On the Allocation of Time – A Quantitative Analysis of the U.S. and France*

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Abstract

We study the allocation of time in the U.S. and in Europe during 1960–2010. We find that while home–production time remained roughly unchanged, market hours decreased and leisure increased most in France and least in the U.S. We show that a version of the growth model with home production can account for the patterns in France and the U.S. if we feed in taxes and labor productivities. To obtain this result it is crucial to measure labor productivity of home production in a comparable way in both countries, instead of calibrating it like the literature does.

Keywords: home production; labor productivity; leisure; time allocation.

JEL classification: E1; J4.

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1 Introduction

Starting with the seminal paper of Becker (1965), many scholars have studied what determines how people allocate time among different activities. A prominent example is Prescott (2004), who argued that differences in income taxes are an important reason for why Americans work much more in the market than Continental Europeans. Prescott's contribution stimulated a growing literature in quantitative macroeconomics that assesses how public policy affects the allocation of time among market work, home work, and leisure.[1] A consensus view is emerging in this literature that hours worked differ as theory predicts: people who live in developed countries with higher taxes tend to work less in the market and more at home.[2] However, to the best of our knowledge the evidence corroborating this view is rather thin. Indeed, the most detailed evidence exists for the U.S. where Aguiar and Hurst (2007), Ramey (2009), and Ramey and Francis (2009) documented long time series for both leisure and home hours. Outside of the U.S., Gimenez-Nadal and Sevilla-Sanz (2012) documented facts about leisure for several countries from the 1970s to the 2000s, but long time series for home hours are missing.[3]

In this paper we shed more light on how people in different countries allocate their time. Our first contribution is to come up with consistent estimates of the average hours that a working–age person allocates to market work, home work and leisure in the U.S. and the large European countries France, Germany, and the UK during 1960–2010. The stylized fact that emerges from our analysis is that in all four countries, hours devoted to home production remained essentially flat while changes in market hours were mirrored by changes in leisure.[4] Since this stylized fact is at odds with the prediction of standard theory, the goal of this paper is to understand why home hours remained essentially flat. To make progress in this regard, we narrow our focus to the two countries that are at the opposite ends of the spectrum, namely the U.S. and France. Whereas the U.S. time allocation changed relatively little, the French time allocation changed most strongly with the largest decrease in market hours and the largest decreases in leisure while home hours did not change much. We start studying these countries in 1970, because from then on we have all French data that are required for the rest of our analysis. We stop in 2005 because our analysis is about secular trends and not about the Great Recession.[5]

[1] See for example Greenwood et al. (2005), Rogerson (2007), Rogerson (2008), Ngai and Pissarides (2008,2011), Ohanian et al. (2008), Olovsson (2009), Rendall (2010), McDaniel (2011), Guner et al (2012a,b), Ngai and Petrongolo (2013), Ragan (2013), Bick (2014) and Bick and Fuchs-Schuendeln (2014).

[2] Scandinavia is the notable exception where people work more than theory predicts. Rogerson (2007), Olovsson (2009), and Ragan (2013) argued that this is due to the nature of public expenditures and transfers in Scandinavia.

[3] Juster and Stafford (1991), Freeman and Schettkat (2001), Burda et al. (2008) and Ragan (2013) provide evidence from individual cross sections.

[4] In independent work that came to our attention after the first draft of this paper was completed, Fang and McDaniel (2014) documented similar facts. In contrast to us, they did not attempt to provide an explanation for these facts.

[5] Aguiar et al. (2013) study the allocation of time during the Great Recession. Later on, we will also investigate

In order to understand the economic forces that are behind the time allocations of France and the U.S. during 1970–2005, we view them through the lens of a version of the growth model with a household sector.[6] Our version has the following key features: there is subsistence consumption that implies that the income elasticity of consumption is smaller than one and the income elasticity of leisure is larger than one; consumption is produced both in the market and at home whereas investment is produced only in the market; capital and labor are used in both market production and home production. To discipline the model, we require that it be consistent with the observed labor productivities of market work and home work and with the observed relative prices of investments in the stocks of market and home capital. Except for the labor productivity of home production, we use the–shelf values for these statistics. Obtaining numbers for the labor productivity of home production is tricky because the value added produced at home is typically not traded in the market. Therefore, the literature calibrates how productive home production is.

A second contribution of this paper is that we measure the real value added of home production. To achieve this, we follow the income approach that the BEA uses for its satellite accounts and that many experts of NIPA have endorsed; Juster and Stafford (1991) offer a detailed justification for using this approach in the context of home production.[7] Calculating the real labor productivity of home production is then straightforward, as one just needs to divide the real value added by the hours worked at home from MTUS. Two insights emerge from calculating the real labor productivity of home production. First, it has almost stagnated in the U.S. during 1970–2005, which is similar to what typical calibration exercises infer and what Bridgman (2013) found. Second, in France labor productivity at home started at a much lower level than in the U.S. and then grew to eventually catch up with the U.S. level. This is different from what typical calibration exercises such as Rogerson (2008) or McDaniel (2011) assume. We will see below that this difference is an important reason for why home hours have remained flat in France.

We calibrate our model to match the allocation of time in the U.S. in 1970 and 2005 as well as the paths of the labor productivities in the market and at home and the relative prices of market and home investments. The model does well at replicating the secular trends of the U.S. time allocation during 1970–2005. We also assess the performance of our model during the entire period 1965–2010 for which we have time use data for the U.S. We find that although we only target the time allocation during 1970–2005, the model also captures most of what happened also during 1965–1970 and 2005–2010. Turning then to France, we impose upon our

how our model performs out of sample during 2005–2010.

[6]Benhabib et al. (1991) and Greenwood and Hercowitz (1991) were the first papers that developed versions of the growth model with a household sector.

[7]Bridgman (2013) implemented a similar exercise for the U.S. during the last century. To the best of our knowledge we are the first to provide comparable numbers for France. In a companion paper, Bridgman et al. (2014), we impute the value added of home production for a broad set of OECD countries.

model the actual French data series for taxes, labor productivities in the market and at home, and the relative prices of investments in France. We find that the otherwise unchanged model also accounts well for the time allocation in France. In particular, it replicates that the time allocated to home work remained roughly flat, that the time allocated to leisure increased by roughly the same hours as the time allocated to market work decreased, and that the changes in leisure and market hours were large in France compared to the U.S. We provide economic intuition for our results by conducting counterfactual exercises and by deriving analytical solutions for a static version of our model. This establishes that the key reason for why our model replicates the French allocation of non–market time is that it captures how the increases in the effective income taxes interact with the increases in labor productivity of home production. If we had instead made the usual assumption that French labor productivity at home stagnated as it did in the U.S., our model would have generated the usual prediction that the decrease in market hours was accompanied by an increase in home hours.

Our findings are related to the thesis of Freeman and Schettkat (2005) that while the U.S. experienced a marketization of consumption during which people substituted market hours for home hours, this happened to a much lesser extent in Continental Europe. Since the ratio of market to home hours remained roughly unchanged in the U.S., one might initially not want to conclude that there was a marketization in the U.S. However, the picture starts to emerge when we recall our finding that in France the ratio of market to home hours declined, as market hours decreased while home hours remained flat. So compared to French people, people in the U.S. work increasingly more in the market than at home. Given that our imputation exercise generates numbers for real value added produced at home, we can also look at the value added side of marketization and ask how the composition of consumption changed over time. Considering the ratio of market–to–home–produced consumption, the marketization of services comes through more clearly: we find that Americans strongly increased that ratio whereas the French decreased it. In other words, while there was marketization of consumption in the U.S., the opposite happened in France. Since value added equals the product of hours worked and labor productivity, our analysis brings out the reasons for the different experiences: market hours decreased more in France than in the U.S. while home hours remained flat in both countries; labor productivity of home production grew more in France than in the U.S. while labor productivities in market production behaved similarly. We emphasize that our model is consistent with these patterns.

The rest of the paper is organized as follows. In the next section, we carefully document the facts about home production in the U.S. and the large European countries. In the subsequent section, we lay out our environment and characterize the equilibrium. Section 4 connects our model with the U.S. data. Section 5 contains the results for France, the intuition for our results, and the results from several counterfactual exercises. Section 6 concludes. An appendix contains technical details and the documentation of our data work.

2 What the Data Say about Home Production

2.1 Evidence on the Allocation of Time

2.1.1 Evidence for the U.S., France, Germany, and the UK

We start by reporting the facts about the allocation of time in the U.S. and the three European countries France, Germany, and the UK. We choose these countries because they are the large European countries and we have enough data for them to estimate time series of hours worked and leisure during the last fifty or so years. While the U.S. facts are well known from the work of Ramey (2009), Ramey and Francis (2009) and Aguiar and Hurst (2007), the evidence outside of the U.S. is more spotty. A notable exception is Gimenez-Nadal and Sevilla-Sanz (2012), who documented facts about leisure for Australia, Canada, Finland, France, Netherlands, Norway, and the UK during the 1970s, 1980s, 1990s, and the 2000s. Unfortunately, they do not say much about home production time. The existing evidence regarding home hours is typically coming from one or a few cross sections that are fairly close together in time. Freeman and Schettkat (2001) and Ragan (2013) are examples of the former and Burda et al. (2008) and Juster and Stafford (1991) of the latter.

Our data sources for the facts about time allocation are time use surveys that were standardized by the Multinational Time Use Study (MTUS). Table 10 in Appendix A.1 lists the dates of each time use survey and its number of participants. Although time use surveys are not available as frequently as we would want, the ones that are available are typically large and representative. We deal with the fact that surveys are not conducted every year by interpolating and extrapolating the data points that we have, taking into account the information that we have about changes in the demographic composition of the working–age population and in market hours worked from the Groningen Growth and Development Centre (GGDC henceforth). Appendix A.2 explains the details. Note that since our interpolation and extrapolation take into account that market hours fluctuate over time, the estimated non–market hours fluctuate too.

We adopt the standard concept of market work as paid work in the market and at home plus travel to and from work. We adopt a concept of home work that is close to that of Ramey (2009), implying that we include gardening, shopping, and childcare in home production. We define leisure as the remaining disposable time. A list of the categories included in market work, home work and leisure can be found in Table 11 of Appendix A.1. Figures 1 show the resulting time patterns for the U.S. and France. All numbers are in percent of an average person's disposable weekly time, which equals the total weekly time endowment minus the time spent for education, personal care, and sleep. We can see that hours worked at home behaved

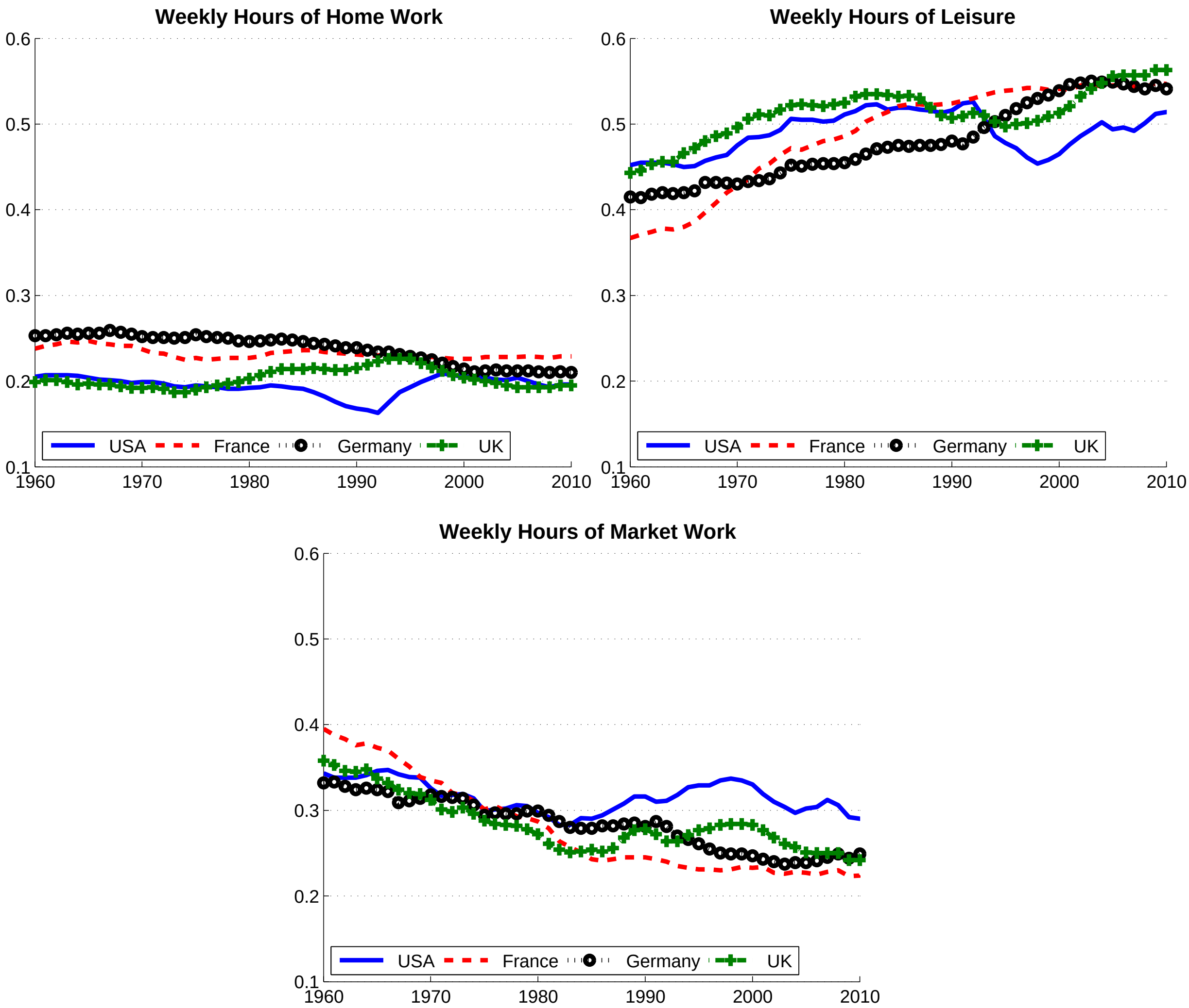


Figure 1: Allocation of Time 1960–2012 (fractions of total available time)

similarly in all countries: they declined somewhat and then converged to similar levels towards the end of the sample. In contrast, hours allocated to leisure increased strongly in all three European countries but increased only mildly in the U.S. Market hours showed the opposite trends than leisure.[8]

2.1.2 More Evidence for the U.S. and France

In what follows, we will narrow our focus to the U.S. and France. The reason for leaving out Germany is that the unification introduced serious data issues at the beginning of the 1990s. The reason for leaving out the UK is that a number of statistics which we require later in our quantitative analysis are not available. We plan to analyze Germany and the UK in future work.

[8]It is worth pointing out that the decline in French market hours happened long before the statutory work week of 35 hours was introduced in February 2000.

We start analyzing the U.S. and France in 1970 because some data required for other aspects of our analysis are not available before 1970. We stop in 2005 because we want to avoid the Great Recession. We should point out that while for the U.S. there are microdata from many time use surveys, for France we only have the microdata for the time use surveys from 1965, 1970, and 1998. This implies that extrapolation and interpolation play an important role in obtaining the French series; see Appendix A.2 for the details of how we extrapolate and interpolate. In order to make sure that our findings are not driven by the details of that procedure, we compare them with the results from two additional French time use surveys that were collected in 1985 and in 2010. We did not use these surveys in out estimation because INSEE makes them available only in rather aggregate form (the 1985 survey is available in book form in the INSEE library whereas the 2010 survey is available online). Reassuringly, we find that our estimated numbers for 1985 and 2010 are close to those resulting from the numbers published by INSEE. The results are available upon request.

Table 1: Hours per working–age population (as shares of available time)

		(i) Baseline		(ii) 1965 Demographics	
		1970	2005	1970	2005
U.S.	Market	32.6	30.2	32.6	29.4
	Home	19.9	20.4	19.9	20.1
	Leisure	47.5	49.4	47.5	50.5
France	Market	33.5	22.7	32.9	21.9
	Home	23.7	22.8	24.0	22.6
	Leisure	47.2	54.5	43.1	55.5
		(iii) Childcare in leisure		(iv) Education in leisure	
		1970	2005	1970	2005
U.S.	Market	32.6	30.2	32.1	29.5
	Home	17.2	16.2	19.6	19.9
	Leisure	51.2	53.4	48.4	50.6
France	Market	33.5	22.7	32.9	22.4
	Home	20.2	19.5	23.6	22.5
	Leisure	46.7	57.8	43.5	55.0

Sources: MTUS

Table 1 reports the allocation of time in the U.S. and France during 1970–2005. Part (i) of Table 1 reports the allocation of time in the U.S. and France for the Ramey classification that we use for our baseline analysis. 32.6 in the table means that in 1970 a working–age American on average allocated 32.6 percent of his disposable time to working in the market. The table implies the following key facts about the allocation time among home work, leisure, and market work during 1970–2005: hours devoted to home production stayed roughly constant;[9] changes in market hours and leisure roughly offset each other; in 1970, people in the U.S. and France devoted more hours to work (at home and in the market) than to leisure; in 2005, people in the U.S. devoted more hours to work while people in France devoted more hours to leisure.

A natural first question to ask at this point is why we calculate market hours from MTUS instead of using the off–the–shelf numbers from the OECD or the Groningen Growth and Development Center (GGDC henceforth). A first reason for using MTUS is that we want our estimates for market hours, home hours and leisure to be all based on the same data source. In addition, there is an issue with the cross–country comparability of the numbers from the standard data sources. In fact, on its website the OECD explicitly warns the reader that "... the data are intended for comparisons of trends over time; they are unsuitable for comparisons of the level of average annual hours of work for a given year, because of differences in their sources".[10] One important reason for the lack of comparability is that the data sources of the OECD are not of the same type: depending on the country it either uses labor force surveys, employer surveys, or NIPA employment (which presumably is based on labor force and/or employer surveys). Another reason for the lack of comparability is that even the national labor force surveys often do not take holidays into account properly and in ways that are comparable across countries. Bick et al. (2014) show that this can lead to considerable biases in the measures of hours worked.

Despite the discussion in the previous paragraph, it is of interest to compare separately for each country the time series patterns of hours worked from MTUS with those from the OECD and the Conference Board. Figure 2 shows that in both countries, the levels of our series are larger. This is likely to be due to the fact that our measure of market hours is broader, including such activities as commuting time which labor force surveys tend to leave out. Other than that, the qualitative patterns are similar, that is, market hours worked decline in France compared to the U.S. We should add that for the U.S. the MTUS estimates imply that market hours have declined somewhat whereas the OECD and GGDC estimates imply that they have increased somewhat. We leave it to future research to investigate the reason for this discrepancy among the different data sources.

Given that we broadly followed Ramey's definition of homework to the extend possible, it is also natural to ask how our estimates for home hours compare with hers. The first two

[9]Ramey (2009) discovered a related fact about the first half of the last century: as Americans moved out of home production during the first part of the last century, they did not reduce the home hours they provided themselves but reduced the home hours that they hired.

[10]This statement appears when one clicks the info button next to the title of http://stats.oecd.org/Index.aspx?DataSetCode=ANHRS.

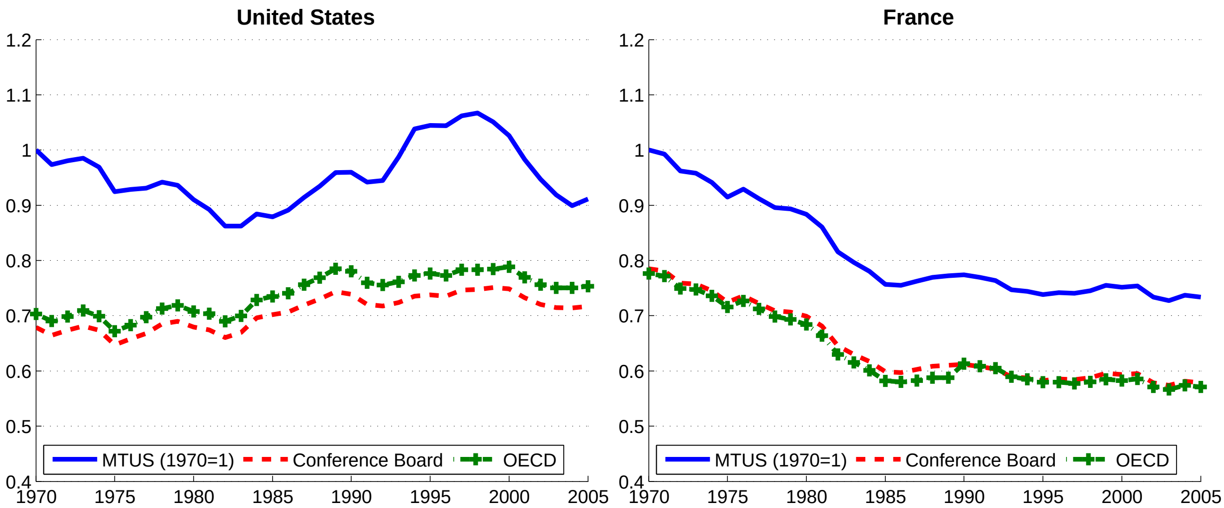


Figure 2: Market Hours 1970–2005 from different Data Sources (hours are divided by the MTUS 1970 hours)

rows of Table 2 report the series from Ramey's website and our series. We can see that they agree that starting from 1975 home hours stayed essentially flat but that they disagree in two respects: Ramey finds a decline in home hours between 1965 and 1975 whereas we find that they were flat; Ramey finds that people work at least two hours more at home than according to our numbers. In Appendix A.3, we establish that these discrepancies are due to three differences in the nuts and bolts of the construction home hours: Ramey focuses on the age group 18–64 whereas we focus on the working–age population 15–64; Ramey uses AHTUS, which has a finer classification system for the U.S. than has MTUS; we use MTUS because AHTUS does not cover France; in order to achieve consistency of her series over time, Ramey makes several ad hoc choices that we do not need to make. Using additional information that MTUS offers for the U.S. but not for France, we can replicate Ramey's steps closely, which gives row three of Table 2. We can see that these numbers are almost the same as those in row one. The details behind row three are explained in Appendix A.3. Note that the small discrepancies between rows one and three are to be expected, since row one is based on AHTUS and row three on MTUS, and AHTUS and MTUS do not exactly report the same categories.

Table 2: Average weekly hours of home work in the U.S.

	1965	1975	1985	1995	2005
Ramey	26.5	22.5	21.3	22.3	23.2
Duernecker–Herrendorf	20.6	20.0	19.2	20.2	20.4
Duernecker–Herrendorf with Ramey's choices	26.8	22.9	21.8	22.4	23.5

There is a debate in the literature about several aspects of the Ramey methodology. To begin with, Aguiar and Hurst (2007) argued that it is instructive to separate the changes in hours that result from changes of individual behavior from those resulting from changes in the demographic composition of the population. While the baseline part of Table 1 reports the average hours with the actual demographic composition of the population, part (ii) reports the average hours if the demographic composition is kept constant at the 1965 values.[11] We can see that while the levels change, the qualitative patterns described above are robust. Aguiar and Hurst (2007) also argued that it may be more appropriate to include child care in leisure instead of in home production. Part (iii) of Table 1 reports average hours if we include child care into leisure. We can see that while the levels change, the qualitative patterns described above again do not. In particular, it is still the case that home hours do not move much while changes in leisure are offset by opposing changes in market hours.

A last potential issue with our classification is that we have excluded education from the disposable time. In contrast, some authors include education as part of disposable time and classify it as leisure; see for example Rogerson (2008). Although it seems plausible to us that education has a leisure component, we do not feel comfortable with classifying it entirely as leisure. Be that as it may, part (iv) of the table reports the numbers if we include education both in the total available time and in leisure. Again, the qualitative patterns described above are robust. Note that the shares of market work in total disposable time change as a result of including education in total disposable time.

2.2 Evidence on the Value Added of Home Production in the U.S. and France

The goal of this subsection is to measure the value added of home production in the U.S. and France. Since it is not traded in the market, the value added of home production is not part of NIPA.[12] To impute it, we follow the methodology underlying the BEA's Satellite Account for Household Production, which is based on the income approach of calculating value added and combines information about the production factors used in home production with the rental prices for comparable production factors in the market. According to this methodology, value added of home production equals the sum of capital and labor used at home, each multiplied with an appropriate rental price. Kendrick (1979), Landefeld et al. (2009) and Bridgman (2013) offer detailed descriptions of this methodology and Schreyer and Diewert (2014) provide a theoretical justification for it. Our contribution here is to apply this methodology to our definition

[11]In this exercise, we use the 1965 demographics instead of the 1970 demographics because a time use survey was collected for 1965 but not for 1970.

[12]An exception to this statement is the imputed value added for owner–occupied housing, which in fact is included in GDP.

of home production and to come up with comparable estimates for the value added produced at home in both the U.S. and France. To the best of our knowledge, we are the first to achieve this.

We define capital used for home production as the stock of consumer durables. We view this as a first step and acknowledge that there are other sensible choices. For example, papers which study business cycles like Greenwood and Hercowitz (1991) and Fisher (2007) included residential housing as part of the capital used in home production. In contrast, Ramey (2009) focused on the substitutability between capital and labor in home production and defined home capital more narrowly as household appliances. We choose not to include residential housing, because NIPA includes imputed rents of owner–occupied housing in GDP and it is convenient to use the off–the–shelf numbers for GDP. Moreover, the ratio of residential housing to GDP remained fairly constant during our period of study, implying that leaving it out of measured home value added has a level effect only. We choose to include all consumer durables, and not just household appliances, in capital used for home production because many capital goods that are used in household production are part of consumer durables but not of household appliances. Examples include equipment for gardening, tools for maintenance, cars etc. Looking ahead, we will find that capital used in home production plays a quantitatively small role for our question. This suggests that although in other contexts consumer durables may be too broad a measure of home capital, this is not likely to drive our results here.

To calculate the stock of capital used for home production, we obtain investment as the sum of the final expenditure on consumer durables in constant prices from the OECD and then use the perpetual inventory method. We convert capital in constant prices into capital in current prices by using the price index of investment in consumer durables in the current period. Appendix A.4 contains the details. We follow Bridgman (2013) and use the ten–year rates of return on government bonds plus the depreciation rate as the rental price for home capital. Note that this way of proceeding does not include in value added the valuation gains or losses that result from changes in the relative prices of consumer durables, which, as we shall see, were very large during our period of study. The reason for this is that NIPA does not count valuation gains or losses as part of value added.

We impute the value added generated by hours worked at home by valuing them at the average hourly compensation of workers in the private–households sub–sector as reported in NIPA. To appreciate what that entails, it may be useful to recall the NAICS definition of this sub–sector: *"Industries in the Private Households subsector include private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household. These private households may employ individuals, such as cooks, maids, and butlers, and outside workers, such as gardeners, caretakers, and other maintenance workers."* To calculate real labor productivity of home production, we translate nominal value added into constant–price, constant–PPP value added by using the OECD price indexes for

Table 3: Facts about the household subsector

	U.S.		France	
	1970	2005	1970	2005
Panel (i): Labor in the private households subsector				
Hours (millions)	2,273	1,643	520	452
% of aggregate hours	1.4	0.7	1.2	1.2
Employment (thousands)	2,281	1,313	137	225
% of aggregate employment	2.6	0.9	0.6	0.9
Panel (ii): Average hourly wages by sector	in current $		in current €	
Total economy	4.3	29.5	2.0	26.3
Private–households sector	2.0	9.4	1.4	13.1
Minimum wage	2.0	5.0	1.0	9.0

Sources: OECD; EU KLEMS

expenditure on close market substitutes to household consumption.[13]

An alternative to using the compensation of workers in the private–households would be to use the average market wage as the rental price of hours worked at home. This might seem more appealing at first sight because it captures the opportunity costs of working at home instead of working in the market. Nonetheless, it is not appropriate to use the opportunity cost approach here, because it would imply that the productivity of working at home is determined by a person's productivity of working in the market. This would mean, for example, that PhD economists have a higher productivity when working at home than professional home workers, which is implausible [Schreyer and Diewert (2014)]. Moreover, estimating a life–cycle model with home production, House et al. (2008) find that for each dollar women earned in the market, on average they gave up only 25 cents worth of home production. This evidence suggests that it is preferable to use the average wages of professional household workers which are considerably lower than the average market wages of all workers; see Panel (ii) of Table 3.

There are several potential issues with using the average hourly compensation of professional household workers as the rental price of home hours. To begin with, one may wonder how large this subsector is and whether our results are driven by small samples. Panel (i) of Table 3 shows that the household sector commands between half one and two–and–a–half percent of total employment. For comparison, employment in U.S. agriculture has been in the same ballpark in recent years. Second, one might suspect that the wages of French household

[13]The available price indexes refer to final expenditure whereas our imputed home production is value added. Using price indexes for final expenditure for value added categories works better the smaller the share of intermediate inputs in final expenditure are.

workers are driven by the fairly high minimum wages in France. Panel (ii) of Table 3 shows that, except in the U.S. in 1970, the average wages of household workers were much larger than the minimum wage. In particular, at the end of our sample, the average wage in the private–households subsector exceeded the minimum wage considerably. A third potential concern is that the composition of human capital in the private–households sector may have changed, for example, because low–educated immigrants play an increasingly important role in that sector in the U.S.. Since we use wages per worker instead of wages per efficiency unit, we do not take such changes into account. This is not likely to be of first–order importance though, as most workers in the private–households sector have rather low skills to begin with. One way to see this is to compare the average wage in the private–household sector with the economy–wide average wage. Panel (ii) of Table 3 shows that the average household worker made less than half of the average hourly wage in 2005.

Table 4 reports the results for the value added of home production. Since the absolute numbers do not mean much to most people, we report the value added of home production in terms of two different current–price ratios: the first row divides it by GDP and the second row divides it by market–produced final consumption. We can see that in 1970 the ratios of home value added relative to GDP in the U.S. and France were identical and the ratios of home value added relative to market–produced consumption were similar. Subsequently, the U.S. experienced a strong decrease of relative home value added whereas France experienced a strong increase. In the language of Freeman and Schettkat (2005), the U.S. experienced a marketization of consumption whereas France experienced the opposite.

Table 4: Facts about Home Production

	U.S.		France	
	1970	2005	1970	2005
Home value added divided by GDP	0.32	0.20	0.32	0.48
Home – over market–produced consumption	0.41	0.25	0.44	0.60
Labor productivity, level	12.3	12.6	6.2	15.6
Labor productivity, average growth in %	0.1		2.6	
Capital–output ratio	1.04	1.55	0.67	0.53

Sources: MTUS, OECD, own calculations

2.3 Evidence on the Labor Productivity of Home Production in the U.S. and France

We are now in the position to obtain estimates of the labor productivity of home production, that is, the real value added of home production divided by hours worked. Given that we have calculated the capital stock of home production, we also report the capital–output ratio in current prices (where output refers to value added). Rows 3–5 of Table 4 list the results. Two key facts emerge: labor productivity in the U.S. has hardly grown at all; labor productivity in France started at a much lower level than in the U.S., grew at an impressive 2.6%, and eventually caught up and even overtook the U.S. That labor productivity at home has hardly grown in the U.S. since 1970 is similar to what Bridgman (2013) found, although he used a different concept of home capital that excludes part of consumer durables but includes part of housing and infrastructure. This is also similar to what usual calibrations of home productivity deliver. That labor productivity in France grew strongly to eventually catch up with the U.S. level is different from what is typically assumed in the literature, which postulates that the ratio of the labor productivities in the market and at home showed the same behavior in the two countries; see for example Rogerson (2008) or McDaniel (2011). Taking the stark differences between the U.S. and France in the patterns of labor productivity of home production into account is potentially important for understanding the reasons behind the different time allocations. We will return to this issue in subsection 5.4 below when we conduct counterfactual exercises.

Regarding the capital–output ratio of home production, we find that it has consistently been much larger in the U.S. than in France. Moreover, the capital–output ratio of home production grew in the U.S. whereas it fell somewhat in France. To put the numbers into perspective, note that a typical estimate for the capital–to–output ratio in the market is around three, so home capital–to–output ratios around 0.5 are fairly small, suggesting that home production is fairly labor intensive.

3 Model

In this section, we build a version of the growth model with endogenous labor supply and a household sector. An implication of employing the growth model is that we will work with a stand–in household which captures what happens at the aggregate level but remains silent about what happens at the disaggregate level at the intensive and extensive margins, for men and women, in different age groups etc. We think that while these margins are important to understand why aggregate labor supply changes, a natural first step is to investigate how far we can push the aggregate model to account for the aggregate facts.

3.1 Environment

The stand–in household is endowed with one unit of time and positive amounts of the initial capital stocks for market and home production, $K_m(0)$ and $K_h(0)$. Households derive utility from market– and home–produced consumption, C_m and C_h, and leisure, L. The period–utility function is given by:

$$U(C, L) = \alpha_u \log(C - \bar{C}) + (1 - \alpha_u) \log(L) \tag{1}$$

$$C = [\alpha_c C_m^{\sigma_c} + (1 - \alpha_c) C_h^{\sigma_c}]^{\frac{1}{\sigma_c}} \tag{2}$$

where $\alpha_u, \alpha_c \in (0, 1)$ are relative weights, C is a composite consumption good, $\bar{C}$ can be thought of as a subsistence level of consumption, L is leisure, and $\sigma_c \in (-\infty, 1)$ determines the elasticity of substitution between market–produced and home–produced consumption (with $\sigma_c = 0$ being the Cobb–Douglas case).

Except for the subsistence term $\bar{C}$, the above utility function is the same as that in Prescott (2004), which is commonly used in the business cycle literature. The presence of $\bar{C}$ implies that preferences are non–homothetic in that the income elasticity of leisure is larger than one. This features will be essential for matching the fact that leisure has increased in both the U.S. and France since 1970. In related work, Restuccia and Vandenbroucke (2013) and Restuccia and Vandenbroucke (2014) found that subsistence consumption is important for accounting for the long run trends of market work, leisure and educational attainment.

The technology for producing market output Y_m is represented by a Cobb–Douglas production function:

$$Y_m = (K_m)^{\alpha_m} (A_m H_m)^{1-\alpha_m}$$

K_m and H_m are capital and hours worked in the market, A_m is labor–augmenting technical progress, and α_m is the capital–share parameter. The technology for producing home output Y_h is represented by a CES production function:

$$Y_h = [\alpha_h (K_h)^{\sigma_h} + (1 - \alpha_h)(A_h H_h)^{\sigma_h}]^{\frac{1}{\sigma_h}} \tag{3}$$

K_h and H_h denote capital and hours allocated to home production, A_h is labor–augmenting technological progress, α_h is the capital–share parameter, and σ_h determines the elasticity of substitution between home capital and home hours. We do not a priori restrict that elasticity but calibrate it so as to match key features of home production.

Turning now to the feasibility constraints, we assume that market output may be used for market consumption, C_m and for investment into market and home capital, X_m and X_h. Consumption and both investments are non–negative. We also assume that the marginal rates of transformation are governed by the exogenous variables B_m and B_h as follows:

$$C_m(t) + \frac{X_m(t)}{B_m(t)} + \frac{X_h(t)}{B_h(t)} = Y_m(t)$$

A larger value of B implies that less consumption has to be given up for obtaining one unit of X. Below we calibrate the B's so as to match the relative prices of investment in market and home capital to market consumption.

The household faces the following additional feasibility constraints:

$$1 = H_m(t) + H_h(t) + L(t) \tag{4}$$

$$C_h(t) = Y_h(t) \tag{5}$$

$$K_m(t+1) = (1 - \delta_m)K_m(t) + X_m(t) \tag{6}$$

$$K_h(t+1) = (1 - \delta_h)K_h(t) + X_h(t) \tag{7}$$

The first constraint specifies that the amounts of time allocated to market production, home production, and leisure must add up to the total time endowment of one. The second constraint specifies that home–produced consumption equals home–produced output. The last two constraints describe the accumulation of market and home capital where $\delta_m, \delta_h \in (0, 1)$ denote the depreciation rates on market and home capital. Underlying these equations is the assumption that capital is sector specific, that is, it can only be used in the sector in which it is installed. Since investment must be non–negative, (6)–(7) imply the additional constraints that next period's capital stock cannot be smaller than this period's capital stock after depreciation:

$$K_m(t+1) \geq (1 - \delta_m)K_m(t) \tag{8}$$

$$K_h(t+1) \geq (1 - \delta_h)K_h(t) \tag{9}$$

Since in our applications, all capital stocks will be non–decreasing, these constraints will not bind.

3.2 Equilibrium

Choosing market consumption as the numeraire, the household's budget constraint is given as:[14]

$$(1 + \tau_{cm})(C_m + p_h X_h) + (1 + \tau_{xm})p_m X_m = (1 - \tau_{hm})wH_m + (1 - \tau_{km})rK_m + \mathcal{T}$$

[14]Note that we abstract from the fact that many countries have specific rules according to which accounting depreciation is deductible from capital–income taxes. The reason for not taking this into account is that the capital–income tax rates from McDaniel, which we will use below, abstract from depreciation allowance and just calculate the capital–income tax rate as capital income tax paid divided by capital income.

where p_h and p_m are the relative prices of investment for home and market capital, w and r denote the wage and interest rate in terms of market consumption, τ_{cm}, τ_{xm}, τ_{hm}, and τ_{km} denote the tax rates on consumption and investment in home production, on investment for market production, on labor income, and on capital income, and $\mathcal{T}$ is a lump–sum rebate of the resulting tax revenues. Note that it will be important for our results that we assume that the tax revenues are rebated, instead of consumed by the government. The reason, of course, is that with rebated tax revenues, taxes imply a substitution effect but not an income effect. Note that investment in home capital is taxed at the same tax rate as market consumption because it is composed of durable consumption goods and consumption taxes do not distinguish between durable and non–durable consumption goods.[15] Dividing the budget constraint by consumption taxes gives:

$$C_m + p_h X_h + (1+\tau_x) p_m X_m = (1-\tau_w) w H_m + (1-\tau_r) r K_m + T \tag{10}$$

where the effective tax rates are given as:

$$\begin{aligned} \tau_x &\equiv \frac{\tau_{xm} - \tau_{cm}}{1+\tau_{cm}} \\ \tau_w &\equiv \frac{\tau_{hm} + \tau_{cm}}{1+\tau_{cm}} \\ \tau_r &\equiv \frac{\tau_{km} + \tau_{cm}}{1+\tau_{cm}} \end{aligned}$$

Putting the different ingredients together, we obtain the household problem:

$$\max \sum_{t=0}^{\infty} \beta^t \left[\alpha_u \log(C(t) - \bar{C}) + (1-\alpha_u) \log(L(t)) \right] \quad \text{s.t.} \quad (2)-(10) \quad \forall t$$

Appendix B contains the first–order conditions for an interior solution to this problem. From now on, we proceed under the assumption that the (8)–(9) do not bind, solve for the equilibrium, and then verify that indeed (8)–(9) do not bind.

Assuming that individuals have perfect foresight about the path of future taxes, the definition of competitive equilibrium is as follows:

Definition. *A competitive equilibrium are sequences of effective tax rates* $\{\tau_x(t), \tau_w(t), \tau_r(t)\}$, *prices* $\{p_h(t), p_m(t), w(t), r(t)\}$, *allocations* $\{H_m(t), H_h(t), L(t)\}$, $\{K_m(t+1), K_h(t+1)\}$, $\{X_m(t), X_h(t), C_m(t), C_h(t)\}$ *such that*

[15] A broader definition of home capital would include residential housing. We include residential capital in market capital here because we think that the key margin of substitution between home capital and labor refers to consumer durables (e.g., washing machines) versus labor. See Greenwood and Hercowitz (1991) for a different treatment that includes residential housing in home capital.

- *taking prices, wages, interest rates, effective tax rates and the initial capital stocks as given,* $\{H_m(t), H_h(t), L(t), K_m(t+1), K_h(t+1), X_m(t), X_h(t), C_m(t), C_h(t)\}$ *solve the household problem*
- *taking prices and wages as given,* $H_m(t), K_m(t)$ *maximize profits*
- *markets clear.*

Eliminating the multipliers, the first–order conditions to the household problem imply 4 consolidated conditions that have obvious interpretations. In writing them, we highlight the tax distortions in boldface. First, the optimal allocation of time between leisure and market work equalizes the marginal utilities of leisure and market work:

$$\frac{1-\alpha_u}{L(t)} = \frac{\alpha_u \alpha_c}{C(t)-\bar{C}} \left[\frac{C(t)}{C_m(t)}\right]^{1-\sigma_c} \mathbf{[1-\boldsymbol{\tau}_w(t)]} w(t) \tag{11}$$

The first–order conditions shows that the marginal utility of market work is distorted by the income tax $\tau_w(t)$. Second, the optimal allocation of time between home work and market work equalizes the marginal utilities of home work and market work:

$$\frac{1-\alpha_c}{C_h(t)^{\sigma_h-\sigma_c}}(1-\alpha_h)A_h(t)^{\sigma_h}\frac{1}{H_h(t)^{1-\sigma_h}} = \frac{\alpha_c}{C_m(t)^{1-\sigma_c}}\mathbf{[1-\boldsymbol{\tau}_w(t)]}w(t) \tag{12}$$

Again, the marginal utility of market work is distorted by the income tax $\tau_w(t)$. Third, the optimal allocation of market capital satisfies the following Euler equation:

$$\begin{aligned}&\mathbf{[1+\boldsymbol{\tau}_x(t)]}\frac{C(t)^{1-\sigma_c}}{C(t)-\bar{C}}C_m(t)^{\sigma_c-1}p_m(t) = \\ &\quad \beta\frac{C(t+1)^{1-\sigma_c}}{C(t+1)-\bar{C}}C_m(t+1)^{\sigma_c-1}\Big\{\mathbf{[1-\boldsymbol{\tau}_r(t+1)]}r(t+1) + \mathbf{[1+\boldsymbol{\tau}_x(t+1)]}(1-\delta_m)p_m(t+1)\Big\}\end{aligned} \tag{13}$$

This Euler equation is distorted by the investment taxes today and tomorrow and the capital–income tax tomorrow. Fourth, the optimal allocation of home capital satisfies the following Euler equation:

$$\begin{aligned}&\frac{C(t)^{1-\sigma_c}}{C(t)-\bar{C}}\alpha_c C_m(t)^{\sigma_c-1}p_h(t) = \\ &\quad \beta\frac{C(t+1)^{1-\sigma_c}}{C(t+1)-\bar{C}}\Big\{(1-\alpha_c)C_h(t+1)^{\sigma_c-\sigma_h}\alpha_h K_h(t+1)^{\sigma_h-1} + \alpha_c C_m(t+1)^{\sigma_c-1}(1-\delta_h)p_h(t+1)\Big\}\end{aligned} \tag{14}$$

This Euler equation is not distorted by taxes because the tax on investment in household capital cancels with the tax on market consumption and no other taxes affect home production.

In each period, we have 14 endogenous variables: $p_h(t), p_m(t), w(t), r(t), H_m(t), H_h(t), L(t), K_m(t+1), K_h(t+1), X_m(t), X_h(t), C(t), C_m(t), C_h(t)$. To determine these, we have the four conditions

(11)–(14) from above. In addition, consolidating the first–order conditions to the firm's problem and the feasibility constraints, we obtain the additional 10 conditions:

$$p_m(t) = \frac{1}{B_m(t)}, \quad p_h(t) = \frac{1}{B_h(t)}, \quad r(t) = \alpha_m Y_m(t) K_m(t)^{-1}, \quad w(t) = (1-\alpha_m) Y_m(t) H_m(t)^{-1}$$
$$K_m(t+1) = (1-\delta_m)K_m(t) + X_m(t), \quad K_h(t+1) = (1-\delta_h)K_h(t) + X_h(t)$$
$$1 = H_m(t) + H_h(t) + L(t), \quad C(t) = [\alpha_c C_m(t)^{\sigma_c} + (1-\alpha_c)C_h(t)^{\sigma_c}]^{1/\sigma_c}$$
$$C_m(t) + \frac{X_m(t)}{B_m(t)} + \frac{X_h(t)}{B_h(t)} = K_m(t)^{\alpha_m}[A_m(t)H_m(t)]^{1-\alpha_m}$$
$$C_h(t) = \left[\alpha_h K_h(t)^{\sigma_h} + (1-\alpha_h)[A_h(t)H_h(t)]^{\sigma_h}\right]^{1/\sigma_h}$$

4 Connecting the Model with the U.S. Data

We now calibrate the model to the U.S. economy. Units are such that

$$A_m(1970) = A_h(1970) = B_m(1970) = B_h(1970) = 1$$

We use the information provided on McDaniel's webpage to calculate effective tax rates for $t = 1970, ..., 2005$.[16] The following parameters are chosen to obtain reasonable values for the corresponding data targets: $\beta = 0.96$, which gives a real rate of return on capital after taxes and depreciation of 4.8%; $\delta_m = 0.05$ and $\delta_h = 0.19$, which are the NIPA depreciation rates of market capital and consumer durables; $\alpha_m = 0.37$, which is the standard capital share; $B_m(t)$ and $B_h(t)$ for $t = 1971, ..., 2005$ so as to match the relative prices of investments in capital and consumer durables from the OECD.[17]

This leaves us with six parameters and the series for technological change to calibrate: the three relative weights $\alpha_u, \alpha_c, \alpha_h$; the two elasticity parameters σ_c, σ_h; the subsistence term $\bar{C}$; $A_m(t)$ and $A_h(t)$. We calibrate them jointly to hit six data targets and the annual time series for market and home labor productivity. The target are: U.S. hours worked in the market and at home for $t = 1970$ and 2005 from MTUS; U.S. share of home capital investment in market output, $p_h(t)X_h(t)/Y_m(t)$, for $t = 1970$ and 2005 from the OECD; the annual growth of U.S. labor productivity of market production and home production for $t = 1971, ..., 2005$ from the OECD and our own calculations.

Since we have a subsistence term in the utility function, we cannot impose balanced growth on our equilibrium path. We therefore add the initial and terminal capital–output ratios in market and home production (measured in current prices) as targets to pin down the initial and

[16] See http://www.caramcdaniel.com/researchpapers and McDaniel (2007) for a additional details.

[17] There are different concept of what constitutes capital used in home production. The broadest concept includes residential housing. The narrowest concept includes only household appliances. Consumer durables is between these two concepts. We use it here because comparable data are available from NIPA for both the U.S. and France.

final capital stocks: $p_m(t)K_m(t)/Y_m(t)$ for $t = 1970$ and 2005 (from the BEA); $p_h(t)K_h(t)/Y_h(t)$ for $t = 1970$ and 2005 (from the BEA and own calculations). An alternative to our way of proceeding would be to recognize that given sustained growth the subsistence terms becomes negligible at time goes to infinity and the model converges to a balance growth path. Instead of imposing the terminal capital–output ratios in market and home production from the data, we could therefore impose that at some date far in future the model reaches a balanced growth path; see for example McDaniel (2011). At first sight, this way of proceeding appears to impose less information from the data. We emphasize, however, that one would need to take a stand on the growth rates of technical change between the last period for which we have data and the future period when the balanced growth path is presumably reached. McDaniel (2011) assumed that technological progress grows at some constant rate. Since this is ad hoc, we prefer to impose the terminal conditions from actual data. Having said this, we should add that if the alternative way of proceeding replicates the paths that the two capital stocks take during the time period for which we have data, then the two ways of proceeding give the same results for the allocation of time. In other words, choosing between them is purely a matter of taste and not essential for what we are after here.

Table 5: Average Annual Growth Rates in the U.S. (in %)

			Data	Model
Labor productivity of				
	market production	$\Delta Y_m/H_m$	1.69	1.69
	home production	$\Delta Y_h/H_h$	0.07	0.07
Technological change in				
	market production	ΔA_m		1.03
	home production	ΔA_h		-0.32
	market investment	ΔB_m		1.01
	home investment	ΔB_h		3.07

Table 5 shows that we hit the targets for labor productivity exactly. Interestingly, we end up with small growth of labor productivity at home but negative labor–augmenting technical change at home. The reason why these seemingly contradictory statements are true at the same time is because of massive investments in consumer durables, which were spurred by the large fall in the relative price of home capital that our model maps into large technical progress of 3.07% per year. One interpretation of negative labor–augmenting technical change at home is that the sector–specific human capital of the people who actually doing home work has deteriorated. There are several possible reasons for this. To begin with, people may just know less about home economics than they used to. This is consistent with the fact that home economics is no longer taught at schools. A second possible reason is related to the fact that during our period of investigation women have entered the labor force in large numbers. If the women who left the home for the market have higher than average human capital relevant for home work, then selection may explain why average human capital used in home production has decreased. An additional effect of women entering the labor force is that a larger part of homework is now done by men. If men have less human capital relevant for home work than women, then the average human capital used in home production has decreased yet further. Our model with a stand–in household and without heterogenous skills will interpret these selection and composition effects as negative technological change occurring at home. We leave it to future research to pursue these issues more seriously.

Table 6: Targets of the Joint Calibration to the U.S. Economy

		Data		Model	
		1970	2005	1970	2005
Market hours	H_m	32.6	30.2	32.6	30.2
Home hours	H_h	19.9	20.4	19.9	20.4
Share of consumer durables in GDP	$p_h X_h / Y_m$	0.11	0.10	0.11	0.10
Capital–output ratio in the market	$p_m K_m / Y_m$	2.99	3.14	2.99	3.14
Capital–output ratio at home	$p_h K_h / Y_h$	1.04	1.55	1.04	1.55

Table 6 shows that our model hits the six joint targets exactly. Note that since the shares of market work, home work, and leisure add up to one, we hit the shares for leisure exactly too, and so we do not report leisure as an independent target. A skeptical reader might suspect that the model hits the shares exactly because we cherry picked our period of investigation. To preempt this suspicion, we have also investigated how our model performs out of sample during 1965–1970 and 2005–2010. Table 7 shows that the results are encouraging: our model captures very well what happened to the time allocation during 1965–1970; our model captures very well that market hours declined during 2005–2010; our model captures that leisure increased during 2005–2010, but this increase is somewhat too small; the previous two points imply that our model misses that home hours fell somewhat during 2005–2010. Overall our model does a great job at capturing that during 1965–2010, market home hours did not change much while the sizeable decrease in market hours was offset by an increase in leisure of similar size, which is what it was designed for. To fine tune the short–run performance of our model during the Great Recession, we suspect that it will be necessary to add features such as adjustment costs or learning by doing. We leave investigating this to future research.

The calibrated parameter values are in Table 8. We emphasize the following features of our calibration: home capital and home labor come out as complements; there is a positive subsis-

Table 7: Out–of–sample Performance of our Model for the U.S.

	Data				Model			
	1965	1970	2005	2010	1965	1970	2005	2010
Market hours	34.6	32.6	30.2	29.0	34.5	32.6	30.2	29.1
Home hours	20.4	19.9	20.4	19.6	20.1	19.9	20.4	20.6
Leisure	45.0	47.5	49.4	51.4	45.4	47.5	49.4	50.3

tence level of consumption; market–produced and home–produced consumption come out as complements. Some remarks are useful to put the calibrated parameter values into perspective. First, the value 0.08 for the relative weight on home capital is fairly low. This is likely to be due to the fact that we have defined home capital as consumer durables, which does not include residential housing. Second, to get a sense of the importance of the subsistence term, we express it as a share of total consumption: in the U.S., $\bar{C}$ amounted to 17% of total consumption in 1970 and 11% in 2005. Third, the finding that capital and labor are complements in home production is consistent with the estimate of Ramey (2009); defining household capital more narrowly as household appliances, she obtained an elasticity of substitution of 0.8 between appliances and labor in home production.

Table 8: Calibrated Parameter Values

Weight on consumption	α_u	0.54
Weight on market–produced consumption	α_c	0.79
Weight on home capital	α_h	0.08
Non–homotheticity term	$\bar{C}$	0.10
Elasticity between home capital and home labor	$1/(1-\sigma_h)$	0.88
Elasticity between market and home–produced consumption	$1/(1-\sigma_c)$	0.76

Our calibrated value of 0.76 for the elasticity substitution between home consumption and market consumption is much lower than the values that are typically used in the literature. Citing evidence from Rupert et al. (1995) and McGrattan et al. (1997), the related paper by Rogerson (2008) chose an elasticity of 1.82, implying that home consumption and market consumption are substitutes. It is important to realize that his elasticity is not directly comparable with our elasticity, because his elasticity governs the substitutability with market–produced *services* whereas our elasticity governs the substitutability market–produced *consumption*. Since market–produced consumption contains both the services and the goods that are consumed, it has many components that are not substitutable with home produced consumption. Therefore, our elasticity is expected be lower than his elasticity. To establish this point more formally, we abstract from capital for a moment so that the production functions become linear in labor:

$$C_j = A_j H_j, \quad j \in \{m, h\} \tag{15}$$

The first–order condition (12) for the optimal allocation of time between home work and market work then simplifies to:

$$\frac{H_m}{H_h} = \left[(1-\tau_w)\frac{\alpha_c}{1-\alpha_c}\right]^{\epsilon_c} \left[\frac{A_m}{A_h}\right]^{\epsilon_c - 1} \tag{16}$$

where

$$\epsilon_c \equiv \frac{1}{(1-\sigma_c)} \in [0, \infty)$$

denotes the elasticity of substitution between market and home consumption. This equation is essentially the same as equation (7) in Rogerson (2008), except that in his case H_m refers to hours worked in market services instead of all market consumption. The key insight that we can take away from equation (16) is that the choice of ϵ_c depends critically on how H_m/H_h and A_m/A_h behave, which in turn depends critically on what m refers to.

Let us first consider Rogerson's choice of ϵ_c when m refers to market services. We know that structural change implied that hours worked in market services went up. From the evidence we documented above, home hours stayed roughly constant. Hence, H_m/H_h grew. We know that labor productivity of market services grew whereas the evidence presented above suggests that labor productivity of home production stagnated. Given linear production functions, A_m/A_h therefore grew. In order to reconcile the behavior of H_m/H_h with that of A_m/A_h given equation (16), Rogerson needs to a value $\epsilon_c > 1$, that is, home and market services need to be substitutes in his utility function. He assumes that $\epsilon_c = 1.82$.

Now, consider our case in which m refers to market consumption. According to our data listed in Table 1 above, H_m/H_h fell because market hours fell whereas home hours stayed roughly constant. Moreover, now A_m/A_h grew more strongly than before, because in the data labor productivity grew more strongly in goods production than in services production. In order to reconcile the patterns of H_m/H_h and A_m/A_h, we now need $\epsilon_c < 1$, that is, home and market services need to be complements in the utility function. Our calibration of $\epsilon_c = 0.76$ does that.

We should add two points. First, in a previous version of this paper, we disaggregated market consumption into goods and services and assumed that market services substitute for home services whereas market goods substitute for the aggregate of market and home services.[18]

[18] We did not pursue this previous version because aggregating market goods and services into market consumption gives the same results and is easier to handle. In particular, it avoids some issues which arose in the previous version because the split into consumed goods and consumed services comes from the final consumption side of NIPA whereas the split into hours worked in goods and service production comes from the value added side of

Consistent with the intuition that we have just developed, we obtained a calibrated elasticity between market and home services that was larger than one (the value was reasonably close to that of Rogerson) and a calibrated elasticity between market goods and the service aggregate that was smaller than one. Another way of understanding why our elasticity above comes out as it does is to think of it as a weighted average of these two elasticities. Second, in our analysis, we used MTUS to obtain consistent estimates for market hours, home hours and leisure and used outside information about market hours only for the interpolations. We found that market hours in the U.S. declined somewhat, implying that H_m/H_h declined. If we had instead used the OECD numbers for market hours worked as Rogerson did, then we would have found that market hours actually increased during this time period; see Figure 2 above. This would have implied that H_m/H_h increased, instead of decreased. If we had calibrated our model to this case, then we would have ended up with $\epsilon_c > 1$. Note, however, that the resulting elasticity would still have been smaller than what Rogerson chose. The reason for this is that H_m/H_h increase less and A_m/A_h increases more when m refers to market consumption than when m refers to market services.

We also should add that our elasticity between market and home produced consumption is not immediately comparable with the existing empirical estimates, which tend to be around two. For example, Fan and Zhu (2012) obtain an estimate for people who are 25–60, married, and employed. In contrast, our calibrated elasticity refers to the entire working–age population, and so it includes individuals that are not working in the market at all and therefore tend to have a lower elasticity. Moreover, Fan and Zhu (2012) do not have any information about actual home consumption whereas we use our imputed numbers for home value added. Similarly, Rupert et al. (1995) estimate the elasticity of substitution between market and home consumption goods for individuals who are working full time. They use the PSID, which has consumption information only about food consumption. Food consumption at home and restaurant meals are much closer substitutes than total home–produced and market–produced consumption.

5 France

We now ask how well our model accounts for the French allocation of time between market work, home work, and leisure. We first present our results. We then develop intuition for our results by studying the model version with the linear production function and by conducting counterfactual exercises. We also discuss in some detail the implication of our findings for the marketization of consumption.

NIPA. Relating one to the other requires the use of input–output tables, because part of the hours worked in goods and services are used to produce investment goods; see Herrendorf et al. (2013) for the details.

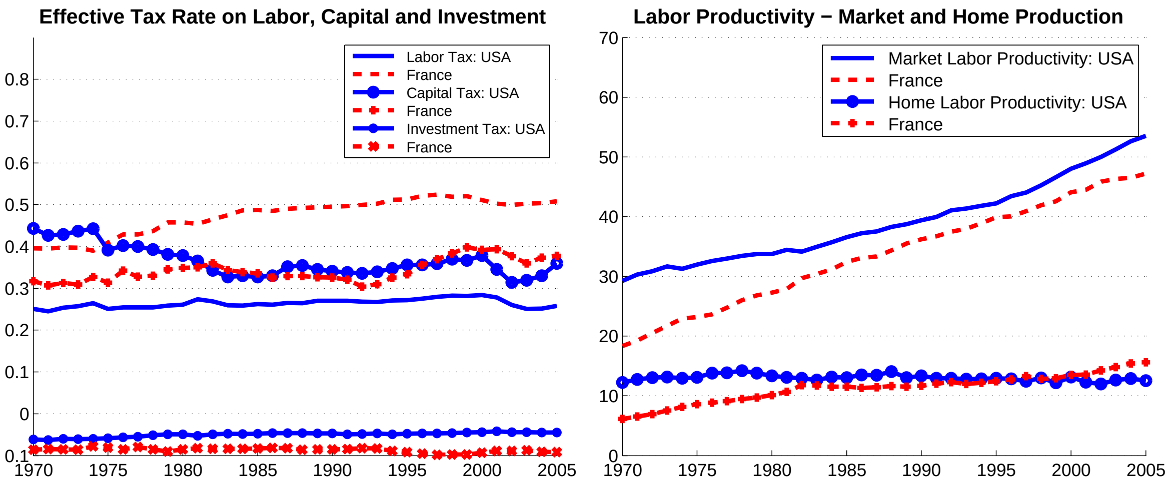


Figure 3: U.S. and French labor productivities and taxes

5.1 Results

We leave the calibrated "deep" model parameters unchanged and ask how well our model accounts for the allocation of time in France if we feed into it the French taxes and the French labor–augmenting technical change in market and in home production. Specifically, we take the French taxes again from McDaniel for $t = 1970, ..., 2005$. We obtain labor–augmenting technical change by targeting the French labor productivities relative to those in the U.S. for $t = 1970, ..., 2005$ (from OECD for market production and own imputations for home production). We feed into the model the values of $B_m(t)^{FR}$ and $B_h(t)^{FR}$ for $t = 1971, ..., 2005$ that match French relative prices of investment in market capital and consumer durables (from the OECD). Lastly, we target the initial and final capital–output ratios in market and home production for $t = 1970$ and 2005 (from the OECD and our own calculations).

Figures 3 depict the series for effective taxes and labor productivity in both countries. The left figure shows the well known fact that the main difference between the tax systems of the two countries is that in France the effective income taxes were much larger than in the U.S. Moreover, in France they increased considerably whereas in the U.S. they remained roughly constant on average. Another noteworthy feature of the tax series is that effective capital taxes in the U.S. were initially larger than in France but have came down considerably and are now similar in both countries. The right figure shows that in 1970 there were sizeable gaps between the U.S. and France both in the productivities in the market and at home. Subsequently, France caught up to the U.S. and closed the gaps. In fact, during the last ten years or so, home productivity in France even overtook that in the U.S. This also means that the growth rate of labor productivity in the market and at home are similar in France, which is in stark contrast to the US where labor productivity in the market grew much more strongly than at home.

Figures 4 plot the results of feeding in French taxes and productivities. We can see that our

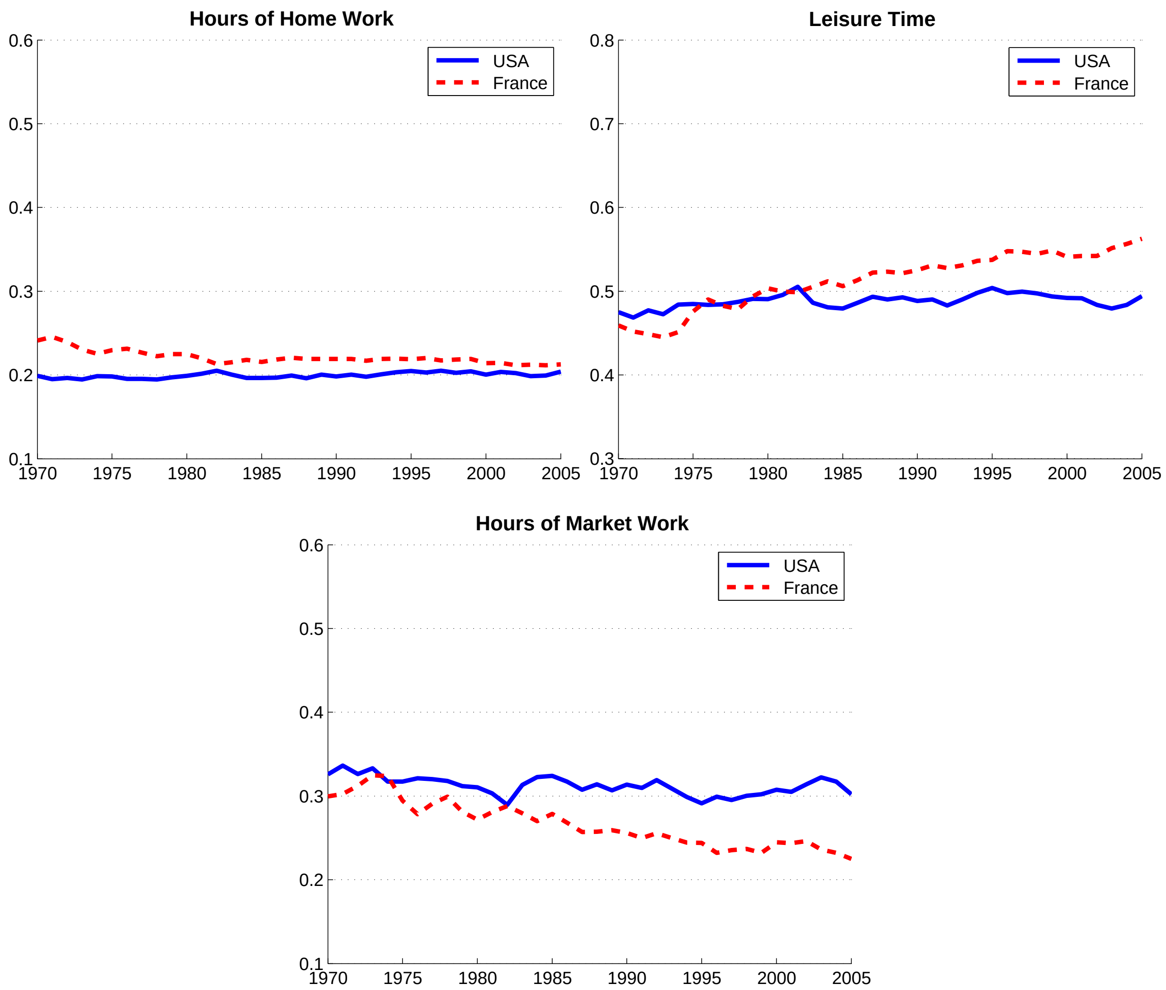


Figure 4: Time Allocation Predicted by the Model

Table 9: French Hours in the Data and the Model

		Data		Model	
		1970	2005	1970	2005
Market Hours	H_m	33.5	22.7	30.0	22.5
Home Hours	H_h	23.7	22.8	24.1	21.3
Leisure	L	47.2	54.5	45.9	56.2

model matches the stylized facts that the decline in French market hours was mostly compensated by an increase in French leisure, while home hours changed much less. Table 9 reports the exact numbers for 1970 and 2005. We can see that also quantitatively our model accounts for most of the changes in the French time allocation.

5.2 Intuition

To build intuition for the main forces at work in our model, it is useful to simplify our environment such that we can obtain closed–form solutions. To this end, we go back to the linear production functions (15), which imply the closed–form solution for the allocation of market and home hours (16). The intuition for equation (16) goes back to Ngai and Pissarides (2007), who studied how labor gets reallocated in the face of uneven technological progress across sectors ($\Delta A_h \neq \Delta A_m$ in our notation). They showed that if sector outputs are complements in the utility function ($\epsilon_c \in [0, 1)$ in our notation), then uneven technological progress leads to the reallocation of labor to the sector with the slower productivity growth.[19] Our calibration for the U.S. gave $\epsilon_c = 0.76$ and $\Delta A_h < \Delta A_m$. In our context, labor in the U.S. will be therefore be reallocated from market production to home production. Note that the tax term $1 - \tau_w$ does not show up in Ngai and Pissarides (2007) because they do not consider taxes. As in Rogerson (2008), this term captures that home production is exempt from taxes, implying that an increase in labor income taxes leads to the substitution from market to home goods. For our calibration, this effect comes out quantitatively stronger than the previous one, because the exponent $\epsilon_c = 0.76$ is larger than the exponent $1 - \epsilon_c = 0.24$.

The second step to building intuition is to derive a closed–form solution for leisure. In the simplified environment with linear production functions, leisure depends on the effective labor income taxes, wages, and the price level P associated with the CES aggregator,

$$P \equiv \left[\alpha_c^{\epsilon_c} + (1 - \alpha_c)^{\epsilon_c} p_h^{1-\epsilon_c}\right]^{\frac{1}{1-\epsilon_c}} \tag{17}$$

[19]In Ngai and Pissarides' application to structural change, this was the service sector. See Herrendorf et al. (2014) for a generalization to non–homothetic CES utility functions.

where $p_h = (1 - \tau_w)w/A_h$ denotes the shadow price of home production.[20] In Appendix C we show that:

$$L = \frac{1 - \alpha_u}{\alpha_u(1 - \tau_w) + (1 - \alpha_u)} \left[1 - \tau_w H_h - \frac{\bar{C}}{w/P} \right] \tag{18}$$

This equation brings out clearly how taxes and real wage growth affect the optimal leisure choice of the stand–in household. First, an increase in w/P implies that L increases, and hence hours worked $1 - L$ decrease. Note that if there was no subsistence consumption, i.e., $\bar{C} = 0$, then preferences would be homothetic, the income and substitution effects would cancel, and leisure L would not respond to changes in w/P. Second, we can see that an increase in τ_w has three effects: it decreases the denominator of (18); it decreases the second term in parenthesis; it decreases P and therefore decreases the third term in parenthesis. The first effect captures the usual substitution from working hours to leisure when income tax increases; the second effect captures that the income tax does not affect home production, implying that the usual effect is smaller in our case; the third effect captures that a tax increase implies an increase in the real wage (because it decreases the price index), which reduces the bite of the subsistence term. One can show that for our parameter values, the net effect is the standard one, that is, an increase in the labor income tax increases leisure.

Equipped with equations (16) and (18), we are now in the position to develop the intuition for our results about the allocation of time among leisure, market production, and home production. We start with the U.S. Since the U.S. is fairly rich already in 1970, real wages are high and $\bar{C}/(w/P)$ is low. Further increases in w/P therefore lead to a quantitatively small decrease in hours worked (in the market and at home) and a quantitatively small offsetting increase in leisure. Given total hours worked, the increase in the labor productivity of market production relative to home production implies that hours are reallocated from market to home production. This effect is relatively small quantitatively because the exponent is small, $1 - \epsilon_c = 0.24$. Since effective labor income taxes do not change much, they do not change the allocation of time. The net effects are as follows: leisure increases somewhat, market hours decrease somewhat, and home hours remain flat. The latter happens because the opposing effects from changes in $\bar{C}/(w/P)$ and A_m/A_h turn out to offset each other quantitatively.

We continue with France. In 1970, real wages were still considerably lower than in the U.S. The subsequent increases in w/P therefore lead to a quantitatively sizeable decrease in hours worked and an offsetting increase in leisure. The fact that the increases in the labor productivities of market and home production are similar implies there is hardly any reallocation between market and home hours through this margin. The increase in labor income taxes implies that hours are reallocated from market to non–market uses, so both home work and leisure increase

[20] With a linear production function, $p_h = (1 - \tau_w)w/A_h$ is the shadow price of home production because one unit of home production requires $1/A_h$ units of time, which has a market price of $(1 - \tau_w)w$.

as a result. This effect is sizeable quantitatively, as the elasticity of substitution between market and home consumption is close to one. The net effects are that leisure increases strongly, market hours decrease strongly, and home hours remain flat. Home hours stay flat because it turns out that, again, the opposing effects from $\bar{C}/(w/P)$ and τ_w offset each other quantitatively.

5.3 Marketization of consumption

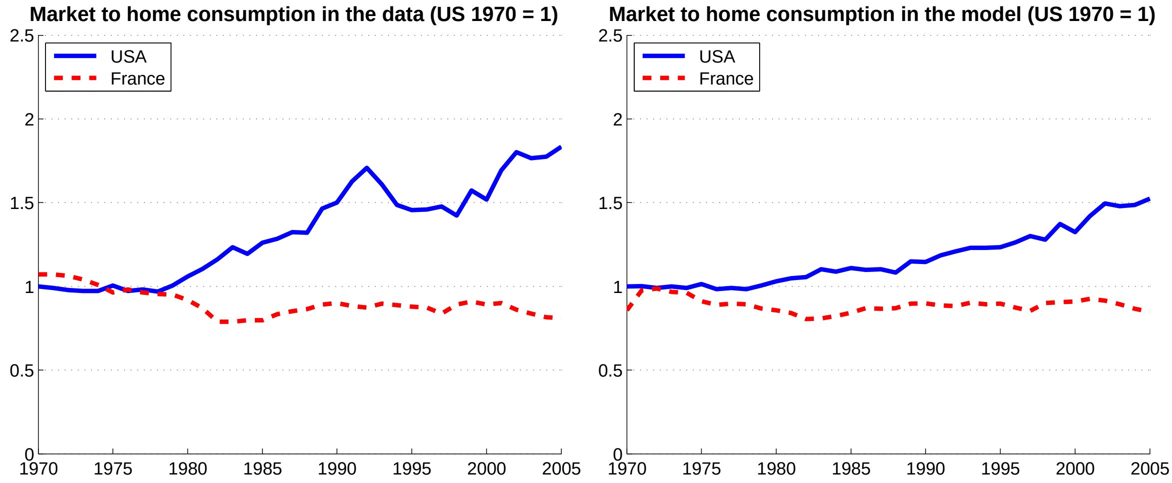
Freeman and Schettkat (2005) argued that one important reason for the employment gap between the U.S. and Germany is differences in the marketization of services, that is, Americans buy many services in the market that Germans produce at home. In this subsection, we ask whether our evidence is consistent with the marketization hypothesis for the U.S. and France. There might be some initial doubt because we found that home hours behave in similar ways in the U.S. and France. However, this does not contradict the marketization hypothesis because at the same time market hours in France declined much more strongly than in the U.S. As a result, the ratio of market–to–home hours declined a lot in France and little in the U.S. In other words, the evidence on hours suggests that in France the marketization of services did not happen to the same extent as in the U.S. However to draw that conclusion with confidence, we need additional information on how the composition of consumption behaved in the two countries.

Looking at market and home produced consumption, instead of at market and home hours worked, the marketization hypothesis comes through very clearly. Figure 5 depicts the ratios of market–to–home–produced consumption in the data and the model, normalizing the U.S. market–to–home consumption ratio to one in 1970 and expressing the French ratio relative to U.S. (that is, using the 1970 U.S. relative price of the two consumptions also for France). We can see that this ratio increased strongly in the U.S. while it declined in France. In other words, the U.S. experienced a marketization of consumption and France experienced the opposite. We emphasize that to reach this conclusion, we need the imputed value added of home production in both the U.S. and France.

Our model is qualitatively consistent with the marketization patterns in the U.S. and France. To understand the reason for this, it is useful to go back to the static special case that we used in the previous subsection to develop intuition. As expression (15) shows, both market and home produced consumption are then the products of labor productivity A_j and hours worked H_j. In this case, it is straightforward to deduce what happens to the consumption ratio: in the U.S. labor productivity has strongly increased in the market but remained flat at home at the same time as which market hours and home hours have not changed much. Hence, market consumption must have gone up relative to home consumption. In contrast, in France the increases in the labor productivities of market and home production were similar at the same time as which French market hours declined and home hours did not change much. Hence, market consumption must have declined relative to home consumption. This is exactly what

Figure 5 depicts.

Figure 5: Marketization of consumption in the data and the model



5.4 Counterfactual exercises

A different way of building intuition for the key forces at work in our model is to conduct counterfactual exercises. In what follows we will report two such exercises, which will serve to establish that differences between U.S. and French effective labor income taxes are largely responsible for the differences in the time allocation and that it is critical to use imputed home labor productivities, instead of calibrated ones.

The first counterfactual exercise assesses how the U.S. time allocation would change if the U.S. adopted French labor–income taxes ("U.S. with French labor–income taxes"). To this end, we feed effective French labor–income taxes into the otherwise unchanged U.S. economy. Figure 6 shows the results. We can see that the differences in labor income taxes are responsible for a large part of the differences in the time allocation, in particular between market and non–market time. This is consistent with the findings of Prescott (2004) that differences in labor income taxes account for a large part of the differences in market hours between the U.S. and Continental Europe. We can also see that at the beginning of the sample, effective labor income taxes alone do not account for the differences in the behavior of hours worked at home and leisure. This suggests that the other differences between France and the U.S. have a role to play too.

The second counterfactual exercise assesses how the French time allocation would change if instead of technological progress that we imputed, the French experience the technological regress of the U.S. ("France with U.S. home technology"). To this end, we follow the literature and assume that technological change at home relative to the market behaves in the same way

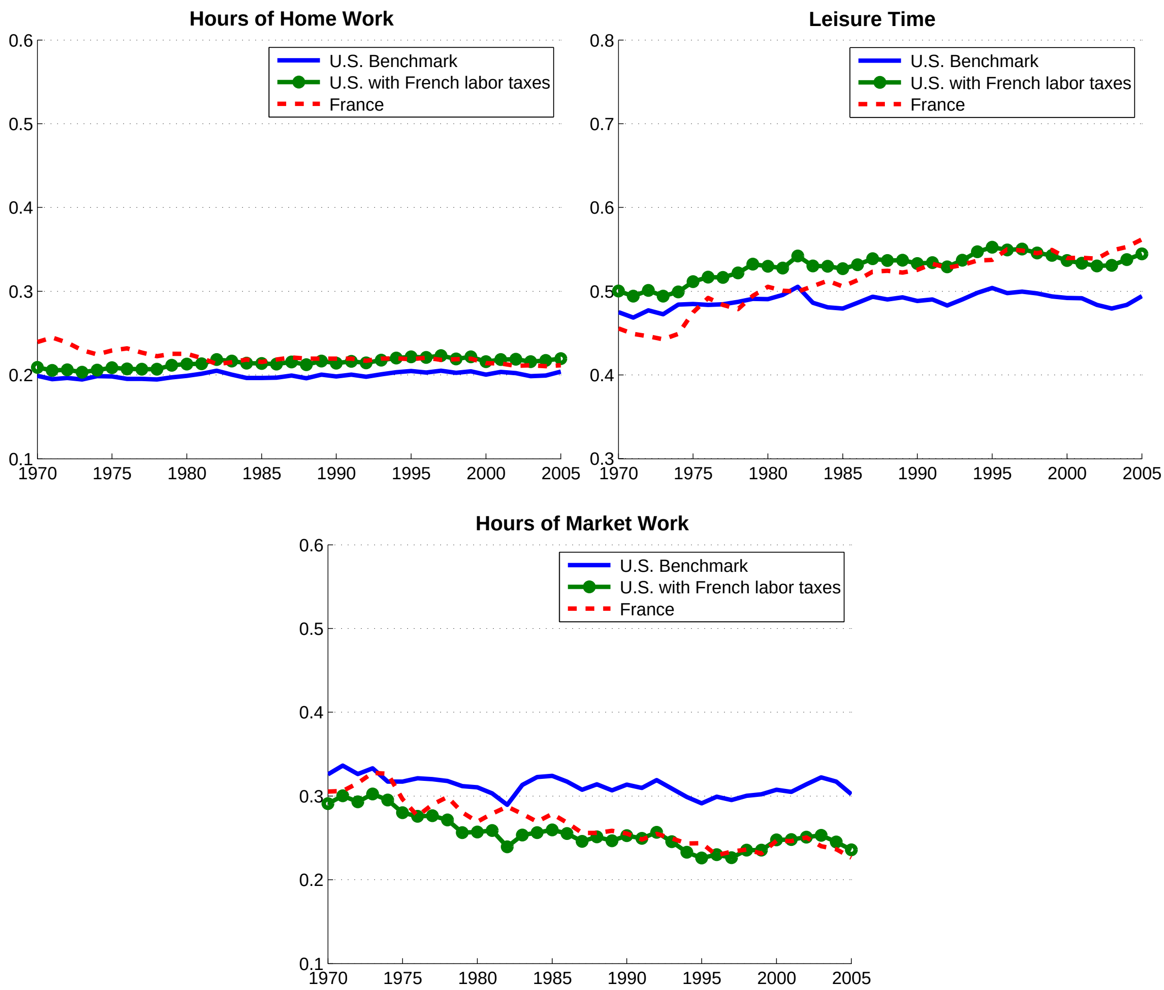


Figure 6: U.S. with French labor–income taxes

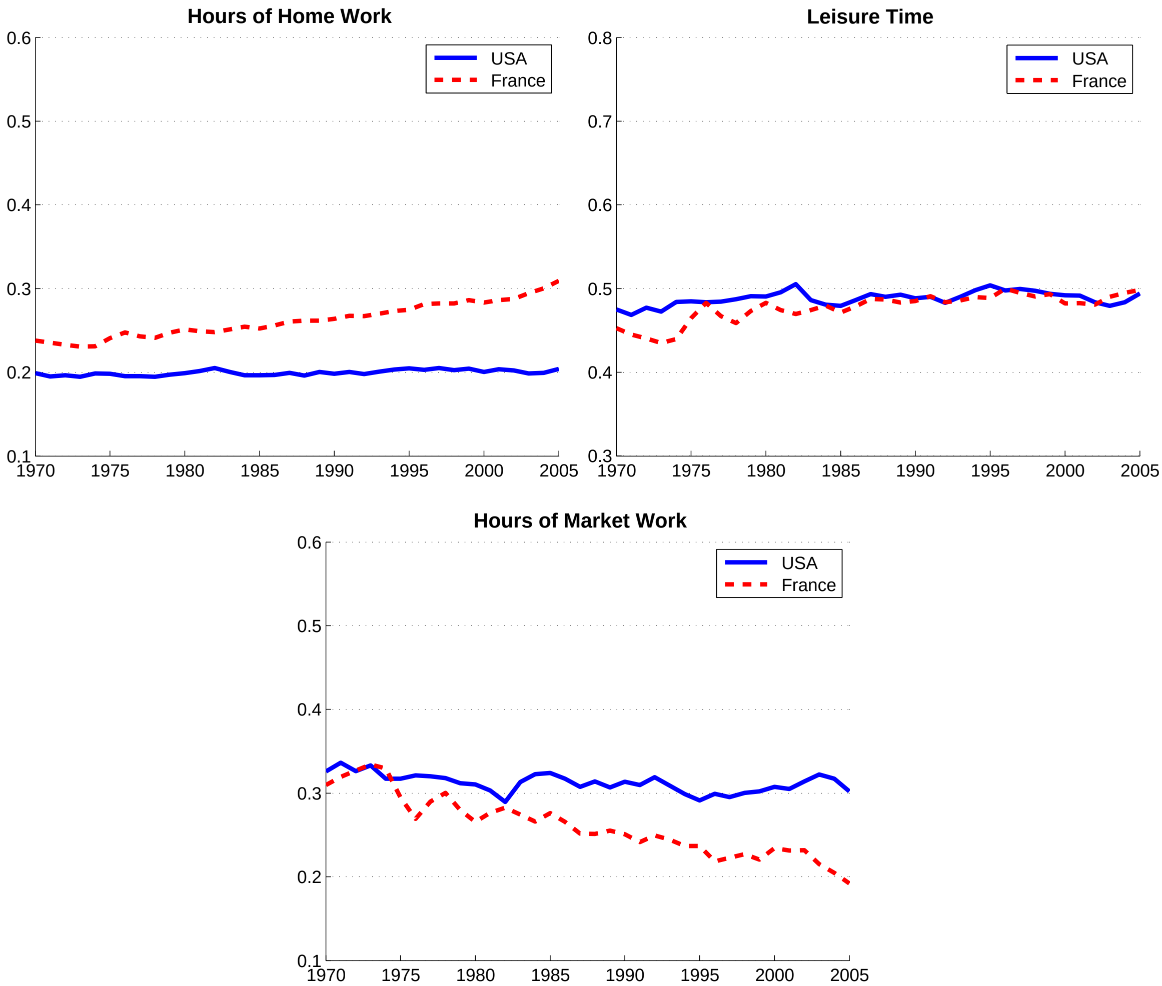


Figure 7: France with U.S. home technology

in France as in the U.S.:

$$\frac{A_h^{FR}(t)}{A_m^{FR}(t)} = \frac{A_h^{US}(t)}{A_m^{US}(t)} \tag{19}$$

We leave all other parameter values of the French economy unchanged. Figure 7 shows that we then get the counterfactual implication that French home hours rise. This establishes that it is crucial for obtaining our results that we target the measured French labor productivity of home production, instead of calibrating it. The intuitive reason for why French home hours rise when we give France the relative U.S. technological progress at home is closely linked to the fact that our calibration home and market consumption are complements. A reduction in French home labor productivity then leads to an increase in French home hours relative to market hours (see Equation (16) for the precise expression in the static special case of our model).

We draw two conclusions from the counterfactual exercises. First, effective labor income taxes are a key driver of the different time allocations in the U.S. and France. Second, to generate the time allocation in France, it is crucial to use measured home labor productivity.

6 Conclusion

We have documented new facts about the time allocations in the U.S. and France since 1970. During the last forty years, market hours per working–age population decreased and leisure increased while hours devoted to home production did not change much. We have asked what accounts for the time allocations in the U.S. and France. To answer this question, we have build a version of the growth model with market production, and home production and with capital in the production of home and market output. We have found that differences in effective income taxes and in labor productivities are the key forces behind the differences in the time allocations in the U.S. and France. In this context, it has been crucial to use measured, instead of calibrated, labor productivity of home production.

The natural next steps for future research are to extend the analysis to other countries, and to understand why technological change at home behaves so differently in the U.S. and France. We plan to pursue more seriously than in our discussion above how important it was in this context that many women entered the labor force in the U.S. Beyond that, we believe that the production of leisure warrants more attention. While this is typically not modeled at all, many of the same considerations as for home work apply also to the production of leisure. We think that this is an important and promising subject for future research.

References

Aguiar, Mark and Eric Hurst, "Measuring Leisure: The Allocation of Time Over Five Decades," *Quarterly Journal of Economics*, 2007, *122*, 969–1006.

——, **Erik Hurst, and Loukas Karabarbounis**, "Time Use during the Great Recession," *American Economic Review*, 2013, *103*, 1664–1696.

Becker, Garry S., "A Theory of the Allocation of Time," *Economic Journal*, 1965, *75*, 493–517.

Benhabib, Jess, Richard Rogerson, and Randall Wright, "Homework in Macroeconomics: Household Production and Aggregate Fluctuations," *Journal of Political Economy*, 1991, *99*, 1166–1187.

Bick, Alexander, "The Quantitative Role of Child Care for Female Labor Force Participation and Fertility," Manuscript, Arizona State University 2014.

—— **and Nicola Fuchs-Schuendeln**, "Taxation and Labor Supply of Married Couples across Countries: A Macroeconomic Analysis," Manuscript, Arizona State University 2014.

——, **Bettina Brueggemann, and Nicola Fuchs-Schuendeln**, "Labor Supply Along the Extensive and Intensive Margin: Cross-Country Facts and Time Trends by Gender," Manuscript, Arizona State University 2014.

Bridgman, Benjamin R., "Home Productivity," Manuscript, Buerau of Economic Analysis 2013.

——, **Georg Duernecker, and Berthold Herrendorf**, "Household Production in OECD Countries," Manuscript, Arizona State University 2014.

Burda, Michael C., Daniel S. Hamermesh, and Philippe Weil, "The Distribution of Total Work in the EU and US," in Tito Boeri, Michale C. Burda, and Francis Kramarz, eds., *Working Hours and Job Sharing in the EU and the USA: Are Europeans Lazy? Are Americans Crazy?*, Oxford: Oxford University Press, 2008.

Fan, Lei and Guozhong Zhu, "Home Production Technology and Time Allocation: Empirics, Theory, and Implications," Working Paper 2012–19, Federal Reserve Bank of Atlanta 2012.

Fang, Lei and Cara McDaniel, "Trends in Home Hours in the U.S and Europe," Manuscript, Arizona State University and Federal Reserve Bank of Atlanta 2014.

Fisher, Jonas, "Why Does Household Investment Lead Business Investment Over the Business Cycle?," *Journal of Political Economy*, 2007, *115*, 141–168.

Freeman, Richard B. and Ronald Schettkat, "Marketization of Production and the US–Europe Employment Gap," *Oxford Bulletin of Economics and Statistics*, 2001, *63*, 647–670.

—— **and** ——, "Marketization of Household Production and the EU–US Gap in Work," *Economic Policy*, 2005, *20*, 7–50.

Gimenez-Nadal, Jose Ignacio and Almudena Sevilla-Sanz, "Trends in Time Allocation: A Cross–Country Analysis," *European Economic Review*, 2012, *56*, 1338–1359.

Greenwood, Jeremy, Ananth Seshadri, and Mehmet Yorukogly, "Engines of Liberation," *Review of Economic Studies*, 2005, *72*, 100–133.

—— **and Zvi Hercowitz**, "The Allocation of Capital and Time over the Business Cycle," *Journal of Political Economy*, 1991, *99*, 1188–1214.

Guner, Nezih, Remzi Kaygusuz, and Gustavo Ventura, "Taxation and Household Labor Supply," *Review of Economic Studies*, 2012, *79*, 1113–1149.

——, ——, and ——, "Taxing Women: A Macroeconomic Analysis," *Journal of Monetary Economics*, 2012, *59*, 111–128.

Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi, "Two Perspectives on Preferences and Structural Transformation," *American Economic Review*, 2013, *103*, 2752–2789.

——, ——, and ——, "Growth and Structural Transformation," in Philippe Aghion and Steven N. Durlauf, eds., *Handbook of Economic Growth*, Vol. 2, Elsevier, 2014, pp. 855–941.

House, Christopher, John Laitner, and Dmitriy Stolyarov, "Valuing Lost Home Production of Dual Earner Couples," *International Economic Review*, 2008, *49*, 701–736.

Juster, F. Thomas and Frank P. Stafford, "The Allocation of Time: Empirical Findings, Behavioral Models, and Problems of Measurement," *Journal of Economic Literature*, 1991, *29*, 471–522.

Kendrick, John W., "Expanding Imputed Values in the National Income and Product Accounts," *Review of Income and Wealth*, 1979, *25*, 349–363.

Landefeld, J. Steven, Barbara M. Fraumeni, and Cindy M. Vojtech, "Accounting for Household Production: A Prototype Satellite Account Using the American Time Use Survey," *Review of Income and Wealth*, 2009, *55*, 205–225.

McDaniel, Cara, "Average Tax Rates on Consumption, Investment, Labor and Capital in the OECD 1950–2003," Manuscript, Arizona State University 2007.

——, "Forces Shaping Hours Worked in the OECD, 1960–2004," *American Economic Journal: Macroeconomics*, 2011, *3*, 27–52.

McGrattan, Ellen, Richard Rogerson, and Randall Wright, "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy," *International Economic Review*, 1997, *38*, 267–290.

Ngai, L. Rachel and Barbara Petrongolo, "Gender Gaps and the Rise of the Service Economy," Manuscript, London School of Economics 2013.

—— **and Chrisopher A. Pissarides**, "Structural Change in a Multisector Model of Growth," *American Economic Review*, 2007, *97*, 429–443.

—— **and** ——, "Trends in Hours and Economic Growth," *American Economic Journal: Macroeconomics*, 2008, *11*, 239–256.

—— **and** ——, "Taxes, Social Subsidy, and the Allocation of Work Time," *Review of Economic Dynamics*, 2011, *3*, 1–26.

Ohanian, Lee E., Andrea Raffo, and Richard Rogerson, "Long–term Changes in Labor Supply and Taxes: Evidence from OECD Countreis, 1956–2004," *Journal of Monetary Economics*, 2008, *55*, 1353–1362.

Olovsson, Conny, "Why do Europeans Work so Little?," *International Economic Review*, 2009, *50*, 39–61.

Prescott, Edward C., "Why Do Americans Work So Much More Than Europeans?," *Federal Reserve Bank of Minneapolis Quarterly Review*, 2004, *2-13*, 28.

Ragan, Kelly S., "Taxes and Time Use: Fiscal Policy in a Household Production Model," *American Economic Journal: Macroeconomics*, 2013, *5*, 168–192.

Ramey, Valerie A., "Time Spent in Home Production in the Twentieth–Century United States: New Estimates from Old Data," *Journal of Economic History*, 2009, *69*, 1–47.

Ramey, Valery A. and Neville Francis, "A Century of Work and Leisure," *American Economic Journal: Macroeconomics*, 2009, *1*, 189–224.

Rendall, Michelle, "The Rise of the Service Sector and Female Market Work: Europe vs. US," Technical Report, University of Zurich 2010. Manuscript.

Restuccia, Diego and Guillaume Vandenbroucke, "A Century of Human Capital and Hours," *Economic Inquiry*, 2013, *51*, 1849–1866.

—— **and** ——, "forthcoming: Explaining Educational Attainment across Countries and over Time," *Review of Economic Dynamics*, 2014.

Rogerson, Richard, "Taxation and Market Work: is Scandinavia an Outlier?," *Economic Theory*, 2007, *32*, 59–85.

——, "Structural Transformation and the Deterioration of European Labor Market Outcomes," *Journal of Political Economy*, 2008, *116*, 235–259.

Rupert, Peter, Richard Rogerson, and Randall Wright, "Estimating Substitution Elasticities in Household Production Models," *Economic Theory*, 1995, *6*, 179–193.

Schreyer, Paul and W. Erwin Diewert, "Household Production, Leisure, and Living Standards," in Dale W. Jorgenson, J. Steven Landefeld, and Paul Schreyer, eds., *Measuring Economic Sustainability and Progress*, Chicago, IL: University of Chicago Press, 2014.

Appendix A: Details of the Data Work

Appendix A.1: Background Information to Times Use Surveys

Table 10: Dates of times use surveys and number of participants

U.S.	1965	1975	1985	1992	1994	1998	2003	2004
Total	1,965	5,807	2,539	6,178	937	1,720	16,760	11,187
Males	1,082	3,264	1,340	3,307	543	977	9,320	6,204
Females	883	2,543	1,199	2,871	394	743	7,440	4,983
			2005	2006	2007	2008	2009	2010
Total			10,564	10,440	9,808	10,199	10,344	10348
Males			5,902	5,872	5,434	5,558	5,780	5,686
Females			4,662	4,568	4,374	4,641	4,564	4,662

France	1965	1974	1985	1998	2010
Total	2,898	4,633	16,047	12,393	27,903
Males	1,460	2,202	7,455	5,987	
Females	1,438	2,431	8,592	6,406	

Germany	1965	1991	2001
Total	2,137	21,801	27,583
Males	945	10,531	12,827
Females	1,192	11,270	14,756

UK	1961	1974	1983	1987	1995	2000	2005
Total	8,360	14,301	7,432	10,841	1,422	14,169	3,614
Males	4,163	6,753	2,934	5,001	679	6,520	1,646
Females	4,197	7,548	4,498	5,840	743	7,649	1,968

Table 11: Definitions of market work, home work, and leisure

Home work: AV 6:11	Leisure: AV 12,15,17:40	Market work: AV 1:3,5
Personal care: AV 13,14,16	Education: AV 4	(AV stands for Activity)
AV 1 Paid work	AV 15 Meals and snacks	AV 29 Visit friends at their homes
AV 2 Paid work at home	AV 16 Sleep	AV 30 Listen to radio
AV 3 Paid work, second job	AV 17 Free time travel	AV 31 Watch television or video
AV 4 School, classes	AV 18 Excursions	AV 32 Listen to records, tapes, cds
AV 5 Travel to/from work	AV 19 Active sports participation	AV 33 Study, home work
AV 6 Cook, wash up	AV 20 Passive sports participation	AV 34 Read books
AV 7 Housework	AV 21 Walking	AV 35 Read papers, magazines
AV 8 Odd jobs	AV 22 Religious activities	AV 36 Relax
AV 9 Gardening	AV 23 Civic activities	AV 37 Conversation
AV 10 Shopping	AV 24 Cinema or theatre	AV 38 Entertain friends at home
AV 11 Childcare	AV 25 Dances or parties	AV 39 Knit, sew
AV 12 Domestic travel	AV 26 Social clubs	AV 40 Other leisure
AV 13 Dress/personal care	AV 27 Pubs	
AV 14 Consume personal services	AV 28 Restaurants	

Appendix A.2: Interpolation and Extrapolation of Hours

Interpolation of hours

- Suppose we have time use data for 1965 and 1975 (as in the case of the U.S., for instance).
- **Market hours**. The average weekly time spent on market work (for individuals between 15 and 64 years) in 1965 and 1975 are equal to $H_m(65)$=34.9 hours and $H_m(75)$=30.6 hours respectively. We want to obtain a smooth interpolation which is based on the actual evolution of hours of work. To this end, we look at the evolution of average annual market hours per working age person between these two points in time. The data for market hours per working age person are taken from the GGDC database.
  - Step 1: Annual hours of market work per working age person are in row (1) of the table below.
  - Step 2: Compute the "forward" change in hours for each year with respect to the start year 1965. That is: $H(65)/H(65), H_{66}/H(65), H_{67}/H(65), ..., H(75)/H(65)$. See row (2).
  - Step 3: Compute the "backward" change in hours for each year with respect to the final year 1975. That is: $H(75)/H(75), H(74)/H(75), H(73)/H(75), ..., H(65)/H(75)$. See row (3).

– Step 4: Compute the implied weekly, "forward" hours for each year as: $H_m(66)^f = H_m(65) * H_{66}/H(65)$, $H_m(67)^f = H_m(65) * H_{67}/H(65)$, ..., $H_m(75)^f = H_m(65) * H(75)/H(65)$. See row (4)

– Step 5: Compute the implied weekly, "backward" hours for each year as: $H_m(74)^b = H_m(75) * H(74)/H(75)$, $H^b_{m,73} = H_m(75) * H(73)/H(75)$, ..., $H_m(65)^b = H_m(75) * H(65)/H(75)$. See row (5)

– Step 6: Interpolation. Taking the simple average of these two series is not an option because the resulting series would not go through the actual period-start and -end points. Instead, we do a weighted interpolation: $H_m(66) = (9 * H_m(66)^f + 1 * H_m(66)^b)/10$, $H_m(67) = (8 * H_m(67)^f + 2 * H_m(67)^b)/10$, ..., $H_m(74) = (1 * H_m(74)^f + 9 * H_m(74)^b)/10$. See row (6), which is our final series for hours of market work.

Table 12: Interpolation of market hours

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1)	1194.6	1207.2	1199.6	1196.8	1201.5	1167.7	1144.1	1159.6	1172.0	1160.1	1114.4
(2)	1.000	1.010	1.004	1.002	1.006	0.978	0.958	0.971	0.981	0.971	0.933
(3)	1.072	1.083	1.076	1.074	1.078	1.048	1.027	1.041	1.052	1.041	1.000
(4)	34.9	35.3	35.1	35.0	35.1	34.1	33.4	33.9	34.3	33.9	32.6
(5)	32.8	33.2	33.0	32.9	33.0	32.1	31.4	31.9	32.2	31.9	30.6
(6)	**34.9**	35.1	34.6	34.3	34.3	33.1	32.2	32.5	32.6	32.1	**30.6**

There are two different ways of computing home hours (and leisure). Let's start with Approach (i)

- **Total hours - Approach (i)**. To be able to compute leisure and home hours, we, first, need a series for total disposable time. From the time use we have the total weekly disposable time in 1965 and 1975: $H(65) + L(65) = 100.9$ hours and $H(75) + L(75) = 102.4$ hours.

  – Step 1: Compute the percentage of market hours in total hours in 1965 and 1975. See rows (1) [total weekly time in hours], (2) [weekly market hours], (3) share of weekly market hours in total time.

  – Step 2: Linearly interpolate between the start- and the end-percentage. See row (4).

  – Step 3: Recover the total time for each year by dividing the market hours by the share of market hours. See row (5).

- **Home hours - Approach (i)**. The time use data gives us two observations for home hours: $H_{h,65} = 20.6$ and $H_{h,75} = 20.0$.
  - Step 1: Compute the share of weekly home hours in total weekly hours for 1965 and 1975. See rows (6) [total weekly time in hours], (7) [weekly home hours], (8) share of weekly home hours in total time.
  - Step 2: Linearly interpolate between the start- and the end-percentage. See row (9).
  - Step 3: Compute weekly home hours by multiplying the total weekly time by the share of home hours. See row (10).
- **Leisure - Approach (i)**. The series for leisure is obtained by subtracting market hours and home hours from the total weekly time. See row (11).

Table 13: Interpolation of total time, home hours and leisure, Approach (i)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1)	100.9										102.4
(2)	34.9										30.6
(3)	34.6										29.9
(4)	34.6	34.1	33.7	33.2	32.7	32.3	31.8	31.3	30.8	30.4	29.9
(5)	100.9	102.7	102.9	103.5	104.7	102.6	101.4	103.7	105.7	105.6	102.4
(6)	100.9										102.4
(7)	20.6										20.0
(8)	20.4										19.5
(9)	20.4	20.3	20.2	20.2	20.1	20.0	19.9	19.8	19.7	19.6	19.5
(10)	20.6	20.9	20.8	20.9	21.0	20.5	20.2	20.5	20.8	20.7	20.0
(11)	45.4	46.8	47.4	48.3	49.5	49.0	49.0	50.7	52.3	52.9	51.8

We now turn to Approach (ii).

- **Total hours - Approach (ii)**. From the time use we have the total time in 1965 and 1975: $H(65) + L(65) = 100.9$ and $H(75) + L(75) = 102.4$.
  - Step 1: Linearly interpolate between the start and the end values of total time. See row (1).
  - Step 2: Compute the share of home hours in non-market time for 1965 and 1975 and linearly interpolate between the start and the end points. See row (2).

- **Home hours - Approach (ii)**: Compute home hours for each year by multiplying the non-market time with the share of home hours in non-market time. Row (3).
- **Leisure - Approach (ii)**. The series for leisure is obtained by subtracting market hours and home hours from the total weekly time. See row (4).

Table 14: Interpolation of total time, home hours and leisure, Approach (ii)

year	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1)	100.9	101.0	101.2	101.3	101.5	101.6	101.8	101.9	102.1	102.2	102.4
(2)	31.2	30.9	30.6	30.2	29.9	29.5	29.2	28.8	28.5	28.2	27.8
(3)	20.6	20.4	20.3	20.2	20.1	20.2	20.3	20.0	19.8	19.8	20.0
(4)	45.4	45.6	46.2	46.8	47.1	48.3	49.3	49.4	49.7	50.4	51.8

- **Résumé**: We favor Approach (ii) for the following reason: Approach (i) implies a strong co-movement between market hours and total time. For instance, between 1974 and 1975, we see a decline in market hours from 32.1 to 30.6 weekly hours. At the same time, total hours drop from 105.6 to 102.4. Moreover, the series for total time is very volatile (because it's directly linked to market hours which fluctuate a lot). This is somewhat counterfactual - at least for the U.S. In the late 2000s, we have annual time use observations and we see that individuals change their total weekly time ($H_m + H_h + L$) typically by less than an hours from one year to the next. Approach (ii) is consistent with this observations because it linearly interpolates the total time and does not link it to market hours.

Extrapolation of hours

For some countries we need to extrapolate the hours series. For instance, the last time use observation for France is for 1998 but we want to know what the hours are in 2005. There are three different ways to do the extrapolation. All three approaches use the same way to compute market hours. So let's first look at how market hours are computed.

- Suppose we are looking at France, we have time use data for 1998, and we want to extrapolate the series until 2005.
- **Market hours**. The weekly market hours in 1998 are equal to $Hm(98)$=24.5. As above, we make use of the data on the evolution of actual hours of work per working age person.
  - Step 1: Market hours per working age person are in row (1) of the table below .

– Step 2: Compute the change in hours for each year with respect to the start year 1998. That is: $H(98)/H(98), H_(99)/H(98), H(00)/H(98), ..., H(05)/H(98)$. See row (2).

– Step 3: Compute the implied weekly hours for each year as: $H_m(99)^f = Hm(98) * H(99)/H(098)$, $H_m(00)^f = Hm(98) * H(00)/H(098)$, ..., $H_m(05)^f = Hm(98) * H(05)/H(098)$. See row (3)

Table 15: Extrapolation of market hours

year	1998	1999	2000	2001	2002	2003	2004	2005
(1)	1005.4	1018.2	1014.1	1016.6	989.3	981.3	994.0	989.3
(2)	1.000	1.013	1.009	1.011	0.984	0.976	0.989	0.984
(3)	**24.5**	24.8	24.7	24.8	24.1	23.9	24.2	24.1

Now let's look at the three approaches to compute home hours and leisure in greater detail.

- **Total hours - Approach (1)**. We, first, need a series for total disposable time. From the time use we have the total time in 1998 which is: $H(098) + L(098) = 106.0$.

  – Step 1: Compute the share of market hours in total hours in 1998. See rows (1) [total weekly time in hours], (2) [weekly market hours], (3) share of weekly market hours in total time.

  – Step 2: Assume that this share remains constant during the period from 1998 to 2005. See row (4).

  – Step 3: Recover the total time for each year by dividing the market hours by the share of market hours. See row (5).

- **Home hours - Approach (1)**. The time use data gives us an observations for home hours in 1998: $H_{h,98} = 24.1$.

  – Step 1: Compute the share of weekly home hours in total weekly hours for 1998. See rows (6) [total weekly time in hours], (7) [weekly home hours], (8) share of weekly home hours in total time.

  – Step 2: Assume that this share is constant during the period from 1998 to 2005. See row (9).

– Step 3: Compute weekly home hours by multiplying the total weekly time by the share of home hours. See row (10).

– Step 4: The series for leisure is obtained by subtracting market hours and home hours from the total weekly time. See row (11).

Table 16: Extrapolation of total time, home hours and leisure, Approach 1

year	1998	1999	2000	2001	2002	2003	2004	2005
(1)	106.0							
(2)	24.5							
(3)	23.1							
(4)	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1
(5)	106.0	107.4	107.0	107.2	104.3	103.5	104.8	104.3
(6)	106.0							
(7)	24.1							
(8)	22.7							
(9)	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
(10)	24.1	24.4	24.3	24.3	23.7	23.5	23.8	23.7
(11)	57.5	58.2	57.9	58.1	56.6	56.1	56.8	56.6

- **Total hours, home hours and leisure - Approach (2)**. We, first, need a series for total disposable time. From the time use we have the total time in 1998 which is: $H(098) + L(098) = 106.0$.

  – Step 1: Assume that the total weekly time remains constant during the period from 1998 until 2005. See row (1):

  – Step 2: Compute the share of weekly home hours in total weekly hours for 1998. See rows (2) [total weekly time in hours], (3) [weekly home hours], (4) share of weekly home hours in total time.

  – Step 3: Assume that this share is constant during the period from 1998 to 2005. See row (5).

  – Step 4: Compute weekly home hours by multiplying the total weekly time by the share of home hours. See row (6).

– Step 5: Compute leisure by subtracting market hours and home hours from the total weekly time. See row (7).

Table 17: Extrapolation of total time, home hours and leisure, Approach 2

year	1998	1999	2000	2001	2002	2003	2004	2005
(1)	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0
(2)	106.0							
(3)	24.1							
(4)	22.7							
(5)	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
(6)	24.1	24.1	24.1	24.1	24.1	24.1	24.1	24.1
(7)	57.5	57.2	57.3	57.2	57.9	58.1	57.8	57.9

- **Total hours, home hours and leisure - Approach (3)**. We, first, need a series for total disposable time. From the time use we have the total time in 1998 which is: $H(098) + L(098) = 106.0$.
  - Step 1: Assume that the total weekly time remains constant during the period from 1998 until 2005. See row (1):
  - Step 2: Compute the share of weekly home hours in weekly non-market hours for 1998. See rows (2) [weekly non-market time in hours], (3) [weekly home hours], (4) share of weekly home hours in non-market time.
  - Step 3: Assume that this share is constant during the period from 1998 to 2005. See row (5).
  - Step 4: Compute weekly home hours by multiplying the weekly non-market time by the share of home hours in non-market time. See row (6).
  - Step 5: Compute leisure by subtracting market hours and home hours from the total weekly time. See row (7).
- **Résumé**: The differences between the three approaches are fairly small.

Table 18: Extrapolation of total time, home hours and leisure, Approach 3

	1998	1999	2000	2001	2002	2003	2004	2005
(1)	106.0	106.0	106.0	106.0	106.0	106.0	106.0	106.0
(2)	81.5							
(3)	24.1							
(4)	29.5							
(5)	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5
(6)	24.1	24.0	24.0	24.0	24.2	24.2	24.1	24.2
(7)	57.5	57.3	57.3	57.3	57.8	57.9	57.7	57.8

Appendix A.3: Ramey versus Herrendorf–Duernecker categories of home production

The purpose of this part of the appendix is to clarify why the estimates of the average weekly home production time for the U.S. differ between our 2014 paper "*On the Allocation of Time*" and Valerie Ramey's 2009 paper "*Time Spent in Home Production in the Twentieth-Century United States: New Estimates from Old Data*".

Table 19: Average weekly hours of home work in the U.S.

		Age	Source	Categories	1965	1975	1985	1995	2005
1	Ramey	18–64	AHTUS		26.5	22.5	21.3	22.3	23.2
2	D–H	15–64	MTUS	41 activities	20.6	20.0	19.2	20.2	20.4
3	D–H	18–64	MTUS	41 activities	22.4	21.2	20.3	20.9	21.9
4	D–H	18–64	MTUS	69 activities – our categories	27.4	23.7	23.0	23.8	24.7
5	D–H	18–64	MTUS	69 activities – Ramey's categories	26.8	22.9	21.8	22.4	23.5

Data sources

Ramey uses The American Heritage Time Use Study (AHTUS) whereas we use The Multinational Time Use Surveys (MTUS), whereas we use the Multinational Time Use Surveys (MTUS), which is a repository that contains a large number of harmonized time use surveys for different countries and years. We use MTUS because its data is comparable across countries and time. While ATUS and MTUS are fairly close for the U.S., there are some differences and one should not expect Ramey's numbers to be exactly equal to our numbers even if we both follow exactly the same steps.

Age groups

Ramey considers the sample of individuals with age between 18 and 64 years. In contrast, we consider the individuals between 15 and 64 years of age, which is the standard definition of the working–age population. The third row in Table 19 shows our series computed for individuals with age between 18 and 64 years. The level of home hours is higher than in our original series and home hours now decline somewhat at the beginning of the time period.

Categorization of activities

MTUS has classification systems with 41 and 69 activities. Since the classification with 69 activities is not available for the 1965 and 1975 surveys for France, we use 41 activities for all countries and years. This ensures the cross–country comparability of our estimates of home production time.

Table 20: Home production activities in the MTUS classification system

41 activities	69 activities – D–H categories	69 activities – Ramey's categories
Cook, wash up	Food preparation, cooking	Food preparation, cooking
Housework	Set table, wash/put away dishes	Set table, wash/put away dishes
Odd jobs	Cleaning	Cleaning
Maintenance of home or car	Laundry, ironing, clothing repair	Laundry, ironing, clothing repair
Household management	Home/vehicle maintenance/improvement	Home/vehicle maintenance/improvement
Pet care	Other domestic work	Other domestic work
Gardening	Purchase goods	Purchase goods
Shopping	Purchase personal care services	
Child care	Purchase other services	Purchase other services
Adult care	Pet care (other than walk dog)	Pet care (other than walk dog)
	Physical or medical child care	Physical or medical child care
	Teach child a skill, help with homework	Teach child a skill, help with homework
	Read to, talk or play with child	
	Supervise, accompany, other child care	Supervise, accompany, other child care
	Adult care	Adult care
	Child/adult care–related travel	
	Travel for shopping, personal/household care	Travel for shopping, personal/household care

Since the MTUS data for the U.S. has both activity classifications, we can check by how much our numbers change if we apply the classification with 69 activities instead of that with 41 activities. The fourth row in the table has the results. Three remarks are in order. First, the constancy of home hours between 1975 and 2005 is largely preserved. Second, the drop in home hours between 1965 and 1975 is now more pronounced than before and the magnitude of the change is close to what Ramey finds (14% in our data versus 15% in Ramey). Third, the level of home hours is higher than before. The last point is due to the fact that using the finer classification allows us to be more accurate when we classify home production activities. As a result, several activities are now part of home production but were previously included in leisure, market production or personal care time. This applies for instance to several activities related to travel (for instance, child/adult care-related travel and travel for shopping, or household care). The second and the third column in Table 20 show, for both activity classifications, all activities that our definition includes in home production

Ramey's categorization of activities

Ramey excluded a number of activities from home production that are arguably part of home production. The reason for doing this was that the pre–1965 time use data that she utilizes do not report these activities, so by excluding them she ensured the consistency of her categorization over time. The last row in Table 19 below shows our estimates for home hours if we exclude the same activities from our definition of home production as Ramey did. These activities include for instance "purchasing personal care services" or "adult care travel". The third column in Table 20 shows the remaining home production activities included in our definition. As expected, the level of home production time drops further. More importantly, the last series is very close to Ramey's series indeed.

Appendix A.4: Calculation of home capital and labor productivity

Home capital and labor productivity in France

Home capital, Version 1

Step 1: Take the data from the OECD on final consumption expenditures (in national currency and current prices) on the following goods categories[21]: *P31CP051: Furniture and furnishings, carpets and other floor coverings, P31CP052: Household textiles, P31CP053: Household appliances, P31CP054: Glassware, tableware and household utensils, P31CP055: Tools and equipment for house and garden, P31CP061: Medical products, appliances and equipment, P31CP071: Purchase of vehicles, P31CP082: Telephone and telefax equipment, P31CP091: Audio-visual, photographic and information processing equipment, P31CP092: Other major durables for recreation and culture, P31CP093: Other recreational items and equipment, gardens and pets, P31CP095: Newspapers, books and stationery.*

[21] The label of the dataset is *Dataset: 5. Final consumption expenditure of households.*

There is an (almost) one-to-one mapping between these categories and those that the BEA includes in its variable Consumer Durable Goods. The availability of the OECD expenditures data differs across countries. For instance, for France, the data are available from 1959 onwards, whereas the series for Spain starts only in 2000. In our baseline scenario, we do not include housing into our measure of the capital stock. Only a certain fraction of the housing stock is used for household production (e.g. the kitchen), whereas the rest is used for different purposes. It is hard to quantify this fraction which is why we disregarded it at this point. We will consider alternative definitions of household capital in the future. Most likely, we will consider a broad and a narrow definition in addition to the baseline scenario. The broad definition includes consumer durables (as in the baseline) and housing whereas the narrow definition includes assets whose use is unambiguously linked to household production (such as household appliances).

Step 2: Use the perpetual investment method (PIM) to compute the stock for each asset category. Start by setting the initial stock of category i, $K(59)^i$ equal to initial investment $I(59)^i$. Then, use the standard formula to compute the series for $K(t)_{t=60}^{10}$ in a recursive manner: $K(t)^i = (1 - \delta^i)K_{t-1}^i + I(t)^i$. The depreciation rate is asset-specific and constant over time. The value of δ^i is taken from the BEA and corresponds to the 1925–2012 average depreciation rate for each of the asset categories (computed as $Depreciation(t)^i/Stock(t)^i$). Taking the 1960–2010 average or the 1970–2005 average instead of the 1925–2012 average makes only a very small difference. The depreciation rates for the different asset classes range from 14% to 31%. The high values of δ^i guarantee that the capital stock computed via the PIM converges to the "true" stock relatively quickly. We compute the current-cost capital stock. This requires to, first, transform past investments into current-price investment. That is, to compute period–t capital, we express the investment of periods $t - 1$, $t - 2$, ... in prices of period t and, then, apply the PIM.

Step 3: Compute the total capital stock for each period by aggregating up the individual stocks: $K(t)^{CD} = \sum_i K(t)^i$.

Home capital, Version 2

Step 1: Take the data from the OECD on final consumption expenditures (in national currency and current prices) on *P311B: Durable goods*. The OECD categorizes consumer expenditures into four different classes: *Durable goods*, *Semi-Durable goods*, *Non-Durable goods*, *Services*. It is not visible for an OECD-outsider how this categorization is done, i.e. which expenditure categories are included in each of these four groups. However, it is certain that *Durable goods* is a subset of what has been considered as Durable Goods in the Version 1 above (because the sum of expenditures is larger then the reported expenditures on *Durable goods*).

Step 2: Use the PIM to compute the stock. The depreciation rate is taken from the BEA and it is equal to the 1925-2012 average depreciation rate for Consumer Durable Goods.

The difference between the Version 1 total stock and the Version 2 stock is sizable (and equal to around 35%) but very stable over time. To illustrate: the stock increases between 1980 to 2010 by a factor 4.9 for Version 1 and by a factor of 4.8 for Version 2 (over the period 1990 to 2010 the numbers are 1.88 and 1.81).

Labor Productivity in Home Production

Step 1: Compute current-price value added. Value added is the sum of two components and computed as follows:

$$\text{VA} = (r + \delta) * \text{capital input} + w * \text{labor input}$$

Now, let's talk about the computation of the individual components.

1. **Capital input** ... is equal to the nominal stock of consumer durables and it is computed as described above. In the baseline scenario, we use the procedure labeled as Version 1. *Data source:* see above.

2. δ is the depreciation rate. We do not use some aggregate depreciation rate and multiply it with the aggregate home capital stock. To be more accurate, we compute instead the aggregate home capital depreciation by using the capital stocks for each asset category (as described above) together with the asset-specific depreciation rates. I.e. $\delta * K(t) = \sum_i \delta^i K(t)^i$. *Data source:* see above.

3. **r** is the gross return on consumer durables. Ideally we would like to have information on the rate of return of individual financial asset holdings. If we had this return, we could invoke an arbitrage argument and apply the same rate of return for household capital (that is: when the agent has two investment opportunities - household capital and financial assets - then the rate of return has to be equalized in equilibrium). We do not have this information for most OECD countries, so we use the nominal yield on the respective country's 10-year government bonds as a proxy. One way to improve this approximation would go as follows: we have the data on the rate of return on financial assets for a short period of time (2000-2010). For this period, we can compute the spread between this return and government 10-year bond returns. Then, we make the assumption that this spread is constant over time and add it to the observed government bond return to get the return on financial assets. **NOTE:** this modification will affect - if anything - only the

level of home value added but not the change over time because of the constant spread. *Data source:* FRED, Saint Louis Fed

4. **Labor input** ... is the annual aggregate amount of time (measured in hours) spent on household work by individuals aged between 15-64 years. This variable is computed as the product of the annual individual hours of household work and the total population aged between 15 and 64 years. We do not capture the household work done by individuals younger than 15 and older than 64 years (also not for the U.S.). There is limited or no time use data for these age groups and that is why we do not consider them.

   The annual individual hours of household work are computed as the weekly individual hours of household work times 52. The weekly individual hours of household work are computed from the Multinational Time Use Study (MTUS).

   Data sources: MTUS (individual time use data), OECD (population aged 15-64 years).

5. **w** is the return on the labor input. To compute w, we use data on the hourly compensation of private household workers, i.e. people who are directly employed by households to do household work. The main assumption is that the marginal product of these household workers is the same as the marginal product of a non-household worker who is doing household work. We use data from the EU-KLEMS on (i) total annual hours worked by private HH workers and (ii) the total labor compensation of private HH workers. We divide the latter by the former to obtain the hourly compensation which is our measure of **w**.

Step 2: Compute constant-price home value added. The central question here is, which price index to use to convert current-price into constant-price value added. We explore two different approaches: (a) the price index of value added of the household sector, (b) the price index of private consumption expenditures on goods and services which have a home-produced substitute. The key disadvantage of the first approach is that the main component of household sector value added is housing services (rents and owner-occupied housing), hence the price index would give us the price of housing which is somewhat unrelated to what we are trying to capture by household production (also, we do not consider housing capital as input in household production. Approach (b) is not ideal either because it a final expenditure price and not a value added price. The idea behind (b) is as follows: all home-produced goods and services have a market-produced substitute. That is, all home production could be outsourced to the market. Hence, when we look at the market price of goods and services which could be produced by the household, then we have an approximation of the price of the household's actual output. This consideration abstracts from issues regarding the composition of household output. That is, it assumes that the output bundle of the home sector is comparable to the composition of home-substitutes produced in the market.

In the baseline case, we chose (b) and compute the price index as follows. We take the data provided by the OECD on final consumption expenditures of households on *Food and non-alcoholic beverages*, *Clothing*, *Maintenance and repair of the dwelling*, *Goods and services for routine household mainte.ce*, *Out-patient services*, *Hospital services*, *Operation of personal transport equipment*, *Transport services*, *Restaurants and hotels*, *Personal care*[22]. This is our list of market-produced goods and services which have a home-produced substitute. To compute a single price index, we divide the sum of current price expenditures by the sum of constant price expenditures (the constant-price series in NOT chained - hence we can do the summation). The base year of this index is 2005.

Finally, we divide the value of nominal value added by the price index to obtain the constant price value added.

Step 3: PPP-adjustment. To make the series comparable across countries, we do a PPP-adjustment of the constant price series. Again, the question is, what PPP factor to use? Obviously, there is no data on PPP for home value added, so we have to come up with a proxy. The OECD provides data on PPPs for a large class of final expenditure categories for the year 2005. We proceed as in Step 2 above and construct a composite PPP using the PPPs for those expenditure categories which have a home produced substitute. In particular, we compute the aggregate PPP factor as the expenditure-weighted average of the PPPs of the following categories: *Food and non-alcoholic beverages*, *Clothing and footwear*, *Housing, water, electricity, gas and other fuels*, *Household furnishings, equipment and maintenance*, *Health*, *Transport*, *Restaurants and hotels*.

Finally, we divide the constant price series of home value added by the PPP factor to obtain the adjusted series

Step 4: Labor productivity. In the last step, we divide the constant price, constant PPP series of home value added by the annual aggregate hours of household work (mentioned above in Step 1) to obtain labor productivity.

U.S.

Step 1: Compute current-price value added. This is done in the same way as above. I.e. value added is the sum of two components and computed as follows:

$$\text{VA} = (r + \delta) * \text{capital input} + w * \text{labor input}$$

[22]The dataset is called *Dataset: 5. Final consumption expenditure of households*.

1. The **capital input** is equal to the nominal stock of consumer durables. There's no need to do the PIM because the BEA provides data for the nominal stock of consumer durables (BEA Table 8.1)

2. The depreciation is taken from the BEA Table 1.3.

3. The gross return on consumer durables **r** is set equal to the return on financial assets. This return is computed as the *Personal income receipts on assets* (BEA Table 2.1) divided by total *financial assets* (Flow of Funds) net of *equity in noncorporate business* (Flow of funds).

4. As above, the **labor input** is the annual aggregate amount of time (measured in hours) spent on household work by individuals aged between 15-64 years. This variable is computed in the same way as above.

5. The return on the labor input **w** is computed as above as the *Compensation of private HH workers* (BEA 6.2) divided by the *FTE private HH workers thousands* (BEA 6.5).

Step 2: Compute constant-price home value added. We use the same price index as above and it is computed using the following final expenditure categories: *Food and nonalcoholic beverages purchased for off-premises consumption*, *Food produced and consumed on farms*, *Garments*, *Household supplies*, *Outpatient services*, *Hospital and nursing home services*, *Motor vehicle services*, *Ground transportation*, *Purchased meals and beverages*, *Nursery, elementary, and secondary schools*, *Personal care and clothing services*, *Social services and religious activities*, *Household maintenance*. The data is taken from BEA tables 2.4.3 and 2.4.5.

Appendix B: First–order Conditions for an Interior Solution to the Household Problem

The Lagrangian to the household problem is as follows:

$$\mathcal{L} = \sum_{t=0}^{\infty} \beta^t \Bigg\{ \alpha_u \log(C(t) - \bar{C}) + (1-\alpha_u)\log(L(t)) + \eta_c(t)\Big(\Big[\alpha_c C_m(t)^{\sigma_c} + (1-\alpha_c) C_h(t)^{\sigma_c}\Big]^{\frac{1}{\sigma_c}} - C(t)\Big)$$
$$+ \eta_h(t)\Big(\Big[\alpha_h K_h(t)^{\sigma_h} + (1-\alpha_h)(A_h(t)H_h(t))^{\sigma_h}\Big]^{\frac{1}{\sigma_h}} - C_h(t)\Big)$$
$$+ \lambda(t)\Big[[1-\tau_w(t)]w(t)H_m(t) + [1-\tau_r(t)]r(t)K_m(t) + T(t) - C_m(t) - p_h(t)X_h(t) - [1+\tau_x(t)]p_m(t)X_m(t)\Big]$$
$$+ \phi_m(t)\Big[(1-\delta_m)K_m(t) + X_m(t) - K_m(t+1)\Big] + \phi_h(t)\Big[(1-\delta_h)K_h(t) + X_h(t) - K_h(t+1)\Big]$$
$$+ \mu(t)\Big[1 - L(t) - H_m(t) - H_h(t)\Big]\Bigg\}$$

The first–order conditions to household's problem stated in the body of the paper are given by (8)–(9) and

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial C(t)} &: \quad 0 = \frac{\alpha_u}{C(t) - \bar{C}} - \eta_c(t) \\
\frac{\partial \mathcal{L}}{\partial L(t)} &: \quad 0 = \frac{1-\alpha_u}{L(t)} - \mu(t) \\
\frac{\partial \mathcal{L}}{\partial C_m(t)} &: \quad 0 = \eta_c(t) C(t)^{1-\sigma_c} \alpha_c C_m(t)^{\sigma_c - 1} - \lambda(t) \\
\frac{\partial \mathcal{L}}{\partial C_h(t)} &: \quad 0 = \eta_c(t) C(t)^{1-\sigma_c} (1-\alpha_c) C_h(t)^{\sigma_c - 1} - \eta_h(t) \\
\frac{\partial \mathcal{L}}{\partial H_m(t)} &: \quad 0 = \lambda(t)[1-\tau_w(t)]w(t) - \mu(t) \\
\frac{\partial \mathcal{L}}{\partial H_h(t)} &: \quad 0 = \eta_h(t) C_h(t)^{1-\sigma_h} (1-\alpha_h) A_h(t)^{\sigma_h} H_h(t)^{\sigma_h - 1} - \mu(t) \\
\frac{\partial \mathcal{L}}{\partial X_m(t)} &: \quad 0 = -\lambda(t)[1+\tau_x(t)]p_m(t) + \phi_m(t) \\
\frac{\partial \mathcal{L}}{\partial X_h(t)} &: \quad 0 = -\lambda(t) p_h(t) + \phi_h(t) \\
\frac{\partial \mathcal{L}}{\partial K_m(t+1)} &: \quad 0 = -\phi_m(t) + \beta\Big(\lambda(t+1)\Big\{[1-\tau_r(t+1)]r(t+1) + \tau_x(t+1)p_m(t+1)\delta_m\Big\} + \phi_m(t+1)(1-\delta_m)\Big) \\
\frac{\partial \mathcal{L}}{\partial K_h(t+1)} &: \quad 0 = -\phi_h(t) + \beta\Big(\eta_h(t+1) C_h(t+1)^{1-\sigma_h} \alpha_h K_h(t+1)^{\sigma_h - 1} + \phi_h(t+1)(1-\delta_h)\Big)
\end{aligned}$$

Appendix C: Derivations for Section 5.2

Without capital, the household problem simplifies to:

$$\max\ \alpha_u \log(C-\bar{C}) + (1-\alpha_u)\log(L)$$
$$\text{s.t. } C = (\alpha_c C_m^{\sigma_c} + (1-\alpha_c) C_h^{\sigma_c})^{\frac{1}{\sigma_c}}, \quad C_m = (1-\tau_w) w H_m + T, \quad 1 = L + H_m + H_h, \quad C_h = A_h H_h$$

The Lagrangian is:

$$\begin{aligned}\mathcal{L} =& \alpha_u \log(C-\bar{C}) + (1-\alpha_u)\log(L) + \eta_c \left[C - (\alpha_c C_m^{\sigma_c} + (1-\alpha_c) C_h^{\sigma_c})^{\frac{1}{\sigma_c}}\right] \\ &+ \eta_h \left[A_h H_h - C_h\right] + \lambda \left[(1-\tau_w) w H_m + T - C_m\right] + \mu \left[1 - L - H_m - H_h\right]\end{aligned}$$

The first–order conditions are:

$$\frac{\partial \mathcal{L}}{\partial C}: \quad \frac{\alpha_u}{C-\bar{C}} = \eta_c \tag{20}$$
$$\frac{\partial \mathcal{L}}{\partial L}: \quad \frac{1-\alpha_u}{L} = \mu \tag{21}$$
$$\frac{\partial \mathcal{L}}{\partial C_m}: \quad \eta_c C^{1-\sigma_c} \alpha_c C_m^{\sigma_c - 1} = \lambda \tag{22}$$
$$\frac{\partial \mathcal{L}}{\partial C_h}: \quad \eta_c C^{1-\sigma_c} (1-\alpha_c) C_h^{\sigma_c - 1} = \eta_h \tag{23}$$
$$\frac{\partial \mathcal{L}}{\partial H_m}: \quad \lambda (1-\tau_w) w = \mu \tag{24}$$
$$\frac{\partial \mathcal{L}}{\partial H_h}: \quad \mu = \eta_h A_h \tag{25}$$

To derive (18), we rewrite (22)–(23) as:

$$\eta_c C^{\frac{1}{\epsilon_c}} \alpha_c C_m^{-\frac{1}{\epsilon_c}} = \lambda \tag{26}$$
$$\eta_c C^{\frac{1}{\epsilon_c}} (1-\alpha_c) C_h^{-\frac{1}{\epsilon_c}} = \frac{\mu}{A_h} = \lambda \frac{(1-\tau_w) w}{A_h} = \lambda p_h \tag{27}$$

Next, we raise each of these equations to the power $1-\epsilon_c$ and rearrange:

$$\eta_c^{1-\epsilon_c} C^{\frac{1-\epsilon_c}{\epsilon_c}} \alpha_c C_m^{-\frac{1-\epsilon_c}{\epsilon_c}} = \lambda^{1-\epsilon_c} \alpha_c^{\epsilon_c}$$
$$\eta_c^{1-\epsilon_c} C^{\frac{1-\epsilon_c}{\epsilon_c}} (1-\alpha_c) C_h^{-\frac{1-\epsilon_c}{\epsilon_c}} = \lambda^{1-\epsilon_c} (1-\alpha_c)^{\epsilon_c} p_h^{1-\epsilon_c}$$

Adding these two equations and raising the result to the power of $1/(1 - \epsilon_c)$ gives us:

$$\eta_c = \lambda P$$

Using this equations and the first–order conditions from above, we obtain a consolidated first–order condition for the allocation of C and L:

$$(1 - \alpha_u)P(C - \bar{C}) = \alpha_u(1 - \tau_w)wL \tag{28}$$

In order to obtain the closed–form solution (18), we need to bring in the budget constraints of the government and the households. Combining them gives:

$$wH_m = C_m$$

Adding $p_h C_h$ on each side and using that $p_h C_h = (1 - \tau_w)wH_h$, we get:

$$w(1 - L) - \tau_w w H_h = C_m + p_h C_h \tag{29}$$

The next step is to show that:

$$C_m + p_h C_h = PC$$

We begin by rewriting (26)–(27) to:

$$\begin{aligned} C^{\frac{1}{\epsilon_c}} \alpha_c C_m^{\frac{\epsilon_c - 1}{\epsilon_c}} &= \frac{\lambda}{\eta_c} C_m \\ C^{\frac{1}{\epsilon_c}} (1 - \alpha_c) C_h^{\frac{\epsilon_c - 1}{\epsilon_c}} &= \frac{\lambda}{\eta_c} p_h C_h \end{aligned}$$

Adding these two equations and using (17) gives:

$$C^{\frac{1}{\epsilon_c}} C^{\frac{\epsilon_c - 1}{\epsilon_c}} P = CP = C_m + p_h C_h \tag{30}$$

Combining (29)–(30), we find:

$$w(1 - L) - \tau_w w H_h = PC \tag{31}$$

Equations (28) and (31) imply the closed–form solution (18) for leisure that we used in the main text.