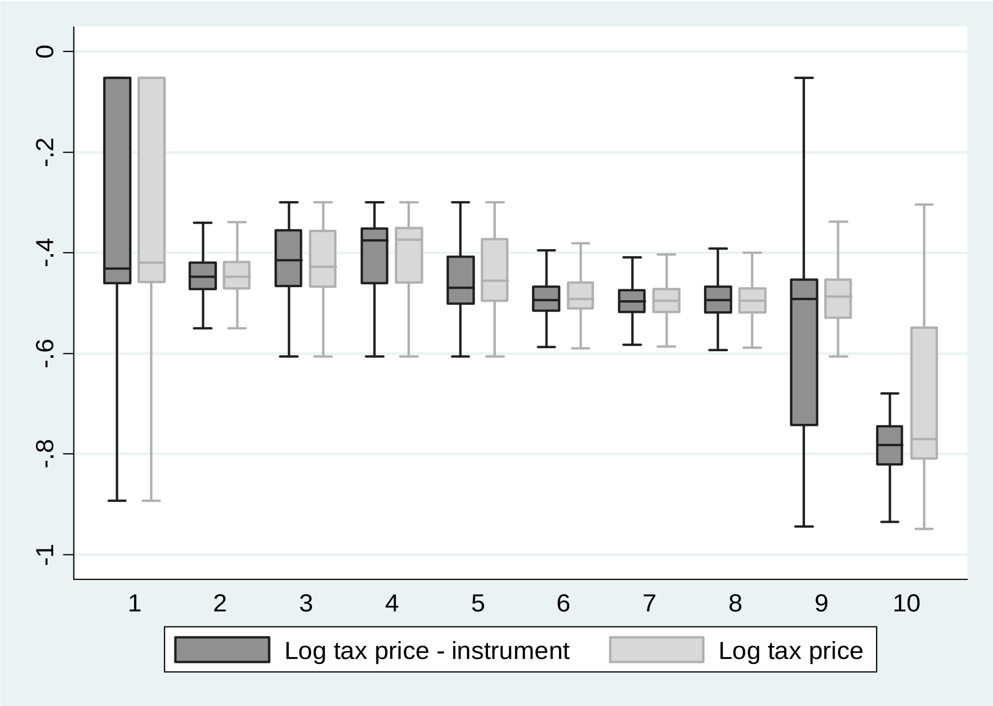

Figure 4. Log tax price instrument and log tax price by decile. Boxes are bordered at the 25th and 75th percentiles. The upper (lower) horizontal line is given by the largest (smallest) value that is less (greater) than or equal to the third (first) quartile plus (minus) 1.5 times the inter quartile range.

5. Regression results

5.1 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 IV 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 0.4. 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. This finding is at odds with standard consumer theory, which predicts that own compensated elasticities always should be non-positive since the substitution matrix is negative semidefinite.

The picture is, however, reversed when instrumental variables are used. As described above, the instruments for the log tax price and the 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. [14]

The most striking feature of the IV 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 -0.53 when income variables are included in the regressions. The estimate of the virtual income elasticity still indicates that contributions are a normal

[14] For the full model, column 6, the values of these F-statistics are 84,000 (first stage for log tax price) and 1,700,000 (log virtual income).

good. The magnitude of the elasticity has, however, drastically decreased and is now estimated to be 0.11 when the full set of control variables are added in column (6). One should recognise that both key elasticities are estimated with great precision: The 99 percent confidence interval ranges from -0.599 to -0.471 for the tax price elasticity, whereas the corresponding confidence interval for the virtual income elasticity is 0.101 to 0.126.

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

	Fixed effects OLS			Fixed effects IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Log tax price	-0.132	0.404	0.399	-0.841	-0.533	-0.535
	(0.012)***	(0.013)***	(0.013)***	(0.019)***	(0.025)***	(0.025)***
Log virtual income		0.323	0.315		0.121	0.113
		(0.004)***	(0.004)***		(0.005)***	(0.005)***
Log other income		0.008	0.003		0.009	0.004
		(0.002)***	(0.002)*		(0.002)***	(0.002)**
Control variables	No	No	Yes	No	No	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	317953	317953	317953	317953	317953	317953
Number of individuals	104239	104239	104239	104239	104239	104239

Standard errors in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. See Appendix Y for a description of the full set of control variables.

The sharp discrepancy between the OLS and IV estimates clearly points to that the reverse causality problem outlined in section 3.4 is a severe one: By deducting pension contributions the self-employed individual simultaneously alters (usually raises) her own tax price. As *Figure 4* made clear, the distributions of the endogenous tax price regressor and its instrumental variable differs, 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 IV case the estimated elasticity is considerably larger in absolute terms (column 4). On the other hand, adding a host of control variables (which are all listed in Appendix D) makes little difference to the results. To some extent this is explained by the fact that a majority of the control variables are rather time-invariant in nature, rendering the identifying variation to be quite small.

From *Table 2* it can also be seen that the elasticity estimates for 'other exogenous income' are substantially lower than the virtual income elasticities. As a robustness check, I have also estimated analogous models, where exogenous income has been included in the computation of the virtual income measure. For the full model, corresponding to column (6), the response in log tax prices is then somewhat sharper, the coefficient is -0.74, and the virtual income elasticity is almost halved (0.06).[15] However, in that setting one cannot rule 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 earlier found in the literature on how private pension savings respond to marginal tax rates.[16] 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.

[15] Full results can be provided upon request.
[16] 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 to why the endogeneity problem is much more severe in my study is that the deduction limits are considerably more generous for self-employed.

5.2 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 whether or not to contribute to tax-favoured pension savings accounts. I have therefore estimated fixed effects linear probability models on the complete population. The results from this exercise are displayed in *Table 3*. Again, when the endogenous variables are used to estimate the probability to contribute (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 instruments are regressed directly on the probability to contribute (column 2) the tax price coefficient exhibits expected signs.

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 IV, but that the signs of the two coefficients differ! If we evaluate the implied elasticity at the mean value of the probability to contribute (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 3. Regression results for the discrete margin. Dependent variable: An indicator variable for making contributions.

	Fixed effects OLS		Fixed effects IV
	(1)	(2)	(3)
Log tax price	0.070 (0.004)***		-0.072 (0.005)***
Log tax price – instrument		-0.055 (0.004)***	
Log virtual income	0.038 (0.001)***		0.019 (0.001)***
Log virtual income – instrument		0.021 (0.001)***	
Log other income	0.003 (0.000)***	0.003 (0.000)***	0.003 (0.000)***
Control variables	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Observations	560185	560185	560185
Number of individuals	180380	180380	180380

Standard errors in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. See Appendix D for a description of the full set of control variables.

5.3 Comparison with alternative estimators

Table 4 reports results from regressions where a random effects IV estimator and a pooled IV estimator are employed. If the unobserved heterogeneity, ϕ_i, is uncorrelated with the covariates random effects and fixed effects estimations should yield similar results. *Table 4* indicates that this is not the case. The estimate of the tax price elasticity is now -0.89, which can be compared with -0.53 for the fixed effects case.[17] The virtual income elasticity is estimated to 0.225, which is considerably larger than the fixed effects estimate of 0.11. A Hausman test rejects the null hypothesis that the coefficient parameter vectors generated by

[17] Here I let 'IV random effects' estimator 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.

the random effects and fixed effects estimator are equal. When observations from all years are pooled both the tax price elasticity and virtual income elasticity increase even more in absolute value.

An advantage with the two alternative estimators is that they allow us to obtain a view on the relationship between the time-invariant gender variable and contributions. Interestingly, the coefficient for the male dummy is positive.[18] Moreover, the estimated coefficients for the quadratic in age in *Table 4* suggest that the contributed amount to pension savings increases in age but at a decreasing rate.

Table 4. Results from alternative estimations. Dependent variable: Log contributions

	Random effects IV	Pooled IV
	(1)	(2)
Log tax price	-0.891	-1.564
	(0.023)***	(0.026)***
Log virtual income	0.225	0.306
	(0.004)***	(0.004)***
Log exogenous income	0.019	0.038
	(0.001)***	(0.002)***
Male	0.089	0.048
	(0.009)***	(0.006)***
Age	0.088	0.053
	(0.003)***	(0.002)***
Age squared	-0.001	-0.000
	(0.000)***	(0.000)***
Observations	317953	317953
Number of individuals	104239	104239

Standard errors in parenthesis. *** denotes significance at a level of 1 %, ** at a level of 5% and * at a level of 10%. See Appendix D for a description of the full set of control variables.

[18] 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 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, in comparison with previous related works, 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 basically were held constant. To identify variation in tax prices and virtual incomes I have exploited the fact that before-tax profits of the self-employed varies due to factors that are outside the individual's control.

When instrumental variables are used to address the problem that tax prices are 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 -0.53 and a virtual income elasticity of 0.11. On the contrary, OLS produces estimates with signs that conflict with standard consumer theory. The huge discrepancy between the IV and OLS estimates suggests that the self-employed use pension deductions as a means to switch tax bracket owing to transitory increases in before-tax profits.

The precisely estimated tax price elasticity of -0.53 suggests that, at the margin, contributions to tax-favoured accounts increases with around half a percent when the tax price increases with one percent. 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. It has, however, 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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Appendices

Appendix A. Computation of P_F

We have already stated that $P_{F,l} = (1-\tau_k)\frac{(1+q_F)}{(1+q_W)}$. The marginal tax rate at the k:th segment of the income tax function, τ_k, is computed according to the formula

$$\tau_k = (LTR_k + FTR_k)*(1+RR_k - PF_k) + PF_k \quad \text{(A.1)}$$

where LTR is the local tax rate, FTR the 'federal' tax rate, RR the reduction rate applying to the standard deduction and PF a mandatory pension fee that is deductible against assessed income. For a given municipality and year LTR is constant on all segments of the tax function except for the first one, where it is zero due to the standard deduction. The average local tax rate has been hovering around 30-32 percent during the period.[19] FTR is zero for segments up to SEK 310,200 in 2005. Since 1999 there are two levels of FTR, namely 0.2 and 0.25. As the standard deduction is phased in at lower income levels and then is phased out at higher levels, RR could either be negative or positive. The phase in rate was 0.25 between 1999 and 2002 and 0.2 between 2003 and 2005. For the whole period of study the phase out rate has been 0.1.

The mandatory pension fee ('allmän pensionsavgift'), PF, is treated as a part of the income tax system. This fee was levied on incomes up to the limit for pension benefits in the public pension system. In practice there was no fiscal connection between the fee and the public pension benefits. Accordingly, without any implications for the pension benefits it has been reduced during the period of study, from 0.0695 in 1998 to 0.00875 in 2005.

How to handle $\frac{(1+q_F)}{(1+q_W)}$ in the expression $P_{F,l} = (1-\tau_k)\frac{(1+q_F)}{(1+q_W)}$ is a more tricky issue. From a legal point of view both the special tax levied on pension contributions ('särskild

[19] Until 1999, the local tax rate included a church tax.

löneskatt'), q_F , and the 'pay-roll tax' ('egenavgifter'), q_W , should be seen as taxes. However, in contrast to q_F , q_W generates social benefits, including pension benefits, up to certain monetary limits that are determined by the price basic amounts and the income basic amounts. Here I do, however, treat q_W as a pure tax. For the whole period of study $q_F = 0.2426$ whereas q_W gradually declined somewhat from 0.3125 in 1998 to 0.3089 in 2005.

Appendix B. Important rules with respect to tax-deductible pension contributions

B1. Maximum deduction limits

From 1999 and onwards, the maximum deduction amounts to 35 percent of business income, even though it is not allowed to exceed 10 basic amounts. For the whole period, the income base for calculating the maximum deduction is always business income *net of* other deductions. The two key deductions were sums allocated for expansions ['avsättningar för expansionfond'] and transformation of earned income to capital income ['räntefördelning']. When calculating the contribution limit for a specific tax year, the sole proprietor may use the maximum of the actual tax year income and the preceding tax year's income.

B.2 Other rules

The main requirement for tax-preferential treatment of pension capital is that accumulated assets are not allowed to be withdrawn before the age of 55.[20] Contributions to a tax-deferred savings plan can either be made in the form of purchases of traditional pension insurance or deposits to a special pension savings account. The latter kind of savings form, which enables

[20] An interesting aspect of this extreme illiquidity from the point view of the self-employed individual is that pension assets are not distrainable -- in the case of a bankruptcy the pension wealth of the sole proprietor is not affected. Thus, risk elimination in a more narrow sense than the more general precautionary savings motive might underlie the investment in pension insurance or pension savings account.

the individual to have disposal over her own voluntary pension savings portfolio, was introduced in 1994. The yield tax is paid by the insurance companies or the financial institution that administers the pension capital. It is calculated by multiplying 15 percent of the state lending rate by the fund capital. The stock of pension assets was exempted from wealth taxation.

Appendix C. Virtual income

Let us define N as the segment of the income tax function into which $\tilde{y}$ falls. As in the main text, k is the segment into which W falls. Let f_i be the lower limit to the i th segment of the budget constraint in the (C, F) -plane. The segment limits are defined by (c.f. Reece and Zieschang 1985):

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

$$f_l = \tilde{y} - b_{N-l+1}, \quad l \in [2, N] \qquad \text{(C.2)}$$

Virtual income at segment l is given by the following recursive formula (c.f. Blundell and MaCurdy 1999, p.1619-20):

$$M_1 = \tilde{y} - \sum_{i=1}^{N-1} \tau_i (b_{i+1} - b_i) - \tau_N (\tilde{y} - b_N) + m \qquad \text{(C.3)}$$

$$M_l = M_{l-1} + (p_l - p_{l-1}) f_l, \qquad l \in [2, N] \qquad \text{(C.4)}$$

Inserting $p_l = (1 - \tau_{N-l+1}) = (1 - \tau_k)$, and (C.2) in (C.4) yields equation (5) in the main text.

Appendix D. Description of variables and summary statistics

Table D1. Descriptive statistics

	Complete population		Population conditional on contributing	
	Mean	Standard deviation	Mean	Standard deviation
Log contributions			9.142	1.061
Share with positive contributions	0.568	0.495		
Log tax price	-0.473	0.150	-0.496	0.148
Log tax price - instrument	-0.486	0.153	-0.517	0.150
Log virtual income	11.247	1.013	11.517	0.735
Log virtual income - instrument	11.216	1.008	11.464	0.739
Log other income	11.246	1.514	11.428	1.381
Male	0.708	0.455	0.679	0.467
Age	42.497	8.304	43.255	7.739
Age squared	1874.989	672.005	1930.879	639.360
Children aged below 18	0.879	1.102	0.901	1.080
Children aged between 4 and 10	0.317	0.645	0.314	0.637
Children aged between 0 and 3	0.087	0.318	0.072	0.288
County dummies:				
Stockholm	0.240	0.427	0.205	0.404
Uppsala	0.034	0.181	0.035	0.184
Södermanland	0.028	0.165	0.029	0.168
Östergötland	0.043	0.203	0.046	0.210
Jönköping	0.031	0.172	0.032	0.176
Kronoberg	0.019	0.136	0.020	0.142
Kalmar	0.028	0.166	0.029	0.168
Gotland	0.012	0.108	0.012	0.109
Blekinge	0.014	0.119	0.016	0.125
Skåne	0.147	0.354	0.145	0.352
Halland	0.036	0.186	0.039	0.193
Västra Götaland	0.170	0.376	0.171	0.376
Värmlands	0.024	0.153	0.025	0.157
Örebro	0.026	0.160	0.028	0.164
Västmanland	0.024	0.154	0.026	0.160
Dalarna	0.025	0.156	0.030	0.170
Gävleborgs	0.025	0.157	0.028	0.165
Västernorrland	0.022	0.148	0.026	0.159
Jämtland	0.015	0.123	0.018	0.133
Västerbotten	0.015	0.122	0.017	0.131
Norrbotten	0.019	0.135	0.022	0.145
Type of education (dummies)				

General programmes	0.340	0.474	0.314	0.464
Education	0.017	0.130	0.017	0.131
Humanities and arts	0.034	0.182	0.028	0.165
Social sciences, business and law	0.108	0.311	0.108	0.310
Science, mathematics and computing	0.012	0.108	0.009	0.097
Engineering, manufacturing and construction	0.254	0.435	0.268	0.443
Agriculture and and veterinary	0.065	0.246	0.071	0.257
Health and welfare	0.053	0.224	0.062	0.241
Services	0.084	0.278	0.102	0.303
Unknown	0.033	0.178	0.020	0.141
Level of education (dummies)				
Less than 9 years of schooling	0.069	0.254	0.059	0.236
Primary or secondary eduction 9-10 years	0.202	0.401	0.195	0.396
Upper secondary education	0.550	0.497	0.580	0.494
Post-secondary education less than 2 years	0.048	0.213	0.045	0.208
Post-secondary education more than 2 years	0.120	0.325	0.116	0.320
Postgraduate education	0.002	0.042	0.002	0.040
Dummies for marital status				
Single, never legally married	0.380	0.485	0.356	0.479
Married man	0.340	0.474	0.352	0.478
Married woman, not cohabiting with the spouse	0.004	0.066	0.004	0.062
Divorced person and not remarried	0.107	0.309	0.102	0.302
Widow/widower	0.004	0.066	0.005	0.071
Married woman, cohabiting with the spouse	0.164	0.370	0.181	0.385
Registered partner (men)	0.000	0.020	0.000	0.019
Registered partner (women)	0.000	0.011	0.000	0.009
Year dummies:				
year1999	0.152	0.359	0.150	0.357
year2000	0.152	0.359	0.146	0.353
year2001	0.151	0.358	0.153	0.360
year2002	0.144	0.351	0.147	0.354
year2003	0.136	0.343	0.137	0.344
year2004	0.137	0.344	0.136	0.343
year2005	0.128	0.334	0.130	0.337
# observations	560185		317953	

Appendix E. Computation of $\tilde{F}$

The dependent variable in the regressions mirrors all deferrals that have been made to tax-favoured pension accounts during the relevant tax year. However, when adding back the deducted amount of contributions to the business income measure it is crucial not to add back contributions that not have been deducted. Otherwise, a correlation between the error term and the independent variable can occur. While using the variable labels from the official Swedish tax registers I have defined , $\tilde{F}_t$, as

$$\tilde{F}_t = 'aslspe'_t \text{ } if \text{ } 'aslspe'_t \geq 'akupens'_t$$

$$\tilde{F} = \max(ded\lim_t, 'akupens'_t) \text{ } otherwise$$

The deduction limit, dedlim, is defined as

$$dedlim_t = 0.5 \cdot PBA_t + \min(10 \cdot PBA_t, \max(BASE_t, BASE_{t-1})),$$

where $BASE_t = 'nakte'_t + 'nakthb'_t + q_{W,t}('nakte'_t + 'nakthb'_t) + q_{F,t} \cdot 'aslspe'_t$. $'aslspe'$ is the deducted amount for which the business owner has paid a special wage tax, $'akupens'$ is the contributed amount reported by financial institutions, PBA is the price basic amount, $'nakte'_t$ is assessed business income from sole proprietorships, $'nakthb'_t$ is assessed business income from partnerships.

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