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Flat Tax Reforms: a Dynamic General Equilibrium Analysis for Sweden

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Abstract

This thesis uses a dynamic general equilibrium model to evaluate the steady state effects of a flat tax reform in Sweden. The reforms considered range from a purely proportional tax scheme to a flat tax with 30 percent deduction on labor income. We evaluate the welfare implications and the changes in output, effective labor input and capital stock. We find that a flat tax reform can lead to an increase in long run output, effective labor input and capital stock. Moreover there are potential welfare gains for the two most efficient groups, as well as for the least efficient. However, none of the reforms are Pareto improving.

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1 Introduction

While the tax systems in the established industrial nations have a tendency to become more complex, several of the former members of the Eastern bloc have moved in the opposite direction, and introduced a flat tax. Estonia became the first nation to introduce a flat tax on personal income and corporate profits at 24 percent in 1994. Others have followed example.[1]

Flat tax is a hot issue, increasingly debated in the public as well as the academic field. In Sweden, some of the strongest voices have been raised by members of the Centre Party and the Swedish Tax Payers' Association. Proponents suggest that the efficiency of the flat tax is a key reason behind Eastern Europe's high growth. Efficiency gains from a flat tax reform mainly arise from lower deadweight losses since the tax rate under a flat tax scheme is typically well below the top marginal taxes under a progressive tax scheme. Other arguments stressed by advocates are the simplicity, and that a flat tax is a more fair system, in the sense that all income is taxed at the same rate. Opponents point out that a flat tax can cause increased inequality compared to a progressive system, with the poor paying more while the wealthy pay less.

A true flat income tax taxes all income, regardless of size or source, at one uniform rate. More commonly, a flat tax is understood as a replacement of the different tax brackets on labor income with one unique flat tax rate. There are several different flat tax proposals. They generally differ regarding underlying tax base and the fixed deduction level. A proposal that has received large attention in the academic debate is Hall and Rabushka's (1995). They move beyond a true flat income tax by also eliminating the double taxation on capital and allowing for deductions of new investments. However, as González-Torrabadella and Pijoan-Mas (2006) note, these aspects regarding specific taxation on income from capital are generally left aside in the public debate on flat taxes.

Given the large attention that the flat tax has received we find it interesting to evaluate the impacts of a flat tax reform on the Swedish economy. We consider a flat tax as it is commonly understood in the public debate, where all labor income above a fixed deduction level and all capital income are taxed at one single rate. We use a dynamic general equilibrium model to evaluate the quantitative effects of such a reform. We analyze changes in aggregate variables and welfare implications in steady state due to a flat tax reform. We consider the effects of several different government revenue neutral flat tax reforms, ranging from a purely proportional income

[1] The other Baltic countries Lithuania and Latvia soon followed. Notably, the trend has already reached Russia.

tax with no deduction to one where the fixed deduction on labor income is 30 percent of the mean income level.

Summarizing, the aim of this thesis is to:

1. *examine the steady state effects of a flat tax reform for the Swedish economy on output, effective labor input and capital stock.*
2. *assess the welfare implications of such a reform for different groups.*

The outline of this paper is as follows. Section 2 provides a brief overview of results from similar studies. Section 3 describes our model. In section 4, we calibrate our model to resemble the Swedish economy. Section 5 describes the benchmark economy. In section 6 we present our results. Section 7 provides a sensitivity analysis. Finally, in section 8 we summarize our findings and provide suggestions for further research.

2 Literature Overview

Several studies evaluate the effects of a flat tax reform. We first present studies on the U.S. economy. Though unique for each study, the models used all have their origin in the dynamic life-cycle simulation model developed in Auerbach and Kotlikoff (1987). We focus on reviewing the results relevant to the aim of our thesis: changes in aggregates and welfare implications. Secondly, we give a brief overview on Swedish proposals. The studies presented consider different flat tax reforms, illustrative for the many different proposals in the public debate.

Altig et al. (2001) consider the effects of five tax reforms. The one that most closely resembles our flat tax reform is a proportional income tax applied to all income from labor and capital.[2] Aggregate output increases by 4.9 percent due to a 5.6 percent increase in the capital stock and a 4.7 percent increase in the effective labor input. The reform increases welfare for the most efficient households while less efficient households are worse off. The authors conclude that there are long-term gains at the aggregate level, but that these gains come at the expense of the less efficient households. The other reforms considered have features to mitigate this inequality. They succeed to some extent, although this reduces the gains at the aggregate level.

Ventura (1999) simulates the Hall and Rabushka proposal. He considers two different fixed deduction levels: 20 and 40 percent of current mean income. Output increases in both

[2] The authors do not include a fixed deduction for income from labor. The other reforms include an increasing degree of progressivity in the form of deductions. The deductions on income from labor and capital differ.

simulations, and more at the lower deduction level. The capital stock increases significantly at both levels. Ventura concludes that this is mostly due to the removal of double taxation on capital. Interestingly, aggregate hours worked remains fairly constant while the effective labor input increases due to a redistribution of labor hours from low to high productivity individuals. The conclusion is that while a flat tax reform increases aggregate output it does so at the expense of the less efficient households' income and wealth.

Conesa and Krueger (2006) do not evaluate an explicit flat tax reform, but rather the optimal progressivity of the U.S. tax system. They find that a single marginal tax rate at 17.2 percent on income from labor and capital along with a fixed deduction of 9 400 dollar is optimal. In the new steady state aggregate output and effective labor input increase 0.54 and 0.64 percent respectively. The welfare gains are equivalent to a 1.7 percent increase in consumption across all agents. Households with low and high income pay a lower amount in income taxes while middle-income households face a higher tax burden. The conclusion is that this reform is desirable.

Finally, Diaz-Gimenez and Pijoan-Mas (2006) consider a single flat tax rate on all income coupled with two different fixed deduction levels on labor income, 16 000 and 32 000 dollar.[3] The tax system with the lower deduction level increases long run output by 2.4 percent. The other reform decreases output by 2.6 percent. The authors also evaluate the welfare effects of a flat tax reform. Aggregate welfare falls under the flat tax system with the lower deduction level while it increases under the other.

Several organisations have designed different flat tax proposals for the Swedish economy. Among those are the Swedish Employer's Confederation (Du Rietz and Jacobsson 2000) and the Federation of Private Enterprises (Juth 2001). Rather than showing how and why a flat tax would be beneficial these proposals contain a detailed description of how the reforms would be done. The proposals replace the current system with a fixed deduction and different flat marginal taxes on income from labor and capital. The reforms are supposed to be financed by cuts in government expenses and from dynamic effects stemming from the reform. Halápi (2005) evaluates the effects of a flat tax with no deductions using a static model that does not consider potential changes in behaviour due to a change of the tax scheme. The resulting government revenue neutral flat tax is 31.60 percent. The tax burden increases for many of the low and middle income groups, whereas the high income groups face a lower burden.

[3] Of all the reforms discussed in the literature overview this is the reform that is most similar to our reform.

3 Model

We model Sweden as a closed economy. We use a version of the dynamic life-cycle simulation model developed by Auerbach and Kotlikoff (1987). Our framework closely follows the extended version introduced by Altig et al. (2001). Thus, we include a pension system and a bequest motive. We capture inter- and intragenerational differences by including four different groups within each age cohort, each with its own human capital profile. We do not consider implications of market incompleteness or uninsurable idiosyncratic risks. Households are assumed to have rational expectations. Along with no uncertainty this implies that households have perfect foresight. We capture the bracket structure of the current Swedish labor income tax code. Moreover, endogenous labor supply allows us to analyze how changes in the tax system effect hours worked. Finally, by allowing for heterogeneity among households, we can better isolate the underlying reasons for changes in the aggregates due to the flat tax reform.

3.1 Households

3.1.1 Demographics

Households are represented by agents who live for 60 periods. Agents begin their economic life at age 21, retire at 66, and die at 80. One period in the model represents one year in the real world. Each age cohort consists of four representative agents. Each *j*-type agent has their own specific human-capital profile. Agents give birth to a new generation at age 40. We assume no population growth and that each *j*-type agent constitutes a fixed share, ω_j of all age cohorts. Thus, at any given time the economy consists of 60 overlapping generations.

3.1.2 Preferences

Agents derive utility from consumption (c) and leaving bequests (b), and lose utility from providing labor (h). All agents who are born in period t choose a perfect foresight labor supply and consumption path to maximize lifetime utility, U_t:

$$U_t = \sum_{s=21}^{80} \left(\beta^{s-21} u_{t+s} \right) + \beta^{59} \mu \ln b_{s=80} \qquad \text{where } \beta < 1 \tag{1}$$

All parameters represented by Greek letters, are assumed to be constant across the different agents and time periods. In (1) β represents the agents' time discount factor, s denotes the age in a specific period, and μ is the agents' utility weight on leaving bequests.

The utility from a specific year is given by u_{t+s}:

$$u_{t+s} = \ln c_{t+s} - \varphi \frac{h_{t+s}^{1+1/\gamma}}{1+1/\gamma} \tag{2}$$

where the parameter φ determines the level of labor supply. How responsive the choice of labor supply is to life-cycle changes in wage levels is represented by γ, the Frisch labor supply elasticity.

3.1.3 Budget Constraints

Agents are forced to retire when they become 66 years old. The budget constraint for working age agents is given by (3) and for retired by (4):

$$a_{j,s+1,t+1} + (1+\tau_t^C)c_{j,s,t} \leq (1-\bar{\tau}_{j,s,t}^W)[(1-\tau_t^P)w_t e_{j,s} h_{j,s,t}] + [1+(1-\tau_t^K)r_t](a_{j,s,t} + g_{s,t}) \tag{3}$$

$$a_{j,s+1,t+1} + (1+\tau_t^C)c_{j,s,t} \leq (1-\bar{\tau}_{s,t}^W)p_{s,t} + [1+(1-\tau_t^K)r_t]a_{j,s,t} - b_{j,s,t} \tag{4}$$

Capital holding of a *j*-type agent aged *s*, in the year *t*, is denoted $a_{j,s,t}$. Agents take wages, w_t and the return to savings, r_t as given. The *j*-type age dependent human-capital level is represented by $e_{j,s}$. Consumption is taxed at rate τ_t^C, τ_t^K is the tax on capital income and $\bar{\tau}_{j,s,t}^W$ denotes the average labor income tax. Retired agents receive a pension, $p_{s,t}$. The pension system is funded by a tax on gross wages, τ_t^P. Agents leave bequests, $b_{j,s,t}$ at their death, i.e. $b_{j,s,t} = 0$, for $s \neq 80$. Bequests are distributed evenly as gifts, $g_{s,t}$ across the generation that they have given birth to, i.e. $g_{s,t} = 0$, for $s \neq 40$. We assume that agents have no capital at birth, $a_{j,20,t} = 0$. We also impose a borrowing constraint such that agents are not allowed to be net borrowers, i.e. $a_{j,s,t} \geq 0$.

3.1.4 Optimization

Households maximize life-time utility (1) subject to constraints (3), (4) and the borrowing constraint through a choice of consumption and hours worked in each period. This yields the following intertemporal condition for all agents:

(5) $$\frac{1}{c_t\left(1+\tau^C\right)} \geq \frac{\beta}{c_{t+1}\left(1+\tau^C\right)}\left[1+\left(1-\tau^K\right)\right]r_{t+1}$$

Equation (5) holds with equality when the borrowing constraint is not binding, i.e. when $a_{j,s,t} > 0$. Working age agents also have to choose labor supply which results in an intratemporal condition:

(6) $$h_{j,t,s} = \left[\frac{\left(1-\tau^W_{j,s,t}\right)\left(1-\tau^P\right)w_t e_{j,s}}{\left(1+\tau^C\right)c_t \varphi}\right]^{\gamma}$$

Finally, agents in their final year choose how much bequest to leave according to:

(7) $$b_{j,s=80} = \mu\left(1+\tau^C\right)c_{s=80}$$

3.2 Technology

We assume that firms have a constant return to scale production technology. The technology is represented by a Cobb-Douglas production function:

(8) $$Y_t = K_t^{\alpha}\left(EH\right)_t^{1-\alpha}$$

where α is the capital's share to output, K_t is the aggregate capital stock, $(EH)_t$ is the effective labor input and Y_t is output. Every period the capital stock depreciates at a constant rate, δ. Thus, the economy's investments equal:

(9) $$I_t = K_{t+1} - (1-\delta)K_t$$

3.3 Fiscal Structure

3.3.1 Pension System

We consider a separate pension system. The pension system is modeled as a pay-as-you-go system with defined contributions. The system is financed by pension taxes on gross wages. The pension system has to run a balanced budget in each year. In a given year all retirees receive the same pension.

$$p_t = \frac{\tau_t^P \sum_{s=21}^{65} \sum_{j=1}^{4} \omega_j w_t e_{j,s} h_{j,s,t}}{\#\,retirees} \tag{10}$$

Hence the pension received in each period equals the sum of all pension taxes levied from the agents divided by the number of retirees.

3.3.2 Taxation

All taxes are collected at the household level. Prior to the reform the government collects a proportional tax on capital income and consumption, and a progressive tax on labor income and pensions. The taxable income from labor and pension, $I_{j,s,t}$ of a *j*-type agent of age *s* is given by:

$$I_{j,s,t} = \left(1 - \tau^p\right) w_t e_{j,s} h_{j,s,t} \quad \text{for } s \leq 65 \tag{11}$$

$$I_{j,s,t} = p_{s,t} \quad \text{for } s > 65 \tag{12}$$

Similarly to Ventura (1999) we model the progressive labor income tax as a system with different income brackets, I_i with matching marginal tax rates, τ_i^W .[4] Income below the level I_0 is fully deductible. Thus the agents face a marginal tax rate that increases step-wise with increasing income. Suppose for example that an agent earns $I_{j,s,t}$, where $I_1 < I_{j,s,t} < I_2$. He then faces a marginal tax rate, τ_t^2, and pays total labor income tax:

$$T_{j,s,t} = \tau_t^1 \left(I_1 - I_0\right) + \tau_t^2 \left(I_{j,s,t} - I_1\right) \tag{13}$$

The average tax rate on labor income or pensions that the agent faces is thus:

$$\bar{\tau}_{j,s,t}^W = \frac{T_{j,s,t}}{I_{j,s,t}} \tag{14}$$

After the reform the marginal tax on pensions and labor income above a single fixed deduction level, I_0 will be equal to the tax on capital income:

$$\tau_t^W = \tau_t^K = \tau_t^{flat} \tag{15}$$

[4] For example, Altig et al. (2001) use a quadratic approximation to capture the progressive income tax.

3.3.3 Government Budget Constraint

The government spends G_t in every period, which is financed through taxation. We assume that government consumption yields no utility to the individual households. Furthermore we require that the government runs a balanced budget in each period, such that:

$$G_t = \sum_{s=21}^{80}\sum_{j=1}^{4} \bar{\tau}^{W}_{j,s,t}\omega_j w_t e_{j,s} h_{j,s,t} + \bar{\tau}^{W}_{j,s,t}\omega_j p_t + \tau^{K}_t \omega_j r_t a_{j,s,t} + \tau^{C}_t \omega_j c_{j,s,t} \tag{16}$$

3.4 Equilibrium

In equilibrium (*i*) all agents optimize consumption, labor supply, and bequests such that life-time utility is maximized; (*ii*) the factor markets clear such that all factors are paid their marginal product:

$$r_t = \alpha K_t^{\alpha-1}(EH)_t^{1-\alpha} - \delta \tag{17}$$

$$w_t = (1-\alpha)K_t^{\alpha}(EH)_t^{-\alpha} \tag{18}$$

Moreover, (*iii*) the market for savings and labor clear. In our closed economy this implies that firms' demand for capital equals households' aggregate savings and firms' demand for labor equals aggregate effective labor input.

$$K_t = \sum_{s=21}^{80}\sum_{j=1}^{4} \omega_j a_{j,s,t} \tag{19}$$

$$(EH)_t = \sum_{21}^{65}\sum_{j=1}^{4} \omega_j e_{j,s,t} h_{j,s,t} \tag{20}$$

Furthermore an equilibrium demands that (*iv*) the government budget constraint is satisfied and (*v*) that the goods market clear:

$$C_t + G_t + I_t = Y_t \tag{21}$$

3.5 Welfare Measurement

In order to evaluate the flat tax reform we measure the utility for each *j*-type agent under the two different tax systems. Consider the two formulas for lifetime utility below:

$$W_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln c_{PT,j,s} - \varphi\frac{h_{PT,j,s}^{1+1/\gamma}}{1+1/\gamma}\right]\right) + \beta^{59}\mu\ln b_{PT,j,s=80} \tag{22}$$

$$W_{FT,j}(x) = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln(1-x_j)c_{FT,j,s} - \varphi\frac{h_{FT,j,s}^{1+1/\gamma}}{1+1/\gamma}\right]\right) + \beta^{59}\mu\ln b_{FT,j,s=80} \tag{23}$$

W_{PT} is the lifetime utility under a progressive tax system. $W_{FT}(x=0)$ is the lifetime utility under a flat tax system. We measure the welfare effects of the reform by finding the x_j that solves: $W_{PT} = W_{FT}(x_j)$.[5] The x_j is the agent's utility increase in consumption equivalents due to the reform. Thus, positive x_j indicate that the agents are better off in the flat tax system, whereas negative x_j indicates that the agents are worse off.

We use two approaches to determine whether the flat tax reform is welfare enhancing. The first approach is to evaluate whether the flat tax reform is Pareto improving or not. If at least one x_j is positive and no x_j is negative the flat tax reform is Pareto improving and thus worthwhile to implement. Secondly, we consider a utilitarian approach where we use a single x representing all agents. If the sign of x is positive the reform is welfare improving according to this criterion.

4 Calibration

We assume an initial steady state and calibrate our model to make it resemble Sweden's economy. Previous estimates and standard methods are used to set our parameter values for technology and preferences. We lay emphasis on the calibration of the tax system. All parameters are assumed to be constant over time and can be found in *Table 3*.

4.1 Technology and Preferences

Capital's share in the production function is set to 0.36.[6] According to Domeij and Flodén (2006a) estimates for the Frisch labor supply elasticity are typically in the range 0 to 0.5 for men. Heckman and MaCurdy (1980) find that the Frisch elasticity is higher for women. We set γ to 0.5. The weight on labor supply, φ is set to 0.05.

Edvinsson (2005) estimates the average capital/output ratio to 2.5 and the average investment/output ratio to 0.2 for Sweden over the period 1995-2000. We set δ at 0.08 to match

[5] For a complete solution of this problem, see Appendix.
[6] Ventura (1999) estimates the average ratio of capital income to total income from 1959-90 in U.S. to 0.36.

the target investment/capital ratio. β and μ are set to match the target capital/output ratio and to smooth the consumption profile over the life-cycle.

4.2 Human Capital Profile

Similarly to Auerbach and Kotlikoff (1987) we base our human capital profiles on earning profiles. We use estimates obtained by Domeij (2006), who has regressed annual earnings of Swedish employed workers on age, education level and sex.[7] Our agents are divided into four different groups based on their education level. Higher education level corresponds to an upward shift of the human capital profile. The human capital profiles exhibit typical concave characteristics and peak at age 46. We use data from Domeij (2006) for 2002 to determine the size of each group. The majority are high school graduates. The remaining three groups are of roughly equal sizes. The weights are summarized in *Table 1*.

Table 1 – Weights for Each Group

Did not complete high school	ω_1	15.6 %
High school graduates	ω_2	50.6 %
Some college experience	ω_3	16.8 %
College graduates	ω_4	17.0 %

4.3 Fiscal Structure

The tax system used in our benchmark economy is designed to resemble the current Swedish tax code. We consider four different taxes and focus on the characteristics of the labor income tax. In the benchmark economy we model a progressive labor income tax, and a proportional capital tax. After the reform labor income above the fixed deduction level and capital income are taxed at the same flat rate. The pension tax and consumption tax are proportional and fixed throughout the experiment.

Similarly to Domeij and Flodén (2006b), the pension tax is calibrated to target the size of the Swedish pension system relative to GDP, 6.9 percent.[8] We set the pension tax at 11.0 percent. The tax code allows for several exemptions and deductions. Since we model all consumption as homogenous, and only consider one kind of capital we have to consider average efficient tax

[7] For a more detailed explanation please see Appendix.
[8] We use data from 2001 for old age cash benefits relative to GDP, (OECD Social Expenditures Database).

rates. We set the initial capital income tax rate at 35.7 percent, and the consumption tax at 19.8 percent as estimated by Carey and Rabesona (2003).[9]

We calibrate the labor income tax to approximate the features of the 2005 tax code. Labor income below 16 600 kronor is deductible (Swedish Tax Authority).[10] We use this level as the standard deduction for all income levels.[11] All labor income above the standard deduction level is taxed at the municipal rate averaging 31.6 percent in 2005 (Statistics Sweden).[12] The government tax is collected on net income above 298 600 kronor and is 20 or 25 percent depending on income level (Swedish Tax Authority). *Table 2* summarizes the labor income tax code.

Table 2 - Income Bracket Levels and Corresponding Marginal Tax Rates 2005

Income bracket, (SEK)	Marginal tax rate, (percent)
0 – 16 600	0
16 601 – 298 600	31.6
298 601 – 450 500	51.6
450 501 –	56.6

Source: Swedish Tax Authority, *Belopp och procent – inkomståret 2005/taxeringsår 2006*; Statistics Sweden, *Offentlig ekonomi.*

In order to calibrate our model's bracket levels we follow Ventura (1999). The mean labor income for ages 21 to 65 was 291 600 kronor in 2005 (Statistics Sweden). We calculate the bracket levels by considering multiples of the model's mean labor income level, $\mathcal{I}$. The standard deduction level corresponds to approximately 5.7 percent of the mean income. Correspondingly we set I_0 to $0.057\mathcal{I}$. The other brackets are set in a similar fashion and summarized below. The size of the government consumption, G_t is determined endogenously through the government budget constraint.

[9] These are the average estimated efficient tax rates over the period 1990 – 2000.
[10] Swedish Tax Authority, Swedish translation: Skatteverket.
[11] The true standard deduction depends on income level.
[12] Statistics Sweden, Swedish translation: Statistiska Centralbyrån

Table 3 - Summary of Parameters

Symbol	Definition	Value
	Preferences	
γ	Frisch labor supply elasticity	0.5
φ	Weight on labor supply	0.05
μ	Weight on bequest	3
	Technology	
α	Share of capital in production	0.36
β	Time discount factor	0.965
δ	Depreciation rate of capital	0.08
	Target Ratios in Initial Steady State	
I/Y	Investment/Output	0.2
K/Y	Capital/Output ratio	2.5
P/Y	Size of the pension system/Output	0.69
	Values of Fiscal Variables in Initial Steady State	
τ_1^W	Marginal income tax rate (>0.057$\mathcal{J}$– 1.024 $\mathcal{J}$)	31.6 %
τ_2^W	Marginal income tax rate (>1.024$\mathcal{J}$– 1.545$\mathcal{J}$)	51.6 %
τ_3^W	Marginal income tax rate (>1.545$\mathcal{J}$–)	56.6 %
τ^C	Consumption tax rate	19.8 %
τ^K	Capital income tax rate	35.7 %
τ^P	Pension tax rate	11 %

5 Benchmark Economy

In order to illustrate the fit of the benchmark economy to data we consider some key variables, summarized in *Table 4*. We then present how hours worked change over the life cycle for the four representative agents in order to better understand our results from the different simulations.

Table 4 - Key Variables from the Benchmark Economy and Swedish Data

	Benchmark economy	Swedish data
K/Y	2.594	2.5[a]
I/Y	0.207	0.2[a]
G/Y	0.339	0.274[b]
C/Y	0.454	0.494[b]
P/Y	0.070	0.069[c]

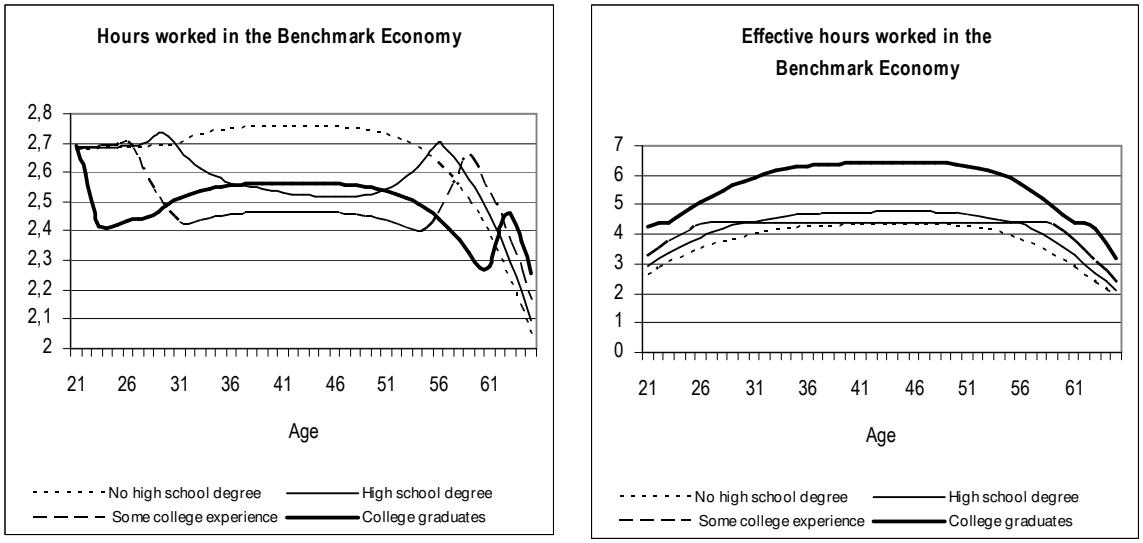
[a] Edvinsson (2005).
[b] Calculated using numbers from Statistics Sweden *Nationalräkenskaper*. Averages over the years 1993-2005.
[c] OECD *Social Expenditure Database*.

Our calibrated benchmark economy generates a capital/output ratio of 2.594. The investment rate, 20.7 percent, is close to the target ratio. Private consumption is below what data indicates at 45.4 percent of total output whereas government consumption is above data at 33.9 percent. The size of the pension system is close to our target ratio at 7 percent of total output. Over all the aggregate variables correspond fairly well to actual Swedish data.

A crucial aspect determining agents' labor supply is their human capital profile and which marginal tax rates they face. Agents that did not complete high school are the single group that faces only one marginal tax over the working life, 31.6 percent. Their hours worked profile is similar to their human capital profile, concave with peak at age 46. The other agents face higher marginal tax rates over their peak income years, which act as a downward pressure on their mid-life labor supply.[13]

[13] For an overview of hours worked in the benchmark economy, please see Appendix.

Figure 1a-b – Hours Worked and Effective Hours Worked in the Benchmark Economy



Finally, consider *Figure 1a*. Hours worked for college graduates decreases initially. This can be understood by considering *Figure 1b*. College graduates choose labor supply such that their effective hours worked generate a labor income just below the second labor income tax bracket. Those with some college experience and with a high school degree initially work at a constant rate caused by a binding borrowing constraint. Due to the same mechanism as for the college graduates, hours worked then decreases for these groups. Finally, towards the end of the agents' working life we see a hump in hours worked for the three most efficient groups. Due to decreasing human capital these agents face lower marginal taxes in their marginal decision. Hence, hours worked increases.

6 Results

6.1 Simulation

We simulate a flat tax reform where today's system with a progressive tax on labor income and a proportional tax on capital income is replaced by a single tax rate on all capital income, and all labor income above a fixed deduction level. The four brackets of the current labor income tax are replaced by a simpler two bracket system. The deduction levels are set as the income brackets in the benchmark economy. We simulate five different fixed deduction levels: 0, 5, 10, 20 and 30

percent.[14] We consider government revenue neutral reforms, thus the flat tax rate is determined endogenously within the model such that government consumption is a constant fraction of output.[15] The resulting tax system is progressive in terms of average taxes increasing with labor income. The only pure proportional tax scheme is the one with no deduction where all income from capital and labor are taxed at the same constant marginal rate.

6.2 Changes in Aggregate Variables

We start by considering relative changes in aggregate variables: capital stock (*K*), aggregate hours worked (*H*)[16], effective labor input (*EH*), and output (*Y*). Results are summarized in *Table 5*.

Table 5 – Changes in Aggregate Variables

Deduction level (%)	Changes in aggregate variables relative to benchmark economy (%)					
	τ^{flat}	*K*	*H*	*EH*	*Y*	*K/Y*
0	31.95 %	10.65	5.16	6.00	7.65	2.79
5	33.32 %	8.19	4.23	5.09	6.20	1.88
10	34.88 %	5.40	3.21	4.09	4.56	0.81
20	38.59 %	-1.09	0.79	1.71	0.69	-1.77
30	42.89 %	-8.72	-2.19	-1.22	-3.99	-4.93

As a first note, the flat tax rate increases with the deduction levels. There are two main driving forces. Firstly, an increased deduction level decreases the underlying tax base. Secondly, a higher tax rate distorts the agents' labor supply and savings decisions more. Therefore we need higher tax rates to generate government revenue neutrality.

Output increases in all simulations except the one with the highest deduction level, 30 percent. Similarly to Ventura (1999) and Diaz-Gimenez and Pijoan Mas (2006) output increases more with lower deduction levels and lower marginal taxes. The change in output is a result of the interplay between changes in capital and effective labor input. Both the capital stock and the effective labor input increase with decreasing flat tax rates. The capital stock increases for deduction levels at 0, 5, and 10 percent, whereas the effective labor input also increases at the 20 percent

[14] For reference these deduction levels correspond to 0, 5.31, 10.45, 20.14, and 28.80 percent of the benchmark's mean income level.
[15] The basic intuition behind this is that if output increases, government expenditures also increases in terms of higher salaries etc.
[16] Aggregate hours worked is the sum of all agents' labor supply.

deduction level. Changes in aggregate variables are a result of several different interactions within the model. We present a brief intuition behind the main changes due to the reform.

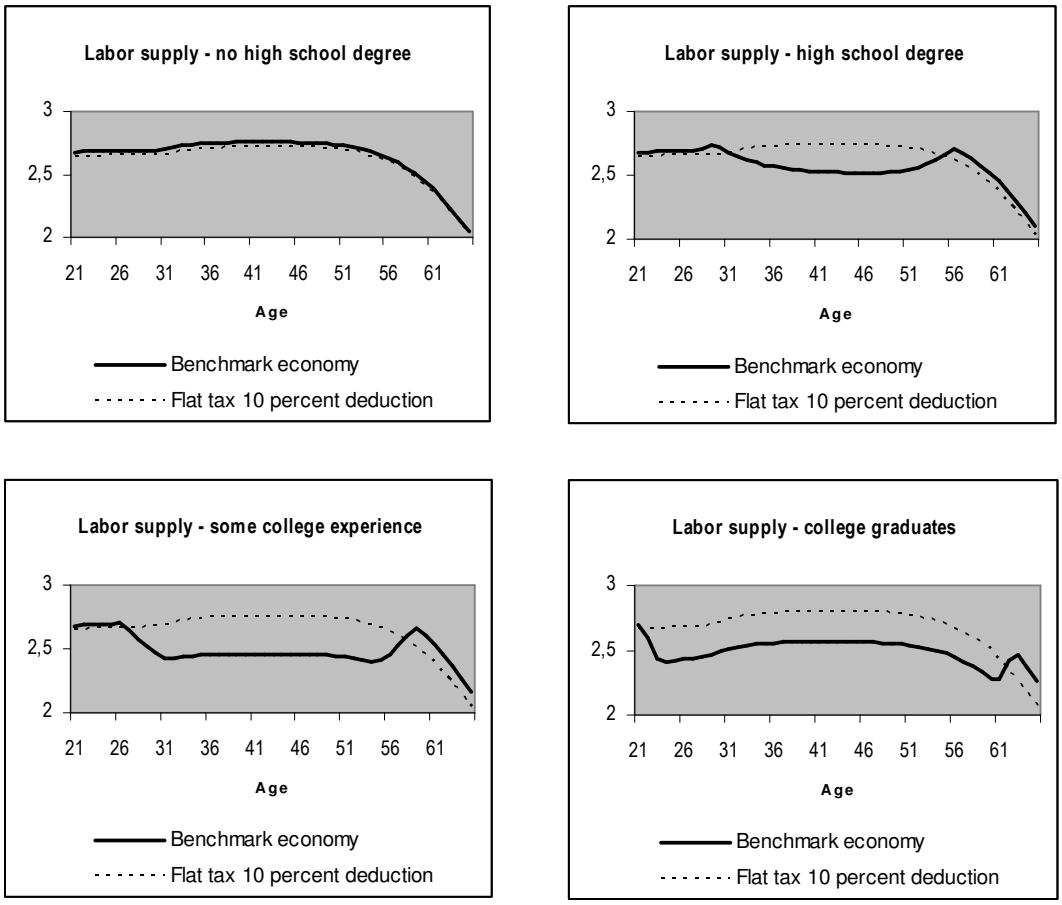
The changes of aggregate hours worked and effective labor input can be better understood by looking at how individual labor supply changes. Consider changes in marginal taxes and capital intensity. Agents who previously faced a marginal tax rate of 31.6 percent on labor income now face a higher marginal tax rate, whereas the opposite is true for others. As an illustrative example we consider how the labor supply paths for the different groups change at a 10 percent deduction level presented in *Figure 2a-d*.[17] Those with no high school degree previously faced a 31.6 percent marginal tax on labor income over the lifecycle. The effects of higher marginal taxes at 34.88 percent outweigh the opposing force of increased wages due to higher capital intensity. Consequently, they decrease their labor supply at all ages. The other groups face lower marginal tax rates over their peak earning years while it increases during the beginning and end of their working life. As a result these groups are engage in intertemporal labor substitution, working relatively more in their highly efficient middle age. Thus, similarly to Ventura (1999) we see effective labor input increasing more/decreasing less than aggregated hours worked for all reforms considered.

We move on to consider how the effective labor input differ depending on the deduction level. As a first note, no agents earn less than the deduction levels considered. Thus, all agents face a marginal tax rate in their marginal decision. Therefore a lower flat tax rate implies more hours worked. Furthermore lower flat tax rates drive up the capital intensity and corresponding wages. Consequently we see effective labor input increase with lower flat tax rates.

We see two main reasons why the capital stock increases for the three lower deduction levels. Firstly, in our model an increased effective labor input implies that capital becomes more efficient. Secondly, consider how lifetime earnings change due to the reform. As previously noted groups with a high school degree or more increase their labor supply over their peak years and decrease their labor supply just prior to retiring. This causes a more uneven income profile. Therefore savings from these years increase in order to smooth the lifetime consumption profile.

[17] The logic behind changes at an individual level is similar for the other deduction levels.

Figure 2 a-d – Labor Supply (10 percent deduction level)



6.3 Welfare Implications

We now discuss the welfare effects of the reforms. Our main results are presented in *Table 6*.

Table 6 – Welfare Effects

Deduction level (%)	0	5	10	20	30
τ^{flat}	31.95%	33.32%	34.88%	38.59%	42.89%
x_1	-0.0147	-0.0096	-0.0059	-0.0012	0.0038
x_2	-0.0091	-0.0069	-0.0063	-0.0085	-0.0115
x_3	0.0064	0.0062	0.0042	-0.0039	-0.0140
x_4	0.0609	0.0555	0.0479	0.0266	0.0004
Utilitarian	0.0049	0.0057	0.0050	-0.0005	-0.0075

a) Remember, positive values for x_j indicate that the agents are better off due to the reform.

From *Table 6* we draw three main conclusions. Firstly, from a utilitarian perspective there are welfare gains from a flat tax reform with a deduction level of 0, 5, and 10 percent of the mean income. Furthermore these welfare gains are maximized close to the 5 percent level when the corresponding flat tax rate is approximately 33 percent. Given that these deduction levels generate welfare losses for the two least efficient groups, it is clearly questionable whether this is a suitable measure to say whether these reforms should be implemented.

Our second main finding is that none of our tax reforms are Pareto improving. In fact, at least two groups are worse off at all deduction levels. For all reforms college graduates benefit while those with a high school degree are worse off. Those without a high school degree suffer welfare losses at all deduction levels except the highest. Those with some college experience are better off in the first three simulations.

The welfare increases strictly with increasing deduction levels for those without a high school degree. The opposite is true for the two groups with the highest levels of education. The basic intuition is that with a deduction a larger fraction of the least efficient groups' earnings becomes deductible than that of the more efficient groups. Thus the welfare gains from a higher deduction level more than offsets the losses from an increased flat tax for the least efficient group. The largest group, those with a high school degree, suffer welfare losses at all deduction levels, and are hurt least at the 10 percent deduction level. Thus, the flat tax reforms considered hurt the majority of the population.

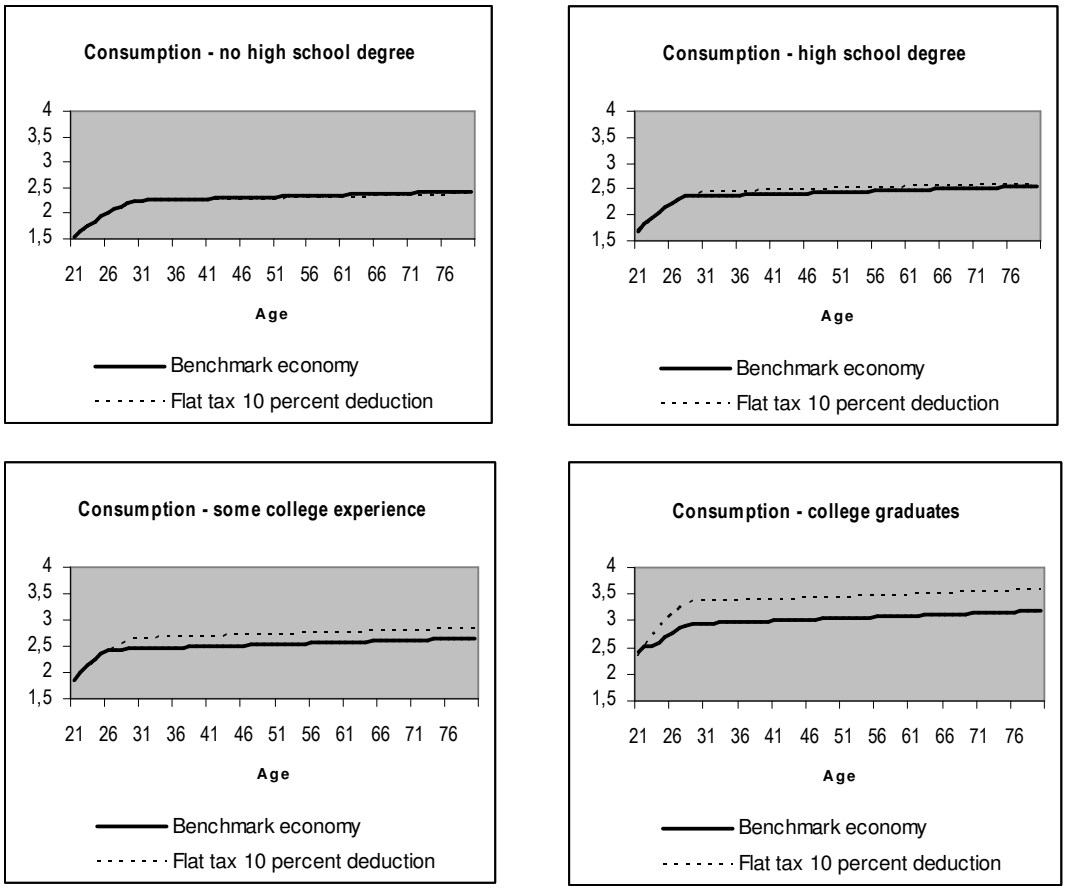
Our third conclusion is drawn from the simulation with the highest deduction level. Both those with the highest education level and those with the lowest level benefit from to this reform. In the public debate a flat tax is often viewed as harming those with low level of education. As highlighted by Conesa and Krueger (2006) and Altig et al. (2001) and confirmed by our simulation, a flat tax reform can be designed to benefit those households with most and least human capital at the expense of the middle classes.

Finally, to better understand what drives the welfare changes we provide an illustrative example and consider how hours worked, as earlier presented, and consumption change at the 10 percent deduction level described in *Figure 3a-d*.[18] Those with no high school degree work less due to the

[18] Same logic behind welfare changes also applies to the other deduction levels.

reform, however they also consume slightly less which sums up to decreased utility. Those with a high school degree consume slightly more after the reform, but along with more hours worked their lifetime utility decreases. Those with some college experience and college graduates move in the same direction by consuming more and working more over their peak years due to the reform. Altogether these two groups are the ones that benefit from the specific reform.

Figure 3 a-d – Consumption (10 percent deduction level)



7 Sensitivity Analysis

We provide a sensitivity analysis in order to examine the robustness of our result. A crucial parameter for our estimates is the Frisch labor supply elasticity. We consider how our results are altered by setting $\gamma = 1$. We also consider how our results change depending on what initial capital income tax rate we use. An older reference often used in previous literature is Carey and

Tchilingurian (2000) who estimate an average capital tax rate in Sweden at 30.5 percent.[19] We therefore consider lowering the initial capital income tax rate to 30 percent. Both these changes generate a capital-output ratio that is well within the range of previous estimates.[20] The results for the sensitivity analysis are summarized in *Table 8-11* in the appendix.

Increasing the labor supply elasticity, γ to unity implies that agents are more willing to reallocate their labor supply towards their relatively more efficient years. This magnifies the changes of all aggregate variables. Similarly to the previous simulations none of the reforms are Pareto improving. Notably those with no high school degree and those with some college experience are now better off also at the 20 percent deduction level. From a utilitarian perspective the reform with a 20 percent deduction level is now also welfare enhancing.

By lowering the initial capital tax to 30 percent the changes in aggregate capital are smaller than the changes in previous simulations for all deduction levels except for 20 percent. The changes in effective labor input are larger than in the previous simulations. The resulting changes in output due to the reform are lower. There are still no Pareto improving reforms, while at a utilitarian level all flat tax reforms are now welfare enhancing. Summarizing, the sensitivity analysis generate relatively few sign changes. We conclude that our results are fairly robust.

8 Conclusion

There are several different types of flat tax reforms. In this paper we have chosen to evaluate a flat tax reform often discussed in the public debate, where all labor income above a fixed deduction level and all capital income are taxed at one single rate. We use a dynamic general equilibrium model to evaluate the quantitative effects of such a reform on the Swedish economy.

Firstly, we evaluate the steady state effects of a flat tax reform on output, effective labor input and capital stock. Effective labor input increases for all deduction levels except 30 percent. The capital stock increases at all deductions level except for the two highest. The resulting output increases at all deduction levels except 30 percent. Thus, a flat tax reform can lead to an increase in long run levels of output, effective labor input and capital stock.

[19] Estimated average over the years 1991 – 1997 for Swedish data.
[20] The benchmark capital-output ratio becomes 2.67 when we alter the initial capital tax, and 2.59 when we increase the Frisch labor supply elasticity.

Secondly, we evaluate the welfare implications of a flat tax reform at a utilitarian level as well as for different groups. From a utilitarian perspective the flat tax reforms with deduction levels of 0, 5 and 10 percent are welfare enhancing. We find no Pareto improving flat tax reform. The largest group in the society, those with a high school degree, is strictly worse off. Thus, even though a flat tax reform can be both welfare enhancing and raise output, it will come at the expense of a majority of the society.

Finally, several relevant extensions of the model can be made. Foremost the results would be more reliable by more accurately estimating the human capital profiles. It would also be interesting to consider more groups. Then we would be able to more precisely identify the winners and losers of a flat tax reform. Another relevant extension is to more closely model the Swedish institutions. We leave this for further research.

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10 Appendix

10.1 Solving the Welfare Measure Problem

Consider the following two equations:

$$W_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln c_{PT,s,j} - \varphi\frac{h_{PT,s,j}^{1+1/\gamma}}{1+1/\gamma}\right]\right) + \beta^{59}\mu\ln b_{PT,s=80,j}$$

$$W_{FT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln(1-x_j)c_{FT,s,j} - \varphi\frac{h_{FT,s,j}^{1+1/\gamma}}{1+1/\gamma}\right]\right) + \beta^{59}\mu\ln b_{FT,s=80,j}$$

where the sub index PT indicates lifetime utility under a progressive tax system and FT indicates lifetime utility under a flat tax system.

$$W_{PT,j} = W_{FT,j} \Leftrightarrow$$

$$U_{PT,j} = W_{FT,j} \Leftrightarrow$$

$$U_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln(1-x_j)c_{FT,s,j} - \varphi\frac{h_{FT,s,j}^{1+1/\gamma}}{1+1/\gamma} + \mu\ln b_{FT,s,j=80}\right]\right) \Leftrightarrow$$

$$U_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln(1-x_j) + \ln c_{FT,s,j} - \varphi\frac{h_{FT,s,j}^{1+1/\gamma}}{1+1/\gamma} + \mu\ln b_{FT,s=80,j}\right]\right) \Leftrightarrow$$

$$U_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\ln[1-x_j]\right) + \sum_{s=21}^{80}\left(\beta^{s-21}\left[\ln c_{FT,s,j} - \varphi\frac{h_{FT,s,j}^{1+1/\gamma}}{1+1/\gamma} + \mu\ln b_{FT,s=80,j}\right]\right) \Leftrightarrow$$

$$U_{PT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\ln[1-x_j]\right) + U_{FT,j} \Leftrightarrow$$

$$U_{PT,j} - U_{FT,j} = \sum_{s=21}^{80}\left(\beta^{s-21}\ln[1-x_j]\right) \Leftrightarrow$$

$$\frac{U_{PT,j} - U_{FT,j}}{\sum_{s=21}^{80}\beta^{s-21}} = \ln(1-x_j) \Leftrightarrow$$

$$e^{\frac{U_{PT,j}-U_{FT,j}}{\sum_{s=21}^{80}\beta^{s-21}}} = 1 - x_j \Leftrightarrow$$

$$x_j = 1 - e^{\frac{U_{PT,j}-U_{FT,j}}{\sum_{s=21}^{80}\beta^{s-21}}}$$

10.2 Human Capital Profiles

Domeij (2006) estimate life-time earnings for individuals by regressing log earnings on a polynomial of degree 4 for age and dummy variables for level of education, sex and industry. This yields the following coefficients that are summarized in *Table 6*:

Table 7 – Coefficients for Age, Education Level and Sex

Constant	Age	Age^2	Age^3	Age^4	Sex	High school	Some college	College graduate
0.7585	0.5985	-0.0211	3.33E-4	-1.98E-6	-0.2729	0.1320	0.2353	0.5049

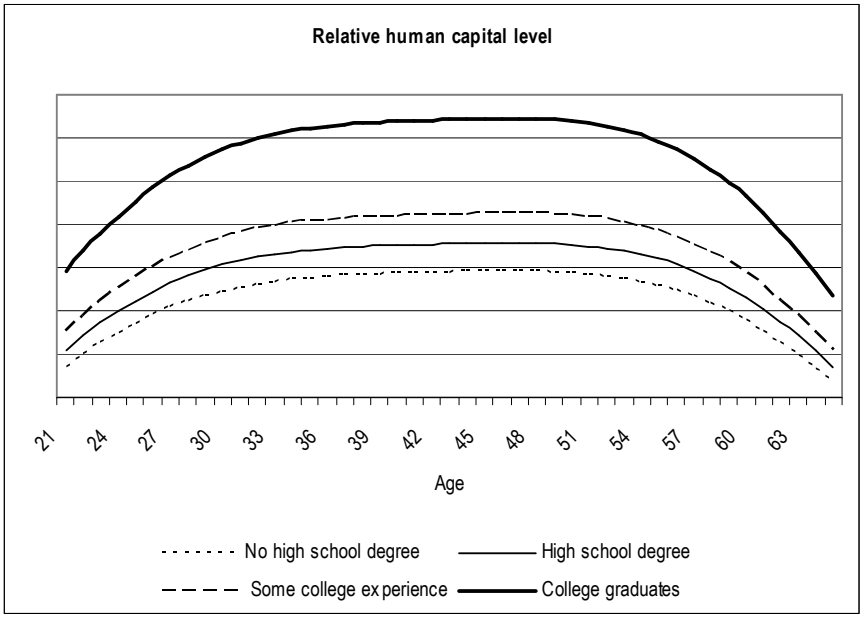
We have chosen to populate our economy with four types of households. The selection is based solely on level of education: no high school degree, high school degree, some college experience and college graduates. In order to use the above coefficients to calculate life-time earnings profiles it is necessary to put a weight on the *sex* dummy variable. These weights are summarized in *Table 7*:

Table 8 – Percentage of Women in Each Group

No high school degree	High school degree	Some college experience	College graduate
42.44 %	48.50 %	53.50 %	55.00 %

By combining the coefficients in *Table 6* and the weights in *Table 7* we calculate the life-time earnings profiles for the four types of households. These life-time earnings profiles are then used as the human capital profiles in our model. These profiles are shown in *Figure 4* below:

Figure 4 – Human Capital Profiles



10.3 Sensitivity Analysis

Table 9 – Changes in Aggregate Variables ($\gamma = 1$)

deduction level (%)[a]	Changes in aggregates relative to benchmark economy (%)					
	τ^{flat}	K	H	EH	Y	K/Y
0	31.87 %	15.36	5.81	9.42	11.39	3.57
5	33.33 %	12.44	4.07	8.12	9.49	2.69
10	34.99 %	8.92	2.33	6.49	7.59	1.24
20	38.59 %	0.95	1.16	2.92	2.09	-1.11
30	43.05 %	-8.27	-0.58	-1.62	-3.98	-4.46

Table 10 – Welfare Effects ($\gamma = 1$)

Deduction level (%)	0	5	10	20	30
τ^{flat}	31.87%	33.33%	34.99%	38.59%	43.05%
x_1	-0.0078	-0.0048	-0.0035	0.0007	0.0003
x_2	-0.0002	-0.0001	-0.0019	-0.0046	-0.0132
x_3	0.0158	0.0135	0.0091	0.0006	-0.0152
x_4	0.0702	0.0630	0.0530	0.0317	-0.0001
Utilitarian	0.0136	0.0125	0.0093	0.0034	-0.0092

Table 11 – Changes in Aggregate Variables (benchmark τ^K=0.3)

deduction level (%)[a]	Changes in aggregates and factor prices Relative to benchmark economy (%)					
	τ^{flat}	K	H	EH	Y	K/Y
0	30.47 %	7.71	4.17	6.22	6.55	1.09
5	31.92 %	6.59	2.50	5.18	5.36	1.17
10	33.44 %	2.91	0.83	4.15	3.87	-0.93
20	37.03 %	-3.02	-0.83	2.07	0.30	-3.30
30	42.05 %	-5.92	-4.17	-2.07	-1.49	-4.50

Table 12 – Welfare Effects (benchmark τ^K=0.3)

Deduction level (%)	0	5	10	20	30
τ^{flat}	30.47%	31.92%	33.44%	37.03%	42.05%
x_1	-0.0075	-0.0052	-0.0018	0.0027	0.0053
x_2	-0.0017	-0.0021	-0.0016	-0.0037	-0.0420
x_3	0.0140	0.0113	0.0093	0.0017	0.0005
x_4	0.0684	0.0609	0.0536	0.0337	0.0325
Utilitarian	0.0120	0.0104	0.0096	0.0046	0.0035