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Iceland's Natural Experiment in Supply-Side Economics

By MARCO BIANCHI, BJÖRN R. GUDMUNDSSON, AND GYLFI ZOEGA*

The supply-side experiment in the United States under President Reagan received worldwide attention. The massive tax cuts agreed upon in 1981, and implemented in 1982, preceded a period of spectacular growth starting in the fall of 1983 and lasting until the beginning of the 1990's. While the proponents of supply-side economics have taken this epoch as a proof of the soundness of their policy recommendations, the verdict among academic economists is more mixed. While a majority appears to accept significant effects of taxes on incentives—to work, save, and invest—most do not think that these effects are empirically very strong (see, e.g., Martin Feldstein, 1986). The emerging consensus has been supported by a vast literature on the microeconomic evidence for the effect of tax cuts on labor supply.¹

A much-less-noticed experiment took place in Iceland, a country with a population of only 1/1,000 that of the United States. This experiment is in many ways better suited to judge the empirical significance of the supply-side effects of income tax cuts. In 1987–1988, Iceland moved from a system under which taxes were paid on previous year's income to a pay-as-you-earn system. The transition to the new system

created a gap in the tax base and a tax-free year emerged. Once the new system was in place in 1988, the tax base had also shifted over to that year, but the tax base in 1987 was income earned in 1986: income earned in 1987 was never taxed.²

This experiment creates a unique opportunity to study the labor-supply response of individuals who were temporarily faced with a zero marginal—and average—income tax rate. Moreover, the income effect was reduced because workers were still paying taxes, although not on income earned in 1987. For this reason, we are able to find an upper limit on the effect of tax cuts on labor supply. The notable effect on labor supply can be seen in Figures 1 and 2, which have the *employment rate* defined as the ratio of the total number of weeks worked to the potential supply by all working-age individuals³ for the period 1960–1996. The rate jumps by around 3 percent from 1986 to 1987 and then drops from 1987 to 1988 down to its earlier level.⁴ The response by women was slightly larger: an increase of 4.16 percent while that for men rose by 2.36 percent. There were also significant output effects. The rise in labor supply coincided with a 8.5-percent increase in real

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¹ The positive response of labor supply to a cut in income taxes has been documented in a number of studies (see, e.g., Jerry A. Hausman, 1981a, b; Don Fullerton, 1982). Hausman finds that replacing the progressive system of income taxation with a linear income tax would raise hours of work although not sufficiently to increase tax revenue. Fullerton also finds the United States to the left of the peak of its Laffer curve.

² The collection of income tax in the old system involved two steps. In the first half of the year, each individual's tax payment was based on his previous year's taxable income—which was earned two years before. In the second half of the year, when taxable income—earned in the previous year—became known, he paid the difference between this forward payment and the actual amount due in income tax.

³ The employment rate is calculated from a database for entitlements related to work accidents. The database has the number of working weeks of all Icelandic workers.

⁴ The fall in the employment rate after 1988 was to some extent caused by a rise in unemployment. Unemployment averaged 0.7 percent in 1980–1986 and 3.0 percent in 1988–1996. The annual unemployment rates were as follows:

	Percent	Percent	Percent	Percent	Percent				
1984	1.3	1987	0.5	1990	1.8	1993	4.4	1996	4.3
1985	0.9	1988	0.6	1991	1.5	1994	4.8	1997	3.9
1986	0.7	1989	1.7	1992	3.0	1995	5.0	1998	3.0



FIGURE 1. THE EMPLOYMENT RATE IN ICELAND, 1960-1996

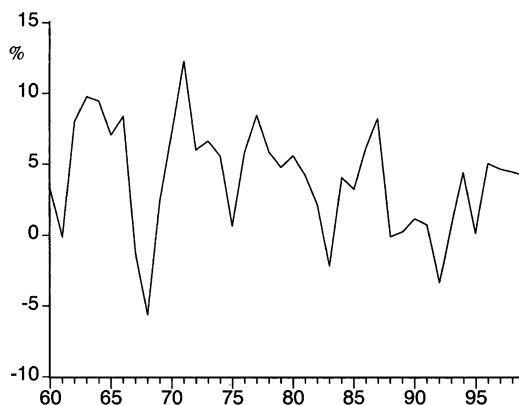


FIGURE 2. THE RATE OF GROWTH OF REAL GDP

GDP in 1987. When compared to the average of 1986 and 1988, real GDP was 4.16 percent higher. We should note that the rise in GDP can also be traced to a favorable terms-of-trade development and an increase in domestic demand.

In this paper, we study a cross section of individuals in the period surrounding the tax reforms to learn about the responsiveness of labor supply to the tax cuts. This enables us to determine the effect on labor-force participation, the effect on the number of weeks supplied by each worker, and an assessment of the determinants of the labor-supply response: in particular, we can estimate how the change in the supply of labor depends on observable characteristics such as age, gender, previous income, and the number of children. Our analysis is a statistical description of the data rather than an estimation of any particular model of labor supply.

I. A Note on the Theory of Labor Supply

While our emphasis will be on describing the data without resorting to any formal modeling, we would like to start out by stating, for the record, some economic intuition.

The economic theory which was the foundation of the design of controlled income maintenance experiments in the 1960's⁵ is relevant in

our context despite its lack of macroeconomic considerations. The theory was surveyed by, amongst others, Guy H. Orcutt and Alice G. Orcutt (1968) and Charles E. Metcalf (1973). One of the important questions addressed involved determining what could be inferred from the results of a limited-duration tax experiment about behavior following its permanent implementation. Metcalf (1973) shows that a temporary negative income tax experiment—which simultaneously reduces taxes (that is, tax rates) and also the level of nonwage income—will understate the income effect of the decrease in nonwage income while overstating the effect of lower tax rates because its income effect is underestimated. The former would lead us to underestimate the increase in labor supply while the latter would give an overestimate. Moreover, if a household is below some break-even point such that it experiences increased income net of taxes, the income effect of the fall in nonwage income dominates the income effect from lower taxes which guarantees that labor supply is increased since the substitution effect also goes in the same direction. For high-income households, the converse may hold: the income effect from reduced taxation may dominate and reduce labor supply.

The Icelandic experiment is similar in nature to the negative income tax experiments in that tax rates were reduced (to zero) while nonwage income was also reduced through taxation (of last year's earnings) that did not depend on current earnings. This was an extreme experi-

⁵ Such as the New Jersey-Pennsylvania Graduated Work Incentive Experiment.

ment as tax rates were brought down to zero. However, the short duration of the experiment reduced any form of income effect and continued taxation (although of previous year's income) reduced the income effect further. For this reason, we can think of the experiment as providing an upper bound on the labor-supply response.

It should be clear that the labor-supply response may differ across individuals since the elasticity of intertemporal substitution may depend on the form of the utility function, the earnings of individual workers and their non-wage income. Thus, women may enjoy higher levels of nonwage income due to their husbands' (higher) earnings and workers with dependent children—who may not be able to lengthen their working hours due to domestic responsibilities—may have a low elasticity of substitution. We will find that there were large differences in the response of individuals to the tax changes: while the majority chose to increase labor supply, quite a few actually reduced their supply of labor in the year of zero marginal tax rates. In addition, the labor-supply response differed across workers depending on sex, the presence of children, marital status, and extent of self-employment.

Ours is not the first analysis of a natural experiment involving labor supply. Nada Eissa (1996) has looked at the effect of the Economic Recovery Tax Act of 1981 on the labor supply of upper-income women. This episode differs from the Icelandic experiment in several ways. First, the tax change was perceived to be more permanent, thus having much stronger income effects. Second, the tax rates were reduced by less.⁶ Finally, the tax cuts could be anticipated to a certain extent since the Republican party had emphasized large tax cuts in the 1980 presidential election campaign.

Eissa observes that the legislation involved a significant fall in marginal tax rates for upper-income individuals and a much smaller reduction for those with lower income, in addition to a tax deduction for secondary earner's income. Thus the labor supply of upper-income women should have been affected by more than that of

lower-income women, enabling her to apply the difference-in-difference regression model. Using data from the 1981 and 1985 CPS, she found some evidence that the labor-force participation of upper-income married women was responsive to taxes (elasticity of 0.79).⁷

II. A Chronicle of Events

A. *The Tax Reforms*

The Icelandic government decided in the fall of 1986 to simplify the personal income tax system. There appears to have been a broad consensus that such reforms were justified although previous attempts at introducing a pay-as-you-earn system in 1977 and 1981 had been unsuccessful. Following a request from labor unions and industry, which formed a part of a wage settlement in December 1986, tax reforms were put on a fast track with the introduction of a pay-as-you-earn income tax to be effective at the beginning of 1988. At the same time, there was political willingness to increase the redistribution of income through the personal income tax system.

In spite of a low average tax burden of the personal income tax in comparison with the other Nordic countries (14.5 percent of average blue-collar income in 1985,⁸ relative to an average of 32 percent in the other Nordic countries), the marginal rate could go as high as 56.3 percent. So in order to shift the tax burden from the lowest income earners, and at the same time reduce the marginal rates at the high end of the income distribution, the following changes were made.

- Four distinct tax brackets were consolidated—both state and local—into a single bracket of 35.2 percent.
- A single personal tax allowance was introduced to replace various deductions dependent on family status and income.

⁷ The Tax Reform Act of 1986 provided another natural experiment analyzed by, amongst others, Hausman and James M. Poterba (1987), Eissa (1995), Eissa and Jeffrey B. Liebman (1995), and Martin Feldstein (1997).

⁸ This applied to a single individual; married people enjoyed lower rates.

⁶ Lawrence B. Lindsey (1987) estimated that tax liability was reduced by 26.8 percent in 1984.

TABLE 1—AVERAGE AND MARGINAL TAX RATES (SINGLE INDIVIDUALS) (IN THOUSANDS OF ICELANDIC KRONAS)

	1986	1988	Change
Threshold of taxable income (current prices)	197	530	170 percent
Lowest marginal rate (percent)	28.3	35.2	6.9
Highest marginal rate (percent)	56.3	35.2	-21.1
Average wages, thousand IKR (current prices)	390	686	76 percent
Threshold of taxable income as percent of average wages	50.5	77.3	26.8
Average tax (percent)	14.5 ^a	8.0 ^b	-6.5

Source: Ministry of Finance (1997).

^a Figure taken from OECD (1998) and applies to 1985.

^b Calculated from lines 1–5 in table.

- A special scheme for interest deductions and tax credits for owner-occupied houses was introduced.
- Benefits (such as child benefits) were to be paid out directly instead of being part of the tax system.

Table 1 summarizes some of the key changes in the tax system in 1987.

The announcement about the impending change in the tax system was made only a couple of months before the legislative procedure was finalized. As a result, households and the corporate sector did not have much room to respond to the news prior to the changes becoming effective. Because the announcement was made in late 1986, we can eliminate the possibility that changes in labor supply occurring in 1986 had anything to do with the tax-free year.⁹

B. Economic Conditions Around the Time of the Tax Reforms

Being prone to fluctuations arising from the importance of natural resources (fishing and fish processing), the Icelandic economy was in a strong upswing at the time of the tax reforms. Prior to the announcement, employment had been rising and the labor-force participation rate was at an all-time high at 80 percent in 1986. With unemployment at only 0.7 percent, and the

labor market in a state of excess demand, inflation was running at 20–30 percent annually.

On the external side, the current account moved temporarily into surplus in 1986 following continuous deficits since the late 1970's. This favorable outcome in 1986 was mostly due to a positive terms-of-trade shock. In 1986 and 1987, real GDP rose by 6 percent and 8½ percent respectively. Initially driven by increased exports and improved terms of trade, the upswing turned from an export-led to a domestic-demand-led boom in mid- to late 1987. This followed a 3.3-percent growth rate in 1985. A collective wage agreement in late 1986 resulted in a 20-percent increase in nominal wages. However, as it turned out, wages rose by a staggering 40 percent, and per capita real disposable income rose by 25 percent.

It can be argued that the tax reform came at precisely the right time to offset some of the labor-market pressures which had built up during 1986 and 1987. In the absence of this “extra” labor supply, the inflation outcome might have been much worse. Price inflation—measured by the GDP price deflator—was 17.8 percent in 1987, lower than in both 1986 (22.7 percent) and 1988 (20.6 percent).

Obviously, the economic situation in 1986–1987 was unsustainable with a widening current-account deficit and mounting inflationary pressures. As a result, the government tried to stabilize the economy by tightening fiscal policy and devaluing the domestic currency. In 1988 and in the following years, the economy cooled down as GDP stagnated well into the mid-1990's.

⁹ However, it is possible—and in fact, quite likely—that self-employed workers moved some income from 1986 to 1987. Thus income earned in 1986 may have been reported in 1987 to avoid taxation.

III. The Data at First Glance

We now turn to the analysis of the labor-supply response of the individuals in our sample. The data set is drawn from two databases. One is individual tax returns (SOURCE1) (OECD, 1998), and the other has the number of working weeks for each individual taken from a database compiled by the authorities (in connection with a special employers' insurance charge based on the number of weeks worked) (SOURCE2) (OECD, 1988). By merging these two it is possible to establish a one-to-one relationship between individual income and the number of weeks worked.¹⁰ Both have the same system of identification numbers, allowing us to link the number of weeks worked for a given individual from SOURCE2 to his income and other attributes taken from SOURCE1.

We use a random sample of 9,274 individuals, who filed income tax returns in 1986, 1987, and 1988.¹¹ This gives a total of 27,822 observations, three for each of the 9,274 individuals in our sample. These individuals are randomly chosen and include both workers who are employed, unemployed, and out of the labor force. The sample has 4,668 men and 4,606 women. This includes 2,782 couples. There are 1,236 individuals who have at least some income from self-employment, the rest being employees only. In addition, we have data on total direct tax payments, wages earned from salaried employment, wages earned through self-employment, age, gender, marital status, and the number of children.¹²

¹⁰ Both files are kept at the National Economic Institute, which ensures anonymity of personal information. A major drawback of the data set on working weeks is that each individual can as a maximum work 52 weeks for the same employer. So, someone previously working 52 weeks, but increasing his overtime the following year, is still only counted as working 52 weeks. Only if he takes a second job with another employer will the increase be counted.

¹¹ It should be noted here that although 1987 was a tax-free year with respect to personal income taxed, individuals had to file a normal tax return. Since all working-age individuals had to file a tax return, no sample-selection bias is created by only sampling among those who filed a tax return in all three years.

¹² All variables are taken from SOURCE1 apart from the number of weeks worked, which is taken from SOURCE2.

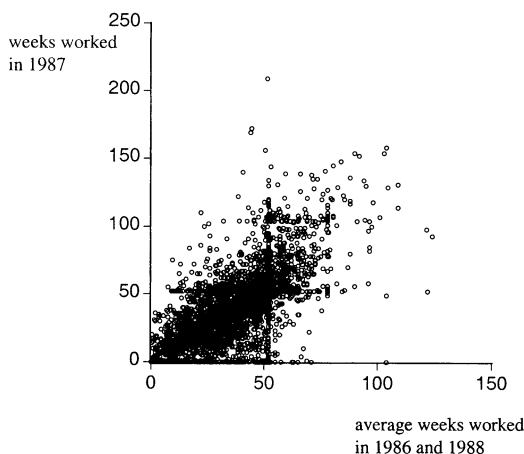


FIGURE 3. THE AVERAGE LABOR SUPPLY IN 1986 AND 1988 AND THE SUPPLY OF LABOR IN 1987

Figure 3 shows average labor supplied in 1986 and 1988, and the supply of labor in 1987 for all 9,274 workers in the sample. We use the average of 1986 and 1988 as a baseline to account for any linear trend in labor supply, earnings, or wage rates. Note that the number of weeks worked can exceed 52 when individuals hold more than one job at a time. There is a large variation in the change in labor supply. Thus some workers (2,762) decided to work less in 1987 while others (4,171) decided to work more. This leaves a large number (2,341) with an unchanged labor supply. The figure shows that workers who raised their labor supply in 1987 did so on average by more than those who reduced it.

The 9,274 individuals supplied on average 308,913 weeks of labor in 1986 and 1988, of which the 4,606 women accounted for 122,435 weeks. In 1987, the 9,274 workers in the sample increased their supply of labor from 308,913 to 326,554 weeks, that is, by 5.7 percent. When we correct for entry in 1988—which reduces the measured supply response in 1987—we get a 6.7-percent rise in weeks supplied. The increase in labor supply by men was slightly higher than the average: they worked 202,252 weeks in 1987 instead of an average of 186,477 weeks for 1986 and 1988, which is an 8.46-percent increase over 1986—8.8 percent when we have corrected for entry in 1988. Women in the sample worked 124,302 weeks, an increase of

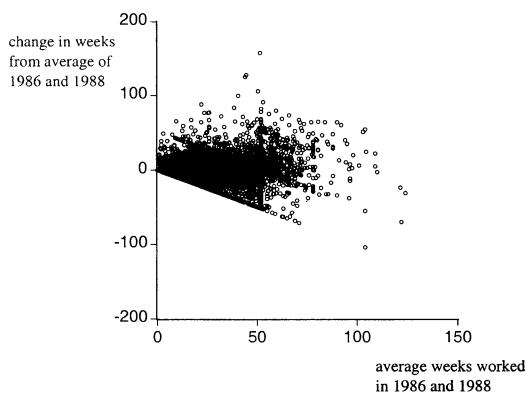


FIGURE 4. THE AVERAGE LABOR SUPPLY IN 1986 AND 1988 AND THE SUPPLY RESPONSE IN 1987

only 1.5 percent—or 3.5 percent when we have corrected for entry in 1988.

Before proceeding any further, it is interesting to look at the relationship between the change in labor supply in 1987 from the average level for 1986 and 1988, on the one hand, and the average level of labor supply in 1986 and 1988, on the other hand, to see if workers who increased their supply of labor worked part-time, full-time, or not at all in 1987. This is Figure 4. We notice clusters at full employment in that year. Besides this, no relationship is apparent. Thus part-time workers do not seem to respond more than others to the tax change. Note that the straight line arises because the number of weeks worked is bounded from below by the zero-weeks constraint.

The problem with the number of weeks worked as a measure of labor supply is that it does not capture changes in hours per week. With a constant hourly wage, changes in earnings measure both changes in the number of weeks and in hours per week. For this reason we do the same calculations using the change in earnings as a measure of the labor-supply response. Earnings are measured as the sum of wage income and income from self-employment, both measured in real terms (1986 kronas). However, this may overestimate the labor-supply response because real wages did increase from 1986 to 1987 as shown in Table 2.

Figures 5 and 6 correspond to Figures 3 and 4, but use earnings instead of weeks worked. The pattern of observations is similar although

TABLE 2—GROWTH OF HOURLY (REAL) WAGES FOR BLUE-COLLAR WORKERS (INCLUDING OVERTIME)

Year	Percent
1984	-1.3
1985	3.7
1986	5.3
1987	18.2
1988	3.4
1989	-5.5

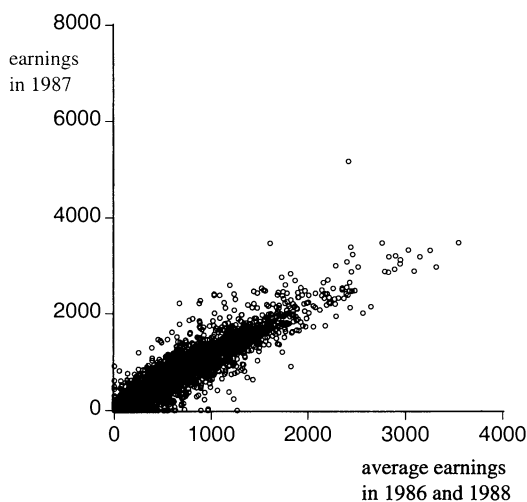


FIGURE 5. AVERAGE EARNINGS IN 1986 AND 1988 AND THE LEVEL OF EARNINGS IN 1987

the supply response may be easier to detect in Figure 5 than in Figure 3.

The question arises whether the changes in labor supply are primarily caused by entry into the labor force or by employed workers changing their supply of weeks. Given the very low unemployment rate in 1986 (0.7 percent), we define anyone who works at least one week as part of the labor force and those who supply zero weeks as out of the labor force. Table 3 has the change in the (total) number of weeks and earnings due to entry and exit from employment in 1987, on the one hand, and due to existing workers changing their supply of weeks in 1987, on the other hand. The baseline is the average of weeks supplied in 1986 and 1988. For this reason we add a third line, which has the change in this difference due to entry in 1988.

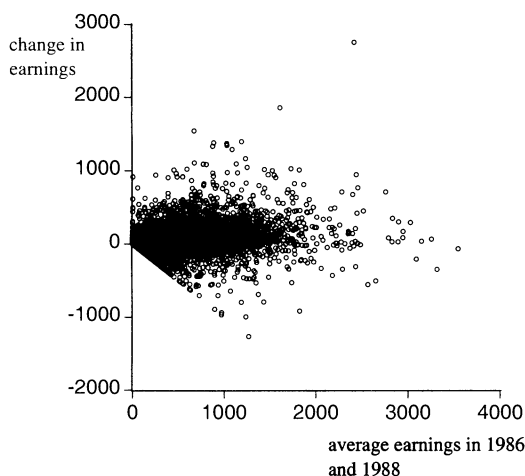


FIGURE 6. AVERAGE EARNINGS IN 1986 AND 1988 AND THE SUPPLY RESPONSE IN 1987

We see that both men and women reduced their supply of weeks due to exit/entry in 1987 while employed men increased their supply significantly. Despite the fact that more women are employed in 1987 than in 1986 (more on this later), their supply of weeks falls from the benchmark case due to entry and exit: the ones who quit employment worked more on average than those who joined. When we look at earnings—the sum of wage income and income from self-employment in current prices—a similar pattern is revealed. The key difference lies in the increase in earnings for women due to entry and exit.

Table 4 reports elasticities of supply—for both those workers already in the labor market in 1986 and those who decided to join in 1987—where the elasticities are defined as:¹³

$$\eta^L = \frac{\sum_i (L_{87} - L_A)/L_A}{\sum_i T_{86}/E_{86}}$$

$$\eta^E = \frac{\sum_i (E_{87} - E_A)/E_A}{\sum_i T_{86}/E_{86}}$$

¹³ The elasticities were found by running a regression where the proportional change in the supply of labor was the dependent variable and the tax rate in 1986 the sole independent variable.

TABLE 3—CHANGES IN LABOR SUPPLY (PERCENT) RELATIVE TO THE AVERAGE OF 1986 AND 1988

	Weeks		Earnings	
	Male	Female	Male	Female
Entry and exit in 1987	-1.4	-0.6	0.0	0.2
Δ weeks (Δ earnings)	6.6	2.0	8.9	2.9
Entry in 1988	-0.2	-0.8	0.0	0.0
Sum	5.0	0.6	8.9	3.1
Both sexes	5.6		12.0	

L is the number of weeks supplied in a given year, E is earnings (the sum of wage income W and income from self-employment P), and T is the level of income taxes. $E_A(L_A)$ denotes average earnings (weeks) in 1986 and 1988. As before, we use this average to account for any linear trend in labor supply, earnings, or wage rates. We note that we use an average tax rate while the marginal one would be preferred. The difference between the two was pointed out in Table 1.

The average elasticity for both sexes combined is 0.42 (0.07) when weeks worked are used and 0.67 (0.25) when earnings are used. The elasticities fall close to those reported by Mark Killingsworth (1983) for American workers. Looking only at the substitution effect—which makes the estimates most comparable with our experiment—the Killingsworth estimates range from -0.05 to 0.50 for men and from 0.50 to 1.65 for women.

We will now look separately at the response by those workers supplying at least one week of labor in 1986 and those who did not work at all in that year. Given the low rate of unemployment in 1986 (0.7 percent) we can look at the latter as a labor-force participation decision. In this section, we will first describe the data informally along these lines, while in Section IV we use regression analysis to further disentangle the different relationships.

A. Changes in the Number of Weeks (Hours) Worked by Those Working in 1986

In Tables 5 and 6 we only look at workers who worked at least one week in 1986 and then turn later to those who were inactive in that

TABLE 4—ELASTICITY OF LABOR SUPPLY (CALCULATED FROM SAMPLE AVERAGES)

	Number of observations		$\Delta L/L_A$		T/E		Elasticity	
	Male	Female	Male	Female	Male	Female	Male	Female
<i>L</i>	4,668	4,606	0.154 (0.016)	0.117 (0.019)	0.157 (0.002)	0.097 (0.002)	0.58 (0.08)	0.06 (0.13)
<i>E</i>	4,668	4,606	0.309 (0.099)	0.337 (0.101)	0.157 (0.002)	0.097 (0.002)	0.80 (0.12)	0.40 (0.62)

Note: Standard errors are in parentheses.

TABLE 5—ELASTICITY OF LABOR SUPPLY FOR WORKERS EMPLOYED IN 1986 (CALCULATED FROM SAMPLE AVERAGES)

	Number of observations		$\Delta L/L_A$		T/E		Elasticity	
	Male	Female	Male	Female	Male	Female	Male	Female
All workers	4,180	3,346	0.143 (0.016)	0.103 (0.019)	0.157 (0.002)	0.099 (0.002)	0.53 (0.08)	0.04 (0.13)
Self-employed	812	264	0.241 (0.051)	-0.070 (0.043)	0.182 (0.006)	0.122 (0.007)	0.71 (0.21)	-0.34 (0.26)
Employed	3,368	3,082	0.119 (0.015)	0.118 (0.021)	0.151 (0.002)	0.097 (0.002)	0.46 (0.08)	0.08 (0.14)
Married	2,535	1,964	0.108 (0.015)	0.092 (0.025)	0.194 (0.002)	0.104 (0.002)	0.54 (0.07)	0.05 (0.18)
Single	1,645	1,382	0.197 (0.033)	0.119 (0.030)	0.099 (0.003)	0.092 (0.003)	0.48 (0.22)	0.02 (0.19)
With children	1,701	1,321	0.104 (0.013)	0.107 (0.031)	0.194 (0.003)	0.106 (0.003)	0.44 (0.06)	0.10 (0.23)
Without children	2,479	2,025	0.169 (0.025)	0.101 (0.025)	0.135 (0.003)	0.093 (0.003)	0.61 (0.13)	0.00 (0.15)
Self-employed and married	613	215	0.237 (0.021)	-0.126 (0.049)	0.195 (0.006)	0.120 (0.007)	0.75 (0.09)	-0.60 (0.31)
Self-employed and single	199	49	0.253 (0.199)	0.174 (0.082)	0.143 (0.014)	0.129 (0.023)	0.58 (0.84)	0.35 (0.42)

Note: Standard errors are in parentheses.

year. As in Tables 3–4, we use both weeks worked and earnings as a measure of labor supply. It appears that, among workers who were already in the labor force in 1986, men increased their labor supply by more on average.

Working men who received some income from self-employment in 1986 have a considerably higher elasticity of labor supply or 0.71, while the elasticity is negative for women in that group. Male workers with some income from self-employment increased their labor supply by 24.1 percent, compared to the just over 14.3-percent increase by all men. The comparable figure for men who did not receive any income from self-employment is 11.9 percent.

The higher elasticity for men with some income from self-employment can be caused by either a greater ability to substitute labor between years, and/or an ability to report income, earned in 1986 or 1988, in 1987 and hence evade taxes.¹⁴ Married men have a slightly higher elasticity than their single counterparts and the same applies to women.

¹⁴ Looking at sectoral output data and the share of self-employment in employment does not reveal a relationship between the two variables. We cannot demonstrate that those sectors that rely more on self-employment have higher output growth than others. However, this may only indicate that other variables than self-employment explain most of the cross-sectoral variation in the output response.

TABLE 6—ELASTICITY OF TOTAL EARNINGS FOR WORKERS EMPLOYED IN 1986 (CALCULATED FROM SAMPLE AVERAGES)

	Number of observations		$\Delta E/E_A$		T/E		Elasticity	
	Male	Female	Male	Female	Male	Female	Male	Female
All workers	4,178	3,346	0.207 (0.043)	0.145 (0.015)	0.157 0.002	0.099 0.002	0.85 (0.07)	0.43 (0.10)
Self-employed	812	264	0.182 (0.017)	0.223 (0.067)	0.182 0.006	0.122 0.007	0.70 (0.07)	0.85 (0.41)
Employed	3,367	3,082	0.213 (0.053)	0.138 (0.016)	0.151 0.002	0.097 0.002	0.90 (0.10)	0.38 (0.10)
Married	2,535	1,964	0.230 (0.070)	0.161 (0.021)	0.194 0.002	0.104 0.002	0.91 (0.10)	0.54 (0.15)
Single	1,644	1,382	0.171 (0.015)	0.122 (0.023)	0.099 0.003	0.092 0.003	0.64 (0.10)	0.29 (0.12)
With children	1,578	1,321	0.146 (0.009)	0.187 (0.030)	0.194 0.003	0.106 0.003	0.67 (0.04)	0.67 (0.22)
Without children	2,600	1,889	0.244 (0.069)	0.112 (0.015)	0.135 0.003	0.093 0.003	0.99 (0.13)	0.30 (0.09)
Self-employed and married	613	215	0.205 (0.020)	0.167 (0.046)	0.195 0.006	0.120 0.007	0.76 (0.08)	0.77 (0.30)
Self-employed and single	199	49	0.112 (0.035)	0.468 (0.302)	0.143 0.014	0.129 0.023	0.51 (0.15)	1.07 (1.51)

Note: Standard errors are in parentheses.

TABLE 7—THE PROPORTION OF WORKERS SUPPLYING AT LEAST ONE WEEK OF LABOR (SAMPLE AVERAGES)

	1986		1987		1988	
	Male	Female	Male	Female	Male	Female
All workers	0.895	0.726	0.874	0.738	0.848	0.713
Self-employed	0.979	0.649	0.960	0.818	0.942	0.855
Employed	0.877	0.734	0.855	0.745	0.828	0.699
Married	0.911	0.706	0.893	0.750	0.885	0.731
Single	0.872	0.758	0.845	0.721	0.794	0.685
With children	0.965	0.766	0.957	0.830	0.967	0.799
Without children	0.858	0.699	0.829	0.674	0.784	0.652

Men without children appear to have a much stronger response than those who have children.

The main surprise is the negative response by self-employed women. This effect turns out to be especially strong among self-employed women who are also married, as shown at the bottom of the table. While married and self-employed women reduce their supply of weeks, their single counterparts increase it.

With our earlier caveat regarding the use of earnings as a measure of labor supply in mind, we report the corresponding elasticities. As in Table 5, both married men and

those without children responded more to the tax cut than did their married and employed counterparts. Comparing Tables 5 and 6, we see that single, self-employed women experience higher earnings but supply fewer weeks. Similarly, self-employed men now show a smaller response than employed men.

B. Changes in Labor-Force Participation

We now turn to the group of workers who were inactive in 1986—that is, did not work a single week in that year. In 1987, 448 workers who did not work in 1986 entered employment. At the same time, 494 workers left employment.

TABLE 8—TAXES AND THE ELASTICITY OF LABOR SUPPLY (CALCULATED FROM SAMPLE AVERAGES)

	Number of observations		$\Delta L/L_A$		T/E		Elasticity	
	Male	Female	Male	Female	Male	Female	Male	Female
<20 percent	2,807	3,163	0.166 (0.021)	0.145 (0.021)	0.091 (0.001)	0.075 (0.001)	0.80 (0.19)	0.52 (0.22)
<40 percent	1,353	422	0.107 (0.012)	-0.042 (0.025)	0.258 (0.001)	0.249 (0.002)	0.41 (0.05)	-0.15 (0.10)
>40 percent	104	46	0.474 (0.275)	-0.149 (0.124)	0.600 (0.022)	0.637 (0.031)	0.76 (0.44)	-0.28 (0.18)

	Number of observations		$\Delta E/E_A$		T/E		Elasticity	
	Male	Female	Male	Female	Male	Female	Male	Female
<20 percent	2,834	3,282	0.181 (0.032)	0.272 (0.103)	0.091 (0.001)	0.075 (0.001)	0.93 (0.28)	0.89 (1.10)
<40 percent	1,355	430	0.148 (0.009)	0.100 (0.017)	0.258 (0.001)	0.249 (0.002)	0.56 (0.03)	0.40 (0.07)
>40 percent	108	52	0.776 (0.502)	-0.085 (0.097)	0.600 (0.022)	0.637 (0.031)	1.18 (0.78)	-0.20 (0.14)

As a result, there were 46 fewer workers employed in our sample in 1987 than in 1986. However, there were 55 more women employed in 1987 while the number of employed men in the sample fell by 101. Table 7 has the proportion of workers supplying at least one week in each of the three years—which we define as the condition for labor-force participation.

The participation rate of men fell in all cases while that for women tended to increase. The increase was most significant for married women and those with children. However, single women and those without children had lower rates in 1987 than in 1986. In both cases, this appears as a trend which continues in 1988. The same applies to all categories of men—their employment rate was falling throughout.

IV. Worker Characteristics and the Responsiveness to Tax Cuts

Table 8 analyzes the supply response for individuals in three (average) tax brackets: those paying less than 20 percent of their earnings in taxes, those paying between 20 percent and 40 percent in taxes, and those paying more than 40 percent. Looking first at men, it is clear that the largest response came from those in the highest

tax group. This is the case when using both the weeks worked and the earnings measure of labor supply. However, the elasticity is also high for the lowest tax group. The relatively large response for the lowest group can be explained by a low initial labor supply (40 weeks as opposed to 49 weeks for the group above). The converse holds for women: those women in the lowest tax group respond most, both when measured by weeks worked and earnings. Note, in this case, the fall in weeks worked for the top two groups and also the fall in earnings for the top group.

A. Regression Analysis for the Number of Weeks Worked (Earnings)

We have looked at both tax rates and worker characteristics and calculated simple correlation coefficients. The next step is to use regression analysis to disentangle the different determinants of the change in the supply of labor. We first look at those already supplying at least one week in 1986 and then look separately at the decision whether to supply at least one week—what we can call the labor-force participation decision.

We estimate the following equation which explains the increase in labor supply as a func-

TABLE 9—DETERMINATION OF THE RESPONSIVENESS TO TAX CUTS (WEEKS WORKED)

Variable	Coefficient	<i>t</i> -ratio
Number of observation: 8,062		
Method of estimation: Least-squares		
Dependent variable: $L_{87} - L_A$		
Constant	8.34	5.84
<i>Income:</i>		
Wage income (<i>W</i>)	0.04	0.51
Income from self-employment (<i>P</i>)	0.97	6.40
<i>Characteristics:</i>		
Gender (<i>s</i>)	-2.57	-5.73
Age (<i>a</i>)	-0.30	-3.60
Age-squared (a^2)	0.003	3.04
Family status (<i>m</i>)	1.84	3.39
Children (<i>c</i>)	-0.17	-0.68
Tax rate (τ)	0.69	0.33

TABLE 10—DETERMINATION OF THE RESPONSIVENESS TO TAX CUTS (EARNINGS)

Variable	Coefficient	<i>t</i> -ratio
Number of observation: 8,062		
Method of estimation: Least-squares		
Dependent variable: $E_{87} - E_A$		
Constant	19.75	1.45
<i>Income:</i>		
Wage income (<i>W</i>)	0.05	7.77
Income from self-employment (<i>P</i>)	0.20	13.77
<i>Characteristics:</i>		
Gender (<i>s</i>)	-27.39	-6.39
Age (<i>a</i>)	0.99	1.22
Age-squared (a^2)	-0.02	-2.07
Family status (<i>m</i>)	10.25	1.98
Children (<i>c</i>)	0.03	0.01
Tax rate (τ)	105.20	5.24

tion of wage income (*W*) and income from self-employment (*P*), both measured in 1986 kronas:

$$(1) \quad L_{87} - L_A = \alpha_0 + \alpha_1 W + \alpha_2 P + \alpha_3 \tau + A\mathbf{x}.$$

We do not have data on the distribution of weeks worked between employment and self-employment and for this reason we cannot calculate wage rates for the two different income variables. The variable *P* then measures the importance of income from self-employment and τ is the (average) tax rate. The second group of variables, contained in vector *x*, has the personal characteristics of workers: age (*a*), gender (*s*) (indexed by 1 for women), marital status (*m*) (indexed by 1 for married people), and the number of children (*c*).

The results follow first for weeks worked and then for earnings as measures of labor supply, as Tables 9 and 10 show. As before, self-employment appears to be the most important determinant of the labor-supply response. We also find that women and older workers respond by less. Single individuals increase their labor supply by less. Most importantly, and disappointingly, the (average) tax rate in 1986 is not a statistically significant determinant.

When we include wage rates—as the ratio of total income from both types of employment and weeks worked—and also the ratio of wage income to income from self-employment, the results are very similar to Table 9 in that the wage-rate variable is insignificant while the variable measuring the ratio of the two kinds of income comes out positive and very significant. However, there exists a possible division bias in this case. The variable measuring the number of weeks worked in 1986 is used on both sides of the equation—on the left-hand side in the change of weeks worked and on the right-hand side in calculating the wage rate. To deal with this, we used the analogous wage rate in 1988 as an instrument for the wage rate in 1986. This made the variable positive and significant while not affecting the other coefficients too much. Most importantly, the tax-rate variable did not become more significant.

When we omit all income variables from the regression, the coefficient of the tax rate becomes larger and slightly more significant (*t*-ratio of 1.57). Other coefficients do not change significantly. This regression compares the differential impact of the tax cut for different individuals depending on the extent of this tax cut.

We now measure the labor supply by total earnings, *E*. The key difference lies in the

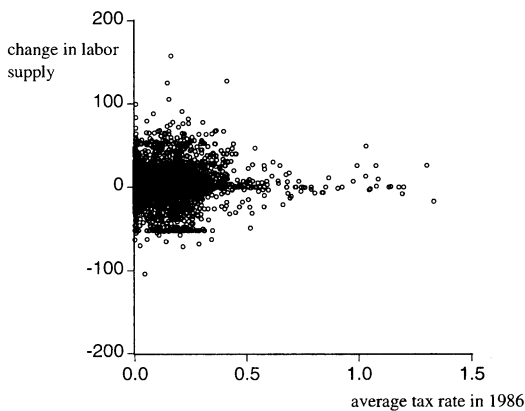


FIGURE 7. THE CHANGE IN THE SUPPLY OF WEEKS AND THE AVERAGE INCOME TAX RATE IN 1986 (FROM AVERAGE OF 1986 AND 1988 TO 1987)

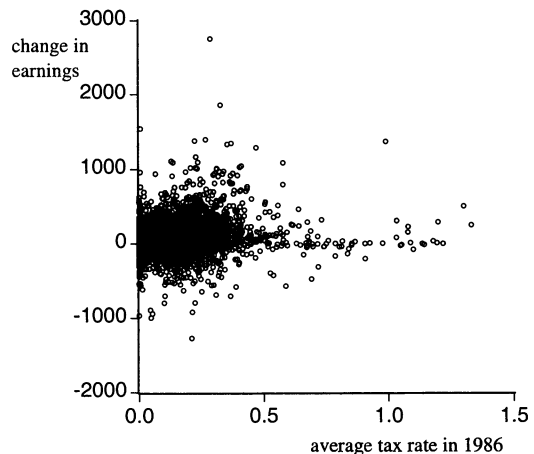


FIGURE 8. THE CHANGE IN EARNINGS AND THE AVERAGE INCOME TAX RATE IN 1986

significance of the tax-rate variable and a different dependence on age. While the youngest workers are likely to respond most in terms of weeks, they are not likely to experience the largest absolute increase in earnings. Also, for obvious reasons, high-wage workers experience larger absolute increases in earnings.

In light of Table 8, the absence of a strong relationship between weeks worked and the (average) tax rate in Table 9 comes as a surprise. The absence of any obvious relationship between the tax rate and our two measures of labor supply is demonstrated in Figures 7 and 8.¹⁵

We next estimate the relationships allowing for nonlinearities. This will reveal whether the relationship between taxes and labor supply is confined to a certain range of tax rates—being absent for others. To test for nonlinearities in equation (1), we maintain the assumption of additivity among the regressors and use a scatterplot smoother (see Trevor Hastie and Robert Tibshirani, 1990) to estimate explicitly any nonlinearities in the relationship between the changes in labor supply and its determinants (*general-additive model* or GAM). There is no reason, a priori, to expect the relationships to be perfectly linear. The general form of the equation to be estimated is

¹⁵ We note that tax rates could exceed unity since taxes in 1986 were paid on income earned in 1985. So if income in 1986 was much lower than in 1985, the calculated tax rates could be very high.

$$(2) \quad \Delta L_i = f_1(w_i) + f_2(\pi_i) + f_3(s_i) + f_4(a_i) \\ + f_5(m_i) + f_6(c_i) + f_7(\tau_i) + \varepsilon_i$$

where the functions f can take any form, w is the wage rate, π is the ratio of income from self-employment to salaries (P/W), and ε is a zero-mean error term. The statistical results are in Figures 9 and 10. Figure 9 has the results for weeks worked and Figure 10 for earnings.

We now detect a relationship between the supply of weeks and the tax rate. There is a positive relationship with tax rates when these range from 20 percent to 40 percent but no relationship at lower and higher rates. In addition, we find that, again, the supply response is rising in income from self-employment. Moreover, the response is highest for those workers under the age of 20. Looking at our results for the binary variables (not reported here), men respond more than women and married people more than single ones.

The important difference here lies in the tax rates where, allowing for nonlinearities, a positive relationship is apparent. Figure 10 has results when the change in earnings is used as a dependent variable. These results are consistent with those in Table 10. Moreover, as in Figure 9, we have learned that the positive relationship between the tax rate and the supply response occurs in the tax range from 20 percent to 40 percent.

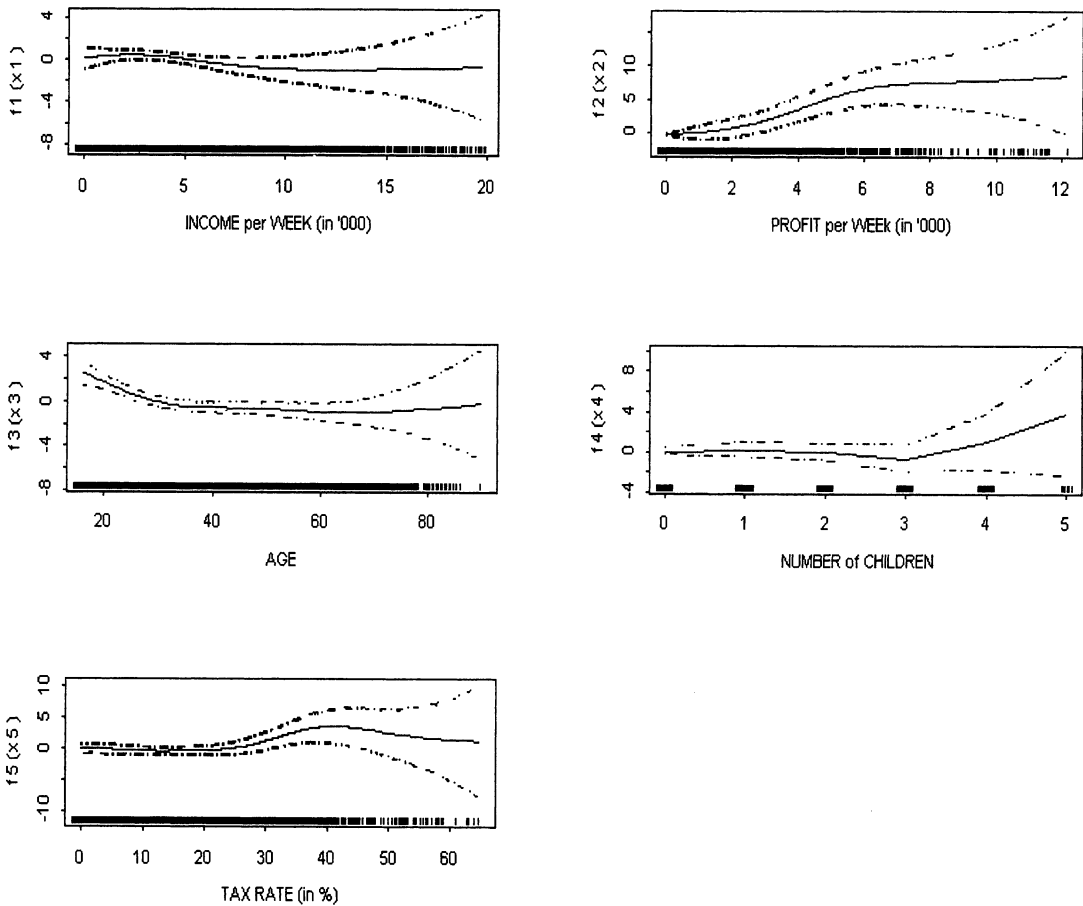


FIGURE 9. RESULTS OF GAM ESTIMATION FOR WEEKS WORKED
 Note: The broken lines define the 95-percent confidence interval.

B. Regression Analysis for the Participation Decision

Turning to the labor-force participation decision, we have found that women were more likely to join the labor force than men. In Table 11 are the results of a probit regression of the following equation:

$$(3) \quad p = \mathbf{a}x + \mathbf{b}d^{87}x$$

where p is a binary variable which takes the value one when a worker is employed for at least one week during the year and zero otherwise, and x has the same variables as before:

gender (s), family status (m), number of children (c), and age (a).¹⁶ The terms \mathbf{a} and \mathbf{b} are vectors of coefficients and d^{87} is a dummy variable which takes the value one for the year 1987.

We find that women were less likely to work than men, and this probability is decreasing in the number of children they have and lower for married women than single ones. Independent of gender, married people are more likely to be employed than singles and, finally, parents are less likely to be employed. When we look at the coefficient estimates in vector \mathbf{b} , we find that

¹⁶ The logit estimates were qualitatively identical.

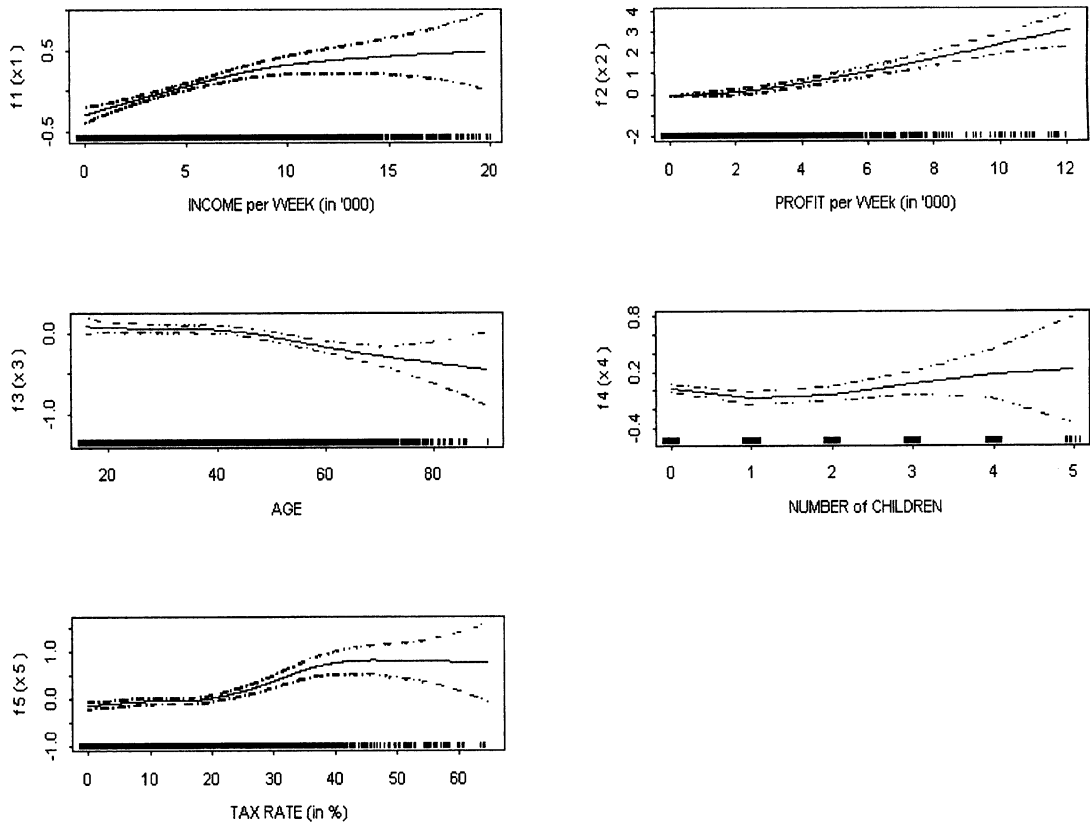


FIGURE 10. RESULTS OF GAM ESTIMATION FOR EARNINGS

Note: The broken lines define the 95-percent confidence interval.

TABLE 11—DETERMINANTS OF THE LABOR-FORCE PARTICIPATION DECISION

Variable	\hat{a}_i	t -ratio	\hat{b}_i	t -ratio
Number of observation:	27,822			
Estimation method:	Probit			
Dependent variable:	p (1 if in labor force and 0 otherwise)			
Observations with $p = 0$:	5,575			
Observations with $p = 1$:	22,247			
Constant	-0.430	-5.38	0.943	6.78
Gender (s)	-0.142	-3.66	-0.068	-1.01
Age (a)	0.118	28.07	-0.049	-6.88
Age-squared (a^2)	-0.002	-35.38	0.001	6.75
Family status (m)	0.391	8.31	0.034	0.42
Children (c)	-0.061	-2.19	-0.011	-0.25
Gender * family	-0.753	-13.08	0.134	1.36
Gender * children	-0.134	-4.35	0.121	2.34
Standard error =	0.33			

younger workers are more likely to participate in 1987 than in the other two years in the sample and that married women with children were more likely to work in 1987.

V. Conclusions

We have looked at the response of labor supply during the tax-free year in Iceland in 1987 using a sample of 9,274 workers out of a total of 180,577 in that year. We take the observed increase in labor supply to be an upper bound on the effect of tax cuts for three reasons: First, tax rates were brought down to zero. Second, (marginal) tax rates were reduced for only one year and during this one year taxes were still paid (that is, on income earned in 1986). For both reasons, the income effect of the tax

cut was reduced while the substitution effect remained intact. Third, the economy was booming because of other factors which could be expected to raise labor supply through higher wages. Our observations can be summarized as follows:

- There is a large variation across individuals in their labor-supply response. Some workers (2,455) decided to work less in 1987 while others (3,860) decided to work more.
- When averaging across the whole sample, the elasticities of labor supply fall close to those reported by Killingsworth (1983) for American workers. The elasticity of weeks worked to the rise in after-tax wages was 0.42 for all workers, 0.58 for men, and 0.06 for women when looking at all workers—both those who were employed in 1986 and those who decided to join in 1987. The elasticity of earnings was 0.80 for men and 0.40 for women with an average of 0.67. The higher elasticity using earnings may be partially explained by an increase in real wages.
- Looking only at workers who were employed in 1986, men responded more than women. Men who received some income from self-employment in 1986 had a considerably higher elasticity of labor and increased their labor supply by 24.1 percent, compared to the 14.3-percent increase by all men. Married men and women also had a slightly higher elasticity.
- The increase in labor supply during the tax-free year—measured either by the number of weeks worked or earnings—is a positive function of the tax rate in the previous year for tax rates between 20 percent and 40 percent but independent of the tax rate outside of this range.
- The participation rate for men in our sample fell in all cases while that for women tended to increase. The increase was most significant for young workers and married women.

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