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Welfare Policy and the Distribution of Hours of Work

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Abstract
We examine the distribution of hours of work across industrial sectors in OECD countries. We find large disparities when sectors are divided into three groups: one that produces goods without home substitutes and two others that have home substitutes — health and social work, and all others. 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. Health and social care subsidies increase hours in that sector. We compute these effects for nineteen OECD countries.

Keywords: hours of work, employment shares, home production, childcare, tax wedge, welfare state, social subsidies
JEL classifications: E02, H53, I18, I38, J22

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There are large differences in the kind of jobs that people do across the industrial countries of the Organisation for Economic Cooperation and Development (OECD). To illustrate the point, we report in Table 1 the percentage distribution of hours of work in three countries with different social support

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

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.

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. Sector 2 is the health and social work sector, which has home counterparts, especially in childcare. Sector 3 consists of all other sectors, which produce less specialized services and which also have close substitutes in home production, such as retailing (a substitute for shopping time) and catering (a substitute for cooking time).

The share of sector 1 is very similar across the three countries, taking up about 63% of market work (the figures are rounded). 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 ten percentage points. Why these large differences in the distribution of work?

One possible cause of these differences is related to past productivity growth in different sectors of the economy. In our earlier work (Ngai and Pissarides, 2007, 2008) we showed in a dynamic model that if final outputs are poor consumption substitutes for each other, employment shares grow faster in sectors characterized by lower rate of productivity growth. So, if historically Swedish productivity growth in health and social work was much below productivity growth in the United States and Japan, there could be a productivity explanation for the large share of this sector in Sweden.

[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 Esping-Andersen (1990, 1999).

Similarly for unskilled services in Japan.

But this cannot be the main explanation for the type of cross-country differences shown in Table 1. The cross-country differences shown are in *shares*, i.e., in the ratio of hours in one sector to the sum of hours in the other sectors. Such differences need to be explained by differences in *relative* productivity levels. So if productivity is to explain the larger health and social work sector in Sweden, the ratio of productivity in health and social work to the rest of the private economy in Sweden needs to be much smaller than the same ratio in Japan or the United States. Moreover, if productivity were the reason for the differences in time allocations, the substitutions would not be exclusively between sectors 2 and 3 but they would affect sector 1 as well. We compute the differences in productivity ratios required to explain the different allocations shown in Table 1 for all countries in our sample, and conclude that they are implausible. Moreover we find no compelling reasons for bigger deviations in technology between sectors 2 and 3 than between either of these sectors and sector 1.[2]

We argue that the key reason for the large differences in the cross-country allocation of hours is policy, and the home-market substitution. In Sweden taxes on market economic activity are much higher than they are in either the United States or Japan, but a large part of the revenue is used to subsidize the provision of social care. Consumption demand shifts from the output of the taxed sectors to the subsidized social care sector and the untaxed home production. We document the policy differences across 19 OECD countries and quantify their impact on the sectoral allocation of work. The data requirements for this work are large and they are the main limiting factor in our choice of countries and time period.

Taxes have distortionary effects on the sectoral allocation of market work for two reasons. First, not all types of work are equally taxed. We find 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, vary a lot across countries, and this explains some of the sectoral differences across countries.

We find, however, that quantitatively the policy impact on the cross-market substitutions is not big enough to explain the large differences in

[2] Another possible cause of the observed differences in the distribution of work are differences in tastes. We do not model the origin of tastes, so we cannot properly evaluate such an explanation. But we still find this explanation implausible because the "relative" differences in tastes required to explain the data are very large. For example, one would need to find reasons that explain why Swedes like market-produced health and social work relative to market-produced food much more than Americans and Japanese do.

reallocations of the kind shown in Table 1. 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 childcare 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 there are no tax distortions between sectors 1 and 3, the asymmetries shown in Table 1 require a much higher elasticity of substitution between the outputs of sectors 2 and 3 than between the outputs of sectors 1 and 2. This does not seem plausible and there is no empirical evidence supporting it.

In order to explain the big impact of tax-subsidy programs and the large differences across sectors, we need the second reason for the distortionary effects of taxation, which works even when taxation is uniform across the economy: 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. Because the elasticity of substitution is high between market goods and home production, taxation has a big quantitative impact; and because this elasticity is not the same across all goods, the impact is not uniform across all sectors of market activity. The differential substitutions between market and home production, when combined with the differential tax treatment of social work, drive our results. We find support for this claim in our quantitative evaluation of the impact of policy in 19 OECD countries.

We are not the first ones to study the impact of market-home substitutions on market economic activity, although we believe that we are the first ones to derive the distribution of market work across sectors in an equilibrium model. Freeman and Schettkat (2005) study micro 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 Weill (2008). We focus on the impact of the market-home substitutions conditional on total market work, and our results require market-home substitutions at the micro level, although not necessarily one-for-one.

Kelly Ragan (2006) looks at policy effects on the choice between home and market work, and makes use of time use surveys, so in this respect her study is close to ours. But unlike us, she studies total hours of work in a small sample of countries, using a variant of the model of Rosen (1997), one of the pioneers in this area of research. Total hours of work (in Sweden and how they compare with the United States) is also the focus of studies by

Rogerson (2007) and Olovsson (2009).[3] Davis and Henrekson (2005) study questions similar to ours in a partial equilibrium task-assignment model, and estimate the impact of taxation on employment in three sectors of economic activity, eating and drinking establishments, lodging and retail trade.[4] Their estimation results are consistent with the results of our model.

Finally, Rogerson (2008), in a study that takes an approach similar to ours, shows that the gap in total hours of work between the United States and an aggregate of five continental European countries is due to differences in the size of the service sector. He argues that marketization is a key reason behind these differences. But although his argument is similar to ours, his focus is the dynamic evolution of total hours of work in services since 1950. In this paper we do not aggregate all service activities together, because some are treated differently by tax-subsidy programs and some do not have home-production substitutes. We construct tax-subsidy rates for each and every one of our nineteen countries, distinguish between three types of service activities and look at the distribution of hours across these activities.

Our model has the smallest number of sectors needed to capture the distortionary impact of uniform taxation and targeted subsidies. As in the example of Table 1, we distinguish between three market sectors. One that includes all sectors that produce output that has no close home substitutes; one with health and social work that has close home substitutes and is subsidized;[5] and one that includes all other sectors that have close home substitutes and are not subsidized (a full listing of two-digit sectors is given later in this paper, in Table 3). Corresponding to the three market sectors, and given the assumptions that we are making, there are two types of home-produced goods, which we also call sectors for easier reference. One home sector produces goods that are close substitutes to health and social work (mostly childcare) and the other produces goods that are close substitutes to all other services.[6]

[3]For more detailed discussion of the Swedish welfare state and its role in the economy, see Lindbeck (1997).

[4]They deliberately omit childcare 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.

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

[6]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 consisetent with that evidence. See also Robinson and Godbey (1997) for the US and Burda, Hamermesh and Weil (2008) for cross-country comparisons.

Our model has simple linear production functions with no capital, which we believe is a useful restriction for the points that we want to make. The key to the 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 than on sector 1, because sector 3 loses more hours to the untaxed home sector. But sector 2 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 non-subsidized sectors.

In order to quantify our predictions we need three different types of data.[7] 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 data sets 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 Mediterranean, the United States, Canada, Australia, New Zealand, Japan and Korea, so we have a good mix of welfare states and policy regimes.

Section 1 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 2 we describe the relevant data for the 19 countries in our sample and summarize their main features. In section 3 we give the parameter values used in the quantitative evaluation of the impact of policy. The quantitative evaluation begins with section 4, 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 5, 6 and 7, beginning with cross-market substitutions and following up with substitutions between market and home production.

1 The model

Consumer allocations. We solve the time allocations for a representative agent who has a static CES utility function defined over consumption goods

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

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 government balances its budget with lump-sum transfers.

The representative agent's utility function is

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

where c is a consumption aggregate, l_m is market work (private and government), and l_h is home work. $v(.)$ 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 $\omega_i > 0$, $\Sigma\omega_i = 1$. 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 τ, 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 and supply goods to consumers. 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 from c education services, 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 in c health and social care. 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, which are a component of their social policy and include an item for balancing the budget. The assumptions made about the substitution possibilities between government-supplied goods and goods bought privately influence the size of the implicit lump-sum transfer from the government to the representative agent. The lump-sum transfer plays a critical role in studies of the impact of taxation on total hours of work, such as that of Prescott (2004) and its offshoots. It plays no role in our study of the percentage distribution of work, so we do not need to be explicit about its magnitude.

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,

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

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 re-write (4) as

$$\sum_{i=1}^{3}(1+t_i)p_i c_i \leq (1-\tau)wl - (1-\tau)w(l_{2h} + l_{3h}) + T. \tag{6}$$

Next, substitute l_{jh} from (5) into (6), to obtain,

$$\sum_{i=1}^{3}(1+t_i)p_i c_i + \sum_{j=2}^{3} p_{jh} c_{jh} \leq (1-\tau)wl + T, \tag{7}$$

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 (7). From the optimality conditions we derive some key results, focusing our discussion only on the results that have a direct bearing on the distribution of market work.

Market shares. We make predictions about the distribution of market work by computing the market share of each sector, defined by $s_j = 100l_j/\Sigma_{i=1}^{3} l_i$. 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 re-writing the shares as:

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

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:

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

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:

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

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 $p_{jh} = (1 - \tau) w / A_{jh}$. This substitution yields,

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

We define the "tax wedge" that applies to sector j, denoted t_{wj}, by[8]

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

The relative price of the market good to the implicit price of the home good in sectors 2 and 3 becomes,

$$\frac{(1 + t_j) p_j}{p_{jh}} = \frac{A_{jh}}{(1 - t_{wj}) A_j} \qquad j = 2, 3. \tag{15}$$

[8] 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.

Given now the linear production functions, the marketization condition (9) translates into the following condition for the marketization of time in sector j :

$$\frac{l_j}{l_{jh}} = \left(\frac{1}{\psi_j} - 1\right)^{-\sigma_j} \left(\frac{A_j}{A_{jh}}\right)^{\sigma_j - 1} (1 - t_{wj})^{\sigma_j} \quad j = 2, 3. \tag{16}$$

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.[9] More importantly for our present objectives, the impact of policy is summarized in a single composite, the tax wedge. Higher tax wedge leads to less marketization and the impact is bigger when the elasticity σ_j is bigger.

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

$$\frac{l_j}{l_1} = \left(\frac{\omega_j \psi_j}{\omega_1}\right)^{\varepsilon} \left(\frac{A_1}{A_j}\right)^{1-\varepsilon} \left(\frac{1 + t_j}{1 + t_1}\right)^{-\varepsilon} \left(\frac{c_j}{\tilde{c}_j}\right)^{1-\varepsilon/\sigma_j}. \tag{17}$$

Calculating $c_j/\tilde{c}_j$ from (3), (9) and (15), we obtain

$$\frac{c_j}{\tilde{c}_j} = \psi_j^{-\sigma_j/(\sigma_j - 1)} \left[1 + \left(\frac{1}{\psi_j} - 1\right)^{\sigma_j} \left(\frac{A_{jh}}{A_j(1 - t_{wj})}\right)^{\sigma_j - 1}\right]^{-\sigma_j/(\sigma_j - 1)}. \tag{18}$$

(17) is a key equation for the model because it gives the dependence of market sectors on policy. For given taxes and subsidies, employment shares are driven by technology and preferences. Under the plausible restriction $\varepsilon < 1$, the less productive sectors attract relatively bigger shares. Policy influences employment shares in two ways. If two sectors are equally taxed ($t_j = t_1$), policy influences their relative size only 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. Sectors with closer home substitutes suffer bigger losses of demand and employment than sectors with less good home substitutes. From (17) 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.

[9] 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.

A second impact of policy on market shares is due to non-uniform taxation, because of 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, ε.

The model makes strong predictions about two features of sectoral allocations that can be confronted with data. First, the relative employment shares in (17) depend on expenditure tax differentials and on market-home substitutions. Second, the marketization in (16) depends on the tax wedge applying to the sector. We now discuss the data needed to quantify these two predictions.

2 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.

Time use surveys record "market work" as the aggregate of the number of hours spent at the place of work, time taken to travel to work and any other activities related to market work, such as working at home in evenings or weekends, job search, reading literature connected with the job etc. For this reason market work reported in time use surveys exceeds hours of work reported in household or employer surveys. In the countries of our sample the mean log difference between market work reported in time use surveys and the total hours reported by employers over a comparable period of time (and including government employment and education) is 27.3, with standard deviation 4.7, so differences across countries are of a comparable order of magnitude.

Time use surveys, however, despite very detailed reporting of the kind of activities done away from the market, do not report the occupational or 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 percent-

Table 2:
The percentage distribution of aggregate hours of work

Country	market	home	Country	market	home
Belgium	27	73	Ireland	39	61
Germany	33	67	Australia	40	60
France	34	66	Canada	42	58
Italy	34	66	Portugal	42	58
Spain	34	66	USA	43	57
New Zealand	35	65	Denmark	43	57
Sweden	36	64	Norway	44	56
Netherlands	38	62	Japan	49	51
Finland	38	62	Korea	56	44
UK	39	61			

Market hours are mainly from EU KLEMS and they are the average over 1994-2003. See the Appendix. Home hours are from time use surveys, one for each country, taken around 2000.

age distribution of total market hours across the model's three sectors. The absolute number of hours is needed only in the marketization equations of sectors 2 and 3, and we also obtain them from the same source.[10]

Consider first the distribution of aggregate hours of market and home work in the nineteen countries in our sample.[11] Table 2 shows the percentage distribution across the nineteen countries of the sample, using the employer sources for market hours and time use surveys for home hours. The table shows wide variations across countries, with the central and southern European countries having the smallest percentages of market hours and the two Asian countries the largest market shares. Belgium and Japan-Korea are outliers at either end, with the market share in Korea more than twice as much as that in Belgium.

[10] We could obtain an absolute number of sectoral market work from time use surveys by multiplying the EU KLEMS share of each sector by the total in the time use surveys. But doing this may artificially increase the negative correlation between market hours in the sector and home hours due to any measurement errors. We put the model through a more stringent test by taking market hours and home hours from different sources, even though the former excludes auxiliary activities such as travel to work, whereas the latter includes them.

[11] Full definitions, year of the survey and source are given in the data Appendix.

Table 3:
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 aux. transport
gas, electricity, water	membership organizations, media activities		refuse disposal recreational, other personal
construction			

All economic sectors in EU KLEMS are included except for public administration, defence 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.

EU KLEMS gives hours of work for two-digit sectors with very few gaps for most countries, and covers all countries in the sample except for Canada, Norway, and New Zealand, for which we used other sources. We grouped the two-digit sectors into the model's three sectors according to the classifications in Table 3. The market activities in the sub-sectors 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 childcare, which is a close substitute for market-based childcare, and most also report a much smaller number of hours for care of other dependents. Given this information, ideally we would have wanted to split the 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 data sets, so we treat the aggregate of health and social work as the market activity, with childcare and adult household care as its close home substitute. The overall figure for adult care is very small, and mostly done by older age groups (over 65s), so our home production time for care is dominated by childcare, which is well measured in all time use surveys.

Government employment and education are excluded from the analysis. Our aggregate economy is made up of the sectors listed in Table 3 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. 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 sectors. This is consistent with our model, to the extent that the two asymmetric influences on hours of market work, the subsidization of some activities and the market-home production substitution, impact directly on the other two sectors.

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. 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). 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 subsidize heavily 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 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 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.

The main substitution between market and home is in social care, which is primarily childcare. 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 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 on medical services.[12] We applied this fraction to all countries and so divided by 2 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 conversely. 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 there is less arbitrariness in the construction of this rate.

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 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% in Sweden to 27% in Korea, in contrast to the tax wedge for health and social work, which ranges from -40% in Norway to $+26\%$ in Italy.[13] The correlation coefficient between the two tax wedges is equal to

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

[13] 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

-0.41, picking up the obvious fact that tax rates are higher in the countries that give more social care subsidies.[14]

3 Parameter values

The key equations used in the predictions of the market shares are (16), (17) and (18). Equation (17) 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. Policy influences on the ratio of hours in sector 3 to sector 1 work only through the market-home substitution. Equation (16) shows that this substitution is influenced by the common tax wedge of the two sectors.

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

Beginning with σ_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 $1.5 - 2.3$.[15] In our model σ_j is the elasticity of substitution between market and home goods in two sub-sectors of the economy, where there might be different substitution possibilities. For sector 3, we would expect the substitution possibilities to be stronger than for the economy as a whole, because of the selection of goods for inclusion in that sector. 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. 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 childcare to family-provided care. We have

tax. Depending on their relative size, the outcome could be either positive or negative.

[14] Recently, Ohanian, Raffo and Rogerson (2008) used a different method from ours to construct a whole-economy tax wedge for a sub-sample 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.

[15] See Rupert, Rogerson and Wright (1995), McGrattan, Rogerson and Wright (1997) and Chang and Schorfheide (2003).

no information from direct estimates for either and we used the same value as for sector 3 in our benchmark, $\sigma_2 = 2.3$, although we report also results for lower values.

The elasticity ε 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 elasticity is a weighted average of the σ and ε elasticities, with weights that depend on all the parameters of the model. So on the assumption that $\sigma > \varepsilon$, in a model with home production the ε elasticity should be less than the estimated overall price elasticity of demand.

Estimates of the price elasticity of demand for service goods or sub-groups within services are all below 1, and usually in the range $0 - 0.3$.[16] More recently, Herrendorf, Rogerson and 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 ε 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 seems to be an upper bound for this elasticity, with 0 a lower bound.

4 A quantitative illustration

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.

There are four tax variables 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 variables as sector 1. Table 4 shows the sample means for these tax variables 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 shown in Table 1.

[16] See Falvey and Gemmell (1996), Summers (1985) and Blundell, Pashardes and Weber (1993) for micro-econometric estimates.

Table 4:
Alternative tax regimes

Tax	means	lo uniform	hi uniform	lo subsidy	hi 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

The column headed means shows the sample means. Lo uniform applies a uniform tax to all sectors, with the level set at the value for Japan for sectors 1 and 3. Hi uniform does the same but sets the tax rates at the levels for Sweden. The lo subsidy column gives the actual rates for Japan and the hi subsidy column gives the actual rates for 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 5. When taxation is uniform across the three sectors (i.e., the health and social work subsidy is ignored), 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 when taxation is uniform. 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% 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 5, 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 to accommodate the rise in sector 2 share, because both substitution forces act in the same direction. In contrast, because Japan has low taxation, it has a high sector 3 share (but not as high as it would have had with no taxes at all). The model's predictions are again very close to the data shown in Table 1, and the economic forces behind them are the same.

It is clear from the discussion and from the computations shown in Table

Table 5:
Sector shares under alternative tax regimes

Sector	means	lo uniform	hi uniform	hi subsidy	lo subsidy
1	63.4	61.8	72.8	64.2	60.1
2	9.7	5.9	4.2	15.5	8.4
3	26.9	32.3	23.0	20.3	31.5

5, 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, for example, respective shares of the three sectors of $62.2, 10.4$ and 27.4. Compared with the results in the hi-subsidy case in Table 5, 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 ε, the elasticity of substitution across goods, required to bring the prediction of health and social work up to the 15.5% level of Table 5 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.

This example shows 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 ε elasticity and a high σ_j elasticity, especially for sector 3 - consistent with the empirical estimates of these elasticities.

5 Explaining country differences: Substitutions across market goods

If we shut down the market-home substitution channel (e.g., by evaluating the model solutions at $\psi_j = 1$), the cross-country hours distribution could differ for two reasons: different tax rates across sectors or different productivity ratios. For $\psi_j = 1$ equations (17) and (18) yield,

$$\frac{l_j}{l_1} = \left(\frac{\omega_j}{\omega_1}\right)^{\varepsilon} \left(\frac{A_j}{A_1}\right)^{-(1-\varepsilon)} \left(\frac{1+t_j}{1+t_1}\right)^{-\varepsilon}. \tag{19}$$

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 are measured by the last term in (19). In deviations from log means we obtain, for each country in the sample,

$$\ln \frac{l_2}{l_1} - E \ln \frac{l_2}{l_1} = -\varepsilon \left(\ln \frac{1+t_j}{1+t_1} - E \ln \frac{1+t_j}{1+t_1} \right) \tag{20}$$

where E in front of the log denotes the sample mean. We use (20) 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 (20) 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 3 the predictions for market shares obtained from (20). Applying the methodology of (20) to sector 3 as well gives a "naive" prediction for $\ln l_3/l_1$ at the sample means. 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 45^0 line and lines for the sample means of the data and prediction.[17] An "ideal" prediction would have all the points lying along the 45^0 line, whereas a naive prediction would have them along the sample mean line. The predictions shown in figure 3a are clearly superior to the "naive" predictions, but they are a long way from the ideal ones. The mean absolute distance of the predictions from the 45^0 line is 2.68, compared with the naive prediction's 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 $\rho = 0.81$, 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,

[17] The share predictions were adjusted to have the same mean as the data for shares. (Recall that they were derived from the log deviations from sample mean for the ratio l_2/l_1.)

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 (20) gives $\varepsilon = 1.7$ for the whole sample and $\varepsilon = 1.4$ when Korea is excluded from the estimation, with a large increase in R^2. The best fitting line to the share data is between these, 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 45^0 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 45^0 line (including Korea, which is an outlier) is 1.76, only 58% 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, as we discussed earlier on.

One might still ask if a simpler model that ignores home production, combined with a high value for ε, is a useful shortcut that might explain the data. The answer is that it does not, because of the symmetric way in which this simplified model influences the other two sectors. This goes against the evidence shown in Figure 1, where 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. Computing the implied share of sector 3 for $\varepsilon = 0.3$ and $\varepsilon = 1.5$ 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. This is further evidence that although substitution across market goods contributes to the cross-country variation in employment shares, it is not the only (or even main) explanation of such differentials.

Of course, it is possible that the part of the variation not explained by cross-market substitutions can be explained by productivity differences across countries. To investigate the contribution of productivity differences we require data for the productivity ratios in sectors 2 and 3, A_j/A_1. Given the difficulty of obtaining good estimates of relative productivity differentials in each sector, which are also comparable across countries, we approach the problem in reverse. We calculate the productivity differences required if market productivity is to explain the observed differentials in the cross-country hours distributions in the absence of market-home substitutions, given the observed tax differentials for sector 2.

From (19) we obtain the following equation for the productivity ratios:

$$\frac{A_j}{A_1} = \left[\left(\frac{\omega_j}{\omega_1} \right)^{-\varepsilon} \left(\frac{l_j}{l_1} \right) \left(\frac{1+t_j}{1+t_1} \right)^{\varepsilon} \right]^{-1/(1-\varepsilon)} . \tag{21}$$

As with the tax predictions, we take logs and compute the log difference of A_j/A_1 from the log mean, required to explain the cross-country differences in l_j/l_1, given the tax ratios. We normalize the mean to 1 for both sectors 2 and 3 and report the results in Figure 4.

The required productivity ratios in most cases are implausibly large. The best way to see the intuition behind these results, given that they are ratios of ratios, is to conjecture that because tradeables are concentrated mainly in sector 1, productivity differences across the open economies of the OECD should be less for sector 1 than for the other sectors. Suppose for the sake of the intuitive argument that sector 1 productivities are the same in all countries. Figure 4 then shows that in order to explain the larger relative employment in health and social work in Denmark, hourly productivity in that country in health and social work has to be half of the sample mean. Similar results hold for the other Scandinavian countries. Similarly, in order to explain the smaller size of this sector in Spain, hourly productivity in that country has to be 65% more than the average hourly productivity in the OECD sample. The most extreme case is Korea, where the health and social work sector is so small that productivity in that sector needs to be nearly 8 times as high as the mean to explain it.[18] The differentials required for the allocations in sector 3 are of a similar order of magnitude.

Such differences in relative productivities are implausible, given measured productivity differences. But we find even less plausible the requirement that the productivity differences in sectors 2 and 3 should be negatively correlated. The simple correlation coefficient of the points shown in Figure 4 is -0.28, and if the two outliers, Portugal and Korea, are excluded, it rises to -0.72. Thus, if productivity differences are to explain the observed differences in hours, the countries that are more efficient than the average in sector 2 have to be less efficient in sector 3. There is no reason for such a ranking in productivities. Of course, the reason that the model requires this negative correlation is that the countries that have large social sectors, like the Scandinavians, are also the countries that have small unskilled service

[18] Korea is an outlier not shown in figure 4. Undoubtedly, trade and its more recent development play a role in explaining the large manufacturing sector in that country. Nevertheless, the productivity difference required to explain its relative sector 3 size is not an outlier, so the feature that drives the very high productivity requirement in the health and social work sector is the very small size of that sector.

sectors, so the required productivities have to go in opposite directions. It is again related to the asymmetric substitution from the other sectors into sector 2, that we pointed out was a problem for the cross-market substitution explanation of the hours differences.

6 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 investigate first the impact of home production on the hours distribution whatever the source of differences in home production across countries. By doing this we are allowing for the possibility that our quantitative model of home production does not capture all the influences on home production, in particular on activities such as childcare.[19] We follow this analysis by investigating the impact of policy on the cross-country differences in home production.

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 (17) 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, we obtain,

$$\begin{aligned}\frac{c_i}{\tilde{c}_i} &= \left[\psi_i + (1-\psi_i)\left(\frac{c_i}{c_{ih}}\right)^{-(\sigma_i-1)/\sigma_i}\right]^{-\sigma_i/(\sigma_i-1)} \\ &= \psi_i^{-\sigma_i/(\sigma_i-1)}\left[1+(\frac{1}{\psi_i}-1)\left(\frac{A_i}{A_{ih}}\right)^{-(\sigma_i-1)/\sigma_i}\left(\frac{l_i}{l_{ih}}\right)^{-(\sigma_i-1)/\sigma_i}\right]^{-\sigma_i/(\sigma_i-1)} \quad (22)\end{aligned}$$

[19] See the discussion that follows in section 7.

Substitution of (22) into (17) yields

$$\begin{aligned}\ln\frac{l_j}{l_1} &= \varepsilon\ln\frac{\omega_j}{\omega_1}+\frac{\sigma_j(1-\varepsilon)}{\sigma_j-1}\ln\psi_j-(1-\varepsilon)\ln\frac{A_1}{A_j} \\ &\quad -\varepsilon\ln\left(\frac{1+t_j}{1+t_1}\right)-\frac{\sigma_j-\varepsilon}{\sigma_j-1}\ln\left(1+x_j\left(\frac{l_j}{l_{jh}}\right)^{-(\sigma_j-1)/\sigma_j}\right)\end{aligned} \tag{23}$$

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 (23) about the sample mean, we obtain,

$$\begin{aligned}&\ln\left(1+x_j\left(\frac{l_j}{l_{jh}}\right)^{-(\sigma_j-1)/\sigma_j}\right) \\ &= \ln\left(1+x_je^{\bar{z}_j}\right)+\frac{x_je^{\bar{z}_j}}{1+x_je^{\bar{z}_j}}\frac{\sigma_j-1}{\sigma_j}\left(\ln\left(\frac{l_j}{l_{jh}}\right)-E\ln\left(\frac{l_j}{l_{jh}}\right)\right)\end{aligned} \tag{24}$$

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

As before, we use the model to make predictions of the allocations across countries in deviations from sample means. Combining (23) and (24), we obtain

$$\begin{aligned}\ln\frac{l_j}{l_1}-E\ln\frac{l_j}{l_1} &= -\varepsilon\left(\ln\frac{1+t_j}{1+t_1}-E\ln\frac{1+t_j}{1+t_1}\right) \\ &\quad -\frac{x_je^{\bar{z}_j}}{1+x_je^{\bar{z}_j}}\frac{\sigma_j-\varepsilon}{\sigma_j}\left(\ln\left(\frac{l_j}{l_{jh}}\right)-E\ln\left(\frac{l_j}{l_{jh}}\right)\right).\end{aligned} \tag{25}$$

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 (20), 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 (25), as there are no tax distortions between sectors 1 and 3 and $t_3 = t_1$.

The coefficient $x_je^{\bar{z}_j}/(1+x_je^{\bar{z}_j})$ is a number between 0 and 1 but we have no information on its value, being a combination of preference and technology parameters over market and home consumption. If this coefficient is 0, home production plays 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 the shares of market to home production. These targets hold exactly for $\sigma_j = 1$, but we do not impose this restriction on σ_j in any of the other calculations. The outcome for each sector is,[20]

$$\frac{x_2 e^{\bar{z}_2}}{1 + x_2 e^{\bar{z}_2}} \frac{\sigma_2 - \varepsilon}{\sigma_2} = 0.64 \tag{26}$$

$$\frac{x_3 e^{\bar{z}_3}}{1 + x_3 e^{\bar{z}_3}} \frac{\sigma_3 - \varepsilon}{\sigma_3} = 0.80. \tag{27}$$

The predictions for the ratios l_2/l_1 and l_3/l_1, when the values in (26) and (27) 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 σ_2. 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 5a and 5b for $\sigma_2 = \sigma_3 = 2.3$.[21] The model fits the data well for both sectors, except for the Korea outlier in sector 3. As before, the three lines are the 45^0 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 towards the 45^0 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 towards the 45^0 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

[20] A log linear regression estimate of (25) 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 ε, but still one that we would regard to be too high, 0.77, with p value 0.03.

[21] The predictions for $\sigma_2 = 1.5$ are virtually indistinguishable from the ones shown.

data goes down to 2.64.[22]

7 Can taxes and subsidies explain marketization?

Can taxes explain the cross-country differences in the marketization of time? The key equation of the model is (16), 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 6a and 6b show the results with the elasticities of substitution previously used, 2.3 in both sectors.[23] The model picks up well the difference between the Scandinavian countries and the rest of the sample in the marketization of family care, but the elasticity used (or the specification, which assumes common technologies and preferences) cannot distinguish between the other countries on the basis of the tax wedge alone. The correlation between data and prediction with $\sigma_2 = 2.3$ is 0.64. Results are virtually identical for a lower elasticity of substitution. For $\sigma_2 = 1.5$, the correlation improves slightly to 0.65 but the graph of the predictions against the data is indistinguishable from Figure 6a. Similarly, when the broader subsidy that includes health is included, the results are also very similar to the ones shown in Figure 6a. The correlation between data and predictions for $\sigma_2 = 2.3$ is 0.60 and rises to 0.63 when $\sigma_2 = 1.5$.

In contrast, the marketization of other services is explained well by the different tax rates, with the exception of Korea, which is an outlier. As before, the problem with this country is that its market hours in sector 3 are extremely high when compared with other countries, and with the lowest home hours in the sample as well it yields a ratio of market to home that is too high to be explained by policy alone.

One might speculate why the model fails to explain fully the marketiza-

[22] The problem with Korea is that it has 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.

[23] Simple log-linear regressions of equation (16) with the 19 observations for sectors 2 and 3 give respectively $\sigma_2 = 1.3$ ($p = 0.057$) and $\sigma_3 = 2.2$ ($p = 0.0005$). This ranking is consistent with our discussion in section 3.

tion of family care with policy, in light of recent work on culture and social norms. Our model points also to the ratio of market to home technology, and to differences in tastes over home and market production, as additional influences on the market-to-home substitution. In some countries there might be mistrust of government-sponsored childcare centres, or religion and other social norms might dictate that the care of family members - pre-school children or sick parents - should be done at home. Further work is needed to test whether the reasons for the differences in the distribution of work not explained by taxation are due to differences in tastes or technology, or to other factors.[24]

8 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 alone without the market-home substitution explain some of the differences in the allocation of time but not enough. Moreover, there are facts that they cannot explain at all, such as the fact that the main differences in the allocation of hours of work across countries are in two types of sectors, health and social work and unskilled services. When the market-home substitution is included in the model both can be explained, the larger response of market hours to taxes and the fact that the main impact of taxes is on health and social care and unskilled services, which have close home-produced substitutes.

The key mechanism of the model is two-fold. Taxes and subsidies cause substitutions across market goods, with consumers switching from taxed goods to subsidized ones. The elasticities involved here, however, are too small to explain the differences that we see in the data. But the taxation of market work makes people substitute home production for market production, and this margin is powerful enough to explain larger responses of market work to policy in sectors that produce goods that can also be produced at home. In addition, making use of data on home production from time use surveys, we found that although taxation explains a large part of the differences that we see in home production time across the OECD, there are also unexplained differences, especially in family care. These unexplained

[24]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. See for example, Esping-Andersen (1990, 1999), and Algan and Cahuc (2009), where questions related to religious beliefs and culture are investigated.

differences, which may be due to differences in tastes or technology, also contribute to the explanation of the differences in the allocation of market work across the countries in our sample.

9 Data appendix

Time use data

Time use data record activities at regular intervals (e.g. every 15 minutes) during a 24-hour day. For the purposes of this paper we extracted from time use surveys two numbers, time spent on caring for a child or an adult household member, including related travel time, and other home work time.

Home work in time use surveys includes activities that could be delegated but are done by members of the household, either inside or outside the home. The main activities are shopping, house and garden cleaning and maintenance, cooking, laundry, pet care and car care. Travel time is included with the corresponding activities, e.g. travel time to shops is included in shopping. Childcare is a separate item. Caring for others within the household is a separate item, although some surveys at our disposal did not report separately this item. The item is small, accounting for less than 20% of childcare time, and where missing we constructed a series for it from other information, as explained below. Caring for others outside the family was reported separately by a very small number of surveys but we could not get data for it for most countries. Where reported it was a very small item. Most surveys included it with other small activities in "other voluntary work", a small item that is part of other home production time.

The main data source for the European countries is the *Harmonised European Time Use Survey* (HETUS: https://www.testh2.scb.se/tus/tus/). It was the result of a cooperation between a number or national statistical institutes and Eurostat in the 1990s, with the objective to harmonize time use statistics in the European Union. The HETUS covers 9 of our 19 countries around the year 2000. They are Belgium (1998), Finland (1999), France (1998), Germany (2001), Italy (2002), Norway (2000), Spain (2002), Sweden (2000, age group 20+) and the United Kingdom (2000). Detailed national tables for each country are downloadable from the HETUS website. Each national table reports time use of population by age. We compute the time use for the 15+ category by weighting each group by its population size, using population data from the United Nations, *World Population Prospects* (http://esa.un.org/unpp/index.asp?panel=2).

The HETUS does not report explicitly the time taken for caring for house-

hold members. We obtained accurate data from the national source used by HETUS for Finland, Germany, Norway, Spain, and the United Kingdom. For the other countries HETUS reports a residual aggregate of "other household work," which includes caring for others as one of the main items. For Belgium and Italy we used Spain's ratio of "caring for others" to the HETUS "other household work" to get the time of caring for others from the HETUS residual. For France the HETUS residual was clearly misreported, as it was 1 minute a day for all age groups. We increased France's childcare time by Spain's fraction of caring for others to childcare. Finally, for Sweden we used the average decomposition of "other household work" for Norway and Denmark to obtain the time for caring for others from the HETUS aggregate.

For the remaining 10 countries, we use national time use statistics, as follows (in some cases, as indicated below, it was not possible to obtain data for the 15+ category but for a near age group):

Australia: 1997 Time Use Survey conducted by the Australian Bureau of Statistics (ABS). Tables are available from the publication, *How Australians Use Their Time 1997*, available online through http://www.abs.gov.au/AUSSTATS.

Canada: *General Social Survey* (GSS) conducted by Statistics Canada in 1998 and available online through http://www.statcan.gc.ca/. Adult care is included in a residual "other household work". We used the US fractions to decompose this item into caring for others and other items.

Denmark: Data are available only in Danish for 2001, age groups 15-74, translated and tabulated for this paper by Jens Bonker of the Rockwool Foundation Research Unit, Copenhagen (to whom we express our thanks).

Ireland: The *Irish National Time-Use Survey 2005* is a pilot survey conducted by Economic and Social Research Institute for the Department of Justices, Equality and Law Reform. We obtained the time use table from the publication, *Time-Use in Ireland 2005: Survey Report*. Age group 18+. (http://www.ucd.ie/issda/dataset-info/timeuse.htm)

Japan: The 2001 Survey on *Time Use and Leisure Activities* conducted by the Statistics Bureau, Ministry of Internal Affairs and Communications. (http://www.stat.go.jp/english/data/shakai/2001/unpaid/tabu.htm)

Korea: Data provided for this paper by the Korea Labor Institute, Seoul, following a visit by one of the authors in 2008 (C Pissarides). Data for 1999, age group 10+ (data also available for 2004 with virtually identical results).

Netherlands: Netherlands Institute for Social Research. At the time of writing detailed tables were available online in English but now discontinued. We obtained our aggregates from Burda et al. (2008), age group 20-74.

New Zealand: *Time Use Statistics 1999* prepared by Statistics New Zealand, tables downloaded from: http://www.stats.govt.nz/. Only total family care is available (childcare and adult care).

Portugal: *1999 Time Use Survey*, conducted by Instituto Nacional De Estatistica (INE). Table and document (in Portuguese) are downloadable from: http://www.ine.pt/

United States: *The American Time Use Survey 2003* by the Bureau of Labor Statistics (http://www.bls.gov/tus/).

Hours of work

Sectoral hours were obtained mainly from the database *Productivity in the European Union: A Comparative Industry Approach* (EU KLEMS), http://www.euklems.net/, file extension .08I, released March 2008. The following KLEMS sectors are in each one of our sectors:

Sector 1 includes KLEMS Sectors A (agriculture, hunting, forestry), B (fishing), C (mining and quarrying), D (manufacturing), E (electricity, gas, water), F (construction), G51 (wholesale trade), I62 (air transport), I64 (post and telecommunications), J (financial intermediation), K (real estate, renting and business services), O91 (activities of membership organizations nec) O911t2 (media activities)

Sector 2 is the KLEMS sector N (health and social work)

Sector 3 includes the KLEMS sectors G50 (sale and maintenance of motor vehicles and motorcycles), G52 (retail trade), H (hotels and restaurants), I60 (inland transport), I61 (other water transport), I63 (other supporting travel activities), O90 (sewage and refuse disposal), O92 (recreational, cultural and sporting activities), O923t7 (other recreational activities), O93 (other service activities)

Three countries are not in KLEMS: Canada, Norway, and New Zealand. We constructed their shares from the KLEMS predecessor, the OECD *Structural Analysis Database* (STAN), following the same sector decomposition.

Some data entries are missing. In all cases the missing entries were for very small sectors. We constructed the missing data series by assuming that the shares of the missing series within its sector were the same as the corresponding shares in neighboring countries with a similar industrial structure. In most cases the missing data were for media activities (sector O92 1&2). In the United States, where this sector is relatively large, it accounts for about 30% of hours in sector O, which accounts for about 6% of total hours. The "similar" country shares used to construct the media sector in the countries that it is missing were selected as follows: for Denmark we used the media's hours share for Finland. For Italy we used Spain's. For Japan we used Korea's. For the Netherlands we used the UK's. For Sweden we used Finland's.

STAN does not have a breakdown of hours for New Zealand but it has

total hours. We obtained employment data for industrial sectors by status (part time or full time) from the website of Statistics New Zealand, to calculate the shares of employment in individual sectors (weighting part-time employment by 25/40), and then multiplied these shares by total weekly hours for the 15+ population to obtain hours in each sector.

For Canada no data are available for the decomposition of sector O, we use US's shares to allocate hours within sector O sub-sectors. Similarly for Norway, we used Finland's shares to allocate total sector O hours to its components.

The population aged 15 and above that was used to derive per capita hours was obtained from *World Developments Indicators.*

Taxes

The tax rates were calculated from the data given in Nickell (2006), the OECD/CEP data set. Briefly, they are as follows.

The employment tax rate is defined as ESS/(IE-ESS), with ESS equal to employers' social security contributions and IE equal to total compensation for employees. ESS is available from the OECD *National Accounts* and IE from the OECD *Revenue Statistics.*

The direct tax rate is defined as DT/HCR, with DT equal to income tax plus employees' social security contributions and HCR equal to household current receipts. Income tax and employees' social security contributions were taken from the OECD *Revenue Statistics.* HCR was calculated from the OECD *National Accounts* as the sum of compensation of employees, property income, social contributions and benefits and other current transfers.

The indirect tax rate is defined as (TX-SB)/CC, with TX equal to indirect taxes, SB equal to subsidies and CC household final expenditures. All three were taken from OECD *National Accounts.*

For the employment subsidy we obtained total spending on active labour market measures (code 600) from the OECD *Social Expenditure Database* (SOCX) and divided it by total employee compensation from KLEMS. Data are missing for New Zealand, and we set this rate at the Australian rate (generally, this is a very small number for all countries).

The rates used in the paper were averages for 1994-2003. Most countries had complete data sets and all countries had at least some entries for those years, which were used to arrive at averages. The only exception is Korea, for which there were no tax data at all. For this country only we used the tax data available at the OECD *National Accounts: Korea.*

Social subsidies

The social subsidies are available in SOCX, 1980-2003, released 2007. Social expenditure are given as a percentage of each country's GDP. We multiplied by GDP from the OECD *National Accounts* to obtain the absolute amounts, and then divided by the gross output of the health and social work sector, available in KLEMS, to obtain the rates. The value of "benefits in kind" for the following social expenditure categories were aggregated to arrive at the social subsidy: old age (code 120), incapacity (code 320), and family (code 520). In all these categories the benefits in kind were for residential or day care and home-help services. The common feature uniting these items was that the employees delivering these "benefits in kind" worked in the health and social work sector.

Our broader health and social subsidy adds half of total spending on Health care, (code 420), also available in SOCX.

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Figure 1. Percentage distribution of hours of work, 1994-2003, sorted according to sector 2 size

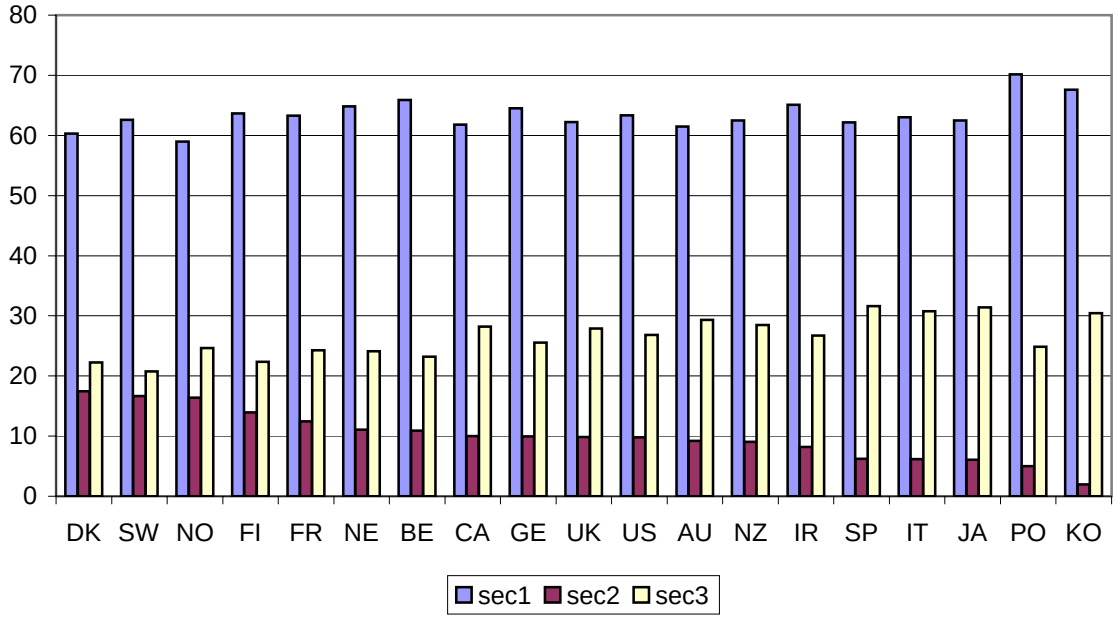


Figure 2. The calculated tax wedge, 1994-2003 (social subsidies only)

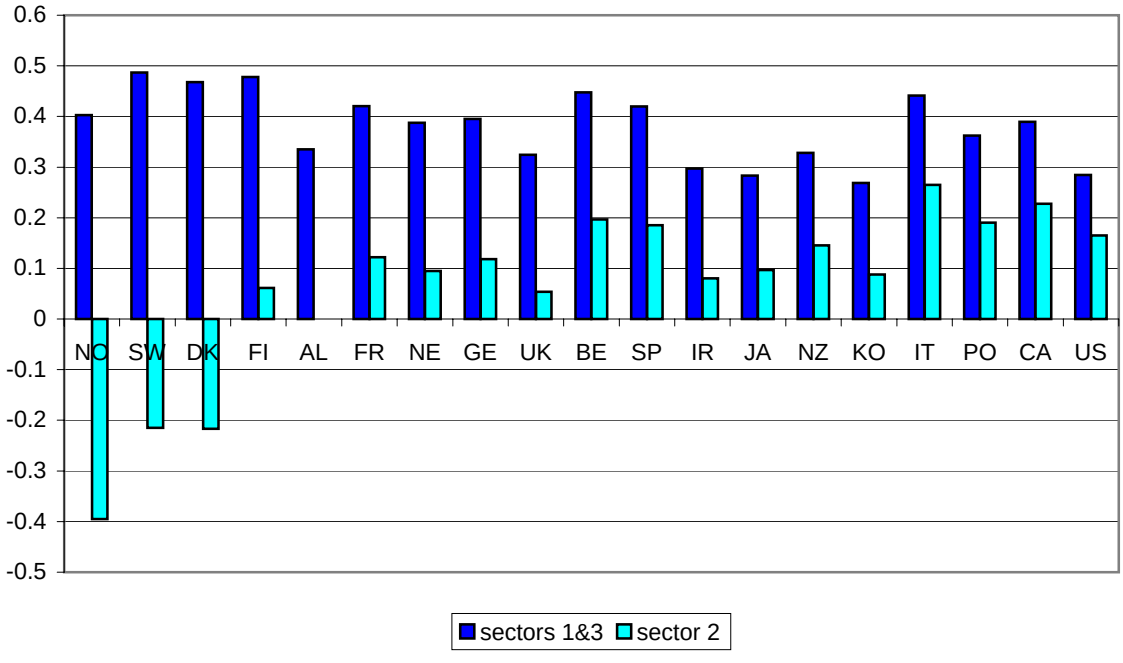


Figure 3a Predicted impact of taxation, share of health and social care sector

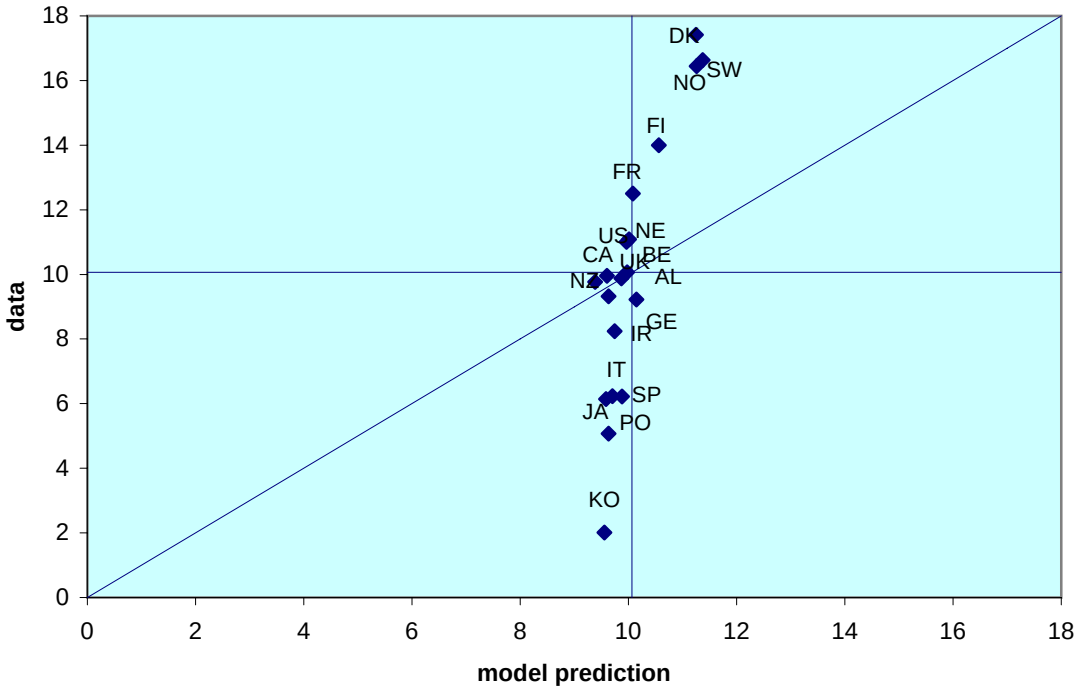


Figure 3b Predicted impact of taxation, share of health and social care sector, epsilon 1.5

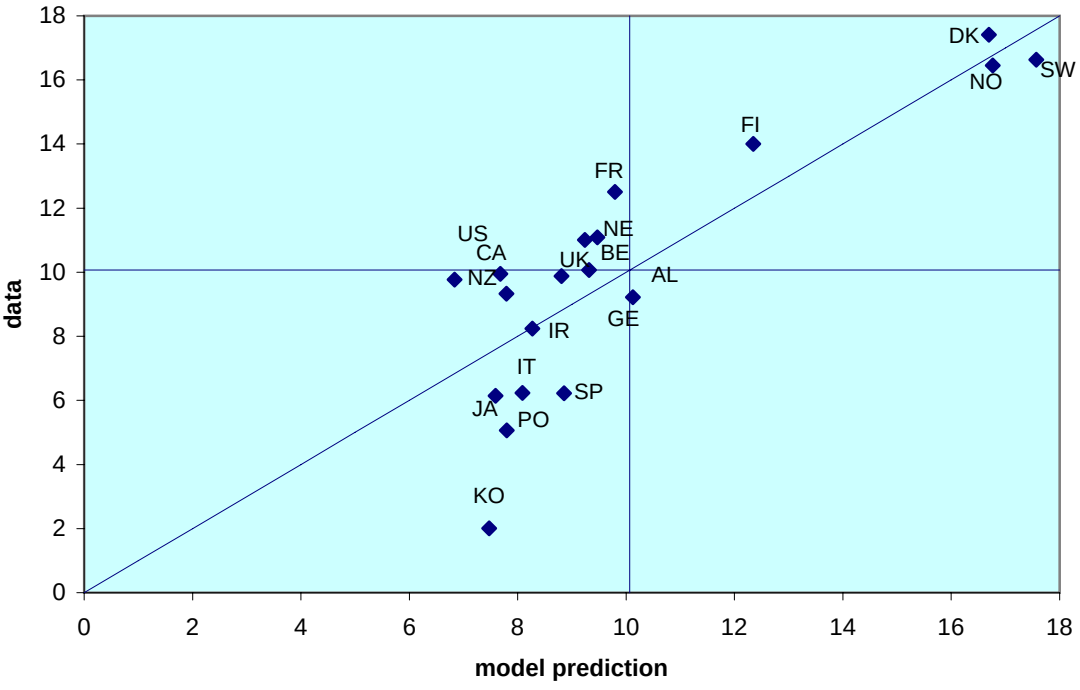


Figure 4. Required productivity ratio to match relative hours, deviations from log mean (mean=1)

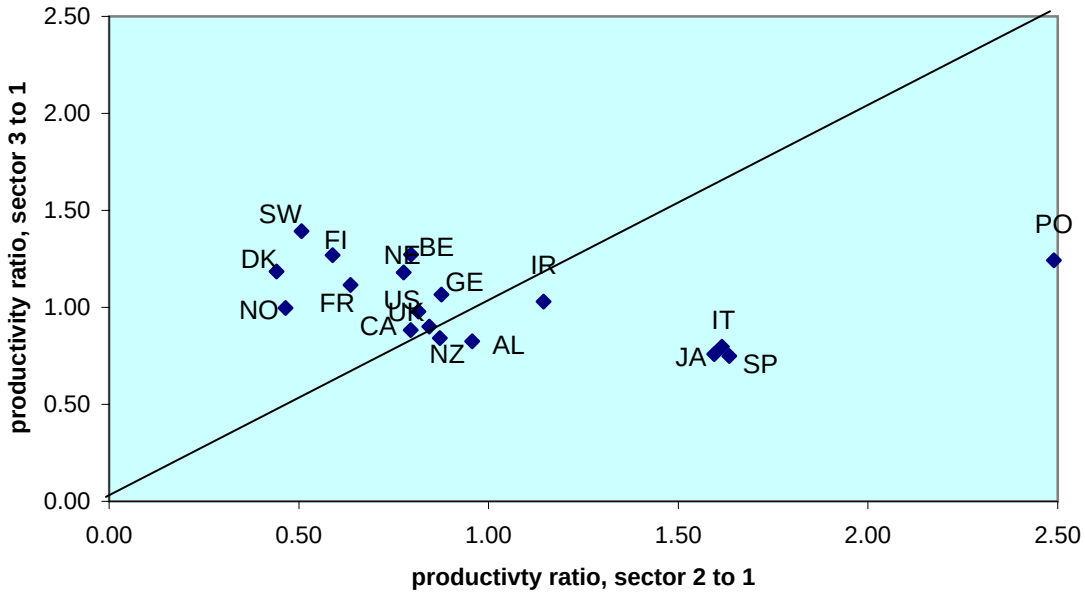


Figure 5a
Predicted sector 2 share, home production exogenous

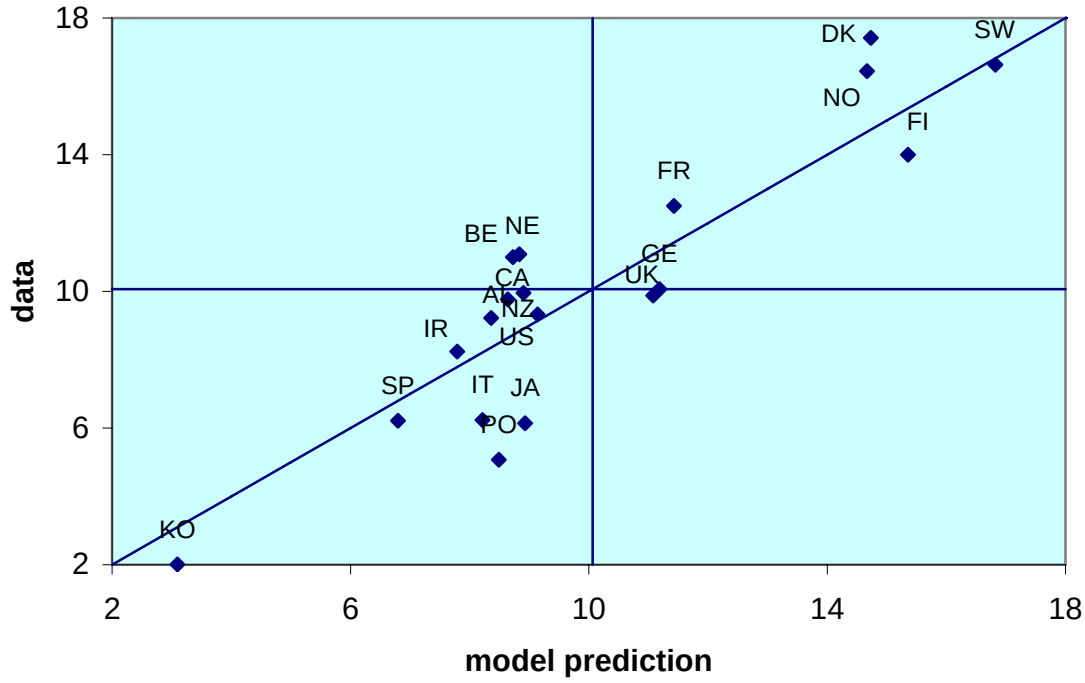


Figure 5b
Predicted sector 3 share, home production exogenous

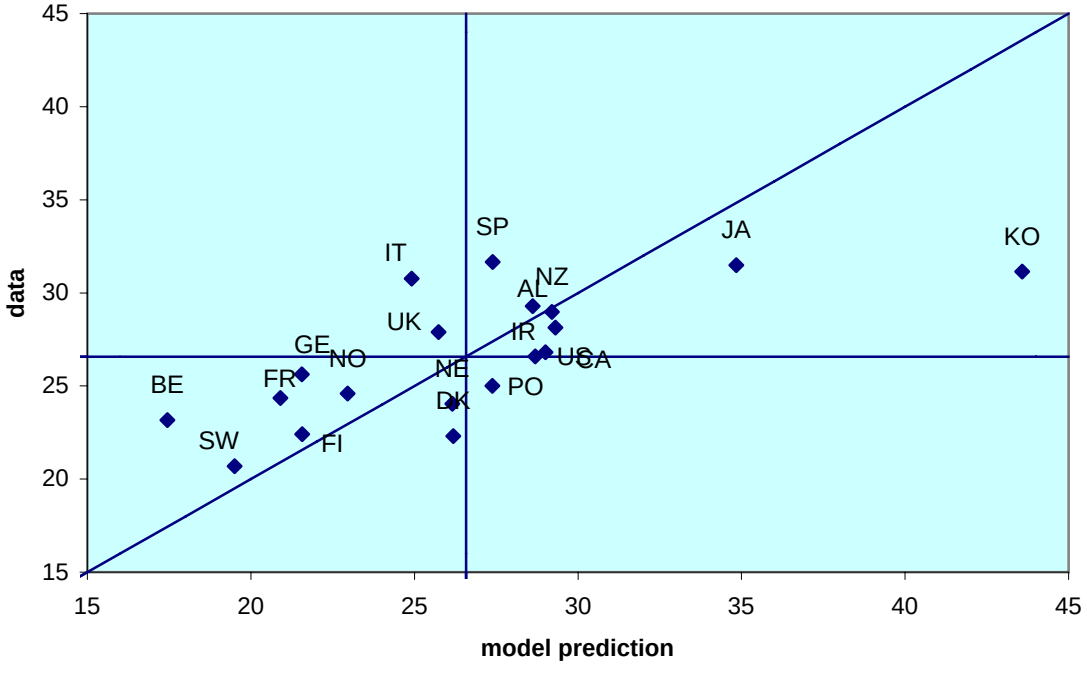


Figure 6a
Actual and predicted marketization in health and social work

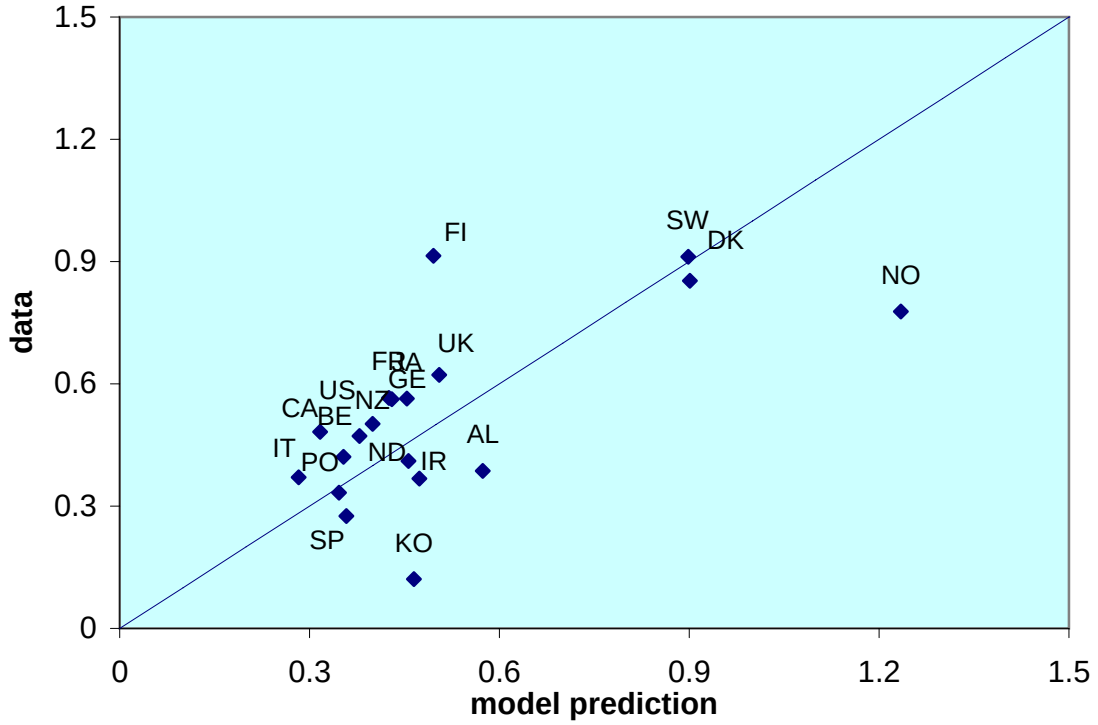
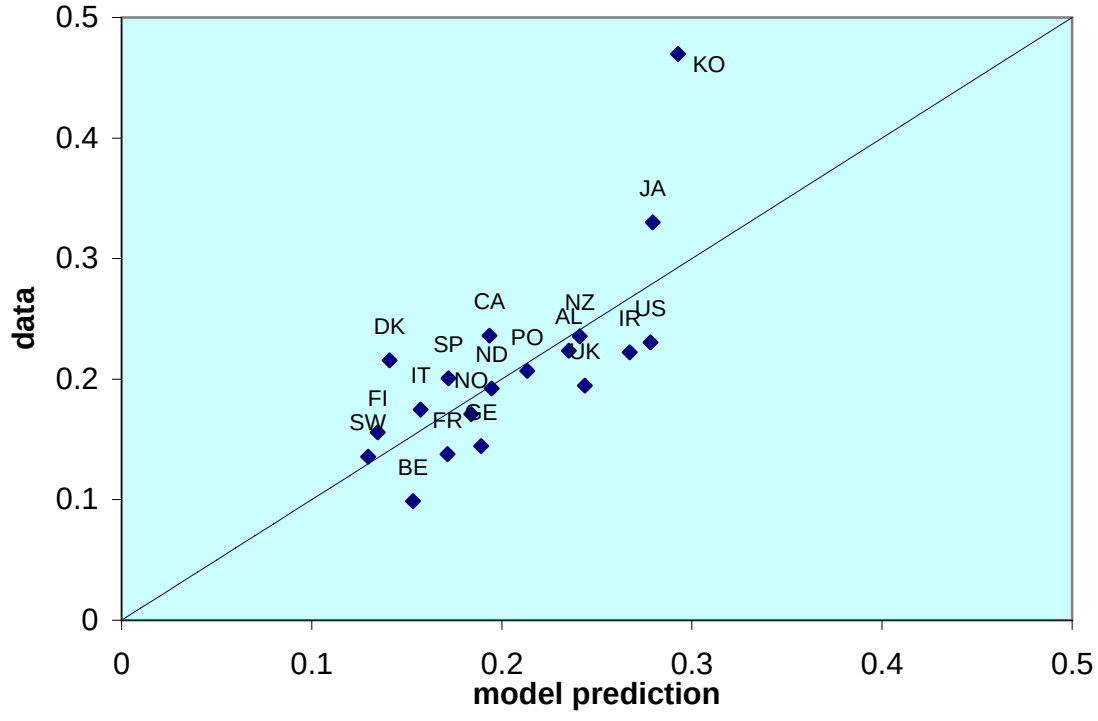


Figure 6b
Actual and predicted marketization in other services



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