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MARKET WORK, HOME WORK AND TAXES:
A CROSS COUNTRY ANALYSIS

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ABSTRACT

This paper uses a simple model of labor supply extended to allow for home production to understand the extent to which differences in taxes can account for differences in time allocations between the US and Europe. Once home production is included, the elasticity of substitution between consumption and leisure is almost irrelevant in determining the response of market hours to higher taxes. But to account for observed differences in leisure and time spent in home production, one requires a large elasticity of substitution between consumption and leisure, and a small elasticity of substituion betwen time and goods in home production.

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1. Introduction

The observation that hours of market work in several European countries is almost 30% less than in countries such as the US has generated a considerable amount of research directed at uncovering the cause of this large difference. Motivated by the work of Prescott (2004), one factor that has received considerable attention is the large differences in the size of tax and transfer systems across countries. Prescott argues that differences in taxes on labor income can account for virtually all of the observed differences in hours of work across the countries that he studies. Subsequent work by Ohanian et al (2007) for a larger set of countries reinforces this conclusion. A key feature of these analyses is that the only way that one can obtain sufficiently large differences in hours of market work in response to observed differences in tax rates is if individuals are sufficiently willing to substitute leisure for consumption.

Recent work on cross country differences in time use (see, e.g., Freeman and Schettkat (2001, 2005), Ragan (2005), and Burda et al (2008)) has found that on average, the countries in continental Europe with low levels of market work have substantially higher levels of time spent in home production than the US.[1] This suggests that a model that stresses three uses of time–market work, home work and leisure– is likely to be more appropriate for understanding cross country differences in market work. In general, a model with home production can lead to lower levels of market work not only by having individuals substitute leisure for

[1] See also Davis and Henrekson (2004) for indirect evidence in support of this finding. They find that European countries with high labor taxes have much less employment in those activities which have good nonmarket substitutes.

market consumption, but also by having individuals substitute market goods for time spent in home production. It follows that in such a model, the willingness of individuals to substitute leisure for consumption may no longer play a key role.

The objective of the present paper is to present a simple analysis to illustrates the importance of the two elasticities just mentioned. In particular, I consider the canonical model of labor supply extended to include home production. I then use this model to assess the implications of an increase in the size of a tax and transfer program that levies a proportional tax on labor income and uses the proceeds to fund a lump sum transfer. I calibrate the model to the US economy making different assumptions about the two key elasticities, and then examine the implications of the model for time allocations in the US and another economy that is the same in all respects except for a higher tax rate.

Several interesting findings emerge. Whereas in the model without home production, the elasticity of substitution between leisure and consumption plays a critical role in how much market hours drop in response to a tax increase, this elasticity is almost irrelevant in the model with home production. In contrast, the elasticity of substitution between market goods and time in the home production function does play an important quantitative role. Values of this elasticity that are consistent with empirical estimates imply that differences in tax and transfer systems can explain differences in hours of work of 25% or more independently of individuals' willingness to substitute leisure for consumption.

I then ask under what configurations of elasticities the model can account for not only the differences in market work between the US and Europe, but also the breakdown of the remaining time between leisure and home production. Here I find that if individuals are quite willing to substitute leisure for consumption, and the elasticity of substitution between market goods and time in the home production function is at the small end of the empirical estimates in the data, then the model can produce outcomes that are consistent with the results from time use studies. In short, although the model can produce large differences in hours of market work without a large willingness to substitute leisure for consumption, this elasticity needs to be quite large in order to be consistent with observed differences in leisure and time spent in home production.

This work is related to many papers in the literature beyond those already mentioned. The important role of home production in models of labor supply was first emphasized by Becker (1965), with other early contributions made by Gronau (1977). Much later, Benhabib et al (1991) and Greenwood and Hercovitz (1991) argued that explicit modeling of home production in aggregate models was important to understand changes in aggregate economic variables. McGrattan et al (1997) found that home production was important for understanding the response of the US economy to fluctuations in taxes. More recently, Rogerson (2008) and McDaniel (2008) have both argued that home production is quantitatively important in understanding the impact of higher tax rates on hours of market work in continental Europe, but neither of them considered how different values of the two elasticities interact.[2]

[2] Ragan (2005), Olovsson (2005) and Rogerson (2007) have also argued that thinking about home production is also critical to reconciling the effects of tax and transfer systems in Scandinavia with those in continental Europe.

An outline of the paper follows. Section 2 reviews some evidence on differences in market work and taxes between the US and continental Europe, and then uses a canonical model of labor supply without home production to assess the quantitative implications of higher tax rates. This analysis serves to highlight the important role of the labor supply elasticity. Section 3 then develops the model with home production and presents the quantitative findings. Section 4 concludes.

2. Market Work and Taxes Across Countries: Background

This section presents some data on hours of market work and labor tax rates across countries. It then uses a benchmark model of labor supply to assess the extent to which the observed differences in labor tax rates can account for the differences in hours of work observed between countries such as the US on the one hand, and those of continental Europe on the other hand. This analysis will focus on the role of the elasticity of substitution between leisure and consumption in determining whether the tax story can plausibly account for the bulk of the differences between these countries.

2.1. Data on Hours Worked and Taxes

In this subsection I present data showing how hours of market work differ among OECD economies. Although the subsequent focus will be on the US and a subset of countries from continental Europe, I think it is useful to see the distribution of hours worked over a larger set of countries to better appreciate the context. The measure of hours worked is the product of total employment and annual hours of work per person in employment. The employment data is taken from the OECD Labor Statistics Database, and the hours data is taken from the Groningen Growth and Development Center (GGDC). It is important to note that the hours data are meant to include differences in vacation and statutory holidays, as well as differences in workweek. Because countries have different sizes, it is necessary to normalize these measures of aggregate annual hours by some measure of population. I choose the size of the working age population, i.e., those aged 15-64, though note that this normalization is not important for the patterns that we focus on. To facilitate comparisons I report all values relative to the US. Table One shows the resulting distribution of relative hours of work across countries.

Table One

Hours Worked Relative to the US in 2006

$< .8$	$[.8, .9)$	$[.9, .95)$	$\geq .95$
Belgium (.73)	Austria (.81)	Denmark (.93)	Australia (.96)
France (.73)	Norway (.81)	Finland (.90)	Canada (.98)
Germany (.73)	Spain (.88)	Greece (.90)	Ireland (.98)
Italy (.70)		Sweden (.91)	Japan (1.02)
Netherlands (.77)		Switzerland (.93)	New Zealand (1.00)
		UK (.90)	Portugal (.96)

The table reveals that there are dramatic differences in hours of work across countries, with the economies of continental Europe working more than 25% less than their counterparts in the US. While these numbers are for one particular year and have not been corrected at all to account for temporary changes due to business cycle fluctuations, these differences do reflect persistent differences that have been present for more than a decade. In what follows I will focus on the countries that represent the larger differences in this table, specifically the US and the economies of continental Europe.

A key question for researchers is to uncover the factors that account for these large differences, and several recent papers have addressed this issue. One particular explanation, first put forward by Prescott (2004), and that has received considerable attention is that these large differences in hours of work are largely accounted for by differences in tax rates on labor. McDaniel (2006) produces series for effective average tax rates on labor income using the methodology outlined by Prescott (2004), which represent taxes levied on labor income, payroll and consumption for 15 OECD countries from the mid 1950s through the early 2000s. She finds that the effective average labor tax in the highest hours worked countries is around 30%, while the same rate is around 50% in the lowest hours worked countries.[3]

2.2. A Benchmark Model

This section describes a standard one-sector representative agent framework that will be used to assess the implications of a simple tax and transfer program on hours of work. Although the model below can be cast as the steady state analysis in a representative agent version of the standard growth model, for expositional

[3] Although there are some differences in details, McDaniel's work extends the earlier estimates of average tax rates across countries by Mendoza et al (1994). The two methods produce similar differences for the period of overlap.

purposes I will abstract from capital accumulation and therefore focus on a static version of the model.[4]

There is a representative household with preferences defined over consumption (c) and leisure $(1-h)$ given by $u(c, 1-h)$. The function u is assumed to have the standard properties: it is twice continuously differentiable, increasing in both arguments, strictly concave in c and $(1-h)$ jointly. We also assume that c and $(1-h)$ are both normal goods. The individual is endowed with one unit of time. There is a production technology that uses labor to produce the single good. This technology is assumed to be constant returns to scale, and we furthermore choose units so that one unit of labor produces one unit of the consumption good. We assume a government that levies a proportional tax τ on labor income and uses the proceeds to finance a lump sum transfer T to households.

I solve for the competitive equilibrium for this economy. Normalize the price of output to equal one. Given the linear technology, it follows that the wage rate in equilibrium must also equal one. The optimization problem of the household in equilibrium can then be written as:

$$\max u(c, 1-h) \tag{2.1}$$

$$s.t.\ c = (1-\tau)h + T, \quad c \geq 0,\ 0 \leq h \leq 1$$

This leads to a first order condition:

[4] The results obtained here are virtually identical to those that would emerge from a steady-state analysis in the standard growth model.

$$(1-\tau)u_1((1-\tau)h+T,1-h) = u_2((1-\tau)h+T,1-h) \tag{2.2}$$

Substituting the government budget constraint $\tau h = T$ into the household's first order condition yields:

$$\frac{u_2(h,1-h)}{u_1(h,1-h)} = (1-\tau) \tag{2.3}$$

This condition completely characterizes the equilibrium value of time devoted to market work as a function of the tax rate τ.

One can show that an increase in τ leads to a decrease in h, given our assumption of normality. This result is intuitive–the direct effect of the tax increase on hours of work consists of both a substitution and an income effect, the former of which is negative and the latter of which is positive. But the fact that tax revenues are used to fund a lump sum transfer induces an offsetting income effect, thereby leaving only the substitution effect. The next section examines the magnitude of the negative effect on hours.

2.3. Quantitative Assessment

Prescott (2004) can largely be reinterpreted as a quantitative assessment of the extent to which the above framework with varying levels of τ can account for differences in labor input in the US and several European countries, both in the cross section and over time. Given that there are some slight differences in the exercises, I report results for the current model.[5]

Preferences are restricted to be of the form:

$$u(c, 1-h) = \alpha \log c + (1-\alpha)\frac{(1-h)^{1-\gamma}}{(1-\gamma)}.$$

The first order condition then becomes:

$$\frac{\alpha(1-\tau)}{h} = (1-\alpha)(1-h)^{-\gamma} \tag{2.4}$$

which simplifies to:

$$\frac{h}{(1-h)^{\gamma}} = \frac{\alpha}{1-\alpha}(1-\tau) \tag{2.5}$$

To assess the quantitative significance of these tax and spending policies on time devoted to market work I calibrate the model to match features of the US economy and then consider the implications for changes in tax rates holding all of the preference parameters fixed. Following McDaniel (2006), I take $\tau = .30$ to correspond to the US tax rate, and as is typical in this literature, I take $h = 1/3$ as the fraction of discretionary time devoted to market work. Given a value of γ the value of τ and the target value for h can be used to infer a value of the parameter α. There is considerable controversy over the appropriate value of γ in this type of exercise. In a dynamic setting this parameter describes the willingness

[5] Prescott (2004) carries out his analysis in the context of the growth model without imposing steady state, and as a result hours worked in any given period depend both upon current conditions as well as expected future conditions. In his analysis the ratio of current consumption to output enters into the analysis since it captures the influence of future factors. One issue is that differences in c/y might be due to factors other than taxes on labor.

of the household to intertemporally substitute leisure. Many studies using micro data conclude that this willingness is very small for prime aged married males, while other studies have found much larger values for married females.[6] Rogerson (2006) argues that existing evidence from micro data is likely to be of little use in determining the relevant elasticity to study the consequences of changes in aggregate tax rates. Specifically, in the micro data much of the variation in wages is idiosyncratic. Given the need to coordinate working times across individuals, one would not expect much response of individual hours to idiosyncratic wage changes.[7] More recently, Rogerson and Wallenius (2008) argue that the estimates from panel data on prime aged males provide very little information about the aggregate labor supply elasticity. Here I will not try to ascertain what the definitive value of γ is for representative household model under consideration. Instead, I will simply assess the effect of different values for γ on the model's implications regarding the importance of tax and transfer systems on differences in hours of work.

Given that labor tax rates in continental Europe are around 50%, Table Two shows the relative time devoted to market work associated with a tax rate of 50% relative to that in the equilibrium of the calibrated model that has a tax rate of 30%. Recall that α is recalibrated for each value of γ.

[6] A recent paper by Imai and Keane (2004) incorporates learning by doing and finds a much higher estimate of the intertemporal elasticity of substitution.

[7] See also Prescott (2006) for a discussion of this issue.

Table Two

Market Work For $\tau = .5$ Relative to $\tau = .3$

$\gamma = .50$	$\gamma = 1.0$	$\gamma = 2.0$	$\gamma = 5.0$	$\gamma = 10$	$\gamma = 20$
.76	.79	.84	.90	.94	.97

This table implies that if γ is less than or equal to 1, then the differences in tax rates can plausibly account for the bulk of the differences in hours worked between the US and continental Europe. On the other hand, if γ is five or higher, then the differences in tax rate are not the dominant factor, though the effects are still sizeable. Note that the reductions for the $\gamma = 10$ case are only about 30% as large as the changes for the $\gamma = 1$ case. Obviously the value of γ is significant in terms of assessing the quantitative significance. Prescott (2004) concentrated on the $\gamma = 1$ case in presenting his results. For future reference we note that the percent changes in leisure are roughly half of the percent changes in market work, since in the original equilibrium the time allocation is one third to market work and two-thirds to leisure. So the differences in leisure range from 13% to a little more than 1%, depending upon the value of γ.

It is also of interest to assess the welfare effects associated with an increase in taxes from 30% to 50%. It should be noted up front that in this model there is no role for a tax and transfer scheme, so that these calculations simply serve to inform us about the welfare consequences associated with the distortions created by these programs, and do not attempt to quantify any benefits that may be associated. The welfare measure used is the percent increase in consumption required to leave the representative household indifferent between the two equilibrium allocations.

Table Three presents the welfare results.

Table Three

Welfare Cost of Moving to $\tau = .5$ From $\tau = .3$

$\gamma = .50$	$\gamma = 1.0$	$\gamma = 2.0$	$\gamma = 5.0$	$\gamma = 10$	$\gamma = 20$
.11	.09	.07	.04	.02	.00

This table shows that when the increase in taxes leads to large decreases in hours of work, they are also associated with a large welfare cost–in the range of 10% when measured in terms of consumption. Note that when γ is very large, the tax and transfer scheme is effectively non-distortionary since market work is relatively unaffected, so the program is very close to a lump sum tax used to finance an equal lump sum transfer, which clearly has no welfare effects.

3. The Analysis With Home Production

The previous analysis has assumed that there are only two uses of time: market work and leisure. The essence of home production theory is that it can be useful to consider a third use of time, namely time spent in home production. A key implication of this theory is that changes in taxes lead not only to a reallocation of time from market work to leisure, but also a reallocation of time from market work to home production. If this is true, then the large differences in taxes across countries should imply that time spent in home production could be an important margin of adjustment. In this section we review some evidence regarding this margin of adjustment and reexamine the effects of taxes in a model that allows for home production.

3.1. Cross-Country Evidence on Home Production

Several recent studies offer information about differences in home and market work between the US and European countries based on time use studies. A common finding is that differences in market work are indeed significantly offset by differences in homework. Freeman and Schettkat (2005) report that as of the early 1990s, time spent in home production in European countries is about 20% larger than in the US. In an earlier paper that focused only on married couples in Germany, Freeman and Schettkat (2001) found that total working time was roughly the same in the two economies, with the only difference being the allocation of these hours between home and market work. This study also shows that the pattern of consumer expenditure differs in a corresponding fashion, i.e., Germans spend more time on meal preparation at home and spend less money at eating establishments. Using data from the recent Harmonized Time Use Study, Ragan (2005) compares several European countries with the US and finds that the European countries studied here have between 15% and 20% more homework than do Americans.[8]

In a third study of time use data, Burda et al (2008) reach a similar conclusion based on information for Germany, Italy, the Netherlands and the US. In particular, they find that Europeans engage in $15-20\%$ more time in home production than do Americans.[9] This study also reports differences in leisure time of around

[8] Alesina, Glaeser and Sacerdote (2005) present data from another source which challenges this conclusion. As noted by these authors, however, their data set seems ill-suited to cross-country comparisons. The Harmonized Time Use data set used by Ragan was designed to specifically address the shortcominings mentioned by Alesina et al, and hence seems more reliable.

[9] In comparing countries using the 2003 data it is important to be aware of changes in survey

15%, though there are some differences across countries. Similar to the finding of Freeman and Schettkat, Burda et al find that leisure time in Germany and the US is basically the same, though individuals in the Netherlands and Italy have substantially more leisure than do Americans.

Related work has also been carried out by Davis and Henrekson (2004). Consistent with the economic mechanism mentioned earlier, they show that countries with higher marginal tax rates systematically have lower employment in those market activities for which there are good nonmarket substitutes.

There are many issues associated with comparing the results of time use surveys across countries. (See Burda et al (2008) for an extensive discussion of this point.) Nonetheless, I interpret the above evidence as showing that the lower time devoted to market work in continental Europe is associated both with an increase in leisure and an increase in time devoted to home production. Moreover, though there is some variation across countries, with Germany being somewhat of an outlier, the increases in these two dimensions of time allocation are each in the range of $15-20\%$.

3.2. A Model With Home Production

In this section we extend the earlier model to allow for home production. Specifically, following Becker (1965) we now assume that there is a home production function that uses goods (g) and time (h_n) as inputs to produce total consumption

design in the US. Relative to earlier surveys in the US, the American Time Use Survey, initiated as part of the CPS, tends to generate larger amounts of time reported to child care. In the US this results in an almost 50% increase in time devoted to child care relative to the 1985 time use survey data.

(c) according to:

$$c = f(g, h_n)$$

This function is assumed to be twice continuously differentiable, strictly increasing in each argument, concave in the two arguments jointly and strictly concave in each argument, and in addition displays constant returns to scale. Following Gronau (1977), preferences are now written as:

$$u(c, 1 - h_m - h_n)$$

where c is total consumption, h_m is time devoted to market work, and h_n is time devoted to home production. The function u is assumed to be twice continuously differentiable, strictly increasing in both arguments and strictly concave. As before, there is an aggregate production function that uses market hours to produce the single good, and as before we normalize units so that one unit of market time yields one unit of the market good. The government is modeled exactly as before: it levies a constant proportional tax on market wages and uses the proceeds to fund a lump sum transfer. We again solve for the competitive equilibrium, and as before we assume without loss of generality that the price of consumption and the market wage are normalized to one.

The consumer's problem in equilibrium can then be written as:

$$\max_{c, h_m, h_n} \; u(c, 1 - h_m - h_n)$$

$$\begin{aligned}
\text{s.t. } g &= (1-\tau)h_m + T \\
c &= f(c, h_n) \\
h_m &\geq 0,\ h_n \geq 0,\ h_m + h_n \leq 1
\end{aligned}$$

Substituting the budget equation and the home production function into the objective function, and assuming an interior solution, the first order conditions for market work and time spent in home production are:

$$\begin{aligned}
& (1-\tau)u_1\left(f((1-\tau)h_m + T, h_n), 1 - h_m - h_n\right) f_1((1-\tau)h_m + T, h_n) \\
= \;& u_2\left(f((1-\tau)h_m + T, h_n), 1 - h_m - h_n\right) \\
& u_2\left((1-\tau)h_m + T, h_n, 1 - h_m - h_n\right) f_2((1-\tau)h_m + T, h_n) \\
= \;& u_2\left(f((1-\tau)h_m + T, h_n), 1 - h_m - h_n\right)
\end{aligned}$$

The interpretation of these two conditions is standard. They together imply that the marginal value of time allocated across the three activities–market work, home work and leisure–are equated. The first requires that the marginal rate of substitution between leisure and market consumption is equal to the after tax wage rate, while the second requires that the marginal rate of substitution between home production time and leisure be equal to unity. As before, the government budget constraint implies that in equilibrium, $T = h_m\tau$, so that these two first order conditions can be written as:

$$(1-\tau)u_1\left(f(h_m,h_n),1-h_m-h_n\right)f_1(h_m,h_n) = u_2\left(h_m,h_n,1-h_m-h_n\right)$$
$$u_1\left(h_m,h_n,1-h_m-h_n\right)f_2(h_m,h_n) = u_2\left(h_m,h_n,1-h_m-h_n\right)$$

Manipulating these two equations, and suppressing arguments of the functions, one can obtain the following two equations:

$$(1-\tau) = f_2/f_1$$
$$u_2/u_1 = f_2$$

Note that only the first of these two equations contains the tax rate τ. Moreover, given that the function f satisfies constant returns to scale, the first equation determines the ratio h_m/h_n as a function of the tax rate, and this ratio is decreasing in τ. That is, the greater the tax rate, the less is the ratio of market to home work. The second equation is independent of the tax rate and therefore depicts a stable relationship in h_m-h_n space. If this relationship is downward sloping, then it follows that an increase in τ leads to a decrease in h_m and an increase in h_n.

3.3. Quantitative Results

In this section we consider the quantitative implications of a change in the size of the tax and transfer program in the model with home production. We adopt the following functional forms:

$$u(c, 1-h_m-h_n) = \alpha \log c + (1-\alpha)\frac{(1-h_m-h_n)^{1-\gamma}-1}{1-\gamma}$$

$$f(h_m, h_n) = (a_m h_m^\eta + (1-a_m)h_n^\eta)^{1/\eta}$$

The utility function is of the same form as the one used in the model studied earlier that did not include home production. In particular, this function imposes offsetting income and substitution effects, and the parameter γ determines the elasticity of substitution between consumption and leisure. The choice of home production function is standard in the literature. The parameter η determines the extent of substitutability between goods and time in producing consumption, and will play a key role in determining how market hours respond to a change in the scale of the tax and transfer program.

We adopt a similar calibration procedure to that used previously. In particular, we assume a tax rate of .3 in the US, and pick values for the two elasticity parameters γ and η. Having picked these values, we then calibrate the parameters α and α_m so that the equilibrium has $h_m = 1/3$ and $h_n = 1/4$. This ratio of time devoted to market work and home production is consistent with the averages for the US over the recent past, as presented by Francis and Ramey (2007) and Aguiar and Hurst (2007).

As before, we consider values of γ equal to .5, 1, 2, 5, 10, and 20. For η we consider values of 0, .4, .5, and .6. I noted earlier that there is considerable controversy regarding the appropriate value of γ to be used in a model such as this one. In contrast, the estimates of η in the literature all lie within the range of $.4 - .6$. Using aggregate data, McGrattan et al (1997) find a value of η in the range of $.40 - .45$, while Chang and Schorfheide (2002) find a value in the range of $.55 - .60$. Using micro data, Rupert et al (1995) find an estimate in the range $.40 - .45$, while Aguiar and Hurst (2008) report an estimate for their benchmark specification in the range of $.50 - .60$. I include the value of $\eta = 0$ since we know from the work of Benhabib et al (1991) that when $\gamma = 1$ and $\eta = 0$ the presence of home production has no impact on the behavior of market hours, thereby making it an interesting benchmark.

For the model without home production studied earlier, the implications are completely summarized by examining the change in market work, since this also allows one to deduce the change in leisure. In the model with home production there is no longer a one-to-one mapping between changes in hours of market work and changes in leisure. The next three tables display how the relative values of market work, home work and leisure respond to an increase in taxes from .3 to .5 for the various combinations of the two elasticity parameters.

Table Four

Market Hours for $\tau = .5$ Relative to $\tau = .3$

	$\gamma = .5$	$\gamma = 1$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$	$\gamma = 20$
$\eta = 0$	.76	.79	.81	.83	.84	.85
$\eta = .4$	.69	.71	.73	.74	.75	.75
$\eta = .5$	.66	.67	.68	.70	.70	.70
$\eta = .6$	.60	.61	.62	.63	.63	.64

Table Five

Home Hours for $\tau = .5$ Relative to $\tau = .3$

	$\gamma = .5$	$\gamma = 1$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$	$\gamma = 20$
$\eta = 0$	1.07	1.10	1.14	1.17	1.18	1.19
$\eta = .4$	1.21	1.25	1.27	1.30	1.31	1.32
$\eta = .5$	1.28	1.32	1.34	1.37	1.38	1.38
$\eta = .6$	1.40	1.42	1.44	1.46	1.47	1.47

Table Six

Leisure for $\tau = .5$ Relative to $\tau = .3$

	$\gamma = .5$	$\gamma = 1$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$	$\gamma = 20$
$\eta = 0$	1.14	1.10	1.07	1.03	1.02	1.01
$\eta = .4$	1.11	1.08	1.05	1.02	1.01	1.01
$\eta = .5$	1.10	1.07	1.04	1.02	1.01	1.01
$\eta = .6$	1.07	1.05	1.03	1.02	1.01	1.01

While the above tables present a wealth of information, I would like to focus on a few simple points. First, as one would expect, as one increases the elasticity of substitution between time and goods in the home production function, (i.e., increases η), holding γ fixed, one gets larger effects on market hours from the 20% increase in tax rates. This is because there is a larger increase in time devoted to home production. Somewhat surprisingly, the increase in η is also associated with a decrease in the effect of τ on leisure time. Intuitively, the presence of home production provides an alternative way to reallocate the time associated with a reduction in market work, and therefore leisure time responds less. It follows

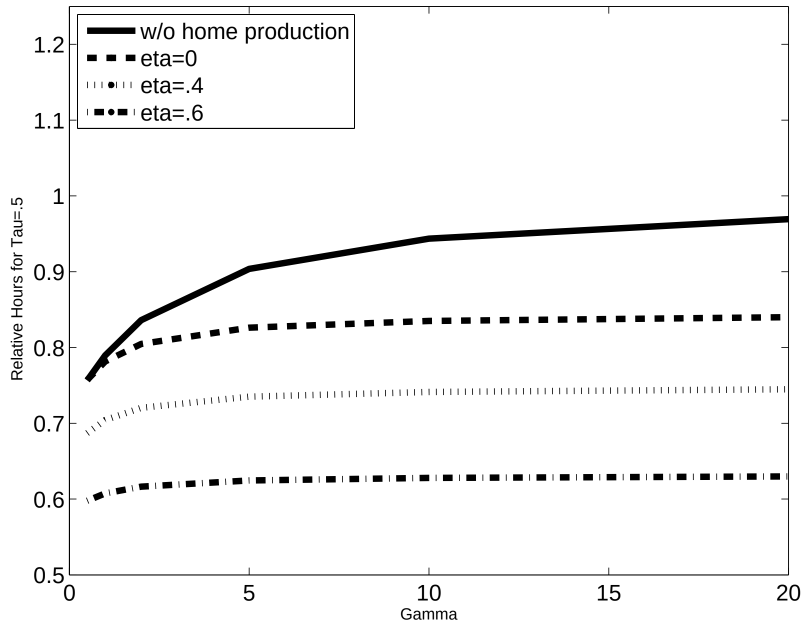

Figure 1: The Effect of γ on the Response in Hours

that if one only looks at the effect of the tax increase on market work, it is now relatively easy to obtain decreases that are 30% or greater. When $\eta = .5$, the decrease in market hours is 30% even for values of γ that are as large as 10 or 20.

A closer look at Table Four reveals another interesting pattern. Specifically, the sensitivity of the reduction in hours to changes in the value of γ are much less than in the model without home production. This is true even if $\eta = 0$. To see this, Figure 1 plots curves showing the relative hours of market work as a function of gamma for both the model without home production as well as the home production models for several values of η.

The solid line in this figure plots the results displayed in Table One. The other three lines plot the results from Table Four, for the cases of $\eta = 0$, .4, and .6. As noted earlier, when $\eta = 0$ and $\gamma = 1$, the model with home production and the model without home production have identical implications for market work, and the figure indicates this result. However, what is striking is that all of the curves from the model with home production are virtually flat compared to the curve for the model without home production. The effect of changes in the elasticity between time and goods in the home production function is effectively to shift the curve downward in a parallel manner.

The key finding from the above analysis is that once one considers an explicit model of home production, the value of γ plays very little role in influencing the effect of increases in taxes on the amount of time devoted to market work. This is in sharp contrast to the model that did not contain home production. There we found that the decrease in market work was hugely affected by the value of γ with the result changing by almost an order of magnitude as we moved from $\gamma = .5$ to $\gamma = 20$.

Next we consider the extent to which there are parameter values for which the model can mimic the differences along all three dimensions of time allocation. Recall that based on time use data, the differences between the US and continental Europe are in the range of $10 - 20\%$ for both dimensions, and the differences in market hours is in the range of 25-30%, though we note that Germany was somewhat of an outlier since the difference in leisure was close to zero. Looking to Table Three, it is clear that there are many combinations of parameters that yield a drop in market work of the order of $25 - 30\%$. Note that this rules out the combination of $\eta = 0$ and values of γ that are 1 or above, since these do no produce a sufficient drop in hours, as well as value of $\eta = .6$, since it produces too large of a decrease. Next we consider which of these generate changes in both leisure and home production in the $10-20\%$ range. Interestingly, almost none of the combinations lie in this range. Typically the change in leisure is too small relative to the data and the change in home production time is too large relative to the data. Values of η that lie in the range of previous estimates, i.e., in the range of .4 to .6, tend to produce changes in home production that are too large relative to what is found in the data, though for $\eta = .4$ and smaller values of γ the difference in home production time is less than 25%. Also note that in order to generate differences in leisure that are close to those noted in time use surveys it is necessary to have a fairly low value of γ.

In doing these comparisons it is important to keep in mind the qualifications noted earlier regarding the issues involved in comparing time use survey data across countries. Nonetheless, we think that this exercise is informative as a crude test to see if a standard home production model with taxes can account not only for the differences in market time but also for how this time is reallocated toward leisure and home production. I would summarize the findings of the above exercise to be that this is possible as long as γ and η are relatively small. It is therefore interesting to note that although a model with home production does not require a small value of γ in order to generate large differences in hours of market work, it does require a relatively small value of γ in order to get substantial differences in leisure.

Lastly, it is of interest to ask how the welfare comparisons are affected by the introduction of home production. As before, we compute the amount of market consumption that individuals in the $\tau = .3$ economy would be willing to give up in order to make them indifferent to living in the $\tau = .5$ economy. We note that the compensation is only in terms of market goods, and not overall consumption. The results are in Table Seven.

Table Seven

Welfare Cost of Moving to $\tau = .5$ From $\tau = .3$

	$\gamma = .5$	$\gamma = 1$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$	$\gamma = 20$
$\eta = 0$	.10	.09	.08	.07	.07	.07
$\eta = .4$	.13	.13	.12	.11	.11	.11
$\eta = .5$	.15	.14	.14	.13	.13	.13
$\eta = .6$	.17	.17	.16	.16	.16	.16

Note that for $\gamma = 1$ and $\eta = 0$ the welfare result is the same as in the model without home production. The table shows that welfare costs are increasing in the value of η, just as the decrease in market hours is increasing in η. While it is true that with a higher value of η individuals are more willing to substitute between these two factors, it remains true that the welfare cost of the distortion is increasing. In order to obtain a negligible effect we would need not only that γ is large but also that η is a very large negative number. This would lead to very little change in the time allocation along all margins, and thereby effectively turn the tax and transfer program into a lump sum tax used to fund a lump sum transfer. Note also that whereas in the model without home production we found that the welfare effects were negligible for large values of γ, this is no longer the case here.

The reason for this is that even when γ is very large, the tax and transfer scheme still has a large distortion on allocations, by changing the mix of goods and time used in the home production function.

4. Conclusion

This paper has used a simple model of labor supply extended to include home production to understand how two key elasticities influence the response of time allocation to increases in tax rates. Three key results emerged. First, once home production is incorporated, the elasticity of substitution between consumption and leisure becomes almost irrelevant in determining the response in time devoted to market work to an increase in taxes. This is in sharp contrast to the findings in a model that does not include home production. Second, the elasticity of substitution between goods and time in the home production function are an important determinant of the response in time devoted to market work to an increase in taxes. Third, in order to match both the observed differences in time allocation along all three dimensions–market work, home work and leisure–one needs a fairly large elasticity of substitution between consumption and leisure, as well as not too large of an elasticity between time and goods in the home production function. There may be some tension between the observed differences in time allocations across countries and the estimates of the elasticity between time and goods from previous empirical work. Improvements in measurement that will allow us to better compare time use studies across countries will be important in making further progress in this area.

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