Taxes and Time Allocation: Evidence from Single Women and Men*

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Abstract

The classic model of Becker (1965) suggests that labor supply decisions should be analyzed within the broader context of time allocation and market good consumption choices, but most empirical work on policy has focused exclusively on measuring impacts on market work. This paper examines how income taxes affect time allocation during the entire day, and how these time allocation decisions interact with expenditure patterns. Using the Panel Study of Income Dynamics from 1975 to 2004, we analyze the response of single women's housework, labor supply, and other time to variation in tax and transfer schedules across income levels, number of children, states, and time. We find that when the economic reward to participating in the labor force increases, market work increases and housework decreases, with the decrease in housework accounting for approximately two-thirds of the increase in market work. Analysis of repeated cross-sections of time diary data from 1975 to 2004 shows that "home production" decreases substantially when market hours of work increase in response to policy changes. Data on expenditures show some evidence that expenditures on market goods likely to substitute for housework increase in response to a greater incentive to join the labor force. The baseline estimates imply that the elasticity of substitution between consumption of home and market goods is 2.61. The results are consistent with the Becker model. Meanwhile, single men show little response to changes in tax policy, and we are able to rule out an elasticity of substitution between home and market goods for this group of more than 1.66.

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The classic model of Becker (1965) suggests that labor supply decisions should be analyzed within the broader context of time allocation and market good consumption choices, but most empirical work on policy has focused exclusively on measuring impacts on market work. This paper makes four contributions to understanding these issues. First, we examine how income taxes affect time allocation in the entire day among single women and men, including time spent on both market and non-market work, and we analyze how these time allocation decisions interact with expenditure decisions. Second, we use these results to develop a well-identified estimate of the elasticity of substitution between home and market goods, which is one of the crucial parameters for understanding work decisions and for calibrating business cycle models (Benhabib, Rogerson, and Wright 1991). Third, we compare the estimated pattern of responses with the Becker model. Fourth, we develop one of the first estimates of labor supply responses to tax policy changes using a fixed effect panel data model, thus addressing the question of whether previous labor supply results using repeated cross sections of data could be biased by changes in the composition of the population studied.

Using the Panel Study of Income Dynamics from 1975-2004, we find that among single women, labor force participation rises significantly when the fraction of their earnings taken away in taxes falls, consistent with findings in previous literature (Eissa and Liebman 1996; Meyer and Rosenbaum 2001). The baseline specification shows that when hours worked rise by 1 hour in response to lower taxes, time spent on housework falls by about 40 minutes. The finding that market work rises substantially and housework falls substantially in response to decreased taxation of labor earnings is robust to a wide variety of specification checks. Time devoted to activities other than market work and housework changes insignificantly, although the confidence intervals do not rule out substantial responses. Under a commonly-used utility specification, the baseline estimates are consistent with an elasticity of substitution between home and market goods of 2.61. For single men, however, we find no evidence of significant labor supply and housework responses to taxation. Our central point estimate of the elasticity of substitution between home and market goods for single men is 1.17, and the standard errors are small enough that we can rule out an elasticity larger than 1.66.

The repeated cross sections of time diary data assembled by Aguiar and Hurst (2007a) allow us to supplement our results in the PSID by examining how taxes affect detailed time use outcomes. This analysis also shows that an increased net-of-tax share causes a substantial and significant increase in market hours worked and a decrease in housework for single women. We investigate a variety of definitions of "home production" and "leisure" and find consistent evidence that the increase in market work corresponds to substantial and significant decreases in home production or non-market work. We also find evidence that leisure decreases substantially. Interestingly, time spent on child care changes insignificantly. The point estimates suggest that time spent eating and preparing food decreases, although the estimates are insignificant. We again find no evidence of responses of market or non-market time among single men.

Analysis of expenditure data supplements these results by showing evidence consistent with the finding that individuals use market goods to substitute for home work. We find that expenditures on food prepared away from home—which could substitute for time spent on food preparation—increase in response to an increase in the incentive to participate in the labor force, whereas expenditures on food at home is insignificantly affected. We find that overall food expenditures rise significantly in a preferred specification. In combination with the point estimates suggesting that time spent eating and preparing food falls, we interpret these results as consistent with the Becker model. In this framework, individuals derive utility from consumption of "commodities," each of which is produced using both a time input and a market goods input. Among other things, the model predicts that in response to a compensated wage increase, individuals' purchases of market goods inputs rise relative to time inputs for a given commodity, consistent with our results with respect to time spent on food and overall food expenditures.[1]

Our analysis builds on several previous studies that empirically examine important aspects of time allocation. Aguiar and Hurst (2005) and Hurd and Rohwedder (2003, 2008) examine how older workers smooth consumption upon retirement by offsetting declines in expenditures on market goods with increases in home production. Burda and Hamermersh

[1] We discuss later the conditions under which this holds true.

(2009) find that the employed take substantially less "leisure" than the unemployed but also find substantial home production responses to temporary increases in local area unemployment rates. Another relevant set of studies use cross-sectional variation to estimate the elasticity of substitution between home and market goods, including Benhabib, Rogerson, and Wright (1991), Rupert, Rogerson and Wright (1995), and Aguiar and Hurst (2007b). Meyer and Sullivan (2008) examine the time use and expenditures of single mothers in 1993 and 2003, and Meyer and Sullivan (2004) examine expenditures of single mothers before and after several policy reforms.

Our paper adds to these findings in notable ways. We present the first estimates of the joint time allocation and consumption responses to income tax changes, and then specify a testable form of the Becker model and relate our results to this framework. Relative to previous estimates of the elasticity of substitution between home and market goods, we use both ostensibly exogenous variation from policy changes and population-representative data. We estimate an elasticity of substitution of 2.61 for single women, which is somewhat higher than the results for this group in Rupert, Rogerson, and Wright (1995) and Aguiar and Hurst (2007b). With respect to single men, we differ from previous studies because we find small standard errors and bound the maximum substitution elasticity at 1.66, which calls into question how substitutable these goods are for a large segment of the population. In addition to estimating the substitutability of home and market goods and exploring outcomes that allow us to relate the results to the Becker framework, our main results add to the Meyer and Sullivan findings by using panel data with individual fixed effects on both single women and men over a thirty-year period. Multiple identification strategies prove to yield mutually consistent results, and we estimate the separate impacts of tax changes and welfare reform. Our point estimates of the labor supply response for single women are approximately 50% larger with individual fixed effects than without them, suggesting that earlier estimates from repeated cross-sections of data may be substantially biased by compositional changes over time.

Section 1 briefly reviews some of the major changes in tax policy over the time period in question. Section 2 describes the data. Section 3 discusses our empirical specifications. Section 4 turns to the results from the PSID. Section 5 contains the results from the repeated cross-

sections on time use. Section 6 describes results from the CEX and relates the results to the Becker model. Section 7 discusses the tax implications of the results. Section 8 concludes.

1. Policy Environment

During the period under consideration, a series of tax acts, passed in 1981, 1986, 1990, 1993, 2001 and 2003, dramatically changed the federal income tax code. We focus mainly on the components of these acts that affected single women the most. We then briefly discuss other tax changes that affected broader populations, including our sample of single men. Among low-income single women, the primary changes came from large expansions of the Earned Income Tax Credit (EITC), which increased the incentive to participate in the labor force.[2] The size of the EITC, which is a refundable tax credit, depends on earned income and the number of qualifying children. The EITC tax schedule has three regions. Over the "phase-in" range, a percentage of earnings is transferred to individuals. Over the "plateau" region, an individual receives the maximum credit, after which the credit is phased out.

A small EITC was first introduced in 1975. The EITC was expanded substantially in the tax acts of 1986, 1990, and 1993. The 1986 expansion of the EITC increased the phase-in rate and region. These changes were reinforced by increases in the standard deduction and the dependent exemption to reduce income tax liabilities for tax filers at the bottom of the income distribution. The largest expansion of the EITC was in 1993. This reform increased the additional maximum benefit for taxpayers with two or more children, which reached $1400 in 1996. The phase-in rate for the lowest-income recipients increased from 18.5% to 34% for families with one child and from 19.5% to 40% for families with two or more children. The tax act of 2001 reduced the bottom tax bracket rate from 15% to 10%. Figure 1 summarizes important features of the changes in tax policy over this period for our PSID sample of single women. From the mid-1980s to the mid-to-late 1990s, the fraction of earnings a woman keeps if she participates in the labor force rose substantially for single women with children relative to

[2] See Blank (2002), Hotz and Scholz (2003), Moffitt (2002), Moffitt (2003) and Eissa and Hoynes (2006) for reviews of the literature on welfare and the Earned Income Tax Credit.

those without children.[3] While both single women and men tend to have incomes that are lower than the mean, tax policy toward higher-income individuals affects many single taxpayers. Broadly speaking, the 1981, 1986, 2001, and 2003 tax acts tended to lower marginal income tax rates on higher-income taxpayers relative to lower-income taxpayers, whereas the 1990 and 1993 acts tended to raise them.

While we primarily focus on tax policy in this paper, it is worth discussing changes in welfare policy, which we sometimes include as a control variable. Prior to 1997, Aid to Families with Dependent Children (AFDC) provided cash payments primarily to single mothers with children. The Food Stamp program gives low-income households coupons to purchase food. AFDC program parameters were set by the states. Most Food Stamp parameters are the same in all states, but because eligibility for Food Stamps and AFDC interact, people in similar situations in different states may receive different benefits under Food Stamps. Both of these programs had secularly growing expenditures until the mid-1990s. The typical effective tax rate imposed by the AFDC program was two-thirds. From 1980 through 1993, mean benefits for a working single mother remained roughly constant as implicit tax rates were reduced. Under AFDC, states could receive waivers to experiment with the parameters of their welfare programs. Between January 1993 and August 1996, the federal government approved welfare waivers in 43 states. Under waiver programs, states usually made welfare eligibility criteria more stringent and reduced the generosity of welfare benefits. In 1997, the Personal Responsibility and Work Opportunity Reconciliation Act replaced AFDC with Temporary Assistance to Needy Families (TANF), resulting in a wide variety of changes to the welfare system, including further cuts in average welfare benefits, work requirements, and more stringent time limits.

2. Data

We use three datasets that are described more fully in our data appendix. Our main analysis uses the Panel Study of Income Dynamics. We use data from 1976-2005 on unmarried heads of household aged 25-55 (inclusive), excluding cohabitators, who appear in at least two

[3] We describe below how we calculate the fraction of earnings a woman keeps if she participates in the labor force.

survey waves.[4] We focus on single women and men for a number of reasons. First, because married women's labor supply decisions interact with their husbands', their labor supply responses cannot be interpreted in terms of a canonical single-agent model such as Becker (1965) or Gronau (1977). By looking at singles, we provide evidence on these basic models of time allocation. Second, married individuals' labor supply decisions may interact with each other (Blundell and MaCurdy 1999), complicating estimation of their labor supply decisions. It is difficult to measure the true average tax rate for married individuals: this can be done by assuming that one spouse takes the other spouse's earnings as given in making the labor supply decision, but there is evidence that this produces substantially biased estimates of labor supply parameters (e.g. Gelber 2010). Estimation of married couples' labor supply responses to taxation instead requires credible independent variation in the tax rate of each spouse, but spouses almost always face the same tax rate in the U.S. Focusing on singles avoids these difficult issues. Third, many of the policies we examine were specifically oriented toward increasing the labor force participation of single mothers, providing fruitful exogenous variation.

Following previous literature, we use data only from the nationally representative Survey Research Center component of the PSID sample and exclude observations with allocated values of any outcome variable. We measure labor force participation, usual weekly hours of market and home work, earned and unearned income, and demographics. Usual weekly hours worked includes hours worked at both main and extra jobs during the previous calendar year. We construct a binary variable measuring labor force participation, which is equal to one if the respondent has positive usual hours worked and is equal to zero otherwise.[5] As our measure of housework, we use the answer to the following question: "About how much time do you spend on housework in an average week? I mean time spent cooking, cleaning, and doing other work around the house." We use PSID data beginning in survey year 1976 because that is the first year this question was asked. For further details about the construction of our dependent variables, please refer to the Data Appendix. All observations are weighted by the PSID cross-sectional weights.

[4] Survey years 1976-2005 contain data on activities in the previous year, i.e. data on years 1975-2004.
[5] In Appendix Table 1 we show that our main results are robust to alternative measures of hours worked and labor force participation.

The sample of single women includes 9,242 observations, corresponding to 1,243 individuals. Summary statistics for the primary variables of interest are in Table 1. It is notable that individuals in the sample work nearly a full workweek (37.47 hours) on average. 89% of the sample works a positive number of hours during the year. For a comparison with the Current Population Survey, please see the Data Appendix. Figure 2 shows the trends over time in mean market work and housework among single women with and without children, using PSID data. Over the period of the primary policy changes, from the mid-1980s to the mid-to-late 1990s, mean hours worked rose markedly for single women with children relative to those without children. In other time periods, little relative change is seen over time in the two groups. The trends in housework in the two groups look like a mirror image of the trends in market work. Housework fell substantially for single women with children relative to those without children during the period of the primary policy changes, and the relative change in housework in the two groups is over half as large as the relative change in market work. Single men's summary statistics for the PSID, in Table 1 Panel B, differ markedly from single women's. The sample of men includes 6,230 observations, corresponding to 1,069 individuals. Male labor force participation and mean hours worked are high (94% and 44.4 hours, respectively). Mean male housework is 7.45 hours, and the mean number of children is .12.

Our more detailed time use data use come primarily from the repeated cross sections assembled by Aguiar and Hurst (2007a), henceforth AH.[6] The reader can review their paper for a detailed description of the data. AH use data from 1965, 1975, 1985, 1992-4 (referred to as "1993" for concision), and 2003. AH code time use categories as consistently as possible across cross sections. We make the following changes relative to the AH data. We use data from 1975-2004 and restrict the sample to unmarried female heads of household aged 25-55 (inclusive). We exclude the 1965 cross section since it is unrepresentative of the country (with no sample weights to make it representative), and since it is outside of the time frame we consider in our analysis of the PSID and CEX. For the 1993 cross-section, number of children is missing, though a variable measuring the presence of a child is available. As a result, we impute it by

[6] Books on time use include Becker and Ghez (1975), Juster and Stafford (1985), Robinson and Godbey (1999), and Hamermesh and Pfann (2005). Ramey (2008) critiques some aspects of the AH definition of leisure; AH (2008) respond.

assuming that everyone with at least one child has exactly two children.[7] The 2003 AH data come from the American Time Use Survey (ATUS), and we supplement the 2003 data with data from the 2004 ATUS cross-section to increase sample size and match exactly the final labor market year in the PSID. We also construct an analogous sample of time use data for single men.

We follow AH in defining several alternative measures of leisure and home production. Leisure 1 consists of activities broadly relating to socializing, relaxing, and enjoyment of life. Leisure 2 includes all of the activities in Leisure 1, plus eating, sleeping, and personal care. Leisure 3 includes all of the activities in Leisure 2, plus child care. AH define Home Production as preparing meals, housework, and gardening and pet care. They define Non-Market Work as Home Production plus time spent obtaining goods and services. Summary statistics from the time use data are displayed in Table 1 Panel C. The time use data cover only selected years during the period 1975-2004, so it is unsurprising to find some minor differences in the summary statistics. There are two notable differences between the PSID and the time diary data. Market hours of work are lower in the time diary data than in the PSID, consistent with the standard finding that time use data show lower hours worked than the PSID or Current Population Survey (Aguiar and Hurst 2007a). Mean hours of housework is substantially lower in the time diary data; as noted by Knowles (2005) and confirmed in our data, housework in the PSID corresponds much more closely to "home production" in the time diary data.

While we follow previous studies in our measures of housework, home production and leisure, these measures may have limitations. For example, some elements of housework (as measured in the data) may involve elements of leisurely activities, and residual time may involve elements of home production. A full discussion of the definitions and measurement of home production and leisure is beyond the scope of this paper, but we briefly comment on these issues here. The classic work of Reid (1934) defines home production as "those unpaid activities which…might be replaced by market goods, or paid services, if circumstances such as income, market conditions, and personal inclinations permit the service being delegated to someone outside the household group." In Reid's view, in other words, home production consists of activities for which there is a high degree of substitutability between time and market goods.

[7] The results are not sensitive to other imputation strategies.

While most elements of housework such as cooking and cleaning have market-based substitutes, many activities may be included in home production that fall outside of the PSID category of "housework," which is a potential limitation of the PSID data. Turning to the definition of leisure, if we define leisure according to the enjoyment of an activity—a definition that Ramey (2008) partly relies on—some elements of housework could have enjoyable or leisurely components for some individuals. This constitutes a second potential limitation of the PSID data. Meanwhile, market work is typically considered to be any time spent in return for remuneration, even if this time may have elements of "leisure" in the sense that it may be pleasurable or involve substantial amounts of time spent idle. This follows the distinction in Becker (1965) between time spent earning wages and all other uses of time. While we may measure any of these variables—market work, housework, home production, or leisure—with error, classical measurement error should affect the standard errors of the estimates but not the point estimates themselves. Moreover, in the repeated cross sections of time diary data, we are able to estimate the results under multiple alternative definitions of leisure or home production, and we find generally similar results across all of these definitions.

We use data from the CEX interview sample from 1980-2003 on unmarried female heads of household aged 25-55 (inclusive). We use the raw CEX data produced by the Bureau of Labor Statistics measuring expenditures on various disaggregated expenditure categories of interest, as well as demographics including state of residence and number of children. As in Charles, Hurst, and Roussanov (2009), we collapse the quarterly CEX data to the yearly level as described in the Appendix. Summary statistics for the CEX are shown in Table 1 Panel D. Demographics are within the range expected from the PSID, given the differing sampling methods and time periods covered. We again construct an analogous sample of CEX data for single men.

3. Empirical Specifications

In our basic empirical specification in the PSID, we perform an OLS regression of usual weekly hours of time spent on an activity (market work, housework, or other time) for individual

i in year t on the average net-of-tax share (1-τ), a measure of unearned income Y, a set of demographic control variables X, year fixed effects θ, and individual fixed effects Γ:

$$h_{it} = \beta_1(1-\tau_{it}) + \beta_2 Y_{it} + X_{it}\beta + \theta_t + \Gamma_i + \varepsilon_{it} \qquad (1)$$

The effective average net-of-tax share is in turn defined as the fraction of earnings that an individual would keep, if he or she chose to work:

$$(1-\tau_{it}) = [E_{it} - (T_{w,it} - T_{nw,it})]/E_{it}$$

where E is earnings if you work, T_w is net taxes paid if you work, and T_{nw} is net taxes paid if you do not work. This measures an individual's incentive to participate in the labor force and is relevant if an individual makes a choice between staying out of the labor force and participating in the labor force and earning the pre-tax amount E. This may be the relevant choice if individuals face fixed costs of work or a discrete menu of options of numbers of hours to work.[8] For single men, we also report results using the individual's marginal tax rate at earnings level E as the independent variable of interest, since men's labor supply is typically analyzed as varying along the intensive margin.[9]

Since earnings-if-work E is unobserved, we impute E by performing a regression of actual annual earnings on demographic variables and year fixed effects:[10]

$$\ln(E_{it}) = X_{it}\beta + \phi_t + \varepsilon_{it} \qquad (2)$$

The demographics included are a full set of dummies representing all possible values of age, education, and number of children.[11] Since earnings are approximately lognormally distributed, we log earnings before including it in the regression; similar but slightly less precise results are obtained when we use a linear regression to impute earnings. Only individuals with positive values of labor income are included in the earnings imputation regression. We then construct predicted earnings for each individual in each year using the coefficients estimated from this

[8] Previous work has found a strong extensive margin response to tax incentives for single mothers but no evidence of an intensive margin response (see the surveys cited above). Consistent with these findings, when we include both the average and marginal tax rate in our regressions for single women, the coefficient on the marginal tax rate is small and insignificant, and the coefficient on the average tax rate is large, highly significant, and very similar to the coefficient estimates in the main specifications. Our specification above omits the wage because wages are not observed for women who do not work. We later address this by including a measure of the wage in several specifications.

[9] Most studies of male labor supply responses to taxation, such as Hausman (1981), implicitly assume that male labor supply varies along the intensive margin and study the response of labor supply to the marginal tax rate.

[10] We address self-selection into the labor force in several specifications discussed later.

[11] Only the "main effects" of these demographics are included; interactions of the demographic variables with each other are not included in the regressions.

regression. Earnings are imputed for those with both positive earnings (whose actual earnings could be endogenous) and for those with zero earnings (whose earnings if they worked are unobserved). This imputation strategy bears similarities to the strategies in Meyer and Rosenbaum (2001) and Blau and Kahn (2007).

Using imputed earnings E_{it} for each individual in each year, we then construct simulated average and marginal tax rates using the Taxsim program of the National Bureau of Economic Research (Feenberg and Coutts 1993). We include federal and state income and payroll taxes.[12] For calculating welfare benefits, we use earnings to construct the value of food stamp and AFDC/TANF benefits if the individual does and does not work. These are constructed using the information on food stamp and AFDC/TANF generosity at different income levels in the Urban Institute's TRIM3 database. For constructing these, we incorporate the same information as Meyer and Rosenbaum (2001).

Since all versions of (1) include individual fixed effects, as well as controls for (at a minimum) the same demographic variables that appear in the imputation regression (2), identifying variation in the constructed tax rates in (1) will derive from variation across individuals and time in national and state policy changes. In particular, we exclude from (1) the interactions of year dummies with the demographic variables (age, education, and number of children), and we also exclude from (1) the interactions of state with year. These excluded interactions identify the regression, as we now describe. Since only demographics and year dummies appear in the imputation regression (2), in a given year and state individuals with the same values of age, education, and number of children will have the same imputed tax rate. Nonetheless, the tax schedule varies across year, and differentially so for individuals with different demographic characteristics, so the exclusion of the interaction of demographics with year helps identify the regression. For example, over the period under consideration single women with children on average received tax cuts relative to single women without children. We include the main effects of year and number of children in (1) but exclude their interaction, and thus (1) is identified partly because single women with and without children were

[12] Following Meyer and Rosenbaum (2001), we do not use capital income in constructing marginal tax rates. The results are not sensitive to this choice.

differentially affected by the tax policy changes considered.[13] We also investigate a substantial number of variants of (1), described more fully in our results section. It is worth noting that estimates of the response to taxation in a panel must address mean reversion in income (Moffitt and Wilhelm 2000; Gruber and Saez 2002). As Moffitt and Wilhelm (2000) note, this imputation procedure avoids the problem of mean reversion.

In the repeated cross sections of data from the CEX, our basic specification is the same as (1) but lacks individual fixed effects:

$$h_{it} = \beta_1(1-\tau_{it}) + \beta_2 Y_{it} + X_{it}\beta + \theta_t + \varepsilon_{it} \qquad (3)$$

In the repeated cross sections of data on time use, our specification is the same as (3), but we lack a consistent measure of unearned income and omit this from the regression:

$$h_{it} = \beta_1(1-\tau_{it}) + X_{it}\beta + \theta_t + \varepsilon_{it} \qquad (4)$$

To hold the method constant across datasets, we use coefficients obtained from the PSID to impute earnings and simulated tax rates in the time use and CEX data. Since we initially impute taxes and then use an imputed variable in the main regressions (1), (3), and (4), we bootstrap the standard errors in these regressions.[14]

Limitations

This basic strategy has a number of limitations, some of which are addressed in detail in the results section. It is important to note two remaining issues. First, the labor supply specification we consider can be derived from a model of utility maximization in a static context (Blundell and MaCurdy 1999). This can be interpreted in a dynamic context only in the presence of myopia or constrained capital markets. We interpret our findings on consumption in terms of a static Becker model of consumption and time allocation, but we acknowledge that this interpretation is less clear in a dynamic model in which consumption and labor supply decisions are made jointly. Second, individuals who go from single to married are excluded from the sample, and those who choose to divorce are included in the sample. These choices could

[13] We have tried including interactions of all of the state dummies with all of the year dummies and obtained similar results to the regressions reported. Thus, it appears that the excluded interactions of demographics with year are the key variables driving the estimation.

[14] We bootstrap as follows. We draw a subsample of the individuals who appear in the regressions with replacement; run the earnings imputation, using all years of data on these individuals to account for individual-level serial correlation; calculate the tax rate using these values of imputed earnings; and then run the main regressions (1), (3), and (4) using this subsample of individuals and these imputed values of the tax rate. We then calculate standard errors using 100 bootstrap replications.

themselves be influenced by policy variation (see Meyer 2009 for a survey). Alm and Whittington (1995) find a substantial impact of the tax consequences of marriage on the marriage decisions of cohabitators, who are excluded from our sample, and little evidence of responses among other groups.

4. Results: Panel Study of Income Dynamics

A. Basic Estimates for Single Women

The main PSID results are in Table 2, organized into four panels. Panel A shows results from the PSID with a dummy for labor force participation as the outcome and a linear probability model;[15] Panel B shows usual hours worked as the outcome; Panel C shows usual hours of housework as the outcome; and Panel D shows residual (non-housework, non-market work) time as the outcome. Column 1 of Table 2 shows the results with the basic specification, including individual and year fixed effects, as well as a full set of dummies representing all possible values of age and number of children. The effect on labor force participation in Panel A is strong and precisely estimated. The implied elasticity of participation with respect to the net-of-tax share is .41, which falls within the existing range of estimates (.35 to 1.7, with a central elasticity of .7; see Eissa, Kleven, and Kreiner 2008). Column 1 of Panel B likewise shows a strong and highly significant effect on usual hours worked, with an elasticity of .53.

Column 1 of Panel C shows that this corresponds to a strong negative effect of the net-of-tax share on usual hours of housework. The final row of Panel C (labeled "% of change in hours worked") shows that the coefficient on the net-of-tax share variable (-15.69) is 66.91% as large as the coefficient (23.45) when hours worked was the dependent variable in Panel B Column 1, suggesting that most of the increase in hours worked is accounted for by decreases in time spent on housework. Column 1 of Panel D shows a smaller and insignificant decrease in other time, with a corresponding coefficient of -7.76, and with a confidence interval that does not rule out a substantial response. The final row of Column 1 of Panel D shows that the point estimate of the effect of the tax variable on other time is 33.09% as large as the point estimate for market work; the time budget constraint implies that the absolute value of the decrease in housework plus the

[15] We find similar results when we use Chamberlain's conditional logit.

absolute value of the decrease in other time equals the increase in market work.[16] The coefficient on the net-of-tax share when housework is the dependent variable is significantly more negative than the coefficient on the net-of-tax share when other time is the dependent variable ($p<.01$).[17]

Several aspects of these results are notable. First, different aspects of non-market time are differentially affected by taxes. Housework is estimated to change more in response to taxes than residual time is. Second, the point estimate of the elasticity of hours worked with respect to the net-of-tax rate is only a bit larger than the point estimate of the elasticity of labor force participation with respect to the net-of-tax rate (.53 and .41 in the baseline specification, respectively). This suggests that, consistent with the findings of previous literature, most of the response to the incentives occurs through the extensive margin labor supply choice, rather than through the intensive margin labor supply choice (see, for example, Eissa and Hoynes 2006). Third, our results are consistent with the model of Gronau (1977). In the Gronau model, individuals choose among three possible uses of their time: market work, home work, and leisure time. The model predicts that home production decreases in response to entry into the labor force induced by a decrease in the tax rate. If we interpret the PSID measure of housework as a measure of home production, then our results are consistent with the Gronau model: housework falls significantly in response to a fall in the tax rate.

B. Comparison to Specification without Individual Fixed Effects

For comparison, Column 2 shows the results from the specification in Column 1 without individual fixed effects. In this specification we effectively treat the data as repeated cross sections, as in most previous studies of the effects of policy changes on labor supply. In these regressions we control for dummies for an individual's educational attainment categories; this variable appears in the earnings imputation but is collinear with the individual fixed effects, so

[16] From the regressions in which market work and housework are the dependent variables, the confidence intervals on the tax rate are large enough that we cannot rule out that the entire change in market work is accounted for by the change in housework.

[17] We consider the baseline estimates to be a central specification for a number of reasons. The baseline specification includes the longest possible time period and generates broadly similar results to all other specifications except when we instrument for the average net-of-tax rate (Column 10 of Table 2). The IV for the net-of-tax share could be considered a second central specification but cannot be performed in the time use and expenditure results because they are not panel datasets and therefore lack a measure of a person's average income over several years.

we omit it from the specification in Columns 1 but must include it in Column 2 since it appears in the imputation. It is notable that when labor supply is the outcome in Panels A and B, the coefficients on the net-of-tax share are about 50% larger in Column 1 (with individual fixed effects) than in Column 2 (without individual fixed effects). The coefficient on the net-of-tax share is still approximately 50% larger with individual fixed effects than without individual fixed effects under all of the other specifications we consider below, including when we omit or include any combination of additional controls we have tried.

These results suggest that labor supply regressions that do not include fixed effects may estimate substantially downward-biased effects of taxes on market work due to changes in the composition of population studied. If, due to compositional changes across the demographic groups observed in the data, the unobserved taste for market work tended to decrease relatively more in demographic groups whose taxes on average fell relatively more during this period, this may lead to a downward bias in the estimated effect of taxes on market work. To illustrate this point, consider a differences-in-differences comparison of labor supply and taxes over time for single women with and without children: in repeated cross sections of data, tax rates tended to fall for those with children relative to those without children over the sample period, and labor supply tended to increase for those with children relative to those without children over the sample period. Suppose that those who became single women with children over the sample period (but started out as single women without children) tended to have lower unobserved tastes for market work both when compared with the unobserved taste for market work of those who remained single women with children throughout the sample period, and when compared with the unobserved taste for market work of those remained single women without children throughout the sample period. All else equal, this would tend to bias downward the estimated coefficient on the net-of-tax rate. This is potentially relevant because the share of the population comprised of single women with children increased greatly over the period studied (Meyer and Rosenbaum 2001).

C. Specification Checks

We now turn to various specification checks. We concentrate our effort on robustly establishing the market work and housework results in the PSID because only the PSID offers panel data and consistent measures of these outcomes. These specification checks are oriented

toward addressing a number of possible concerns. First, welfare reform also occurred during our sample period, and variation in these policies could have effects on labor supply. We address this issue in Columns 3 and 4. Second, the correlation we find between taxes and labor supply could be confounded by the influence of other factors not related to tax variation. We address this by controlling for a variety of other factors in Columns 5 through 7. Third, we address self-selection into the labor force and the presence of concurrent wage variation in Columns 8 and 9. Fourth, we observe our measure of tax incentives with error, which we address in Column 10. Finally, we investigate other definitions of the dependent variable in Appendix Table 1 Columns 1-3. Throughout all of these robustness checks, the same pattern of results will hold: a strong positive effect of the net-of-tax share on market work, a negative effect on housework that accounts for around half or more of the increase in market work, and an insignificant effect on other time.

Welfare Variation

Column 3 adds to the regression a measure of the incentives created by transfer programs. We control for the "welfare average tax rate," defined as welfare transfers if an individual works minus welfare transfers if an individual does not work, as a fraction of imputed earnings. "Welfare" includes both food stamps and AFDC/TANF transfers. The coefficient on the net-of-tax share is nearly unchanged from Column 1. Welfare benefits have a significant effect on both hours worked and housework of the expected (opposite) sign from the net-of-tax rate, although the coefficient on the welfare average tax rate is substantially smaller than the coefficient on the net-of-tax rate.[18] Column 4 limits the sample to the period prior to 1993, when state welfare waivers were first implemented, in order to isolate tax variation from variation in welfare program parameters other than monetary benefits. We again find a similarly-sized coefficients on the net-of-tax rate, but because the sample size is much smaller, it is unsurprising that the coefficients typically lose significance.[19]

Other Potential Confounding Factors

In Column 5, we recognize that non-labor income is not exogenously determined and instrument for it using the size of welfare benefits that a woman would receive if she did not

[18] Meyer and Rosenbaum (2001) find that welfare played a smaller role than taxes in explaining changes in hours worked over the period 1984-1996. They find no evidence for an effect of Medicaid benefits on labor supply.
[19] We also tried controlling for state welfare waivers and their interaction with number of children and found similar results.

work. We recognize that welfare benefits have both price and income effects on labor supply, and so we also control separately for the welfare average tax rate from Column 3. A limitation of this approach is that the welfare average tax rate is separately identified from the instrument, welfare benefits if an individual does not work, solely off functional form. The results are again similar to those in Column 1, with a slightly larger fraction of the change in market work accounted for by the change in housework.

Column 6 controls for various other factors that could impact labor force and housework activity: the minimum wage in the state, state GDP, the presence of a welfare waiver, average labor income for an individual over the full sample period interacted with year, and interactions of dummies for five education groups with a full set of year fixed effects. The interaction of education group fixed effects with year fixed effects controls for demand shocks potentially arising from sources such as skill-biased technological change. The results are remarkably similar to the basic set of results in Column 1.

Column 7 is an important robustness check because it represents a substantially different identification strategy, which proves to yield similar results to the basic strategy. In Column 7, we use the specification in Column 1 but add interactions of a dummy for whether a woman has a child with the year dummies, which we refer to as "child-by-year fixed effects." This is particularly noteworthy since the child-by-year fixed effects take out *all* of the variation displayed in Figures 1 and 2. In other words, we know from the above discussion and from previous literature that usual hours worked increased substantially for single women with children relative to single women without children over the sample period, and that the net-of-tax share rose for single women with children relative to single women without children over this period. By putting in child-by-year fixed effects, we investigate whether other sources of variation also drive increased hours worked and decreased housework. Including child-by-year fixed effects also addresses the potential concern that women with and without children exhibited differential trends in time use over this period for reasons other than tax policy.

As shown in Figure 3, the net-of-tax share rose much more for low-income women with children than for higher-income women with children.[20] The figure shows that correspondingly, the change in market work was substantially more positive, and the change in housework substantially more negative but smaller in absolute value than the change in market work, for high-income women with children than for low-income women with children. This illustrates an important source of variation driving our regressions in Column 7. In this specification, the coefficients are still very significant and large. The point estimates are about one-third smaller than those in Column 1, but as before, the effect of taxes on hours of housework is greater than half of the effect of taxes on hours of market work.[21]

Addressing the Presence of Wage Variation and Self-Selection

Column 8 addresses the possibility of self-selection. We perform a Heckman selection correction and add the inverse Mills ratio to the right-hand-side of the imputation regression (2).[22] We identify the selection term by calculating the average net-of-tax share that an individual with their true number of children and with average income (over all individuals in the sample) would face in a given year. We add this tax rate to the first stage predicting labor force participation but omit it from the second stage. We then estimate (2) and compute imputed incomes for each individual, on the basis of which we calculate imputed net-of-tax shares using the method described in Section 3. Column 8 shows results using the selection-corrected average tax rate, which yields similar results to Column 1, with somewhat larger point estimates.

Column 9 instruments for the net-of-tax wage using the net-of-tax rate. Since wages are not observed for those who do not work, we impute wages using demographics. We perform regression (2) for labor force participants, with the hourly wage rate as the dependent variable, and where the hourly wage rate is constructed by dividing yearly earnings by yearly hours worked. The endogenous variable is then the imputed wage rate multiplied by the net-of-tax rate constructed using an individual's average earnings over the full sample period. The instrument

[20] Education and age appear in our imputation regression and drive substantial variation in imputed income.

[21] To address the possibility that an individual's number of children could be endogenous to tax policy, we calculated the maximum number of children that an individual has over the full sample period, rather than using the actual number of children that the individual has at a given point in time, and use this (maximum) number of children to calculate the net-of-tax share in each year. We obtained similar results to those in the basic specification. We also removed individuals who are living with adult relatives (who might also be doing housework) and obtained similar results.

[22] This is similar to the imputation in Eissa and Hoynes (2004).

is the net-of-tax rate constructed using earnings imputed with demographics.[23] The coefficient on the net-of-tax wage represents the effect on hours worked or hours of housework of a $1 increase in the net-of-tax wage. While they are scaled differently, the results in Column 9 are similar to those we have found previously, both in terms of the estimated elasticities and in the sense that most of the increase in hours worked is accounted for by the change in hours of housework, with an insignificant effect on residual time.

To further investigate the responsiveness of hours worked with respect to the net-of-tax wage, we ran a selection-corrected Tobit. Following the procedure suggested in Wooldridge (2002), we first ran a Tobit of hours worked on the actual net-of-tax hourly wage rate and the basic control variables (omitting individual fixed effects and treating the data as repeated cross sections); for observations with positive hours, we obtained the Tobit residuals; for observations with positive hours, we regressed the net-of-tax hourly wage on the basic control variables, the Tobit residuals, and the average net-of-tax share computed using an individual's actual number of children and the average income over all years in the full sample (the last of which provides the identifying variation); obtained the fitted values; and finally ran a Tobit of hours worked on the basic controls (omitting individual fixed effects) and the fitted values. This effectively constitutes an entirely different way of assigning net-of-tax wages to non-participants, than our imputation procedure for assigning tax rates in the main specification; the method for assigning the net-of-tax rate here is the standard selection correction technique. The estimated elasticity of hours worked with respect to the net-of-tax wage, computed at the mean, is .47 (with a standard error of .22). This is in the same range as the elasticity of hours worked with respect to the net-of-tax rate we estimate in Column 9 (.63).[24]

In our discussion of our results, we interpret an increase in the net-of-tax rate as representing an increase in the net-of-tax wage. Several further analyses bolster the conclusion

[23] Note that division bias should not affect the results, both because we use the imputed (rather than actual) wage, and because the instrument is not affected by division bias.

[24] In order to address selection in yet a different way, we performed the earnings imputation instead by matching labor market participants and non-participants in a given year through a propensity score (calculated through a logistic regression of a labor force participation dummy on dummies for age, education, number of children, and race). We then replaced the net-of-tax share of a non-participant with the net-of-tax share of the participant to which she was matched and used this as our measure of the non-participant's net-of-tax share. We again obtained similar results.

that even after accounting for wage variation, we still find similar results regarding the effect of taxes. Single women with and without children respond similarly to economic shocks such as changes in the unemployment rate.[25] It is therefore reasonable that demand shocks to the two groups changed their wages in similar ways. Because they are competing in similar labor markets, it is unlikely that the incidence of the policy changes on the pre-tax wage was different in the two groups. As a piece of evidence that the pre-tax wage was not positively correlated with the net-of-tax share (due to tax incidence or demand shocks), we regressed the pre-tax hourly wage of labor market participants on the imputed net-of-tax share, plus age, number of child, and year fixed effects. We found a small and insignificant negative coefficient on the imputed net-of-tax share.

Measurement of the Average Tax Rate

In Column 10, we address the fact that our measure of the average net-of-tax share is a noisy measure of the true fraction of earnings taken away from a given individual, both because our imputation may not measure the true earnings potential of any given individual, and because we do not have administrative data on variables such as taxable income and number of dependents. To address measurement error, we form a second measure of the average net-of-tax share that an individual faces. Our second measure of the average net-of-tax share is calculated using an individual's average labor income over the full sample period. In a given year, we calculate the average net-of-tax share that each woman would face given that she earned her average labor income over the full sample period and faced the true tax schedule in that year. We then instrument for this measure of the average net-of-tax share using the measure based on imputed earnings that we have used in the previous specifications. This makes a large difference to the estimated coefficients, almost doubling them relative to Column 1, and moving the implied elasticity of participation a bit above the midpoint of elasticities previously estimated in the literature. The larger coefficient estimates suggest that measurement error may be leading to attenuation bias in other specifications. The central conclusion that we take away from the PSID tables—that at least half of the increase in market work came from housework—still holds.[26]

[25] Meyer and Rosenbaum (2001) discuss the validity of this control group in detail.

[26] In another check on the imputation, we formed imputed labor income by first imputing a person's hourly wage using demographics and then multiplying the imputed hourly wage by the mean number of hours in the sample. We obtained similar results.

Another issue relating to the specification of the tax rate variable is the possibility that higher moments of the distribution of average tax rates conditional on demographics are important, rather than only the mean. To address this issue, we performed quantile regressions of earnings on our demographic variables for the 10th, 20th, 30th…90th, 99th quantile of the earnings distribution. We then imputed income at each of these quantiles, calculated the implied average net-of-tax share at each quantile, and for each individual in each year averaged together the implied net-of-tax shares over all quantiles. We then used this measure of the average net-of-tax share in (1). We obtained similar results to the baseline specification, which were less precise but still highly significant. In still another check on the specification of the average tax rate, we used the log of the net-of-tax share, rather than its level, and estimated similar elasticities.

Other Definitions of the Variables

The specifications in Columns 1-3 of Appendix Table 1 use other definitions of the dependent variable. In Column 1 of Appendix Table 1, we show the results when yearly hours of market work is the dependent variable. Putting the coefficient on the average net-of-tax rate (991.17) in weekly terms by dividing by 52 yields an estimated weekly increase of 19.06, which is similar to the coefficient estimate (23.45) in the baseline specification. We previously defined labor force participation as positive usual weekly hours of work, in order to be consistent with the definition of our hours worked variable. In Column 2 of Appendix Table 1, we instead define labor force participation as "currently working" and obtain similar results. In Column 3, we define labor force participation as positive hours of work over the course of the year and again obtain similar results.

D. Heterogeneity Analysis

Table 3 shows an analysis of the heterogeneity of the effects across population groups. Individuals under 40 show a larger reaction to the net-of-tax share than those over 40. We split the sample into women with and without children. Interestingly, for women with children, the point estimates show that most of the increase in market work is accounted for by decreases in housework, whereas for women without children, the increase in market work is accounted for by decreases in residual time. Since we obtain significant hours worked responses when we run the regression on only women with children, this again demonstrates that our results rely on more variation than simply the comparison over time of single women with and without children.

In results not shown, we split the sample into halves by imputed income, in order to assess whether the policy changes tended to affect those expected to be in lower or higher income ranges. The point estimates suggest that among lower-income individuals, housework responds to taxation more than among higher-income individuals (similar to the results in Meyer and Sullivan 2008).

E. Correlations between Housework and Market Work

To investigate how market work and housework relate in the summary statistics, we regressed usual hours of market work on a dummy for participating in the labor force, individual fixed effects, year fixed effects, and the controls from our basic specification; in a second regression, we performed this regression but with usual hours of housework as the dependent variable; and in a third regression, we performed this regression but with residual time as the dependent variable. The results are shown in Columns 4 through 6 of Appendix Table 1. When individuals participate in the labor force, the decrease in their housework time accounts for only a small fraction of the increase in their hours of market work. We obtain very similar results when we omit individual fixed effects.

This finding is noteworthy for two reasons. First, this is the opposite result from what we obtain using variation coming from policy changes, highlighting the important role that these changes play in identifying the results. A potential reason for the divergence is unobserved heterogeneity: individuals who do larger amounts of market work also tend to do larger amounts of housework. It is likely that in a cross-section, employed individuals have substantially different tastes for market work and leisure than individuals who are not employed. The results in Columns 4 to 6, furthermore, are quite similar when we do and do not include individual fixed effects. This leads us to believe that the fixed effects estimates in Columns 4 to 6 are also strongly driven by (time-varying) unobserved heterogeneity. Second, one possible objection to the main results of the paper is that individuals could inaccurately report a roughly constant sum of housework and market work, perhaps because they feel they ought not admit that they do little work in either the market or the home. Column 5 shows that reported housework is only slightly lower among labor force participants than among non-participants, so such a story cannot explain our main results.

F. Results for Single Men

In Table 4, we investigate single men's responses to tax policy. Marginal tax rates for single men in different income groups show substantial relative variation over time in our sample, including through the fall in marginal tax rates for high-income men relative to low income men from the tax reforms of 1981 and 1986. In Columns 1-4, we investigate the response to the marginal tax rate. The marginal tax rate is typically the independent variable of interest for analyzing men's responses to taxation, since male labor force participation is extremely high and men are assumed to respond to taxes primarily along the intensive margin. Interestingly, the point estimates of the response are all remarkably small, and the standard errors are small enough that we can rule out large responses. This is true also when we include any of the relevant extra controls used in the specifications in Table 2. For comparability to our analysis of single women, in Columns 5-8 we also show the results when we use the average net-of-tax share as the independent variable of interest. As before, we find no evidence of significant responses, and again this result continues to hold with any combination of controls or any other empirical strategy we have tried. When we include both the average and the marginal net-of-tax rate as independent variables, we continue to find insignificant responses to taxation.

G. Elasticity of Substitution Between Home and Market Goods

Our findings relate to the literature in macroeconomics, following from Benhabib, Rogerson, and Wright (1991), that explains the magnitude of business cycle fluctuations in part through substitutability between market and home goods. Following one of their analyses, suppose utility is defined as:

$$U_i = \ln[a_i c_{mi}^e + (1-a_i)c_{ni}^e] + v_i(1-h_{mi}-h_{ni})$$

where c_{mi} is consumption of market goods equal to net-of-tax earnings $w_i h_{mi}(1-\tau_i)$ (where w_i is the wage and τ_i is the tax rate), c_{ni} is consumption of non-market goods, h_{mi} is market work, h_{ni} is non-market work, v_i is the utility of leisure, and all agents have the same production technology $c_{ni}^e = Bh_{ni}$. Then the first order condition for agent i implies:

$$\ln(h_{mi}/h_{ni}) = \frac{1}{e-1}\ln(B) - \frac{e}{e-1}\ln(w_i) - \frac{e}{e-1}\ln(1-\tau_i) + \frac{1}{e-1}\ln(\frac{1-a_i}{a_i})$$

Assuming that the final term is a constant that is taken out by individual fixed effects, and that the wage w_i changes equally for individuals in the treatment and control groups in the empirical analysis (as our data bear out) so that the wage term can be treated as a constant, we can estimate $-e/(e-1)$ by subtracting the elasticity of housework with respect to the net-of-tax share from the elasticity of market work with respect to the net-of-tax share. The elasticity of substitution

between home and market goods is thus calculated using only information from the PSID about the responses of market work and housework to tax variation.

Our baseline estimates from the PSID of the relevant elasticities for single women imply that *e* is .62,[27] which is remarkably close to the Benhabib, Rogerson, and Wright (1991) estimate of .60. This implies that the elasticity of substitution 1/(1-*e*) of market and home consumption is 2.61.[28] However, for single men, our results imply an elasticity of substitution of market and home goods of only 1.17, and the 95% confidence interval rules out an elasticity larger than 1.66. While some previous work has found little substitutability among single men, our low upper bound on the substitution elasticity is informative in ruling out substantial scope for substitution among this group.

5. Results: Time Diary Data

We next examine in greater detail the effect of taxes on time use using the repeated cross sections of time diary data assembled by AH (2007a). This is useful for at least two reasons. First, it allows us to check the results from the PSID against the results in other data. Second, the AH data contain a much more detailed breakdown of uses of time than the PSID, which contains only information on market work and housework. Since we are estimating a model without individual fixed effects, this raises the possibility that the results may be biased due to compositional changes in the population studied, as noted above. Insofar as we are investigating a similar set of results in the PSID and time use data, we might expect similar biases: a downward bias in the estimated effect of the net-of-tax rate on market work, an upward bias in the estimated effect on leisure, and little bias in the estimated effect on housework.

[27] When we implement this specification more directly by regressing the log of the ratio of market work to housework on the log of the net-of-tax share and the controls in our baseline specification (adding one to both market work and housework before logging so that we include zeroes in the regression), we estimate a coefficient on the log net-of-tax share of 2.39 with a standard error of .39, implying that the elasticity of substitution is 3.39. Adding 5 to both market work and housework before logging yields an elasticity of substitution of 2.56. The estimates for market work and home production in the repeated cross sections on time use imply an elasticity of substitution of 3.35 for single women.

[28] Rupert, Rogerson, and Wright (1995) estimate an elasticity of substitution between home and market goods for single women of 1.8. Aguiar and Hurst (2007b) estimate an elasticity of substitution between time and goods in home production for single women of 1.95.

The basic results for single women are shown in Table 5. Columns 1 and 2 show that as in the PSID, labor force participation and hours of market work rise significantly in response to an increase in the net-of-tax share. The coefficients on the net-of-tax share when labor force participation is the dependent variable (.47) and when hours worked is the dependent variable (35.57) are higher than the results of the basic specification in Column 2, Panels A and B of Table 2, in which the coefficients are .29 and 14.90, respectively.[29] Column 3 shows that housework falls in response to an increase in the incentive to participate in the labor force. The point estimate of the fall in housework is insignificantly smaller than in the PSID, which is unsurprising since mean hours of housework is lower in the time diary data. Similarly, the broader AH measure of "Home Production" falls substantially and significantly, with a coefficient a bit over half the size of the coefficient in Column 2. The effect on "Non-Market Work," equal to Home Production plus time spent obtaining goods and services, is similarly sized and significantly different from zero. Columns 6 through 8 show the effect on AH's various measures of leisure, Leisure 1 through Leisure 3. The estimated effect on leisure is negative, substantially larger than in the PSID, and significant for Leisure 1 and Leisure 2 but not but for Leisure 3. We cannot reject at conventional significance levels that the effect on home production is different than the effect on any of the measures of leisure. Overall, relative to the PSID results, the AH results also show a strong effect of taxes on housework (or home production or non-market work), but the AH data show more evidence that leisure also changes in response to changes in taxes.

Columns 9 through 12 show other outcomes of interest. Time spent preparing and eating meals falls insignificantly. Interestingly, time spent with children increases insignificantly, with a standard error that rules out a large decrease in time spent with children. To the extent that this regression is identified off the comparison over time of women with and without children, this result must be interpreted with caution because women without children spend little time with children. To address this concern, we estimated the regression only for women with children. This regression also showed no evidence that child care decreased significantly: with a sample size of 2,108, the coefficient on the net-of-tax share was 5.22, and the standard error was 8.68.

[29] The specification in Table 5 has no individual fixed effects and therefore is most comparable to Table 2 Column 2, which is also based on a specification with no individual fixed effects.

"Hard-working" individuals are often thought to sleep less than "lazy" individuals. In light of the view of some that "idle" single mothers need motivation from policy to "work harder," it is noteworthy that sleep is insignificantly changed by an increase in the net-of-tax share, with a small point estimate of the effect of taxes.[30] Finally, eating, sleeping, and personal care are sometimes considered together as a "tertiary" category alongside home production and leisure (e.g. Burda, Hamermesh and Weil 2008). Column 12 shows that this category falls insignificantly. We ran the same regressions on the sample of single men, but as in the PSID, we found no evidence of significant responses.

6. Results: Expenditure Data

Table 6 shows results for single women using expenditure data.[31] These data allow us to investigate how the patterns in time use interact with expenditure patterns; as we discuss below, the Becker model suggests that these decisions should be interdependent. In Column 1 of Table 6, we use PSID data on food expenditures and find a substantial positive but insignificant effect of the net-of-tax share on food expenditures.[32] Columns 2 and 3 rely on data from the Consumer Expenditure Survey. Since we are estimating a model without individual fixed effects in the CEX, this again raises the possibility that the results are biased due to compositional changes in the population studied. However, since we are typically investigating a very different set of dependent variables in the CEX from those we investigated in the PSID and time use data, these biases are difficult to anticipate. We investigate expenditures on domestic services and major appliances, since these seem most likely to be substitutable with home time.[33] The point estimates indicate that both rise, although the coefficients are insignificant. Among single men, we once again find no significant responses to tax policy among these expenditure categories and have omitted the results.

Comparison with the Becker Model

[30] Biddle and Hamermesh (1990) explore the relationship between market work and sleep.
[31] When we run regressions in the CEX of hours worked or labor force participation on the net-of-tax rate, analogous to those we ran in the PSID and time diary settings, we obtain similar results to those shown in Tables 2 through 5.
[32] Our effect on the level of expenditures on food at home or away in the PSID is likewise insignificant. See DeLeire and Levy (2005) on food expenditures by single mothers.
[33] The estimated effect on child care expenditures is very similar to the effect on expenditures on domestic services.

A rise in food expenditures, in combination with a decrease in time spent preparing and eating food, can be seen as consistent with the Becker model.[34] In the Becker model, individuals derive utility $U(Z_1, Z_2, \ldots Z_m)$ from consumption of commodities $Z_1, Z_2, \ldots Z_m$. Each of the Z_i, in turn, is produced using goods x_i and time T_i: $Z_i=f_i(x_i, T_i)$. This utility function is maximized subject to the time constraint ($T_1+\ldots T_m+T_w=T$, where T is the time endowment and T_w is the time spent on market work) and the budget constraint ($p_1x_1+\ldots p_mx_m=V+T_ww(1-t)$, where p_i are prices, w is the wage, t is the tax rate, and V is unearned income). We consider the version of the Becker model in which substitution between goods and time is possible in producing a commodity (i.e. production of the commodity is not Leontief in goods and time). As Becker (1965) notes, for a given amount of a commodity—holding Z_i constant—a compensated wage increase will cause x_i/T_i to rise. If the wage change causes substitution *across* commodities, then it is possible that the associated change in the level of Z_i could cause a fall in goods relative to time, if f is not homothetic and this effect of the scale of Z_i on the ratio of goods to time is large enough to overwhelm the substitution effect between goods and time holding Z_i constant. In the leading case of a homothetic production function f, the ratio of time to goods is invariant to the scale of Z_i, and so it is unambiguously the case that a compensated wage increase causes a rise in goods relative to time:[35,36] $\frac{d(x_i/T_i)}{dw(1-t)}|_u > 0$.

It is important to note that in Becker's model, time allocation is adjusted continuously, whereas the average net-of-tax rate is appropriate for a model in which labor supply is adjusted discretely. Nonetheless, our empirical analysis is still relevant to the Becker model. Suppose individuals make an extensive margin labor supply choice in a Becker framework in which a joint choice is made over market work, market goods, and non-market time inputs, and suppose the net-of-tax wage rises from below to above the level required to induce an individual to participate in the labor force. In this case, individuals' time allocation decisions still respond as

[34] See Hamermesh (2008) on the substitutability of goods and time in producing consumption of food.
[35] This more generally holds when the effect of the scale of Z_i does not cause goods to fall too much relative to time.
[36] The Becker model prediction is about the time and market goods responses to a compensated wage change. Policy-induced changes in labor supply and other time use outcomes along the extensive margin are typically considered compensated changes (see e.g. Eissa, Kleven, and Kreiner 2008). It is nonetheless worth noting that we investigated the effect of unearned income on time spent eating and preparing food in the 2003 ATUS cross section (since most time use cross sections lack a measure of unearned income). We found a positive and insignificant effect of unearned income (expressed in $100,000's), with a coefficient of .007 and a standard error of .08, which would imply that income effects are very small.

above: for any given commodity, their time inputs fall relative to their goods inputs (which is guaranteed at least by homotheticity of the commodity production function). The intuition is that their opportunity cost of time has now risen, so time inputs have now become more expensive relative to market goods inputs and individuals substitute toward market goods inputs.

We observe $p_i x_i$ in the data, but in a competitive product market, p_i should be the same in our treatment and control groups. Thus, if we observe that $p_i x_i / T_i$ rises, we interpret this as an increase in x_i / T_i. Expenditures on the market input (food bought in the market) should rise relative to the time input (time spent preparing and eating food) into a commodity (food consumption).[37] If the initial level of x_i differs across the treatment and comparison groups, then an equal change in the price level for each group should cause a larger response of expenditures in the group with the larger initial level of x_i. To address this issue, we estimate the response of log food expenditures to the net-of-tax rate in Columns 4-6 of Table 6, which constitutes our preferred specification.[38] Importantly, we find in Column 4 that log food expenditures in the PSID rise significantly in response to an increase in the net-of-tax rate, which is stronger evidence in favor of the Becker framework. We next break down food expenditures into their component parts: food at home (primarily food purchased at grocery stores) and food away from home (primarily food purchased from restaurants). Column 5 shows that food away from home—which seems the most likely to substitute for time spent preparing food—rises significantly. Food at home changes insignificantly (Column 6), and its elasticity with respect to the net-of-tax share is significantly smaller than that of food away from home. Nonetheless, it is possible that for those who increase market work hours due to a lower tax rate, less time is spent searching for lower prices due to their higher opportunity cost of time spent searching (Aguiar and Hurst 2007b). As a result, p_i could be higher for this group, leading expenditures on goods $p_i x_i$ to increase, and thus violating the assumption that changes in p_i are equal across groups.

7. Tax Implications

[37] The Becker model also predicts that as the net-of-tax wage increases, individuals' consumption of earnings-intensive commodities should fall relative to consumption of less earnings-intensive commodities. However, we do not directly observe the relative earnings intensities of different commodities.

[38] We do not estimate the response of the log of other expenditure categories to the tax rate because they are often equal to zero, whereas food expenditures are rarely equal to zero. Adding 1 or 10 or 100 to the dependent variable before logging it yields similar results to those shown in the table.

Our results shed new light on the efficiency costs and optimal design of indirect taxes. In the standard Ramsey tax framework with a simple labor-leisure choice, Corlett and Hague (1953) demonstrate the desirability of taxing more heavily those market goods that are relatively complementary with (untaxed) non-market time (i.e. leisure time in a framework with a simple labor-leisure choice). In particular, when consumption of a good shows a higher compensated elasticity with respect to the net-of-tax wage, that good should be taxed at a higher rate. The intuition is that by taxing leisure complements, this partially offsets the distortion away from market work and toward non-market time that results from labor income taxation. Kaplow (forthcoming) confirms that this finding holds in the Atkinson and Stiglitz (1976) model, in which consumption taxes and a non-linear income tax are simultaneously optimized. Studies including Sandmo (1990) and Kleven, Richter, and Sorenson (2000) reexamine the implications of optimal taxation in the presence of home production, and Kleven (2004) focuses on these issues when time is further disaggregated in the more general Becker framework. Throughout these models, the Corlett-Hague result remains valid in the sense that goods for which consumption increases more with a tax-induced increase in non-market time ought to be taxed relatively heavily. However, understanding which market goods exhibit a high degree of complementarity with non-market time can be difficult.

We provide direct estimates of relevant cross-elasticities by estimating the elasticity of consumption of various goods with respect to the income tax rate. Our clearest result pertains to food: the estimated elasticity of food consumed away from home with respect to the net-of-tax rate is significantly higher than the estimated elasticity for food at home at the 5% level. This suggests, as argued by Iorwerth and Whalley (2002), that on pure efficiency grounds it is desirable to tax grocery food at a higher rate than restaurant meals—which, as they point out, is the opposite of what is typically done in practice.[39] Our estimated elasticities could also be used to calibrate preference parameters in Computable General Equilibrium models as in Piggot and Whalley (2001) to determine whether or not proposed tax reforms are welfare-improving.

[39] By contrast, we find little evidence that consumption of other goods is either complementary or substitutable with non-market time. This would be an important input into calculating the optimal commodity tax treatment of these goods.

Turning to the literature on the efficiency costs of labor income taxation, Harberger (1964) shows that the deadweight cost of labor income taxation can be calculated as a function of the elasticity of hours worked with respect to the net-of-tax wage, the square of the tax rate, and the size of the tax base.[40] Our results on the elasticity of labor supply are relevant to this calculation: the estimated elasticity of participation is 32.56% smaller when we exclude individual fixed effects (with an elasticity of .29) than when we include individual fixed effects (with an elasticity of .43). This means that all else equal, the implied deadweight cost of labor income taxation would be underestimated by a factor 32.56% if, as in previous literature, repeated cross sections were used to perform the estimates rather than panel data with individual fixed effects.[41] If there are externalities from home production or leisure—for example, externalities arising from the effect of parental investment in children on children's well-being—then the response of home production or leisure to taxes would also be relevant for their efficiency cost. Furthermore, Moffitt (2006) argues that welfare programs are commonly judged in part through "merit goods" arguments and derives the efficiency properties of welfare programs in the presence of merit goods. If leisure time is judged by society to be "inherently bad" and work to be "inherently good," then our estimates of the time allocation response to taxation would be crucial in calculating the efficiency cost of taxation.[42]

8. Conclusion

We examine how income taxes affect time allocation. We find that when single women keep a greater fraction of their earnings when participating in the labor force, they work substantially more: the baseline estimates show that the elasticity of hours worked with respect to the average net-of-tax share is .53. This represents one of the first examinations of the effect of tax incentives on hours worked using panel data and individual fixed effects. The estimate of the labor supply elasticity for single women with individual fixed effects is about 50% larger than the estimate without individual fixed effects, suggesting that earlier estimates from repeated

[40] Eissa, Kleven, and Kreiner (2008) extend this to a setting with an extensive margin labor supply choice.
[41] Nonetheless, it is worth noting that our baseline estimate of the elasticity of participation, .43, is somewhat lower than the central estimate of .7 discussed in Eissa, Kleven, and Kreiner (2008).
[42] We discuss the tax implications for single-agent households since our empirical results pertain to single women and men. See Piggott and Whalley (1996), Apps and Rees (1999) or Schroyen (2003) on the efficiency implications of home production for two-earner households.

cross-sections may be substantially biased by compositional changes such as the large increase in the population share of single mothers over the period studied.

We find that the increase in market work corresponds to a substantial and significant decrease in housework: across our specifications, the point estimates center around showing that two-thirds of the increase in hours worked corresponds to a decrease in housework. Employed individuals take substantially less "leisure" time than the unemployed (Burda and Hamermesh 2009), and we confirm in our data that the employed do only a bit less housework than the non-employed. It is perhaps surprising, then, that when we use tax policy to identify the estimates in the PSID, tax-induced increases in market work are associated with greater decreases in housework than in other time. These results are robust to a wide variety of specification checks in the PSID and are in the same range as the results from repeated cross sections of time diary data. In the repeated cross-sections of time diary data, we find evidence that both the "home production/non-market time" and the "leisure time" of single women decreases substantially and significantly in response to an increase in the incentive to join the labor force. One concern about policies encouraging female labor force participation is that they could decrease time spent with children, but we find no evidence for this hypothesis. We also find some evidence that single women's expenditures on goods that appear substitutable with housework increase in response to an increased incentive to enter the labor force. In contrast, we find no evidence that the time allocation and expenditures of single men respond significantly to taxation.

Our results have implications for several areas of economic inquiry. The finding for single women in the PSID that the increase in market work corresponds largely to a decrease in housework suggests that public policies affecting labor force incentives primarily shift single women from one productive activity to another. This is notable in light of the fact that the policy reforms pursued over the period in question were motivated in part by the desire to decrease the "unproductive" activity of "idle" single mothers. In light of the fact that microeconomic studies tend to estimate smaller labor supply elasticities than macroeconomic studies (Prescott 2004; Rogerson and Wallenius 2009), it is also noteworthy that we examine a panel of 30 years and estimate an elasticity of labor supply that is still well below what is estimated in many studies in

the macroeconomics literature.[43] This is true even while our estimate of single women's elasticity of substitution between home and market goods (2.61) is somewhat higher than estimates in previous macroeconomic literature. The small standard errors we estimate for men's time allocation allow us to bound their elasticity of substitution below 1.66.

Our results lend support to economic models of time allocation. When the net-of-tax rate rises, implying that the net-of-tax wage rises, food expenditures rise significantly or change insignificantly, but the point estimate suggests that the fall in the time spent eating and preparing food is substantial. Collectively, we interpret this evidence as consistent with the classic Becker (1965) model. The results in the PSID and time use data are also consistent with the model of Gronau (1977), which predicts a decrease in home production in response to entry into the labor force induced by a decrease in the tax rate.

Future work could fruitfully examine a number of further questions. Further work on a dynamic model of labor supply, housework, leisure, and consumption decisions would be relevant. Valuing the output of housework or home production would be relevant to welfare analysis. Finally, investigating how taxes affect married couples' decisions about housework, labor supply, leisure, and consumption would be a natural extension of the issues examined in this paper.

[43]In a cross-country study on time use, Freeman and Schettkat (2005) find that individuals work more in the market and less at home in the U.S. than in Europe, but Alesina, Glaeser, and Sacerdote (2006) and Burda, Hamermesh, and Weil (2008) find little evidence for this.

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Data Appendix

Panel Study of Income Dynamics (PSID): The PSID is a nationally representative longitudinal survey that contains detailed information on a wide array of topics including demographics, labor market participation, housework, and income. Individuals in family units were surveyed every year from 1968-1997 and every two years thereafter. Our analysis covers survey years 1976-2005 (excluding survey year 1982) because hours of housework are consistently measured only during these years. The sample is restricted to members of and movers into the Survey Research Center sample. We focus on unmarried and non-cohabitating female and male heads of household age 25-55 who are present in the PSID for at least two years.[44] We further exclude observations that have allocated values for hours of work and housework. Weights are used throughout to ensure the sample remains representative.

The PSID asks for usual weekly hours of housework as follows: "About how much time do you spend on housework in an average week? I mean time spent cooking, cleaning, and doing other work around the house." We measure usual weekly hours worked in the previous calendar year. We use responses to several questions to construct this variable. The PSID asks about work at a main job in the previous calendar year. The following is the typical main job hours question: "We're interested in how you spent your time from January through December <previous calendar year>…On the average, how many hours a week did you work on your main job(s)." The PSID then asks respondents about extra jobs: "Did you have an extra job or other way of making money in addition to your main job in <previous calendar year>?...On the average, how many hours a week did you work on this job?" Responses to the main and extra jobs questions are then added together to form our measure of total usual weekly hours worked per week.[45]

The mean of our measure of usual weekly hours worked among single women is 37.47, whereas for the same population over the same set of years in the Current Population Survey (CPS), the mean of usual weekly hours worked is 32.32. This discrepancy is largely explained by labor force participation rates: over the full sample period, in the CPS, 81.31% of the population of female heads of household aged 25-55 reported doing any work last year, whereas 89.25% of the sample reported doing any work last year in the PSID. In light of these discrepancies, it is worth noting that despite these differences in the level of hours worked, the trend over time in hours worked in the full sample is extremely similar in the PSID and CPS, as is the relative trend among women with and without children. Indeed, when we run the same set of regressions on the same sample population in the CPS with hours worked as the dependent variable and the net-of-tax share as the independent variable (as well as the other regressors that appear in the PSID except individual fixed effects), we obtain similar results to those we obtain in the PSID when we remove individual fixed effects from the estimation. The coefficient on the net-of-tax share when a dummy for labor force participation is the dependent variable is .32 in the CPS (standard error .012; N = 365,703); the coefficient in the PSID when we remove individual fixed effects in Table 2 Panel A is .29. The coefficient on the net-of-tax share when usual hours worked is the dependent variable is 11.57 in the CPS (standard error .53; N = 365,703); the coefficient in the PSID when we remove individual fixed effects in Table 2 Panel B is 14.90.

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[44] Our sample excludes what the PSID calls "permanent" cohabitators defined as having lived together for at least a year or present for two or more waves of data collection. A small number of "temporary" cohabitators remain in our sample.

[45] Before asking about work at main and extra jobs, the PSID first asks respondents to report current employment status. Regardless of the answer to the current employment status question, the PSID then asks the questions above about previous calendar year work experience, but respondents' answers are coded as one variable if the respondent is currently employed, and a second variable if the respondent is not currently employed. We naturally combine these responses (for those currently employed and not) to form our measure of previous calendar year work hours.

The PSID also contains a constructed measure of total annual hours in the previous calendar year. Total annual hours is defined as the sum over all jobs of the product of total weeks worked and usual weekly hours worked plus total annual overtime hours. We define a binary variable for labor force participation as equal to one if the respondent has positive usual hours worked and zero otherwise. We define "residual time" in the PSID as total hours in a week (168) less usual hours of housework less usual hours of market work.

Time Use Data: We draw on four cross-sections of time use data assembled and described in great detail in Aguiar and Hurst (2007a).[46] These data ask respondents to account for time spent during the previous day. We use data from the 1975 Time Use in Economic and Social Accounts, the 1985 Americans' Use of Time, the 1993 National Human Activity Pattern Survey, and 2003 American Time Use Survey. We choose these datasets because they are nationally representative and overlap with the period of analysis in the PSID. We also add the 2004 American Time Use Survey to increase sample size and correspond exactly with the final year of analysis in the PSID. We use Aguiar and Hurst's coding of activities and refer the reader to their variable glossary. Given the lack of consistent labor income data in the time use surveys, we instead impute labor income for each respondent using demographic information and the coefficients obtained from the PSID labor income imputation described in the text. We then feed imputed labor income into TAXSIM to calculate the simulated average net-of-tax share. We use weights throughout and follow Aguiar and Hurst (2007a) in weighting each survey equally.

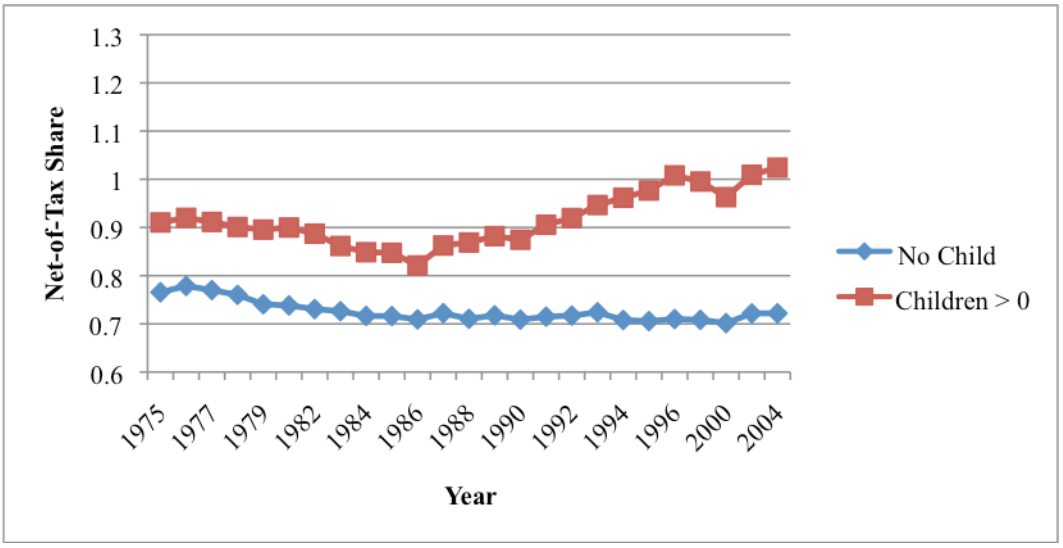
We select our sample to be as consistent as possible across survey years as well as with the PSID sample. In all years we require non-missing data on education and number of children, as well as complete time diaries that account for activities in all 168 hours in a week. We select the sample of single women as follows: *1975*: unmarried female heads of household age 25-55; *1985*: unmarried females who answered the telephone survey age 25-55; *1993*: female adults living in one adult household age 25-55; *2003/2004*: unmarried female heads of household age 25-55.

Consumer Expenditure Survey: Data on expenditures on domestic services and major appliances are taken from the quarterly CEX interview files. Domestic services include babysitting, day care, and hired help for cleaning. The underlying CEX UCC codes are 340310, 340410, 340420, 340520, 340530, 340903, 340906, 340914, 340210, 340211, 340212, and 670310. Expenditure on major appliances is calculated as expenditures on washers, dryers, stove ovens, microwave ovens, portable dishwashers, electric cleaning equipment, and refrigerators (UCC codes 300210, 300220, 300310, 300320, 300330, 320511, and 300110).

Since state of residence is missing for a substantial fraction of the sample, we use only Federal tax variation for identifying the estimates; we obtain similar results when we use the state data that are available. To better match the actual distribution of tax rates, we add to earnings before imputing income. For comparability with the NBER data, we collapse the raw quarterly data to the yearly level by summing expenditures across a year. To address attrition, we follow Charles, Hurst, and Roussanov (2009) in imputing expenditures in quarters in which an individual is missing by assuming that a woman would have spent as much in the quarters in which data is missing as the average amount she spent in the quarters in which she is in the data. We use survey weights throughout. All dollar amounts are expressed in real 2005 dollars.

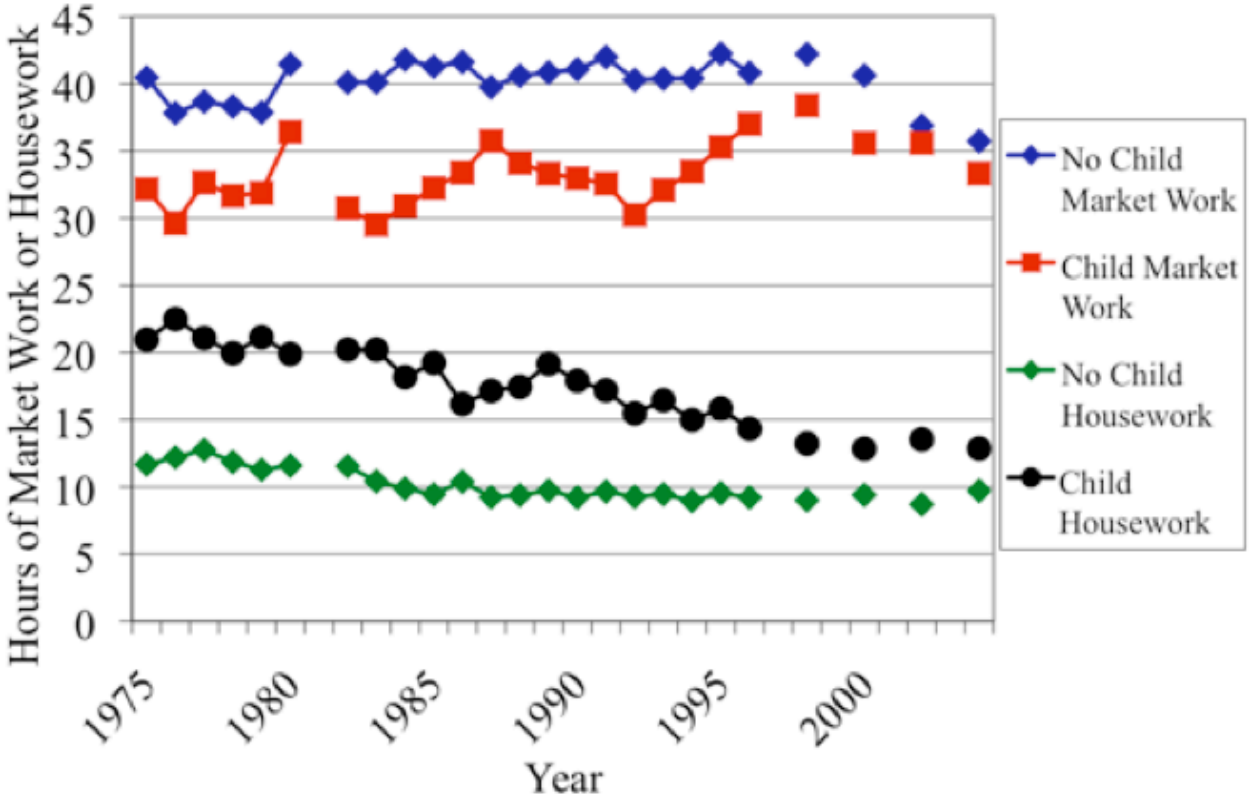
[46] The data are available for download at http://troi.cc.rochester.edu/~maguiar/timeuse_data/datapage.html

Figure 1. *Changes in tax rates over time: mean imputed average net-of-tax share by year for single women with and without children*



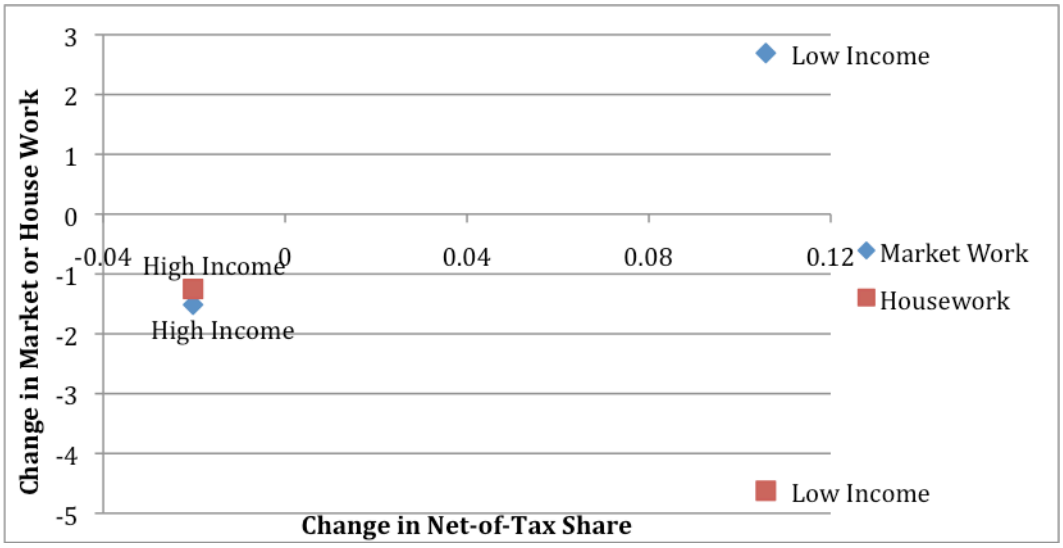
Notes: The data are taken from the Panel Study of Income Dynamics. The figure shows that starting in the mid-1980s, there was an increasing incentive to participate in the labor force for low-income single women with children relative to those without children: the average net-of-tax share (defined as the share of earnings a woman keeps if she participates in the labor force) rose substantially for single women with children relative to those without children. Average tax rates are calculated using Taxsim by calculating a woman's tax liability if she works and if she does not work, and then calculating the fraction of her earnings that would be taken away in taxes if she works. A woman's tax liability if she works is calculated by applying Taxsim to the woman's imputed earnings. Earnings are imputed by regressing earnings on age, number of children, education, and year fixed effects in the full sample and deriving the fitted values, as described in Section 3. The average net-of-tax share for women with children is greater than one primarily because the EITC transfers a substantial amount of money to a low-income woman if she works, often implying that the effective tax rate is negative.

Figure 2. *Mean usual hours of market work and housework of single women with and without children, 1975-2004*



Notes: The data are taken from the Panel Study of Income Dynamics. The figure shows mean usual hours worked and usual hours of housework for single female heads of household aged 25-55, excluding cohabitators, with and without children. The figure shows that mean usual hours of market work increased substantially for single women with children relative to those without children from the mid-1980s to the mid-to-late 1990s, a period coincident with the relative tax policy changes shown in Figure 1. During this period, mean hours of housework fell substantially for women with children relative to those without. This suggests that much of the increase in hours of market work during this period corresponded to a decrease in hours of housework. During the period without the policy changes that differentially affected women with and without children, there is little discernable trend in housework and market work for single women with children relative to those without children.

Figure 3. *Additional identifying variation: mean change in usual weekly hours of market work and housework in high and low income groups (y-axis), plotted against mean change in net-of-tax share in high and low income groups (x-axis), among single women with children*



Notes: The data are taken from the Panel Study of Income Dynamics. The figure shows that among women with children, the mean tax cut was larger for lower-income individuals than for high-income individuals, and the mean increase in market work and decrease in housework was also larger for low-income individuals than for high-income individuals. This demonstrates that in addition to the identifying variation shown in Figures 1 and 2 coming from a comparison across women with and without children over time, there is additional identifying variation stemming from a comparison of changes in market/home work and taxes in low and high income groups over time. "High income" refers to individuals with imputed income above the median, and "low income" refers to all others. The "change" in market work, housework, and the net-of-tax share is computed by calculating the change in the mean of the variables from the 1975-1986 period to the 1987-2004 period.

Table 1. *Means and Standard Deviations of Main Variables*

Panel A: PSID Data for Single Women

	Mean (Standard Deviation)
Work > 0 Hours During the Year	.89 (.31)
Weekly Hours Worked	37.47 (17.54)
Weekly Housework	12.66 (10.55)
Weekly Residual Time	117.86 (17.75)
Average Net-of-Tax Share	.80 (.13)
Age	38.72 (8.82)
Number of Children	.71 (1.04)
Total Food Expenditures	5,062.18 (64,135.41)
Food at Home	3,277.34 (2,431.98)
Food Away from Home	1,773.535 (63,713.14)
N	9,242

Panel B: PSID Data for Single Men

	Mean (Standard Deviation)
Work > 0 Hours During the Year	.94 (.23)
Weekly Hours Worked	44.40 (17.49)
Weekly Housework	7.45 (6.50)
Weekly Residual Time	116.15 (18.64)
Marginal Net-of-Tax Share	.61 (.07)
Age	36.33 (8.42)
Number of Children	.12 (.46)
N	6,230

Panel C: Time Diary Data for Single Women

	Mean (Standard Deviation)
Work > 0 Hours During the Week	.75 (.43)
Weekly Hours Worked	27.34 (29.53)
Weekly Housework	6.13 (10.37)
Weekly Home Production	14.17 (15.55)
Weekly Non-Market Work	19.91 (18.69)
Weekly Leisure 1	33.83 (23.56)
Weekly Leisure 2	107.39 (27.47)
Weekly Leisure 3	112.31 (27.61)
Weekly Food Preparation and Eating	12.29 (9.85)
Weekly Sleep	59.06 (16.24)
Weekly Child Care	4.91 (9.92)
Average Net-of-Tax Share	.88 (.17)
Age	39.14 (9.04)
Number of Children	.91 (1.24)
N	4,444

Panel D: CEX Expenditure Data for Single Women

	Mean (Standard Deviation)
Domestic Services	236.77 (792.97)
Major Appliances	88.78 (329.59)
Average Net-of-Tax Share	.91 (.17)
Age	38.15 (8.78)
Number of Children	.88 (1.18)
N	25,395

Notes: The table shows the means and standard deviations of the central variables in the analysis. In Panels A and B, the sample is taken from the PSID data from 1975-2004. In Panel C, the data are taken from repeated cross sections on time use assembled by Aguiar and Hurst (2007a) and the 2004 American Time Use Survey, spanning 1975-2004. Panel D shows data from the Consumer Expenditure Survey from 1980-2003. Expenditure amounts are expressed in real 2005 dollars. The sample in Panels A, C, and D consists of unmarried female heads of household aged 25-55, and the sample in Panel B consists of unmarried male heads of household aged 25-55.

Table 2. *Regressions of single women's time allocation on imputed average net-of-tax share, non-labor income, and control variables in the PSID*

Panel A: Dependent Variable is Dummy for Labor Force Participation

	(1) Basic Controls	(2) No Indiv. Fixed Effects	(3) Control for Welfare	(4) Sample is pre-1993	(5) IV for Non-Labor Income	(6) Extra Controls	(7) Child-by-Year Fixed Effects	(8) Control for Self-Selection	(9) IV for Net-of-Tax Wage	(10) IV for ANTR
ANTR	.43	.29	.43	.31	.46	.43	.26	.45		.75
	(.11)***	(.14)**	(.10)***	(.27)	(.23)**	(.11)***	(.11)***	(.12)***		(.19)***
Non-Labor	.007	-.23	.004	.14	2.16	.0002	.005	.006	.006	.01
Inc.	(.001)	(.13)**	(.10)	(.13)	(3.12)	(.10)	(.10)	(.10)	(.10)	(.10)
Welfare			-.14	-.03	-.14	-.13				
ATR			(.07)**	(.09)	(.16)	(.07)*				
Net Wage									.04	
									(.01)***	
R-Squared	.59	.15	.59	.65		.59	.59	.04		
N	9,242	9,242	9,242	5,736	9,242	9,242	9,242	9,242	9,242	9,242
Elasticity	.41	.27	.42	.30	.44	.41	.25	.43	.53	.72

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. The average net-of-tax rate is the percentage of income that a woman would keep if she participated in the labor force. Standard errors are bootstrapped as described in the text. Each regression using the full sample contains data on 1,243 individuals. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects; this is also the set of "basic controls" used in Column 1. Column 2 removes individual fixed effects and controls for education dummies (which appear in the imputation but in other specifications are collinear with the individual fixed effects). Column 3 controls for the incentives created by AFDC, TANF, and food stamps, summarized by the variable "Welfare ATR," equal to the difference between welfare benefits if a woman works and does not, as a fraction of earnings if she works. Column 4 limits the sample to the period before 1993. Column 5 instruments for non-labor income with the value of the welfare benefits a woman would receive if she did not work. Column 6 controls for the state minimum wage, state GDP, the presence of a welfare waiver, average labor income interacted with year, and education-by-year fixed effects. Column 7 adds the interaction of year dummies with a dummy for having a child. Column 8 uses a Heckman selection correction in imputing income, as described in the text. Column 9 instruments for the imputed net-of-tax wage using the average net-of-tax share. Column 10 instruments for one measure of the average net-of-tax share using another measure, as described in the text. Columns 1-4 and 6-8 run OLS regressions. The actual coefficients and standard errors on non-labor income have been multiplied by 100,000. "Elasticity" refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 2, Panel B: Dependent Variable is Usual Weekly Hours of Market Work

	(1) Basic Controls	(2) No Indiv. Fixed Effects	(3) Control for Welfare	(4) Sample is pre-1993	(5) IV for Non-Labor Income	(6) Extra Controls	(7) Child-by-Year Fixed Effects	(8) Control for Self-Selection	(9) IV for Net-of-Tax Wage	(10) IV for ANTR
ANTR	23.45	14.90	23.67	23.45	22.65	25.79	19.87	25.34		41.25
	(6.56)***	(6.42)**	(6.69)***	(12.52)*	(10.59)**	(6.97)***	(7.39)***	(7.56)***		(11.96)***
Non-Labor	-.02	-.17	-.02	-.02	-.90	-.04	-.02	-.02	-.024	-.02
Inc.	(.06)	(.07)**	(.06)	(.07)	(2.97)	(.06)	(.06)	(.06)	(.060)	(.06)
Welfare			-5.67	-1.50	-5.61	-6.88				
ATR			(3.32)*	(4.23)	(4.44)	(3.60)*				
Net Wage									1.94	
									(.61)***	
R-Squared	.57	.15	.57	.62		.57	.57	.04		
N	9,242	9,242	9,242	5,736	9,242	9,242	9,242	9,242	9,242	9,242
Elasticity	.53	.34	.55	.86	.52	.60	.46	.58	.63	.95

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. The average net-of-tax rate is the percentage of income that a woman would keep if she participated in the labor force. Standard errors are bootstrapped as described in the text. Each regression using the full sample contains data on 1,243 individuals. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects; this is also the set of "basic controls" used in Column 1. Column 2 removes individual fixed effects and controls for education dummies (which appear in the imputation but in other specifications are collinear with the individual fixed effects). Column 3 controls for the incentives created by AFDC, TANF, and food stamps, summarized by the variable "Welfare ATR," equal to the difference between welfare benefits if a woman works and does not, as a fraction of earnings if she works. Column 4 limits the sample to the period before 1993. Column 5 instruments for non-labor income with the value of the welfare benefits a woman would receive if she did not work. Column 6 controls for the state minimum wage, state GDP, the presence of a welfare waiver, average labor income interacted with year, and education-by-year fixed effects. Column 7 adds the interaction of year dummies with a dummy for having a child. Column 8 uses a Heckman selection correction in imputing income, as described in the text. Column 9 instruments for the imputed net-of-tax wage using the average net-of-tax share. Column 10 instruments for one measure of the average net-of-tax share using another measure, as described in the text. Columns 1-4 and 6-8 run OLS regressions. The actual coefficients and standard errors on non-labor income have been multiplied by 1,000. "Elasticity" refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 2, Panel C: Dependent Variable is Usual Weekly Hours of Housework

	(1) Basic Controls	(2) No Indiv. Fixed Effects	(3) Control for Welfare	(4) Sample is pre-1993	(5) IV for Non-Labor Income	(6) Extra Controls	(7) Child-by-Year Fixed Effects	(8) Control for Self-Selection	(9) IV for Net-of-Tax Wage	(10) IV for ANTR
ANTR	-15.69	-15.19	-15.97	-12.06	-17.79	-15.25	-9.07	-16.18		-27.59
	(3.59)***	(3.96)***	(3.62)***	(7.69)*	(12.58)	(3.72)***	(4.24)**	(3.90)***		(6.76)***
Non-Labor Inc.	.02	.02	.02	.03	-1.47	.01	.01	.02	.018	.02
	(.02)	(.03)	(.02)	(.03)	(5.68)	(.02)	(.02)	(.02)	(.021)	(.02)
Welfare ATR			7.39	2.57	7.43	6.22				
			(2.01)***	(2.83)	(6.62)	(1.98)***				
Net Wage									-1.30	
									(.30)***	
R-Squared	.57	.23	.57	.61		.58	.58	.09		
N	9,242	9,242	9,242	5,736	9,242	9,242	9,242	9,242	9,242	9,242
Elasticity	-1.07	-1.04	-1.09	-.82	-1.21	-1.04	-.62	-1.10	-1.23	-1.88
% of change in hours worked	66.91	102.94	67.47	51.43	78.54	59.13	45.65	63.85	67.01	66.88

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. The average net-of-tax rate is the percentage of income that a woman would keep if she participated in the labor force. Standard errors are bootstrapped as described in the text. Each regression using the full sample contains data on 1,243 individuals. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects; this is also the set of "basic controls" used in Column 1. Column 2 removes individual fixed effects and controls for education dummies (which appear in the imputation but in other specifications are collinear with the individual fixed effects). Column 3 controls for the incentives created by AFDC, TANF, and food stamps, summarized by the variable "Welfare ATR," equal to the difference between welfare benefits if a woman works and does not, as a fraction of earnings if she works. Column 4 limits the sample to the period before 1993. Column 5 instruments for non-labor income with the value of the welfare benefits a woman would receive if she did not work. Column 6 controls for the state minimum wage, state GDP, the presence of a welfare waiver, average labor income interacted with year, and education-by-year fixed effects. Column 7 adds the interaction of year dummies with a dummy for having a child. Column 8 uses a Heckman selection correction in imputing income, as described in the text. Column 9 instruments for the imputed net-of-tax wage using the average net-of-tax share. Column 10 instruments for one measure of the average net-of-tax share using another measure, as described in the text. Columns 1-4 and 6-8 run OLS regressions. The actual coefficients and standard errors on non-labor income have been multiplied by 1,000. "Elasticity" refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 2, Panel D: Dependent Variable is Weekly Residual Time

	(1) Basic Controls	(2) No Indiv. Fixed Effects	(3) Control for Welfare	(4) Sample is pre-1993	(5) IV for Non-Labor Income	(6) Extra Controls	(7) Child-by-Year Fixed Effects	(8) Control for Self-Selection	(9) IV for Net-of-Tax Wage	(10) IV for ANTR
ANTR	-7.76	.29	-7.70	-11.39	-4.86	-10.55	-10.80	-9.16		-13.66
	(6.92)	(7.35)	(6.91)	(13.09)	(17.31)	(6.99)	(8.14)	(7.63)		(12.45)
Non-Labor Inc.	.01	.15	.01	-.01	2.36	.02	.01	.01	.006	.01
	(.06)	(.07)**	(.06)	(.07)	(7.53)	(.06)	(.06)	(.06)	(.06)	(.06)
Welfare ATR			-1.71	-1.07	-1.83	.65				
			(3.26)	(3.92)	(7.90)	(3.56)				
Net Wage									-.64	
									(.62)	
R-Squared	.49	.05	.49	.53		.50	.49	.03		
N	9,242	9,242	9,242	5,736	9,242	9,242	9,242	9,242	9,242	9,242
Elasticity	-.06	.00	-.05	-.08	-.03	-.07	-.08	-.07	-.07	-.10
% of change in hours worked	33.09	-2.94	32.53	48.57	21.46	40.87	54.35	36.15	32.99	33.12

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. The average net-of-tax rate is the percentage of income that a woman would keep if she participated in the labor force. Standard errors are bootstrapped as described in the text. Each regression using the full sample contains data on 1,243 individuals. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects; this is also the set of "basic controls" used in Column 1. Column 2 removes individual fixed effects and controls for education dummies (which appear in the imputation but in other specifications are collinear with the individual fixed effects). Column 3 controls for the incentives created by AFDC, TANF, and food stamps, summarized by the variable "Welfare ATR," equal to the difference between welfare benefits if a woman works and does not, as a fraction of earnings if she works. Column 4 limits the sample to the period before 1993. Column 5 instruments for non-labor income with the value of the welfare benefits a woman would receive if she did not work. Column 6 controls for the state minimum wage, state GDP, the presence of a welfare waiver, average labor income interacted with year, and education-by-year fixed effects. Column 7 adds the interaction of year dummies with a dummy for having a child. Column 8 uses a Heckman selection correction in imputing income, as described in the text. Column 9 instruments for the imputed net-of-tax wage using the average net-of-tax share. Column 10 instruments for one measure of the average net-of-tax share using another measure, as described in the text. Columns 1-4 and 6-8 run OLS regressions. The actual coefficients and standard errors on non-labor income have been multiplied by 1,000. "Elasticity" refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 3. *PSID heterogeneity analysis: OLS regressions of single women's time allocation outcomes on imputed average net-of-tax share, non-labor income, individual fixed effects, and control variables. Dependent variable shown in column heading*

	Age Under 40			Age 40 and Over			No Children			At Least One Child		
	(1) Weekly Hours Worked	(2) Weekly House-work	(3) Weekly Residual Time	(4) Weekly Hours Worked	(5) Weekly House-work	(6) Weekly Residual Time	(7) Weekly Hours Worked	(8) Weekly House-work	(9) Weekly Residual Time	(10) Weekly Hours Worked	(11) Weekly House-work	(12) Weekly Residual Time
ANTR	26.98	-19.32	-7.65	13.18	-1.79	-11.38	34.87	3.25	-38.12	20.08	-15.81	-4.28
	(9.00)***	(4.64)***	(9.09)	(12.02)	(5.88)	(13.77)	(30.56)	(9.95)	(32.38)	(9.51)**	(5.71)***	(10.07)
Non-	.06	.04	-.09	-.07	.001	.06	-.05	-.03	-.02	-.10	.06	.04
Lab. Inc.	(.10)	(.04)	(.09)	(.09)	(.03)	(.09)	(.07)	(.03)	(.07)	(.11)	(.05)	(.11)
R-Sq.	.58	.64	.49	.69	.59	.61	.60	.58	.54	.60	.57	.53
N	5,275	5,275	5,275	3,857	3,857	3,857	3,651	3,651	3,651	5,591	5,591	5,591
Elas.	.64	-1.29	-.06	.31	-.12	-.10	.80	.22	-.27	.45	-1.08	-.04

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. Standard errors are bootstrapped as described in the text. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects. See other notes to Table 2. The total sample size is smaller than in Table 2 because singletons are dropped from the regressions, and the set of singletons is larger when a subset of the data is used. The actual coefficients and standard errors on non-labor income have been multiplied by 1,000. "Elas." refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 4. *PSID Results for Men: OLS regressions of time allocation outcome on imputed average net-of-tax share, non-labor income, individual fixed effects, and control variables. Dependent variable shown in column heading*

	(1) Labor Force Participation	(2) Weekly Hours Worked	(3) Weekly Housework	(4) Weekly Residual Time	(5) Labor Force Participation	(6) Weekly Hours Worked	(7) Weekly Housework	(8) Weekly Residual Time
MNTR	.01	-.49	-1.59	1.10				
	(.09)	(7.13)	(3.14)	(7.70)				
ANTR					-.07	11.87	4.12	-16.00
					(.30)	(18.84)	(9.77)	(19.99)
Non-Labor	.001	-.05	-.003	.05	.001	-.05	-.005	.06
Inc.	(.003)	(.17)	(.10)	(.20)	(.003)	(.17)	(.01)	(.20)
R-Squared	.61	.56	.51	.56	.61	.56	.51	.56
N	6,230	6,230	6,230	6,230	6,230	6,230	6,230	6,230
Elasticity	.003	-.01	-.14	.01	-.04	.17	.35	-.10

Notes: "MNTR" refers to the marginal net-of-tax rate, calculated using income imputed with demographics, as described in the text. "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. Standard errors are bootstrapped as described in the text. Each regression contains data on 1,069 individuals. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects. The actual coefficients and standard errors on non-labor income have been multiplied by 100,000. See other notes to Table 2. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 5. *Time Use Data: OLS regressions of single women's time allocation outcomes on imputed average net-of-tax share and control variables. Dependent variable shown in column heading*

	(1) LFP	(2) Hours Worked	(3) House-work	(4) Home Prod-uction	(5) Non-Market Work	(6) Leisure 1	(7) Leisure 2	(8) Leisure 3	(9) Food Prep and Eating	(10) Child Care	(11) Sleep	(12) Eating, Sleep, Personal Care
ANTR	.47	35.57	-11.59	-18.98	-17.51	-25.66	-29.74	-21.40	-2.33	8.34	-.50	-4.08
	(0.21)**	(11.72)***	(6.97)*	(9.17)**	(10.29)*	(12.22)**	(12.56)**	(13.11)	(5.07)	(5.12)	(9.88)	(8.94)
R-Sq.	.18	.09	.08	.11	.08	.05	.06	.07	.13	.24	.05	.05
N	4,444	4,444	4,444	4,444	4,444	4,444	4,444	4,444	4,444	4,444	4,444	4,444
Elas.	.59	1.22	-1.78	-1.26	-.83	-.72	-.26	-.18	-.18	1.59	-.01	-.05

Notes: The table shows the effect of the Average Net-of-Tax Rate (ANTR) on the weekly amount of time spent on each activity in question. The data are the repeated cross sections of time use data in Aguiar and Hurst (2007), in addition to the 2004 American Time Use survey. "LFP" refers to labor force participation. The definitions of the time use outcomes can be found in Section 2. Standard errors are bootstrapped as described in the text. All regressions control for dummies for year, five education categories, and all possible values of age and number of children. "Elas." refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Table 6. *Expenditure Data: OLS regressions of single women's expenditures on imputed average net-of-tax share and control variables. Dependent variable shown in column heading*

	Linear Specification			Log Specification		
	(1) Total Food (PSID)	(2) Domestic Services (CEX)	(3) Major Applian-ces (CEX)	(4) Total Food (PSID)	(5) Food at Home (PSID)	(6) Food Away (PSID)
ANTR	2306.11	64.83	25.59	.76	.36	1.09
	(5886.23)	(124.20)	(33.13)	(.34)**	(.27)	(.39)***
Capital	.04	.01	.003	.004	.0004	.006
Inc.	(.02)	(.003)***	(.001)***	(.001)***	(.002)	(.002)***
R-Sq.	.10	.05	.01	.54	.55	.51
N	8,293	25,395	25,395	8,108	7,893	7,159
Elas.	.40	.25	.26	.61	.29	.87

Notes: The table shows the effect of the Average Net-of-Tax Rate (ANTR) on expenditures on different items, expressed in real 2005 dollars. Columns 1 and 4-6 are based on PSID expenditure data. Total food expenditures are calculated by summing food at home and food away from home. Columns 2 and 3 are based on Consumer Expenditure Survey data. CEX data are taken from the CEX interview files. All regressions control for dummies for year, five education categories, and all possible values of age and number of children. In Columns 1 and 4-6 we also include individual fixed effects. Standard errors are bootstrapped as described in the text. We do not examine the log of expenditures on items other than food because they more frequently take on a value of zero. The sample size differs across Columns 4-6 because zeroes of the dependent variable are not included as observations; adding 1 or 10 or 100 to the dependent variable before logging it yields similar results. The actual coefficients and standard errors on capital income have been multiplied by 1,000. "Elasticity" refers to the implied elasticity of the dependent variable with respect to the ANTR, calculated at the means. *** denotes significance at 1%; ** at 5%; * at 10%.

Appendix Table 1. *OLS regression results: alternative specifications for single women. Dependent variable shown in column heading*

	(1) Yearly Hours Worked	(2) Currently Working	(3) Positive Yearly Hours of Work	(4) Weekly Hours Worked	(5) Weekly Housework	(6) Weekly Residual Time
ANTR	991.17	.51	.40			
	(321.80)***	(.13)***	(.11)***			
Participation Dummy				35.87	-4.71	-31.16
				(.71)***	(.73)***	(.94)***
R-Squared	.60	.54	.59	.41	.10	.26
N	9,242	9,242	9,242	9,242	9,242	9,242

Notes: "ANTR" refers to the average net-of-tax rate, calculated using income imputed with demographics, as described in the text. The average net-of-tax rate is the percentage of income that a woman would keep if she participated in the labor force. Standard errors in Columns 1-3 are bootstrapped as described in the text. Standard errors in Columns 4-6 are clustered by individual, with 1,243 clusters. All regressions control for dummies for all possible values of age and number of children, as well as individual and year fixed effects. Yearly hours worked includes hours on secondary jobs and overtime hours. The "participation dummy" is a dummy that equals one if usual weekly hours worked is positive, zero otherwise. "Currently working" refers to a dummy that measures whether someone's employment status is "working now." "Positive yearly hours of work" is a dummy that equals one if the person reports working a positive number of hours over the course of the entire year. *** denotes significance at 1%; ** at 5%; * at 10%.