Forces Shaping Hours Worked in the OECD 1960-2004*

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Abstract

The goal of this paper is to examine the role of taxes and productivity growth as forces influencing market hours. To achieve this goal, the paper considers a calibrated growth model extended to include home production and subsistence consumption, both of which are found to be key features influencing market hours. The model is simulated for 15 OECD countries. The primary force driving changes in market hours is found to be changing labor income tax rates and productivity catch-up relative to the United States is found to be an important secondary force.

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There are dramatic differences in the evolution of market work in Organisation for Economic Co-operation and Development (OECD) countries from 1960 onward. For example, in France and Germany the number of market hours worked per adult in 1960 was greater than in the United States. Over the period 1960-2004, hours declined more than 30% in France and Germany. In contrast, hours per adult in the United States remained relatively flat over the same period. This paper studies a set of potential forces shaping market hours worked over the time period 1960-2004.

To study potential forces shaping hours, I construct a growth model extended to include home production and government. The model incorporates productivity growth in the market and home sectors, subsistence consumption, and taxes on labor and capital income. The parameters are calibrated to the United States over the period 1960-2004. Calibrated parameter values are held constant across countries, and country-specific tax series and productivity processes are fed into the model to produce simulations for 15 OECD countries. I find changes in the effective tax rate on labor income to be the primary force influencing the decision to work in the market. I also find productivity catch-up in both the home and market sectors to be an important secondary force.

The finding that labor taxes influence market hours worked is not new; it has been the subject of recent research. Prescott (2004) compares market hours per adult at two points in time (the early 1970s and the mid-1990s) in G-7 countries. Prescott looks at the wedge in the first-order condition governing labor supply in a calibrated version of the growth model extended to include labor taxes. He finds that differences in hours worked are consistent with differences in labor taxes across time and countries. Ohanian, Raffo and Rogerson (2008) extend Prescott's work to more countries and more time periods, but again focus on wedges in the static first-order condition. They find that wedges are much smaller in a model with taxes than in a model without taxes.

In this paper, rather than simply focusing on the static first-order condition, I solve for the time series of choice variables given country-specific tax rates and productivity series. I include in the model home production and subsistence consumption and evaluate the importance of these features. I find that, for most countries studied, the model that includes home production and subsistence consumption generates series for market hours that are meaningfully different compared to series generated by models that exclude these features.

In a model with subsistence consumption, the income elasticity of the market-produced consumption good is less than one at low levels of income. As market productivity grows, time spent working in the market sector declines. While subsistence consumption is not likely a major factor influencing hours in the United States over the period 1960-2004, the income per capita in many European countries in 1960 was less than half of the United States' income per capita. This opens the possibility that subsistence consumption may have influenced market hours in these economies as they grew.

The extension of the model to include home production allows tax rate changes and productivity growth to influence market hours in two ways. First, home production adds an extra margin to the household market labor supply decision. In the standard framework, the household has two uses of time: market work and leisure. If labor taxes are added to the model, then households shift time away from market work to leisure. Home production gives the household a third, utility-producing alternative. Distortionary labor taxes then lead to a reallocation of time between market work, leisure, and home production. This allows the possibility for tax rate changes to have a stronger effect on market labor supply than they have in the standard model. Second, productivity growth differentials in the home and market sectors also influence the labor supply decision. If time and goods in the home sector are substitutes, then a higher growth rate in market sector productivity, manifested by higher real wages, leads the household to shift time away from home production into market work.

Several papers have stressed the importance of home production. On the empirical side, Freeman and Schettkat (2005) and Ragan (2005) document that the households in Continental Europe spend more time engaged in home production than do those in the United States. Davis and Henrekson (2005) show that in OECD countries with high labor taxes, those market sectors with home-produced substitutes show the largest decrease in hours. On the theoretical side, Ragan (2005) and Rogerson (2008) analyze labor taxes in models that include home production. Ragan considers the implications of her model for recent cross-sections of hours worked. Rogerson considers market work at two points in time for, effectively, two economies. Greenwood, Seshadri and Yorkukoglu (2005) also study home production and market hours. Their work focuses on how time allocation decisions are influenced by changes in prices of durable goods. The approach to modeling home production in this paper differs slightly with respect to work by Greenwood et al., and these differences are discussed in section 1. This paper contributes to the existing literature by examining time series implications of potential driving forces in a dynamic model for a large set of countries.

The model presented in this paper successfully captures the direction of change in market hours from 1960 to 2004 for the majority of the OECD countries studied. The model also does a fair job of generating cross-country differences in levels of hours, but generates a lower level of market hours for most of the countries studied. This, as will be evident later in the paper, is not completely surprising given that the differences in tax and transfer policies across countries are not modeled. If country-specific policies are stable over time, then changes in hours should be relatively immune to these differences. Also, given the dynamic nature of the model, the series produced for investment is examined. The model generates levels of investment generally below those seen in the data, and the model-generated series is significantly more volatile. However, while the patterns generated by the model are exaggerated, they are relatively close to what is observed in the data.

1 Model

The model is a standard, representative agent neo-classical growth model extended to include home production, government, and subsistence consumption. The representative household is endowed with one unit of time that it can allocate to market work (h_{mt}), home production (h_{nt}), or leisure. Household preferences are represented by:[1]

$$U = \sum_{t=0}^{\infty} \beta^t \Big(log(c_t) + alog(1 - h_{mt} - h_{nt}) \Big)$$

The household receives utility from leisure and consumption. In the spirit of Becker (1965), c_t is a home production function that aggregates market goods (c_{mt}) with time spent engaged in home production:

$$c_t = \Big(b(c_{mt} - \bar{c})^{\varepsilon} + (1 - b)(A_{nt} h_{nt})^{\varepsilon} \Big)^{\frac{1}{\varepsilon}}$$

Technological change in the home production function is captured by A_{nt}. The parameter $\bar{c}$ represents subsistence consumption. The parameter ε determines the degree of substitutability between the market-produced consumption good and time spent in home production. The parameter ε can take any value less than 1. As ε approaches 1, time spent in home production and market-produced consumption goods become better substitutes.

There is an aggregate production function that produces output (Y_t) using capital (K_t) and market labor (H_{mt}):

$$Y_t = K_t^{\theta} (A_{mt} H_{mt})^{1-\theta},$$

where A_{mt} captures technological change in the production of market goods. Output can be consumed or invested (x_t):

$$Y_t = c_{mt} + x_t$$

[1] The logarithmic utility function generates a relatively large market labor supply elasticity. This is an important assumption; work by Rogerson and Wallenius (2009) supports this choice of utility function.

and capital evolves according to:

$$k_{t+1} = (1 - \delta)k_t + x_t$$

where δ is the depreciation rate.

There is a government that taxes consumption expenditures ($\tilde{\tau}_t^c$), investment expenditures, ($\tilde{\tau}_t^x$), labor income ($\tilde{\tau}_t^h$), and capital income ($\tilde{\tau}_t^k$). As in Prescott (2004), I assume the government uses tax revenues to finance a lump-sum transfer to the household (T_t) while maintaining a balanced budget each period:[2]

$$T_t = \tilde{\tau}_t^c c_{mt} + \tilde{\tau}_t^x x_t + \tilde{\tau}_t^h w_t h_{mt} + \tilde{\tau}_t^k r_t k_t$$

The average tax rate on labor income, $\tilde{\tau}^h$, is a combination of two tax rates, the payroll tax rate τ^{ss} and the income tax rate τ^{inc}:

$$\tilde{\tau}_t^h = \tau_t^{ss} + \tau_t^{inc} \tag{1}$$

As mentioned in the introduction, Greenwood, Seshadri and Yorkukoglu (2005) study home production. This specification differs from that employed by Greenwood et al. They model output in the home sector as a function of durable goods and time, with home-produced goods and market-produced goods entering the utility function separately. In their specification, home production technology is embodied in the durable goods. As the price of durable goods falls, the household shifts time from home production to market work and leisure. In the model used in this paper, durable goods are part of market consumption. A fall in the relative price of durable goods is captured by growth in market production technology. This leads to an increase in the consumption of market goods (and therefore market hours)

[2] In a web appendix to this paper, I show model predictions for hours when some revenue is used by the government to purchase a good that enters the household utility function separately.

and leisure, assuming home production and market-produced goods are substitutable. While the specifications are different, the intuition behind both models is similar. The specification used in this paper is advantageous as there is no need to separate durable goods from other market consumption goods.

1.1 Equilibrium

I study competitive equilibrium for this economy. I restrict my attention to perfect foresight paths. While this may seem at first unrealistic, it is the best starting point for this type of analysis. When this assumption is relaxed, there is little effect on market hours (see web appendix). With given series for A_{mt}, A_{nt}, taxes, and an initial condition (k_0), equilibrium is a sequence of prices $\{r_t^\star\}$, $\{w_t^\star\}$ and quantities $\{k_t^\star\}$, $\{x_t^\star\}$, $\{c_{mt}^\star\}$, $\{h_{mt}^\star\}$, $\{h_{nt}^\star\}$, $\{Y_t^\star\}$, $\{T_t^\star\}$, $\{K_t^\star\}$ $\{H_{mt}^\star\}$, such that

(Consumer Optimization) (i) taking prices, taxes, and transfers as given, $\{x_t^\star\}$, $\{c_{mt}^\star\}$, $\{h_{mt}^\star\}$, $\{h_{nt}^\star\}$ are a solution to:

$$\max_{c_{mt},h_{mt},h_{nt},x_t} \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{\varepsilon} log \left(b(c_{mt} - \bar{c})^\varepsilon + (1-b)(A_{nt}h_{nt})^\varepsilon \right) + alog(1 - h_{mt} - h_{nt}) \right)$$

s.t.

$$c_{mt}(1+\tilde{\tau}_t^c) + x_t(1+\tilde{\tau}_t^x) = r_t^\star k_t(1-\tilde{\tau}_t^k) + w_t^\star h_{mt}(1-\tilde{\tau}_t^h) + T_t^\star$$

$$k_{t+1} = x_t + (1-\delta)k_t$$

$$h_{mt} + h_{nt} \leq 1 \text{ , } k_t \geq 0, \ h_{mt} \geq 0, \quad h_{nt} \geq 0$$

(Firm Optimization) (ii) taking prices as given, in each period $\{Y_t^\star\}$, $\{K_t^\star\}$, and $\{H_{mt}^\star\}$, are a solution to:

$$\max_{K_t, H_{mt}} Y_t - r_t^\star K_t - w_t^\star H_{mt}$$

$$\text{s.t.}$$

$$Y_t \leq K_t^\theta (A_{mt} H_{mt})^{1-\theta}$$

(iii) the government budget constraint is satisfied:

$$T_t^\star = \tilde{\tau}_t^c c_{mt}^\star + \tilde{\tau}_t^x x_t^\star + \tilde{\tau}_t^h w_t^\star h_{mt}^\star + \tilde{\tau}_t^k r_t^\star k_t^\star$$

(iv) markets clear:

$$\begin{aligned} Y_t^\star &= c_{mt}^\star + x_t^\star \\ K_t^\star &= k_t^\star \\ H_{mt}^\star &= h_{mt}^\star \end{aligned}$$

Following standard procedures, it is straightforward to derive necessary equilibrium conditions. Suppressing the "$\star$"s, this yields the following three equations:

$$\frac{a c_t^\varepsilon (c_{mt} - \bar{c})^{1-\varepsilon}}{b(1 - h_{mt} - h_{nt})} = (1-\theta) A_{mt}^{1-\theta} \left(\frac{k_t}{h_{mt}}\right)^\theta (1 - \tau_t^h) \tag{2}$$

$$\left(\frac{1-b}{b}\right)\left(\frac{(c_{mt} - \bar{c})^{1-\varepsilon}}{A_{nt}^{-\varepsilon} h_{nt}^{1-\varepsilon}}\right) = (1-\theta) A_{mt}^{1-\theta} \left(\frac{k_t}{h_{mt}}\right)^\theta (1 - \tau_t^h) \tag{3}$$

$$\frac{c_{t+1}^\varepsilon (c_{mt+1} - \bar{c})^{1-\varepsilon}}{\beta c_t^\varepsilon (c_{mt} - \bar{c})^{1-\varepsilon}} = (1 + \tau_{t+1}^{cx}) \left(\theta A_{mt+1}^{1-\theta} \left(\frac{k_{t+1}}{h_{mt+1}}\right)^{\theta-1} (1 - \tau_{t+1}^k) + 1 - \delta\right) \tag{4}$$

Equations (2) and (3) are the static first-order conditions for the optimal allocation of time. Equation (2) shows that the marginal rate of substitution between market consumption and leisure is equal to the after-tax return to market work. The after-tax return to market work is the quantity of the market-produced consumption goods that can be purchased with the earnings of an additional hour of work. The effective tax rate on labor income, τ^h, includes the tax rate on consumption expenditures, $\tilde{\tau}^c$, and the average *marginal* tax rate on labor income, $\tau^{ss} + \phi\tau^{inc}$. The payroll tax, τ^{ss}, is assumed to be proportional with respect to income and the income tax, τ^{inc}, progressive. Under a progressive tax system, higher income results in a higher tax rate. The parameter ϕ scales the average income tax to create a marginal income tax rate.[3] The tax that distorts this first-order condition is the effective tax on labor income:

$$\tau_t^h = \frac{\tau^{ss} + \phi\tau^{inc} + \tilde{\tau}_t^c}{1 + \tilde{\tau}_t^c} \tag{5}$$

Equation (3) shows that the marginal rate of substitution between time in home production and market goods is also equal to the after-tax return to market work. This equation illustrates the important role of effective labor taxes and market sector productivity relative to home sector productivity in the allocation of time between home and market work. In particular, when holding $\frac{k_t}{h_{mt}}$ fixed, an increase in effective labor taxes leads to a decrease in the right hand side of this equation. This implies an increase in time spent in the home sector relative to market consumption. Conversely, an increase in market productivity, A_{mt}, relative to home productivity, A_{nt}, leads to substitution from home time to market goods.

Equation (4) is the dynamic first-order condition. It illustrates that the marginal rate of substitution between market consumption in period t and market consumption in period $t + 1$ is equal to the tax-adjusted return to capital. There are two terms that capture the

[3]This formulation of the effective tax on labor income is the same used by Prescott (2004).

effective tax distortion. The first is the effective tax on capital income:

$$\tau_{t+1}^{k} = \frac{\tilde{\tau}_{t+1}^{k} + \tilde{\tau}_{t+1}^{x}}{1 + \tilde{\tau}_{t+1}^{x}} \tag{6}$$

Notice that the effective capital tax is a function of both the tax on capital income and the tax on investment expenditures. The second tax distortion is:

$$\tau^{cx} = \frac{(1 + \tilde{\tau}_{t}^{c})(1 + \tilde{\tau}_{t+1}^{x})}{(1 + \tilde{\tau}_{t+1}^{c})(1 + \tilde{\tau}_{t}^{x})} - 1 \tag{7}$$

Note that this tax distorts the return to capital only if the tax distortion on consumption, $(1 + \tau_t^c)$, grows at a different rate than the tax distortion on investment, $(1 + \tau_t^x)$.

1.2 Balanced growth competitive equilibrium

A positive value for $\bar{c}$ implies that a balanced growth path in this economy can exist only asymptotically. Along a balanced growth path, asymptotic or otherwise, h_{mt} and h_{nt} are constant and k_t, c_{mt}, and y_t grow at constant rates. I choose to consider a balanced growth path with positive values for both h_{nt} and h_{mt}. On such a path, taxes must be constant and market and home productivity must grow at the same constant rate:

$$\frac{A_{mt+1}}{A_{mt}} = \frac{A_{nt+1}}{A_{nt}} = (1 + g) \tag{8}$$

Under these conditions, all growing variables grow at rate g.[4] I denote variables divided by growth factors with a $\hat{}$. Using equations (2) through (4), it follows that the balanced growth competitive equilibrium satisfies:

[4]Alternatively, as in Ngai and Pissarides (2008), $\frac{A_{mt+1}}{A_{mt}} > \frac{A_{nt+1}}{A_{nt}}$. This would lead to constant growth rates for k, c_m, y, and h_m constant. The home sector would disappear asymptotically and $h_n = 0$. This formulation would yield identical results to those presented in section 3.

$$\frac{a\hat{c}^{\varepsilon}\hat{c}_m^{1-\varepsilon}}{b(1-h_m-h_n)} = (1-\theta)\hat{A}_m^{1-\theta}\left(\frac{\hat{k}}{h_m}\right)^{\theta}(1-\tau^h) \tag{9}$$

$$\left(\frac{1-b}{b}\right)\left(\frac{\hat{c}_m^{1-\varepsilon}}{\hat{A}_n^{-\varepsilon}h_n^{1-\varepsilon}}\right) = (1-\theta)\hat{A}_m^{1-\theta}\left(\frac{\hat{k}}{h_m}\right)^{\theta}(1-\tau^h) \tag{10}$$

$$\frac{1}{\beta}(1+g) = \theta\hat{A}_m^{1-\theta}\left(\frac{\hat{k}}{h_m}\right)^{\theta-1}(1-\tau^k)+1-\delta \tag{11}$$

2 Calibration

The model is calibrated to match average hours per adult (aged 15-64) in the United States over the period 1960-2004. It is standard practice when calibrating this type of model to assume that the United States is on a balanced growth path. There are three main problems with that assumption in this case. First, labor taxes (described further in section 3.1) trend upward over the period 1960-2004. Second, this model has a subsistence consumption term implying a balanced growth path exists only asymptotically. The third and most important issue is that the ratio $\frac{h_{mt}}{h_{nt}}$ displays a substantial upward trend. Specifically, although market hours have remained relatively flat as a fraction of available time, home hours have declined significantly. This has been documented by Ramey and Francis (2009) and Aguiar and Hurst (2007*b*). These authors estimate that market hours have increased 28% to 38% relative to home hours. These three issues necessitate a modification of the standard calibration procedure. However, in what follows I show that with some modification, it is still possible to apply a standard method.

Instead of assuming the United States is on a balanced growth path for the period 1960-2004, I assume that it begins converging to a balanced growth path after 2004. Since labor taxes trend upward, market hours remain relatively stable, and home hours trend downward, it cannot be the case that the market and home sector productivity are growing at the same rate. The market productivity series (A_m) can be calculated from aggregate data (more details are located in the next section). The series for the United States (see figure 3) displays a relatively constant trend, with some fluctuation. If the home sector and market produced goods are substitutes (as they are found to be), a necessary condition for such dynamics is a lower rate in the growth of home productivity relative to the market. Given market sector productivity growth is relatively constant over the period 1960-2004 in the United States, I choose to target a constant growth rate ($\tilde{g}$) for home sector productivity series (A_n) over the same period.

From 2004 on, I assume that the United States begins convergence to a balanced growth path. Specifically, I assume that both market productivity growth and taxes are constant after 2004. Also in 2004, I assume that A_{nt} begins to grow at the same rate as A_{mt}, another necessary condition of the balanced growth path as described in section 1.2. Having pinned down the asymptotic behavior, I can then solve for the transitional dynamics over the period 1960-2004. My calibration strategy is to require that the model match several moments from the data over this period, even though the economy is not on a balanced growth path.

2.1 Parameter calibration

In this subsection, I describe the procedure used to calibrate the model parameters and calculate productivity series. More details about the data are located in the web appendix. My calibration strategy is as follows: I set values for θ, g, ε, and ϕ that can be determined without solving the model. I then jointly calibrate a, b, β, $\bar{c}$, δ, and $\tilde{g}$ to match as closely as possible specific moments in the data.

I set $\theta = 0.3$. This is consistent with payment to capital over the period 1960-2004 calculated using data from the Bureau of Economic Analysis (2007). I assume that g is equal to the average growth rate of A_{mt} over the period 1960-2004, which equals 0.018.[5]

I set $\varepsilon = 0.5$, which implies an elasticity of substitution between market- and home-produced goods equal to 2. Several papers provide estimates of the elasticity of substitution between home and market goods. Using microeconomic data, Rupert, Rogerson and Wright (1995) estimate this elasticity to be between 1.6 and 2 depending on the demographic group. Also using micro data, Aguiar and Hurst (2007*a*) estimate the elasticity of substitution equal to 2. Using macro data, Chang and Schorfheide (2003) estimate elasticity equal to 2.3 and McGrattan, Rogerson and Wright (1997) estimate it to be 1.8. My choice of $\varepsilon = 0.5$ is consistent with the findings from both micro and macro data.

Tax series used to simulate the model, described in further detail in the next section, are all average tax rates. In order to properly adjust average income tax rates to average marginal income tax rates, I need to scale the income tax series by ϕ. I choose a constant value for ϕ that represents the average adjustment to the income tax rates over all households. Prescott (2004) performs his calculations with $\phi = 1.6$. Sunley and Stotsky (1998) present data on the average marginal federal income tax rate for income quintiles. Using this data, I calculate the weighted average marginal income tax rate for six years during the 1970s, 1980s, and 1990s. Dividing by the average tax rate for each year supports the choice of $\phi = 1.6$. This value is held constant for all years.

It remains to calibrate values for a, b, β, $\bar{c}$, δ, and $\tilde{g}$. The choice for any one parameter will affect the series generated by the model and therefore the value of the other parameters, so the parameters are chosen jointly to match, as closely as possible, six moments in the data. I choose parameters such that the model-produced series for $\frac{x_t}{y_t}$ matches the average investment-output ratio in the United States over the period 1960-2004. Over the same period, I target an average after-tax real rate of return of 4%. I target four moments relating

[5]Data to calculate A_{mt} is described in the next section. Calculation of A_{mt} requires a value for θ and δ. The values used are the same values from this section. See web appendix for details.

to hours. In the model, h_{mt} represents the fraction of total time the household spends engaged in market work. In the data, this is analogous to aggregate market hours worked per week divided by total time endowment. I assume that each member of the population aged 15-64 is endowed with 100 hours per week to devote to market work, home production, or leisure (I exclude sleep and personal care from leisure activities). Data for market hours are obtained from GGDC (2007) and population data from OECD (2007). Series for average home hours worked per week come from Ramey and Francis (2009).[6] Parameters are chosen to generate the average level of market and home hours over the period 1960-2004 as well as the change in both series over the same time period.

Table 1 shows the calibrated parameter values and table 2 shows the calibration targets from the data with those generated by the model. The off-balanced growth path dynamics are generated by $\tilde{g} < g$ and a value for $\bar{c} > 0$. Parameter $\bar{c}$ displayed in table 1 is difficult to interpret, as it is virtually meaningless without some context. When the model is simulated for the United States, the parameter $\bar{c}$ is equivalent to 27% of market consumption in 1960 and 12% of market consumption in 2004. Table 8 in section 4 shows $\bar{c}$ as a percent of simulated market consumption in 1960 and 2004 for all countries studied.

Table 1: Calibrated parameter values

a	b	β	$\bar{c}$	δ	ε	g	$\tilde{g}$	ϕ	θ
0.93	0.58	0.98	0.06	0.14	0.50	0.018	0.003	1.6	0.30

Figure 1 shows the series generated by the calibrated model for hours per week spent working in the market with the data for the United States. Several remarks are worthwhile at this point. First, the cyclical fluctuations generated by the model do not match exactly what is seen in the data for market hours. For most periods the disparity is not too great. Some of the fluctuations in the 1970s are not quite captured, but the model does generate the

[6] Ramey and Francis report average home production hours worked per week by adults aged 18-64. See appendix for details.

sharp decline observed in the 1980s. Second, the model does not capture the large increase in market hours during the 1990s and the subsequent fall after 2000. As time passes and more data is collected, it appears that the increase in hours in the 1990s is best interpreted as temporary. The most-recent expansion has not seen hours climb anywhere near the levels of 2000[7]. Figure 1 also shows the model generated series for hours per week worked in the home sector with Ramey and Francis (2009) data. The simulated series does not display the same trend as shown in the Ramey and Francis data series. While the change over the period 1960-2004 is targeted, it is not quite matched by the model. This is due to the restriction of a constant growth rate in A_{nt} over the period 1960-2004. This restriction prevents all four moments relating to hours from being exactly matched by the model.

Table 2: Calibration targets

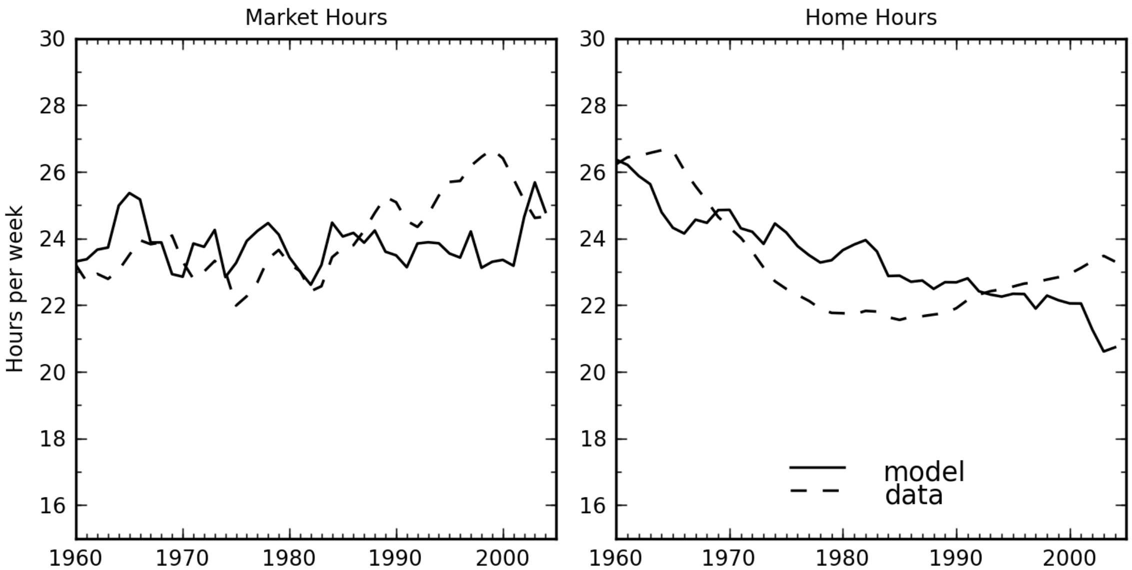
	Data	**Model**
Real return	4 %	4 %
Inv/output	0.19	0.19
Average h_m	24	24
Change h_m	1.5	1.5
Average h_n	23	23
Change h_n	-2.9	-5.6

3 Simulations for OECD countries

I now use the calibrated model to simulate series for 14 other OECD countries and compare the time series for market hours and investment generated by the model with those in the data. The countries examined in this paper are Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the

[7]McGrattan and Prescott (2010) provide an explanation for this temporary increase in market hours and subsequent return to early 1990s levels. Technological change in certain industries over this period led to an increase in research and development and uncompensated hours worked. Both of these activities are considered by the authors to be intangible investment, but are not recorded as such using standard accounting measures.

Figure 1: Hours per week, United States



United Kingdom, and the United States.[8] Each economy is assumed to have the same preference parameters a, b, β, $\bar{c}$, ε and technology parameters θ and δ. Tax and productivity series are country-specific. For the baseline simulations, income tax scale parameter, ϕ, is held constant across countries.

3.1 Tax series

Tax series for each country come from McDaniel (2007). Taxes calculated in McDaniel (2007) are average tax rates and are reported for the period 1950-2003. McDaniel assigns tax revenue in each country in each year as generated from taxes on household income, payrolls, capital income,[9] consumption expenditures, and investment expenditures. Each revenue category is divided by the relevant income or expenditure category reported in the national accounts to calculate the average tax rate on household income, the average payroll or social

[8]The sample of countries is limited to those for which comparable tax measures are available.
[9]Capital tax revenue includes a portion of household income tax revenue, property taxes, and corporate income taxes.

security tax rate, the average tax rate on capital income, the average tax rate on consumption expenditures, and the average tax rate on investment expenditures.[10] These tax series correspond to $\tau^{inc}, \tau^{ss}, \tilde{\tau}^k, \tilde{\tau}^c$, and $\tilde{\tau}^x$ in the model. The model variables $w_t h_{m_t}, r_t k_t, c_{m_t}$, and x_t from section 1 correspond neatly to McDaniel's classification of labor income, capital income, consumption expenditures, and investment expenditures. This makes the McDaniel tax series useful for this kind of analysis. Other papers provide average tax series, *e.g.*, Mendoza, Razin and Tesar (1994) and Carey and Rabesona (2002), but the McDaniel series has the advantage of covering the most countries for the longest time period. When simulating after 2003, it is assumed that taxes remain at their 2003 levels for all countries.[11]

Figures 2(a) and 2(b) show the effective labor (τ^{inc} has been scaled by ϕ) and capital tax series used for all countries. For all countries and years, τ_t^{cx} is effectively zero so this series is not shown. A look at the figures shows that most countries experience an increase in labor tax rates over this period. The degree of the change varies from country to country, generating greater cross-country differences in labor income tax rates in later years relative to the 1960s. Increases in the United States and Australia are relatively modest while the increase in European countries tends to be greater. A notable exception is the Netherlands. This economy shows a decline in tax rates post-1980, the period where most countries experience an increase until about 1995. Comparing figure 2(a) to 2(b) shows that the cross-country dispersion and change in labor tax rates is much greater than for that of capital taxes.

Table 3 shows the contribution of individual tax series to effective tax series. For the effective labor income tax series, the importance of each component varies quite a bit across countries and time. Consumption taxes constitute the majority of effective labor income taxes in Canada and France in 1960, but by 2004, their importance is diminished. Investment

[10] The tax revenue from investment expenditures includes a portion of indirect business taxes that cannot be strictly allocated to consumption. For example, value-added taxes may be levied on the production of final consumption goods or investment goods. See McDaniel (2007) for details.

[11] For the majority of countries in the study, tax rates cease to increase in the few years prior to 2003, so this assumption is reasonable.

tax rates in all countries and time periods (save Italy in 1960) represent a smaller share of effective capital tax than capital income tax rates do, but as will be shown in section 4, changes in the effective capital tax rates do not have a large effect on hours.

Table 3: Contribution of individual tax rates to effective tax rates

	1960					2004				
	% of τ^h			% of τ^k		% of τ^h			% of τ^k	
Country	$\tilde{\tau}^c$	$\phi\tau^{inc}$	τ^{ss}	$\tilde{\tau}^k$	$\tilde{\tau}^x$	$\tilde{\tau}^c$	$\phi\tau^{inc}$	τ^{ss}	$\tilde{\tau}^k$	$\tilde{\tau}^x$
Australia	48.5	51.5	0.0	86.0	14.0	44.4	55.6	0.0	82.6	17.4
Austria	46.4	24.8	28.8	55.0	45.0	32.5	30.5	37.0	60.9	39.1
Belgium	43.0	26.6	30.4	51.9	48.1	31.7	35.9	32.4	65.3	34.7
Canada	59.2	32.0	8.8	75.0	25.0	37.8	44.2	18.1	75.8	24.2
Finland	44.3	37.7	18.0	73.0	27.0	36.4	35.0	28.6	67.1	32.9
France	58.5	13.2	28.4	46.5	53.5	38.0	24.2	37.8	57.1	42.9
Germany	36.9	26.2	36.9	68.5	31.5	29.3	27.4	43.3	59.0	41.0
Italy	41.0	19.2	39.8	44.8	55.2	34.0	32.1	33.9	59.0	41.0
Japan	59.7	22.5	17.9	87.9	12.1	37.0	22.1	40.9	82.7	17.3
Netherlands	30.0	42.0	28.0	66.0	34.0	39.5	24.0	36.5	56.7	43.3
Spain	32.2	9.9	57.9	57.6	42.4	40.5	25.2	34.3	68.0	32.0
Sweden	42.5	45.6	12.0	66.7	33.3	43.4	33.2	23.3	62.2	37.8
Switzerland	36.6	45.2	18.2	72.4	27.6	33.2	43.7	23.2	71.7	28.3
U.K.	33.1	49.8	17.1	84.0	16.0	34.4	43.5	22.1	83.8	16.2
U.S.A.	32.2	51.6	16.1	89.1	10.9	22.1	46.5	31.4	88.0	12.0

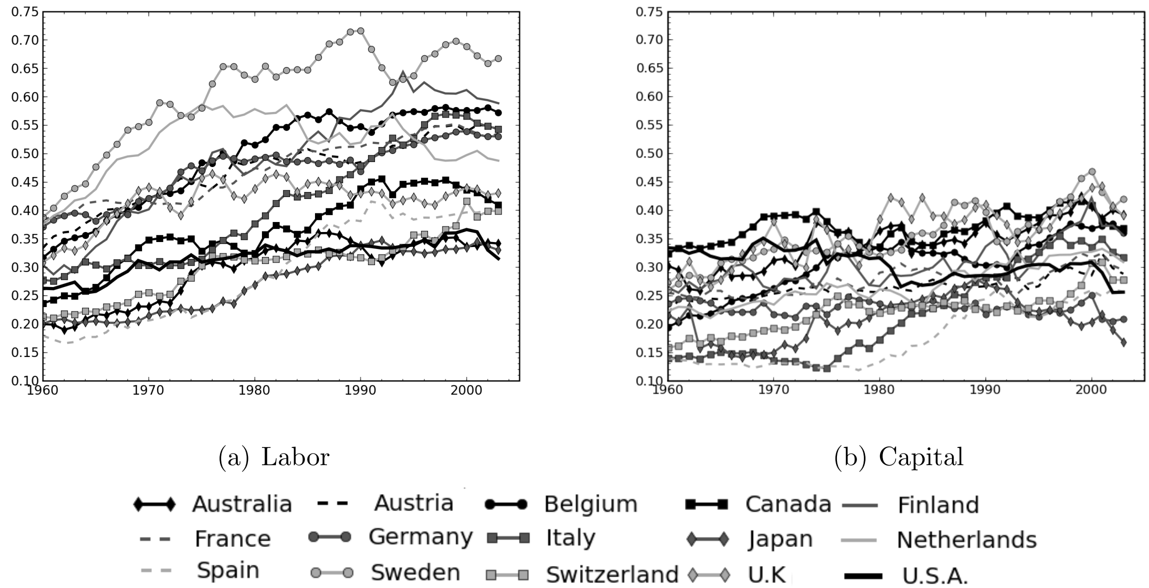
3.1.1 Market productivity series

Series for A_{mt} for each country are calculated using aggregate data from Heston, Summers and Aten (2006) and GGDC (2007). Recall that output in the model is produced with an aggregate production function.

$$\begin{aligned} Y_t &= K_t^{\theta}(A_{mt}H_{mt})^{1-\theta} \\ A_{mt} &= \left(\frac{Y_t}{K_t^{\theta}H_{mt}^{1-\theta}}\right)^{\frac{1}{1-\theta}} \end{aligned}$$

Since the model household is a representative household with one unit of time, model variables can be mapped to aggregate variables by multiplying by the time endowment. Since

Figure 2: Effective tax rates



(a) Labor

(b) Capital

the time endowment cancels in the above equation, A_{mt} can be calculated using aggregate variables. Real output is constant-dollar real GDP from Heston, Summers and Aten (2006) adjusted to be net indirect taxes using McDaniel's tax series; aggregate market hours come from the total economy data base GGDC (2007); and the series for capital is constructed using a perpetual inventory method and real investment data from Heston, Summers and Aten (2006). The value for θ is the same across countries as is listed in table 1. More descriptive details are located in the web appendix.

The series for A_{mt} terminates in 2004. Figure 3(a) shows that most countries experience a leveling off relative to the United States by that point. I make the assumption that A_{mt} grows at the same rate as the United States after 2004. This implies that A_{mt} relative to the United States is constant after 2004. Table 4 displays A_{mt} relative to the United States in 1960 and 2004. As is also shown in the figure, many countries experience a significant productivity catch-up.

Table 4: Productivity relative to the United States

	1960	**2004**
Australia	0.77	0.78
Austria	0.57	0.91
Belgium	0.58	0.93
Canada	0.84	0.78
Finland	0.48	0.78
France	0.62	0.93
Germany	0.58	0.94
Italy	0.56	0.82
Japan	0.39	0.66
Netherlands	0.76	0.89
Spain	0.48	0.71
Sweden	0.70	0.87
Switzerland	0.85	0.75
U.K.	0.72	0.89
U.S.A.	1.00	1.00

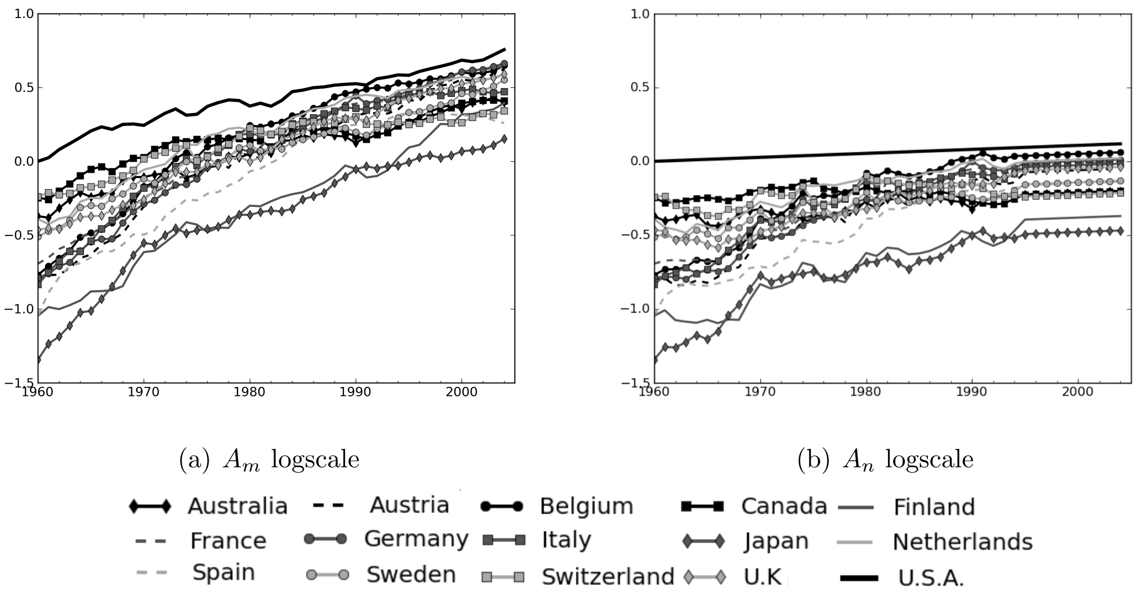
3.1.2 Home productivity series

I do not have data to directly calculate a series for A_{nt} for each country. As a reasonable starting point, I assume that productivity catch-up relative to the United States in the home sector resembles that experienced in the market sector. Figure 3(a) shows that most countries reach maximum market productivity relative to the United States by 1995. In the mid-1990s the United States experiences a boost in market productivity growth. Many of the other OECD countries do not experience such a boost. Consistent with my calibration for the United States economy, I assume that the post-1995 productivity boom was specific to the market sector. Hence I assume for a given country j:

$$A_{nt}^{j} = \frac{A_{mt}^{j}}{A_{mt}^{USA}} A_{nt}^{USA} \tag{12}$$

up until 1995. After 1995, I assume that home sector productivity relative to the United States in country j is constant at the 1995 level. This implies that home sector productivity relative to market sector productivity is the same across countries.[12] Figure 3(b) shows the series A_{nt} for all countries.

Figure 3: Productivity series



(a) A_m logscale

(b) A_n logscale

3.2 Implications for market hours

For each economy, given productivity and tax series, I simulate time series using the model. In order to do this, I must choose an initial condition for capital stock. As in section 2, I pick the capital stock in 1950 that is consistent with investment behavior subsequent to 1950. To avoid any effects associated with the choice of initial condition, I simulate the model from 1950 onward but I report results only from 1960 onward. By 1960, the effects of the choice of initial condition have effectively vanished.

[12]Since the home sector is found to be a key model mechanism shaping market hours over this period, assumptions about the path of A_{nt} have the potential to be important. Other assumptions about the level and growth of A_{nt} are included in the web appendix. While alternative assumptions do influence levels and time series path of market hours, the specification presented above does a better job reflecting what is observed in the data.

It is important to note at this point that the model is simulated and calibrated with tax series adjusted to be marginal. The relationship between average tax rates and marginal rates, represented by ϕ, is assumed to be the same across countries. I also implicitly assume that the relationship between marginal and average taxes is constant over time for a given country. While this seems a reasonable starting point, it is of future interest to develop time series for marginal taxes and evaluate the potential importance of this channel.

The simulated model produces the fraction of time spent working in the market. As previously mentioned, I assume members of the working aged population (ages 15-64) have a time endowment of 100 hours per week to devote to market work, home production, or leisure. Data series for market hours per adult is created using the same method and data sources as the United States described in section 2.1. When evaluating model predictions for market hours, I study both the model's prediction for levels of hours per week and changes across time. Prescott (2004) shows that the cross-country differences in labor supply tax wedges are highly correlated with the cross-country differences in hours in the 1970s and late 1990s. Here I address whether a calibrated general equilibrium model including home production and subsistence consumption can also account for differences in levels over time.

The first six columns of table 5 display the baseline model's prediction for market hours per week with that observed in the data in 1960, 1980, and 2004. The next two columns of the table show the level change in market hours over the period 1960-2004 observed in the data and generated by the model. The final column, "Average Absolute Value Differences," shows the average absolute value difference between the hours generated by the model and the data for each country. Entries for countries where the model, on average, generates market hours less than observed in the data are shown with a '$-$' sign and entries where the model generate hours, on average, greater than the data are followed with a '$+$' sign. Consider the entry for Germany. Over the period 1960-2004, market hours generated by the model are, on average, 2.2 hours per week different and less than what is observed in the

Table 5: Market hours per week 1960-2004

	1960		**1980**		**2004**		**Δ 1960-2004**		**Average Absolute Value Difference**†	
	Model	*Data*	*Model*	*Data*	*Model*	*Data*	*Model*	*Data*		
Australia	28.5	24.6	24.4	23.3	24.0	24.3	-4.4	-0.3	1.9	(+)
Austria	29.7	30.8	19.2	23.9	17.1	19.9	-12.6	-10.8	3.8	(−)
Belgium	27.6	26.7	17.2	19.5	14.7	18.8	-12.9	-7.9	2.5	(−)
Canada	25.6	22.5	24.4	23.3	21.9	24.8	-3.7	2.3	2.1	(−)
Finland	32.5	32.2	22.1	25.9	16.3	22.4	-16.2	-9.8	4.6	(−)
France	25.9	28.3	18.6	23.0	17.1	18.5	-8.8	-9.8	2.9	(−)
Germany	27.6	28.9	18.9	22.2	17.9	19.8	-9.6	-9.1	2.2	(−)
Italy	29.6	24.2	23.3	19.1	15.8	19.4	-13.8	-4.8	4.4	(+)
Japan	40.0	31.4	29.3	28.6	28.1	25.6	-11.9	-5.8	2.8	(+)
Netherlands	24.6	25.6	14.9	20.2	18.4	20.3	-6.2	-5.4	3.5	(−)
Spain	34.4	23.8	28.4	20.0	21.2	21.1	-13.2	-2.7	7.3	(+)
Sweden	23.1	26.9	13.9	23.2	11.7	22.3	-11.4	-4.6	9.6	(−)
Switzerland	28.8	30.1	25.9	25.8	22.7	24.7	-6.1	-5.4	1.3	(−)
U.K.	26.3	29.4	19.2	23.9	20.5	22.5	-5.8	-7.0	3.5	(−)
U.S.A.	23.3	23.2	23.4	23.2	24.8	24.7	1.5	1.5	1.1	(−)
Average	25.6	24.1	22.0	24.9	19.8	24.9	-9.0	-5.3	3.6	(−)

† Entries where the model under-predicts market hours are followed with a '−', entries where model genenerated hours are greater than those observed in the data are followed with a '+' sign.

data. Also note the entry -1.1 for the United States. While the average level of hours and the change in market hours generated by the model are identical to what is observed in the data, there are periods when the model generated series is not identical to the data series. The average absolute value difference between the data and the model is 1.1.

Time series of the level of market hours worked are shown in figure 4. Note that the series for hours generated by the model displays higher frequency variation relative to the data. Series A_m, τ^h, and τ^k are fed into the model raw instead of smoothed. Simulated market hours are quite sensitive to changes in after-tax wage, as will be shown in section 4. The period-by-period deviation of hours from trend is not a focus of this paper, but tax and productivity series are left unfiltered as the trends are still easy to identify.

The model underestimates market hours worked per adult for the majority of countries. In these countries, the disparity in the levels of market hours generated by the model relative to the data remains relatively constant over the whole period except for Canada, Finland

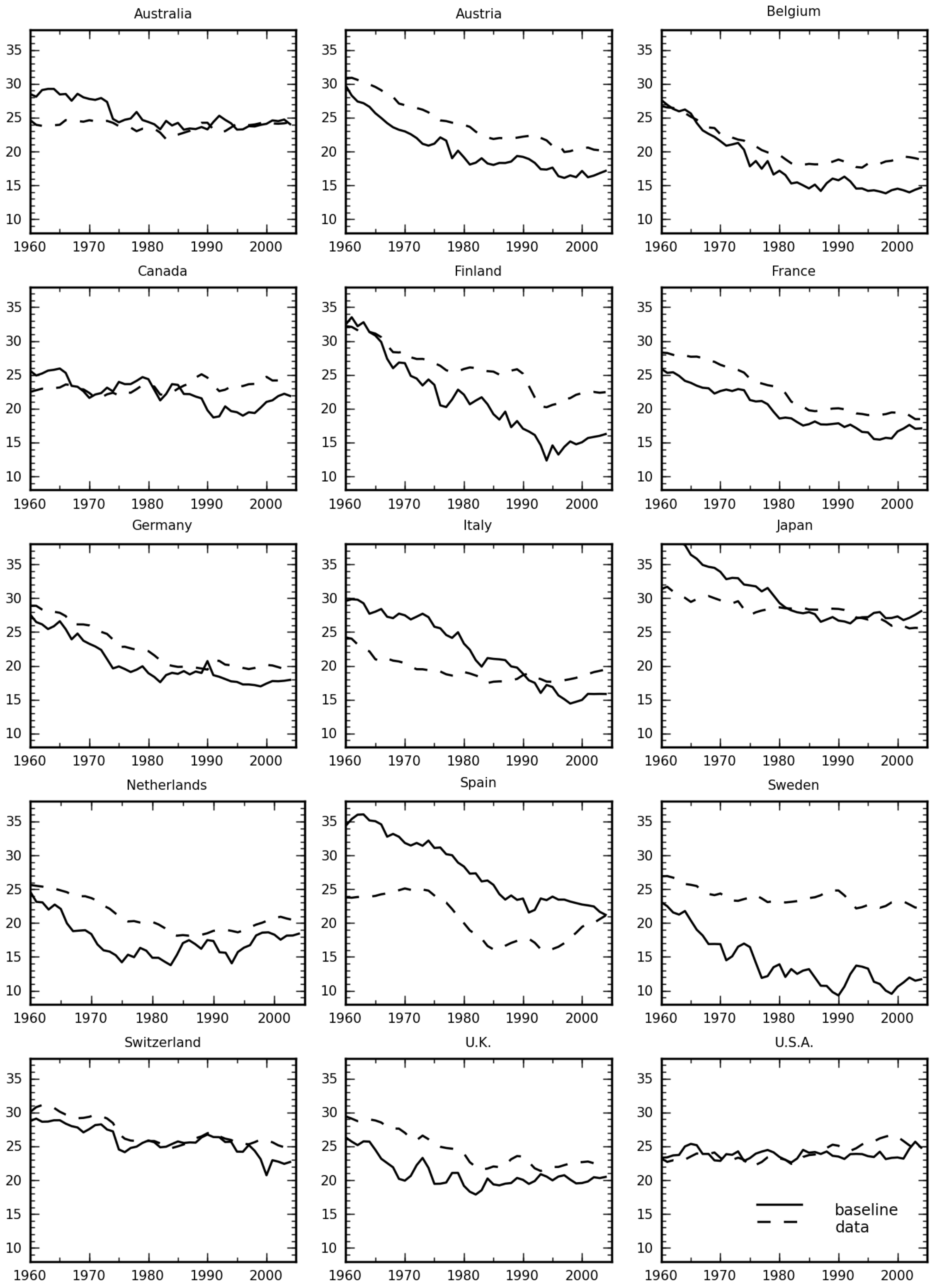
and Sweden. In Canada, the model generated series is fairly close to the data until about 1980. In the face of increasing tax rates and relatively low market productivity growth, the model predicts market hours fall in Canada while they remain relatively constant in the data.

There is an existing literature that studies hours in Scandinavian countries. Rogerson (2006) proposes an explanation for the higher levels and lack of decline in hours in the face of high and increasing tax rates. Rogerson argues that government spending in Scandinavian countries is not equivalent to a lump-sum transfer to the household and that some of the government spending provides incentive for the household to engage in market work. This hypothesis is supported by Ragan (2005). Since the baseline model described in section 1 does not account for different types of government spending, it is of no surprise that the model generates a decline in market hours in Finland and Sweden that is much greater than the decline observed in the data.

The model overestimates the level of market hours worked in Australia, Italy, Japan, and Spain. The model-generated series is relatively close to the data in Australia after 1975. The model significantly overestimates the level of market hours in Japan in the earlier years. Japan began the period with the lowest productivity level relative to the United States in 1960. Table 4 shows that productivity is roughly 40% of the United States' in 1960. As expected, the inclusion of subsistence consumption in the model generates market hours higher in Japan in 1960 than in any other country. The model not only overestimates market hours in Italy and Spain in the early period, but also misses on the general trend of hours over time. Though not as extreme as Japan, Spain and Italy begin the period as relatively low productivity countries, which explains the high model-generated hours in the early period. However, the general disparity between the model and the data implies there are important forces that shape hours in Spain and Italy that are not included in the model.

In summary, the model does a fair job generating the levels of market hours per adult

Figure 4: Market hours per week 1960-2004



in th 15 countries studied. The model does a better job generating the changes in market hours over the period 1960-2004, though the model over-predicts the change in market hours for several countries. The model generates the correct direction of change in all countries, save Canada.

3.3 Investment

The primary focus of this paper is the forces shaping market hours over time across countries. However, given the dynamic nature of the model, it is possible to evaluate whether or not the forces that shape market hours are also influential in shaping investment. I choose to study the series of investment output ratios in each country from 1960 to 2004. Investment and output data are collected from Penn World Tables national accounts, as detailed in the web appendix. Both series are adjusted to be net of taxes as to be comparable to what is generated by the model. The series for $\frac{x_t}{y_t}$ generated by the model is quite volatile. For this reason, I do not create a table comparing the change and levels and move right to displaying the time series. Figure 5 displays the investment output ratio generated by the model along with the ratio in the data for all countries.

In general the level of investment generated by the model is lower than the level observed in the data, though it is pretty close in many countries. The baseline model does not include government investment or investment subsidies, which may help explain some of the under-prediction in the series. The high degree of volatility in the series generated by the model is likely due to the assumption of perfect foresight over tax and productivity series.[13] If the household can observe that a short-term productivity shock will arrive in the next period and be gone in the period following it, the household will invest more in the current period, cut investment in the low productivity period, and increase investment in the following period.

[13]In the web appendix, I relax this assumption and find that if the household does not anticipate the fluctuations in productivity and tax rates, the series $\frac{x_t}{y_t}$ is more stable.

A model with smoother expectations about growth and taxes would generate a less volatile investment series, though this may not be true for the hours series.

4 Discussion

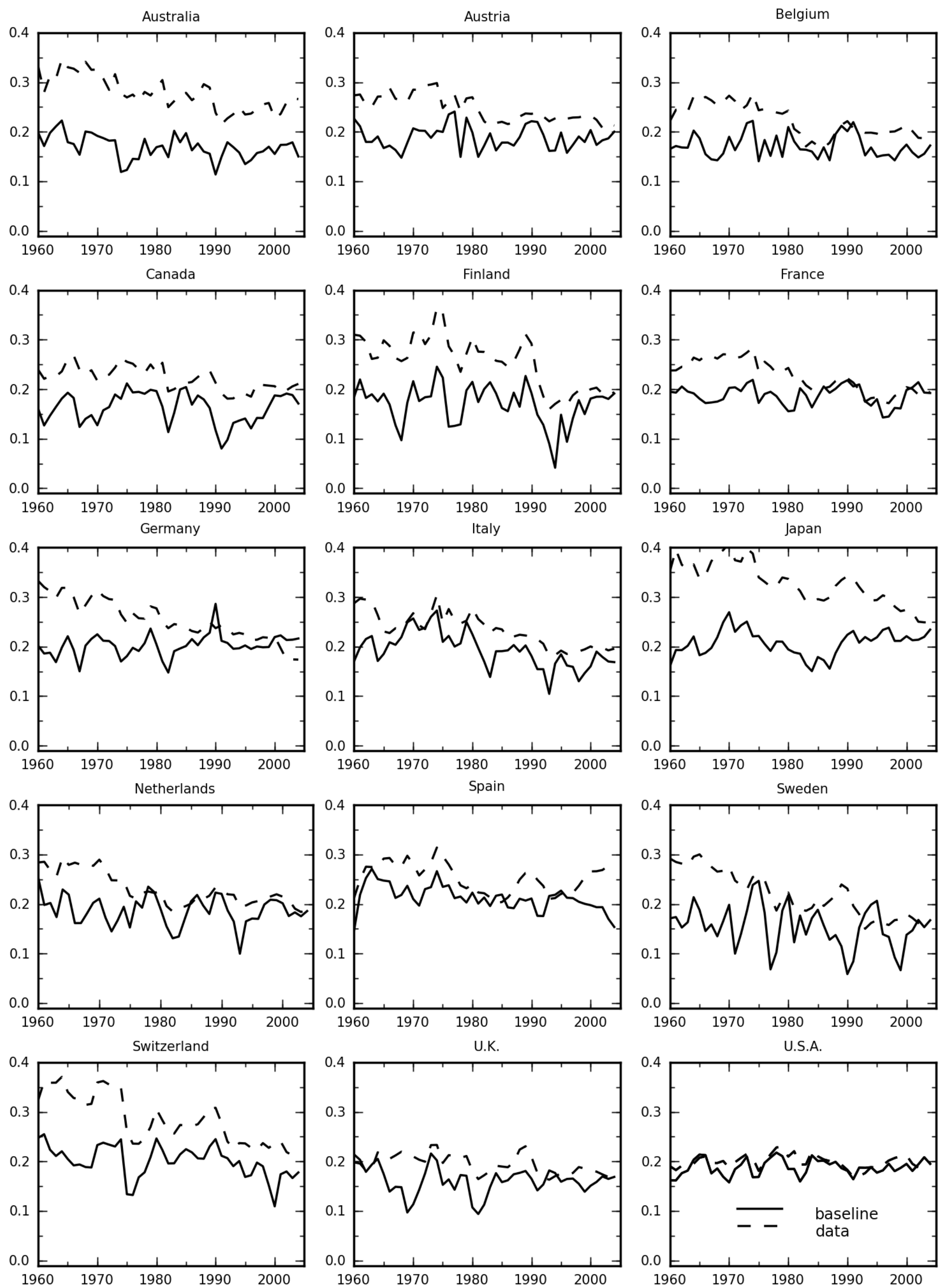
I claim in the introduction that labor income taxes and productivity catch-up are important forces influencing market hours. I also state that there are important differences in hours series generated by models that exclude home production and subsistence consumption relative to the baseline model. In what follows, I evaluate the importance of the forces shaping hours and show differences in model predictions when home production and subsistence consumption are excluded from the model.

4.1 Driving Forces

The model described in section 1 includes three forces that have the potential to influence hours. These are effective labor income taxes, effective capital income taxes, and productivity catch-up (in both the home and market sectors) relative to the United States. I isolate the importance of these forces by simulating the calibrated baseline model with each force eliminated. The results of these simulations are displayed in table 6. Only changes in market hours are shown as the simulated 1960 levels are nearly identical to the baseline case.

The first column of table 6 displays the level change in market hours per week from the data and the second column shows the change in market generated by the baseline model with all forces present. The next column, labeled $\bar{\tau}^h$, shows the change in market hours worked generated by the model with capital income tax rates and home and market productivity varying as in the baseline case, but labor income tax rates held fixed at 1960 levels. The fourth column, labeled $\bar{\tau}^k$, displays the change in hours when capital income tax rates are held constant at 1960 levels, labor income taxes and home and market productivity vary.

Figure 5: Investment/output ratio



Notice the dramatic difference between the change in market hours in the baseline case and in the case with constant labor taxes. The average decline generated by the baseline model is nine hours per week, compared to less than two hours when labor taxes are held constant. In contrast, holding capital income taxes constant has very little impact on model predictions of the change in market hours. Recall figure 2 in section 3 showing greater increases in labor tax rates for most countries. For the vast majority of countries, labor tax rates increase significantly more than capital tax rates. One exception is Belgium. In Belgium, labor tax rates increase by 21 percentage points and capital tax rates increase by about 17 points. The $\bar{\tau}^h$ column of table 6 shows the model generating only a small decline in hours when labor taxes held constant and capital taxes vary in Belgium. The $\bar{\tau}^k$ column shows that when capital taxes are held constant and labor taxes vary the model generates a change in hours close to baseline case. Even in Belgium, the change in effective capital income taxes is not an important force shaping hours.

The mechanisms through which labor taxes and capital taxes affect hours are different. As noted earlier, labor taxes directly distort equation (2) and (3) by lowering the after-tax return to work. Capital income taxes distort equation (4) by reducing the real return to capital. That causes a decrease in the equilibrium of the capital-to-labor ratio and therefore indirectly affects market hours. From this exercise, it is apparent that hours are far less sensitive to changes in capital tax rates than they are to labor tax rates.

The fifth column displays the change in market hours worked per week generated by the model with a constant growth series for A_{mt} used for all countries. The value for A_m in 1960 for each country is as reported in table 3, and $\frac{A_{mt+1}}{A_{mt}} = g$ for years subsequent. Home productivity is assumed to grow at rate $\tilde{g}$ in all countries. Simulated market hours per week decline in all countries except the United States, as in the baseline case. However in most countries, the decline in hours is not as great.

The final column of the table shows the percent of the decline in market hours that can

Table 6: Change in market hours 1960-2004, driving forces

	Data	*Baseline*	$\bar{\tau}^h$	$\bar{\tau}^k$	$\frac{A_{m_{t+1}}}{A_{m_t}} = g$	τ *Share*
Australia	-0.3	-4.4	0.7	-3.4	-3.9	87.1 %
Austria	-10.8	-12.6	-3.9	-12.5	-9.2	73.2 %
Belgium	-7.9	-12.9	-2.8	-12.1	-11.1	85.6 %
Canada	2.3	-3.7	2.7	-3.6	-3.9	106.3 %
Finland	-9.8	-16.2	-5.3	-15.8	-13.3	82.2 %
France	-9.8	-8.8	-2.7	-8.6	-6.7	75.7 %
Germany	-9.1	-9.6	-3.2	-10.2	-6.8	70.2 %
Italy	-4.8	-13.8	-3.9	-12.7	-11.4	83.2 %
Japan	-5.8	-11.9	-7.6	-20.1	-8.5	71.1 %
Netherlands	-5.4	-6.2	-1.5	-5.5	-3.9	63.5 %
Spain	-2.7	-13.2	-5.4	-12.4	-10.2	77.5 %
Sweden	-4.6	-11.4	-0.5	-10.9	-11.0	96.9 %
Switzerland	-5.4	-6.1	1.0	-5.1	-5.0	82.3 %
U.K.	-7.0	-5.8	-1.0	-4.9	-4.4	75.4 %
U.S.A.	1.5	1.5	4.2	1.1	2.3	
Average	-5.3	-9.0	-1.9	-9.1	-7.1	81.1 %

be attributed to changing tax rates (The United States is excluded since simulated hours rise). Consider the case of Germany. When taxes are allowed to vary but productivity catch-up as a potential driving force is removed, the simulated series for hours generates 70.2% of the baseline decline in hours. On average across all countries, tax rate variation generates approximately 81% of the decline in hours generated by the baseline model. This highlights the importance of both sets of driving forces. Clearly, labor income tax changes is the primary force influencing market hours, but productivity catch-up cannot be considered trivial.

4.2 Model Mechanisms

The baseline model is a standard growth model extended to include home production and subsistence consumption. To examine the importance of these extensions, I compare predictions of alternative models with the baseline model and the data. Specifically, I show

Table 7: Market hours 1960-2004, alternative models

	Change 1960 - 2004				**Average Absolute Value Difference**					
	Data	*Baseline*	*No Home*	$\bar{c} = 0$	*Baseline*		*No Home*		$\bar{c} = 0$	
Australia	-0.3	-4.4	-4.5	-3.7	1.9	(+)	1.4	(+)	1.5	(+)
Austria	-10.8	-12.6	-6.6	-5.9	3.8	(−)	4.4	(−)	6.9	(−)
Belgium	-7.9	-12.9	-8.3	-8.8	2.5	(−)	1.9	(−)	5.0	(−)
Canada	2.3	-3.7	-4.5	-4.0	2.1	(−)	2.1	(−)	2.7	(−)
Finland	-9.8	-16.2	-8.8	-8.7	4.6	(−)	6.9	(−)	9.7	(−)
France	-9.8	-8.8	-4.9	-3.3	2.9	(−)	3.0	(−)	5.6	(−)
Germany	-9.1	-9.6	-4.6	-3.1	2.2	(−)	2.6	(−)	5.0	(−)
Italy	-4.8	-13.8	-8.5	-10.0	4.4	(+)	3.1	(+)	3.6	(+)
Japan	-5.8	-11.9	-3.4	-0.1	2.8	(+)	2.6	(−)	2.1	(−)
Netherlands	-5.4	-6.2	-4.0	-3.5	3.5	(−)	2.7	(−)	5.7	(−)
Spain	-2.7	-13.2	-6.7	-7.7	7.3	(+)	4.6	(+)	5.1	(+)
Sweden	-4.6	-11.4	-9.3	-9.8	9.6	(−)	8.9	(−)	13.1	(−)
Switzerland	-5.4	-6.1	-5.7	-6.5	1.3	(−)	2.4	(−)	2.1	(−)
U.K.	-7.0	-5.8	-4.2	-3.1	3.5	(−)	3.6	(−)	5.9	(−)
U.S.A.	1.5	1.5	-1.7	1.5	1.1	(−)	1.5	(+)	1.2	(−)
Average	-5.3	-9.0	-5.7	-5.1	3.6	(−)	3.4	(−)	5.0	(−)

results for a standard growth model that includes neither home production nor subsistence consumption and a model with home production but no subsistence consumption. In each case, I recalibrate the model parameters (see web appendix for details).

Table 7 shows the level change in market hours worked per week (left columns) in the data and generated by the baseline and alternative models. The right-hand columns of table 7 show the average absolute value of the difference between the model-generated hours and the data. Again, entries for countries where the model generates market hours on average less than those observed in the data are followed with a '−' sign, and those where the model generates a series for market hours, on average, greater than the data are followed with a '+' sign. The columns with results from the model with no home production or subsistence consumption are labeled "No home" and the results from the model with home production but no subsistence consumption are labeled "$\bar{c} = 0$."

The primary conclusion of Prescott (2004) is that the inclusion of taxes in a static version of the growth model can account for the decline in market hours in European countries and the relatively small change in hours in the United States over the period 1970 to the mid-1990s. Table 7 shows that a dynamic growth model that includes taxes (the "No home" model) generates a decline in market hours over the period 1960-2004 for all the countries studied. This decline is less than that observed in the data for about half of the countries and the decline is greater in the other half. Note a decline in market hours is not consistent with the actual change in market hours in the United States. This is a concern as the model parameters are calibrated to match (as best as is possible) to the United States.

As mentioned in the introduction, other papers have stressed the important influence of home production in household labor supply decisions. When the standard model is extended to include home production, the model can be calibrated to generate the increase in market hours in the United States in the face of increasing labor income tax rates. Results from the model that include home production, but exclude subsistence consumption, are under the headings "$\bar{c} = 0$." The model with home production generates smaller declines in market hours, on average, and a lower level of market hours compared to the "No home" model. While the model can be calibrated to generate market hours consistent with what is observed in the United States, the "$\bar{c} = 0$" model does not generate series for market hours closer to what is observed in the data compared to the "No home" model for other countries in the sample.

The inclusion of subsistence consumption in the baseline model generates an increase in the average level of market hours for all countries (except the United States, as the model is calibrated to match the average level of hours) and steeper declines in market hours for many of the countries. The differences between the "$\bar{c} = 0$" model and the baseline model are large for some countries and small for others. Table 8 shows the calibrated value of $\bar{c}$ as a percent of simulated consumption in 1960 and 2004 for all countries. The differences between the "$\bar{c} = 0$" model and the baseline model are greatest for countries where $\bar{c}$ represents a large share of simulated consumption in 1960.

Table 8: Subsistence consumption as a percent of market consumption

	1960	**2004**
Australia	33 %	17 %
Austria	54 %	20 %
Belgium	46 %	23 %
Canada	30 %	20 %
Finland	57 %	29 %
France	52 %	20 %
Germany	54 %	18 %
Italy	46 %	24 %
Japan	63 %	20 %
Netherlands	42 %	19 %
Spain	49 %	20 %
Sweden	43 %	34 %
Switzerland	29 %	19 %
U.K.	40 %	18 %
U.S.A.	27 %	12 %

Table 7 shows meaningful differences in the hours series generated by the "No home," "$\bar{c} = 0$," and baseline models for the majority of countries studied. Home production is an important addition to the model, as the models that include home production can generate the increase in market hours observed in the United States over the period 1960-2004. The baseline model with home production and subsistence consumption generates high levels of market hours in early periods and steep declines for countries that experience productivity gains relative to the United States. However, as shown in table 7, the baseline model does not generate series for market hours closer to the data relative to the other models for all countries. It remains to be fully explained why actual market hours are low relative to the baseline simulation in some countries and high in others.

4.3 Additional experiments

There are a few more key assumptions made in the baseline model that have yet to be addressed. First, the household is assumed to have perfect foresight over future tax and productivity levels. Second, all tax revenues are assumed to be transferred back to the household in a lump sum. Third, the relationship between average and marginal tax rates is assumed to be the same across countries and time. More detailed descriptions of the experiments performed to evaluate the importance of these assumptions is available in a web appendix. If the household does not have perfect foresight over future productivity and tax rates, an alternate set of expectations must be chosen. If the household is able to observe only the current period productivity and tax level and then expects that taxes will be constant in the future at current period levels, and expects that A_{mt} and A_{nt} will grow at balanced growth rates forever after, then there is next to no effect on the levels or change in hours over time relative to the baseline case. While there is little effect on hours, the same is not true for the investment output ratio. If the household expects no volatility in future tax or productivity series, the high degree of volatility in the investment output ratio is reduced. On average, there is no significant difference in levels.

In the baseline case, all tax revenues are transferred back to the household in a lump-sum payment. This assumption is not entirely realistic, as the government may use tax revenues to finance the purchase of goods. If the household receives utility from the sum of market-purchased and government-provided consumption goods, the simulation results will be identical to the baseline case. Results may differ if the government-purchased goods enter the utility function separately. Government defense expenditures can be modeled in such a way. According to United Nations (2008), military spending as a fraction of GDP differs across countries and time. If the baseline model is altered to exclude defense expenditures from the lump-sum transfer, the level of hours is on average about one hour per week higher in the simulated series. While it may be safe to claim that accounting for military expenditures to the extent observed in the data does not have a large impact on market hours, transfer policies are important (consider Sweden). Country-specific studies of transfer policies should provide more insight on the cross-country differences in market hours.

A final issue concerns the relationship between average and marginal income tax rates. In the baseline simulation, the parameter ϕ that scales the average income tax rate to reflect average marginal income tax rates is held constant across countries. Setting the parameter ϕ equal to 1 instead of 1.6 generates a series for market hours that is on average 1.1 hours per week greater than the baseline case. While it would be ideal to have a series of average marginal tax rates to feed into the model, scaling average income tax rates by the same adjustment factor has a minor impact on predictions for levels of market hours.

5 Conclusion

In this paper I construct a growth model extended to include home production and subsistence consumption to study differences in market hours worked for 15 OECD countries. I find the forces influencing market hours in the selected OECD countries to be changes in labor income tax rates and productivity growth in the home and market sectors. Based on model simulations, about 80% of the change in market hours can be attributed to changing tax rates, with 20% of the change in market hours generated by productivity catch-up relative to the United States. I find that home production is an important addition to the model. A model with home production can be calibrated to generate the increase in market hours in the United States in the face of increasing labor income taxes. I also find that subsistence consumption is a key feature in a model that includes home production, as it generates high levels of market hours in early periods and the sharp declines in market hours experienced by many OECD countries.

This paper provides several areas for future research. The baseline model generates a series for market hours that fails to capture the levels or patterns observed in the data for some countries. There are some countries and time periods for which the model over-predicts market hours or fails to capture the patterns in hours over time. Questions remain about whether or not there is something distinctive about these economies that lead households to work less than predicted by the model. For other countries, the level of hours generated by the model is generally lower than that observed in the data; a possible explanation may lie in the tax and transfer policies of individual countries. Expanding research on the influence of government policies on hours may potentially better answer the questions regarding levels of hours.

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