Using Random Utility Models for Evaluating and Designing Welfare State Policies

Rolf Aaberge

Research Department, Statistics Norway
and ESOP, University of Oslo

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Purpose: Evaluating the design of the welfare state

- Financing
- Incentives
- Distributional effects

- Requires a framework that allows separation of preferences and policy parameters

Outline

- The random utility model
  - Basic features
  - Simulating the outcomes from changes in policies
- Social evaluation framework
  - Used to evaluate and compare the outcomes from alternative policies
- Prediction performance of the model

The random utility model for labor supply

- simultaneous treatment of spouses' decisions
- exact representation of complex tax rules
- heterogeneity of choice sets; jobs differ with respect to wage rates, hours of work, sector of employment and other characteristics
- quantity constraints in choice of hours of work

The random utility approach is different from the traditional approach

- Traditional model:

max U(C, h)

s.t.

C = f(wh, I)

$h \in [0,T]$

- The random utility model:

max U(C, h, j)

s.t.

C = f(wh,I)

$(h, w, j) \in B$

Basic assumptions

- $U(C, h, j) = v(C, h)\ \varepsilon(h,w,j) =$ **$v(f(wh,l), h)\ \varepsilon(h,w,j)$**
- **$v(f(wh,l), h)$** is the systematic component
- **$\varepsilon(h,w,j)$** is the stochastic component
- $Prob(\varepsilon < u) = exp(-1/u)$

Choice probability

The probability (density) that a single individual chooses a job (h,w) is given by:

$$\varphi(h,w) \equiv \Pr\left[U(f(wh,I),h) = \max_{(x,y)\in B} U(f(xy,I),y) \right] = \frac{\exp(v(f(wh,I),h)\,p(w,h)}{\sum_{(x,y)\in B}\sum \exp(v(f(xy,I),y)\,p(x,y)dxdy}$$

Aaberge, Colombino and Strøm, *J. of Applied Econometrics*, 1999

A simplied version of the random utility model

For fixed w and $p(h,w) = a$ (constant) *for all h we get*

$$\varphi(h) = \frac{\exp(v(f(wh, I), h)}{\sum_{x \in B} \exp(v(f(wx, I), x)}.$$

See van Soest (1995), *JHumanRes*

For en evaluation of alternative representations of the choice sets see Aaberge and Colombino (2009), *JEconSurv*

Structural part of the utility functions for *couples*:

$$\log v\left(h_M, h_F, w_M, w_F, s_M, s_F\right) = \alpha_2 \left(\frac{f\left(w_F h_F, w_M h_M, I\right)^{\alpha_1} - 1}{\alpha_1} \right)$$

$$+ \left(\alpha_4 + \alpha_5 \log A_F + \alpha_6 \left(\log A_F\right)^2 + \alpha_7 s_F + \alpha_8 C_1 + \alpha_9 C_2 + \alpha_{10} C_3 + \alpha_{11} s_F C_1 + \alpha_{12} s_F C_2 + \alpha_{13} s_F C_3 \right) \left(\frac{L_F^{\alpha_{14}} - 1}{\alpha_{14}} \right)$$

$$+ \left(\alpha_{15} + \alpha_{16} \log A_M + \alpha_{17} \left(\log A_M\right)^2 + \alpha_{18} s_M + \alpha_{19} C_1 + \alpha_{20} C_2 + \alpha_{21} C_3 + \alpha_{22} s_M C_1 + \alpha_{23} s_M C_2 + \alpha_{24} s_M C_3 \right) \left(\frac{L_M^{\alpha_3} - 1}{\alpha_3} \right)$$

$$+ \alpha_{25} \left(\frac{L_M^{\alpha_3} - 1}{\alpha_3} \right) \left(\frac{L_F^{\alpha_{14}} - 1}{\alpha_{14}} \right).$$

Empirical applications

- U.S. versus Sweden: The Effect of Alternative In-Work Tax Credit Policies on Labour Supply of Single Mothers (Aaberge, R. and L. Flood, *Mimeo*, 2013)

- Designing Optimal Taxes Based on a Structural Random Utility Model for Labour Supply (Aaberge, R. and U. Colombino, *Scandinavian Journal of Economics*, to appear)

U.S. versus Sweden

Evaluate the effects of the Swedish and the US in-work tax credit systems

•on labor supply, welfare participation and disposable income of *Swedish single mothers*

- on the central government budget

The analysis

•includes individuals who depend on the welfare system, i.e. individuals in as well as outside the labor force

•treat receipt of social assistance as an endogenous variable

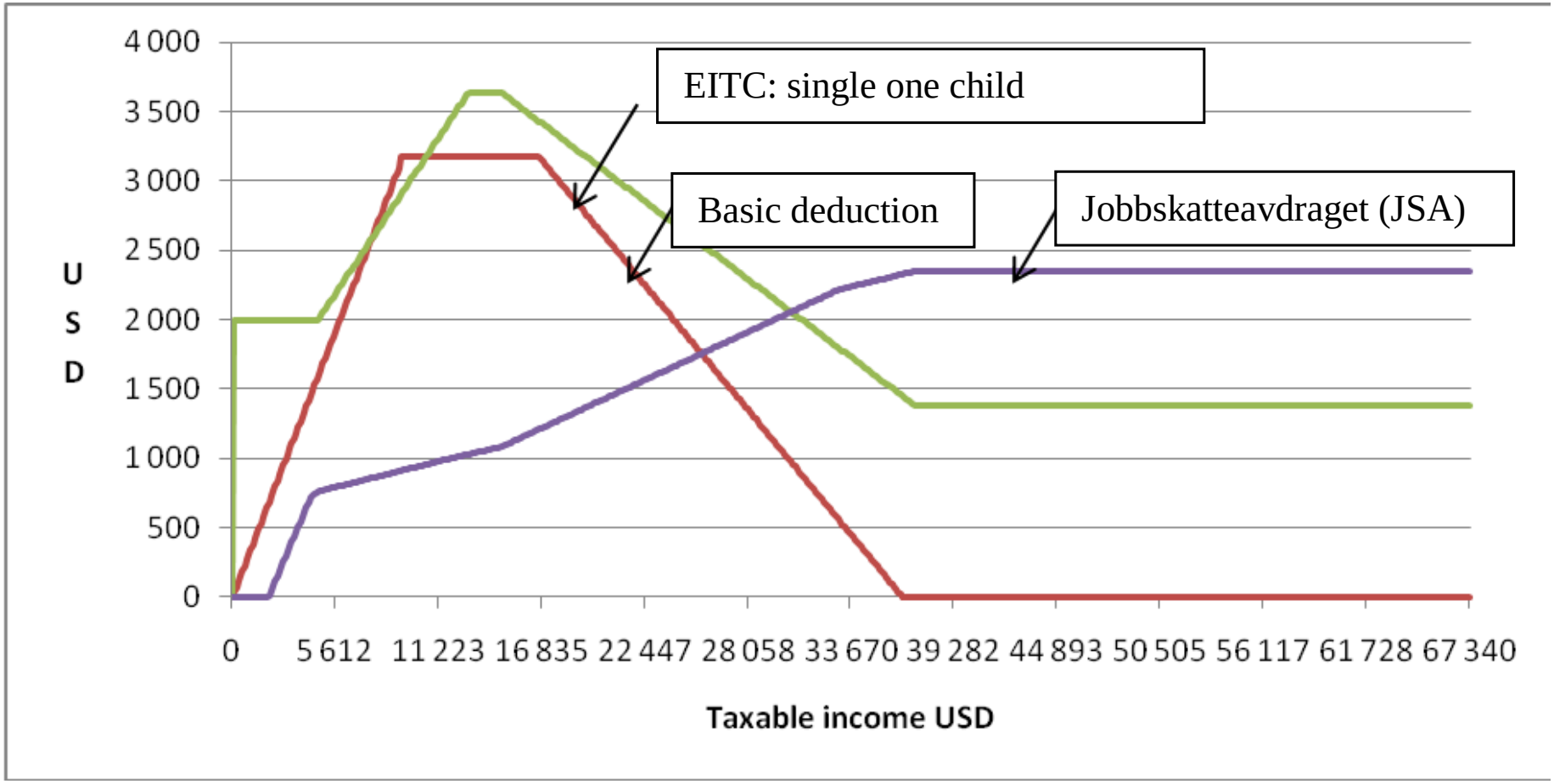
Outline

- The Swedish and US in-work tax credit systems
- Empirical results of the evaluation of the Swedish and US tax credit systems
- The prediction performance of the labour supply model

The Swedish design differs from the EITC since it is

- not targeted to low income households; instead everyone with an income from work receives the credit
- not dependent on family types and number of children
- not refundable
- the credit is calculated automatically by the tax authority and the individual does not have to apply for it
- no phase out region
- an integrated part of the means tested income for welfare programs like social assistance and housing allowance.

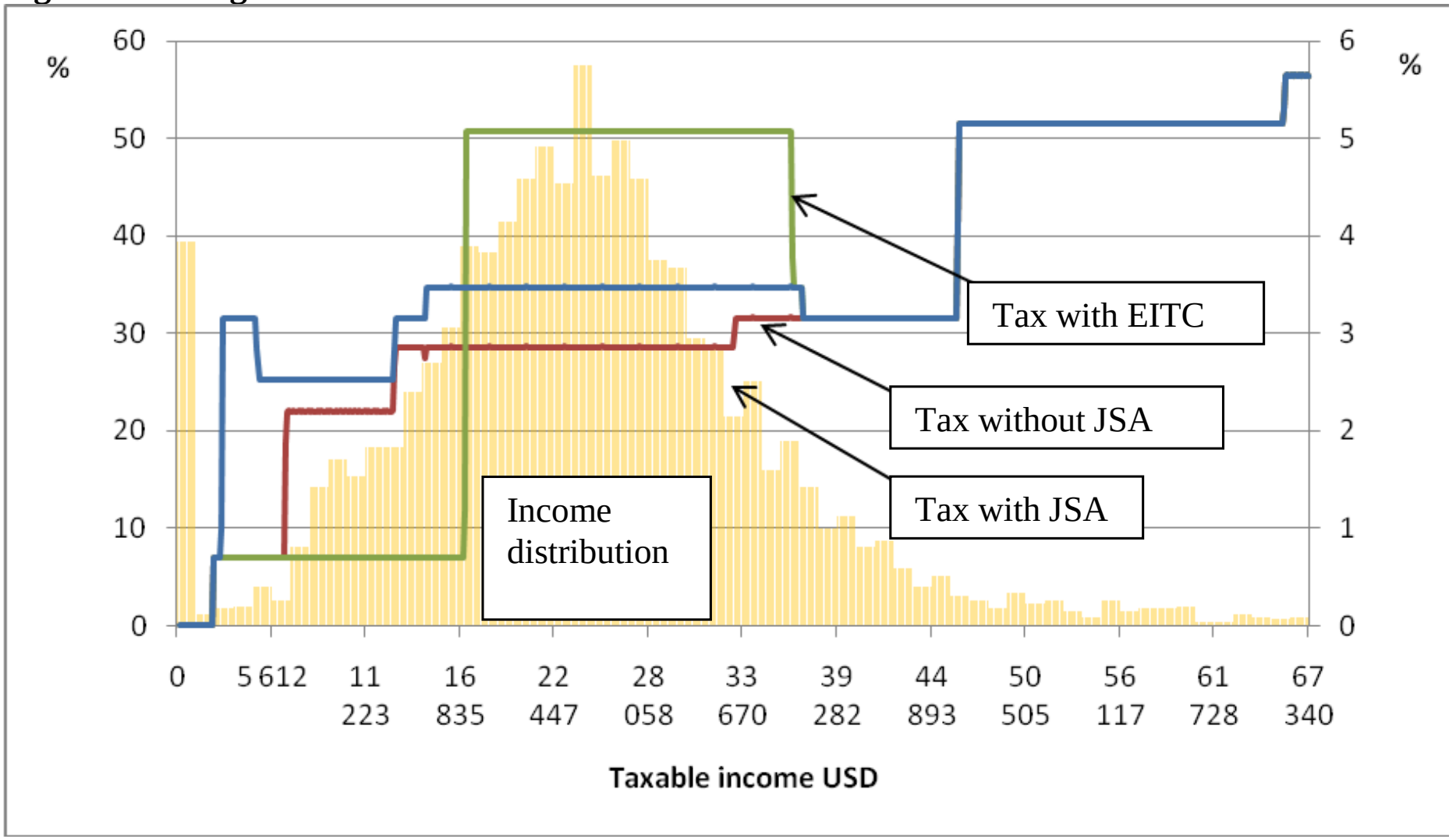
EITC, JSA and basic deduction in 2012



Note: Calculations based on the rules for younger than 65 with an income only from labor at an average municipal tax rate (31.55%).

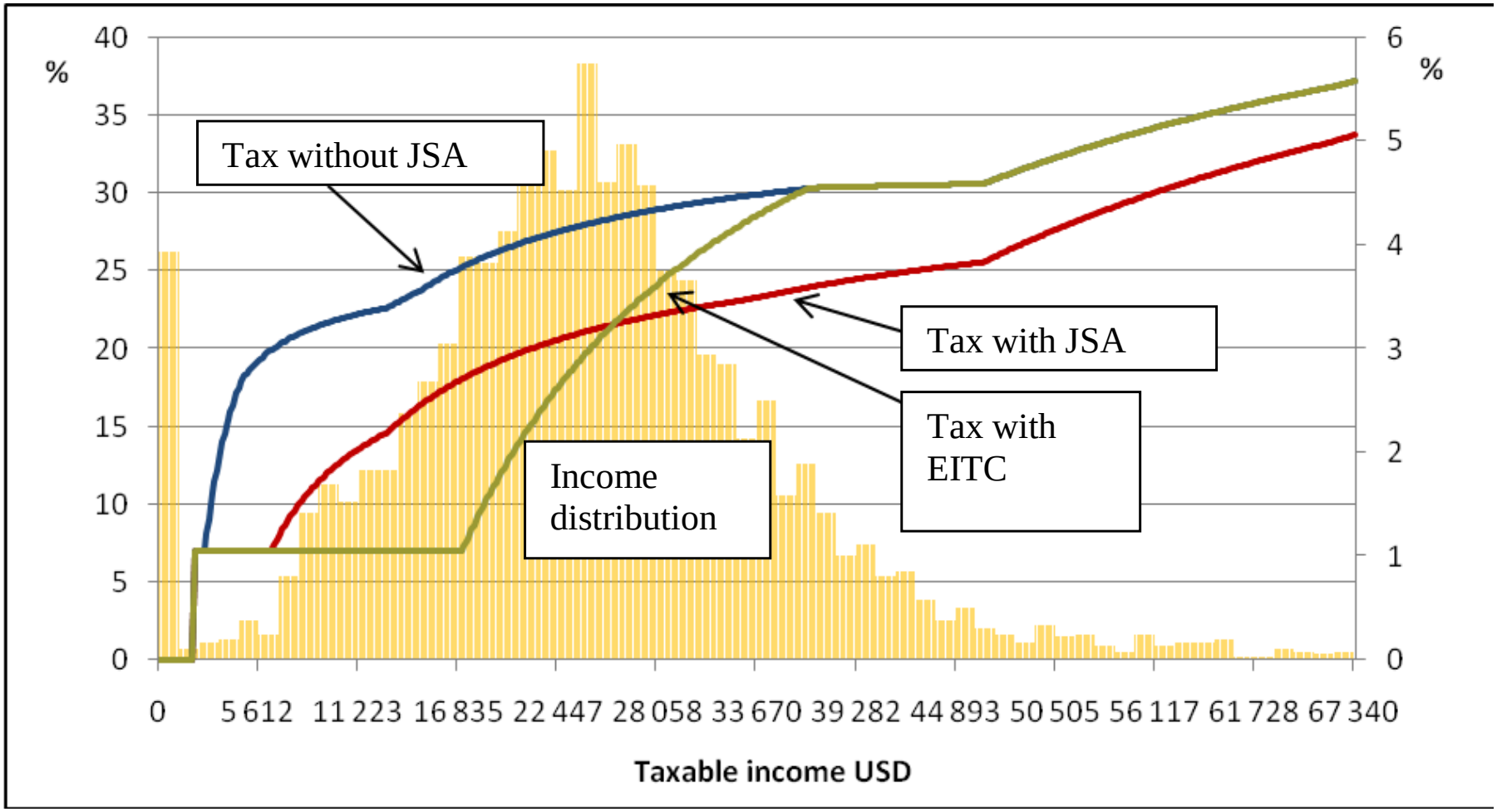
The Swedish labor income taxation 2012

Figure 2.1 Marginal tax rates and income distribution in 2012.



Note: Calculations based on the rules for people younger than 66 years with an income only from labor at an average municipal tax rate (31.55%). For tax rates use left hand side axes and for income distribution use the axes on the right hand side.

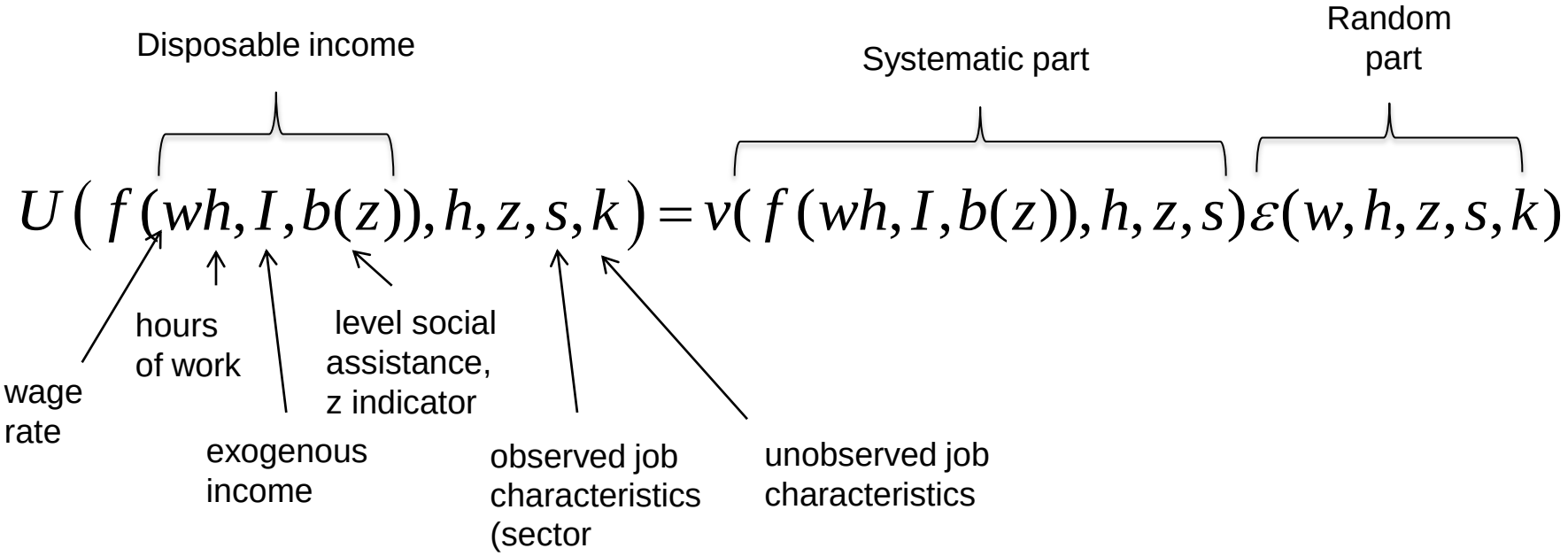
Average tax rates and income distribution in 2012



Note: Calculations based on the rules for younger than 66 with an income only from labor at an average municipal tax rate (31.55%). For tax rates use left hand side axes and for income distribution use the axes on the right hand side.

Specification of the random utility function

We assume that a single mother chooses a "job" from a choice set *B* that may differ across individuals, *B also* contains non-market activities



Assuming that ε is type I extreme value distributed, the probability density that a job with hours *h* and wage rate *w* in sector *s* in combination with or without social assistance can be derived and hence the likelihood function can be formed.

Choice probability

$$\varphi(h,w,s,z) \equiv \Pr\left[U(f(wh,I,b(z)),h,s,z) = \max_{(x,y,i,j)\in B} U(f(xy,I,b(j)),y,i,j) \right] =$$

$$\frac{v(f(wh,I,b(z)),h,s,z)\, p_{11} g_1(h,w,s)}{D},$$

where B is the set of all opportunities available to the household (including non-market opportunities, i.e. a "job" with w=0 and h=0) and

$$D = v(f(0,I,0),0,\cdot,\cdot)\, p_{00} + \sum_{j=0,1} v(f(0,I,b(j)),0,\cdot,j)\, p_{01} +$$

$$\sum_{i=0,1} \iint_{(x,y)\in B_0} v(f(xy,I,0),y,i,\cdot)\, p_{10} g_0(x,y,i)dxdy + \sum_{i=0,1}\sum_{j=0,1} \iint_{(x,y)\in B_1} v(f(xy,I,b(j)),y,i,j)\, p_{11} g_1(x,y,i)dxdy,$$

Specification of choice sets

Offered hours and offered wages are assumed to be independently distributed, i.e.

$$g_{1s}(w)g_{2s}(h)g_3(s,z)$$

wage density

hour s of work density

sector density

Sector-specific wage distributions,

$$\log w = \beta_{s0} + \beta_{s1}\frac{Exp}{100} + \beta_{s2}\left(\frac{Exp}{100}\right)^2 + \beta_{s3}Ed_1 + \beta_{s4}Ed_2 + \sigma_s\eta$$

The sector-density express the available job opportunities conditional on social assistance for “outsiders” as well as “insiders”.

The likelihood includes both utility as well as the opportunity components. Thus, preferences as well as the choice set (demand side restrictions) are accounted for in the estimation.

Simulating elasticities and tax and benefit reforms

Given a **new tax function *t*( )** and using the estimated utility ***U*( )** and choice set ***B*,** the simulation consists of solving for each household

$$\max_{(w,h,s,z)\in B} U(t(wh,I,b(z)),h,s,z)$$

to get new values of $w,h,s,b(z)$ and

$$C = t(wh,I,b(z))$$

Empirical results

Wage and income lasticities

Table 3.3. Labour supply elasticities with respect to wage for single mothers by deciles of disposable income*.

Income decile under the pre-reform system	Elasticity of unconditional expectation of hours of work	Elasticity of the probability of participation	Elasticity of conditional expectation of hours of work
1	4.44	1.82	1.77
2	2.04	0.93	0.39
3-8	0.25	0.16	0.08
9	-0.02	0.00	-0.04
10	0.10	0.13	-0.02
All	0.45	0.29	0.19

Income elasticities

Table. 3.4. Labour supply elasticities with respect to non-labour income for single mothers by deciles of disposable income.

Income decile under the pre-reform system	Elasticity of unconditional expectation of hours of work	Elasticity of the probability of participation	Elasticity of conditional expectation of hours of work
1	0.12	0.06	0.00
2	0.12	0.08	0.03
3-8	-0.01	-0.01	-0.02
9	-0.02	-0.03	-0.03
10	-0.11	-0.13	-0.12
All	-0.01	-0.01	-0.03

Tax credit evaluations

- Benchmark: The Swedish tax system in 2012 without tax credit
- Reform 1: The Swedish tax credit (JSA)
- Reform 2: the US tax credit

Losers and winners from the introduction of the Swedish tax credit system

	Losers	Winners
Income decile under the pre-reform system	Percent of pop.	Percent of pop.
1	2,8	46,9
2	1,4	58,9
3	1,6	54,9
4	3,1	57,4
5	3,1	52,6
6	3,1	63,9
7	1,1	68,1
8	1,1	78,9
9	0,8	74,2
10	0,3	76,9
All	**2,8**	**63,3**

Direct and total effect of the JSA and EITC reforms on disposable income. Per cent

Deciles	Pre-reform disposable Income		JSA		EITC	
	SEK	USD	Direct effect	Total effect	Direct effect	Total effect
1	128250	14410	1.11	18.78	4.55	13.13
2	158608	17821	3.23	13.79	7.5	10.47
3	175642	19735	5.85	11.09	8.73	9.2
4	190200	21371	6.02	9.41	6.85	6.74
5	203888	22909	6.03	9.28	4.76	3.93
6	220085	24729	7.16	9.08	3.66	1.48
7	237997	26741	7.14	8.53	1.74	-2.01
8	258198	29011	7.08	7.44	0.54	-5.37
9	285660	32097	6.85	7.21	0.17	-6.77
10	375392	42179	4.82	5.72	0	-3.65
All	223393	25100	5.79	9.12	3.13	0.99

Labour supply effects of the JSA and EITC reforms. Per cent

Deciles	Participation			Conditional on working			Total effect		
	Before the reform	Change due to the reform		Hours before the reform	Change due to the reform		Hours before the reform	Change due to the reform	
		JSA	EITC		JSA	EITC		JSA	EITC
1	0.49	21.18	24.12	1178	16.29	5.48	519	44.85	29.82
2	0.68	9.75	7.63	1494	2.28	-0.97	950	20.62	8.68
3	0.89	1.29	1.62	1687	1.26	-1.76	1422	2.63	-0.46
4	0.88	2.95	2.3	1729	0.58	-2.22	1508	4.11	-0.25
5	0.87	4.32	2.99	1856	0.95	-2.69	1546	5.29	0.04
6	0.95	1.22	0.3	1891	0.01	-4.28	1778	1.42	-2.83
7	0.95	1.22	1.22	1946	0.29	-5.38	1830	1.15	-4.42
8	0.95	0.92	1.22	1990	-0.02	-7.14	1884	0.82	-5.48
9	0.97	0	0	2054	0.15	-4.82	1977	0.22	-5.61
10	0.92	1.25	0.63	2087	-0.3	-4.21	1922	0.99	-3.64
All	0.86	3.38	3.08	1791	1.55	-3.25	1533	4.53	-1.22

Effect on social assistance of the JSA and EITC reforms

Deciles	Social assistance SEK	Social assistance USD	Percentage change JSA		Percentage change EITC	
			Direct effect	Total effect	Direct effect	Total effect
1	21 319	2 395	-3.81	-25.81	-3.81	-30.35
2	24 500	2 753	-4.79	-27.53	-4.79	-22.37
3	7 913	889	-3.99	-14.72	-3.99	-18.77
4	11 463	1 288	-3.22	-24.55	-3.22	-16.09
5	13 599	1 528	-4.57	-31.58	-4.61	-28.71
6	4 403	495	-4.54	-21.09	-4.54	-11.35
7	6 693	752	-5.24	-12.44	-5.24	-21.71
8	6 152	691	-5.06	-25.03	-5.23	-28.86
9	3 072	345	-4.34	0	-4.34	0
10	3 369	379	-4.63	0	-4.63	0
All	10 249	1 152	-4.34	-23.24	-4.35	-22.36

Change in Governmental revenues and expenditures due to the JSA and the EITC reforms. Per cent

	Before the reform		JSA reform		EITC reform	
	SEK	USD	Direct effect	Total effect	Direct effect	Total effect
(1) Income Taxes	14 279	2 197	-20.2	-15.5	-11.8	-22.1
(2) Payroll Taxes	14 031	2 159	0.0	5.8	0.0	-5.7
(3) VAT	9 282	1 428	6.1	8.6	3.3	0.4
(4) Child care fees	660	102	0.0	6.2	0.0	-5.2
(5) Housing allowance	1 560	240	0.0	-14.6	0.0	10.5
(6) Social assistance	2 632	405	-5.3	-26.4	-7.5	-26.3
Total revenues 1+2+3+4	38 252	5 885	-6.1	-1.5	-3.6	-10.3
Total expenditures 5+6	4 193	645	-3.3	-22.1	-4.7	-12.6
Revenues-Expenditures	34 058	5 240	-6.4	1.1	-3.5	-10.0

Conclusions

Basic features of the 2004 empirical labour supply model for Swedish single mothers

- Overall wage elasticity = 0.45
- the elasticity of probability of working = 0.3
- the elasticity of hours given work is 0.2
- The elasticities decline steeply with income. For the poorest decile the wage elasticity = 4.44
- Overall negative income elasticity = -0.01

- The Swedish reform generates substantial larger labour supply responses and higher disposable incomes than the US version of the tax credit, which is mainly due to the fact that the Swedish tax credit is not phased-out

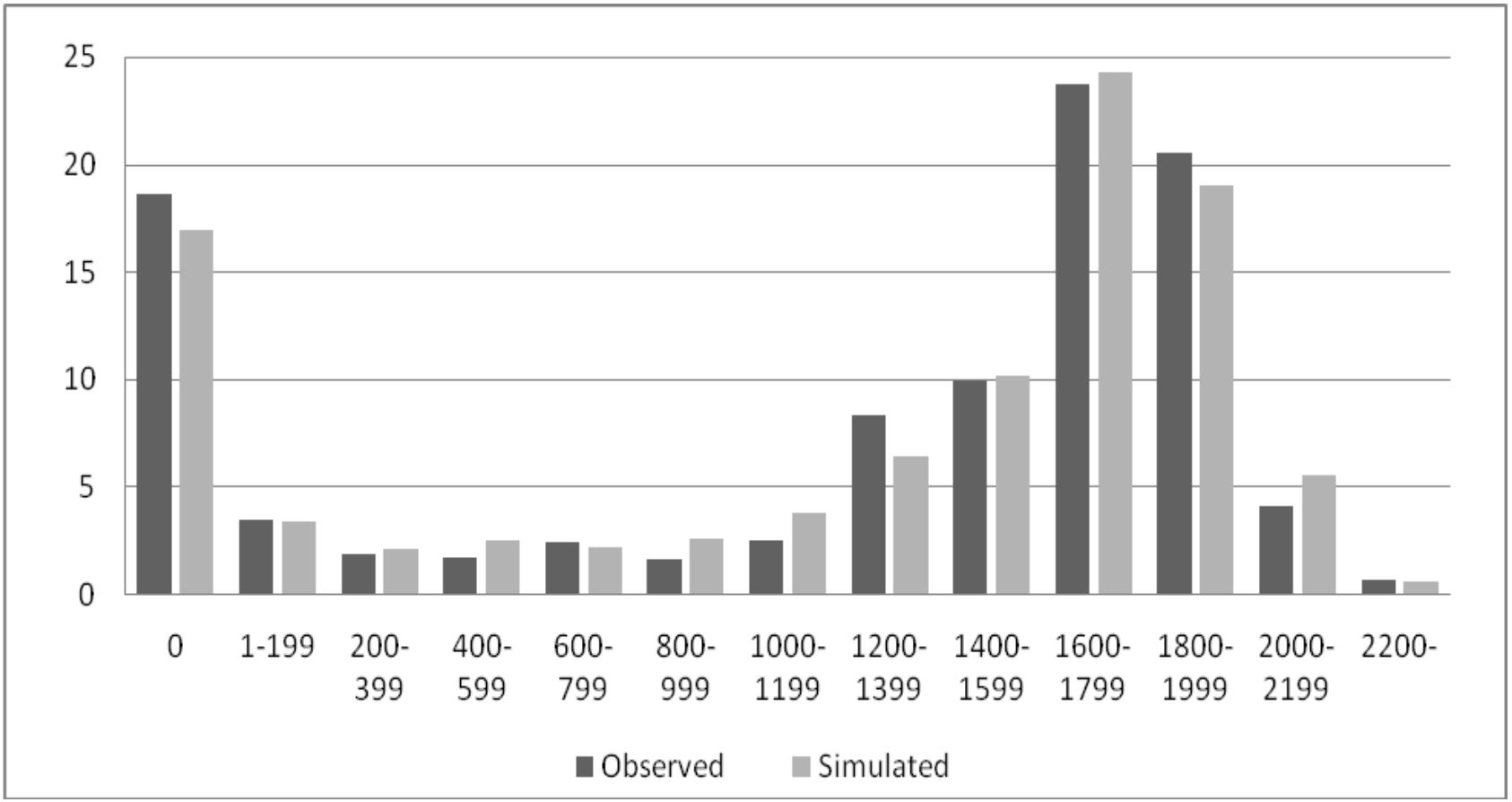
- EITC produces a more equal income distribution than JAS

- Due to increased labour supply and decline in welfare participation the Swedish reform shows to be self-financing for single mothers, whereas a 10 per cent deficit follows from the EITC

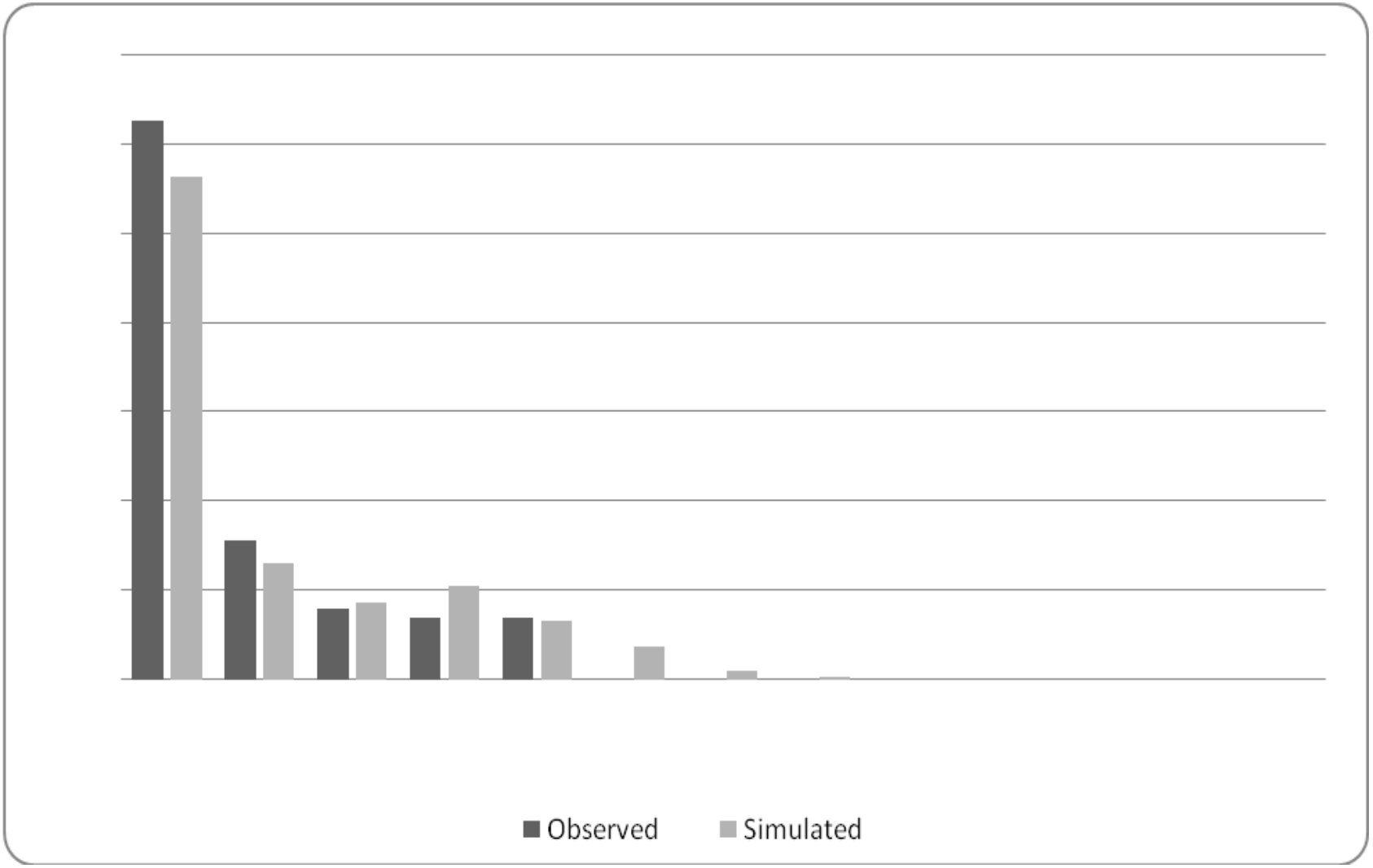
- The US version of the in-work tax credit design creates a more equal income distribution at the cost of lower disposable income and a 10 per cent budget deficit.

- A crucial question remains: How reliable are the random utility model used in this study?

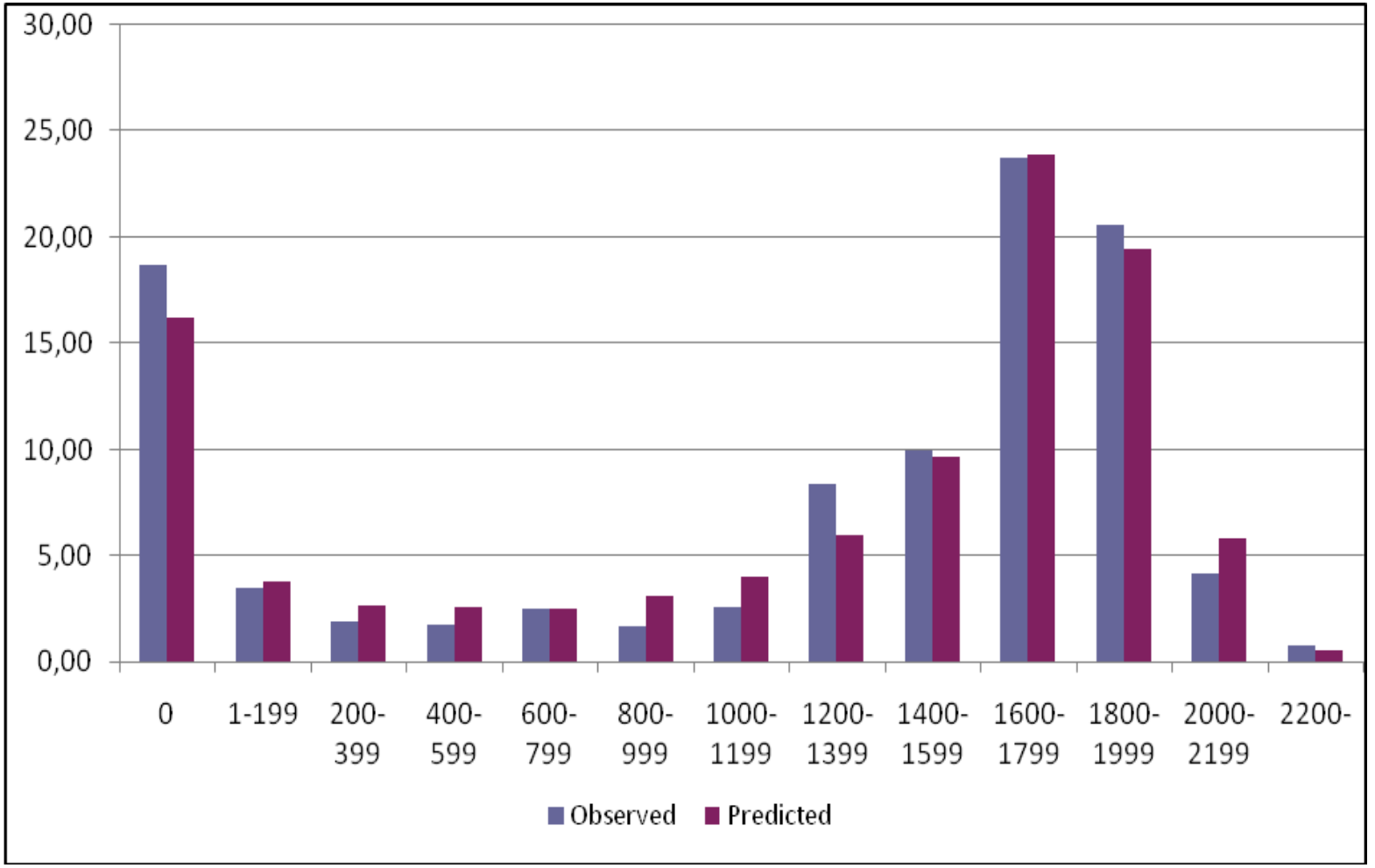
Prediction performance: The 2004 distribution of labour supply for all single mothers



Prediction performance: The 2004 distribution of labour supply for the «outsiders»



Out-of-sample prediction performance, 1992



Designing Optimal Taxes Based on a Structural Random Utility Model for Labour Supply

- Optimal design requires
  - Simulating the behavioral responses from tax changes
  - Social evaluation of outcomes from the tax simulations
- Analyses based on Norwegian data for 1994

Labour supply elasticity

- If, for example, we look at the overall labour supply elasticity in Norway 1994, we read a modest **0.12** ...
- …and then we would answer: NO, this is not relevant, forget about behavioural modelling!
- But if we look BEHIND the aggregate figure the picture changes quite a lot…

Labour supply elasticities w.r.t. wage
Married couples, Norway 1994

Household income deciles	Females		Males	
	Own	Cross	Own	Cross
I	2.54	-0.29	1.77	-0.12
II	0.97	-0.67	1.17	-0.08
III-VIII	0.41	-0.47	0.31	-0.24
IX	0.20	-0.34	0.08	-0.14
X	0.26	-0.10	0.05	-0.42
All	0.52	-0.42	0.39	-0.23

Simulating tax reforms

Given a **new tax function t( )** and using the estimated **U( )** and **B** the simulation consists of solving for each household

max U(C, h, j)

s.t.

C=t(wh, I)

(h, w, j) $\in$ B

to get new values of h and C

What is meant by an optimal tax system?

- *Individual welfare* is a function of leisure and income

- *The social welfare function* =

  weighted sum of the welfare of the individuals

- *Optimal tax system* = the tax system that maximizes the social welfare function

Specification of the individual welfare function

$$\log V(y,h) = \gamma_2 \left(\frac{y^{\gamma_1} - 1}{\gamma_1} \right) + \gamma_4 \left(\frac{L^{\gamma_3} - 1}{\gamma_3} \right)$$

$$y = \begin{cases} c = f\left(wh, I\right) & \text{for singles} \\ \dfrac{c}{\sqrt{2}} = \dfrac{1}{\sqrt{2}} f\left(w_F h_F, w_M h_M, I\right) & \text{for married/cohab. individuals.} \end{cases}$$

Rank-dependent Social Welfare Functions

$$W_k = \frac{1}{n}\sum_{i=1}^{n} p_k\left(\frac{i}{n}\right)V_i, \quad k = 1, 2, \ldots,$$

$$p_k(t) = \begin{cases} -\log t, & k = 1 \\ \dfrac{k}{k-1}\left(1 - t^{k-1}\right), & k = 2, 3, \ldots. \end{cases}$$

Distributional weight profiles of four different social welfare functions

	W_1 (Bonferroni)	W_2 (Gini)	W_3	W_∞ (Utilitarian)
p(.01)/p(.5)	6.64	1.98	1,33	1
p(.05)/p(.5)	4.32	1.90	1.33	1
p(.30)/p(.5)	1.74	1.40	1.21	1
p(.95)/p(.5)	0.07	0.10	0.13	1

Optimal taxation
Class of 9-parameter tax-transfer rule

$$y = \begin{cases} Z + T \ \ if \ \ Z \le E \\ Z + T - \tau_1 (Z - E) \ \ if \ \ E < Z \le Z_1 \\ Z + T - \tau_1 (Z_1 - E) - \tau_2 (Z - Z_1) \ \ if \ \ Z_1 < Z \le Z_2 \\ Z + T - \tau_1 (Z_1 - E) - \tau_2 (Z_2 - Z_1) - \tau_3 (Z - Z_2) \ \ if \ \ Z_2 < Z \le Z_3 \\ Z + T - \tau_1 (Z_1 - E) - \tau_2 (Z_2 - Z_1) - \tau_3 (Z_3 - Z_2) - \tau_4 (Z - Z_3) \ \ if \ \ Z_3 < Z \end{cases}$$

y = income after tax

Z =gross income

E = exemption level

Social welfare function	W_1	W_2	W_3	W_∞
Exemption	29 000	21 000	23 000	24 000
Range of the lowest segment	120 000	130 000	140 000	210 000
Range of the second segment	220 000	230 000	230 000	280 000
Range of the third segment	720 000	710 000	710 000	740 000
Tax rate, lowest segment	6	16	21	23
Tax rate, second segment	30	26	25	28
Tax rate, third segment	39	38	37	33
Tax rate, fourth segment	75	75	75	75
Lump-sum tax	-11 900	-6 000	-2 800	-2 800

Prediction performance: Observed and predicted *relative* distributions of disposable income in 2001

	Couples		Single males		Single females	
Deciles	Observed	Simulated	Observed	Simulated	Simulated	Simulated
1	**50**	**49**	**41**	**42**	**45**	**47**
2	**68**	**64**	**54**	**55**	**56**	**61**
3	**77**	**74**	**65**	**67**	**68**	**71**
4	**83**	**83**	**76**	**76**	**79**	**79**
5	**89**	**90**	**87**	**86**	**90**	**88**
6	**95**	**98**	**97**	**97**	**101**	**98**
7	**102**	**107**	**107**	**108**	**111**	**108**
8	**111**	**117**	**119**	**121**	**123**	**121**
9	**125**	**131**	**137**	**141**	**139**	**138**
10	**199**	**187**	**218**	**207**	**189**	**188**

Conclusion

- Use Random Utility Models if you are concerned about improving the design of the welfare states
- But don’t forget to account for heterogeneity in the choice sets

Thanks to Claudio, Eugenio and Federico for the Winter School in Canazei