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

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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 for differentiated commodity taxation. This paper examines the empirical validity of this claim using consumption data from Finland. The data have extensive information on commodity demand, the use of public services and hours of work. When labour income is controlled for in a semi-parametric way, we find that capital income and housing expenses are negatively associated with hours of work, whereas the use of child care is somewhat positively correlated with labour supply. These results suggest that capital income and housing should be taxed whereas day care could perhaps be subsidised.

Key words: commodity taxation, public provision of private goods, semi-parametric 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 for 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 that could not be achieved by 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 for the public provision of private goods if the separability assumption holds.[1]

If the separability condition does not hold, there is a potentially useful role for these other instruments to complement the income tax in the governmentôs redistributive programme. In these circumstances, goods that are complements to (substitutes for) labour supply (leisure) should be subsidised (taxed) (Edwards, Keen and Tuomala 1994). In addition, the government can benefit if it provides private goods (or over-provides 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.

[1] 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.

Another reason to deviate from uniform commodity taxation arises from taste differences. Even if preferences are separable, but consumption preferences depend on ability, persons with the same income level but having different innate abilities have different consumption baskets. Then differentiated commodity taxation is an indirect way to tax ability (Saez 2002).

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. For a long time, the only reference was Browning and Meghir (1991), who 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 out 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, semi-parametric, 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 the wage rate (assortative matching) is. 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 a similar approach to Gordon and Kopczukôs 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 the householdsô commodity

demands 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. While the general guidelines of public provision are decided by the government, individuals themselves can decide the extent to which they use these services. One example is day care that can either be used (with a heavily subsidised fee) or not. Therefore the choices regarding the use of public services also reveal useful information on the individualsô characteristics. In sum, we can offer a full analysis on the issue about whether specific commodities reveal useful information on the householdsô income-earning abilities. These goods can be both privately and publicly provided.

The empirical studies mentioned above do not cover the effects of public provision on labour supply. Despite numerous theoretical papers on the subject, 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.[2] 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 as 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 discusses the robustness of the basic results. Section 6 concludes.

[2] Society might have commodity-specific egalitarian concerns, where equal access to some goods (such as health care) is seen as more important than equally distributed expenditure on other goods.

2. Our empirical approach

We explain the variation in hours of work controlling for total labour income and adding to the regression model items in the basket of consumption goods or government-provided welfare services, potential candidates for inclusion in the tax base, and test for their inclusion in the model of labour supply. In contrast, Gordon and Kopczuk (2008) set out to explain the variation in hourly wages, controlling for total income, with additional information from the tax files. The idea is that one would ideally like to tax the income-earning ability, and this sort of regression reveals which commodities are correlated to the ability at a given income level, and they should therefore be taxed.

In a simple framework, income is the product of working hours and the hourly wage. Then once income is controlled for, if the individual works few hours, he or she must have a high hourly wage rate. In this sense, the wage rate and the working hours are two sides of the same coin, and if a good x is positively correlated with ability, at a given income level, it is also negatively correlated with the hours of work. What changes is, of course, the interpretation: In the original Gordon-Kopczuk approach, the underlying reason is to tax ability, whereas in our framework, the idea is to support activities that boost labour supply.[3] However, the hourly wage rate is only observed for the working population, and the merit of placing the working hours to the left-hand side is that one can examine both the determinants of the extensive margin (the decision to choose to work) and the intensive margin (working hours for those who actually work). In the case of government-provided welfare services, the former margin of choice is expected to be the more relevant one. Nevertheless, for some robustness checks, we deduce the implicit wage rate from the data set and use it, too, as the dependent variable.[4]

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 partially linear (1) or single-index (2) form

[3] In fact, this comes close to the idea in Edwards et al. (1994) of the merits in subsidising goods that are complements to labour supply.
[4] These results are reported in Section 5. The hourly wage rate is calculated by dividing wage income by the hours of work.

$$h_i = g(z_i) + X_i' \beta_2 + \varepsilon_{2i} \quad (1)$$

$$h_i = f(z_i + X_i'\beta_1) + \varepsilon_{1i,} \quad (2)$$

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

Model (1) 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 model can be considered as a statistical interpretation of the Atkinson-Stiglitz result and as answering the question about whether commodity taxation can achieve anything which could not be achieved using a non-linear income tax schedule. In the model, income and commodity demand are not treated symmetrically. An important feature of the Finnish tax system is the dual income tax structure, where labour income is taxed using a progressive schedule whereas capital income is subject to a flat rate. This means that in the Finnish system, labour income is the variable z, whereas all the other right-hand side variables that we examine are either taxed as flat capital income[5] or via linear commodity taxation. This means that the Finnish tax base is closely related to the structure in model (1).

Gordon and Kopczuk (2008) estimate models of the form (2), the single-index model which treats all observables in a symmetric fashion. They are motivated thus because here the sum $z_i + X_i'b_1$ characterises the actual tax base in the US tax system, and indirectly also the individualsô ability to pay taxes. Our version of model (2) estimates a local link between hours of work and the single index characterizing the tax base. Because of this discussion and the fact that in the Finnish case the tax base resembles the structure of model (1) more, we prefer tests of the Atkinson-Stiglitz result which are based on the residual variation in hours of work, i.e. model (1). Nevertheless, we also estimate models of type (2) to check the robustness of our results. The concrete way to estimate the single-index model is presented in an appendix.

Both models are estimated by methods which are linear in h_i. In the partially linear regression model (1) the potential candidates for inclusion in the labour supply equation enter the model linearly. In effect, our model (1) will test whether residual variation in hours of work, $h_i - g(z_i)$ is

[5] This is also true for housing expenses: The tax deduction for interest payments for owner-occupied housing is granted from capital income. If the capital income is not sufficiently high, the deduction is a certain percentage of the interest payments that reduces the *tax* on labour income.

independent of our other candidates in the tax base $X_i'\beta_2$. Taking conditional expectations of (1) conditional on z_i, we get

$$E(h_i \mid z_i) = g(z_i) + E(X_i \mid z_i)'\beta_2. \quad (3)$$

Subtracting conditional expectations gives

$$h_i - E(h_i \mid z_i) = (X_i - E(X_i \mid z_i))' \beta_2. \quad (4)$$

Model (4) is used to test whether our candidates for the tax base can successfully explain residual variation in hours of work $h_i - E(h_i \mid z_i)$. To estimate $E(h_i \mid z_i)$ and the vector $E(X_i \mid z_i)$ one could use kernel methods based on the 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 γ_{0i}, γ_{1i} using weighted least squares and minimizing

$$\sum w(z_k) (h_k - \gamma_{0i} - \gamma_{1i} z_k)^2 \quad (5)$$

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

$$w(z_k) = W(d_i^{-1}(z_k - z_i)) \quad (6)$$

where d_i is the distance from z_i to the r^{th} nearest neighbour of z_i. That is, d_i is the r^{th} smallest number among $|z_i - z_j|$ for j = 1, é , n. The weight function W is ñtricubeò, $W(x) = (1 - |x|^3)^2$ 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 is chosen by the cross-validation method.[6] In addition to the np package of Hayfield and Racine (2007), the plreg command of STATA is used (Lokshin 2006) for these estimations.

Our right-hand side variables are outcomes of a complicated optimising decision on the part of the households. Therefore our analysis is based on an ad hoc type of model with potential pitfalls.[7] In particular, the results may not necessarily hold out of the initial labour supply

[6] In some robustness checks, reported in Section 5, we used a fixed bandwidth of the smoothing window which was determined on the basis of our baseline estimations. The testing of residual variation is quite robust to our selection of bandwidth.

[7] In our data hours of work, the uptake of government-provided services and consumption expenditures are recorded using separate sources of information. Therefore we do not suspect correlation across the three key sets of

equilibrium, which is conditional on the existing non-linear income tax schedule. As in many other similar exercises, the results may be expected to hold for local, marginal changes. However, we suspect that the results of Browning and Meghir (1991), who use UK consumption data to test for the separability of consumer demand from labour supply, may suffer from similar problems.[8] Changes in the 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 Statistics Finland's household budget survey in 2006 (Statistics Finland, 2008). The survey produces data on the consumption expenditure of households, on housing conditions, the possession of durable goods, and income among households. The survey is a sample survey whose final sample size comprised 4,006 households. The data are collected by means of 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) that has 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; education; health; transport; communication; recreation and culture; hotels and restaurants; and the final category, miscellaneous goods and services. Most expenditure data are collected during a two-week time-period with diaries and purchase receipts.

Tax and income data are recorded on a yearly basis mainly using records from administrative registers. Some data are collected through a comprehensive interview. The aim of this is to give supplementary information about the tax-exempt components of income and purchases of

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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.

[8] 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.

durables, as well as information relating to the composition and size of the households and demographic and socio-economic variables.

The 2006 data were the first survey in Finland to collect information both about the hours of work on the time period when the expenditure data are collected and about the use of welfare services provided by the government (education, health and social services). We measure hours of work using the mean joint hours of the couple; i.e. the reference personôs hours plus the spouseôs hours (if the 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.[9]

Labour income is the sum of wage income and entrepreneurial income (classified as earned income). Capital income contains the householdsô rental income, interest income, dividends and capital gains. Note that we do not include social security transfers in 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 income and consumption expenditure are measured as thousands of euro for the regression analysis.

The provision of welfare services is financed by the government. 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 valuation of welfare services warrants some comments. It is beyond the scope of the present analysis to estimate the willingness to pay for these, and we use the production costs of the services instead. 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, for example in the case of health services, to use 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 valuation of services comparable across categories.[10]

[9] For descriptive statistics of the data used, see Table 1.
[10] The same approach is used when one moves beyond cash income to include the value of government-provided services to get a more comprehensive definition of income for the evaluation of economic well-being at the individual level (Canberra Group, 2001).

The key point to realise is that there is a considerable degree of freedom of choice in the use of the services in Finland. To exemplify this, households can choose to use government-provided day-care services (at a subsidised rate) or one of the parents can take care of the children at home (and then he or she is eligible for a home-care allowance if the youngest child is less than three years old). The labour-market consequences, and a coupleôs joint hours of work, of this choice are clearly very different. Since the level of welfare service use is not just a consequence of administrative decisions about their supply, it makes sense to examine how the use of welfare services is related to the labour supply behaviour at the individual level.

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 of the use of public welfare services.

In all regression models, the dependent variable is the joint hours of a couple, as defined above. All regression equations share a common set of control variables: dummy variables for the age group of the householdôs reference person, 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).

In this section, we discuss those results that are based on the partially linear model, where only wage income enters the nonparametric part and all other variables are included in 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 0.45 (meaning that 45% of the observations are used at a time).

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 (a 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 the hours worked at a given income level, and therefore scope for the other variables to explain part of this residual variation.

The results for the basic set of consumption categories are presented in Table 2. The first thing to note is 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 similar to the result obtained by Gordon and Kopczuk (2008). Two plausible explanations are, first, an income effect, and second, that people with higher skill levels 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 insignificant; the exception is housing expenses, which are negatively related to hours of work.[11] 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 in our static set-up the person cannot be working at the same time. A proper analysis of the importance of these services for labour supply clearly requires a dynamic framework where access to education now could enhance income-earning abilities later.

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 over-consumption of housing. This practice is clearly at odds with the observation that housing is 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 and if one controls for wage income, working hours are reduced by 2 per cent; this is a result with some policy importance, too.

Table 3 present the 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. In

[11] The same observation about housing is also in Gordon and Kopczuk (2008).

transport items, car use ï commuting ï 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!

The results on publicly provided welfare services are presented in Table 4. The most important result is that child-care use for children who are younger than three years 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 three 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 three years are more often in day care. Then the difference between who uses the day-care system and who opts out is not necessarily tied to the parentsô employment status.[12]

Another potentially interesting public service is the care of the elderly, or social services more generally (such as household help for people in need). However, these are not positively related to the hours of work, perhaps because the overall use of these services is rare and they are also frequently allocated when needed and provided to persons outside the labour force.[13] The fact that health-care services have a negative relationship with labour supply is understandable in this static framework. A proper analysis clearly requires a dynamic framework, as noted above in the case of private education.

[12] In fact, municipalities are also mandated by law to offer child care to children whose parents are unemployed, students or 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 a one-to-one basis.

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

5. Robustness

Perhaps the most important item to check is whether our choice of using the hours of work at the left-hand side, as opposed to the wage rate (as in Gordon and Kopczuk 2008), has important implications for the interpretation of the results. To check this, we deduced the hourly wage rate by dividing labour income by the joint hours and ran the same regressions with the wage rate as the dependent variable. The results on the basic set of commodity demand with this modification are reported as Model 2 in Table 5. Since the number of observations decline (we cannot divide the income if the hours are zero) we also present there the results where the dependent variable is working hours when the hours are restricted to be strictly positive (Model 1). The results from Model 1 are otherwise roughly the same as those reported earlier in Table 2, but the housing variables lose significance (so does the use of hotels and restaurants). Therefore it appears that housing is more related to the extensive margin of labour supply (from zero to positive hours) than the intensive margin (change in hours when the individuals are already working).

As expected, a comparison of Models 1 and 2 of Table 5 reveals that the significant variables change signs when the dependent variable changes from working hours to the wage rate. For instance, capital income is negatively related to the hours of work and positively related to the wage rate. Running public services regressions on the restricted sample (where the hours are bigger than zero) reveals that the child-care services also lose significance. These exercises suggest that once the hours are restricted to be strictly positive, the choice of the dependent variable does not appear to drive the result. A more important division is to whether or not zero hours in the hours regression (the extensive margin) are included. The importance for investigating the extensive margin at this context is in line with recent findings in the labour supply literature suggesting that the most important behavioural responses indeed take place at the extensive margin (see e.g. the survey by Meghir and Phillips 2008).

The results for commodity demand arising from the single index structure are depicted in Table 6. Almost all those variables (except those for education expenses) that are significant in the partially linear model are also significant in the single-index model. In addition, some additional variables enter the model now in a statistically significant way. For the latter two models (comparable to those in Tables 3 and 4), the computationally more burdensome asymptotic standard errors of the single-index model appear to be very large and the power of the test may

suffer from the curse of dimensionality. The number of variables that this model can simultaneously test for appears to be smaller than in the case of the partially linear model. This is another reason to rely more on the results based on it in our case with many potentially interesting right-hand side variables.

We also conducted a host of other robustness checks. First, we have removed capital income from the linear part and then all the factor income is included in the nonparametric part. This change does not affect the qualitative results regarding the remaining significant variables. While the bandwidth is chosen using the recommended cross-validation method, we have also examined results with a somewhat larger (0.75) and smaller (0.25) bandwidth for the partially linear model, and the results are robust to these changes. Measuring commodity demand as shares from overall consumption instead of actual euro values used does not affect the qualitative results either.

We have also looked at how the results differ by the type of family (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 into 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). Another interesting division is to divide the sample by the age of the reference person. To prevent too small a sample size, we use three different groups, younger than 30, 30-59, older than 59. In the youngest age group, capital income and housing are not significant, probably since these persons are at that phase of the life cycle where borrowing dominates. Regarding social services, the use of day-care services matters most for the middle age group.[14]

[14] Another interesting division is one based on the education level. While educational attainment itself does not help predict ability or working hours when one controls for income, it is interesting to note that capital income is negatively related to labour supply to others but not to those with academic education. For others, capital income might reduce hours because of the income effect, but for the highly educated, capital income might be more closely related to taste differences.

Dividing the sample into quartiles based on labour income reveals interesting patterns with respect to the significant variables. First, the negative impact of capital income on working hours appears in the top quartile only. This reflects the fact that capital income is heavily concentrated at the top of the income distribution. Housing expenses are negatively associated with labour supply in the second and the third quartile, whereas it does not reduce working hours at the bottom of the distribution. In the case of social services, the labour supply of the middle income groups appears to benefit most from day-care services. Since the relation of capital income and housing to labour supply varies along the income schedule, linear taxes on capital income and housing are not necessarily the most effective instruments to enhance redistribution (Banks and Diamond 2008).

Finally, if the whole model is estimated with OLS, without a flexible income control, many more of the right-hand side variables become significant.[15] This can be interpreted so that having a flexible way to address differences in income is crucial to 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 regard it, as an important tool to make uniform commodity taxation desirable.

6. Conclusion

This 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 are 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

[15] Replacing the nonparametric part with a fourth-order polynomial function for labour income reduces the number of significant variables in comparison with the fully linear model, but it still contains more significant variables than the partially linear model. This suggests that the semi-parametric approach certainly adds value in comparison to simpler non-linear models.

in some specifications. These results suggest that capital income should be taxed at the margin, and the current practice of favouring owner-occupied 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. It is comforting that these results are in line with the findings based on a similar exercise on US data by Gordon and Kopczuk (2008).

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.[16] The key to 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 householdsô 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 estimates of Browning and Meghir 1991).

[16] Interestingly, the VAT rate on food was cut from 17% to 12% in Finland in October 2009. Politicians advertised the reduction with distributive concerns, but food producers, who were active in lobbying for the tax cut, probably expected to benefit from the move.

Appendix: Estimation of the single-index model

In estimating model (2) 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 β_1 by minimizing

$$\times \ (h_i - f(z_i + X_i' \beta_1))^2 \ \text{ w.r.t. } \beta_1. \qquad (7)$$

In the case of unknown f, for a given value of β we can estimate

$$E (h_i \mid z_i + X_i'\beta) = E (f(z_i + X_i'\beta_1) \mid f(z_i + X_i' \beta)) \qquad (8)$$

by the kernel method (the equality follows from $E(\mathring{U}_i \mid z_i, X_i) = 0 \Rightarrow E(\mathring{U}_i \mid z_i + X_i'\beta) = 0$). Ichimuraâs method estimates $f(z_i + X_i'\beta_1)$ by estimator $F_{-i} (z_i + X_i'\beta)$ choosing β by (semi-parametric) nonlinear least squares where $F_{-i} (z_i + X_i'\beta)$ is a leave-one-out nonparametric kernel estimator of $E (h_i \mid z_i + X_i'\beta)$. The bandwidth for the single-index function is again chosen by cross-validation methods, and the estimation is carried out using the np package in R (Hayfield and Racine 2007).

Under some regularity and smoothness assumptions Ichimura (1993) obtains ãn rate of convergence for the β–estimators: $n^{½} (\beta - \beta) \rightarrow N(0, \Omega)$, in distribution,
where the asymptotic variance-covariance matrix, $\Omega = V^{-1} \Sigma V^{-1}$, with
$V = E \{ ((f_i')^2 \ (X_i - E(X_i \mid z_i + X_i'\beta)) (X_i - E(X_i \mid z_i + X_i'\beta))' \}$ and
$\Sigma = E \ \{ \mathring{u}_i^2 \ (f_i')^2 \ (X_i - E(X_i \mid z_i + X_i'\beta)) (X_i - E(X_i \mid z_i + X_i'\beta))' \}$.

Above $f_i' = f'(z_i + X_i'\beta)$ and $\mathring{u}_i^2 = E (h_i - f(z_i + X_i' \beta))^2 \mid z_i, X_i)$. In the formulae we use estimates of $E(X_i \mid z_i + X_i'\beta)$ obtained using non-parametric regression estimators (np package in R), and replace $\mathring{u}_i^2$ by squared residuals $(h_i - f(z_i + X_i' \beta))^2$ to get asymptotically consistent estimators for Ω. The determination of the asymptotic covariance-variances matrix Ω is critically dependent on the estimation of the conditional expectations, $E(X_i \mid z_i + X_i'\beta)$ and the use of finite sample sums in lieu of the expectations, a procedure which may be subject to the curse of dimensionality.

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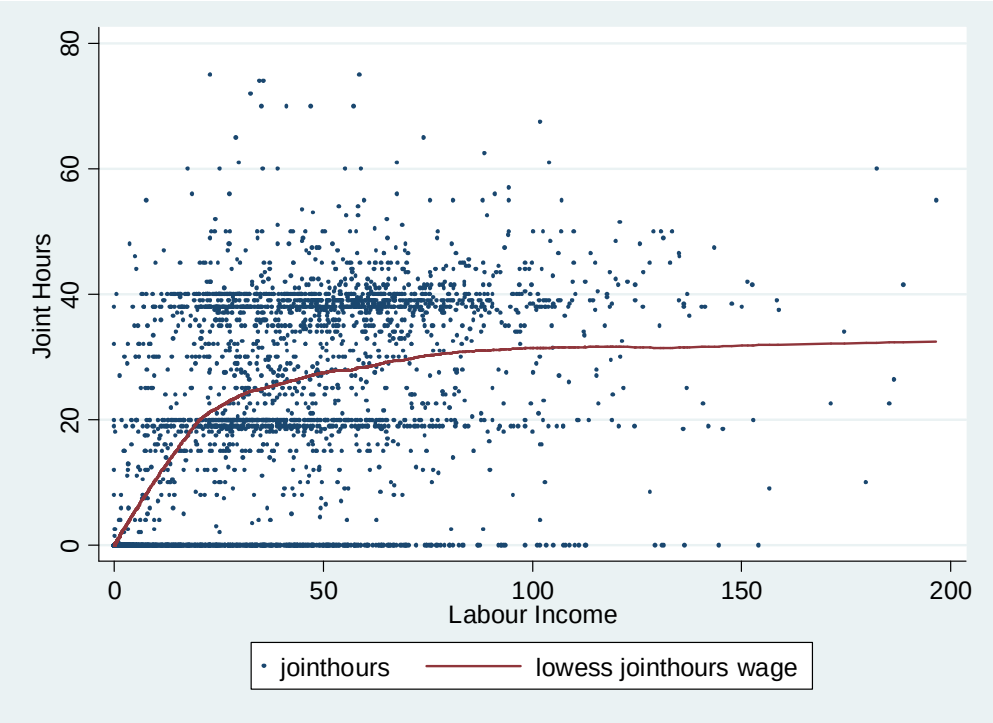

Figure 1: The relation between labour income and hours of work. For the lowess smooth, the bandwidth is 0.45.

Category	Variable	Obs	Mean	Std. Dev.	Min	Max
Hours and income						
	Joint hours	4003	18.00325	17.58438	0	75
	Wage income	4003	33370.9	32778.27	0	275304
	Capital income	4003	6877.464	15617.41	0	527983
Commodity demand						
	Food	4003	4405.39	2597.082	0	26171.08
	Alcohol and tobacco	4003	740.5443	1113.095	0	14367.86
	Clothing and footware	4003	1285.785	2545.866	0	71981.78
	Housing and energy	4003	8949.189	4552.635	0	42200
	Durables	4003	1671.732	2192.436	0	34691.16
	Health	4003	1195.226	1791.983	0	48337.58
	Traffic	4003	5468.849	7783.197	0	84394.22
	Communication	4003	960.4052	733.4035	0	8580
	Culture and leisure	4003	3758.549	4916.441	0	196408.2
	Education	4003	68.16263	341.3837	0	10000
	Hotels and restaurants	4003	1351.092	1853.729	0	40872
	Other services	4003	3996.79	3448.256	0	32043.1
Use of public services						
	Primary school	4003	1798.53	7222.906	0	148175
	Secondary school	4003	568.8104	3129.553	0	106528
	Higher educ (adults)	4003	750.8064	2544.448	0	29880
	Higher educ (children)	4003	175.221	2055.739	0	65424
	Adult education	4003	121.8756	508.9672	0	12400
	Health care	4003	2143.822	6633.462	0	165502
	Health insurance payments	4003	548.8956	1747.501	0	53157
	Day care (< 3 years old)	4003	149.797	1010.872	0	18157.34
	Day care (3 years or older)	4003	719.476	3172.764	0	41247.34
	Social services	4003	91.67424	1281.258	0	48084
	Social services, children	4003	17.96353	604.9685	0	36120
	Social services, adults	4003	49.84662	970.6233	0	48084
	Other social services	4003	21.21009	274.1984	0	8360
	Health care at work	4003	82.88783	356.3156	0	10560

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

	Coef.	Std. Err.
Capital income	-0,077185**	0,017721
Food	-0,1044164	0,1267963
Alcohol and tobacco	0,3494475	0,2202303
Clothing and footware	-0,017814	0,1015552
Housing and energy	-0,276042**	0,067934
Durables	0,0075213	0,1210061
Health	-0,203019	0,1366993
Traffic	0,0202407	0,0329641
Communication	0,1426239	0,4010815
Culture and leisure	-0,019025	0,0577557
Education	-1,430653*	0,7028092
Hotels and restaurants	0,3046681*	0,1493324
Other services	0,0732059	0,095206
Obs.	4003	

Table 2: Estimation results for commodity demand from a partially linear model. Dependent variable: average working hours of a couple. The non-parametric variable is labour income. Other control variables used: age dummies of the reference person in the household, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.45. * denotes significance at the 5 per cent level and ** at the 1 per cent level.

	Coef.	Std. Err.
Capital income	-.0705445**	.01791
Food	-.061993	.1278109
Alcohol	.3610746	.2889909
Tobacco	.4237336	.4402101
Clothing and footware	.0056835	.101672
Actual home	-.2578109**	.0689718
Holiday home	-.1798469	.3817451
Secondary home	-.8819527*	.3871673
Durables	.0515475	.1231259
Health	-.1700581	.1360582
Car purchase	.0056318	.0373348
Car use	.1808078*	.0844938
Public transport	-.3119125	.1715609
Communication	.2463375	.4031564
Audio and video equip.	-.1309558	.2642158
Other leisure equip.	.0698079	.0749156
Sports equip.	-.0046079	.2536642
Concerts, sports ev. etc.	.1843502	.181354
Books and magazines	-1.158996**	.3676472
Holiday trips	-.2566838	.1617529
Education payments	-1.205563	.6996821
Hotels and restaurants	.116768	.1777306
Office meals	2.106819**	.5308404
Hotels and restaurants	.0735217	.4529568
Other services	.1044308	.1016027
Social services	.3009849	.2752108
Obs.	4003	

Table 3: Estimation results with more detailed commodity structure from a partially linear model. Dependent variable: average working hours of a couple. The non-parametric variable is labour income. Other control variables used: age dummies of the reference person in the household, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.45 * denotes significance at the 5 per cent level and ** at the 1 per cent level.

	Coef.	Std. Err.
Primary school	.0129677	.064349
Secondary school	-.0776005	.0991275
Higher educ (adults)	-.1493774	.1103369
Higher educ (children)	.0848753	.1329644
Adult education	-1.093713*	.4629945
Health care	-.0101769	.036148
Health insurance payments	-.0843455	.1359858
Day care (< 3 years old)	.7075979*	.3420198
Day care (3 years or older)	.1021722	.1356743
Social services	.0376368	.2590051
Social services, children	-.2661124	.4098947
Social services, adults	.1347189	.3465966
Other social services	-.1307259	.8504492
Health care at work	.9766961	.6647081
Obs.	4003	

Table 4: Estimation results for the use of welfare services from a partially linear model. Dependent variable: average working hours of a couple. The non-parametric variable is labour income. Other control variables used: age dummies of the reference person in the household, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.45. * denotes significance at the 5 per cent level and ** at the 1 per cent level.

Dependent variable	Joint hours		Hourly wage rate	
	Coeff.	Std. Error	Coeff.	Std. Error
Capital income	-.076352**	.02471	.1923037*	.0788302
Food	-.3271533*	.1327056	.7825507	.4233589
Alcohol and tobacco	.0374394	.2223241	-.6060372	.709261
Clothing and footware	-.0270924	.0930249	-.0446322	.2967691
Housing and energy	-.0714075	.0798207	.1260623	.2546448
Durables	-.0453873	.117706	-.2545566	.3755071
Health	-.1515993	.1533665	.2798163	.4892715
Traffic	.0638689	.0329302	-.1419192	.1050542
Communication	.2549813	.438899	-.3522842	1.400181
Culture and leisure	-.001617	.0541423	.1271373	.1727255
Education	-1.81152**	.6629433	9.655238**	2.114929
Hotels and restaurants	-.0260022	.1423199	.3052629	.4540306
Other services	.0220869	.098625	-.443686	.3146346
Obs.	2333		2333	

Table 5: Estimation results from a partially linear model for commodity demand when either the joint hours of work (model 1) or the hourly wage rate (Model 2) are used as the dependent variable. The non-parametric variable is labour income. Other control variables used: age dummies of the reference person in the household, marital status, and the number of children in the household. Lowess estimation method used for the nonparametric part with a bandwidth of 0.45. * denotes significance at the 5 per cent level and ** at the 1 per cent level.

	Coeff.	Std. Err.
Capital income	-0.60488**	0.02635
Food	-0.61322**	0.030755
Alcohol and tobacco	0.922117**	0.140132
Clothing and footware	0.244937**	0.075429
Housing and energy	-0.85864**	0.017392
Durables	-0.84558	1.174622
Health	-0.96309**	0.151258
Traffic	0.075445**	0.016094
Communication	-0.35783	0.232247
Culture and leisure	-0.11783	0.486305
Education	-1.61648**	0.383541
Hotels and restaurants	1.439396	3.42965
Other services	0.014618	0.095026
Obs.	4003	

Table 6: Estimation results for commodity demand from a single-index model. Dependent variable: average working hours of a couple. Other control variables used: age dummies of the reference person in the household, marital status, and the number of children in the household. 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.