

# **Public provision, commodity demand and hours of work: An empirical analysis**

by

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**Abstract:** Atkinson and Stiglitz (Journal of Public Economics 1976) show that when the government has access to non-linear income taxation and consumer preferences are separable between consumption and leisure, there is no need to differentiated commodity taxation. With similar conditions, public provision of private goods or over- or underprovision of public goods are not desirable. This paper examines the empirical validity of the Atkinson-Stiglitz theorem using consumer survey data from Finland. The data has extensive information on commodity demand, the use of public services and hours of work. When labour income is controlled for in a flexible, semiparametric, way we find that capital income and housing expenses are negatively associated with hours of work, whereas the use of child care is positively correlated with labour supply. These results suggest that capital income and housing should be taxed whereas day care ought to be subsidised.

**Key words:** commodity taxation, public provision of private goods, semiparametric methods.

**JEL classification:** C14, H21, H42

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## 1. Introduction

The information-based approach to optimal taxation builds on the idea that the income-earning ability of households is unobservable, and the government must base its tax policy on observable variables, such as income. The classic paper in this field is, of course, Mirrlees (1971), which characterises optimal (labour) income taxation under asymmetric information.

What is the role of other potential tax policy instruments when non-linear income taxation is used? The central result is due to Atkinson and Stiglitz (1976), who show that when consumer preferences are separable between consumption and leisure, there is no need to differentiated commodity taxation. Either commodity taxes are not needed at all or then they should be uniform. When preferences are separable, there is no difference between commodity demand between people with skill differences but who are at the same income level, and that is why commodity taxation cannot achieve anything which could not be achieved by the income tax alone. The same logic also applies to public good provision. The first-best Samuelson rule remains valid in the second-best case with separable preferences (Boadway and Keen 1993). And similarly, there is no need to public provision of private goods if the separability holds.<sup>1</sup>

If the separability condition does not hold, there is a potentially useful role for these other instruments to complement the income tax in the government's redistributive programme. In these circumstances goods that are complements with (substitutes to) labour supply (leisure) should be subsidised (taxed) (Edwards, Keen and Tuomala 1994). In addition, the government can benefit if it provides private goods (or overprovides public goods) that are used in conjunction with labour supply. The intuition is that lowering the effective price of these goods renders labour supply more attractive and thus the distortions of the income tax can be alleviated. The prime candidate of a good that should be subsidised or provided for free is child care: affordable child care enables both parents to participate in the labour market.

Despite the large amount of theoretical modelling in the area, there has been surprisingly little empirical work on characterising the relationship between commodity use and labour supply.

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<sup>1</sup> Boadway and Marchand (1995), Cremer and Gahvari (1997), Blomquist and Christiansen (1998) and Pirttilä and Tuomala (2002) are among authors who have studied the public provision of private goods using the two-type version of optimal income taxation by Stiglitz (1982) and Stern (1982). Mirrlees (1976) and Christiansen (1981, 1984) examined public good provision and commodity taxation in the continuum case.

For a long time, the only reference was Browning and Meghir (1991) that use UK consumption data to test the separability of consumer demand from labour supply. They first estimate a demand system, conditional on labour force participation and hours of work, and then test whether labour supply is a significant determinant of commodity demand. The issue has been revisited in a Mirrlees Review Chapter on indirect taxation by Crawford, Keen and Smith (2008). They also estimate a conditional demand system, allowing for quadratic Engel curves. Both these studies firmly reject the hypothesis of separability between consumption and labour supply. However, Crawford et al come to the conclusion that the economic magnitude of the likely gain from having non-uniform commodity taxation appears small. Taking into account the administrative burden associated with having a highly detailed commodity tax structure, Crawford et al end up recommending a uniform VAT rate for the UK.

Gordon and Kopczuk (2008) present an alternative approach for determining which goods should be part of the optimal tax base. They start from the notion that, with people at the same income level, there is still quite a lot of variation in the hourly wage rates these people have. Using US data, they then set to explain which additional information in the tax files helps to explain the residual variation in hourly wages, controlling for income. When income is controlled for in a flexible, semiparametric, way they find that people with higher wage rates (which implies that their hours of work are smaller, given labour income) obtain more capital income and pay higher mortgage payments. Spousal income is also the higher, the higher is the wage rate (assortative matching). These results thus suggest that capital income should be taxed and the current practice of favouring owner-occupied housing should be stopped.

In this paper, we use the same approach as Gordon and Kopczuk to shed light on how the use of different goods is associated with labour supply based on Finnish data. We enlarge their analysis by analysing the relationship between a whole set of commodity demand of the households and their labour supply. In addition, we also have detailed information on the use of public welfare services (education, health and social services) by these households. We can therefore offer a full analysis on the issue whether specific commodities reveal useful information on the households' income-earning abilities. These goods can be both privately and publicly provided. We use two different semiparametric methods (single-index models and partially linear models) to estimate these relationships. The benefit of the new approach by Gordon and Kopczuk is that it considerably simpler than the structural estimates used earlier, with less need to find plausible

instruments for labour supply (something which is very difficult with the data sets in use)<sup>2</sup>. The downside is, on the other hand, that since it is a reduced-form type of analysis, the results may not necessarily hold out of the initial equilibrium examined.<sup>3</sup>

The empirical studies mentioned above do not cover the effects of public provision on labour supply. To our knowledge, a similar separability analysis has not been carried out for the valuation of publicly provided private goods. There is, however, a strand of related literature with the aim of establishing causal relationships from public provision to labour supply. This work has been surveyed by Currie and Gahvari (2008). They conclude that while for example child care appears to have some role in boosting female labour supply, the main reasons for public provision must be related to paternalistic concerns.<sup>4</sup> In addition to the literature mentioned there, Lundin, Mörk and Öckert (2008) examine whether reductions in child care prices in Sweden increased female labour supply and Kosonen (2009) uses the municipal level variation of Finnish home-care allowance of children to identify the effect of child-care prices on female labour supply. Finally, Bastani, Blomquist and Micheletto (2009) present a simulation exercise of the impact of public provision on social welfare in comparison to the system of redistributing using the income tax alone. Our paper differs from this work by embedding public provision to the same set-up than private commodity demand.

The structure of the paper is as follows. Section 2 introduces our empirical approach, while the data used is discussed in Section 3. The results are presented in Section 4. Section 5 concludes.

## **2. Our empirical approach**

Gordon and Kopczuk (2008) set out explaining the variation in hourly wages, controlling for total income, with additional information in the tax files. We do not have an independent source of information for hourly wages and we use hours of work instead. We explain variation in hours of work controlling for total labour income and adding to the regression model items in

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<sup>2</sup> Browning and Meghir (1991) and Crawford et al (2008) use education as an instrument for labour supply when estimating a demand system conditional on labour supply. But as Browning and Meghir note, education is not necessarily a good instrument as it may have a direct effect on tastes on commodity demand.

<sup>3</sup> These aspects are discussed below in Section 2.

<sup>4</sup> The society might have commodity-specific egalitarian preferences, where equal access to some goods (such as health care) is seen as more important than equally distributed expenditure on other goods.

the basket of consumption goods or publicly provided welfare services, potential candidates for inclusion in the tax base, and test for their inclusion in the model. Simple application of the method would entail a parametric test whereby a specific functional form of behavioural equation is postulated. Following Gordon and Kopczuk we adopt a more flexible approach, estimating two semi-parametric regression models by local methods. The regressions are either of single-index (1) or partially linear (2) form

$$h_i = f(z_i + X_i' \beta_1) + \varepsilon_{1i}, \quad (1)$$

$$h_i = g(z_i) + X_i' \beta_2 + \varepsilon_{2i} \quad (2)$$

Above,  $h_i$  is the hours of work of individual/household  $i$ ,  $z_i$  is the individual's labour income,  $X_i$  is a vector of other information about this individual, and  $\varepsilon_{1i}$  and  $\varepsilon_{2i}$  are the error terms.

Similarly, as in Gordon and Kopczuk (2008), model (1) allows the relationship between hours of work and observables to be non-linear through unconstrained function  $f$  relating the observable information to hours of work. With no loss of generality we have set the coefficient of  $z_i$  equal to one. The function  $B_i = z_i + X_i' \beta_1$  characterizes the tax base that most closely approximates an individual's earnings ability. If the assumptions in Atkinson and Stiglitz (1976) are right the coefficients  $\beta_1$  should all be zero.

Both models are estimated by methods which are linear in  $h_i$ . In (1) we use weighted semi-parametric minimum least squares introduced by Ichimura (1993). If the functional form for  $f$  were known, we could use the nonlinear least squares method to estimate  $\beta_1$  by minimizing

$$\sum (h_i - f(z_i + X_i' \beta_1))^2 \text{ w.r.t. } \beta_1. \quad (3)$$

In the case of unknown  $f$ , for a given value of  $\beta$  we can estimate

$$E(h_i | z_i + X_i' \beta) = E(f(z_i + X_i' \beta_1) | f(z_i + X_i' \beta)) \quad (4)$$

by the kernel method (the equality follows from  $E(\varepsilon_{1i} | z_i, X_i) = 0 \Rightarrow E(\varepsilon_{1i} | z_i + X_i' \beta) = 0$ ).

Ichimura's method estimates  $f(z_i + X_i' \beta_1)$  by estimator  $F_{-i}(z_i + X_i' \beta)$  choosing  $\beta$  by (semiparametric) nonlinear least squares where  $F_{-i}(z_i + X_i' \beta)$  is a leave-one-out nonparametric kernel estimator of  $E(h_i | z_i + X_i' \beta)$ .

Expecting substantial heteroskedasticity in the error term we use weighted least squares suggested by Ichimura. In the first stage, we estimate equation (1) as written. Next we forecast the square of the resulting residuals by nonparametric regression. Finally, we weigh the observations in a second stage regression. The bandwidth for the single-index function is chosen by cross-validation methods, and the estimation is carried out using the np package in R (Hayfield and Racine 2007).

We augment the analysis based on (1) by the partially linear regression model (2) where potential candidates for inclusion in the labour supply equation enter the model linearly. In effect, our model (2) will test whether residual variation in hours of work,  $h_i - g(z_i)$  is independent of our other candidates in the tax base  $X_i' \beta_2$ . Taking conditional expectations of (2) conditional on  $z_i$ , we get

$$E(h_i | z_i) = g(z_i) + E(X_i | z_i)' \beta_2. \quad (5)$$

Subtracting conditional expectations gives

$$h_i - E(h_i | z_i) = (X_i - E(X_i | z_i))' \beta_2. \quad (6)$$

Model (6) is used to test whether our candidates for the tax base can successfully explain residual variation in hours of work  $h_i - E(h_i | z_i)$ . To estimate  $E(h_i | z_i)$  and the vector  $E(X_i | z_i)$  one could use kernel methods based on the conditional distribution function but we chose to estimate these functions by the locally linear weighted regression, lowess, introduced by Cleveland (1979). The locally weighted (linear) regression computes a locally linear fit  $\gamma_{0i} - \gamma_{1i} z_i$  for each observation, say  $h_i$ , by estimating the parameters  $\gamma_{0i}, \gamma_{1i}$  using weighted least squares and minimizing

$$\sum w(z_k) (h_k - \gamma_{0i} - \gamma_{1i} z_k)^2 \quad (7)$$

The weights  $w(z_k)$  decrease as the distance of  $z_k$  from  $z_i$  increases,

$$w(z_k) = W(d_i^{-1}(z_k - z_i)) \quad (8)$$

where  $d_i$  is the distance from  $z_i$  to the  $r^{\text{th}}$  nearest neighbour of  $z_i$ . That is  $d_i$  is the  $r^{\text{th}}$  smallest number among  $|z_i - z_j|$  for  $j = 1, \dots, n$ . The weight function  $W$  is “tricube”,  $W(x) = (1 - |x|^3)^2$  for  $|x| < 1$ , and  $W(x) = 0$ , otherwise, for details, see Cleveland (1979). The ratio  $r/n$  characterizes

the bandwidth of the smoothing window in terms of the empirical distribution function. The bandwidth for the reported results is set to 0.5 (meaning that 50% of the observations are used at a time). For the estimations, the `plreg` command of STATA is used (Lokshin 2006).

The first model estimates a local link between hours of work and the single index characterizing the tax base. The second uses the local link between hours of work and labour income to test for significance in explaining the residual variation in hours of work left after accounting for labour income. In this respect the second model can be considered as a statistical interpretation of the Atkinson-Stiglitz result and answering whether commodity taxation can achieve anything which could not be achieved using a on a non-linear income tax schedule. In the model income and commodity demand are not treated symmetrically. On the other hand, the single-index model, a version of Gordon and Kopczuk treats all observables in a symmetric fashion. We prefer tests of the Atkinson-Stiglitz result which are based on residual variation in hours of work.

Our right-hand side variables are outcomes of a complicated optimising decision on the part of the households. Therefore our analysis is based on a reduced-form type of model with its well-known pitfalls.<sup>5</sup> In particular the results may not necessarily hold out of the initial labour supply equilibrium which is conditional on the existing income tax schedule. At best the result may be expected to hold for only local, marginal changes. However, we suspect that the results of Browning and Meghir (1991), who use UK consumption data to test the separability of consumer demand from labour supply, may suffer from similar problems. Changes in tax schedule can be expected to affect labour supply equilibrium in a complicated non-linear way, leaving the analysis based on using educational levels as instruments for labour supply vulnerable.

### **3. Data**

Our source of data is the Statistics Finland's household budget survey in 2006 (Statistics Finland, 2008). The survey produces data on consumption expenditure of households, on the housing conditions, possession of durable goods, and income among households. The survey is

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<sup>5</sup> In our data hours of work, uptake of publicly provided services, and consumption expenditures are recorded using separate sources of information. Therefore we do not suspect correlation across the three key sets of variables through say accounting identities (adding-up restrictions) in the data. Similarly, the measurement errors should be independent across these three sets of variables, and measurement errors should not affect the power of our tests under the null hypothesis.

a sample survey whose final sample size comprised 4,006 households. The data are collected with interviews, diaries and purchase receipts kept by households, and extensive use of administrative registers.

Consumption expenditure is classified according to the national COICO-HBS classification (around 900 headings) with 12 main categories of consumption: food and non-alcoholic beverages; alcoholic beverages and tobacco; clothing and footwear; housing, water, electricity and other fuels; furnishings, household equipment and maintenance; health; transport; communication; recreation and culture; hotels and restaurants and the final category, miscellaneous goods and services. Most expenditure data are collected on a two-week time-period with diaries and purchase receipts.

Tax and income data are recorded on a yearly basis using mainly records from administrative registers. Some data are collected through a comprehensive interview. The aim of this is to give supplementary information about tax-exempt components of income and purchases of durables, as well as information relating to the composition and size of the households and demographic and socio-economical variables.

The 2006 data is the first survey in Finland which collected information both about hours of work on the time period when expenditure data are collected and uptake of welfare services provided by the society (education, health and social services). We measure hours of work as the mean joint hours of the couple; i.e. hours of the reference person plus hours of the spouse (if spouse exists), divided by two. We want to capture the potential correlations of the right-hand side variables on both the extensive and intensive margin of labour supply and that is why zero hours are also included.<sup>6</sup>

Labour income is the sum of wage income and entrepreneurial income (classified as earned income). Capital income contains the households' rental income, interest income, dividends and capital gains. Note that we do not include social security transfers to our notion of income. The reason is that we follow the optimal tax literature in viewing both taxes and transfers as a part of the redistributive system. Therefore, we analyse factor income instead of disposable income. All

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<sup>6</sup> For descriptive statistics of the data used, see Table 1.

income and consumption expenditure are measured as thousands of euros for the regression analysis.

The provision of welfare services is financed from public sources.<sup>7</sup> The customer does not pay anything or pays only a small user fee that does not fully cover the costs of producing the services. The measurement of the use of welfare services warrants some comments. Since it is beyond the scope of the present analysis to determine the willingness to pay for these, we use the production costs of the services used. These are calculated by Statistics Finland on the basis of the mean realised production costs of these services at the municipality level. An alternative would be to use for example the number of visits to hospitals, but visits can differ on the basis of their value. Nominal costs are one, albeit an imperfect, way to make the use of services comparable across categories.<sup>8</sup>

#### **4. Results**

We report results for three different equations. The first model (Table 2) presents results on the 12 main categories of private consumption. Second, some consumption categories are split into subgroups (for example, housing is divided into different types of housing expenses). These results are presented in Table 3. Finally, Table 4 contains results for the use of public welfare services.

In all regression models, the dependent variable is the joint hours of a couple (this notion was defined above). The regression equations contain dummy variables for the age group of the reference person of the households, a dummy for having a spouse, and variables for the number of other adults in the households and the number of children (in different age categories).

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<sup>7</sup> In 2006 Finnish households profited on average EUR 6,200 from the use of welfare services provided by the society.

<sup>8</sup> The same approach is used when the value of social services is taken into account in the measurement of inequality of well-being.

<sup>10</sup> Since we unfortunately do not yet have std errors for the single-index model (coding in progress...), these interpretations are based on the results from the partial linear models.

We report results for both a partially linear model, where wage income is the nonparametric part and all other variables enter the model in a linear fashion. In these models, we use the locally linear estimator of Cleveland (1979), lowess, for the nonparametric part. The bandwidth for the reported results is set to 0.5 (meaning that 50% of the observations are used at a time). In the single-index model, we use a standard kernel estimate and the bandwidth is chosen by cross-validation method.

Figure 1 depicts a scatter plot between labour income and the joint working hours of the couple. In addition, the graph includes the fitted lowess curve between these two variables. As expected, the relationship is positive (higher wage rate is associated with higher income levels), but the relation appears to be non-linear. The important point is that on top of the positive relationship, there is quite a lot of variation in hours of worked at a given income level, and therefore scope for the other variables to explain part of this residual variation.

Results for the basic set of consumption categories are presented in Table 2.<sup>10</sup> The first thing to note that in this regression, as in all the others, capital income is highly significant and it is negatively associated with hours of work. This is the same result as the one derived by Gordon and Kopczuk (2008). Two plausible explanations are, first, an income effect, and second, that people with higher skill level tend to save more and therefore also earn more capital income (see for instance the discussion of the evidence in Banks and Diamond 2008). Capital income can therefore be seen as one variable that reveals important information about the skill levels, and since it enters with a negative sign, it should be taxed at the margin.

Almost all of the other consumption categories are not significant; the exception is housing expenses, which are negatively related to hours of work.<sup>11</sup> Therefore, it appears that at this level of aggregation, there is little need for differentiated commodity taxation of various consumption categories. Private education expenses are also negatively related to hours of work, presumably because then the person cannot be working at the same time.

Housing is currently favoured to a large extent by the tax system (mortgage payments are tax deductible and the income from owner-occupied housing is not taxed), which might have led to overconsumption of housing. This practice is clearly at odds with the observation that housing is

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<sup>11</sup> The same observation about housing is also in Gordon and Kopczuk (2008).

actually negatively related to hours of work. The reason for the negative association can be that higher housing expenses reflect higher expected lifetime income for people with high skills but low current hours. The point estimate (-0.28) implies that if annual housing expenses increase by a thousand euros, working hours are reduced by 2 per cent; a result with some policy importance, too.

Table 3 present results for commodity demand when various interesting sub-items of consumption are analysed separately. This analysis reveals that all types of housing enter with a negative sign, but (somewhat surprisingly) expenses on holiday homes are not significant. On transport items, car use – commuting – is positively related to hours of work, but (again somewhat surprisingly) public transport is not. Not all types of leisure expenses are negatively related to labour supply, but for some reason book and magazine expenses are (perhaps reading is so time consuming). And finally, meals eaten at work are clearly related to working hours. This is, we believe, quite plausible!

Results on publicly provided welfare services are presented in Table 4. The most important result is that child-care use for children who are 3 years of younger is positively related to the hours of work, confirming the intuition behind various theoretical papers (e.g. Blomquist, Christiansen and Micheletto (2009)) that child care is a prime example of a publicly provided (and heavily subsidised) good that could boost labour supply. The reason why the age of the child appears to influence the result is probably related to Finnish child-care institutions. For children below 3 years of age, if one of the parents stays at home and takes care of the child, he or she is entitled to a home-care allowance by the state. In addition, many municipalities pay a supplement to the home-care allowance, making it an attractive alternative to especially low-wage parents. Children who are older than 3 years are more often at day care. Then the difference on who uses the day-care system and who does not is not necessarily related to the employment status of the parents.<sup>12</sup>

Another potentially interesting public service is the care of the elderly, or social services more generally (such as household help for people at need). However, these are not positively related

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<sup>12</sup> In fact, the municipalities are mandated by law to offer child care also to children whose parents are unemployed, students are otherwise not working. This makes the actual Finnish day care policy very different to the theoretical analysis in e.g. Blomquist et al (2009) who examine day-care service use that is related to hours of work on one-to-one basis.

to the hours of work, perhaps because the overall use of these services is small and they are also provided to persons out of the labour force.<sup>13</sup> The fact that education and health-care services have a negative relationship with labour supply is understandable in this static framework. A proper analysis of the value of these services for labour supply clearly requires a dynamic framework where access to good health care now could enhance income-earning abilities later.

We have conducted some robustness analysis regarding these results. First, we have tested a somewhat larger (0.75) and smaller (0.25) bandwidth for the partially linear model. This does not influence the qualitative results. Another change that does not influence the qualitative results regarding other variables is if capital income is removed from the linear part and all factor income is included in the nonparametric part. Neither does measuring commodity demand as shares from overall consumption instead of actual euros used. We have also looked at how the results differ by the family type (singles, couples, couples with children, single parents). Much of the variation appears to originate from families with parents and children; their consumption pattern seems to vary more than that of the others. For couples without children, expenses on some sort of durables are negatively associated with labour supply (perhaps if these people put a lot of attention on decorating their homes, leisure becomes too attractive). Capital income is negatively associated with labour supply for all household types except single parents (most of whom do not have much capital income at all).

Finally, if the whole model is estimated with OLS, without a flexible income control, many more of the right-hand side variables become significant. This can be interpreted so that having a flexible way to address differences in income is crucial for having little need to differentiate commodity taxation by commodity type. Therefore, the presence of the non-linear income tax can be regarded, as optimal tax literature does, as an important tool to make uniform commodity taxation desirable.

## 5. Conclusion

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<sup>13</sup> Since the elderly usually live in different households than their adult children, we cannot capture how the access to the care of the elderly might help boost the labour supply of their children using this data set.

This short paper examined to what extent commodity demand and the use of public welfare services are related to hours of work, once one keeps income fixed with flexible, nonparametric methods. This can be seen as a test on to what extent these goods are separable from labour supply, i.e. it is one way to investigate the scope of the Atkinson and Stiglitz (1976) result. The data is household budget survey data from Finland, with enough information on the hours of work, commodity demand, and the value of the social welfare services used.

The results reveal that capital income and housing expenses are negatively related to hours of work, whereas the connection between the use of day care services and labour supply is positive. These results suggest that capital income should be taxed at the margin, and the current practice of favouring housing (via mortgage payments deductions and exempting imputed income from owner-occupied housing) is unwarranted. However, there might be other reasons (such as non-welfarist concerns) to subsidise rental housing.

The current practice in, for example, many EU countries of having lowered VAT rates on some consumption items, such as food expenditure, does not seem to be desirable based on our analysis. The distributional aims behind taxing food at a lower rate could be achieved with smaller efficiency costs via the income tax and transfer system.<sup>14</sup> The key for having little need for not addressing distributional concerns via indirect taxation is the opportunity to tax income in a non-linear way: with only a linear income control, many more of the commodity categories become significantly associated with working hours. On the other hand, in developing countries where the implementation of income taxation is more difficult, the need to address distributional concerns via commodity taxation is more pressing.

In further work, it would be very important to examine these issues using rich panel data. This would allow analysing the importance of, especially, the impact of many of the public services on labour supply over a longer period of the households' lives. Another important extension is related to examining the potential differences in the results arising from different methods of evaluating separability (the indirect approach used here and the more structural demand estimates of Browning and Meghir 1991).

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<sup>14</sup> Interestingly, the VAT rate on food is scheduled to be cut from 17 to 12% in autumn 2009 in Finland. Food producers were active in lobbying for the tax cut.



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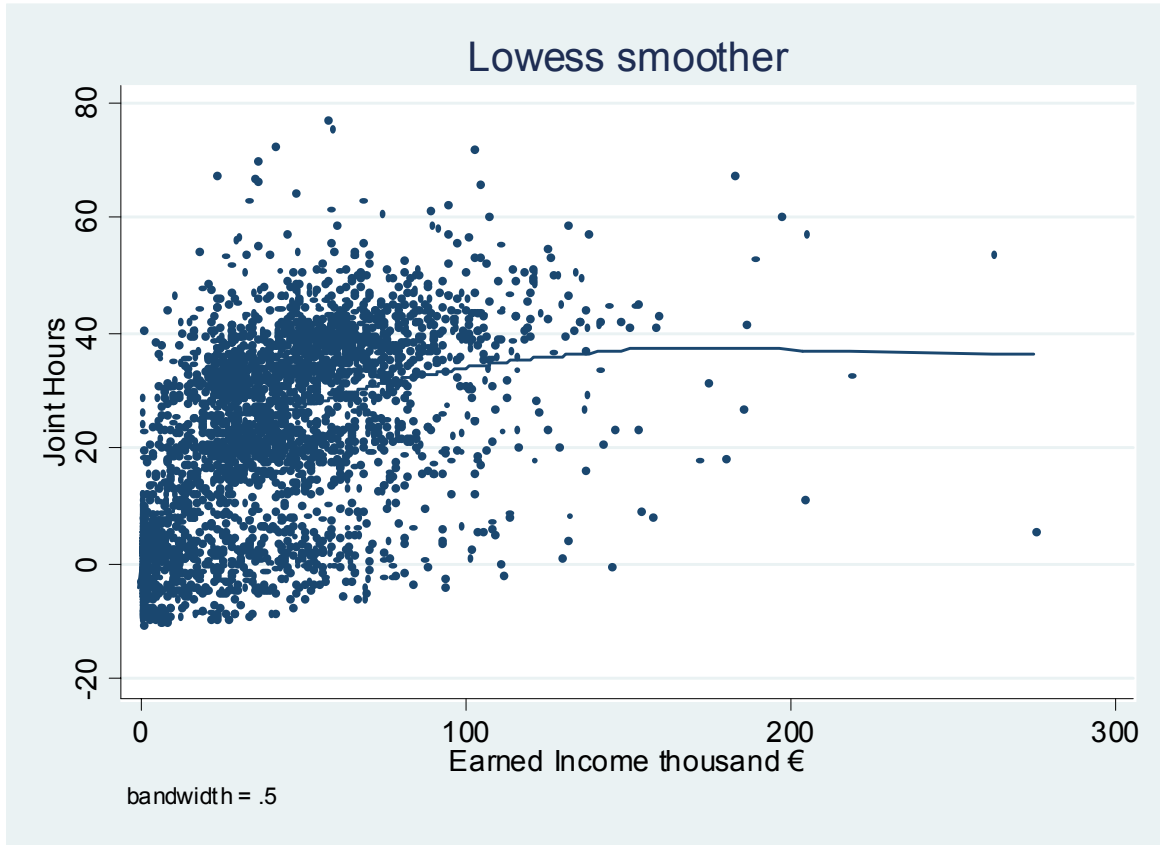


Figure 1: The relation between labour income and hours of work. For the lowess smooth, the bandwidth is 0.5.

| Category               | Variable                  | Obs  | Mean     | Std. Dev. | Min    | Max      |
|------------------------|---------------------------|------|----------|-----------|--------|----------|
| Hours and income       |                           |      |          |           |        |          |
|                        | Joint hours               | 4006 | 17.98977 | 17.58469  | 0      | 75       |
|                        | Wage income               | 4006 | 33342.25 | 32783.17  | -13936 | 275304   |
|                        | Capital income            | 4006 | 6877.628 | 15611.95  | 0      | 527983   |
| Commodity demand       |                           |      |          |           |        |          |
|                        | Food                      | 4006 | 4403.317 | 2597.108  | 0      | 26171.08 |
|                        | Alcohol and tobacco       | 4006 | 741.2318 | 1114.342  | 0      | 14367.86 |
|                        | Clothing and footwear     | 4006 | 1286.907 | 2545.298  | 0      | 71981.78 |
|                        | Housing and energy        | 4006 | 8950.544 | 4551.233  | 0      | 42200    |
|                        | Durables                  | 4006 | 1672.607 | 2191.831  | 0      | 34691.16 |
|                        | Health                    | 4006 | 1198.215 | 1797.56   | 0      | 48337.58 |
|                        | Traffic                   | 4006 | 5466.547 | 7780.044  | 0      | 84394.22 |
|                        | Communication             | 4006 | 960.4932 | 733.0943  | 0      | 8580     |
|                        | Culture and leisure       | 4006 | 3759.606 | 4915.094  | 0      | 196408.2 |
|                        | Education                 | 4006 | 68.15947 | 341.2179  | 0      | 10000    |
|                        | Hotels and restaurants    | 4006 | 1352.8   | 1857.309  | 0      | 40872    |
|                        | Other services            | 4006 | 3997.267 | 3448.737  | 0      | 32043.1  |
| Use of public services |                           |      |          |           |        |          |
|                        | Primary school            | 4006 | 1797.183 | 7220.368  | 0      | 148175   |
|                        | Secondary school          | 4006 | 568.3844 | 3128.42   | 0      | 106528   |
|                        | Higher educ (adults)      | 4006 | 752.6947 | 2547.58   | 0      | 29880    |
|                        | Higher educ (children)    | 4006 | 592.6558 | 3252.89   | 0      | 79828    |
|                        | Adult education           | 4006 | 122.1368 | 508.957   | 0      | 12400    |
|                        | Health care               | 4006 | 2150.289 | 6640.782  | 0      | 165502   |
|                        | Health insurance payments | 4006 | 549.4598 | 1747.148  | 0      | 53157    |
|                        | Day care ( < 3 years old) | 4006 | 149.6849 | 1010.501  | 0      | 18157.34 |
|                        | Day care ( > 3 years old) | 4006 | 718.9372 | 3171.636  | 0      | 41247.34 |
|                        | Social services           | 4006 | 91.60559 | 1280.781  | 0      | 48084    |
|                        | Social services, children | 4006 | 17.95007 | 604.742   | 0      | 36120    |
|                        | Social services, adults   | 4006 | 49.80929 | 970.2606  | 0      | 48084    |
|                        | Other social services     | 4006 | 21.19421 | 274.0963  | 0      | 8360     |
|                        | Health care at work       | 4006 | 82.82576 | 356.1894  | 0      | 10560    |

Table 1: Descriptive statistics. Working hours are measured as weekly hours, all other variables are € per year.

|                        | Partially<br>linear<br>model<br>Coef. | Std. Err. | Single<br>index<br>model<br>Coef. |
|------------------------|---------------------------------------|-----------|-----------------------------------|
| Capital income         | -.077213**                            | .0177162  | -0,7196                           |
| Food                   | -.106404                              | .1266834  | -0,6608                           |
| Alcohol and tobacco    | .3437849                              | .2197072  | 0,8005                            |
| Clothing and footwear  | -.0164324                             | .1014865  | 0,0921                            |
| Housing and energy     | -.2758652**                           | .067911   | -0,8946                           |
| Durables               | .0095728                              | .1209381  | -0,3509                           |
| Health                 | -.1997732                             | .1363334  | -0,3934                           |
| Traffic                | .0200679                              | .0329544  | 0,073                             |
| Communication          | .1458385                              | .4009559  | 1,064                             |
| Culture and leisure    | -.0179314                             | .0577216  | 0,069                             |
| Education              | -1.429105*                            | .7026148  | -0,688                            |
| Hotels and restaurants | .2992733*                             | .1487105  | 1,1472                            |
| Other services         | .0746465                              | .095158   | 0,0703                            |

Table 2: Estimation results for commodity demand. Dependent variable: average working hours of a couple. In the partially linear model, the non-parametric variable is labour income. Other control variables used: age dummies of the reference person the households, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.5. In the single-index model, a constant kernel is used with a bandwidth of 0.718. \* denotes significance at the 5 per cent level and \*\* at the 1 per cent level.

|                           | Partially<br>linear<br>model |           | Single index<br>model |
|---------------------------|------------------------------|-----------|-----------------------|
|                           | Coef.                        | Std. Err. | Coef.                 |
| Capital income            | .0705403**                   | .0179116  | -0,4232               |
| Food                      | -.0623708                    | .1277679  | -0,372                |
| Alcohol                   | .3199166                     | .2876886  | 0,872                 |
| Tobacco                   | .4285779                     | .4402288  |                       |
| Clothing and footwear     | .0094556                     | .1016521  | 0,0704                |
| Actual home               | -.258335***                  | .0689699  | -0,821                |
| Holiday home              | -.1802816                    | .3817667  | -2,9647               |
| Secondary home            | -.877628*                    | .3871845  | -0,5474               |
| Durables                  | .0561421                     | .1230993  | -0,2863               |
| Health                    | -.1612448                    | .135873   | -1,1597               |
| Car purchase              | .0049415                     | .0373358  | 0,1098                |
| Car use                   | .17831*                      | .0844782  | 0,2082                |
| Public transport          | -.3079871                    | .1715548  | -0,5272               |
| Communication             | .2451721                     | .4031626  | 0,6833                |
| Audio and video equip.    | -.1305764                    | .2642393  | 0,9771                |
| Other leisure equip.      | .0729005                     | .0748739  | 0,3505                |
| Sports equip.             | -.0068337                    | .2536548  | 0,8874                |
| Concerts, sports ev. etc. | .186247                      | .1813646  | -0,0572               |
| Books and magazines       | -1.154128**                  | .3676492  | -3,2618               |
| Holiday trips             | -.259516                     | .1617582  | -0,2536               |
| Education payments        | -1.205509                    | .6997474  | -0,8338               |
| Hotels and restaurants    | .1191348                     | .1777203  | -0,0381               |
| Office meals              | 1.901293**                   | .511124   | 2,3308                |
| Hotels and restaurants    | .0766956                     | .4529888  | 0,0265                |
| Other services            | .1064523                     | .101576   | -0,2212               |
| Social services           | .3036426                     | .275203   | 0,8201                |

Table 3: Estimation results with more detailed commodity structure. Dependent variable: average working hours of a couple. In the partially linear model, the non-parametric variable is labour income. Other control variables used: age dummies of the reference person the households, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.5. In the single-index model, a constant kernel is used with a bandwidth of 0.441. \* denotes significance at the 5 per cent level and \*\* at the 1 per cent level.

|                              | Partially<br>linear<br>model<br>Coef. | Std. Err. | Single<br>index<br>model<br>Coeff. |
|------------------------------|---------------------------------------|-----------|------------------------------------|
| Primary school               | .041481                               | .0659179  | -0,4399                            |
| Secondary school             | .0262964                              | .1141423  | 0,0729                             |
| Higher educ (adults)         | -.1299094                             | .100625   | 0,2135                             |
| Higher educ (children)       | -.2203405                             | .1144873  | -0,4385                            |
| Adult education              | -1.078986*                            | .4624283  | -1,5591                            |
| Health care                  | -.0071634                             | .0360961  | 0,05478                            |
| Health insurance<br>payments | -.0891963                             | .1358622  | -0,9269                            |
| Day care ( < 3 years old)    | .7120242*                             | .3416766  | -0,1765                            |
| Day care ( > 3 years old)    | .0988889                              | .1355607  | 0,0629                             |
| Social services              | .0333882                              | .2587816  | -0,5337                            |
| Social services, children    | -.3844866                             | .4143542  | 0,0638                             |
| Social services, adults      | .1441857                              | .3463185  | 0,1545                             |
| Other social services        | -.1299133                             | .849678   | -1,1196                            |
| Health care at work          | 1.011836                              | .6643851  | 1,6963                             |

Table 4: Estimation results for the use of welfare services. Dependent variable: average working hours of a couple. In the partially linear model, the non-parametric variable is labour income. Other control variables used: age dummies of the reference person the households, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.5. In the single-index model, a constant kernel is used with a bandwidth of 4.03. \* denotes significance at the 5 per cent level and \*\* at the 1 per cent level.