Forces Shaping Hours Worked in the OECD 1960-2004
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Web Appendix

In the body of the main paper, I refer to several experiments that I do not describe in detail. In this appendix, I describe in detail the experiments and make a thorough presentation of the results.

A1. Government Transfers

In the baseline model, tax revenues are transfered lump-sum back to the household. Alternatively, tax revenues could be used to purchase a government consumption good. If the household receives utility from the sum of government provided consumption goods and consumption good purchased in the market, then the prediction for market hours by the model would be equivalent to the case with a lump-sum transfer. This is probably reasonable for some types of government expenditures, *e.g.* education, healthcare, transportation, etc., but may not be reasonable for outlays like defense spending. To address this issue, an alternative model is constructed with both a lump-sum transfer and a government provided consumption good that enters the utility function separately. Household preferences are represented by the following function:

$$U = \sum_{t=0}^{\infty} \beta^t \left(log(c_t) + alog(1 - h_t) + v(d_t) \right)$$

Where d_t represents government purchases of a good not equivalent to market consumption that the household values and takes as given. As described before, c_t is a home production function that aggregates market goods (c_{mt}) with time spent in home production (h_{nt}):

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

Now in order for the government budget constraint to balance, $T_t + d_t = \tilde{\tau}_t^c c_{mt} + \tilde{\tau}_t^x x_t + \tilde{\tau}_t^h w_t h_{mt} + \tilde{\tau}_t^k r_t k_t$. Feasibility now requires $y_t = c_{m_t} + x_t + d_t$.

In order to simulate the model and examine compare implication for market hours with the baseline case, I need a series for d_t. I treat d as military expenditure, all other tax revenues are transfered back to the household. The model is simulated with d_t as a fraction of GDP, $d_t = \eta_t y_t$. The household takes the fraction η_t as given each period. For each country and year, η_t is calculated using data from (United Nations 2006)[14] There are differences in military expenditures

[14] These data are not available in all countries/years. Military expenditures are not published for Canada. For countries with missing years, I assume a linear trend in η. I use publications from 1972,1982,1990,1994,and 2006

as a fraction of GDP across countries and time. Table A1 shows military expenditures as a percent of GDP in 1960, 1980 and 2004 for countries where data are available. As is shown in the table, there is some variation across countries and time with the United States consistently spending the largest share of GDP on defense.

Table A1—Military expenditures as % of GDP

	1960	**1980**	**2004**
Australia	2.3	2.8	1.8
Austria	0.7	1.3	0.9
Belgium	3.5	3.1	1.1
Canada	0.0	0.0	0.0
Finland	2.1	1.6	1.3
France	3.7	3.8	1.9
Germany	3.5	3.0	1.2
Italy	2.7	2.0	1.4
Japan	1.1	0.9	0.8
Netherlands	4.0	3.3	1.4
Spain	1.8	2.1	1.0
Sweden	5.0	3.4	1.8
Switzerland	2.5	1.5	1.1
U.K.	6.8	5.7	2.5
U.S.A.	9.7	5.9	4.2

The alternative model is simulated and compared with the baseline model. The model is simulated using the same procedure as described in section III. In order to highlight the difference in market hours when military expenditures are treated differently than other types of government expenditure, the model is not recalibrated. Table A2 shows the alternative simulation under the heading *Military* with the data and the baseline model. As is shown in table A2, the alternative treatment of military expenditures results in a higher level of market hours per adult of an hour per week on average. The figure B1 shows the time series simulated by the alternative model labeled “Military”, baseline model, and the data. Treating military expenditures differently than other types of government expenditures has only a small effect on market hours. However, it is important to recognize that transfer policies are a potentially very important influence on market hours. Work by (Rogerson 2006) supports the notion that tax and transfer policies have the potential to alter the pattern of market hours worked. It is more important to account for government purchases that are substitutes for home production time in as opposed defense spending in the countries and time periods studied here.

TABLE A2—MARKET HOURS, ALTERNATIVE GOVERNMENT PURCHASES

	1960 level			**Δ 1960 - 2004**		
	Data	*Baseline*	*Military*	*Data*	*Baseline*	*Military*
Australia	24.6	28.5	29.5	-0.3	-4.4	-5.1
Austria	30.8	29.7	30.5	-10.8	-12.6	-13.2
Belgium	26.7	27.6	29.1	-7.9	-12.9	-14.2
Canada	22.5	25.6	25.8	2.3	-3.7	-4.0
Finland	32.2	32.5	33.7	-9.8	-16.2	-17.2
France	28.3	25.9	27.6	-9.8	-8.8	-10.1
Germany	28.9	27.6	28.8	-9.1	-9.6	-10.6
Italy	24.2	29.6	30.9	-4.8	-13.8	-14.8
Japan	31.4	40.0	41.3	-5.8	-11.9	-13.0
Netherlands	25.6	24.6	26.0	-5.4	-6.2	-7.3
Spain	23.8	34.4	35.6	-2.7	-13.2	-14.2
Sweden	26.9	23.1	24.8	-4.6	-11.4	-12.9
Switzerland	30.1	28.8	29.8	-5.4	-6.1	-6.8
U.K.	29.4	26.3	28.7	-7.0	-5.8	-7.6
U.S.A.	23.2	23.3	25.5	1.5	1.5	0.4
Average	27.2	28.5	29.8	-5.3	-9.0	-10.1

A2. Perfect Foresight

When simulating the baseline model, I make the assumption that households have perfect foresight over future productivity and tax rates. To evaluate the significance of this assumption, I simulate the model for all countries (keeping parameter values the same) assuming households are relatively myopic. I assume agents observe the actual tax series and productivity levels for the current period. For all periods following, the household expects tax rates to be constant and both market and home productivity will grow at rate g. Time series for market hours where household are myopic are shown in figure B2. The figure shows that there is next to no difference in market hours under the alternative assumption. Labor supply varies little as long as the household has perfect information about tax rate and productivity levels in the current period.

In section 5 of the paper, series for investment are studied. The baseline model generated a much more volatile series for the investment output ratio than observed in the data. The excessive volatility is driven in large part by the perfect foresight assumption. Figure B3 displays the investment output series for the simulation where households some what myopic with the baseline and the data. Much of the volatility in the investment output ratio vanishes, but the average level remains the same.

A3. Alternative A_{nt}

In the baseline model, it is assumed that market sector productivity relative to home sector productivity is the same across countries. In this section, I simulate the model with two alternative assumptions. First, I simulate the model assuming that home sector productivity is equal to market sector productivity in 1960 and then grows at rate $\tilde{g}$ in all countries. These series are represented by the dotted lines labeled “An 1” in figure B4. Next I simulate the model assuming the series for A_{nt} is identical across countries, all equal to that in the United States. These alternative simulated series are shown labeled “An 2”. The model is not recalibrated since A_n for the United States in the same in all cases.

The figures show that assumptions about A_{nt} are more important in some countries than others. Low initial productivity in Japan and Spain leads to low levels of market hours when the home sector is assumed to be more productive than the market (An 2). Countries with significant market productivity catch-up relative to the United States, Austria, Belgium, France, Germany, and others show a smaller change in market hours over the period. If home sector productivity does not keep pace with the market, then the shift out of the market sector is much less pronounced. I conclude that assumptions about the home sector productivity are important, but neither alternative case seems more justifiable than the baseline assumption and the baseline assumption appears to better generate what is observed in the data.

A4. Marginal tax rates

When calibrating the model, I adjusted the average tax on labor income in the United States to reflect the average marginal tax rate. Recall that the effective tax on labor income that distorts the household time allocation decision is

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

For the baseline simulation, I hold ϕ constant at 1.6 across all countries and time. This is most likely a poor assumption as the progressiveness of tax systems varies across countries. Distributions of tax burdens are shown for a given year in (Organisation for Economic Co-Operation and Development 1981) for Australia, Belgium, Canada, Italy, the Netherlands, the and the United Kingdom. The United States is not shown, but data are available in (Sunley and Stotsky 1998). Comparison across countries suggests the difference between average tax rates and marginal tax rates varies across many European countries, at least for the years published. One example is the United Kingdom, where central government income tax rates appear to be near-constant across income levels, implying $\phi \approx 1$. However, it should be noted that the information in OECD (1981) and Sunley and Stotsky is based on central government income tax revenues, state/province and local taxes are not included. While it certainly is of interest to pin down the relationship between average tax rates and marginal tax rates for all countries in all years, I do not do so in this section. I look at how the model prediction of hours changes when the average marginal tax rate equals average tax rate, $\phi = 1$, for all countries (including the United States, but the model is not recalibrated) relative to the baseline. Neither source on tax burden data suggests the relationship between average and marginal is greater than that of the United States, so I keep $\phi = 1.6$ as the upper bound. Table A3 displays the results for levels in 1960 and the change generated by the model with $\phi = 1$ and the baseline.

Table A3— Market hours, $\phi = 1, 1.6$

	1960 level			**Δ 1960-2004**		
	Data	$\phi = 1$	$\phi = 1.6$	*Data*	$\phi = 1$	$\phi = 1.6$
Australia	24.6	29.7	28.5	-0.3	-3.0	-4.4
Austria	30.8	30.6	29.7	-10.8	-10.8	-12.6
Belgium	26.7	28.5	27.6	-7.9	-10.8	-12.9
Canada	22.5	26.5	25.6	2.3	-2.0	-3.7
Finland	32.2	33.7	32.5	-9.8	-14.3	-16.2
France	28.3	26.5	25.9	-9.8	-7.3	-8.8
Germany	28.9	28.7	27.6	-9.1	-8.4	-9.6
Italy	24.2	30.2	29.6	-4.8	-11.9	-13.8
Japan	31.4	40.4	40.0	-5.8	-11.3	-11.9
Netherlands	25.6	26.4	24.6	-5.4	-6.3	-6.2
Spain	23.8	34.6	34.4	-2.7	-11.9	-13.2
Sweden	26.9	25.0	23.1	-4.6	-10.2	-11.4
Switzerland	30.1	29.9	28.8	-5.4	-4.7	-6.1
U.K.	29.4	28.1	26.3	-7.0	-4.9	-5.8
U.S.A.	23.2	25.0	23.3	1.5	2.3	1.5
Average	27.2	29.6	28.5	-5.3	-7.7	-9.0

As is expected, $\phi = 1$ generates higher levels of hours in all countries, an average increase of about 1.2 hours per week. Since the baseline model generates series for hours generally below what is observed in the data, the ϕ adjusted series naturally appears better. However, an average of 1.2 hours per week is not a significant change in the level of hours, so it appears the relationship between average and marginal tax rates is not a primary factor in determining levels of hours. Refer again to table 3. In many of the countries where baseline hours are under-predicted by the model, *e.g.* France, Germany, Austria and Belgium, income taxes contribute a minority share to the effective tax on labor income.

The change in market hours is also shown in table A3. The simulated model with $\phi = 1$ generates an average decline in market hours about 1.2 hours per week less than the baseline case. The difference in the model generated series are greater in the countries with large income tax rate growth, specifically Belgium, Sweden and Finland. While the choice of ϕ does not have a major effect of the prediction of the baseline model, it should not be completely ignored as a factor influencing hours through tax rate changes. Time series plots are shown in figure B5.

A5. Alternative Models

As mentioned in the main paper, alternative models with with no home sector and no subsistence consumption are simulated and compared to the baseline case. Below, the models and calibrations are described in greater detail.

A MODEL WITH A MARKET SECTOR AND TAXES. — In order to evaluate the importance of home production and subsistence consumption as propagation mechanisms for market hours, I construct a model without these mechanisms. Consider a model where the agent has two uses of time: market work (h_t) and leisure. Preferences are similar to those in section I.

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

However, c_t here represents only a market produced consumption good and notice there is no subsistence consumption term. The aggregate production function and government are the same same as in section I. To conserve space, I skip equilibrium definition. The following two equations are necessary equilibrium conditions:

$$a\frac{c_t}{1-h_t} = (1-\theta)A_{mt}^{1-\theta}\left(\frac{k_t}{h_t}\right)^{\theta}(1-\tau_t^h) \tag{A1}$$

$$\frac{c_{t+1}}{\beta c_t} = (1+\tau_{t+1}^{cx})\left(\theta A_{mt+1}^{1-\theta}\left(\frac{k_{t+1}}{h_{t+1}}\right)^{\theta-1}(1-\tau_{t+1}^k) + (1-\delta)\right) \tag{A2}$$

where τ^h, τ^k and τ^{cx} are defined in (5) - (7). These equations are standard for characterizing the trade-off between consumption and leisure and the investment decision of the household in a growth model with taxes.

To calibrate this model, I use the same values for β, δ, g and θ as found in section II.A and reported in table 1. The only parameter left to find is a. With only one parameter, I can match only one moment in the data. I choose to find a by targeting the average of market hours, h_t, in the United States over the period 1960-2003. This implies $a = 1.85$.

With calibrated parameters a, β, δ, g, θ and series for tax rates and A_{mt}, I simulate the model for the fourteen other OECD countries with an initial condition chosen as described in section III. Time series plots are shown in figure B6. The level of hours is slightly lower in earlier periods in the "No home" model than in the baseline, largely due to the lack of subsistence consumption. The change over time is less dramatic as households cannot substitute home production for market-produced goods. Recall table 7 in the main paper. The average change is closer in the model with no home sector, but this is not true for all countries.

A6. A model with home production and no subsistence

Here I evaluate the importance of subsistence consumption by examining a model with home production excluding subsistence consumption. This is the model in section I with preference, technology and government identical save $\bar{c} = 0$. The equilibrium definition and equations that characterize the equilibrium are the same as in section I. To calibrate this model, I follow the same procedure as in section II. However, since I am forcing $\bar{c} = 0$, I cannot match one of the previously matched moments. I choose to match the average value for home hours, but forgo matching the trend. The leads to parameter values for β, δ, g and θ the same as the baseline case shown in displayed in 1. Parameter $a = 0.83$, $b = 0.62$ and $\tilde{g} = 0.009$.

To simulate the model for other countries, I make the same assumption as in section III about the relationship between A_{nt} and A_{mt} relative to the United States. With home productivity, market productivity and taxes, I simulate the model for each country using an initial condition chosen as described in III.

A closer look at the time series in figure B6 (series marked "cbar= 0") shows that in many countries the model with $\bar{c} = 0$ displays a different pattern than the data and the baseline model. For countries that experience steep declines in the data, the series generated by the model with $\bar{c} = 0$ exhibit shallower patterns. Consider France. While the series generate by the model with $\bar{c} = 0$ is shallower, it also displays patterns not seen in the data or generated by the baseline model.

Data Notes

The following subsections describe data used for calibration, the calculation of A_{mt}, and data used to calculate population series.

B1. Calibration data

The calibration procedure requires data series for taxes, population, real output, aggregate market hours, aggregate home hours, capital stock and the investment-output ratio for the United States. McDaniel (2007) provides tax series for consumption and investment expenditures and labor and capital income for the United States and all other countries examined in this paper from 1950-2003. The calculation methods of τ_t^c and τ_t^x imply $\tau^{cx} \approx 0$.

In the model, h_{mt} is the fraction of the time endowment the household spends working in the market. To find a representation of the time endowment in the data, I assume each member of the working-aged population, population aged 15-64, has a total of 100 hours a week (or 5200 hours a year) of discretionary time. Population series is described in section B.B4. To find the fraction of time spent working, I divide aggregate annual hours worked in the market by the annual time endowment.

Time spent working in the home sector is represented by h_{nt} in the model. Ramey and Francis (2009) provide estimates for time spent in home production in the United States from 1900 onward. They consider following activities to be home production: purchasing goods and services, care of family members, cleaning, maintenance of house and grounds, preparing and clean-up of meals, and making, mending and laundering clothes. Ramey and Francis report average hours per week spent engaged in home production by individuals aged 18-64. They use several sources to construct this series. Aguiar and Hurst(2007) also measure home production over time in the United States 1965 to 2004. Ramey and Francis use the same data sources for these years. I choose to calibrate using Ramey and Francis data as they have adjusted the population closer to what I use for market hours. Average hours worked for population aged 15-64 is used for market hours, a series for home hours aged 15-64 should be slightly different than the series for population aged 18-64. Alternatively, I could have used population aged 14-64. There is a small level difference in the estimate for hours between these two series and next to no difference in the change. Calibration using the 14-64 series results in a larger values for a, preference for leisure, and b, preference for market produced goods. Series are not shown, but the recalibrated model generates series for *market* hours virtually identical to the baseline case.

In the model, $\frac{x_t}{y_t}$ is the ratio of investment expenditures net of taxes and aggregate output. For the investment output ratio, I use the current price investment share of GDP provided by the Penn World Tables, 6.2. Both investment and GDP are reported gross of taxes. I adjust the investment output ratio series to be net of taxes using tax rates reported in McDaniel (2007). I report the ratio of investment to output using current prices because the model does not account for the changes in the price of investment relative to output that might drive fluctuations in constant price investment relative to constant price output.

B2. A_{mt} calculation

In the model described in section 2, there is an aggregate production function that takes the form

$$y_t = k_t^{\theta}\bigg(A_{mt}h_{mt}\bigg)^{1-\theta}$$

With this formulation,

$$A_{mt} = \left(\frac{y_t}{k_t^{\theta}h_{mt}^{1-\theta}}\right)^{\frac{1}{1-\theta}}$$

Since the model is a representative agent model, y_t, k_t and h_{mt} are per capita averages. Since the data are consistently available in aggregates, I calculate A^i_{mt}, where i denotes the country, using aggregate series which I denote with capital letters. In each period,

$$A^i_{mt} = \left(\frac{Y^i_t}{{K^i_t}^{\theta} {H^i_t}^{1-\theta}} \right)^{\frac{1}{1-\theta}}$$

Where Y^i_t is real output, K^i_t is capital stock and H^i_t is aggregate hours worked. Parameter θ is the capital share. The capital share is assumed to be the same in all countries. I set $\theta = 0.3$, chosen to be consistent with payment to capital in the United States over the period 1960 - 2003. Data for Y^i_t come from Penn World Tables 6.2. The series for real output is Real GDP per capita (Constant Prices:Chain series) times the Population series. There are no explicit series provided for K^i_t. Capital stocks are calculated using a perpetual inventory method where

$$K^i_{t+1} = X^i_t + (1-\delta)K^i_t$$

The series X_t are a real investment series and δ is a depreciation rate. The value for δ is assumed to be constant and the same for all countries and is set to the value from table 1. The series X^i_t are calculated from Investment share of RGDPL reported in the Penn World tables times Y^i_t for each year. Series X^i_t and Y^i_t are both adjusted to be net of taxes using McDaniel (2007) tax series. There is no information on initial capital stock. Since Y^i_t and X^i_t are available in 1950, I choose a value for K^i_{1950} such that the capital output ratio is equal to 1. The series for K^i_t are then calculated from 1951 to 2004. The earlier values forK^i_t are sensitive to the choice for the value of K^i_{1950}, but by 1960, K^i_t is nearly independent of the initial condition.

The series H^i_t are calculated from (Groningen Growth and Development Centre the Conference Board 2007). The Total Economy Database provides a series for hours per employee per year and total employment for years 1950 onward. The series hours per employee is complete for all years and countries. Total employment is available in 1950, but has missing data points for some countries[15] until 1960. After 1960, series for employment are complete in all countries. I assume a linear trend between missing data points for employment in countries where relevant. Aggregate annual hours and then calculated by multiplying yearly hours by employment.

With a series for Y^i_t, K^i_t and H^i_t, A^i_{mt} are calculated for each country 1950 to 2004. I normalize series for A^i_{mt} in all countries such that the value for $A^{USA}_{m1960} = 1$. Because series for A_{mt} are affected by the choice for K_{1950} and series for H_t are incomplete for some countries up to 1960, results presented in the paper are from 1960 onward. The 1960 onward results are virtually independent of choices for initial capital stock and assumption about trend in employment.

[15]Australia, Austria, Belgium, Finland, France, Italy, Japan,Spain, Sweden, Switzerland, and the United Kingdom

B3. Germany

Penn World Tables 6.2 provide series for Unified Germany from 1970 onward. The GGDC Total Economy database provides an hours series for West Germany 1950 to 1997 and series for Unified Germany 1989 onward. Penn World tables 5.6, (Alan Heston, Robert Summers and Bettina Aten n.d.) has data for West Germany 1950 to 1992. I consider Germany to be West Germany until 1990 and Unified after.

For years 1950 to 1990, I use Penn World Tables 5.6 data for West Germany. I denote values from Penn World Tables 5.6 with a $\tilde{}$. I calculate $\tilde{A}_{mt}^{WDEU}$ according to the method described in the previous paragraphs. I also calculate series $\tilde{A}_{mt}^{USA}$ using Penn World Tables 5.6. I define

$$\begin{aligned} \hat{A}_t^{DEU} &= \frac{\tilde{A}_{mt}^{WDEU}}{\tilde{A}_{mt}^{USA}} \\ t &= 1950, \ldots, 1989 \end{aligned}$$

Series for Unified Germany become available in 1970. I choose a value for K_{1970}^{DEU} such that $\frac{K_{1970}^{DEU}}{Y_{1970}^{DEU}} = \frac{\tilde{K}_{1970}^{WDEU}}{\tilde{Y}_{1970}^{WDEU}}$ and calculate a series for K_t^{DEU} from 1970 onward. Using K_{1990}^{DEU} - K_{2004}^{DEU}, Y_{1990}^{DEU} - Y_{2004}^{DEU} and H_{1990}^{DEU} - H_{2004}^{DEU}, I calculate A_{mt}^{DEU} for unified Germany 1990 onward. I then find[16]

$$\begin{aligned} \hat{A}_t^{DEU} &= \frac{A_{mt}^{DEU}}{A_{mt}^{USA}} \\ t &= 1990, \ldots, 2004 \end{aligned}$$

I then calculate a complete series for A_{mt}^{DEU} by multiplying $\hat{A}_t^{DEU}$ by the normalized A_{mt}^{USA} for $t = 1950 \ldots 2004$.

B4. Population

The working aged population is defined as population aged 15-64. Population series are available from the Database on Labour Force Statistics, (Organisation for Economic Co-Operation and Development 2007). Series for some countries are not consistently available until later years. For earlier years, I consult the United Nations World Populations Prospects, (United Nations Population Division 2006). These data are available 1950 onward at five-year intervals. I assume a linear trend in population growth for missing years. When OECD data are available, I merge the two series. Germany is West only until 1990 and then jumps to unified there after.

[16] A_{mt}^{USA} is not normalized

FIGURE B1. LEVELS OF MARKET HOURS, ALTERNATIVE GOVERNMENT PURCHASES

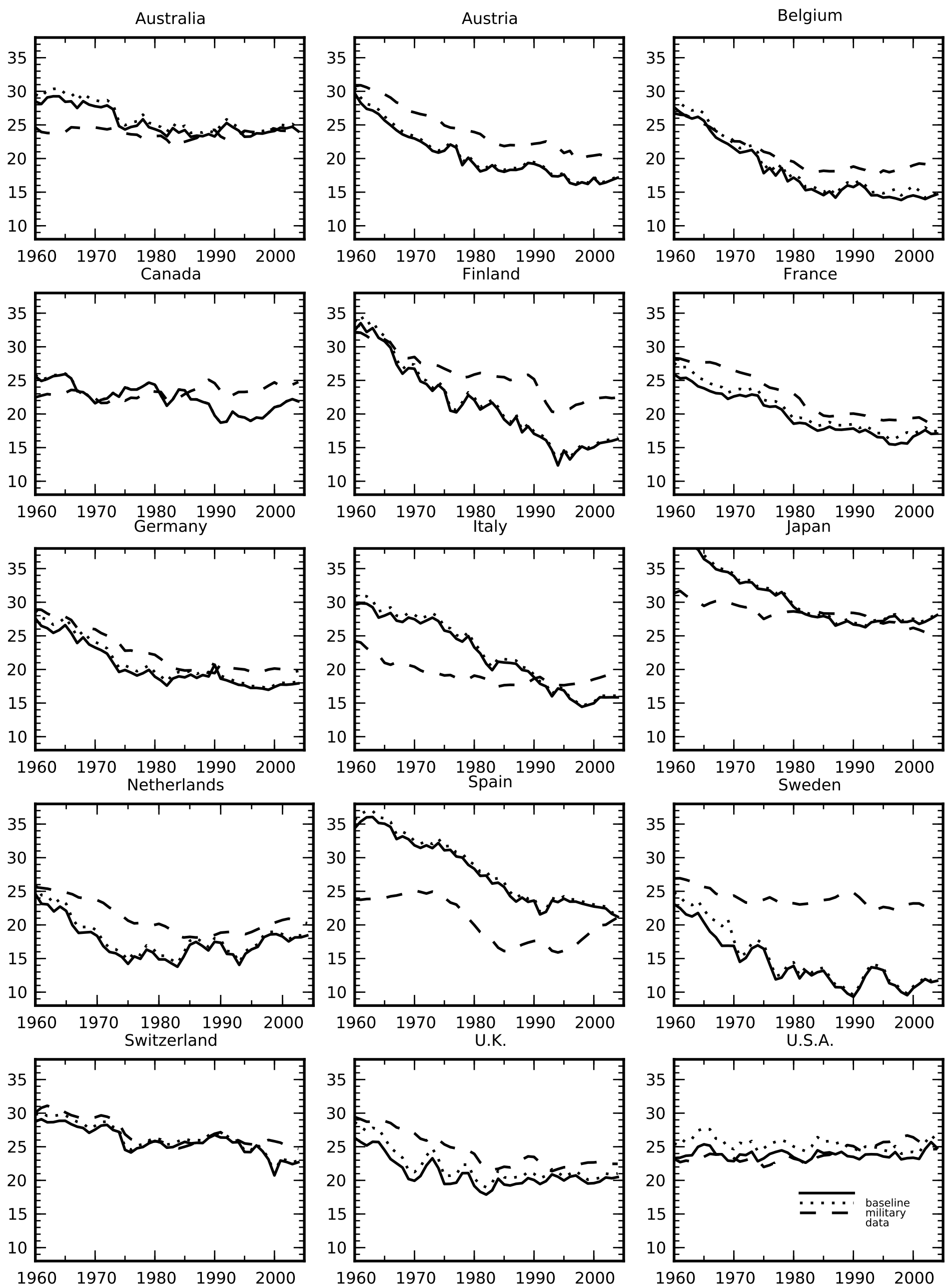

Figure B2. Market hours, alternative foresight

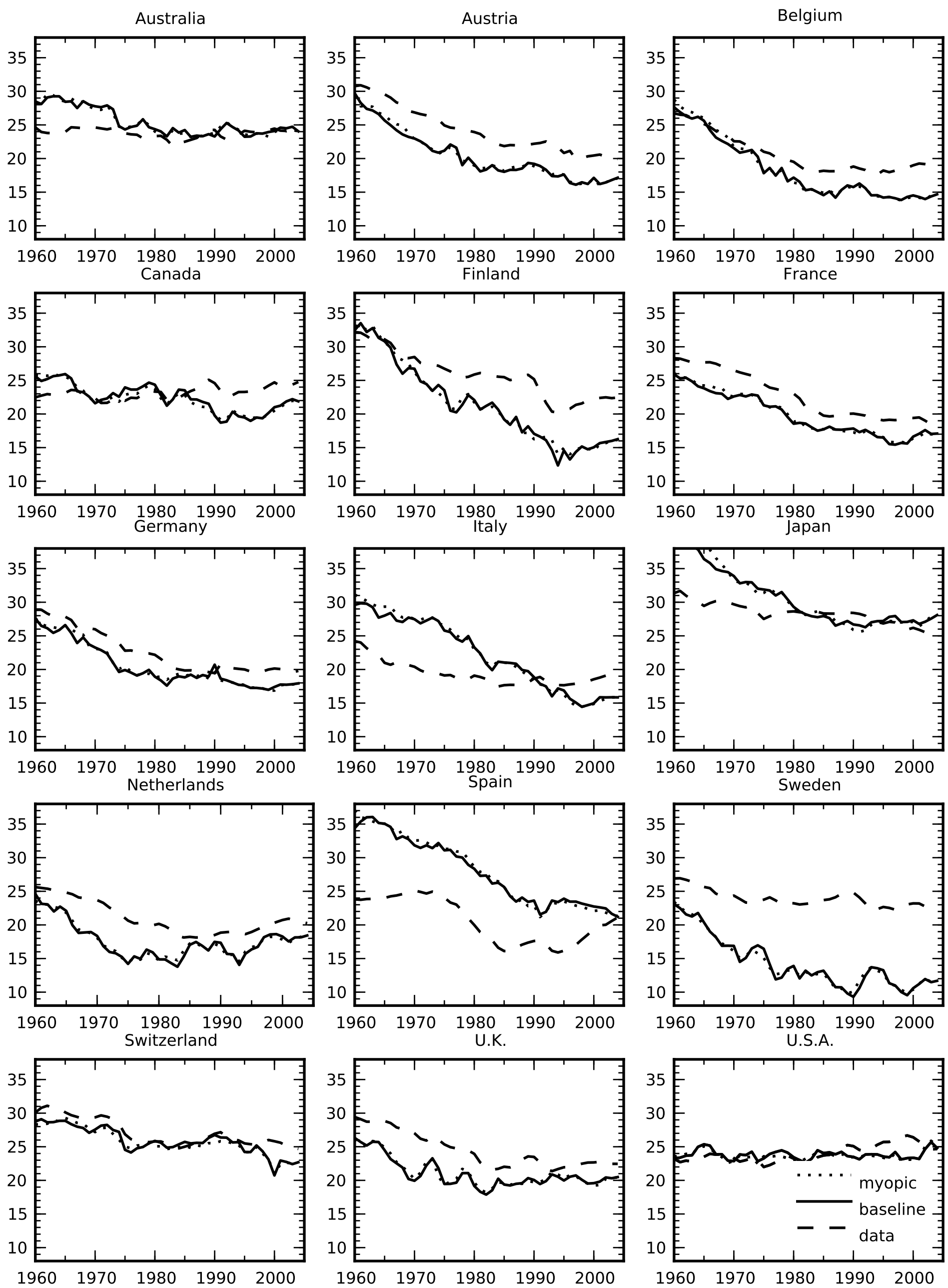

FIGURE B3. INVESTMENT/OUTPUT RATIO, ALTERNATIVE FORESIGHT

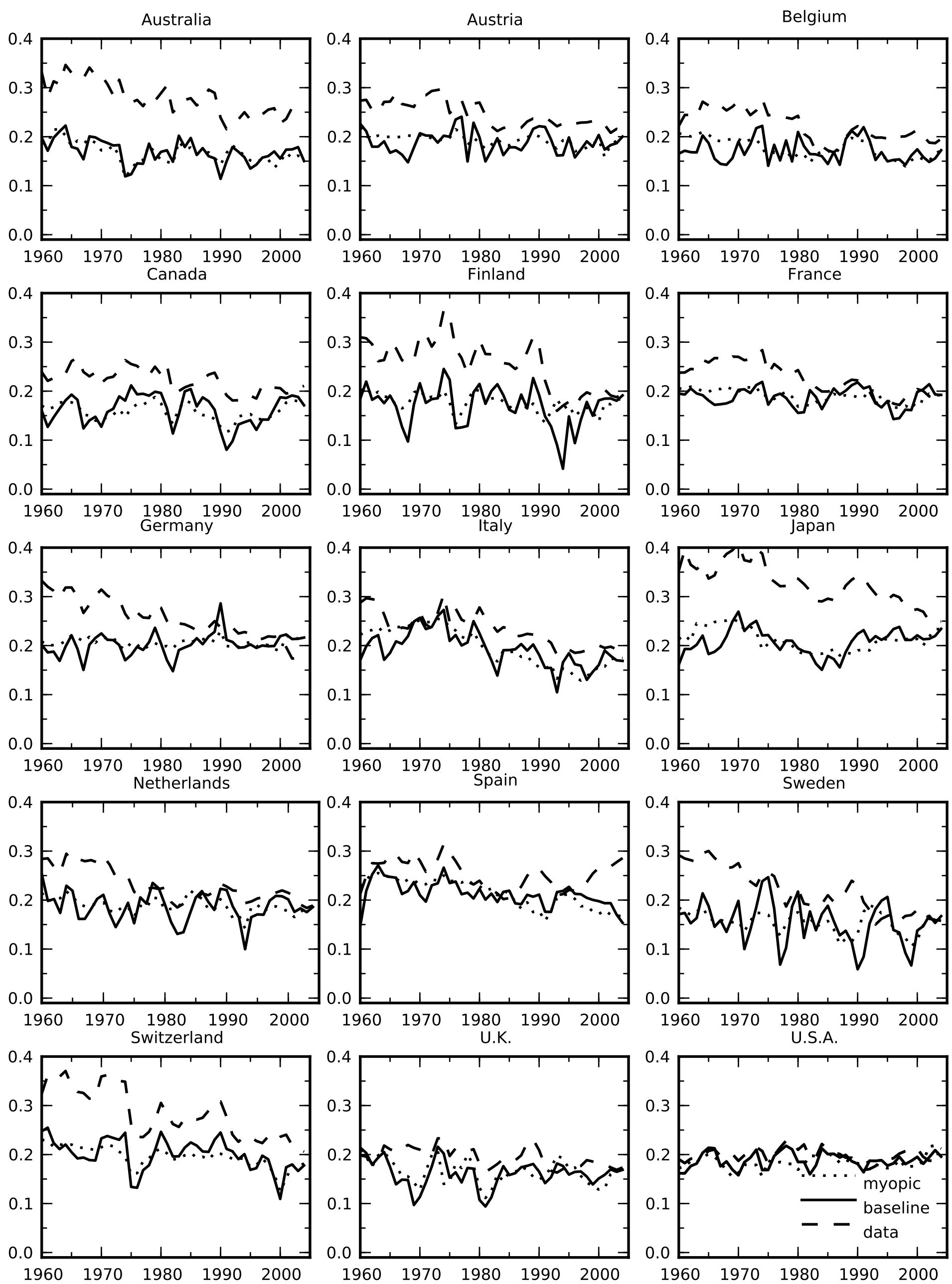

Figure B4. Market hours, alternative A_{nt}

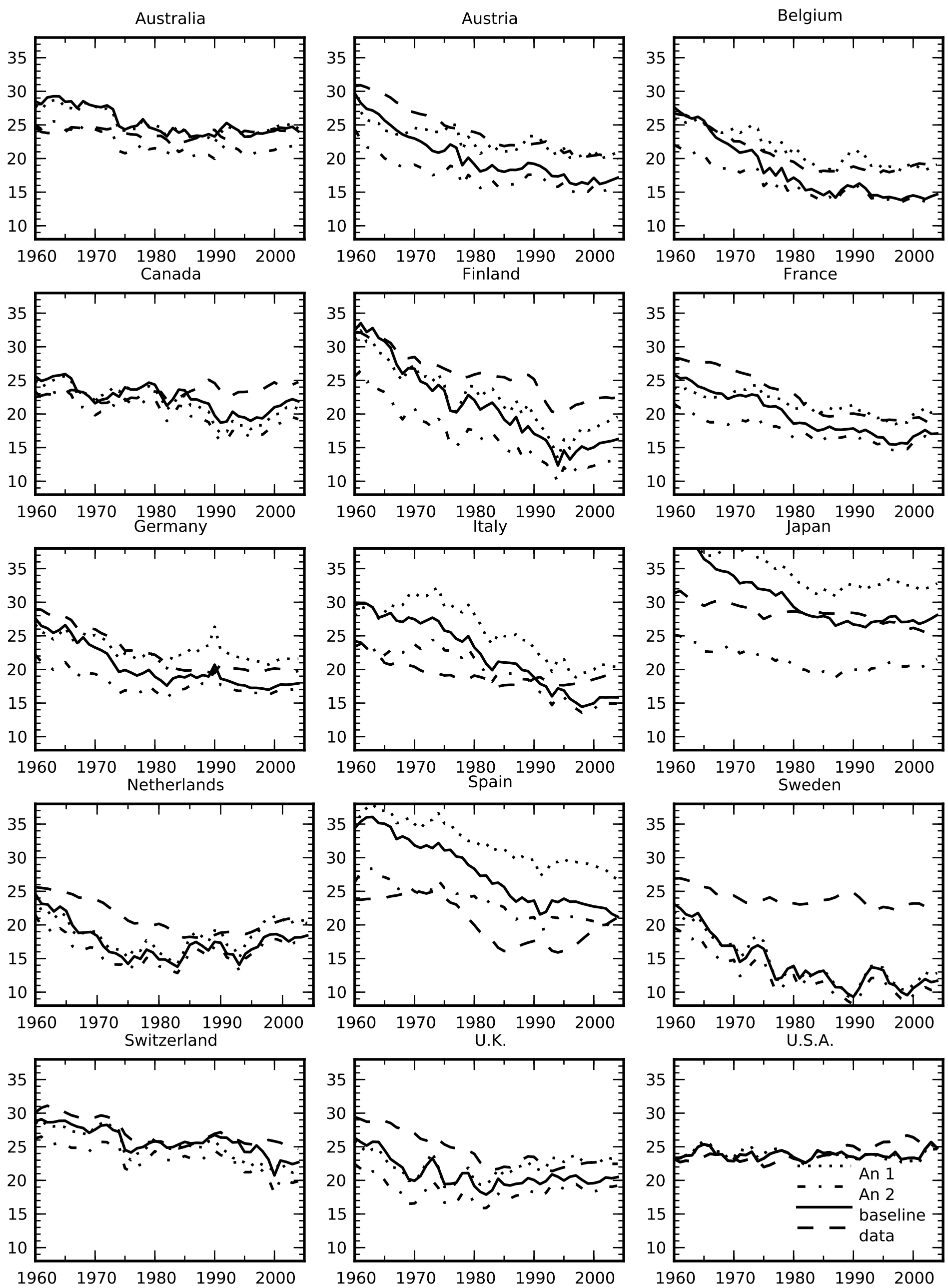

Figure B5. Market hours, alternative ϕ

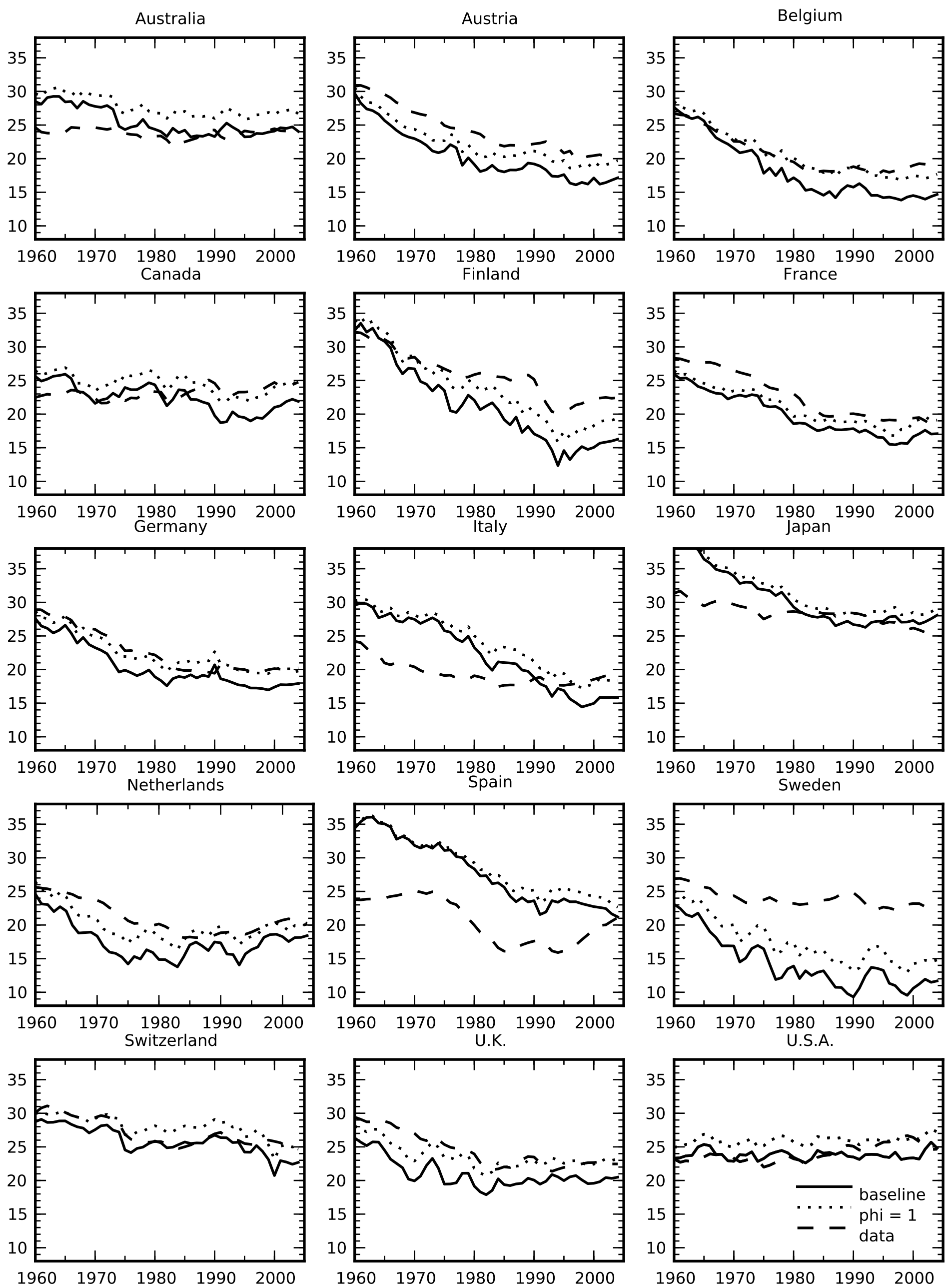

Figure B6. Market hours, alternative models