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The Social Cost of Government Spending in an Economy with Large Tax Distortions
A CGE Decomposition for Norway

Abstract:
We use a CGE model to estimate the social cost of a marginal increase in public expenditure in Norway. Norway exemplifies an economy with high taxes. Distortionary taxes imply wedges between the market prices and the corresponding shadow prices. The shadow prices are unobservable, which is the rationale for using a CGE model to estimate the social cost of government consumption. The social cost is decomposed into a direct resource cost and the cost of public funds. The CGE estimate of the direct resource cost is implicitly a weighted average of different opportunity costs, reflecting distortions in the Norwegian economy. Our estimate of the resource cost equals about ¾ of the *ex ante* market price of the resources consumed. This gap is due to a positive labour supply response combined with a high effective tax rate on labour income. Our estimate of the social cost of raising public funds through a higher pay-roll tax is about 20 percent of the direct resource cost.

Keywords: Tax distortions, Cost-benefit analysis, Cost of public funds, Computable general equilibrium models

JEL classification: H20, H21, H43, J22

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1. Introduction

The principles of how the social costs of increasing public expenditures should be calculated, is probably one of the most explored fields in public economics. Dreze and Stern (1987) and Auerbach and Hines (2002) provide comprehensive overviews. The social cost of a project in which resources are used to provide a public good can be decomposed into two multiplicative components: 1) The direct resource cost and 2) the marginal cost of public funds (*MCF*). The direct resource cost is the shadow price of the resources used in the project. In distorted economies the shadow price of each specific resource is not uniform, but differs between sources of use. The correct shadow price of each one of the resources is a weighted average of the source specific shadow prices, where the relevant weights are the reduction of the resource in each source of use. The *MCF* measures the social unit cost associated with financing the public expenditure by increasing distortionary taxes.[1] A unique number representing the *MCF* for the tax system as a whole, exists only in the theoretical second-best situation, where all tax instruments are chosen optimally. In general, one specific *MCF*-estimate can be associated with each tax instrument.

In principle, empirical assessments of both the direct resource cost and *MCF* require information far beyond what is and will be available. The crowding out effects caused by the project and the additional reallocations caused by the tax financing, should be calculated within general equilibrium models. Although Computable General Equilibrium (CGE) modelling of the distortive effects of taxation has reached an advanced level, there are well known problems of this approach. Credible and robust estimates of key parameters determining consumer and producer behaviour are often lacking. Despite improved access to an increasing amount of data, it is still hard to give a relevant description of important distortions. Non-tariff import barriers represent a good example. Several details in the direct and indirect tax system are lost in CGE models because only a few representative consumers are specified, facing some kind of *average* marginal tax rates, not the actual ones. If peaks and holes in the tax- and tariff systems are camouflaged in widely defined average tax- and tariff rates, the classification and the level of aggregation of goods and industries also affect the potential for welfare gains; a highly aggregated model may lose possibilities for reallocation with high potential impact on aggregate efficiency. In addition, aggregation and simplifications usually imply less operational models. However, although any empirical assessment may be criticised, cost-benefit analyses should

[1] A vast literature discusses conceptual and other theoretical issues related to estimates of *MCF*(s). Examples of surveys include Haakonsen (1998), Auerbach and Hines (2002), Sandmo (1998) and Snow and Warren (1996). There are also several CGE-based assessments to choose from, including e.g. Jorgenson (1996), Madsen (2004). Vennemo (1991), Holmøy and Strøm (1997) and Håkonsen and Mathiesen (1997) assess *MCF* for the Norwegian economy.

play an important role in policy making, and there are no better alternatives than using CGE models to make systematic use of available relevant information in order to get the estimates of social costs as accurate as possible.

The purpose of this paper is to present and interpret a CGE-assessment of the social cost of a marginal project undertaken by the government. Our primary concern is the estimate of the direct resource cost, but our estimate of the total social cost of the project also include *MCF* associated with a broad tax on labour income, such as the pay roll tax. The reason for focusing on the estimate of the resource cost is that CGE-estimates on this cost component are rare in the CGE literature compared to the number of *MCF* estimates. One explanation may be that resource cost estimates are typically needed in cost benefit analyses of rather small well defined projects, which are unlikely to affect relative prices.

However, the subsequent analysis will reveal that estimates of the direct resource cost will benefit from using the information that can be extracted from a CGE-model, even if the project is marginal. The point of using a CGE model is not only to take into account that the project may affect market prices. A more general point is that taxes and market imperfections distort market prices from the corresponding shadow prices. As mentioned above, the shadow price of a resource is not observable, and depends in a possibly complex way on the crowding out effects generated by the project. A properly designed CGE model serves as a way of storing relevant information of price distortions, and it is an indispensable tool for making the best possible estimates of the crowding out effects induced by the project. Norway represents an economy with relatively generous welfare state schemes. Despite the government petroleum revenues the tax rates are among the highest in the OECD area. This makes it especially interesting to use Norway as an illustration of the empirical importance of using CGE estimates of the social cost of a government project rather than its observable market price. Probably, our results have general relevance for welfare states with relatively high effective taxes.

We consider a marginal project, which is "representative" in the sense that the relative composition of labour and other inputs equals the composition for the total government consumption in Norway. We base our estimates on a rather disaggregated intertemporal CGE-model of the Norwegian economy, which has been developed to give a detailed picture of the distortions of the relative prices caused by e.g. taxes, subsidies, various types of industry assistance, monopolistic competition in the home markets, tariffs and non-tariff barriers. Thus, we are able to capture a large number of intra- and intertemporal reallocations potentially important for aggregate efficiency. The richness of the model structure also enables us to take into account several endogenous public budget effects in addition to changes in tax bases due to reallocations.

The paper is organised as follows. In Section 2 we use a highly stylised model to explain what turns out to be the most important driving forces behind the results derived from the simulations on the MSG6 model. Section 3 provides a brief description of the most relevant aspects of our CGE model. Section 4 describes the policy experiment and we present and interpret our estimates. In Section 5 we summarise our results, we compare them with other relevant estimates, and we suggest some directions for future research that may improve our estimates.

2. Social costs in a stylised model of the model

The subsequent formal model analysis highlights how the effective taxation of labour income implies that the social cost of increasing public sector employment is reduced from the *ex ante* market price, the more the project crowds out leisure, rather than consumption. The model is hardly interesting for its own sake. The motivation of the analysis is to focus on what turns out to be the most important determinants of the results of the MSG6 simulations.

Consider a closed economy in which a representative price taking consumer allocates his exogenous time endowment (T) to leisure (F) and market labour (L). The utility function $U = U(F, C)$ is homothetic and scaled so that the marginal utility of money is equal to unity in the initial equilibrium. C is consumption. The labour supply is allocated to the private sector (L_P) and the public sector (L_O). The private sector is competitive and produces X units of a single numeraire good. The private sector has the production function $X = L_P{}^s$, where $0 < s \leq 1$ is the scale elasticity. We disregard public consumption of the private good, so that $X = C$ in equilibrium. Public expenditure affects neither the utility of private consumption and leisure, nor the production function. It is therefore neglected in the analysis, since we are interested in the cost of public expenditure. The consumer receives wages and profits from the private sector. Constant tax rates, t_L, t_C and t_π are levied on labour income, consumption and profits, respectively . The consumer budget constraint is

$\tau_C C + \frac{w}{\tau_L} F = \frac{w}{\tau_L} T + \pi\tau_\pi + R$, where $\tau_C = 1 + t_C$ is the consumer price, $P_F = w(1 - t_L) \equiv w/\tau_L$ is the price of leisure. w is the pre tax wage rate, and $\tau_\pi = 1 - t_\pi$. R is a possible lump-sum transfer, perceived as exogenous by the consumer. We define $\tau' \equiv (1 + t_C)/(1 - t_L) = \tau_C \tau_L \geq 1$ as the effective tax wedge between the social and private terms of trade between leisure and consumption. The first order condition for utility maximisation becomes

(1) $$\frac{U'_C}{U'_F} = \frac{\tau'}{w}.$$

Profit maximisation implies

(2) $$s{L_P}^{s-1} = w\,.$$

Saving means waste in a static model like this, and is ruled out. The public budget constraint implies that the public budget surplus, B, is rebated to the consumer

(3) $$B = t_C C + t_\pi \pi + t_L w L_P - (1 - t_L) w L_O - R = 0\,,$$

Although B = 0, it turns out to be useful to keep it as a variable. Equilibirum in the product and labour market then implies

(4) $$B + C = {L_P}^s$$

(5) $$L_P + L_O = T - F\,.$$

Eqs. (1) - (5) determine the endogenous variables C, F, L_P, B og w, as well as one of the tax instruments t_C, t_L, t_π, or R. Implementing the public sector project implies a the exogenous change dL_O combined with the endogenous adjustment in one of the four tax instruments necessary to keep B = 0.

Solving the model yields the following implicit equilibrium solution for F

(6) $$\frac{U'_C\left(F, (T - L_O - F)^s - B\right)}{U'_F\left(F, (T - L_O - F)^s - B\right)} = \frac{\tau'}{s(T - L_O - F)^{s-1}}\,.$$

We write the corresponding explicit equilibrium solution for F as

(7) $$F = f(L_O, t_C, t_L, B)\,.$$

The general equilibrium relationship $f(L_O, t_C, t_L, B)$ should not be confused with the demand function for leisure. Eqs. (3), (4), (5) and (7) yields the equilibrium solution for C.[2] Inserting this and Eq. (7)

[2] The formal equilibrium relationship becomes $C = {L_P}^s = \left[T - L_O - f\left(L_O, t_C, t_L, B\right)\right]^s$.

into the utility function, yields the equilibrium relationship between private utility and the policy variables

(8) $$U = g(L_O, t_C, t_L, B) .$$

Neither R nor t_π enters Eqs. (6) and (9) because the profit tax works as a lump sum tax. A partial increase in R (or t_π) must be accompanied by a budget neutral adjustment of t_π (or R), as long as B is constant. The net lump-sum transfer is then unchanged, and there are no real effects. The partial derivatives $\partial f/\partial L_O$ and $\partial g/\partial L_O$ measure the equilibrium changes in, respectively, leisure and utility by an increase in public employment, contingent on lump-sum financing. The partial derivatives $\partial f/\partial B$ and $\partial g/\partial B$ should be interpreted as the equilibrium effects on F and U of increased public consumption of the private good through waste or saving without purpose. The partial derivatives $\partial f/\partial t_i$ and $\partial g/\partial t_i$, $i = C, L$ measures the equilibrium effects on F and U of differential taxation used to finance a lump-sum transfer.

Substituting the equilibrium solutions into Eq. (3) yields $B = h(L_O, t_C, t_L, t_\pi, R) = 0$, from which we calculate the adjustment of tax rate i necessary to finance the project dL_O:

(9) $$\left.\frac{dt_i}{dL_O}\right|_{B=0} = -\frac{\partial h/\partial L_O}{\partial h/\partial t_i} > 0 .$$

By substituting the implicit solution for the endogenous tax from $h(L_O, t_C, t_L, t_\pi, R) = 0$ into Eqs. (7) og (8), we obtain the solutions for F and U, satisfying the public budget constraint. The social cost of the budget neutral policy $\{dL_O, dt_i\}$ can be decomposed as

(10) $$\left.\frac{dU}{dL_O}\right|_i = \frac{\partial g}{\partial L_O} + \frac{\partial g}{\partial t_i}\left(-\frac{\partial h/\partial L_O}{\partial h/\partial t_i}\right).$$

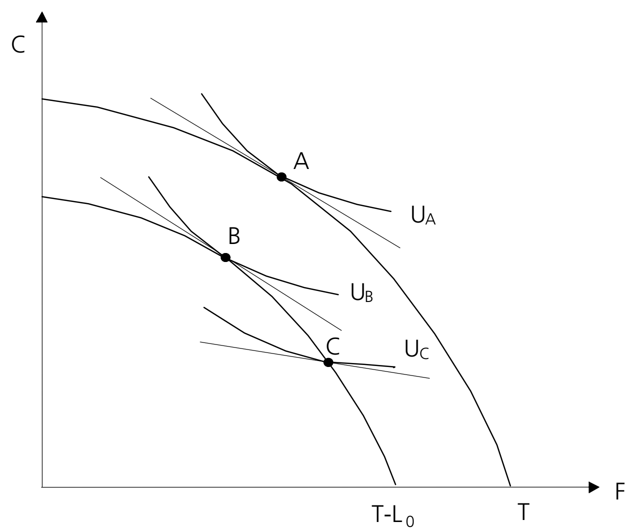
We define $dg/\partial L_O$ as the direct social resource cost or the shadow price of public employment. We define the second term in Eq. (10) as the social cost of financing increased public employment by adjusting tax rate i. Following the definition of MCF in Sandmo (1998), the social cost can be written

(11) $$\left.\frac{dU}{dL_O}\right|_i = \frac{\partial g}{\partial L_O} MCF_i .$$

The multiplier MCF_i reflects the welfare loss of raising public funds by increasing the tax instrument *i*. This definition of MCF_i is also used in Ballard and Fullerton (1992).[3] According to this definition, $MCF = 1$ in the case of lump-sum financing. If the initial equilibrium is second best, $MCF_i = MCF > 1$. It follows that if the initial equilibrium is not second best, financing through a proportional increase in all distortive tax rates implies that *MCF* is higher than in the second best case. But there may exist some taxes for which $MCF_i < 1$ when no restrictions are imposed on possible initial distortions.

Figure 1 og 2, taken from Ballard and Fullerton (1992), illustrate equilibrium allocations and welfare effects caused by increased public employment in the stylised model. In Figure 1 the convex curve starting in *T* on the horizontal time axis, shows the *ex ante* production frontier. The curves denoted U_A, U_B and U_C are indifference curves of the utility function. *A* is the first best equilibrium. The production frontier through *B* shows the production and consumption possibilities *ex post* the increase in public employment. *B* is the *ex post* equilibrium when lump-sum financing is possible. The loss of utility then equals the market price of the project when there are no distortions *ex ante*. In the case of distortive financing the slope of the private budget constraint becomes flatter. *C* exemplifies the equilibrium in this case. The utility loss of moving from *B* to *C* measures the cost of public funds when there are no initial distortions. By our definition, *MCF* is the difference in utility levels obtained in *A* and *C* relatively to the difference in utility levels obtained in *A* and *B*.

Figure 1. Equilibrium effects of increased public employment when the *ex ante* equilibrium is first-best



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[3] Alternative definitions of *MCF* exists in the literature. For the sake of comparison with the *MCF* estimates for the Norwegian economy given in Vennemo (1991), note that Vennemo defines MCF_i as $dU/wdL_o|_i$. This definition includes the effect of the deviation between the shadow price and the market price in *MCF*.

Figure 2. Equilibrium effects of increased public employment when the *ex ante* equilibrium is distorted

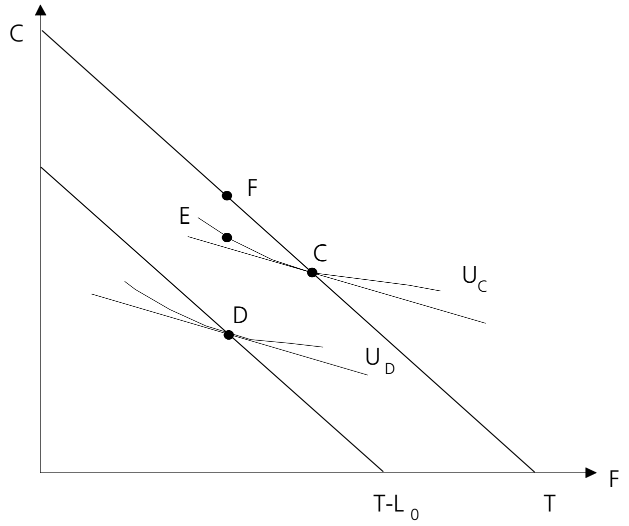

Figure 2 illustrates the more realistic situation where the *ex ante* equilibrium is distorted. The Figure has now been simplified by assuming constant returns to scale. C is the *ex ante* equilibrium, and D is the *ex post* equilibrium with lump-sum taxation. The social cost of the policy is measured by the vertical distance DE. The interesting lesson to learn from Figure 2 is that the social cost is lower than the market price (the distance DF) because of the *ex ante* distortions.

Determinants of the cost components

Eq. (10) provides a conceptual definition of the two components of the total social costs of the project. In order to understand the nature of the determinants of the magnitude of these components, we differentiate the utility function and undertake the substitutions that reveal how the utility effect depends on reallocations and initial distortions:

$$(12) \qquad dU = U'_C\left(dC + \frac{U'_F}{U'_C}dF\right) = \tau_C w\left[\left(\frac{1}{\tau'} - 1\right)dF - dL_O\right] = -\left[P_F\left(\frac{dF}{dL_O}\right) + \tau' P_F\left(\frac{dL_P}{dL_O}\right)\right]dL_O,$$

when $dB = 0$, and utility is transformed by setting the initial marginal utility of income equal to unity. Eq. (12) shows that the social cost equals the market price of the project, wdL_O, when the initial equilibrium is first-best, i.e. $\tau_L = \tau_C = 1$. Except from this reference case, $\tau' > 1$. The last pair of brackets in Eq. (12) illustrates the Ramsey-Boiteux rule; the social cost is a weighted average of the shadow prices of the resources crowded out by the project. In this stylised model, the expansion of public employment crowds out leisure and private consumption through reduced private sector employment. Crowding out of leisure is equivalent to stimulating labour supply. The shadow price of private consumption exceeds the shadow price of leisure by a factor equal to the effective tax rate τ'. Therefore, the ratio of the social cost to the market price is lower the more leisure is crowded out instead of consumption. The equilibrium change in leisure to the policy $\{dL_O, dt_i\}$ can be shown to be

$$\text{(13)} \qquad \left.\frac{dF}{dL_O}\right|_i = \frac{\frac{L}{L_O}\mu_i - 1}{1 + \frac{L_P}{Fb} - \mu_i},$$

where $i = \pi, C, L$ indicates the tax instrument used to finance the project. μ_i measures the additional substitution effect on leisure when tax instrument $i = L, C$ is used to finance the project instead of lump-sum or profit taxation. $\mu_L = (\sigma/b)(L_O/L)$ and $\mu_C = (\sigma/b)(P_F L_O/\tau_C C)$, where σ is the elasticity of substitution between leisure and consumption. $b = s + (1 - s)\sigma$ captures the feed-back effects on time allocation from the fact that variations in private employment brings about changes in relative prices, and thereby substitution effects. b is increasing (decreasing) in s when $\sigma <$ (>) 1. We will confine the discussion below to the case where $\sigma < 1$, since this is the case in MSG6. Moreover, we consider financing by t_L only, as the simulated cost estimates are approximately the same when t_C is used as the tax instrument. As will be explained in the Section 3, decreasing returns to scale is an important aspect of the MSG6 model. However, in order to understand the significance of decreasing returns to scale for the equilibrium changes in the time allocation and utility, it is instructive to first interpret effects in the simpler constant returns case. When $s = 1$, and Eq. (13) simplifies to

$$\text{(13')} \qquad \left.\frac{dF}{dL_O}\right|_L = \frac{\sigma - 1}{1 + \frac{L_P}{F} - \sigma\frac{L_O}{L}},$$

which is more negative the more σ is reduced from the standard reference case of Cobb Douglas preferences, i.e. $\sigma = 1$. Thus, when $\sigma < 1$, the substitution effect in favour of leisure induced by higher taxation of labour income, is not strong enough to dominate the income effect caused by use of labour in the project. In the limit case $\sigma = 0$, the adjustments keep the ratio $F/(T\text{-}L_O)$ unchanged. Eq. (13') shows that the decrease of leisure, or the increase in total employment, is dampened the broader is the *ex ante* base of the tax rate that is raised, i.e. the greater is L_P/F.

Except from the special case $\sigma = 1$, the decrease in leisure is dampened as s decreases from unity. In MSG6, $b < 1$ since $s < 1$ and $\sigma < 1$. Compared to the case of constant returns to scale, there is less crowding out of leisure, which amplifies the social cost of the project. The intuition is that the income effect on leisure is reduced, whereas the substitution effect is strengthened.

3. The CGE-model

General features

MSG6 provides a rather detailed description of Norwegian commodities and industries. The model specifies 32 private business industries, 7 government sectors and 60 commodities. The classification is intended to obtain homogeneity within aggregates with respect to the actual design of trade- and industry policies, as well as to production and demand functions. The Norwegian National Accounts (NA) constitutes the main empirical data source for both calibration and estimation of behavioural and technology parameters. The results presented in the next sections were obtained on a model version calibrated to 1995-data. This means that tax rates and other initial distortions are as they were in this year.[4]

The Norwegian economy is assumed to be too small to affect world prices. The exchange rate is normalised to unity. All agents have access to international markets for financial capital, where they face an exogenous real rate of interest. An intertemporal budget constraint applies to the economy as a whole, reflecting the budget constraints for the household and the government. As the accumulated foreign debt depends on what happens in this transition period, the steady state solution of the model is path dependent.[5] Government consumption and transfers are exogenous in real terms. The public budget constraint is satisfied by endogenous adjustments of tax rates. Goods and services, including those from labour and capital, are perfectly mobile across industries. Supply equals demand in all markets in all periods. Thus, we rule out the possibility that the public project is a free lunch absorbing involuntarily unemployed resources only.

Household Behaviour

Consumption, labour supply and savings are derived from the decisions of a representative price taking household with perfect foresight. The household maximises an intertemporal CES welfare function of the utility obtained in each year over an infinite horizon, subject to an intertemporal budget

[4] Several indirect taxes and subsidies include a Pigou-element. The corresponding externalities are, however, not described in the model. Accordingly, the distortions relatively to the social optimum are not accurately captured by the taxes, subsidies and other price distortions as measured in the model. A correction for this shortcoming is demanding but should be on the agenda for future research.

[5] See e.g. Turnovsky (1995), Ch. 12 for a formal analysis of path dependency of the steady state solution in intertemporale models of open economies.

constraint and a time constraint effective in each period. The period utility is a CES function of leisure and a nested CES aggregate of private consumption of goods and services. We use the welfare function of the household to measure the welfare effects of the use of resource and changes in tax rates implied by the project. The intertemporal elasticity of substitution is assumed to be 0.3. The rate of subjective time preference is fixed equal to the exogenous after-tax interest rate to obtain a steady state solution.

In each period the consumer allocates an exogenous time endowment to leisure and labour according to standard consumer theory. The real wage rate facing the consumer is reduced by several taxes, including the average marginal tax rate on market labour income, VAT and other indirect taxes and tariffs on private consumption. In addition, the household effectively carries the burden of the pay-roll tax and other taxes on production. Based on microeconometric studies of labour supply in Norway, see Aaberge, Dagsvik and Strøm (1995), the elasticity of substitution between leisure and consumption has been set to 0.6 in order to be consistent with an uncompensated wage elasticity of aggregate labour supply equal to 0.1.[6] The compensated wage elasticity of labour supply is 0.5. This parameterisation is of course uncertain. However, we consider it to be consistent with the assessments most Norwegian economists do when they are "forced" to make up their opinion on aggregate labour supply elasticities.[7] The composition of private consumption is determined in a nested separable structure of origo adjusted CES subutility functions, see Aasness and Holtsmark (1995).

Market Structure and Producer Behaviour

Output and input in an industry can change both because of changes at the firm level and as a result of entry or exit of firms. Firms differ in exogenous productivity in most industries, which implies an endogenous distribution of the size of the profitable firms, see Holmøy and Hægeland (1997). Firms are run by managers with perfect foresight, who maximise present after tax value of the cash flow to owners. The private profitability is affected by the system of capital income taxation, the payroll tax, taxes on other input factors, and various commercial policy instruments. Firms are price takers on all factor markets and combine inputs according to a system of nested constant-returns-to-scale CES functions. Most of the elasticities of substitution have been set in accordance with estimates presented in Alfsen, Bye and Holmøy (1996). The production function at the firm level exhibits decreasing returns to scale. The scale elasticities range from 0.85 - 1.00.[8] The general pattern of decreasing

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[6] Existence of non-labour income is the reason why the direct uncompensated wage elasticity of labour supply is positive, despite the elasticity of substitution between leisure and consumption being less than unity.

[7] Bye and Holmøy (1997) provides a more detailed description of the intertemporal behaviour and the labour supply decision in MSG6.

[8] Evidence of decreasing returns to scale at the firm level is presented in Klette (1994). Compared to Klette's estimates, the scale elasticities in MSG6 are negatively biased. This bias was accepted in order to avoid unrealistic specialisation patterns within the export oriented industries.

returns to scale creates pure profits, and it makes the traded goods sector more diversified than in the case of constant returns. Decreasing returns also implies (external) adjustment costs of investment.

Producers of manufactures and tradable services allocate their output between the domestic and the foreign market. It is assumed costly to change the composition of output between exports and domestic deliveries. Firms are price takers in the export markets and in the domestic markets of primary products (such as agricultural products, fish), which are relatively homogeneous. Firms engage in monopolistic competition in the domestic markets of manufactures and services since Norwegian customers are assumed to consider products within these categories as close, but imperfect, substitutes. Drawing on Klette (1994), the mark-up factors are set to 2-5 percent over marginal costs. The elasticities of substitution between the differentiated products within the composite industry goods, are large in order to be consistent with these low mark-up factors. This implies that the scope for love-of-variety effects on aggregate welfare is relatively small.

Imports

Within the categories manufactures and services, imported products are considered as close but imperfect substitutes for the corresponding differentiated products supplied domestically. Thus, import shares of these tradables depend negatively on the ratio of the exogenous import price to the price index of domestic deliveries. Elasticities of substitution between domestic and imported products are based on Naug (1994). Goods produced by primary industries are assumed to be regarded as homogenous by both Norwegian and foreign consumers. The domestic prices of these commodities are equal to the corresponding exogenous import prices, and the model determines *net* imports, as the residual between domestic production and domestic demand.

4. CGE estimates of resource costs and cost of public funds

Defining the project

The hypothetical project requires the same input in each year over an infinite horizon. Confining the analysis to the cost side, we disregard any benefits from the project such as productivity gains in the private sector or direct welfare effects for the households working through the utility functions. The project is marginal; the real value of the inputs equals 100 millions NOK measured in 1995-prices, i.e. 0.01 percent of GDP in 1995. It employs 335 persons. The composition of inputs is equal to the average composition of the total government consumption in 1995. The direct cost share of wages was 61 percent in 1995, whereas the cost shares of materials and capital were 33 and 6 percent respectively. The project does not need any fixed capital. In addition to the resource use, the project involves an endogenous adjustment of a specified set of tax rates, in order to keep the annual public budget surplus unchanged compared to a reference path, in which the project is not implemented.[9]

The resource cost

We estimate the direct social resource cost by simulating the welfare effect of the project when it is financed by lump-sum taxation. This corresponds to estimating $\partial g/\partial L_O$ in the exposition in Section 2. We measure the welfare effect by the change in the household's intertemporal welfare, computed as an annuity. The direct resource cost is estimated to 73 percent of the *ex ante* market price of the resources, see Table 1.

Table 1: Resource costs and MCF. Constant annuities in percent of the *ex ante* market price

	Lump sum	Pay roll tax
A. Social cost (= B + C)	73.2	88.0
B. Resource cost[10]	73.2	73.2
C. Additional excess burden	0	14.8
D. *MCF* (= A/B = 1 + C/B)	1	1.20

The most important reason to the large difference between the resource cost and the *ex ante* market price of the project was explained in Section 2: The high effective tax rate on labour income in Norway makes the social resource cost a decreasing function of the share of leisure in the resources absorbed by the project. A substantial share of the employment needed in the project is the result of crowding out of leisure, not only of private consumption; total employment increases by 303 persons, whereas the project employs 335 persons. The reduction of leisure contributes to reduce welfare by about 30 percent of the *ex ante* market price of the project, corresponding to 41 percent of the welfare loss. In the case of lump-sum taxation, the increase in labour supply is foremost due to the income effect of the project, as relative prices remain almost unchanged; the household provides resources for the project by a close to proportional reduction of private consumption and leisure.

The most important elements in the effective tax rate on labour income (in 1995) include: i) an average marginal tax on personal labour income approximately equal to 40 percent; ii) an effective payroll tax rate, including a compulsory social security premium, on labour costs averaging 17 percent; iii) a net indirect tax rate on consumption averaging 19 percent. The tax wedge made up by

[9] In the "project path" all exogenous variables have the same values as in the reference path, except the ones affected by the project. Effects of the project are measured by the deviation between the project path and the reference path.

[10] The estimated resource cost includes endogenous changes in government real consumption caused by changes in market sales of government output. See Holmøy and Strøm (1997) for an explanation of this effect, which is relatively small.

these three tax rates makes the ratio between the social and the private marginal rate of transformation of leisure into consumption equal to 1.19*1.17/ (1 - 0.40) = 2.32.[11]

The changes in relative prices are bounded to be negligible since we consider a marginal project. However, small changes in relative prices, and thereby also in marginal utilities, should be regarded as a more general result, which make our estimate of unit costs relevant for large projects. The insensitivity of relative prices to the changes in demand caused by the project reflects that the textbook model of a small open economy (SOE) provides quite a good approximation of how relative prices are determined in the MSG6 model. In the SOE-model the assumption of constant returns to scale in all industries, implies that relative prices are completely determined by exogenous productivity conditions in the traded goods sector, independent of the demand side and production levels in the various industries. The same forces are the dominating basic determinants of the real wage rate in the MSG6 model.

However, since MSG6 captures decreasing returns to scale in private industries there is some scope for changes in relative prices. The project generates a slight increase in the real wage rate, reflecting a small increase in marginal labour productivity as the traded goods sector is scaled down. However, scale elasticities in the interval 0.85 - 0.95 make the price elasticity of export supplies relatively large. Consequently, the necessary increase in the producer real wage rate will be small. The rise in the real wage rate is consistent with the intertemporal constraint on foreign debt, because the project reduces the average import share of domestic demand. This is due to a smaller import share in government consumption than in private consumption. This effect dominates the positive effect on imports caused by the expansion of aggregate demand.

Table 2 shows the main macroeconomic reallocations caused by the project when it is financed by lump-sum taxes. Intertemporal substitution to price dynamics implies that the crowding out of private utility increases somewhat over time. The price dynamics is triggered by the reduced investment demand for home goods. Due to the assumption that no investment is required in the government project, the long run result is a reduction in the aggregate capital stock, most notably household capital[12]. The drop in aggregate investments is strongest over the first years, whereas the long run reduction equals the reduction in the replacement investment. This implies, *cet. par.*, lower production and lower marginal costs in the domestic industries producing capital goods. Through mark-up pricing

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[11] Another important distortion is early retirement schemes, which implies a large subsidy of leisure. Holmøy (2002) and Holtsmark (2002) assess the effective tax wedge related to early retirement under the present conditions in Norway. However, our estimates do not include labour supply effects of changes in retirement behaviour.

[12] The most important items in the Household capital are Dwellings and cars.

of domestic deliveries this cost reduction is spread to the prices of domestically produced goods.[13] The short run reduction in aggregate saving is much smaller than the reduction in fixed capital investments; financial investment abroad is increased through an increase in the net exports in the first years following the project implementation. The sharp short run import reduction is due to both the decline in the aggregate import share, as well as the drop in investment demand. These effects dominate the effect of the deterioration of international competitiveness caused by the increase in the real wage rate.

Table 2: Short and long run reallocations in the case of lump-sum taxation. All figures, but *Employment*, are computed as deviations in fixed prices from the reference path in percent of the *ex ante* market price (= 100 mill NOK)

	Instantaneous	Stationary
Utility	-67.8	-75.8
Leisure	-29.5	-30.5
Private (material) consumption	-38.3	-45.3
Government consumption	101.5	100.8
Gross real investment	-25.6	-4.3
Export	-7.2	-9.0
Import	-9.5	-3.1
Current account surplus, current prices	18.8	0.0
Total saving, current prices	-5.6	0.0
GDP	43.6	45.7
Real capital	-24.8	-135.0
Employment, persons	295	301

The public budget effect

In order to estimate the social cost of the public funds associated with the project, the necessary funds, or the public budget effect, must be computed. This corresponds to estimating $\partial h / \partial L_O$ in Section 2. Whereas model simulations show that the welfare effects from reallocations other than increased employment are numerically insignificant, they play a more significant role in the determination of the equilibrium effect on the public budget. Pure theoretical reasoning leaves us with the rather useless qualitative conclusion that the *ex ante* market price of the project *may be* a poor estimate of the equilibrium public budget effect. Our simulations suggest that the budget effect is indeed significantly lower than the *ex ante* market price, see Table 3. In particular, this is true for the long run stationary

[13] In addition the dynamic changes in investments imply that the increase in labour demand is lower in the short run than in the long run. However, this effect is hardly visible when the project is as small as assumed in this paper.

budget effect, which is only 80 percent of the *ex ante* market price. Measured in terms of constant annuities the budget effect equals about 85 percent of the *ex ante* market price.

Table 3: Changes in government income and expenditure caused by the project. Percent of the ex ante market price

	Instantaneous	Stationary
A. Direct tax revenue and social security premiums	17.4	24.8
B. Indirect tax revenue, subsidies etc.	-10.1	-2.3
C. Government consumption	101.1	102.5
= Loss of net revenue (= C – B – A)	93.8	80.0

The primary reason why the budget effect is lower than the *ex ante* market price is that the increase in employment raise the bases for direct labour income taxes and the payroll tax. This effect dominates the revenue loss resulting from the crowding out of private consumption. The computations take into account that the effective resource prices paid by the government are net of taxes, and that most government transfers are indexed to wages or prices. The increase in the direct tax revenue and the decrease in the indirect tax revenue over time are due to the dynamic price and wage effects explained above. The reason why the change in government consumption deviates from 100 is primarily that the reduction in private consumption reduces the market sales of services produced by government sectors.[14]

The cost of public funds

When the project is financed by the payroll tax rather than a lump-sum tax, Table 1 shows that the total social cost of the project increases by 14.8 percent of the *ex ante* market price. This implies a *MCF*-factor associated with payroll taxation equal to 1.20. Table 4 shows the main reallocations generated by the project when, respectively, the payroll tax and the VAT is adjust to neutralise the public budget effect.

The figures confirm the reasoning in Section 2: A higher payroll tax implies a reduction of the consumer real wage rate, which reduces labour supply. Compared to lump-sum tax financing, the project now crowds out more private consumption and less leisure. Thus, the composition of resources crowded out by the project changes in favour of the resource with the highest shadow price.

[14]This effect follows from defining government consumption in the same way as in the National Accounts.

Table 4: Short and long run reallocations in the case of increased payroll taxation. Percent of the *ex ante* market price of the project

	Instantaneous	Stationary
Utility	-75.6	-96.0
Leisure	-9.0	-19.8
Private (material) consumption	-66.6	-76.2
Government consumption	104.3	102.2
Gross real investment	-72.0	-8.0
Export	-2.1	-23.1
Import	-48.2	-18.5
Current account, surplus current prices	48.0	0.0
Total saving, current prices	-18.6	0.0
GDP	-7.4	14.2
Real capital	-67.6	-253.4
Employment, persons	98	229

Since most of the increase in the payroll tax is shifted to a reduced consumer real wage rate, the relative factor prices do not change much. However, the reduction in the capital-labour ratio is stronger with payroll tax financing than with lump-sum taxation. The reason is that the reduction in private consumption is stronger, which reduces Dwellings and other stocks of household capital. The short run decline in total savings is partly offset by the increase in the net exports. In principle, the shift in the composition of savings from Dwellings to financial assets contributes to improve the aggregate efficiency of the Norwegian economy, because the effective tax rate on the returns from Housing capital is much lower than the effective tax rate on other types of capital income. However, when the effect is triggered by our marginal government project, it is hardly visible in the model results. The stronger initial drop in investments reinforces the dynamic changes in the wage rate and prices explained above. Thus, the long run crowding out effects, especially of private consumption, exceed the short run effects.

5. Concluding remarks

We have argued that the social cost of a marginal government project may be lower than its *ex ante* market price even when we take into account the social cost of neutralizing the public budget effect through an increase in the effective tax rate on labour income, which is already high in Norway. Our CGE estimate of the social cost marginal increase in government consumption equals 88 percent of the *ex ante* market price when the project is financed by an increase in the payroll tax rate. We decompose the total social cost into the social resource cost of and the additional cost of public funds. We estimate the ratio of the social cost to the market price to 74 percent, whereas our estimate of the *MCF* associated with pay-roll tax financing equals 1.20, i.e. 20 percent of the social resource cost. The funds that must be raised to finance the project amounts to 85 percent of the market price.

The reason why the total social cost is lower than the *ex ante* market price is that the social resource cost is significantly lower than the market price of the resources. This ratio decreases the more labour intensive is the project. The reason is due to the heavy effective tax wedge distorting the leisure-consumption trade off in the Norwegian economy, which makes the shadow price of labour significantly lower than the producer wage rate. The shadow price of labour is a weighted average of the price of leisure and the price of private consumption. The endogenous weights reflect what is crowded out of the two goods leisure and private consumption. Crowding out leisure means that employment increases from a sub-optimal level. The more leisure that is crowded out, the lower is the social cost of labour.

Changes in relative prices will be negligible as long as the project is marginal. However, in a small open economy facing fixed world prices where all technologies exhibit constant returns to scale, prices and wages will be independent of even a large project. In this reference case the social resource cost will be independent of the scale of the government project, as long as the project does not change the relative supplies of primary factors too much, i.e. beyond the average that can be obtained by a linear combination of the factor intensities in the existing traded goods sectors. The technology of the firms in our CGE model exhibits decreasing returns to scale. Consequently, relative prices, especially the real wage rate, will change if the project is non-marginal. However, the simulation experiments show that the empirical impact on relative prices is modest.

For a large increase in government consumption one effect deserves special attention. Although the direct and indirect import share in government consumption is substantially lower than in the private consumption that is crowded out, the expansion of labour supply and total demand will raise imports as a first round effect. This is inconsistent with the intertemporal constraint on foreign debt, so the general equilibrium adjustments imply an increase in exports and a reduction of import shares. The necessary improvement of international competitiveness is brought about by a reduction in the wage rate. An increase in the wage rate will raise most tax bases. It also raises the price of government consumption as well as most transfers since they are indexed to wages. If the public budget were balanced initially, the budget effect of the increase in wages would be negligible. However, the fiscal policy rule followed in Norway implies that the government petroleum revenue pays for a significant fraction of government expenditure. This revenue is close to independent of wages. Consequently, an increase in the wage rate has a negative budget effect, which contributes to magnify the increase in the endogenous tax instrument, as well as the unit cost of public funds.

Our estimate of the resource cost of a government project in Norway is lower than the CGE estimate in Vennemo (1991). One explanation is that Vennemo assumes that the project does not employ labour, but only intermediate materials. As pointed out above, labour is the dominating input in an average government project, and the social cost is decreasing in the input share of labour in the project. In addition Vennemo's cost estimate is positively affected by an endogenous loss in the terms of trade. This is due to his adoption of the Armington hypothesis, according to which Norwegian products are close but imperfect substitutes for the corresponding foreign products.[15] The welfare effects caused by endogenous terms-of-trade changes are hard to interpret and believe when they show up in CGE-analyses of policy reforms, often as the dominating effect. The Armington hypothesis implies that Norwegian firms can exhaust monopoly rents if firms behave collusively or if the policy changes result in higher costs. In our computations, world prices are fixed, which is the standard assumption in CGE-analyses of policy changes in small open economies. Recent estimates support this assumption, see Naug (2001).

Our *MCF*-estimate associated with the payroll tax of 1.20 lies within the range spanned by corresponding estimates in the literature. Interestingly, a Norwegian expert committee (see NOU 1997:27), recommended that decentralised cost-benefit evaluations of government projects in Norway should set the *MCF* equal to 1.20. This figure was considered to be an appropriate average of the relevant estimates in the *MCF* literature. It is lower than the estimates for Norway in Vennemo (1991). However, Vennemo measures *MCF* as the ratio of the total welfare loss and the *ex ante* market price of the project, i.e. by $dU/wdL_O\big|_i$ in the terminology from Section 2. Consequently, he includes the deviation between shadow price and the *ex ante* market price in the *MCF*. Håkonsen and Mathiesen (1997) argue that a reasonable estimate of *MCF* associated with a tax on labour income in Norway lies in the interval 1.40 – 1.60. Their estimate is based on a stylised static one-sector model in which labour supply is more elastic with respect to the real wage rate than in our model. Madsen (2004) presents *MCF* estimates for broad tax instruments for the Danish economy based on an overlapping generations CGE model. His estimates of the *MCF* associated with broad taxes on labour income are in the vicinity of 1.10.

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[15] For each tradable, export is determined by foreign demand, which is, *cet. par*, decreasing in the price of Norwegian exports in the CGE model used in Vennemo (1991). The reduction of the demand for imports caused by the project requires a an increase in the value of exports, which in turn warrants a reduction in the Norwegian export prices in order to restore the trade balance restriction.

A rather uncontroversial conclusion is that the parameters determining the labour supply behaviour are the most crucial uncertain variables underlying the estimates of the social cost government consumption. The typical CGE models specify a single or a few representative agents. Rather than looking for new and more robust estimates of the parameters of the corresponding aggregate labour supply functions, it may be more efficient to disaggregate the representation of the labour supply decisions in order to better capture the estimates derived in the micro-econometric literature on labour supply. Micro-econometric labour supply studies typically find a large degree of heterogeneity along several dimensions relevant to the labour supply behaviour. Aaberge, Dagsvik and Strøm (1995) represents state of the art as far as estimates on Norwegian household data are concerned. Thus, aggregate labour supply elasticities are difficult to interpret and they may not be autonomous with respect to the shifts. Aaberge, Columbino, Holmøy, Strøm and Wennemo (2004) show that the aggregate labour supply elasticities computed from the corresponding individual elasticities of about 4000 individuals are far from invariant to changes in real wages and non-labour income. Moreover, the representative agents typically face average marginal tax rates, rather than the actual marginal tax rates. In result, the true tax distortions - crucial to the social cost estimates - may be mis-specified. *MCF* estimates based on a CGE model with a much richer representation of the estimated heterogeneous labour supply behaviour belongs to a future research project.

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