

# Fertility, Taxation and Family Policy\*

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Revised, November 2003

## Abstract

Historically, there is clear evidence of an inverse relationship between female labour supply and fertility. However, the relationship across countries is now positive: Countries like Germany and Italy with the lowest fertility also have the lowest female participation rates. This paper analyses the extent to which this can be explained by public policy, in particular taxation and the system of child support. The results suggest that countries with individual rather than joint taxation, and which support families through child care facilities rather than child payments, are likely to have both higher female labour supply and higher fertility.

JEL Classification: H31, H53, J13, J22

Keywords: fertility, taxation, child support.

\*The work for this paper was funded by an Australian Research Council grant. We are grateful to Jonathan Skinner, to seminar participants at the universities of Regensburg, York and Bristol, and to two referees, for very helpful comments. The usual disclaimer applies.

# 1 Introduction

An issue of major policy concern in a number of OECD countries is the problem of supporting social security systems, such as pay-as-you-go pension schemes, in the face of declining ratios of economically active to retired households. Underlying this change in the age composition of the populations of these countries has been a steady and significant fall in fertility rates, which in turn seems to be associated with a steady increase in female labour supply over the same period. The data presented in Table 1 for a group of developed economies certainly confirms, for each country individually, the negative relationship between female employment and fertility over time. Also immediately apparent, however, is that this negative relationship no longer holds across countries. As Figures 1 and 2 show, it existed in 1970 but not in 1990. For example, in 1990 Germany, the Netherlands, Italy and Spain have substantially lower female employment, but also very much lower fertility rates, than the US, Canada, the UK, France and the Scandinavian countries. In the latter, a larger growth in female employment over the period 1970-1990 was accompanied by much smaller falls in fertility than in the former group.

This cross-country comparison has relevance for the debate on how to reverse the fertility decline. If the negative relationship between fertility and female labour supply is an unbreakable law of nature, then the fertility decline can only be reversed by inducing women to leave the labour force and go back into the household. This, as we show below, is effectively the result of the most commonly proposed policy measure, that of increasing (or, in the case of countries such as Italy, introducing) child-related cash transfers to households. To the extent that this increases the demand for children, without changing the relative prices of parental and bought-in child care, it results in a reduction of female labour supply. An alternative policy, however, is to attempt to modify the terms of the trade-off between family size and female labour supply by improving the quality and availability of child care outside the home. Empirical work<sup>1</sup>, as well as casual observation, suggests that a likely explanation for the across-country differences just described is to be found in the effects of their tax and social security contribution structures, in combination with the cost and availability of child care outside the home<sup>2</sup>.

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<sup>1</sup>See for example Fenge and Ochel (2001).

<sup>2</sup>For example, in Germany married women entering the labor force face: joint taxation

These determine the terms of the trade-off between family size and female labour supply, with sharp differences among countries in the nature of this trade-off and the corresponding equilibrium choices of these variables.

**Table 1 and Figures 1,2 about here**

A further empirical fact is the significant variation in female labour supply and fertility across households within a given economy. This has led some influential writers in this area to advocate the stick of tax penalties for households that choose low fertility, in addition to the carrot of higher transfer payments per child, as policies to reverse the fertility decline. In discussing analytically the effects of such a policy on equity and fertility however, we need to have a model that explains this heterogeneity of fertility and labour supply choices across households. It seems to us useful therefore to extend the model to include households of different types, so that the issues arising out of differences in household choices can be formally analysed. This we do in section 4 of the paper.

There is a growing public finance literature on the relationship between taxation and family size.<sup>3</sup> The model used in this paper is particularly close to, though simpler than, those in Balestrino (2001) and Cigno and Pettini (2001). This paper has however a much more specific policy focus. In the literature just cited the main concern is with the general design of welfare maximising tax structures in economies in which households contain children, where family size may or may not be endogenous.<sup>4</sup> A central issue of concern is how family size *ought* to be taxed, given a social welfare function and various assumptions about the type of tax system to be employed. Typical results are, for example, those of Balestrino, Cigno and Pettini (2002), who show that the nature of the welfare optimal taxes or subsidies on children will depend on the interrelationship between comparative advantage in raising children, and in working in the market (as reflected in the wage rate),

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(income splitting), implying a relatively high marginal tax rate; social security contributions well in excess of their incremental actuarial value; very scarce and expensive pre-school child care facilities; and half-day schooling, implying that typically children return home from school at midday. There is good reason to believe that the effect of high marginal tax rates in reducing female labour supply is a desired policy outcome. The paradox is that this does not have the desired result of increasing fertility, but simply raises the maternal time intensity of child rearing.

<sup>3</sup>See for example Balestrino (2001), Balestrino et al (2002), Cigno (1986), (1996), (2001), Cigno and Pettini (2001), Cremer, Dellis and Pestieau (2001), and Fraser (2001).

<sup>4</sup>Apps and Rees (1999) also examines the issue of welfare improving tax reform in the presence of household production, which can be thought of as subsuming child care.

together with the degree of inequality aversion exhibited by the social welfare function.<sup>5</sup> Here, we assume that for some exogenous reason, government would like to increase fertility<sup>6</sup>, and we want to compare the effects of two possible instruments, child grants and subsidies for bought-in child care, for doing so. Moreover, we do not look for optimal taxes, but simply look at the effects of changes in tax rates in a given tax system which is almost certainly non-optimal.

## 2 The Model

The core of any model constructed to explore the relationship between fertility and female labour supply, and the influence of policy variables on this, is the relationship between the female wage rate and the demand for children<sup>7</sup>. In general this is ambiguous. Increasing the female wage raises the opportunity cost of time spent raising children, therefore tending to reduce demand, but also increases household income, thus tending to increase it, given children are a normal good. The evidence of the negative association between female labour supply and fertility seems to suggest that historically the former effect has dominated, since the real wages of women have been increasing. At the same time, the cross-country comparison suggests that place must be made for the effect of the cost and availability of child care outside the home on the form of this relationship. We proceed by drawing on the model presented in Galor and Weil (1996),<sup>8</sup> which shows that if we

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<sup>5</sup>The paper by Fraser shows that if the tax-subsidy system is designed so as to share income risk between households and government, and fertility is reduced by income risk, then the tax-benefit system can be used to increase fertility.

<sup>6</sup>Cigno (1996) gives a thoughtful discussion of possible reasons for this, emphasising the existence of a “fertility externality” in the presence of pay-as-you-go pension systems. When deciding on the number of children, parents do not take into account the effects on the future sustainability of the pension system. We would emphasise imperfections of the capital market and the overall impact of the taxation of working women - see for example Apps and Rees (2001), (2003) for further discussion.

<sup>7</sup>Implicit here is the assumption that women, and not men, care for children. Though certainly not literally true, this is a useful simplification which is also not too bad an approximation.

<sup>8</sup>This paper was concerned with the dynamics of the relationship between real wages, female labour supply and fertility. We have found the model of the household at its core to be a useful starting point for the analysis of this paper, which could be thought of as performing comparative statics on the steady state of an extended version of the Galor-

postulate a simple form for the household's utility function

$$u = \gamma \ln n + (1 - \gamma) \ln c \quad (1)$$

where  $c$  is the household's consumption of a composite market good and  $n$  denotes the demand for children, then in the case where the wife's time is the only input into child rearing, with a fixed coefficient, there is always a strictly inverse relationship between  $n$  and the wife's net of tax wage,  $w_f$ . To see this, let  $z \in [0, 1]$  denote the time the female earner in a household spends in child care, so that  $1 - z$  is her market labour supply. The male earner in a household is assumed to supply 1 unit of time inelastically to market labour, and none to child care. His net wage is  $w_m$ . The production function for child care is simply  $n = \alpha z$ ,  $\alpha > 0$ . Then the household's budget constraint is (taking  $c$  as the numeraire)

$$c = w_m + w_f(1 - z) \quad (2)$$

its demand function for children is

$$n = \frac{\alpha \gamma (w_m + w_f)}{w_f} \quad (3)$$

and

$$\frac{\partial n}{\partial w_f} = \frac{-\alpha \gamma w_m}{w_f^2} < 0 \quad (4)$$

In this paper we examine the effects of the availability of child care outside the home, by assuming a more general production function

$$n = f(z, x) \quad (5)$$

which is linear homogeneous, continuously differentiable and strictly quasi-concave.  $x$ , measured in units of the market good, is a bought-in child care input. The household's budget constraint then becomes

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Weil model. Note that, unlike the family taxation literature cited in the Introduction, this model disregards the possibility that parents may care about the "quality", as well as the number, of children. In an extreme case, it could then be that an increase in "fertility" could take the form of an increase in child quality alone. On the other hand, to the extent that child quality represents future productivity or earning power, as is often assumed in these models, the policy implications of an increase in fertility of this kind are unchanged. Policy makers would still want an increase in fertility in this sense.

$$c + x = w_m + w_f(1 - z) \quad (6)$$

We can define an implicit unit cost or price per child by solving

$$\min C = w_f z + x \quad (7)$$

$$s.t. \quad n = f(z, x) \quad (8)$$

yielding the child care cost function

$$C = p(w_f)n \quad (9)$$

and child care input demand functions

$$z^* = \hat{z}(w_f)n \quad (10)$$

$$x^* = \hat{x}(w_f)n \quad (11)$$

where  $\hat{z} = \hat{z}(w_f)$  is given by the derivative of the unit cost function  $p(w_f)$

$$\frac{\partial p(w_f)}{\partial w_f} = \hat{z} \quad (12)$$

and is the input requirement of maternal time for one unit of child care. Likewise  $\hat{x}$  is the per unit requirement of bought in child care.

The household's problem can then be written

$$\max \gamma \ln n + (1 - \gamma) \ln c = u \quad (13)$$

$$s.t. \quad p(w_f)n + c = w_m + w_f \quad (14)$$

The solution to this problem yields a fertility demand function

$$n^* = \frac{\gamma(w_m + w_f)}{p(w_f)} \quad (15)$$

with

$$\frac{\partial n^*}{\partial w_f} = \frac{\gamma - z^*}{p} \gtrless 0 \quad (16)$$

Thus if the proportion of time the wife spends in child rearing is sufficiently small relative to the preference for children (both  $\gamma$  and  $z$  are defined on  $[0, 1]$ ), an increase in her wage could actually increase fertility. Alternatively,

with  $z^* > \gamma$ , the greater the intensity of bought in child care  $\hat{x}$ , the lower will be  $z^*$  and the less negative will be the effect of the female wage on fertility. In other words, economies with cheap and good quality child care possibilities outside the home will have a weaker negative relationship between female labour supply and fertility, for a given positive relationship between female labour supply and the wage rate. Thus the model captures in a simple way the empirical hypothesis discussed above.

Intuitively, the effect of an increase in an input price on the marginal cost and price of a good is smaller, the smaller the intensity with which that input is used. Introducing a second input into child care weakens the effect of an increased female wage in raising the implicit price of a child, and therefore reduces the price effect relative to the income effect of the wage increase.

Let  $\tau_f$  be the marginal tax rate on the female wage and  $\tau_m$  that on the male wage, where these may or may not be equal.<sup>9</sup>  $\hat{w}_f$  and  $\hat{w}_m$  denote gross market wage rates, held constant throughout. A worker's net of tax wage is

$$w_i = (1 - \tau_i)\hat{w}_i \quad i = f, m \quad (17)$$

The government uses the tax proceeds to fund a direct payment  $g$  per child, and we consider also the introduction of a subsidy of  $\sigma$  units of consumption per unit of bought in child care. We take the initial value of  $\sigma$  as zero, and model policy as making a change  $d\sigma > 0$ . The implicit unit cost of a child now becomes<sup>10</sup> a function also of this subsidy,  $p(w_f, \sigma)$ , with

$$\frac{\partial p(w_f, \sigma)}{\partial \sigma} = -\hat{x} \quad (18)$$

Thus the household's budget constraint now becomes<sup>11</sup>

$$[p(w_f, \sigma) - g]n + c = \sum_{i=f,m} w_i \quad (19)$$

and the fertility demand function now is

$$n^* = \frac{\gamma(w_f + w_m)}{p(w_f, \sigma) - g} \quad (20)$$

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<sup>9</sup>In a system of joint taxation or income splitting  $\tau_f = \tau_m$ . Of course in reality tax rates are not explicitly gender specific. However, if individuals are taxed independently at marginal rates that vary with income, the fact that women typically earn less than men will imply different tax rates for the individuals within a household.

<sup>10</sup>Just re-solve the cost minimisation problem in (7) above with the cost minimand now written as  $C = w_f z + (1 - \sigma)x$

<sup>11</sup>We assume the net cost of a child,  $p(w_f, \sigma) - g$ , is always positive.

The government budget constraint in *per household terms* is

$$\tau_f \hat{w}_f (1 - z^*) + \tau_m \hat{w}_m - gn^* - \sigma x^* = 0 \quad (21)$$

This completes the model.

### 3 Fertility, female labour supply and policy

#### 3.1 Child payments and taxation.

It would generally be expected that the higher the level of the child payment  $g$ , the higher must be the level of fertility in an economy. Certainly the partial effect of an increase in  $g$  on  $n^*$ , given by

$$\frac{\partial n}{\partial g} = \frac{n^*}{p - g} \quad (22)$$

is strictly positive. However, the increase in child support must be financed, and assume this is done by an increase in taxation. For simplicity assume joint or, since there is only one household type, flat rate taxation, so that  $\tau_f = \tau_m = \tau$ . Then the total derivative of fertility with respect to  $g$  is

$$\frac{dn}{dg} = \frac{\partial n}{\partial \tau} \frac{d\tau}{dg} + \frac{\partial n}{\partial g} \quad (23)$$

Now in the case in which a reduction in the female net wage (increase in  $\tau$ ) increases fertility, all terms on the right hand side are positive and we have the expected result. However, in the case in which the income effect of a tax-induced wage change outweighs the price effect, increasing the tax rate reduces fertility and the first term on the right hand side is negative.<sup>12</sup> The necessary and sufficient condition for this takes a simple form, given in

**Proposition 1:** *An increase in the tax rate reduces fertility if and only if the cost of the bought-in child care per child exceeds the child grant,  $\hat{x} > g$ .*

**Proof:** The fertility demand function is in this case

$$n^* = \frac{\gamma(1 - \tau)(\hat{w}_f + \hat{w}_m)}{p((1 - \tau)\hat{w}_f, \sigma) - g} \quad (24)$$

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<sup>12</sup>This of course assumes that  $\partial \tau / \partial g > 0$ , which seems reasonable, since otherwise public expenditure could be increased without an increase in taxation.

and so

$$\frac{\partial n}{\partial \tau} = \frac{\hat{w}_f n^* \hat{z} - \gamma(\hat{w}_f + \hat{w}_m)}{p - g} \quad (25)$$

Multiplying through by  $(1 - \tau)$  makes no difference to the sign of this expression, and so

$$\frac{\partial n}{\partial \tau} < 0 \Leftrightarrow \frac{(1 - \tau)\hat{w}_f n^* \hat{z}}{p - g} - n^* < 0 \quad (26)$$

or

$$\frac{\partial n}{\partial \tau} < 0 \Leftrightarrow (1 - \tau)\hat{w}_f \hat{z} < p - g \quad (27)$$

But recall that  $p = (1 - \tau)\hat{w}_f \hat{z} + \hat{x}$ , and substituting this into the condition gives the result.

Given this condition it is *possible* to have the counter-intuitive result, that increasing the child grant actually reduces fertility. In the Appendix it is shown that we can express the necessary and sufficient condition for this as follows:

$$\frac{dn}{dg} < 0 \Leftrightarrow (\hat{w}_f + \hat{w}_m - \tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \tau}) - \gamma(\hat{w}_f + \hat{w}_m) < 0 \quad (28)$$

The first bracketed term in this condition represents the tax revenue gain from raising the tax rate. The smaller this is, the larger must be the tax increase for any given increase in  $g$ . The derivative  $\partial \hat{z} / \partial \tau$  determines the elasticity of female labour supply with respect to the tax rate, and reflects the elasticity of substitution between maternal and bought-in child care. We would expect that the better the quality of child care facilities outside the home, the greater the elasticity of substitution and so the larger the value of this derivative. We could interpret this term overall as saying: the larger is the female labour supply elasticity, the smaller is the increase in tax revenue from raising the tax rate and so the larger must the tax rate increase be, to fund a given increase in child support.

The second bracketed term reflects essentially the income effect of the tax rate change, which has a negative effect on fertility. Thus the larger this income effect, and the larger the tax rate increase must be, the more likely it is that fertility falls when child support increases. The condition can be given a more succinct form if we define

$$\eta \equiv \frac{\tau}{\hat{z}} \frac{\partial \hat{z}}{\partial \tau} \quad (29)$$

as the elasticity of child care input with respect to the tax rate, and

$$\omega \equiv \frac{\hat{w}_f}{\hat{w}_f + \hat{w}_m} \quad (30)$$

as the share of full income contributed by the wife (which could be thought of as an inverse measure of the “gender wage gap”). Then we have

**Proposition 2:** *Revenue neutral increases in  $g$  and  $\tau$  reduce fertility if and only if*

$$\eta\omega z^* > (1 - \gamma) \quad (31)$$

**Proof:** Simply rearrange (33) and apply the above definitions.

The higher the elasticity of domestic child care with respect to the tax rate, (or equivalently the higher the elasticity of female labour supply), the smaller the gender wage gap, the more time currently devoted to domestic child care, and the stronger the relative preference for children ( $\gamma$ ), the more likely is it that increasing the child grant will reduce fertility. This gives some insight into the relationship between female labour supply and fertility across countries.

### 3.2 Effects of the system of child support.

In this model, child support takes the form of a child payment  $g$  and we consider also the introduction of the subsidy for bought-in child care,  $\sigma$ . Though, *cet. par.*, increases in both can be expected to increase fertility, they have very different effects on female labour supply. An increase in  $g$  reduces female labour supply, since it does not change the relative prices of the different forms of child care. An increase in  $\sigma$  on the other hand will induce a substitution of bought-in for domestic child care, and so this will tend to offset the effect of increasing fertility in reducing female labour supply. Moreover, the requirement that substitution of one form of support for the other be revenue neutral has important implications for the relative sizes of the changes that can be made. The overall outcome of these effects is given by

**Proposition 3:** *The introduction of the subsidy to bought-in child care,  $\sigma$ , financed by a reduction in the child payment,  $g$ , increases both female labour supply and fertility.*

**Proof:** We can show (see the Appendix) that in this case the total derivative of fertility with respect to  $g$  is

$$\frac{dn^*}{dg} = -\frac{\tau\hat{w}_fn^*}{(p-g)}\frac{\partial\hat{z}}{\partial\sigma}\Delta^{-1} \quad (32)$$

where  $\Delta < 0$  is the marginal cost<sup>13</sup> to the government of an increase in  $\sigma$ . Since we assume quite plausibly that  $\partial\hat{z}/\partial\sigma < 0$ , this expression is negative, implying that fertility increases with a reduction in  $g$ . This increase is larger, the higher the female gross wage, the higher the tax rate, the greater the reduction in domestic child care resulting from the subsidy increase, and the smaller the marginal cost of the subsidy.

In two otherwise identical economies, the one which places more weight on subsidising bought-in child care and less on direct child payments will have both higher fertility and higher female labour supply. Note that the result is unambiguous. The key to the intuition underlying it is the effect on female labour supply and hence on the tax base. Both the reduction in  $g$  and the increase in  $\sigma$  expand female labour supply, therefore increasing the tax base. This then allows an increase in  $\sigma$  large enough to increase fertility sufficiently to outweigh the effects of a reduction in  $g$ .

### 3.3 Effects of the tax structure.

Suppose that initially joint or flat rate taxation is the case, so that male and female tax rates are equal, but that a move is made in the direction of progressive individual taxation by reducing the female's tax rate  $\tau_f$  and increasing that of the male,  $\tau_m$ , in a revenue neutral way. We then have

**Proposition 4:** *A revenue neutral increase in the male tax rate and decrease in the female tax rate certainly increases female labour supply, and increases fertility if and only if*

$$\frac{\tau_f}{\hat{z}}\frac{\partial\hat{z}}{\partial\tau_f} > \frac{1-\gamma}{\gamma} \quad (33)$$

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<sup>13</sup>This consists of the direct cost of the subsidy, plus the public expenditures arising out of the induced increase in fertility, but net of the increased tax revenue resulting from the increased female labour supply.

The left hand side is the elasticity of per unit domestic child care with respect to the tax rate. This is positive, and larger, the greater the elasticity of substitution between types of child care. The right hand side is smaller, the greater the relative preference for children in the household utility function.

Intuitively, an increase in the male tax rate reduces fertility by an income effect, a reduction in the female tax rate increases fertility by an income effect, while the increase in the implicit price of a child tends to reduce fertility. Consideration of the fertility demand function alone could then lead one to expect that the net effect would be negative. However, given the revenue neutrality requirement, the fact that female labour supply, and therefore the tax base, increases, means that the reduction in the female's tax rate can be larger than the increase in the male's tax rate<sup>14</sup>, and so, for a high enough female labour supply elasticity, the overall effect can be a rise in fertility. Female labour supply can increase, even though fertility increases, because of the substitution of bought-in for domestic child care, induced by the rise in the female net wage.

These results imply that in two otherwise identical economies, we could very well observe both higher fertility and higher female labour supply in an economy with individual as opposed to joint taxation. This then suggests an explanation of the positive cross-country correlation between female labour supply and fertility, at least in part, in terms of the family taxation system<sup>15</sup>.

## 4 Heterogeneous households

Empirically, households differ significantly in the market labour supply of the female spouse, even after controlling for wage rates and demographic characteristics. In order to discuss analytically the effects on equity and fertility of a tax policy that rewards households with larger families and punishes those with smaller families, we need to understand what causes these differences in the first place. To do this, first we have to build into the model a reason for the heterogeneity. We follow Gary Becker (1976), in assuming that

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<sup>14</sup>Also important here is the fact that the male's labor income is likely to be larger than the female's.

<sup>15</sup>Thus for example it may help to explain why the UK has higher female labour supply and fertility than Germany, but not why the US does, since both Germany and the US have joint taxation.

differences in physical and human capital across households cause differences in productivity in domestic work. In a general model in which child care is only one of several outputs of domestic production there are two possibilities. A household with a higher productivity may specialise in domestic work and therefore have a lower market labour supply. Alternatively, the more domestically productive household may have a higher market labour supply, since a given amount of household work, if carried out with higher efficiency, can be associated with the supply of more time to the market.<sup>16</sup>

Here, as in Becker, we limit our analysis to the case in which the household with higher productivity specialises in producing children and supplies less time to the market. We show that a policy that rewards households with larger families, while punishing those with smaller families, can have a negative effect on fertility and will also be inequitable.<sup>17</sup>

There are two types of households, indexed  $i = 1, 2$ , that differ in their underlying child care production functions, with type 1 having higher productivity in child care. This is assumed to imply the inequalities<sup>18</sup>:

$$p_1(w_f, \sigma) < p_2(w_f, \sigma) \quad (34)$$

$$\hat{z}_1(w_f, \sigma) > \hat{z}_2(w_f, \sigma) \quad (35)$$

$$\hat{x}_1(w_f, \sigma) < \hat{x}_2(w_f, \sigma) \quad (36)$$

at all pairs of values  $(w_f, \sigma)$ . The households are otherwise identical. These assumptions imply in turn that  $n_1^* > n_2^*$ ,  $z_1^* > z_2^*$ . Total bought-in child care is ambiguous, because although type-2 households use more of this per child, they have fewer children. We assume  $x_1^* < x_2^*$ . Thus we have two household types, one of which has more children, lower female labour supply and lower bought-in child care, both per child and in total. Type-1 households have a lower income from market labour supply, and so, under a tax system in which the marginal tax rate depends on joint market income, they will face a lower tax rate and would have a higher net wage than type-2 households.

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<sup>16</sup>For further discussion of this point see Apps and Rees (1999), where we explore the implications of both sets of assumptions for the analysis of welfare-increasing tax reform.

<sup>17</sup>A further argument against this policy would be to note that households with higher female labour supply typically save more (see Apps and Rees (2001), (2003)). Thus, to the extent that they have fewer children, this could be viewed simply as substituting capital for labour, and there is no proof that this worsens the ability of the economy to sustain future consumption.

<sup>18</sup>A simple example of a production function that has these results is  $n_i = B_i z_i^{b_i} x_i^{1-b_i}$ ,  $i = 1, 2$ , with  $B_1 > B_2$ ,  $b_1 > b_2$ .

Assume however, for simplicity, that the two household types in the initial situation face the same net wage rates, so that the tax rate  $\tau$  is interpreted as a flat rate income tax. We examine the effects of a revenue neutral reduction in the tax rate for type-1, and an increase in that for type-2 households, thus implementing a policy of punishing small families and rewarding large families.

Note that type-1 households have higher utility than type-2 households, because the household with the lower implicit price of children will have a higher utility possibility set. Thus the indirect utility function for a household of type  $i$  is

$$u_i = \gamma \ln \frac{\gamma(w_f + w_m)}{p_i(w_f, \sigma) - g} + (1 - \gamma) \ln(1 - \gamma)(w_f + w_m) \quad (37)$$

The households have the same net *full income* and receive the same payment  $g$  per child, and so

$$u_1 > u_2 \Leftrightarrow p_1(w_f, \sigma) < p_2(w_f, \sigma) \quad (38)$$

Since type 1 households have the lower net household income from market labour supply, this underlines the inadequacy of the latter as a welfare indicator in the presence of household production.<sup>19</sup>

Let  $\phi_i$  denote the proportion of type  $i$  households in the population,  $\sum_{i=1}^2 \phi_i = 1$ . The government budget constraint in average per household terms is

$$\tau[\hat{w}_f(1 - \bar{z}^*) + \hat{w}_m] - g\bar{n}^* - \sigma\bar{x}^* = 0 \quad (39)$$

where  $\bar{z}^* \equiv \sum_i \phi_i z_i^*$ ,  $\bar{n}^* \equiv \sum_i \phi_i n_i^*$ , and  $\bar{x}^* \equiv \sum_i \phi_i x_i^*$ .

Under this constraint, since  $z_1^* > z_2^*$ , and  $n_1^* > n_2^*$ , type-1 households pay less tax and receive more in child payments than type-2 households. The overall distributional effect depends also on the last component of the transfer. Empirically however,  $\sigma$  is typically very small, if not zero. Overall we conclude that there is a net transfer from type 2 to type 1 households, which is regressive, since the latter have higher utility.

We now consider the effects on average fertility of revenue neutral changes in tax rates on households,  $d\tau_2 > 0 > d\tau_1$ , where  $\tau_i$  is the tax rate paid by

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<sup>19</sup>It also means that the utility inequality in (43) would be increased if the tax system were progressive on the basis of joint market income, rather than flat rate as assumed here.

household of type  $i = 1, 2$ , and the rates are equal initially. The balanced budget requirement implies that

$$d\tau_2 = -\theta \frac{\phi_1}{\phi_2} d\tau_1 \quad (40)$$

where

$$\theta \equiv \frac{\hat{w}_f(1 - z_1^*) + \hat{w}_m - \tau_1 \hat{w}_f \frac{\partial z_1^*}{\partial \tau_1} - g \frac{\partial n_1}{\partial \tau_1}}{\hat{w}_f(1 - z_2^*) + \hat{w}_f - \tau_2 \hat{w}_f \frac{\partial z_2^*}{\partial \tau_2} - g \frac{\partial n_2}{\partial \tau_2}} > 0 \quad (41)$$

The change in average fertility is

$$d\bar{n}^* = \phi_1 \frac{\partial n_1^*}{\partial \tau_1} d\tau_1 + \phi_2 \frac{\partial n_2^*}{\partial \tau_2} d\tau_2 \quad (42)$$

$$= \phi_1 \left( \frac{\partial n_1^*}{\partial \tau_1} - \theta \frac{\partial n_2^*}{\partial \tau_2} \right) d\tau_1 \quad (43)$$

Then we have

**Proposition 5:** *if the condition in (32) of Proposition 1 is satisfied for type 2 households and not for type-1 households, then regardless of the proportions of the two types in the population, average fertility falls when  $d\tau_2 > 0 > d\tau_1$ .*

**Proof:** An increase in the net female wage reduces fertility in type-1 households, while a fall in the net wage also reduces fertility of type 2 households, if (32) holds, and so fertility must fall, i.e. in (48)  $d\bar{n}^* < 0$ , because  $\partial n_1^*/\partial \tau_1 > 0$ ,  $\partial n_2^*/\partial \tau_2 < 0$  and  $d\tau_1 < 0$ .

Proposition 1 showed that if a household bought in a sufficiently high amount of child care, an increase in its net wage would increase fertility, while with a low level of bought in child care the reverse would be the case. Then if our two household types lie on either side of the critical level of bought in child care, increasing the net wage of the household with more and reducing that of the household with fewer children unambiguously reduces fertility overall. If both household types lie on the same side of the critical level, then no unambiguous conclusions are possible. The net effect will depend on their relative elasticities of demand for children with respect to the net wage, and on the value of  $\theta$ .

## 5 Conclusions

Historically in virtually all developed economies there seems to be clear evidence of an inverse relationship between female labour supply and fertility. However, particularly in the last decade or so, the relationship across countries has been positive: for example countries like Germany, Italy and Spain with the lowest fertility rates also have the lowest female participation rates. We hypothesise that the reason for this lies in the combined effects of a country's tax system and system of child support, and we have sought to clarify this theoretically, using as parsimonious a model as possible. The results do suggest that countries with individual rather than joint taxation, and which support families through improved availability of alternatives to domestic child care, rather than through direct child payments, are likely to have both higher female labour supply and higher fertility. These results are strengthened when we take account of the heterogeneity among households which undoubtedly exists. The simple-minded policy of using the tax system to reward households with larger families and punish those with smaller can have adverse effects both on equity and fertility. Overall we would argue that a reversal of the trend in fertility, which many regard as vital to resolve the problems for social security programs presented by ageing populations, need not be bought at the cost of significant reductions in female labour supply, but on the contrary can best be achieved by policy changes that increase it.

## Appendix

As stated in the text, we assume that initially  $\sigma = 0$ , which is reasonably realistic and reduces the dimensionality of the system to be studied. This means that we can work with a relatively simple equilibrium system:

$$n^* - \frac{\gamma[(1 - \tau_f)\hat{w}_f + (1 - \tau_m)\hat{w}_m]}{p((1 - \tau_f)\hat{w}_f, \sigma) - g} = 0 \quad (44)$$

$$z^* - \hat{z}[(1 - \tau_f)\hat{w}_f, \sigma]n^* = 0 \quad (45)$$

$$\tau_f \hat{w}_f (1 - z^*) + \tau_m \hat{w}_m - gn^* - \sigma x^* = 0 \quad (46)$$

where under a flat rate or joint taxation system  $\tau_f = \tau_m = \tau$ .

**Case (i):** Here we take an exogenous increase in  $g$ , with  $n^*$ ,  $z^*$  and  $\tau$  endogenous, and  $\tau$  increasing to fund the increase in child payment. The comparative statics results are derived from the linear system

$$\begin{bmatrix} 1 & 0 & -\frac{\partial n}{\partial \tau} \\ -\hat{z} & 1 & -n^* \frac{\partial \hat{z}}{\partial \tau} \\ -g & -\tau \hat{w}_f & \hat{w}_f (1 - z^*) + \hat{w}_m \end{bmatrix} \begin{bmatrix} dn^* \\ dz^* \\ d\tau \end{bmatrix} = \begin{bmatrix} \frac{\partial n}{\partial g} \\ 0 \\ n^* \end{bmatrix} dg \quad (47)$$

The determinant of the left hand matrix is

$$\Delta = \hat{w}_f (1 - z^*) + \hat{w}_m - \tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \tau} - \frac{\partial n}{\partial \tau} (\tau \hat{w}_f \hat{z} + g) \quad (48)$$

This expression is the net effect on tax revenue of an increase in the tax rate, and so it is reasonable to assume  $\Delta > 0$ . We then have

$$\frac{dn^*}{dg} = \frac{\frac{\partial n}{\partial g} (\hat{w}_f (1 - z^*) + \hat{w}_m - \tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \tau}) + n^* \frac{\partial n}{\partial \tau}}{\Delta} \quad (49)$$

$$\frac{dz^*}{dg} = \frac{\frac{\partial n}{\partial g} [\hat{z} (\hat{w}_f (1 - z^*) + \hat{w}_m) + gn^* \frac{\partial \hat{z}}{\partial \tau}] + n^* (\hat{z} \frac{\partial n}{\partial \tau} + n^* \frac{\partial \hat{z}}{\partial \tau})}{\Delta} \quad (50)$$

By inserting the specific expressions for the derivatives into these equations and rearranging, we obtain the conditions

$$\frac{dn^*}{dg} < 0 \Leftrightarrow (1 - \gamma) < \eta_z \left( \frac{\hat{w}_f z^*}{\hat{w}_f + \hat{w}_m} \right) \quad (51)$$

$$\frac{dz^*}{dg} > 0 \Leftrightarrow p \frac{n^*}{\hat{z}} \frac{\partial \hat{z}}{\partial \tau} + (1 - \gamma) (\hat{w}_f + \hat{w}_m) > 0 \quad (52)$$

where  $\eta_z \equiv \tau \partial z^* / z^* \partial \tau$  is the elasticity of time spent in child care with respect to the tax rate, and should be thought of as determining the elasticity of female labour supply. The latter condition is obviously satisfied since all terms on the right are positive. The former condition is discussed in the text.

**Case (ii):** Here we take an exogenous change in  $g$ , treating  $n^*$ ,  $z^*$  and  $\sigma$  as endogenous. In this case we have the system

$$\begin{bmatrix} 1 & 0 & -\frac{\partial n}{\partial \sigma} \\ -\hat{z} & 1 & -n^* \frac{\partial \hat{z}}{\partial \sigma} \\ -g & -\tau \hat{w}_f & -x^* \end{bmatrix} \begin{bmatrix} dn^* \\ dz^* \\ d\sigma \end{bmatrix} = \begin{bmatrix} \frac{\partial n}{\partial g} \\ 0 \\ n^* \end{bmatrix} dg \quad (53)$$

The determinant of the left hand matrix is

$$\Delta = -(x^* + (g + \tau \hat{w}_f \hat{z}) \frac{\partial n}{\partial \sigma}) - \tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \sigma} \quad (54)$$

This is the net impact on the government budget of an increase in the subsidy  $\sigma$ , and so it is reasonable to assume  $\Delta < 0$ .

It is straightforward to show that

$$\frac{dn^*}{dg} = \frac{-\tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \sigma} \frac{\partial n}{\partial g} - x^* \frac{\partial n}{\partial g} + n^* \frac{\partial n}{\partial \sigma}}{\Delta} < 0 \quad (55)$$

Substituting the specific expressions for the last two derivatives in the numerator shows that they cancel, and so we have

$$\frac{dn^*}{dg} = \frac{-\tau \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \sigma} \frac{\partial n}{\partial g}}{\Delta} < 0 \quad (56)$$

so that a revenue neutral increase in  $\sigma$  and reduction in  $g$  increases fertility. Similarly one can show that

$$\frac{dz^*}{dg} = \frac{(n^* + g \frac{\partial n}{\partial g}) \frac{\partial \hat{z}}{\partial \sigma}}{\Delta} > 0 \quad (57)$$

so that female labour supply certainly rises when  $g$  falls. In both cases the effects are greater, the larger is  $\frac{\partial \hat{z}}{\partial \sigma}$  in absolute value, *i.e.* the larger the elasticity of substitution between the two types of child care.

**Case (iii).** Here we take an exogenously given  $d\tau_m$ , with  $n^*$ ,  $z^*$  and  $\tau_f$  endogenous. The corresponding differentials  $dn^*$ ,  $dz^*$ ,  $d\tau_f$  must satisfy the government budget constraint<sup>20</sup>, *i.e.* must be revenue neutral. The comparative statics results are derived from the linear system

$$\begin{bmatrix} 1 & 0 & -\frac{\partial n}{\partial \tau_f} \\ -\hat{z} & 1 & -n^* \frac{\partial \hat{z}}{\partial \tau_f} \\ -g & -\tau_f \hat{w}_f & \hat{w}_f(1 - z^*) \end{bmatrix} \begin{bmatrix} dn^* \\ dz^* \\ d\tau_f \end{bmatrix} = \begin{bmatrix} \frac{\partial n}{\partial \tau_m} \\ 0 \\ -\hat{w}_m \end{bmatrix} d\tau_m \quad (58)$$

The determinant of the left hand matrix is

$$\Delta = \hat{w}_f(1 - z^*) - \tau_f \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \tau_f} - (g + \tau_f \hat{w}_f \hat{z}) \frac{\partial n}{\partial \tau_f} \quad (59)$$

This term is the net marginal tax revenue from an increase in  $\tau_f$ , taking into account the loss of revenue resulting from a reduction in female labour supply (the second term) and the cost associated with an increase in fertility (the third term). We assume that  $\Delta > 0$ , since otherwise tax revenue could be increased by reducing tax rates. We then have that

$$\frac{dn^*}{d\tau_m} = \frac{\frac{\partial n}{\partial \tau_m} (\hat{w}_f(1 - z^*) - \tau_f \hat{w}_f n^* \frac{\partial \hat{z}}{\partial \tau_f}) - \hat{w}_m \frac{\partial n}{\partial \tau_f}}{\Delta} \quad (60)$$

$$\frac{dz^*}{d\tau_m} = \frac{\frac{\partial n}{\partial \tau_m} (\hat{w}_f(1 - z^*) \hat{z} + g n^* \frac{\partial \hat{z}}{\partial \tau_f}) - \hat{w}_m (\hat{z} \frac{\partial n}{\partial \tau_f} + n^* \frac{\partial \hat{z}}{\partial \tau_f})}{\Delta} \quad (61)$$

Inserting the relevant partial derivatives and rearranging then gives the results reported in Proposition 4 of the text.

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<sup>20</sup>We can ignore  $dx^*$  because of the assumption  $\sigma = 0$ .

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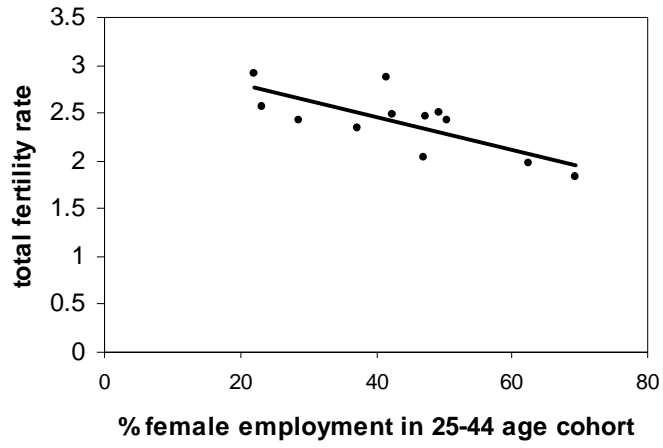
**Table 1: % female employment and TFR**

<b>Year</b>	<b>1970</b>		<b>1990</b>	
	<b>% fem emp 25-44<sup>a</sup></b>	<b>TFR<sup>b</sup></b>	<b>% fem emp 25-44<sup>a</sup></b>	<b>TFR<sup>b</sup></b>
<b>Germany</b>	47.15	2.03	59.50	1.45
<b>Australia</b>	41.60	2.86	63.05	1.91
<b>UK</b>	50.50	2.43	67.05	1.83
<b>US</b>	42.55	2.48	70.05	2.08
<b>Canada</b>	37.15	2.33	69.75	1.71
<b>NL</b>	23.30	2.57	53.30	1.59
<b>Sweden</b>	62.55	1.97	89.45	2.13
<b>Norway</b>	49.45	2.50	74.70	1.93
<b>Finland</b>	69.50	1.83	84.15	1.78
<b>France</b>	47.35	2.47	63.85	1.78
<b>Italy</b>	28.80	2.42	44.95	1.33
<b>Spain</b>	22.10	2.9	31.25	1.36

<sup>a</sup>Source: OECD Labour Force Statistics: from tables for participation and unemployment for women aged 25 to 44 years

<sup>b</sup>TFR: Average number of children a woman would expect to have if she were to experience all of the age-specific birth rate occurring in that year.

**Figure 1: TFR and % female employment 1970**



**Figure 2: TFR and % female employment 1990**

