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# Taxes, Social Subsidies, and the Allocation of Work Time[†]

*By* L. Rachel Ngai and Christopher A. Pissarides*

*We examine the allocation of hours of work across industrial sectors in OECD countries. We find large disparities across three sector groups, one that produces goods without home substitutes, and two others that have home substitutes but are treated differently by welfare policy. We attribute the disparities to the countries' tax and subsidy policies. High taxation substantially reduces hours in sectors that have close home substitutes but less so in other sectors. Subsidies increase hours in the subsidized sectors that have home substitutes. We compute these policy effects for 19 OECD countries.* (*JEL* H24, H31, J22)

There are large differences in the kind of jobs that people do across the industrial countries of the Organisation for Economic Co-operation and Development (OECD). To illustrate the point, we report in Table 1 the percentage distribution of hours of work in three countries with different taxes and social support programs: the United States, Japan, and Sweden.[1] Hours of work are sorted into three groups according to whether or not the output of an industry has close substitutes in home production. Sector 1 comprises agriculture, manufacturing, business services, and other services of a specialized nature, which are activities that have no counterpart in home production, as reported in time use surveys.[2] Sector 2 is the health and social work sector, which has home counterparts, especially in family care. Sector 3 consists of all other sectors, which produce less specialized services and have close substitutes in home production, such as retailing (a substitute for shopping time) and catering (a substitute for cooking time).

* Ngai: London School of Economics, Centre for Economic Performance, Houghton Street, London WC2A 2AE, and Centre for Economic Policy and Research (e-mail: l.ngai@lse.ac.uk); Pissarides: London School of Economics, Centre for Economic Performance, Houghton Street, London WC2A 2AE, and Centre for Economic Policy and Research (e-mail: c.pissarides@lse.ac.uk). We have benefited from many comments received in seminar and conference presentations. Wouter den Haan, Philippe Aghion, and Zvi Hercowitz acted as discussants at three of these conferences, and we are grateful for their comments. We thank our research assistants, Eva Vourvachaki, Katrin Tin, Urban Sila, and Milan Lisicky, and the Centre for Economic Performance, a designated research center of the Economic and Social Research Council at LSE, for financial support.

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[1] Our aggregate is economy-wide hours of work excluding public administration, defense, and education. A discussion of the data for all the countries, including social support programs and their differences, is contained in the main body of the paper. For more information on social programs see Gøsta Esping-Andersen (1990, 1999).

[2] In Ngai and Pissarides (2008) we discuss in detail the kind of activities spent in home production and review their historical development. The sector allocations that we are adopting here are consistent with that evidence. See also John P. Robinson and Geoffrey Godbey (1997) for the United States and Michael C. Burda, Daniel S. Hamermesh, and Philippe Weil (2008) for cross-country comparisons.

Table 1—Percentage Distribution of Hours of Market Work in Three Countries (*Average*, 1994–2003)

| Sector | United States | Japan | Sweden |
|---|---|---|---|
| 1 | 63 | 62 | 63 |
| 2 | 10 | 6 | 17 |
| 3 | 27 | 31 | 21 |

*Notes:* The full definition of sectors is given in Table 3. Sector 1 is mainly manufacturing and business services. Sector 2 is health and social work, and sector 3 is mainly unskilled or semi-skilled services. Government administration and education are excluded.

The share of sector 1 is very similar across the three countries, taking up about 63 percent of market work. In contrast, there are large differences in the shares of the other two sectors. Sweden has a relatively larger health and social work sector, whereas Japan has the largest share in sector 3, exceeding the Swedish share of this sector by 10 percentage points. Why these large differences in the allocation of work time?

We argue that the key reason for these large differences is policy associated with the welfare state. Taxes and subsidies influence allocations along two dimensions. Consumers switch from taxed goods to subsidized ones and from buying services in the market to self-help at home. We compute tax and subsidy rates for 19 OECD countries for each one of the three sectors in Table 1, and show that all countries subsidize health and social work, but Sweden and other Scandinavian countries subsidize them much more than other countries do. The tax differentials between social work on the one hand, and all other economic activity on the other hand, vary a lot across countries, and this could explain sectoral differences across countries through the substitution from other market-produced goods into health and social care services.

We calculate how much is this substitution given reasonable elasticity estimates, and find that quantitatively it is small. For example, when an accountant's services are taxed and a childminder's services subsidized, a family may hire an accountant for fewer hours and take the child to a child care center, but the elasticity of substitution between the services of an accountant and the services of a childminder is not large enough to support the required quantitative impact. Moreover, since sectors 1 and 3 are taxed at the same rate and neither is subsidized, cross-market substitutions cannot explain why the substitution is mainly from sector 3 into health and social work, and not from both of the other sectors.

In order to explain the big quantitative impact of tax subsidy programs and the asymmetric response of different sectors, we need the substitution between market and home production. When market goods and services are taxed, households turn to producing some of those goods in the home, where work is untaxed. Similarly, when market-provided social care is subsidized, less of it is done at home and there is more take-up of social services in the market. Some market-produced goods have close substitutes in home production, and so their response to the tax or subsidy is large. Other goods have less good substitutes in home production, implying lower response. The differential substitutions between market and home production, when combined with the differential tax treatment of social work, drive our results.

We are not the first ones to study the impact of taxes and subsidies and market-home substitutions on market economic activity. But we believe that we are the first to study the impact of different net taxes across sectors and derive the implied equilibrium allocation of market work. At the micro level, Richard B. Freeman and Ronald Schettkat (2005) study time-use data for a small number of countries and conclude that there is virtually one-for-one substitution between home and market work across individuals, a claim that was partially supported by Burda, Hamermesh, and Weil (2008). Our results require substantial market-home substitutions at the micro level, and they are consistent with one-for-one substitutions for some goods. Also at the micro level, although emphasizing sectoral differences, Steven J. Davis and Magnus Henrekson (2005) study questions similar to ours in a partial equilibrium task-assignment model. They estimate the impact of taxation on employment in three sectors of economic activity: eating and drinking establishments, lodging, and retail trade.[3] Their estimation results are consistent with the results of our model.

The macro literature has focused on total hours of work, a topic that we do not address. A main motivation for the macro literature is the reconciliation of high taxation with high participation in Scandinavian countries, which goes against the predictions of Edward C. Prescott's (2004) influential study. The claim made in the more recent literature, consistent with our analysis, is that it is not only taxes that matter, but also how the tax revenue is spent. Prescott effectively assumed that all tax revenue is returned to the public as a lump sum transfer. Lump sum transfers have income effects but no substitution effects, so taxes in his model have their maximum impact on hours of work. But if some of the tax revenue is returned as a consumption subsidy, the tax distortion is reduced. Richard Rogerson (2007) illustrates how the impact of taxes on hours of work in a standard model varies according to the assumptions made about the distribution of tax revenue. He argues that the Scandinavian "outlier" could potentially be explained by a larger consumption subsidy given by Scandinavian countries.

Kelly S. Ragan (2010) goes one step further and calculates the consumption subsidy for purchasing market services related to child care and elderly care. In that respect her study is similar to ours. She uses the computed subsidy to calculate its impact on the choice between total home and total market work, making use of a variant of Sherwin Rosen's (1997) model. She derives a weaker effect of general taxation on total market hours in Scandinavia because of a bigger subsidy in that group of countries. We study its impact at the level of a finer sector decomposition. Because of the aggregative focus of her work, she applies the consumption subsidy to market substitutes of all home production. We disaggregate market substitutes of home production into those that are subsidized and those that are not, and compute a net tax wedge for each sector.

Total hours of work in Sweden and how they compare with the United States is also the focus of Conny Olovsson (2009), who notes that the sum of market and home hours in Sweden and the United States is about the same, but market hours in the

[3] They deliberately omit child care because of difficulties in constructing comparable subsidy rates across the countries in their sample, one of the challenges that we take up in this paper. Their sample of countries for the employment regressions varies between 9 and 14 countries, depending on data availability.

United States account for a bigger fraction of the total. He calibrates whole economy models for the two countries and shows that the differences in time allocations are explained by the higher taxation of market work in Sweden. Rogerson (2008) is another study that emphasizes the distortionary impact of taxes because of the market-home substitution. He uses his model to derive the change in total hours of work in services between 1956 and 2003 in an aggregate of five continental European countries, and compares the outcome with the United States. He shows that the bulk of the difference can be explained by the bigger rise in taxes in Europe over this period.

Because of the important role of the disbursement of tax revenue, the authors who studied total hours of work are forced to make some strong assumptions about it. For example, like Prescott (2004), Rogerson (2008) assumes that all tax revenue is returned to consumers as a lump sum. Olovsson (2009) explores different assumptions, one of which assumes that some tax revenue is used up by the government to finance its own consumption. Moreover, in order to obtain their results, these authors also assume that the government balances incomes and revenues every period, a strong assumption for cross-country comparisons, where debt and deficit levels vary substantially. In contrast, in our study of the allocations across sectors, we do not need to make any assumptions about the use of net tax revenue (gross taxes net of social subsidies), or the government budget, to obtain our results. We consider this to be an important advantage of our work over the studies of whole economy hours. Our sample of 19 countries is also a much bigger number than in most previous studies, despite the bigger disaggregation that we do.[4]

The key to our model are two elasticities of substitution: the one between market goods and the one between market and home production. We show that general taxation has a greater impact on sector 3, services with home substitutes, than on sector 1, whose output has no home substitutes, because sector 3 loses more hours to the untaxed home sector. But health and social care is subsidized, so market hours gain both from the home sector (if the subsidy is large enough to outweigh the impact of the income tax) and from the other two nonsubsidized sectors.[5]

In order to quantify our predictions, we need three different types of data.[6] First, we need to know the hours of work allocated to different sectors, which are available for a fairly large number of countries at the two-digit level through the database *Productivity in the European Union: A Comparative Industry Approach* (EU KLEMS). Second, we need the size of social expenditure on benefits in kind, such as day care centers, which can be obtained from the OECD *Social Expenditure Database* (SOCX). Finally, we need to know the hours allocated to different activities at home, which we obtain from time-use surveys. We constructed comparable datasets for 19 OECD countries, and we focus on cross-country differences around the time of the time-use surveys, circa 2000. These countries include several European countries from Scandinavia to the

[4] The papers on total hours disaggregate, at best, between all services and manufacturing. A pioneering discussion of the differential impact of policy on the allocation of work in Sweden is contained in Assar Lindbeck (1982). See also Lindbeck (1997) for a more detailed discussion of the Swedish welfare state and its role in the economy.

[5] Unfortunately, it is not possible to distinguish between high-skill health care, e.g., surgery, and social work, such as child care centers or elderly care. Ideally, our sector 2 should exclude high-skill health care that has no home substitutes.

[6] See the online Appendix for a full listing of data sources and definitions.

Mediterranean, the United States, Canada, Australia, New Zealand, Japan, and Korea, so we have a good mix of tax and subsidy regimes.

Section I describes our model of three market and two home sectors. We derive equilibrium allocations as functions of three sets of parameters, preferences, technology, and policy. In Section II, we describe the relevant data for the 19 countries in our sample and summarize their main features. In Section III, we give the parameter values used in the quantitative evaluation of the impact of policy. The quantitative evaluation begins with Section IV, where we illustrate the workings of the model within the policy parameter range calculated in the data section, and refer back to the example of Table 1. Predictions with the full sample are given in Sections V, VI, and VII, beginning with cross-market substitutions and following up with substitutions between market and home production.

## I. The Model

*Consumer Allocations.*—We solve the time allocations for a representative agent who has a static CES utility function defined over consumption goods produced at home and in the market, and over leisure. She is a price and wage taker in the market, conditional on taxes and transfers chosen by the government, and chooses home production conditional on linear production functions. There is no capital in the model, so it can be solved as a static resource allocation problem, with linear production functions for market goods as well, and market clearing throughout. There are no profits in equilibrium and all income is in the form of wages.

The representative agent's utility function is

$$U(c, l_m, l_h) = \ln c + v(1 - l_m - l_h), \tag{1}$$

where $c$ is a consumption aggregate; $l_m$ is market work (private and government); and $l_h$ is home work. $v(\cdot)$ is an increasing concave function. Aggregate consumption is a CES aggregate of three types of goods, denoted by $\tilde{c}_i$,

$$c = \left[\sum_{i=1}^{3} \omega_i \tilde{c}_i^{(\varepsilon-1)/\varepsilon}\right]^{\varepsilon/(\varepsilon-1)}, \tag{2}$$

where $\varepsilon \geq 0$ is the constant elasticity of substitution, and $\omega_i > 0$, $\sum \omega_i = 1$. Each $\tilde{c}_i$ is a composite of market-produced and home-produced goods in sector $i$. Sector 1 is comprised of all goods that have no home-produced substitutes, so $\tilde{c}_1$ is the market good $c_1$. In sectors 2 and 3, $\tilde{c}_i$ is a CES aggregate of market- and home-produced goods,

$$\tilde{c}_i = \left[\psi_i c_i^{(\sigma_i-1)/\sigma_i} + (1 - \psi_i) c_{ih}^{(\sigma_i-1)/\sigma_i}\right]^{\sigma_i/(\sigma_i-1)} \qquad i = 2, 3, \tag{3}$$

where $c_i$ is market-produced consumption; $c_{ih}$ is consumption of goods produced at home; $\sigma_i \geq 0$ is the elasticity of substitution between home and market consumption for each good $i$; and $\psi_i \in (0, 1)$.

Government taxes wage income at rate $\tau$ and each market good at a net rate $t_i$ (the gross tax rate less any subsidy). It also taxes or subsidizes employment at a rate $t_e$. It uses its net revenue from the taxes and subsidies to employ labor, supply goods to consumers, or consume other goods. We assume that the product of public administration is a public good that is separable from the goods included in the aggregate $c$. We also exclude education services from $c$ because they are not a final consumption good but an investment good. The employment used to produce the public good and education is part of $l_m$.

We do include health and social care in $c$. This is because our focus is on social care, which is clearly a consumption good that can be produced both at home and in the market. The amount of health services consumed by the representative agent is also a matter of consumption decisions, depending on the cost to the individual. Health and social care are subsidized by the government, either directly through the provision of subsidized care or through transfers. We treat the subsidy as a negative tax, with the individual having free choice over the quantity that she consumes at the subsidized price.

Governments also make lump sum transfers $T$ to the representative agent. Part of the lump sum transfer is a component of social policy, like, for example, transfers to families with children. But lump sum transfers also include tax revenue not used to subsidize consumption of certain goods or employ labor. We briefly return to this topic below.

The disutility from work is independent of sector or location, and there is perfect labor mobility. The wage rate is the same in all sectors, so the budget constraint on the consumption of market goods is

$$\sum_{i=1}^{3} (1 + t_i) p_i c_i \leq (1 - \tau) w l_m + T. \tag{4}$$

The consumption of home goods is constrained by the linear production functions

$$c_{jh} \leq A_{jh} l_{jh}, \quad j = 2, 3, \tag{5}$$

where $l_{jh}$ is the time allocated at home to each activity $j$; and $A_{jh}$ is labor productivity in each activity.

In order to solve the problem, it is convenient to define a new budget constraint for total work $l \equiv l_m + l_h$ that incorporates the production constraints (5). Define "total" after-tax income by $(1 - \tau)wl$, and make use of it and (5) to rewrite (4) as

$$\sum_{i=1}^{3} (1 + t_i) p_i c_i + \sum_{j=2}^{3} p_{jh} c_{jh} \leq (1 - \tau) w l + T, \tag{6}$$

where $p_{jh} \equiv (1 - \tau)w/A_{jh}$ is a net implicit (producer) price for home-produced goods. The numerator is the net wage that the household could get by supplying one unit of labor to the market, and the denominator is the number of units of the home good that she could get by supplying the same unit to home production.

The consumer problem is the maximization of (1)–(3) subject to the single constraint (6). From the optimality conditions, we derive some key results.

*Total Work Hours.*—The first-order maximization conditions yield the following result for total hours of work, $l$:

$$\frac{1}{v'(1-l)} - l = \frac{T}{(1-\tau)w}. \tag{7}$$

In the absence of lump sum transfers, total work depends only on preference parameters because of the logarithmic utility of aggregate consumption. The supply of hours to the market then varies only to the extent that there are substitutions between home and market production (which we call, following Freeman and Schettkat (2005), "marketization" ). In Ngai and Pissarides (2008), we showed that such substitutions can give nontrivial labor supply dynamics, driven by the dynamics of technology. But if there are implicit or explicit lump sum transfers, both the dynamics and cross-sectional properties of the supply of labor become richer, because now there are two substitution margins, the one for overall leisure and marketization. In general, the bigger the lump sum transfer, the stronger the impact of taxation on market work.

Cross-country studies of differences in total hours make use of an equation like (7) to derive their quantitative conclusions. The usual approach, however, is not to compute $T$ directly, but to assume that the government balances its budget with an appropriate choice of $T$ and no borrowing. $T$ is then substituted out of (7) from the budget constraint, leaving only taxes in it (see e.g., Prescott 2004; Rogerson 2008; and Ragan 2010). This implicitly treats all tax revenue (in Ragan's case net of social subsidies) as a lump sum transfer. Government consumption that is not a close substitute for private consumption and the government's administrative wage bill, which is paid conditional on market work, is not accounted for in these studies. This omission, and the assumption that the budget is balanced across countries in the year of the study, casts doubts on this approach to the treatment of the lump sum transfer. In this paper, we do not address the question of the impact of taxation on the total number of hours of work, and, as we show next, this gets rid of the lump sum transfer from our equations, obviating the need to make assumptions about its measurement.

*Market Shares.*—We make predictions about the allocation of market work by computing the market share of each sector, defined by $s_j = 100 l_j / \sum_{i=1}^{3} l_i$. Given the structure of the model, it is convenient to derive these predictions from the model's predictions of the ratios $l_2/l_1$ and $l_3/l_1$ by rewriting the shares as

$$s_j = 100 \frac{l_j/l_1}{\sum_{i=1}^{3} l_i/l_1} \qquad j = 1, 2, 3. \tag{8}$$

To make these predictions, we therefore need to derive expressions for just two ratios of hours of work, $l_2/l_1$ and $l_3/l_1$. We do this in three steps.

*Marketization.*—The composite good $\tilde{c}_j$ can be acquired by buying some $c_j$ from the market at price $(1 + t_j)p_j$, or by producing it at home as $c_{jh}$ at a (shadow) unit cost $p_{jh}$. We define "marketization" as the substitution of one unit of $c_j$ for $c_{jh}$. The extent of marketization is obtained by setting the marginal rate of substitution across goods $c_j$ and $c_{jh}$ equal to their relative prices:

$$\frac{c_j}{c_{jh}} = \left(\frac{\psi_j}{1-\psi_j}\,\frac{p_{jh}}{(1+t_j)p_j}\right)^{\sigma_j} \quad j = 2, 3. \tag{9}$$

Recalling that $p_{jh} = (1 - \tau)w/A_{jh}$, it follows that consumers marketize more of good $j$ if they have higher net wages, if the market good is cheaper, or if labor productivity in home production is lower. The impact of these parameters depends on the elasticity of substitution between market and home goods. In the limit, as $\sigma_j \to 0$, the two types of goods are consumed in fixed proportions. But, for $\sigma_j > 0$, there can be a lot of differences in the marketization of home production across individuals, countries, or over time, depending on the values taken by taxes and market prices.

*Relative Demand for Market Goods.*—We next solve for the ratio of real demand for market goods 2 and 3, which have home substitutes, to the demand for good 1. The objective is to obtain from these ratios the employment shares in each sector of market activity. Setting the marginal rate of substitution across good $j$ and good 1 equal to their relative price, we obtain

$$\frac{c_j}{c_1} = \left(\frac{\omega_j\psi_j}{\omega_1}\right)^{\varepsilon}\left(\frac{(1+t_j)p_j}{(1+t_1)p_1}\right)^{-\varepsilon}\left(\frac{c_j}{\tilde{c}_j}\right)^{1-\varepsilon/\sigma_j}. \tag{10}$$

We note that $c_j/\tilde{c}_j$ is the share of good $j$ that is marketized. It follows that the relative market demand for good $j$ is a decreasing function of its relative consumer price and, under the plausible restriction $\varepsilon \leq \sigma_j$, an increasing function of the degree of its marketization. Marketization is an important channel through which policy influences relative market shares. Higher and uniform taxes on all goods (i.e., $t_j = t_1$) do not affect relative consumption shares for given marketization, but they imply less marketization for good $j$, and so a lower market share for this good, relative to the market share of good 1.

*The Sectoral Allocation of Time.*—In order to derive the market employment shares, we make use of market clearing and the production functions for each market good. Let the production functions be

$$c_i \leq A_i l_i, \quad i = 1, 2, 3. \tag{11}$$

The notation parallels that for home production, with $A_i$ standing for the (market) labor productivity of good $i$ and $l_i$ for the number of hours allocated to it.

The net revenue to the firm from the sale of good $i$ is $p_i A_i l_i$, and is used to pay for wages and employment taxes net of subsidies. Free mobility of labor implies that wages

are the same in all market sectors, so if employment taxes are also the same across sectors, relative producer prices are given by the ratio of the technology parameters:

$$(12) \qquad (1 + t_e) w l_i = p_i A_i l_i \Rightarrow \frac{p_i}{p_j} = \frac{A_j}{A_i}, \qquad i, j = 1, 2, 3.$$

The relative price of the market good to the implicit price of the home good is also obtained from (12), by substituting $w$ from it into the condition $p_{jh} = (1 - \tau) \times w/A_{jh}$. This substitution yields

$$(13) \qquad \frac{(1 + t_j)p_j}{p_{jh}} = \frac{(1 + t_j)(1 + t_e)A_{jh}}{(1 - \tau)A_j}.$$

We define the "tax wedge" that applies to sector $j$, denoted $t_{wj}$, by[7]

$$(14) \qquad t_{wj} = 1 - \frac{1 - \tau}{(1 + t_j)(1 + t_e)}.$$

With the linear production functions and the relative prices just obtained, the marketization condition (9) translates into the following condition for the marketization of time in sector $j$:

$$(15) \qquad \frac{l_j}{l_{jh}} = \left(\frac{1}{\psi_j} - 1\right)^{-\sigma_j} \left(\frac{A_j}{A_{jh}}\right)^{\sigma_j - 1} (1 - t_{wj})^{\sigma_j} \qquad j = 2, 3.$$

The marketization of time is driven by three sets of parameters: preferences, productivity, and taxes. For $\sigma_j > 1$, more is marketized when market productivity is higher than home productivity.[8] More importantly for our present objectives, the impact of policy is summarized in a single composite, the tax wedge. A higher tax wedge leads to less marketization, and the impact is bigger when the elasticity $\sigma_j$ is bigger.

Turning now to market sectors, we derive the employment ratios of sectors from (10) and the linear production functions

$$(16) \qquad \frac{l_j}{l_1} = \left(\frac{\omega_j \psi_j}{\omega_1}\right)^{\varepsilon} \left(\frac{A_1}{A_j}\right)^{1-\varepsilon} \left(\frac{1 + t_j}{1 + t_1}\right)^{-\varepsilon} \left(\frac{c_j}{\tilde{c}_j}\right)^{1-\varepsilon/\sigma_j}.$$

Calculating $c_j/\tilde{c}_j$ from (3), (9), and (13), we obtain

$$(17) \qquad \frac{c_j}{\tilde{c}_j} = \psi_j^{-\sigma_j/(\sigma_j - 1)} \left[1 + \left(\frac{1}{\psi_j} - 1\right)^{\sigma_j} \left(\frac{A_{jh}}{A_j(1 - t_{wj})}\right)^{\sigma_j - 1}\right]^{-\sigma_j/(\sigma_j - 1)}.$$

[7] For small tax rates this is approximately equal to the tax wedge used in econometric studies, $t_{wj} = \tau + t_j + t_e$, but taxes in our sample of countries are not small, and the approximation is not good.

[8] To see the intuition, suppose the goods are perfect substitutes, then $\sigma_j \to \infty$ and all production moves to the more productive location. If $\sigma_j = 0$, the same quantity of each good needs to be produced and consumed, and so more labor is employed in the less productive location to compensate for the higher productivity in the other location.

Equation (16) is a key equation for the model because it gives the dependence of the allocation of time on policy.

Policy influences employment shares in two ways. First, for given marketization of consumption, policy influences market shares because of nonuniform taxation associated with social subsidies. If $t_j < t_1$, as would be the case if sector $j$ is subsidized and sector 1 is not, the relative employment of sector $j$ for given marketization is higher, because of a switch of demand from the taxed sector to the subsidized one. The extent of this switch depends on the elasticity of substitution across market goods, $\varepsilon$.

Second, policy influences the relative size of sectors because of the substitutions between home and market production. In a general equilibrium, there is a switch of hours of work from the taxed market sector to the untaxed home sector that produces close substitutes. This distortion works even if two sectors are equally taxed ($t_j = t_1$), because sectors with closer home substitutes suffer bigger losses of demand and employment than sectors with less good home substitutes. From (16), it is clear that the condition for this intuition to go through is $\varepsilon/\sigma_j < 1$; that is, that the elasticity of substitution between home and market goods should be bigger than the elasticity of substitution across market goods.

The model makes strong predictions about two features of sectoral allocations that can be confronted with data. First, the relative employment shares in (16) depend on expenditure tax differentials and on market-home substitutions. Second, the marketization in (15) depends on the tax wedge applying to the sector. We now discuss the data needed to quantify these two predictions.

## II. Data Derivation and Description

Time-use surveys have proliferated recently, but with very minor exceptions they are still mainly one-off surveys that follow similar principles across countries and over time. The United States began an annual survey in 2003, and the European Union is in the process of setting up Europe-wide standards for regular surveys across the European Union. However, for the purposes of this study, we are restricted to a small number of surveys. We selected one survey for as many countries of the OECD as we could find, undertaken as close to the turn of the millennium as possible. For most countries, this was the only available information. We used time-use surveys to extract time spent in home production in sectors 2 and 3 of the model, as detailed below.

Time-use surveys, however, despite very detailed reporting of the kind of activities done away from the market, do not report the industrial breakdown of market hours. The source of the industrial breakdown of hours of work that is comparable across countries is the EU KLEMS database, which is employer-based. We use this survey to get the percentage distribution of total market hours across the model's three sectors and the absolute number of hours in sectors 2 and 3. The absolute number of hours in each sector is needed only in the marketization equations of these two sectors.

We grouped the EU KLEMS two-digit sectors into the model's three sectors according to the classifications in Table 2. The market activities in the subsectors

TABLE 2—THE THREE SECTORS OF MARKET WORK

| Production and business services | | Health | Other services |
|---|---|---|---|
| Agriculture and allied | Wholesale trade | Health and social work | Sale, motor repairs retail trade |
| Mining and quarrying | Air transport, post, and telecom | | Hotels and restaurants |
| Manufacturing | Finance, insurance, real estate, and business services | | Inland transport, water transport, auxiliary transport |
| Gas, electricity, water | Membership organizations, media activities | | Refuse disposal recreational, other personal |

*Notes:* All economic sectors in EU KLEMS are included except for public administration, defense and compulsory social security (L), and education (M). The very small sector private households with employed persons (P) is also excluded from the analysis because of apparent inconsistencies in the data.

included in sector 3 broadly correspond to the home-production activities reported in time-use surveys, e.g., hours of work in the retail sector correspond to time spent shopping in time-use surveys, restaurants match time spent cooking, etc.

For sector 2, all time-use surveys report hours of child care, which is a close substitute for market-based child care, and most also report a smaller number of hours for care of other dependents. We were able to construct for all countries an estimate of total care done at home, including child and adult care. The equivalent market sector is health and social work, which includes the number of hours worked in child care centers, adult homes, and public and private hospitals. Given that time use surveys do not report time allocated to medical care in the home, ideally we would have wanted to split the market sector into two: one for health services such as hospital treatment, which has no home substitutes; and one for caring services, with home substitutes. However, this is not possible with the available datasets, so we treat the aggregate of health and social work as the market activity, with child care and adult household care as its close home substitute. The overall figure for adult care is small, amounting, on average, to 16 percent of total care, so our home production time for care is dominated by child care time.

Government employment and education are excluded from the analysis.[9] Our aggregate economy is made up of the sectors listed in Table 2, and we study the determinants of the distribution of work among the three sectors of this economy.

The average shares of each of our three sectors for the last ten years of the sample are shown in Figure 1. The acronyms are the first two letters of the country name throughout this paper. Sector 1 is the biggest sector in all countries, but the most interesting fact that emerges from this figure is that despite its size, the cross-sectional variation in the share of sector 1 is less than that in the other two sectors. We show below that this is a key prediction of our model.

The largest shares of sector 2 hours are in the four Scandinavian countries, and the smallest in the two Mediterranean and two Asian countries covered by the sample.

[9] One could argue that medical treatment should be excluded too, as it has many common features with education (government support, investment in human capital, etc.). But this is not possible with the data at our disposal.

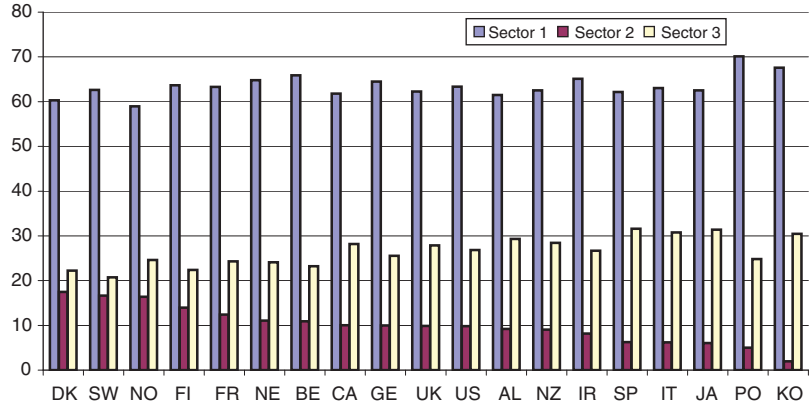


FIGURE 1. PERCENTAGE DISTRIBUTION OF HOURS OF WORK, 1994–2003, SORTED ACCORDING TO SECTOR 2 SIZE

Although naturally no country is exactly the same as another in its treatment of welfare, there are country clusters with broadly similar policies that correspond to the rankings in Figure 1 (see Esping-Andersen 1990, 1999).[10] The Scandinavian countries have the highest levels of overall taxation, but they use a large part of the revenue to subsidize market-based social services. They have the largest sector 2 share. Next come the continental European countries, which also have high taxation and heavily subsidize social services, but not to the extent of the Scandinavian countries. Anglo-Saxon countries have generally lower taxation and welfare transfers, so they have relatively larger sectors 1 and 3, and correspondingly a smaller sector 2 share. Finally, southern European countries do not give support to market-based social care and have the smallest relative size for sector 2. Japan and Korea are in line with southern European countries with no subsidy to market-based social care.

Policy is characterized by three types of instruments: taxes, health and social care subsidies, and lump sum transfers. Lump sum transfers are not relevant for our analysis, but the other two instruments are. The tax rates on labor income, consumer spending, and employment can be calculated from national accounts data given in OECD publications (see the online Appendix). For each country, we also calculated the employment subsidy rate as the ratio of total spending on "active employment measures" to the wage bill. The combination of these taxes net of the employment subsidy gives the tax wedge for sectors 1 and 3.

For the health and social work sector, different countries follow different subsidization policies, and detailed case-by-case modeling for each country is not feasible. We follow a common approach to defining the subsidy rate, which captures the extent of subsidization of this sector. We calculated two alternative subsidy rates: one applying to social care only and one including health subsidies.

[10] The distribution of employment is close to the distribution of hours of work and results would not differ if we worked with employment shares. The correlation coefficients between the hours share and the employment share for sectors 1, 2, and 3, are, respectively, 0.88, 0.98, and 0.88.

The main substitution between market and home is in social care. Our first subsidy measure includes the value of "benefits in kind" in social care, reported in SOCX, which is mainly the money governments spent on subsidizing day care centers for preschool children and homes for older people. The second subsidy adds to this health spending on benefits in kind. Health spending is, on average, much larger than social care spending, but it encompasses both medical services and drugs and medical equipment, which are not part of the output of the health sector. Health expenditure data for the United States shows that about half the health spending is on drugs and equipment and the other half is on medical services.[11] We applied this fraction to all countries, and so divided by two the total health subsidy reported in SOCX. Adding the result to social care spending yields our second health and social care subsidy.

The subsidy rate on health and social care is defined as the ratio of each subsidy amount calculated as in the preceding paragraph, to the gross output of the health and social work sector. As the value added of private health and social care services is not taxed, the subsidy rate calculated for each country is the net expenditure tax on the model's sector 2, which is a negative number in all countries. The simple correlation coefficient between the two calculated subsidy rates is 0.87, so countries that heavily subsidize social care also subsidize health more generously, and countries that do not heavily subsidize social care do not subsidize health as generously. Our results are very similar for the two rates, and for space reasons the detailed results that we report are for the narrower definition only, mentioning only briefly some results for the broader measure. We prefer the narrower definition because the main market-home substitution is in social care, and this rate includes only items that are directly measured.

Figure 2 shows the calculated tax wedge for health and social work, based on the narrower subsidy that excludes health, and the tax wedge for the rest of the economy. Countries are sorted according to the differential between the two rates. As expected, the Scandinavian countries have the biggest differential between the two tax rates and the south European and North American countries have the smallest. A striking feature of the data shown in Figure 2 is the cross-country variation in the two rates. There is much more variation in social subsidies than in total taxes; the total tax wedge ranges from nearly 50 percent in Sweden to 27 percent in Korea, in contrast to the tax wedge for health and social work, which ranges from $-40$ percent in Norway to $+26$ percent in Italy.[12] The correlation coefficient between the two tax wedges is equal to $-0.41$, picking up the obvious fact that tax rates are higher in the countries that give more social care subsidies.[13]

[11] The *Consumption Expenditure Survey* (CEX) of the United States for 2003 gives the following expenditure breakdowns for healthcare: 3.1 percent on health insurance, 1.4 percent on medical services, 1.1 percent on drugs, and 0.3 percent on medical supplies. Excluding insurance, the spending on medical services is 50 percent of total health spending. Insurance spending can be assumed to be in the same proportions as private spending.

[12] In all countries, the health and social care wedge is made up of a negative expenditure tax (the social care subsidy) and two positive taxes (the income tax and the employment tax). Depending on their relative size, the outcome could be either positive or negative.

[13] Recently, Lee Ohanian, Andrea Raffo, and Rogerson (2008) used a different method from ours to construct a whole-economy tax wedge for a subsample of the OECD countries in our sample. The correlation coefficient between our tax wedge for sectors 1 and 3 and theirs is 0.88. The only apparent difference in the rank comparisons is that their method makes Spain and Australia lower tax countries than our methods do.

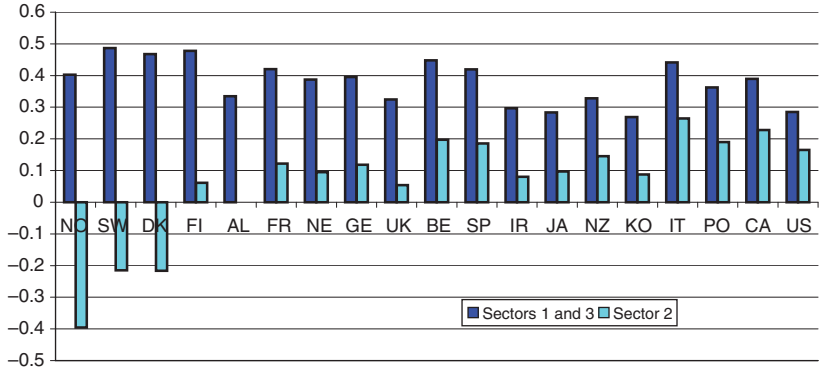


FIGURE 2. THE CALCULATED TAX WEDGE, 1994–2003, SORTED ACCORDING TO THE DIFFERENTIAL BETWEEN THE TWO RATES (*Social subsidies only*)

## III. Parameter Values

The key equations used in the predictions of the market shares are (15), (16), and (17). Equation (16) shows that the impact of the parameters on the ratio of hours can be divided into the impact of the substitution across the three market goods and the impact of the substitution between market and home production. However, because the expenditure taxes in sectors 1 and 3 are the same, the relative size of sector 3 to sector 1 is unaffected by the cross-market substitution.

We study the impact of policy on market shares by investigating each substitution channel separately—across market goods due to the $\varepsilon$ elasticity, for given home production time, and between market and home due to the $\sigma_j$ elasticity. The elasticity values that we used in the computations were chosen as follows.

Beginning with $\sigma_j$, we have estimates in the literature of the elasticity of substitution between all of home production and all market goods. These estimates are in the range 1.5–2.3. [14] In our model, $\sigma_j$ is the elasticity of substitution between market and home goods in two subsectors of the economy, where there might be different substitution possibilities. Sector 3, however, includes virtually all the services that drive the aggregate elasticity of substitution (except for family care). With this selection of services, we would expect the substitution possibilities between sector 3 and home production to be stronger than for the economy as a whole. In view of this, a value in the upper range of the aggregate estimates is more appropriate. We choose $\sigma_3 = 2.3$ as our benchmark, although even higher values might be appropriate.[15] For the health and social work sector, the substitution elasticity is likely to depend on the breakdown of the sector between the health and social work components, and on family views about the closeness of market-provided child care to family-provided

[14] See Peter Rupert, Rogerson, and Randall Wright (1995); Ellen R. McGrattan, Rogerson, and Wright (1997); and Yongsung Chang and Frank Schorfheide (2003).

[15] Rogerson (2008) aggregates all services together and uses a "conservative" elasticity 1.8. His service aggregate includes specialized services for which there is no home substitute, so it should be less than ours.

care. We have no information from direct estimates for either, and we used the same value as for sector 3 in our benchmark, $\sigma_2 = 2.3$. We check the robustness of our computation results by working out the solutions for a large range of $\sigma$, from 1.5 to 10. Results are reported mainly in the online Appendix, but they generally do not differ much from the benchmark ones.

The elasticity $\varepsilon$ is the price elasticity of the three consumption aggregates in our model. In estimates based on models without home production, this is also the price elasticity of demand. But with home production the estimated price elasticity is a weighted average of the $\sigma$ and $\varepsilon$ elasticities, with weights that depend on all the parameters of the model. On the assumption that $\sigma > \varepsilon$, in a model with home production, the $\varepsilon$ elasticity should be less than the estimated overall price elasticity of demand.

Estimates of the price elasticity of demand for service goods or subgroups within services are all below 1, and usually in the range 0–0.3.[16] More recently, Berthold Herrendorf, Rogerson, and Ákos Valentinyi (2009), addressing this issue with consumption expenditure data for the United States for 1947–2007, show that the expenditure estimate of the elasticity of substitution across agriculture, manufacturing, and service goods is around 0.8. But since our production functions are for value added, a more appropriate elasticity is the one derived for the value-added components for each sector. For this estimate they derive an elasticity close to 0.

Given that the $\varepsilon$ of our model should be less than the estimated demand elasticities in econometric studies because of the home production component, and it should be closer to the value-added estimate of Herrendorf, Rogerson, and Valentinyi (2009), the upper value estimate of 0.3 of the econometric studies is an upper bound for this elasticity, with 0 a lower bound.

## IV. A Quantitative Example

We begin our quantitative applications by illustrating the interaction between the cross-market and market-home substitutions that drive our results, with reference to the example discussed in the introduction and summarized in Table 1. The purpose of the example is to derive the impact on the distribution of work of uniform taxation, social care subsidies, and different values of the elasticities of substitution. We assume that all countries in the sample have the same parameter values, except for their tax and subsidy rates. In light of this, the only parameters needed to get predictions, except for the policy parameters, are the two elasticities, $\sigma$ and $\varepsilon$.

There are four tax rates that have an impact on allocations: the expenditure taxes $t_1$ and $t_2$, and the tax wedges $t_{w1}$ and $t_{w2}$. Sector 3 has the same tax rates as sector 1. Table 3 shows the sample means for these tax rates and the values that are used in the illustration. The latter set are drawn from the rates calculated for Sweden and Japan; the extreme countries are shown in Table 1. The column headed "low uniform" assumes that the country is a low-tax country (like Japan) but does not subsidize health and social care at all. The column headed "high uniform" also assumes that there are no social subsidies, but taxes are as high as in Sweden. The other two columns make

[16] See Rodney E. Falvey and Norman Gemmell (1996); Robert Summers (1985); and Richard Blundell, Panos Pashardes, and Gugielmo Weber (1993) for micro-econometric estimates.

Table 3—Alternative Tax Regimes

| Tax | Sample means | Low uniform | High uniform | Low subsidy | High subsidy |
|---|---|---|---|---|---|
| $t_1$, $t_3$ | 0.21 | 0.13 | 0.22 | 0.13 | 0.22 |
| $t_2$ | −0.18 | 0.13 | 0.22 | −0.10 | −0.48 |
| $t_{w1}$, $t_{w3}$ | 0.38 | 0.28 | 0.49 | 0.28 | 0.49 |
| $t_{w2}$ | 0.07 | 0.28 | 0.49 | 0.10 | −0.22 |

*Notes:* Low uniform applies a uniform tax to all sectors, with the level set at the sector 1 and 3 value for Japan. High uniform does the same but sets the tax rates at the levels for Sweden. The low subsidy column gives the actual rates for Japan and the high subsidy column gives the actual rates for Sweden.

Table 4—Predicted Sector Shares under Alternative Tax Regimes

| Sector | Sample means | Low uniform | High uniform | Low subsidy | High subsidy |
|---|---|---|---|---|---|
| 1 | 63.4 | 61.8 | 72.8 | 60.1 | 64.2 |
| 2 | 9.7 | 5.9 | 4.2 | 8.4 | 15.5 |
| 3 | 26.9 | 32.3 | 23.0 | 31.5 | 20.3 |

the same assumptions about taxes, but introduce the subsidies observed in Japan and Sweden.

Solving the model for the sample means and for $\varepsilon = 0.3$ and $\sigma_2 = \sigma_3 = 2.3$, we obtain the sector shares shown in the second column of Table 4. When taxation is uniform across the three sectors, and is increased from the low Japanese rates to the high Swedish rates, the distribution of work shifts from the sectors with home substitutes, 2 and 3, to the sector without substitutes, 1. The home-market substitution is the only driving force behind the changes in the market shares in this case. Sectors 2 and 3 lose hours in similar proportions, but because sector 3 is the bigger one, most of the fall in the percentage share is in this sector. So if, for example, Sweden had the same taxes as at present, but did not use part of the revenue to subsidize health and social care, its health and social work sector would have occupied only 4.2 percent of total market hours, with the bulk of care taking place in the home.

When the subsidies for sector 2 are introduced, in the last two columns of Table 4, both other shares fall, approximately by the same proportion, and the share of sector 2 increases dramatically. The model predictions for Sweden are very close to the data shown in Table 1. Sector 1 gains from the high tax at the expense of sectors 2 and 3, which have home substitutes, and then sector 2 gains from the subsidy at the expense of sectors 1 and 3. Sector 1 share is almost unaffected by the policy because the two substitution channels offset each other. But sector 3 share falls dramatically because both substitution channels act in the same direction. Japan has low taxation, so it has a higher sector 3 share than Sweden, but not as high as it would have had with no taxes at all. The model's predictions for Japan are again very close to the data shown in Table 1.

It is clear from the discussion and from the computations shown in Table 4, that the home-market substitution is crucial in explaining the large variations observed in the share of sector 3 across the countries in the sample. If we assume that the elasticity of substitution between market goods and home goods is zero, we get for Sweden,

respective shares of the three sectors: 62.2, 10.4, and 27.4. Compared with the results in the high-subsidy case in Table 4, we find that the share of sector 1 is less by 2 percentage points, but the share of sector 2 is less by 5 points, and that of sector 3 is higher by 7 points. The value of $\varepsilon$, the elasticity of substitution across goods, required to bring the prediction of health and social work up to the 15.5 percent level of Table 4 is 2.1, but at that level (and $\sigma_j = 0$ for both $j = 2, 3$) the share of sector 1 is 55 and the share of sector 3 is 30.5, which are far off the data points.

We argued that the estimates of the elasticity of substitution between market and home production in the literature give a lower bound on $\sigma_3$, but we have less information about the value of $\sigma_2$, which concerns a single service. The results are, however, robust to reasonable variations of this parameter. Holding $\sigma_3 = 2.3$ and reducing the value of $\sigma_2$ from 2.3 to 0 reduces the share of sector 2 from 15.5 percent to 11.3 percent, with a corresponding increase in the share of sector 1, and virtually no change in the share of sector 3. But even at $\sigma_2$ close to 1, the share of sector 2 is 13 percent, that of sector 1 is 66 percent, and that of sector 3 is 21 percent. So the model is robust to reasonable variations in the elasticity of substitution between home and market care.

The main contribution of this example was to show that in order to reconcile the small country differences in the share of sector 1, with the large differences in the shares of the other two sectors, the model requires a low $\varepsilon$ elasticity and a high $\sigma_j$ elasticity, especially for sector 3. Both of these are consistent with the empirical estimates of these elasticities.

## V. Substitutions across Market Goods as an Explanation for Country Differences

In this section, we show that when the home-production substitution is shut down, e.g., by evaluating the model solutions at $\psi_j = 1$, the taxes and subsidies that we have computed push country hours distributions in the "right" direction, but they are not large enough to explain the large differences in actual distributions, given the small $\varepsilon$. Moreover, if we allow $\varepsilon$ to take larger values, the explanatory power of this channel improves, but it fails to predict the unbalanced responses of the three sectors to the tax differentials.

For $\psi_j = 1$, equations (16) and (17) yield

$$\frac{l_j}{l_1} = \left(\frac{\omega_j}{\omega_1}\right)^{\varepsilon} \left(\frac{A_j}{A_1}\right)^{-(1-\varepsilon)} \left(\frac{1+t_j}{1+t_1}\right)^{-\varepsilon}. \tag{18}$$

For sector 2, $t_2 < t_1$ in all countries in the sample, but for sector 3, $t_3 = t_1$. Taxes therefore cannot predict differences in the ratio $l_3/l_1$ without the market-home substitution, but they could predict differences in the ratio $l_2/l_1$. These differences imply differences in market shares, which we compare with the data that we described in section 2. In deviations from log means, we obtain, for each country in the sample,

$$\ln \frac{l_{2i}}{l_{1i}} - E_j \ln \frac{l_{2j}}{l_{1j}} = -\varepsilon \left( \ln \frac{1+t_{2i}}{1+t_{1i}} - E_j \ln \frac{1+t_{2j}}{1+t_{1j}} \right), \tag{19}$$

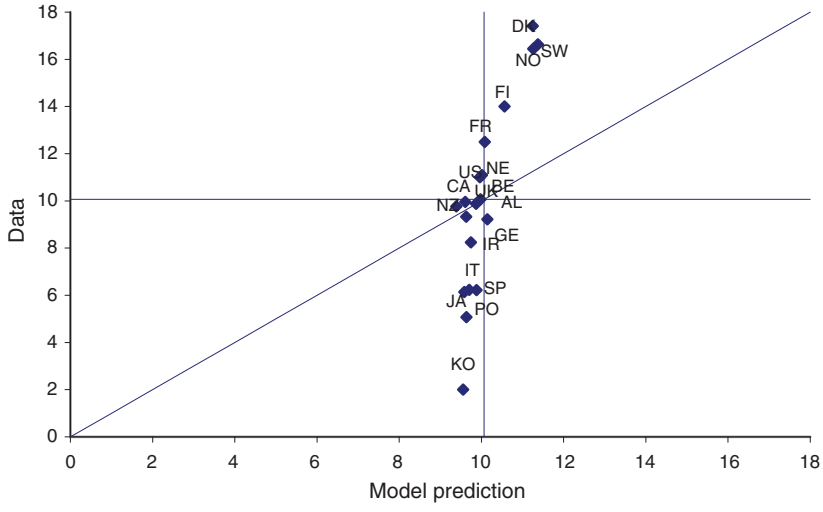


FIGURE 3A. PREDICTED IMPACT OF TAXATION, SHARE OF HEALTH AND SOCIAL CARE SECTOR

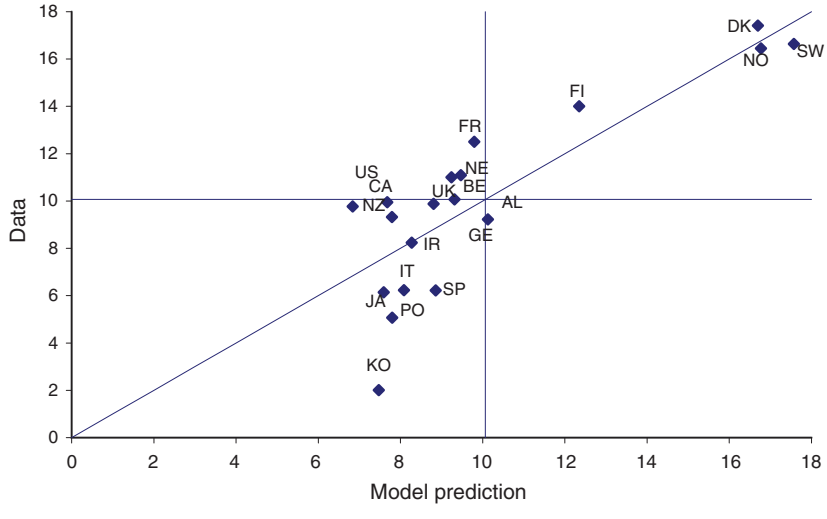


FIGURE 3B. PREDICTED IMPACT OF TAXATION, SHARE OF HEALTH AND SOCIAL CARE SECTOR, $\varepsilon$ 1.5

where $i$ and $j$ are country identifiers, and $E$ in front of the log denotes the sample mean. We use (19) to obtain a prediction for the ratio $l_2/l_1$ for each country.

The predictions for $\varepsilon = 0.3$, which we consider to be at the upper end of the most reasonable values at this level of aggregation, have a good correlation with the data, but do not have enough variation. The simple correlation coefficient between the prediction obtained from (19) and the data for the 19 countries is 0.86. The standard deviation of the data, however, is seven times as big as the standard deviation of the prediction. The conclusion that can be reached from this is that the impact of taxes and subsidies on the relative size of sector 2 is significant and in the right direction. But the quantitative impact of the calculated tax rates when only market substitutions are considered is too small to explain the data.

We show in Figure 3A the predictions for market shares obtained from (19). Applying the methodology of (19) to sector 3 as well gives, as a prediction, the sample means, because there are no tax differences between sectors 1 and 3. Using the two predictions in (8), we obtain a prediction for the share of market hours in sector 2, shown in Figure 3A. The lines drawn in this figure are the 45° line and lines for the sample means of the data and prediction, which are the same by construction. An "ideal" prediction would have all the points lying along the 45° line, whereas, if taxes had no explanatory power, all points would be on the sample mean line. There is clearly predictive power to the model, but the predictions are a long way from the ideal ones. The mean absolute distance of the predictions from the 45° line is 2.68, compared with the distance of the means of 3.02.

The predictions in Figure 3A were derived with the tax rate obtained when only social work subsidies are taken into account. The predictions with the broader measure of subsidies that includes also half of health spending by the government are very similar and not reported. The correlation coefficient between the prediction for $l_2/l_1$ with the data is 0.81, but the standard deviation of the data is 5.2 times as large as the standard deviation of the prediction.

The substitution margin that drives the results in Figure 3A is across market sectors only. It predicts that as health and social care are subsidized, and the other sectors taxed, consumers switch their consumption from the other market goods to health and social care. Our finding is that such a switch takes place, but because health and social care are not sufficiently close substitutes to other market goods there cannot be large substitutions, even when there are large subsidies to health and social care. It is natural to conclude from this that had there been more substitution possibilities, the model would have performed better. A log-linear regression estimate of (19) gives $\varepsilon = 1.7$ for the whole sample and $\varepsilon = 1.4$ when Korea (which is an outlier) is excluded from the estimation, with a large increase in $R^2$. The best fitting line to the share data is between these two, at about 1.5. Figure 3B shows the predicted series for the share of sector 2 for $\varepsilon = 1.5$. A regression line through the points virtually coincides with the 45° line, and gives a good fit ($R^2 = 0.72$), which shows that the best-fitting specification explains a large part of the variation in the employment share of health and social work. The absolute mean deviation of these predictions from the 45° line (including Korea) is 1.76, only 58 percent of the distance of the data points from the sample mean. However, the caveat remains that the value of the elasticity required to give this fit is far off the range of plausible values.

One might still ask if a simpler model that ignores home production, combined with a high value for $\varepsilon$, is a useful shortcut that might explain the data. The answer is that at least for the allocation of work time across sectors, it is not. If the simpler model were used as an approximation, the response of the other two sectors to the health and social work subsidies should be similar, and this goes against the evidence shown in Figure 1. There is more variation in the share of sector 3, and its share is better correlated with the share of sector 2, than is the share of sector 1. The implied share of sector 3 for $\varepsilon = 1.5$ improves the prediction of the sector 3 share over the mean, but only marginally. The absolute deviation of the data from the sample mean for sector 3 is 2.84; for $\varepsilon = 0.3$, it is 2.79; and for the best fitting $\varepsilon = 1.5$, it is 2.43. So although a high $\varepsilon$ is a useful shortcut as an explanation of the differences in the

share of sector 2 in terms of taxes and subsidies, it implies too large a response of sector 1 hours and too small a response of sector 3 hours.

## VI. Substitutions between Market and Home Production

When we allow for the substitution between market and home goods, our model can explain with conventional parameters both the bigger impact of policy on the hours distribution across countries and the asymmetric response of sectors 1 and 3. We first investigate the impact of home production on the hours distribution conditional on observed home production. By doing this, we are allowing for the differences in home production that are not due to policy to also influence the cross-market distributions. Following this, we investigate the impact of policy on home production differences across countries.

Formally, in this section, we are fixing the marketization of time $l_j/l_{jh}$ for sectors 2 and 3 at the observed values in all countries, and derive the optimal allocations across the three market sectors, conditional on the observed marketizations. By fixing the marketization of time, we are effectively also fixing the marketization of consumption, so the question that we are investigating in this section is whether equation (16) does a good job predicting the employment shares, given the observed values for the tax ratios and the marketization ratios. The only difficulty with this prediction is that the marketization of consumption is not observed, so we need to replace it with a term that has the observed marketization of time in its place.

Making use of the production functions for market and home goods to obtain an expression for $c_j/\tilde{c}_j$ in terms of the marketization of time, and substituting into (16), yields

$$\ln\frac{l_j}{l_1} = \varepsilon \ln\frac{\omega_j}{\omega_1} + \frac{\sigma_j(1-\varepsilon)}{\sigma_j-1}\ln\psi_j - (1-\varepsilon)\ln\frac{A_1}{A_j} - \varepsilon\ln\left(\frac{1+t_j}{1+t_1}\right) - \frac{\sigma_j-\varepsilon}{\sigma_j-1}\ln\left(1 + x_j\left(\frac{l_j}{l_{jh}}\right)^{-(\sigma_j-1)/\sigma_j}\right), \tag{20}$$

where $x_j \equiv (1/\psi_j - 1)(A_j/A_{jh})^{-(\sigma_j-1)/\sigma_j}$ is a function of preference and productivity parameters. Taking a log-linear approximation to the last term of (20) about the sample mean, we obtain

$$\ln\left(1 + x_j\left(\frac{l_j}{l_{jh}}\right)^{-(\sigma_j-1)/\sigma_j}\right) = \ln\left(1 + x_j e^{\bar{z}_j}\right) + \frac{x_j e^{\bar{z}_j}}{1+x_j e^{\bar{z}_j}}\,\frac{\sigma_j-1}{\sigma_j}\left(\ln\left(\frac{l_j}{l_{jh}}\right) - E\ln\left(\frac{l_j}{l_{jh}}\right)\right), \tag{21}$$

where $\bar{z}_j$ is the sample mean of $z_j = -\left((\sigma_j-1)/\sigma_j\right)\ln(l_j/l_{jh})$.

As before, we use the model to make predictions of the allocations across countries in deviations from sample means. Combining (20) and (21), we obtain

$$\ln \frac{l_{ji}}{l_{1i}} - E_k \ln \frac{l_{jk}}{l_{1k}} = -\varepsilon \left( \ln \frac{1+t_{ji}}{1+t_{1i}} - E_k \ln \frac{1+t_{jk}}{1+t_{1k}} \right) + \frac{x_j e^{\bar{z}_j}}{1+x_j e^{\bar{z}_j}} \frac{\sigma_j - \varepsilon}{\sigma_j} \left( \ln \left( \frac{l_{ji}}{l_{jhi}} \right) - E_k \ln \left( \frac{l_{jk}}{l_{jhk}} \right) \right), \tag{22}$$

where $i$ and $k$ are country identifiers; and $j$ is the sector identifier, taking the values 2 or 3.

For sector 2, each country's deviation from the sample mean is the sum of two terms. The expenditure tax terms that were computed before from (19), and a second term that is due to home production. For sector 3, the only term in the prediction is the home production term in (22), as there are no tax distortions between sectors 1 and 3 and $t_3 = t_1$.

The coefficient $x_j e^{\bar{z}_j}/(1 + x_j e^{\bar{z}_j})$ is a number between 0 and 1, but we have no information about it being a combination of preference and technology parameters over market and home consumption. If this coefficient were zero, home production would play no role in the allocation of market work, so it is obviously important for our results. However, it turns out that the results are robust to a large range of values for this coefficient, once it exceeds a low value such as 0.2. We adopted the following approach to finding a value for it. $\bar{z}_j$ can be calculated directly from the data on home and market production. To get a value for $x_j$, we assume that the productivity ratio $A_j/A_{jh}$ is 1 in both sectors, as these are low-skill services, and that the preference ratio $(1 - \psi_j)/\psi_j$ is equal to the average ratio of home-to-market production. These targets hold exactly for $\sigma_j = 1$, but we do not impose this restriction on $\sigma_j$ in any of the other calculations. The outcome for each sector is,[17]

$$\frac{x_2 e^{\bar{z}_2}}{1+x_2 e^{\bar{z}_2}} \frac{\sigma_2 - \varepsilon}{\sigma_2} = 0.64 \tag{23}$$

$$\frac{x_3 e^{\bar{z}_3}}{1+x_3 e^{\bar{z}_3}} \frac{\sigma_3 - \varepsilon}{\sigma_3} = 0.80. \tag{24}$$

The predictions for the ratios $l_2/l_1$ and $l_3/l_1$, when the values in (23) and (24) are used, are now much closer to the data than they were without the home production terms. For sector 2, the standard deviation of the data series is only 1.33 times the standard deviation of the predicted series, and the correlation between the two series is 0.89. Moreover, these predictions are virtually identical to the ones for a lower $\sigma_2$.

[17] A log-linear regression estimate of (22) over the cross-section of 19 countries gives the following estimates for this coefficient: 0.67 for sector 2, with $p$ value 0.0003; and 0.34 for sector 3, with $p$ value 0.0007. The regression for sector 2 also gives an estimate for $\varepsilon$, but still one that we would regard to be too high, 0.77, with $p$ value 0.03.

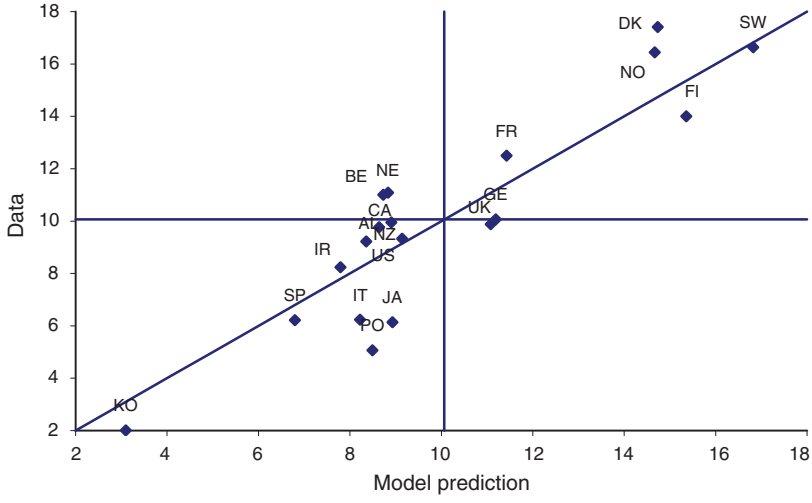


FIGURE 4A. PREDICTED SECTOR 2 SHARE, HOME PRODUCTION EXOGENOUS

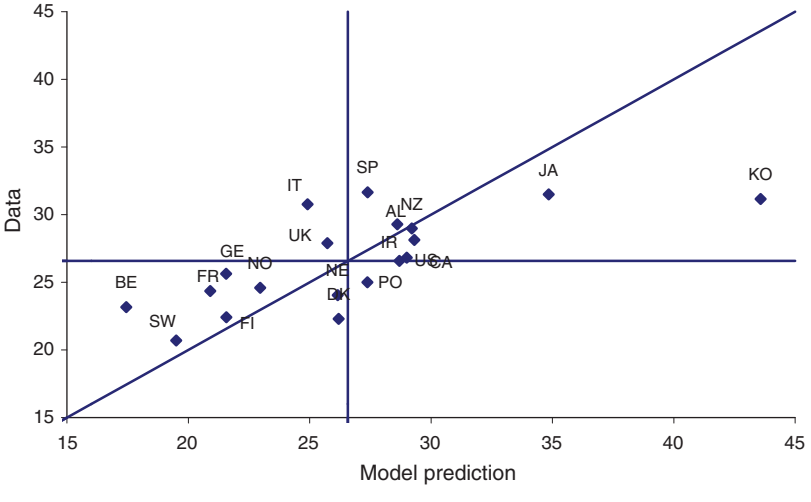


FIGURE 4B. PREDICTED SECTOR 3 SHARE, HOME PRODUCTION EXOGENOUS

For $\sigma_2 = 1.5$, the ratio between the standard deviation of the data to the prediction is 1.49, and the correlation between the two series remains at 0.89. For sector 3, the standard deviation of the data is only 0.44 times the standard deviation of the prediction, with correlation 0.55, but this is largely due to Korea, which is an outlier. If Korea is omitted from the sample, the ratio of the standard deviations becomes 0.62, and their correlation coefficient is also 0.62.

We now use these predictions, including Korea, to derive predictions for the sector market shares. These are shown in Figures 4A and 4B for $\sigma_2 = \sigma_3 = 2.3$.[18] The

[18] The online Appendix reports predictions for lower values of $\sigma$. They are virtually indistinguishable from the ones shown in Figure 4.

model fits the data well for both sectors, except for the Korea outlier in sector 3. As before, the three lines are the 45° line and the lines for the sample means. The model picks up well the Scandinavian group of countries in both sectors, as well as the smaller deviations across the other countries. The large majority of countries, and all the ones with large deviations from the sample mean, are pushed toward the 45° line by the model. The average absolute difference between the data and the prediction for sector 2 is 1.45, compared with the deviation between data and sample mean of 3.02. In sector 3, the model is also pushing the vast majority of countries toward the 45° line, but the averages are distorted because of the Korea outlier. The average absolute deviation between data and prediction is 3.14, compared with the average distance between data and sample mean of 2.84. But when Korea is omitted, the model's average distance from the data goes down to 2.64.[19]

## VII. Can Taxes and Subsidies Explain Marketization?

We conclude that a combination of symmetric cross-market substitutions with asymmetric market-home substitutions explains the observed differences in the distribution of hours of work. But can taxes explain the cross-country differences in the marketization of time? The key marketization equation of the model is (15), which makes the marketization of time a log-linear function of preference parameters, productivity parameters and the tax wedge. As in previous sections, we assume that preferences and productivities are common across the countries of the sample and investigate the extent to which differences in the tax wedge can explain the observed differences in the marketization of time. Figures 5A and 5B show the results with the elasticities of substitution previously used, 2.3 in both sectors.[20] The model picks up well the difference between the Scandinavian countries and the rest of the sample in the marketization of family care, but there are clearly other influences on the marketization of care.[21] The correlation between data and prediction with $\sigma_2 = 2.3$ is 0.645. Results are virtually identical for a lower elasticity of substitution. For $\sigma_2 = 1.5$, the correlation improves slightly to 0.654, but the graph of the predictions against the data is indistinguishable from Figure 5A. Similarly, when the broader subsidy that includes health is included, the results are also very similar to the ones shown in Figure 5A. The correlation between data and predictions for the broader measure is 0.60 for $\sigma_2 = 2.3$ and rises to 0.63 for $\sigma_2 = 1.5$.

[19] The problem with Korea is that it has an extremely high marketization ratio in sector 3. The model then predicts extremely high market share for this sector, but in the data it is not as high because market hours are also very high for sector 1. None of the papers that attempt to predict differences in market hours across countries with taxes include Korea in their sample. The extremely high number of aggregate market hours in that country would defy any prediction based on policy.

[20] Simple log-linear regressions of equation (15) with the 19 observations for sectors 2 and 3 give $\sigma_2 = 1.3$ ($p = 0.057$) and $\sigma_3 = 2.2$ ($p = 0.0005$), respectively. This ranking is consistent with our discussion in Section III. Moreover, as we have already argued, the predictions of the share of sector 2 with an elasticity like the estimated one are virtually indistinguishable from the predictions with $\sigma_2 = 2.3$.

[21] Several writers have written about the differences in the way that OECD citizens view the role of social care and family-related work in the home and the market, so differences in tastes may play a role here. See for example, Esping-Andersen (1990, 1999), and Yann Algan and Pierre Cahuc (2009).

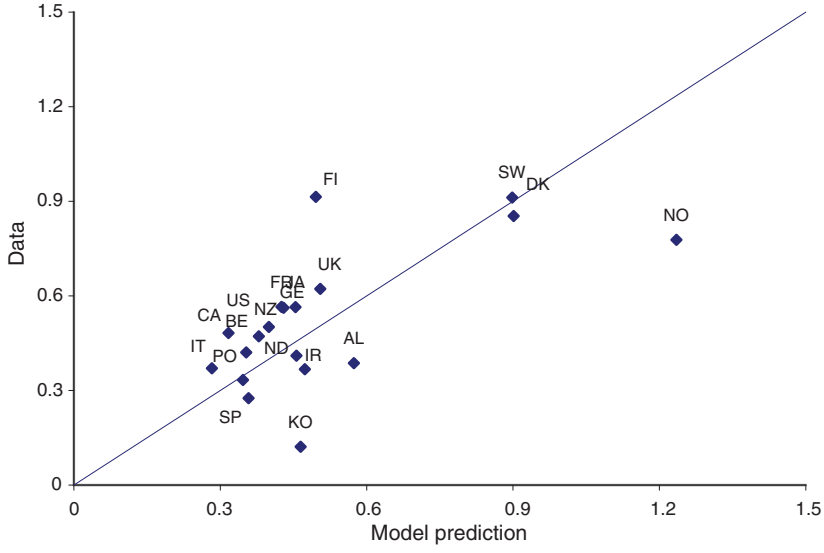


FIGURE 5A. ACTUAL AND PREDICTED MARKETIZATION IN HEALTH AND SOCIAL WORK

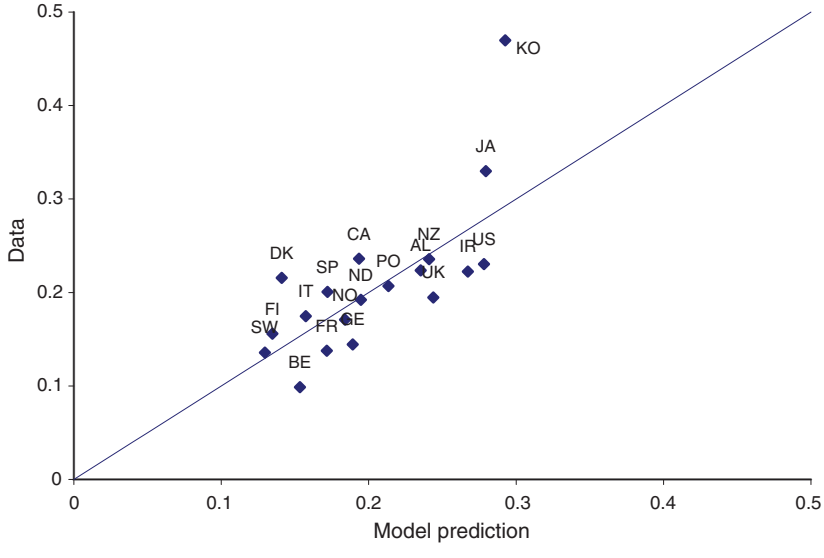


FIGURE 5B. ACTUAL AND PREDICTED MARKETIZATION IN OTHER SERVICES

In contrast, the marketization of other services is explained well by the different tax rates, with the exception of Korea, which is an outlier because of its extremely high market hours in sector 3. But even with Korea included in the predictions, the correlation coefficient between data and predictions for $\sigma = 2.3$, as shown in Figure 5B, is 0.73.

## VIII. Conclusions

We summarize the main findings as showing that the large differences in the allocation of market work across the countries of the OECD can be attributed to the differences in taxation, the subsidization of social work, and the market-home production substitution. Taxes and subsidies cause substitutions along two dimensions, across market goods because of different tax rates applying to different goods, and between market and home production because home production is neither taxed nor subsidized. The interaction between these two margins explains both the quantitative impact of policy and the asymmetric response of different sectors to the taxes and subsidies; in particular, the fact that the main differences in the allocation of hours of work across countries are in health and social work and in unskilled services. The market-home production substitution is the key explanation to the asymmetric response because of the different substitution possibilities between market and home work across goods and services.

We demonstrated these claims by making use of data on taxes and social expenditure from the OECD, home production data from time use surveys, and disaggregated data on hours of work by sector. We were able to do this for 19 OECD countries with favorable results.

## REFERENCES

**Algan, Yann, and Pierre Cahuc.** 2009. "Civic Virtue and Labor Market Institutions." *American Economic Journal: Macroeconomics*, 1(1): 111–45.

**Blundell, Richard, Panos Pashardes, and Guglielmo Weber.** 1993. "What Do We Learn About Consumer Demand Patterns from Micro Data?" *American Economic Review*, 83(3): 570–97.

**Burda, Michael C., Daniel S. Hamermesh, and Philippe Weil.** 2008. "The Distribution of Total Work in the EU and USA." In *Working Hours and Job Sharing in the EU and USA: Are Europeans Lazy? Or Americans Crazy?*, ed. Tito Boeri, Michael Burda, Francis Kramarz, 13–91. Oxford: University Press.

**Chang, Yongsung, and Frank Schorfheide.** 2003. "Labor-Supply Shifts and Economic Fluctuations." *Journal of Monetary Economics*, 50(8): 1751–68.

**Davis, Steven J., and Magnus Henrekson.** 2005. "Tax Effects on Work Activity, Industry Mix and Shadow Economy Size: Evidence from Rich Country Comparisons." In *Labour Supply and Incentives to Work in Europe*, ed. Ramon Goméz-Salvador, Ana Lamo, Barbara Petrongolo, Melanie Ward, and Etienne Wasmer, 44–104. Northhampton, MA: Elgar.

**Esping-Andersen, Gøsta.** 1990. *The Three Worlds of Welfare Capitalism*. Princeton: Princeton University Press.

**Esping-Andersen, Gøsta.** 1999. *Social Foundations of Postindustrial Economies*. Oxford, UK: Oxford University Press.

**Eurostat.** 2005. *Comparable Time Use Statistics: National Tables from 10 European Countries*. Working Papers and Studies. Luxembourg: Office for Official Publications of the European Communities.

**Falvey, Rodney E., and Norman Gemmell.** 1996. "Are Services Income-Elastic? Some New Evidence." *Review of Income and Wealth*, 42(3): 257–69.

**Freeman, Richard B., and Ronald Schettkat.** 2005. "Marketization of Household Production and the EU-US Gap in Work." *Economic Policy*, 20(41): 5–50.

**Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi.** 2009. "Two Perspectives On Preferences and Structural Transformation." National Bureau of Economic Research Working Paper 15416.

**Lindbeck, Assar.** 1982. "Tax Effects versus Budget Effects on Labor Supply." *Economic Inquiry*, 20(4): 473–89.

**Lindbeck, Assar.** 1997. "The Swedish Experiment." *Journal of Economic Literature*, 35(3): 1273–1319.

**McGrattan, Ellen R., Richard Rogerson, and Randall Wright.** 1997. "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy." *International Economic Review*, 38(2): 267–90.

**Ngai, L. Rachel, and Christopher A. Pissarides.** 2008. "Trends in Hours and Economic Growth." *Review of Economic Dynamics*, 11(2): 239–56.

**Ngai, L. Rachel, and Christopher A. Pissarides.** 2011. "Taxes, Social Subsidies, and the Allocation of Work Time: Dataset." *American Economic Journal: Macroeconomics*. http://www.aeaweb.org/articles.php?doi=10.1257/mac.3.4.1.

**Nickell, William.** 2006. "The CEP-OECD Institutions Data Set (1960–2004)." London School of Economics Centre for Economic Performance Discussion Paper 759.

**Ohanian, Lee, Andrea Raffo, and Richard Rogerson.** 2008. "Long-Term Changes in Labor Supply and Taxes: Evidence from OECD Countries, 1956–2004." *Journal of Monetary Economics*, 55(8): 1353–62.

**Olovsson, Conny.** 2009. "Why Do Europeans Work So Little?" *International Economic Review*, 50(1): 39–61.

**Prescott, Edward C.** 2004. "Why Do Americans Work So Much More than Europeans?" *Federal Reserve Bank of Minneapolis Quarterly Review*, 28(1): 2–13.

**Ragan, Kelly S.** 2010. "Taxes, Transfers, and Time Use: Fiscal Policy in a Model with Household Production." Unpublished.

**Robinson, John P., and Geoffrey Godbey.** 1997. *Time for Life: The Surprising Ways Americans Use Their Time*. University Park, PA: The Pennsylvania State University Press.

**Rogerson, Richard.** 2007. "Taxation and Market Work: Is Scandinavia an Outlier?" *Economic Theory*, 32(1): 59–85.

**Rogerson, Richard.** 2008. "Structural Transformation and the Deterioration of European Labor Market Outcomes." *Journal of Political Economy*, 116(2): 235–59.

**Rosen, Sherwin.** 1997. "Public Employment, Taxes, and the Welfare State in Sweden." In *The Welfare State in Transition: Reforming the Swedish Model*, ed. Richard. B. Freeman, Robert Topel, and Birgitta Swedenborg, 79–108. Chicago: University of Chicago Press.

**Rupert, Peter, Richard Rogerson, and Randall Wright.** 1995. "Estimating Substitution Elasticities in Household Production Models." *Economic Theory*, 6(1): 179–93.

**Summers, Robert.** 1985. "Services in the International Economy." In *Managing the Service Economy: Prospects and Problems Essays Commissioned for the Inaugural Conference of the Fishman-Davidson Center for the Study of the Service Sector, Wharton School, University of Pennsylvania*, ed. Robert P. Inman, 27–48. Cambridge, UK: Cambridge University Press.

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