OECD Economics Department Working Papers No. 224

The Economic Effects of Employment-Conditional Income Support Schemes for the Low-Paid: An Illustration from a CGE Model Applied to Four OECD Countries

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https://dx.doi.org/10.1787/083815484206

OECD

Unclassified **ECO/WKP(99)16**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

OLIS : 07-Oct-1999
Dist. : 14-Oct-1999

English text only

ECONOMICS DEPARTMENT

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THE ECONOMIC EFFECTS OF EMPLOYMENT-CONDITIONAL INCOME SUPPORT SCHEMES FOR THE LOW-PAID : AN ILLUSTRATION FROM A CGE MODEL APPLIED TO FOUR OECD COUNTRIES

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ABSTRACT/RÉSUMÉ

Problems of unemployment and low pay amongst the low-skilled and those with little work experience are severe in many OECD countries. Employment-conditional schemes are policy instruments designed to increase the employment prospects of the low-skilled as well as to support their living standard. In this paper a simple CGE model is developed to simulate the impact of the introduction of an employment-conditional scheme in four OECD countries. The simulated policy package is graduated on gross earnings with both “phase-in” and “phase-out” regions. The advantage of the CGE approach is to allow assessing the direct and indirect effects of the financing of the policy scheme on both labour demand and supply. The simulations suggest that employment effects on targeted households are significant while the impact on aggregate employment is modest. Furthermore, the cost-effectiveness of the policy package is found to depend crucially on the earnings distribution, the levels of taxes on labour and the existence of a severe unemployment trap.

JEL classification: C68, H31, J22
Keywords: low pay, unemployment, CGE model, tax reform, in-work benefits

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Les problèmes de chômage et de faible rémunération des salariés les moins qualifiés et de ceux qui possèdent une expérience de travail limitée sont importants dans de nombreux pays de l'OCDE. Les programmes d'aide conditionnés à l'exercice d'un emploi sont des instruments de politique économique destinés à améliorer les perspectives d'emploi des moins qualifiés, et à soutenir leur niveau de vie. Dans cet article, un modèle d'équilibre général calculable (EGC) est développé afin de simuler l'impact de l'introduction d'un programme d'aide conditionné à l'exercice d'un emploi dans quatre pays de l'OCDE. Les mesures de politique économique simulées sont graduées sur les revenus bruts, avec à la fois des zones "d'entrée" (phase-in) et de "sortie" (phase-out) des programmes. L'avantage de l'approche en termes d'EGC est de permettre d'évaluer les effets directs et indirects du financement du programme sur la demande et l'offre de travail. Les simulations suggèrent que les effets sur l'emploi des ménages-cibles sont significatifs, alors que l'impact sur l'emploi agrégé est limité. De surcroît, on montre que l'efficacité en termes de coût des mesures dépend crucialement de la distribution des revenus, du poids de la fiscalité sur le travail, et de l'existence d'une "trappe à chômage" (unemployment trap) plus ou moins grande.

Classification JEL : C68, H31, J22
Mots-Clés : bas salaires, chômage, modèle EGC, réforme fiscale, prestations liées à l’exercise d’un emploi

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Andrea Bassanini, Jørn Henrik Rasmussen and Stefano Scarpetta[1]

Introduction

1. Low-skilled and inexperienced workers often face difficult labour market conditions. In some countries, relatively high wage floors make it difficult for such workers to get a foothold in employment with resulting high and persistent unemployment. Conversely, where low-skilled workers can price themselves into the labour market, market earnings may not be sufficient to lift them and their families out of poverty. Faced with the problems of unemployment or low pay amongst the low skilled, many OECD countries have introduced targeted schemes to increase their employment prospects and their rewards from work. These schemes include direct wage subsidies, employment-conditional benefits or tax credits as well as reductions in labour costs *via* lower payroll taxes. The choice between these approaches is largely related to institutional and social considerations as well as to the characteristics of other welfare and labour market policy schemes (OECD, 1996, 1997, 1999).

2. The dual objective of increasing employment while maintaining (or increasing) earnings of low-paid workers makes it often difficult to assess the cost effectiveness of these schemes. They allow a combination of work and benefit receipt (or higher take-home pay), so that those previously without work may find it easier and financially more attractive to get a job. However, such policies may make it possible for those in work to reduce their labour supply or work effort without losing financially. Moreover, if the costs of these schemes are to be borne by higher taxes for those higher up in the earnings distribution, this could well lead to further reductions in work effort by such workers. Thus, while the effects of these schemes on the employment and earnings prospects of recipients are clear, it is more difficult to assess their overall impact on employment. In any event, the effectiveness of targeted schemes for the low-paid has to take into account the close interactions of these schemes with other institutions and policies - *i.e.* unemployment and other non-employment benefits, health-care benefits etc.

3. This paper aims at shedding some light on these issues by presenting simulations on the economic effects of the introduction of a simplified version of an *employment-conditional tax credit* in four OECD countries: the United States, Germany, the United Kingdom and Sweden. These countries were chosen on the basis of two criteria: i) the availability of micro data on earnings and labour market status; ii) the need to cover a wide range of cases in terms of *ex-ante* earnings distribution, social security benefits and labour supply elasticities. The simulations do not attempt to evaluate similar schemes currently in place in the United States and the United Kingdom, which would involve a much more detailed and

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1. Andrea Bassanini and Stefano Scarpetta: Economics Department of the OECD; Jørn Henrik Rasmussen: Ministry of Finance, Denmark. The authors wish to thank the Danish Ministry of Finance for its support in this project. We also acknowledge useful comments from Jørgen Elmeskov, Philip Hemmings, John Martin and Mark Pearson. The views expressed in the paper are those of the authors and do not necessarily reflect those of the institutions of affiliation.

cumbersome analysis. Rather, the four countries included in the study are taken as archetypes of their specific labour market characteristics, with the objective of identifying key country characteristics that make an employment-conditional income support scheme suitable from an efficiency and redistributive point of view.

4. The simulations presented in this paper are based on a *computable general equilibrium* (CGE) model and show the potential effects on labour supply and income of different workers, as well as the overall impact on welfare. These simulations complement available evidence on the impact of employment-conditional benefits or taxes. Such studies are generally based on microsimulations or "natural experiments" arising from changes in the tax/benefit systems for specific groups of workers. As such, they do not allow a full assessment of the potential implications for other groups (*e.g.* those who finance the scheme), which requires a general equilibrium approach. Likewise, significant employment effects amongst targeted groups will produce changes in wages and labour demand for other workers with feedback effects on targeted employment. In addition, being based on actual schemes, such studies do not easily allow for cross-country comparisons. A CGE model can potentially tackle these problems. However, CGE simulations like those in this paper suffer from other drawbacks. For example, although the parametrisation of the model is based on microdata drawn from Household Panel Surveys and tax models, only a rather small number of representative agents can be considered due to computational constraints. Moreover, the simulations are based on a simplified version of an in-work benefit scheme, which does not consider some of the important details of the schemes currently in use, and available evidence suggests that details of design and implementation do matter. For these reasons, the simulations presented in this paper do not purport to quantify precisely the effects of introducing an employment-conditional benefit; instead they suggest the direction and order of magnitude of potential effects.

5. The plan of the paper is as follows. Section 1 discusses the main features of employment-conditional income support schemes currently in place in some OECD countries. Section 2 briefly introduces the CGE model used to simulate the impact of a specific variant of employment-conditional schemes - an earned-income tax credit (*EITC*) - in the four countries covered in this study. Section 3 presents the results of the simulations, focusing on both the labour supply and welfare effects for different groups. The main simulation considers an *EITC* of 10 per cent of the gross wage for low-paid workers, financed by an increased taxation of those with earnings above a certain threshold. Under this scenario, the *EITC* increases incentives to take up a job amongst those at the lower end of the earnings distribution, but reduces labour supply and work effort amongst high-earnings groups as a result of higher taxes. Section 3 also presents a detailed sensitivity analysis that tests the robustness of the results to changes in key parameters of the model. The sensitivity analysis also includes an alternative policy scenario in which the *EITC* is partially financed by a reduction in unemployment benefits, which could be seen as a more effective strategy in countries with high taxes/benefit levels and a severe unemployment trap. The final section presents some concluding remarks.

1. The economics of employment-conditional benefits or tax credits

6. This section presents a formal analysis of the incentive effects of employment-conditional tax credits graduated on *gross* wage income. Most of its conclusions are also relevant for other forms of in-work benefits. Other more specific aspects of employment-conditional schemes that, albeit important, cannot be captured in the formal exercise of this paper are discussed in Box 1. It should also be stressed that in the CGE simulations (as well as microsimulation models that are not based on quasi-natural experiments) there is basically no distinction between the *EITC* and other forms of in-work benefits or even a graduated employment subsidy scheme, provided that they are graduated in the same way. Thus, the choice of the *EITC* to describe the model is only to simplify the exposition. Dynamic adjustments are also not considered in the analysis, as it is the case in all simulation models existing in the literature, and the analysis focuses on conditions before and after the introduction of (or the change in) the policy scheme.

Box 1. **Key features of employment-conditional schemes**

Employment-conditional schemes benefit people with low incomes who are working. They can be provided as benefits or as tax credits.[2] The tax system is used as a payments mechanism in Canada (at the Federal level, until recently), New Zealand and the United States, while the benefit system is used in Ireland, the United Kingdom and some provinces of Canada.[3] Employment-conditional benefits are generally *graduated* with earnings or income. Non-graduated scheme are extremely expensive, because those who are not in low pay would equally benefit from the scheme, thereby involving large dead-weight losses. Nevertheless, graduated employment-conditional schemes imply a trade-off between increasing the incentive for people without work to take a low-paid job and avoiding that those already in work reduce their hours of work. Low-paid workers are targeted by these schemes since benefits are means-tested and are phased out as earnings rise.[4] This, however, raises the marginal effective tax rates (METRs) for those in the phasing-out region, potentially reducing their incentives to work longer hours and/or invest in more training. The negative effects on labour supply may spread over other groups higher up in the earnings distribution if they have to finance the schemes via higher taxes. Hence, to be effective these schemes have to strike a balance between the incentive effects on the targeted group (low-paid workers and the unemployed) and the disincentive effects that arise *via* higher METRs and the need to increase tax revenues. These considerations suggest that employment-conditional schemes are more likely to be viable in countries where out-of-work benefits are low relative to average earnings and the earnings distribution is sufficiently wide (see *e.g.* OECD, 1996; 1999).

Another concern about the design of the employment-conditional schemes is *their potential effects on second earners in a household*. Employment-conditional schemes, and means-tested benefits more generally, which are based on the *overall* income of a recipient's household, risk leaving secondary (potential) earners in that household the burden of facing very high average and marginal effective tax rates on their earnings, and hence with lower incentives to increase hours of work, invest in training or seek regular employment at all. Furthermore, workers with high wages but who voluntarily work few hours might be eligible for employment-conditional benefits, which goes against the distributional and efficiency objectives of these benefits. However, this problem of targeting can be partially avoided through the requirement of a minimum of working hours, as required by the Working Family Tax Credit in the United Kingdom.

In addition, the *timing of payments* is important. Taxes are generally based on earnings in the previous year, which implies that the entitlement to employment-conditional tax credits can only be determined in retrospect. As a result, most families receive their credit as a windfall, at the end of the year[5] which is not ideal even from the point of view of protecting family income, and the objective of encouraging labour market participation is only achieved if potential recipients are forward-looking. In contrast, the effects of benefit payments are felt immediately on entering employment.

Furthermore, individuals may prefer one *type of payment* over another. For example, payments through the tax system may be less stigmatising than those through the benefit system. Moreover, the authorities can determine eligibility without the need for a formal claim to be made by a potential recipient.[6] Finally, the administrative burden is lower in a tax-based system.

2. Reductions in social security contributions for those in low pay have been introduced in some countries (*e.g.* France, Belgium, the Netherlands) to reduce labour costs while preserving (or raising) take-home pay for low-skilled workers.

3. However, the United Kingdom has recently switched to a scheme delivered (at least nominally) through the tax system, whilst at the same time increasing the generosity of the scheme substantially.

4. Graduation of benefits is based on gross earnings in Canada, Ireland and United States. The Family Credit in the United Kingdom was based on net income, but its substitute, the Working Family Tax Credit, is graduated on gross income.

5. In the United States, individuals are entitled to collect *EITC* funds through their wage packets during the year, with a final reckoning at the end of the fiscal year. However, only a tiny proportion of payments is made in this way. The main reasons are, first, that the extra administration makes many employers very reluctant to process the payments, and second, that low-income families with few capital assets are very cautious about receiving a payment which they may have to repay at the end of the tax year. The United Kingdom is not allowing employers the option of non-co-operation in the payment of the tax credit, and is basing entitlement on current income rather than annual fiscal income.

6. Take-up of employment-conditional benefit payments has historically been a problem in some countries, with only 25 per cent of those entitled (representing 40 per cent of potential payments) actually receiving Family Income Supplement in Ireland (Callan and Nolan, 1997). Take-up of Family Credit in the United Kingdom has, however, increased over time, reaching 72 per cent of the eligible population, as a result of extensive information campaigns. Even this, however, fails to reach the very high rates of take-up possible in tax-based systems (See OECD, 1999).

1.1 Incentive effects induced by EITCs graduated on gross wage

7. The structure of *EITC* schemes generally involves a phasing-out region where benefits are gradually withdrawn. In some cases, it also includes a phasing-in region (Figure 1a), and even a flat region in the middle (Figure 1b).[7] In the phase-in region, between a lower-bound limit and a phase-in threshold (*O* and *A* in both figures), the tax credit is given as a percentage (*phase-in rate*) of gross earnings. At the phase-in threshold (point *A*) the absolute amount of the credit is at its maximum (that is equal to *M* in both figures). In the phase-out region (between the phase-in threshold and the phase-out threshold - respectively *A* and *B* in Figure 1a) the credit is progressively withdrawn in absolute amount as earnings increase. Sometimes another earnings region, the flat region, is inserted between the phase-in and the phase-out ones (that is between *A* and *B* in Figure 1b). In the flat region, the absolute amount of the credit is at its maximum independently of gross earnings.

8. The *phase-in rate* is equal to the slope of the segment *OH* in both figures. The withdrawal rate (*phase-out rate*) specifies the amount of credit that is withdrawn from the maximum credit (that is the credit given at *A* in both figures) as a percentage of gross earnings above the lower border of the phase-out region (respectively *A* in Figure 1a and *B* in Figure 1b). The *phase-out rate* is equal to the slope of the segment *HB* in Figure 1a and of the segment *KC* in Figure 1b.

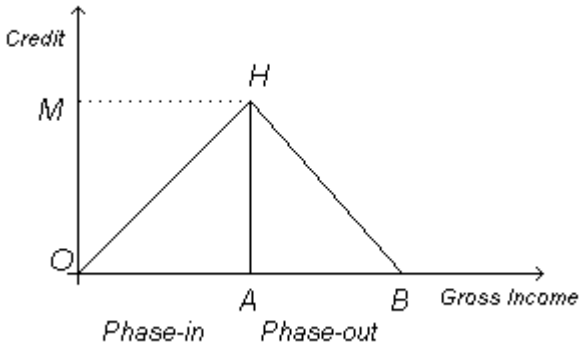

Figure 1a. A simple employment-conditional tax credit scheme

7. This is the design of *EITC* as implemented in the United States. See Eissa and Liebman, 1996; Scholz, 1996; Eissa and Hoynes, 1998; and Hotz and Scholz, 1999, for a more detailed historical description of *EITC* implementation in United States. The British Working Family Tax Credit entails only flat and phase-out regions, albeit restricting eligibility to a minimum of 16 hours worked per week (for more details on the WFTC, see Blundell *et al.*, 1999; Gregg *et al.*, 1999).

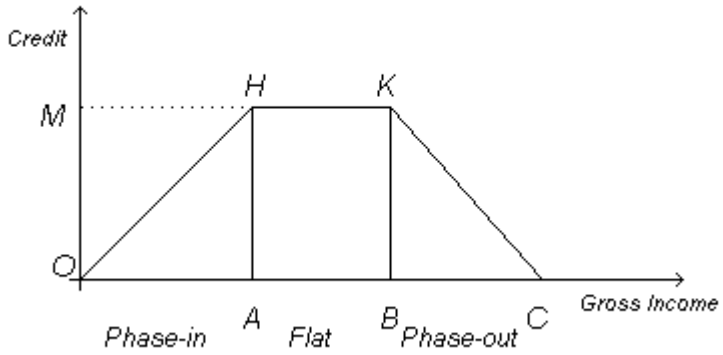

Figure 1b An alternative version of the employment-conditional tax credit scheme

9. The introduction of an *EITC* implies changes in both average and marginal (effective) tax rates (see Table 1). The average tax rate falls in both the phasing-in and the phasing-out regions (see the appendix for a more detailed description of changes in average tax rates). Marginal tax rates are decreased by the phase-in rate in the phase-in region and increased by the phase-out rate in the phase-out region.

Table 1. Changes in average and marginal tax rates after the *EITC* reform

Region	Average tax rate	Marginal tax rate
Phase-in	-	-
Flat	-	0
Phase-out	-	+

+ indicates tax rate increase, 0 indicates constancy, - indicates tax rate decrease.

10. The introduction of an *EITC* scheme induces direct and indirect effects on labour demand and supply. The former can be analysed with usual partial equilibrium tools, while the latter require general equilibrium techniques.

11. The direct effects of the *EITC* scheme include a substitution and an income effects for targeted workers as well as for those who finance the scheme. Income effects depend on changes in average effective tax rate. They mainly involve the decision to either participate in the labour market or if unemployed (and in the absence of very tight work availability conditions attached to unemployment benefits) to take up low-paid jobs. Indeed, a reduction in the average tax rate (that is an increase in potential net earnings from working) raises take-home pay above the reservation wage, strengthening incentives to take up jobs. Substitution effects depend on changes in the marginal effective tax rate (relative price of consumption and leisure). They involve mainly the supply of working time and effort by individuals. The overall labour supply of workers in the phase-in region is likely to increase, but hours worked and/or work effort per worker should decrease in the phase-out region, due to the increase in the effective marginal tax rate.

12. The choice of optimal working time for each household can be illustrated by a conventional economic model in which the agent maximises a two-argument (consumption x and leisure l) utility function subject to a budget constraint. With a proportional tax (*i.e.* a constant marginal tax rate), the budget constraint is linear (represented by the whole shaded area in Figure 2). Indifference curves are represented by the convex curves in the Figure. The amount of working time supplied by each household, once it has decided to work, depends on the real value of one unit of leisure in terms of the available bundle of consumption goods that can be bought in the market. The equilibrium point is represented by A in the figure.

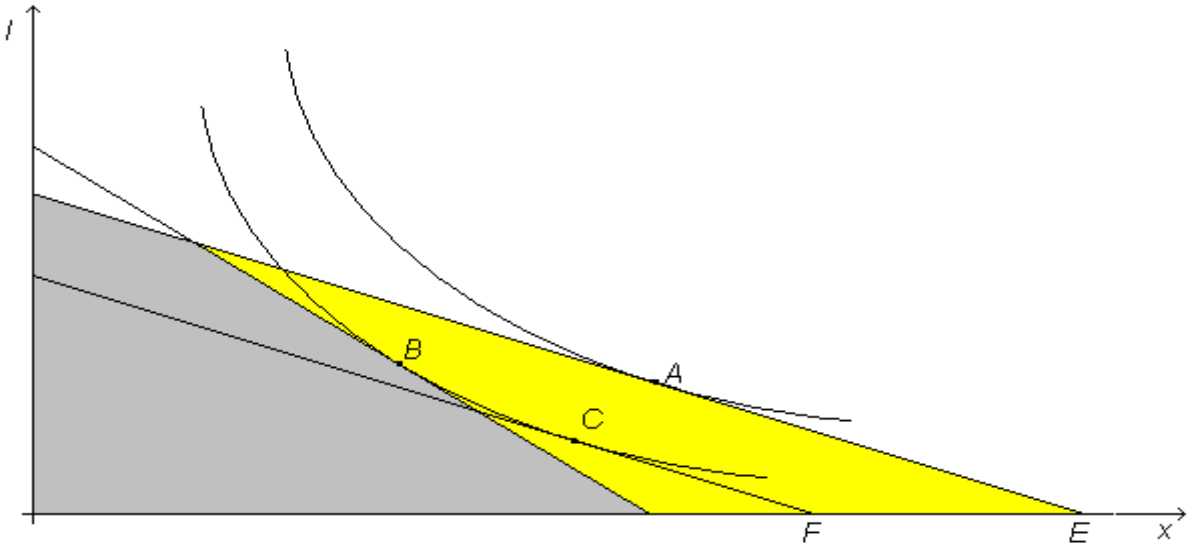

Figure 2. The equilibrium between consumption and leisure with proportional and progressive taxes

13. The introduction of a progressive tax system rotates the linear budget line downwards. The budget set will have a sequence of kinks in line with changes in tax rates that progressively increase the slope of the budget line as earnings increases. In Figure 2, for example, two tax rates are assumed leading to a kink in the budget set (depicted by the dark grey area). This induces both substitution and income effects. The measurement of the income effect in terms of Equivalent Variation (EV) corresponds to the change from *E* to *F* - in other words the change in real earnings (expressed in terms of the consumption bundle) that would have produced the same decrease in utility without any change in the tax schedule. Assuming that the desire for leisure increases with earnings (*i.e.* leisure is a normal good), the income effect works towards increasing labour supply of hours (reduction in consumption of leisure), that is from *A* to *C* in Figure 2. However in the example shown, this effect is more than counterbalanced by the substitution effect (from *C* to *B*).[8] The resulting equilibrium implies both a reduction in consumption and in hours supplied (increase in leisure).

14. Consider now the introduction of an *EITC* scheme. The effects differ for workers in different earnings regions. For those in the phase-in region, both the average and marginal tax rate fall, implying an increase in consumption and, under the example presented above, an increase in hours supplied. In the phase-out region, the average tax falls and the marginal tax increases. This case is displayed in Figure 3.[9] The dark grey area identifies the budget set before the introduction of the scheme. The whole shaded area represents the budget set after the introduction of the *EITC*. The income effect measured in terms of EV is positive (from *E* to *H* when viewed on the x-axis). It brings about an increase in both consumption and leisure (reduction in the amount of hours worked) that is represented by the movement from *A* to *C*. The substitution effect works in the direction of increasing leisure (additional reduction of hours worked) and reducing consumption (from *C* to B) in the figure. The overall effect consists of an unambiguous reduction

8. This needs not to be always the case: the ensuing equilibrium depends on the relative strength of substitution and income effects.

9. For expositional reasons it is assumed that agents do not move across earnings regions after the introduction of the *EITC* scheme. Moreover, a negative effective tax in the phase-in region is also assumed.

of working time, while the change in consumption is unclear (and depends on the magnitude of income vs. substitution effects).

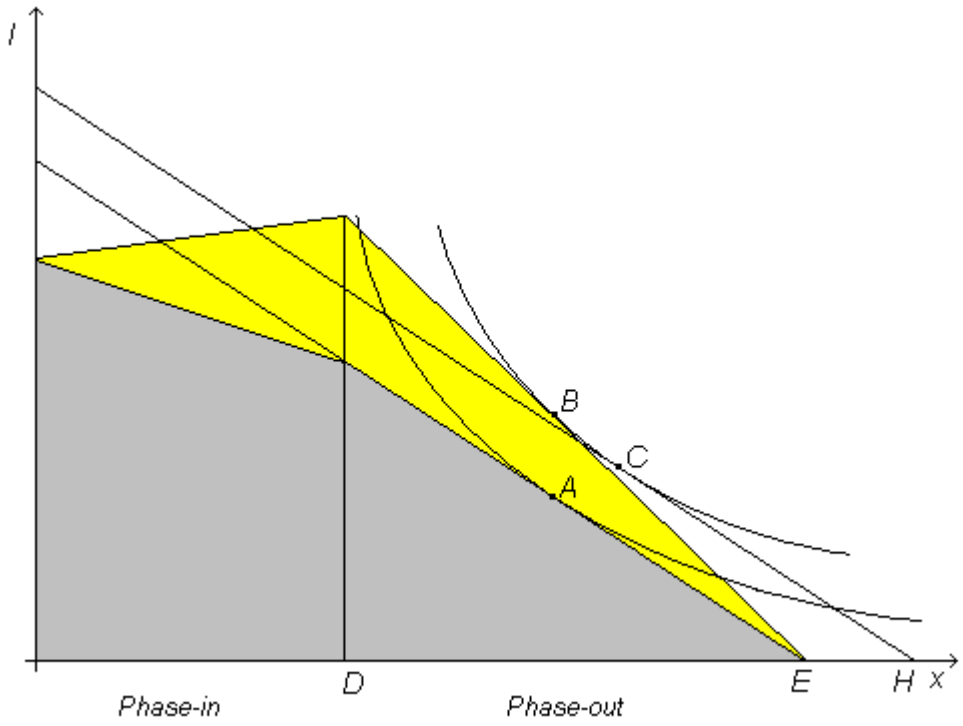

Figure 3. Change in the budget set for those in the phase-out region

15. The positive incentive effect of the *EITC* on labour supply of those with low pay is potentially offset by the negative incentive effects on the supply of working time for those with higher earnings in the phase-out region. Compared with other income support schemes that have a withdrawal threshold at a given level of earnings, the *EITC* (as well as other graduated schemes) has the advantage of smoothing disincentive effects over the phase-out region with potentially limited effects. In the *EITC*, the substitution effect is a function of the length of the phase-out region: the longer the earnings span included in the phase-out region (or the lower the phase-out rate) the lower the substitution effect.[10] However, the longer the phase-out region the higher would be the costs of financing the *EITC* scheme.[11]

16. Indirect effects emerge from the reaction of the labour market to changes in the labour supply of workers in both the targeted and financing regions. An increase in the labour supply of the low-paid prompts a downward pressure on their wages, thereby giving rise to feedback effects on the choice between leisure and consumption while working (smaller supplied working time and higher leisure than what entailed by the partial equilibrium analysis). Similarly, the reduction in the labour supply of workers

10. Conversely, overall income effects on both employment and working time are ambiguous: a flatter phasing-out implies higher income from work with both incentives to take a job as well as larger consumption of leisure for those in employment.

11. A thorough discussion of the disincentive effect on non-targeted groups can be found in Blank *et al.* (1999).

in the financing region leads to some wage pressure with feedback effects. Another important general equilibrium effect is due to the patterns of imperfect substitution (partial complementarity) between different types of labour. If different labour types are not perfect substitutes, reducing employment amongst (skilled) workers in the financing region may lead to a reduction in the marginal productivity of the targeted workers (largely low-skilled), with some additional downward effect on their market wage. This, in turn, may limit the incentives for taking a job and/or increasing the number of hours workers amongst low-paid targeted workers.

1.2 Evidence from other studies on employment-conditional benefits or tax credits

17. Previous work on estimating the impact of employment-conditional schemes can be divided into two groups. Some studies (behavioural models henceforth) have simulated the impact of these schemes by using either static labour supply elasticities available in the literature or developing *ad hoc* models to estimate labour supply elasticities for specific groups (*e.g.* Browning 1995, OECD, 1997, Gregg *et al.*, 1999, Blundell *et al.*, 1999). Conversely, other studies have considered quasi-experimental evidence coming from targeted tax reforms. These studies estimate the response to tax changes of targeted groups by using individuals not eligible for the benefits of tax reform as a control group (*e.g.* Eissa and Liebman, 1996, Eissa and Hoynes, 1998).

18. The advantage of quasi-experimental evidence is that it allows a precise and controlled analytic description of specific historical tax reform episodes. The main disadvantage is the absence of a model linking different individual characteristics to generic behavioural responses. This makes quasi-experimental evidence well suited to analyse specific tax reforms of the past, but ill-suited for planning purposes. The specificity of the analysis makes it difficult to draw general conclusions on the impact of different types of tax reform in different economic contexts.

19. Microsimulation models are built on a wide sample of micro observations allowing for the full computation of different budget sets and the estimation of a behavioural model suited to predict the effects of policy reforms. Furthermore, an advantage of using a behavioural model tailored on the targeted population is that it helps to identify different responses from different population groups. For example, the main targets of *EITC* schemes have generally been lone parents and married couples with children. Responses from the two groups can actually be quite different. For example, Eissa and Hoynes (1998), Gregg *et al.* (1999) and Blundell *et al.* (1999) found that, while the overall labour supply response of lone parents tends to be positive and high both in the phase-in and out regions, labour supply responses of married women are generally low or even negative. In fact, their spouse's earnings enter into the labour supply decisions of married women. Furthermore, their spouses might qualify for benefits if they do not work, but may not if they do (OECD, 1997).

20. A drawback of most studies based on behavioural models is that they are partial equilibrium studies. As discussed before and implicitly recognised by Gregg *et al.* (1999), it cannot be taken for granted that any increase in labour supply in the target group is automatically absorbed by labour demand without changing wages. Moreover, behavioural models, being geared at estimation and simulation of partial equilibria,[12] usually ignore the effects of financing income support schemes.[13] For example if an

12. An exception to this is a study of Graversen and Smith (1998), albeit they simulate only the imposition of an additional lump sum tax.

13. In principle there is nothing that prevents microsimulation models from taking into account the disincentive labour supply effects for those in the financing region. The main reason why this is generally not done is that, since indirect effects are excluded, the two exercises (impact of the support scheme on targeted people and impact of the attached financing scheme on non-targeted people) are not linked together. Indirect effects that arise from the impact on the labour demand of each type of labour (both

EITC scheme is financed by raising taxes on other groups, their labour supply will change and these effects, as well as the indirect effects arising from imperfect substitution among factors, have to be taken into account to have a complete picture of the implications of the policy reform.

2. A Computable General Equilibrium model

21. The reasons described in the previous sections suggest that a general equilibrium approach may complement microsimulation studies and shed some additional light on the effectiveness of employment-conditional schemes. The analysis in this paper is based on simulations from a *Computable General Equilibrium* (CGE) model.[14] The model is parametrised for four countries, which allows comparisons of the potential effects of employment-conditional schemes according to the degree of earnings dispersion, differences in non-employment benefits and taxes as well as differences in labour supply elasticities. Obviously this comes at the price of a simplification concerning household characteristics, including their labour supply response to changes in the tax/benefit systems, due to unavailability of data and computational limitations. For simplicity of exposition, the employment-conditional scheme considered in the CGE simulations is treated as an Earned Income Tax Credit (*EITC*). However, as already discussed in Section 1, the analysis carries over for other policy schemes, provided that they are graduated in the same way.

22. The model assumes a closed economy with four types of households. Each household type is characterised by the average skill level and a utility function that is maximised given prevailing prices and household's own labour endowment.[15] The model assumes only one production sector with a large number of identical profit-maximising firms. Firms are price-takers and employ all four types of labour by means of a flexible technology that allows for imperfect substitution between labour types. The government levies taxes to finance transfers. Unemployment arises within the model as an equilibrium outcome between labour demand and supply, the latter being a function of the reservation wage of each household which, in

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through direct and cross price elasticities) cannot be evaluated with microsimulation models. If significant, these indirect effects imply that total tax revenue necessary to finance the employment-conditional income support scheme is endogenous.

14. There are very few studies that use CGE models to analyse labour market policies. One of the reasons is perhaps the fact that it is generally overly complicated to build into these models a proper labour market structure in which competition is not perfect and markets do not clear. However Buscher *et al.* (1998) recently tested the European Commission's GEM-E3 model and found that introducing wage rigidities into the model produced only small differences in the results of policy simulations. Attempts to introduce labour market imperfections into a CGE model have recently been made by the Dutch Central Planning Bureau. Their CGE model of the Dutch economy (MIMIC) accounts for a number of real-world features of the labour market such as matching, search effort, central bargaining and the underground economy (see De Jager et al., 1996, Donders and Graafland, 1998, and Gelauff and Graafland, 1994). However, these features are strongly country specific and the amount of data required for their proper calibration is massive. Furthermore, as Whalley (1996) points out, the incorporation of these features into their model makes it impossible to use conventional welfare analysis to judge the effects of the policy change. The impact of the introduction of an *EITC* scheme in the Netherlands has been analysed with MIMIC as well (van Oers et al., 1999). Furthermore, using a CGE model similar to that one employed here, Rasmussen (1998) assessed the impact of the introduction of a different *EITC* scheme (where credit is a percentage of tax rates rather than gross earnings) in Denmark.

15. The model assumes that each household is endowed with a given amount of time. Consistently with the household's preferences, available time can be either used as leisure time or traded away as working time for consumption goods that can be purchased by means of the wage earned while working.

turns, depends upon the level of unemployment benefits[16]. A minimum wage is also built in the model that is calibrated on the basis of actual earnings distributions.

23. Dynamic adjustments are ignored in the model. Given the assumption of constant returns to scale, the equilibrium exists and can be computed with the knowledge of endowments, preferences (utility functions), and technology (production functions). The calibration exercise described at the end of this section parametrises endowments, preferences and technologies on the basis of the Social Accounting Matrices built for each of the four countries under analysis. A formal description of the model is given in Appendix A.

24. All functions in the model are calibrated on benchmark data (1996 for all countries except 1993 for the United States). The elasticities of substitution for the production function are discussed in Appendix A. Factor shares are taken from data on total gross wages and employment. Working time per person is standardised to unit. This has no consequences for the interpretation of the results of the simulations. The four household types are identified on the basis of the average gross earnings of their members: the *Very Low* group includes individuals with earnings below 60% of Average Production Worker (APW) earnings (*i.e.* it covers those who are generally considered to be low paid, see OECD, 1996); the *Low* group includes those with earnings between 60% and 75% of APW; the *Low-Middle* group those with earnings between 75% and 90% of APW; and, finally, the *Middle-High* group those with earnings above 90% of APW.

25. Data on benchmark employment, unemployment, gross total wages, marginal and average taxes, and net replacement rates are from *Household Panel* data and other data available at the OECD (see Appendix B).[17] In the case of married couples, the total earnings of the couple is split into two and both individuals are taken to be taxed independently, as in the German system (for cross-country comparison we virtually impose the same system to each country). All other variables come from the GSOEP Equivalent file for 1996, for Germany, the British Household Panel Survey for 1996, for the United Kingdom, the PSID Equivalent file for 1993, for the United States, and 1996 data supplied by the Swedish Ministry of Finance for Sweden. These data suffice in determining benchmark shares for what concerns the four different utility functions. The total endowment of time available to each individual is exogenously fixed at 1.4 (the benchmark for supplied working time is fixed at 1, see Appendix A).[18] Calibration of the elasticities of substitution in the four household utility functions is also discussed in Appendix A.

26. Based on an assessment of existing estimates of labour supply elasticities, a common value of the overall elasticity equal to 0.3 is chosen for the United States, the United Kingdom and Sweden (see Table 2). A lower value is chosen for Germany (0.2) in accordance with the available evidence (a simulation with a higher elasticity is discussed below). Furthermore, overall elasticities are broken into hours and employment elasticities for each group. These choices of the elasticities allow for the closest possible resemblance with available empirical studies.[19] The unemployment rate of each group has been

16. Each representative household may have a different reservation wage. Furthermore, marginal productivity of each type of labour may be different in equilibrium. Consequently, unemployment rates for each group may be different (and, indeed, they turn out to be different in the simulations).

17. The Swedish Ministry of Finance provided tax data for Sweden.

18. No allowance is made for differences in hours worked in different countries. However, based on available data, this does not seem too restrictive, given that normal weekly hours by collective agreements are in a rather small range in the four countries (OECD, 1999).

19. See *e.g.* Hausman (1981), Pencavel (1986), Killingsworth and Heckman (1986), Triest (1990), and Chiappori *et al*. (1998), for the United States; Ashworth and Ulph (1981), Blundell and Walker (1982), Pencavel (1986), Killingsworth and Heckman (1986), Jenkins (1992), and Blundell *et al*. (1992, 1998) for the United Kingdom; Stobernack (1991) and Kaiser *et al*. (1992) for Germany; Blomquist (1983), and

approximated on the basis of available information on the distribution of unemployment by educational attainment (see the appendix for more details).

Table 2. Labour supply elasticities used in the simulations

Overall level	Elasticity type	Very low	Low	Low-middle	Middle-high
0.2 (Germany)	Employment Hours	0.17 0.10	0.11 0.11	0.06 0.14	0.02 0.14
0.3 (Sweden, United Kingdom, United States)	Employment Hours	0.25 0.15	0.17 0.17	0.09 0.21	0.03 0.22

3. Simulation experiments and results

3.1 General description of the simulation

27. The *EITC* scheme considered in the CGE simulations involves a tax credit equal to 10 per cent of gross earnings in the phase-in region (up to earnings equal to 60 per cent of APW earnings). The phase-out rate is set at 20 per cent and affects people with earnings in the range between 60 per cent and 90 per cent of APW earnings. Workers with earnings above 90 per cent of the APW earnings finance the scheme with higher taxes, so as to balance the government budget.[20] This simulation is fairly consistent with the actual *EITC* scheme in the United States.

28. Individuals in the phase-in and phase-out regions receive a tax credit and therefore increase their employment and welfare. For those in the financing region, employment and welfare effects will be negative in the two scenarios as compared with the benchmark. As a second order general equilibrium effect, this will feed back into productivity, wages and employment of those in the phase-in and the phase-out regions as well.

3.2 The labour supply effects of the EITC

29. The results of the two simulations for the four countries crucially depend on a number of key features, including:

Blomquist *et al*. (1990, 1998) for Sweden. The decomposition between earnings levels is taken from a study by Graversen and Smith (1998) for Denmark. In order to calibrate their CGE model, Gelauff and Graffland (1994) follow more closely the strategy of microeconometric studies, that is they consider an estimate of average elasticity to which extra parameters are added or subtracted according to family and personal characteristics of different individuals. Again such a strategy would have required data that were unavailable on a cross-country comparable basis, with no guarantee of being more accurate.

20. In other words, very low earnings households are placed in the phase-in region, low and low-middle earnings ones are in the phase-out region and middle-high earnings households are in the financing region. Households do not move across regions in reaction to the implementation of a policy package. As will become clearer later on, this is due to a combination of the small magnitude of effects and small number of representative households.

- The degree of dispersion in earnings, which determines the size of each earnings region (share of total active population). This affects the number of people who will be eligible for the *EITC* as well as the number of those who will finance the scheme;

- The average earnings in each region, which depends on the distribution of earnings within the region. This determines the average value of the tax credits and thus, given the size of the recipient population, the total cost of the *EITC* scheme;

- The average and marginal tax rates for the different groups;

- The labour supply elasticities (both in terms of employment and hours worked);

30. As can be seen from the simulation results presented in Table 3, the United States, Germany and the United Kingdom have a similar employment effect in the phase-in and phase-out regions. Sweden has a somewhat higher employment response, especially amongst those in the low and low-middle earnings group (*i.e.* the phase- out region). This result is due to the joint effect of changes in disposable income and labour supply elasticities. Changes in tax rates are displayed in Table 4, while changes in wages are reported in Table 5.[21] Increases in disposable income are relatively stronger in Sweden and Germany (due to higher initial levels of taxation) than in the United States and the United Kingdom.[22] However the impact on labour supply is lower in Germany because of the assumed lower labour supply elasticity. The strong increase in disposable income in the phase-out region in Germany and Sweden is also due to the fact that the within-group earnings distributions of those in the phase-in and phase-out regions are skewed to the right and to the left, respectively. This implies that workers in these two regions receive a tax credit close to the maximum possible. Given the associated higher fiscal costs, the situation is reversed in the financing region, where the employment reductions are greater in Germany and Sweden than in the United States and the United Kingdom.

21. Given the size of the wage changes following the introduction of the *EITC* scheme and the *ex-ante* average earnings of the low paid, the minimum wage will not be binding for the representative low paid worker. Increasing the number of representative agents (as in the Dutch MIMIC model) would make a proper analysis of the minimum wage more interesting. In principle, however, it can be expected that the employment effect for those in low pay would be smaller (and, correspondingly, the cost of the program would be smaller as well as the disincentive effects in the financing region).

22. For an equal reduction (in percentage points) of the marginal tax across countries, the increase in net marginal earnings will be higher, the higher the *ex-ante* level of the marginal tax.

Table 3. Labour supply effects (percentage change)

Groups	Germany	United Kingdom	United States	Sweden
Employment				
Very low	2.14	2.22	2.07	2.28
Low	1.07	1.13	1.06	1.73
Low-middle	0.16	0.16	0.14	0.30
Middle-high	-0.52	-0.11	-0.15	-0.26
Total	**0.33**	**0.68**	**0.61**	**0.48**
Working time per household				
Very low	1.30	1.40	1.30	1.45
Low	-0.55	-0.66	-0.53	-0.28
Low-middle	-0.60	-0.64	-0.74	-0.52
Middle-high	-0.82	-0.84	-1.11	-1.94
Total	**-0.33**	**-0.24**	**-0.38**	**-1.01**
Total supply				
Very low	3.44	3.62	3.37	3.72
Low	0.52	0.47	0.53	1.45
Low-middle	-0.44	-0.48	-0.59	-0.22
Middle-high	-1.33	-0.95	-1.26	-2.20
Total labour supply	**-0.01**	**0.44**	**0.23**	**-0.53**

Table 4. Tax rates (percentage of gross earnings)

	Germany		Sweden	
	Benchmark	EITC	Benchmark	EITC
Average tax				
Very low	26.60	16.60	30.00	20.00
Low	29.60	22.63	32.00	21.88
Low-middle	32.40	30.20	32.00	28.13
Middle-high	36.70	39.09	36.00	39.78
Marginal tax				
Very low	46.70	36.70	37.00	27.00
Low	49.60	69.60	38.00	58.00
Low-middle	51.20	71.20	38.00	58.00
Middle-high	53.90	61.13	47.00	60.30
	United Kingdom		**United States**	
	Benchmark	EITC	Benchmark	EITC
Average tax				
Very low	15.60	5.60	16.80	6.80
Low	21.70	15.08	20.60	13.18
Low-middle	24.10	22.03	23.30	21.42
Middle-high	29.20	31.73	29.90	33.78
Marginal tax				
Very low	30.00	20.00	25.90	15.90
Low	34.00	54.00	29.90	49.90
Low-middle	34.00	54.00	29.90	49.90
Middle-high	34.00	40.87	42.90	49.63

Table 5. Wage rates (percentage change)

Groups	Germany	United Kingdom	United States	Sweden
Market wages				
Very low	-3.56	-3.68	-3.7	-4.7
Low	-1.3	-1.24	-1.44	-2.98
Low-middle	0.22	0.26	0.35	0.21
Middle-high	0.5	0.61	0.68	0.86
Take-home wages				
Very low	9.57	7.99	7.87	8.91
Low	8.48	7.11	7.77	11.45
Low-middle	3.48	3	2.8	5.91
Middle-high	-3.29	-2.98	-3.11	-5.1

31. The effects of the *EITC* scheme on hours worked depend on the size of the change in marginal disposable income from work for the different groups, as well as on their labour supply elasticity. In the phase-in region, the effects are somewhat smaller for the United States and Germany. In the former case, this can be explained by the lower level of *ex-ante* marginal taxes that makes the change in net marginal income resulting from the *EITC* smaller than in the other countries. The smaller effects in Germany depend on the lower elasticity of hours worked than in the other countries. The phase-out region does not display particular differences across countries, with the sole exception of Sweden. In the financing region, the

maximum reduction of working time occurs in Sweden, where there is the largest increase in marginal tax rates and, consequently, the largest drop in take-home wages.

32. The combined effect of higher participation and hours worked is reflected in total labour supply. From Table 4 it appears that the introduction of the *EITC* will not increase total labour supply in Germany and, especially, in Sweden where there could even be a fall. An increase in labour supply of low-paid workers will be compensated by a decrease in hours worked amongst those who will finance the *EITC*. These results suggest that a simple *EITC* scheme may not be very effective to raise total effective labour supply, but it may help to raise employment amongst the low skilled. The different results for the United States and the United Kingdom are due to a combination of factors, including an *ex ante* wider earnings distribution, lower reservation wages and a higher proportion of workers in low pay. In these two countries, the *EITC* scheme could lead to a significant increase in the labour supply of low-skilled people, without large negative effects on the labour supply of other workers.[23]

33. Another interesting aspect of the simulations is the effect of the introduction of the *EITC* scheme on the unemployment rate of different workers. Table 6 presents the group-specific unemployment rates before and after the *EITC* schemes. The effects of the simple *EITC* scheme on the unemployment rate of the low paid is of the order of two percentage points. Those in the phase-out region will also experience some reduction in unemployment, while only modest increases may arise for those in the financing region. Overall, the unemployment effects will somewhat reduce disparities across workers with different skill endowment.

Table 6. Unemployment rates (percentage)

Groups	Germany	United Kingdom	United States	Sweden
Before reforms				
Very low	14.6	13.4	13.5	12.7
Low	10.6	9.8	7.2	10.5
Low-middle	7.9	7.4	4.6	9.8
Middle-high	4.9	3.7	2.9	5.5
After Reforms				
Very low	12.7	11.4	11.7	10.6
Low	9.6	8.8	6.2	8.9
Low-middle	7.7	7.2	4.5	9.5
Middle-high	5	3.8	3	5.7

34. The effects of the *EITC* scheme on the welfare of different earnings groups can be assessed in terms of equivalent variation (change in money-metric utility, evaluated at benchmark prices). Table 7 reports groups' equivalent variation as a percentage of benchmark welfare resulting from the implementation of the *EITC* scheme. In particular, the last row presents the total welfare change in percentage terms (this is equivalent to a weighted average of group-specific equivalent variations). The

23. These results are broadly consistent with the literature on the *EITC* scheme in the United States, which highlights a rather important labour supply effect on targeted households with relatively small aggregate effects (see *e.g.* Blank *et al.*, 1999; Hotz and Scholtz, 1999). Furthermore, from a different point of view, these results confirm the point made by some comparative studies (OECD, 1996; Graversen and Smith, 1998) on the importance of the earnings distribution for the cost-effectiveness of the policy package.

Table allows an analysis of the scheme in term of the welfare impact on targeted and non-targeted groups[24].

Table 7. Equivalent variation (percentage)

	Germany	United Kingdom	United States	Sweden
Very low	6.56	5.55	5.38	6.13
Low	6.00	5.46	5.96	5.48
Low-middle	1.56	1.51	1.60	2.11
Middle-high	-2.99	-2.40	-2.86	-3.87
Average[1]	**-0.47**	**-0.10**	**-0.23**	**-1.06**

[1] Percentage variation of the average of individual household money-metric utilities.

35. To some extent the assessment of the *EITC* scheme depends on the weight given to efficiency and distributional issues as well as the weights given to the welfare of different groups. In Germany and Sweden, the distributional impact of the *EITC* scheme is larger than in the United Kingdom and the United States. Indeed in the former two countries, the equivalent variation of the lowest earnings group is higher. However this occurs at the expenses of a greater negative equivalent variation for the middle-high earnings group with no significant differences for the other groups. Overall, welfare effects depend on the size of each earnings group and the average earnings in each group. In the computation of the aggregate effect, the equivalent variation for the poorest earnings group counts more in the United Kingdom and the United States than in Germany and especially in Sweden, because of a larger proportion of people with actual or potential low earnings in the first two countries compared with the other two. This explains the less negative average equivalent variation induced by the *EITC* scheme in the former as compared with the latter. Box 2 presents an extension of the welfare analysis.

3.3 Sensitivity analysis and an alternative policy scenario

36. Calibration of CGE models can be quite sensitive to changes in key parameters. In the context of the *EITC* policy simulations, one such key parameter is the labour supply elasticities of different earnings groups. As stressed above, labour supply elasticities used in the simulations are based on available evidence from the econometric literature, although in some cases there is no strong consensus as to the specific values of these elasticities. To assess the robustness of the results, three alternative simulations were performed: 1) the labour supply elasticities for Germany were set equal to those of the other three countries; and 2) labour supply elasticities of each group were set equal to average elasticities in all countries; and 3) labour supply elasticities of each group in each country were altered so as to lead to the same overall labour supply effect in the four countries. Moreover, two alternative simulations were performed with alternative elasticities of substitution of different types of labour in the production function. Finally, an alternative policy scenario in which the *EITC* is partially financed by a reduction in unemployment benefits is considered for Germany and Sweden.

24. Notice that in equilibrium each household is composed by both employed and unemployed members (see Appendix A). Therefore, formally, equivalent variation for each group should be viewed as actual change in welfare for the representative household and not as a weighted average of changes relative to different households of the same type.

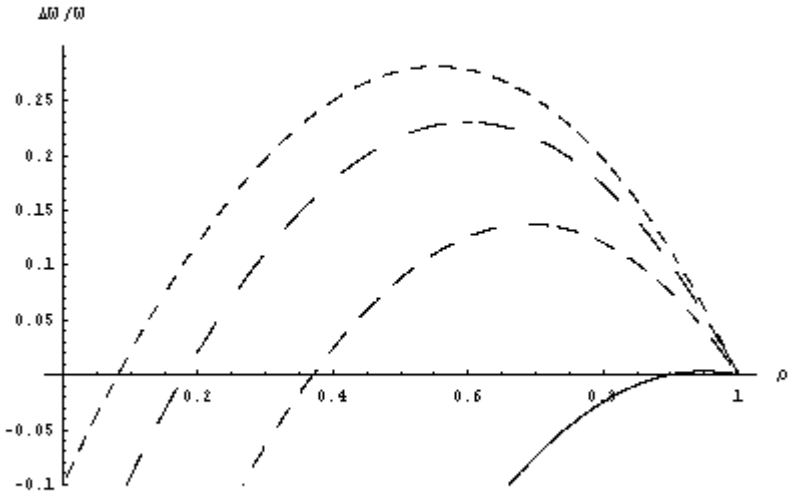
Box 2. **Welfare analysis**

The *EITC* scheme can also be assessed by means of a social welfare function. The choice of a specific function is rather arbitrary, and the literature has generally opted for those with a small number of clearly interpretable parameters, even if this limits the scope of the analysis. A possible choice is the following standard isoelastic function:

$$W = \sum_{j \in \{VL,L,LM,MH,b\}} N_j \frac{e_j^{1-\rho}}{1-\rho}$$

where e_j is money-metric utility for the individual household in group j, N_j is the number of people in group j, and ρ is the aversion against inequality. With ρ=0 all individuals receive equal weight and the aggregate results are those displayed in Table 7. However, the assumption of an equal evaluation by the government of income variations of individuals with different earnings levels is at odds with the main rationale of the *EITC* scheme, that is, the desire to raise income from work for those at the margin of the labour market. With ρ>0, low-paid individuals receive higher weight, so that inequality issues are taken into account.

Of course it is difficult to assess a reasonable value for the ρ parameter and then compare the results in terms of social welfare under different policy schemes. Instead, the Figure below shows how the percentage welfare change varies as ρ increases in the four countries. Interestingly country rankings do not change with ρ, although at high values differences between welfare effects across countries diminish.[25]



Percentage welfare change as a function of ρ.

25. Notice that all curves converge to 0 for ρ converging to 1. At ρ=1, nobody cares about wealth, therefore no reform can change benchmark welfare.

Box 2. **Welfare analysis** (continued)

Interestingly, the simple *EITC* scheme becomes welfare enhancing in Sweden only for very high values of the ρ parameter, while for the other countries social welfare becomes positive if governments assign a reasonably higher value to the earnings of marginal groups. As the Figure above shows, in the case of the United States and especially the United Kingdom, very low values of the parameter (a slight preference for the poorest) are sufficient to turn the overall welfare effect positive.

One way to make sense of the previous Figure is to consider the value of ρ that makes the overall welfare effect equal to zero. An approximate idea of the value of the different implicit weights can be obtained by dividing the ratio of the welfare of each group at ΔW=0 to the welfare of those in the Middle-High group at ΔW=0 by the ratio of the welfare of each group at ρ=0 to the welfare of those in the Middle-High group at ρ=0. These values are reported in the Table below.

Implicit weights given to each group at ΔW=0

	Germany (ρ = 0.37)	UK (ρ = 0.08)	US (ρ = 0.18)	Sweden (ρ = 0.90)
Very low	1.43	1.09	1.2	2.3
Low	1.25	1.06	1.12	1.81
Low-middle	1.18	1.04	1.09	1.44
Middle-high	1	1	1	1

These results suggest that in Sweden the simple *EITC* scheme could be considered welfare improving only if the government assigns a value to the welfare of the low paid that is at least 2.3 times greater than that assigned to the welfare of those in the financing region. As shown in the table, in the United States and the United Kingdom the implicit preference for the low paid necessary to make the *EITC* scheme welfare improving is much smaller.

Different labour supply elasticities

37. Employment and working-time elasticities in the baseline model are presented in Table 2 above. Table 8 presents the main results of a simulation for Germany assuming an average overall elasticity of 0.3 (the same value for the United States, the United Kingdom and Sweden). With a higher labour supply elasticity the results for Germany become closer to those of Sweden, due to the similar shape of the earnings distribution in the two countries. Nevertheless, Germany still shows somewhat higher welfare effects than Sweden, basically due to the larger share of people (in the phasing-in region) who will receive the tax credit.

Table 8. Sensitivity analysis I: higher labour supply elasticity in Germany

(labour supply elasticity in Germany equal to 0.3, as in the other three countries)

	Employment[1]	**Working time per household**[1]	**Total labour supply**[1]	**Equivalent variation**[2]
Very low	2.76	1.75	4.52	6.86
Low	1.49	-0.90	0.60	5.71
Low-middle	0.21	-0.96	-0.75	1.43
Middle-high	-0.60	-1.49	-2.10	-3.22
Total	0.47	-0.70	-0.22	-0.63[3]

[1] Percentage change.
[2] Percentage.
[3] Percentage variation of the average of individual household money-metric utilities.

38. The second simulation in Table 9 assumes common elasticities for all earnings groups within each country (*i.e.* 0.2 for Germany and 0.3 for the other three countries), while maintaining the breakdown between employment and hours elasticities (see Table 2). Compared with previous simulations, this implies a reduction in labour supply elasticities for low-paid workers and an increase in labour supply elasticities for those with median or higher earnings. The country ranking with respect to the employment and income effects of the introduction of the *EITC* scheme is not altered by this alternative assumption. However, the overall effects of the *EITC* scheme are less favourable than in the previous simulation. There will be a smaller increase in employment and total labour supply amongst those in the targeted region, while the increase in taxes will produce a larger dis-employment effect amongst those in the financing region. Moreover, the average equivalent variation becomes negative in all countries in the new simulation: implicitly this suggests that the *EITC* scheme will be a viable policy option only if governments have stronger redistributive objectives. This is no surprise insofar as the *EITC* scheme (as with any employment-conditional income support scheme), financed by higher taxes on other earnings groups is efficiency-enhancing only if labour supply elasticities are different between groups. If they were not, more employment for the low-skilled would arise only at the expense of less employment for those higher up in the earnings distribution. The simulation in Table 9 should be taken as an extreme case which identifies a lower bound for the potential effects of the *EITC* scheme.

Table 9. Sensitivity analysis II: equal within-group elasticities

Groups	Germany	United Kingdom	United States	Sweden
Employment (percentage change)				
Very low	1.63	1.77	1.64	1.76
Low	0.96	1.00	0.94	1.52
Low-middle	0.14	0.14	0.12	0.27
Middle-high	-0.57	-0.17	-0.23	-0.41
Total	**0.18**	**0.52**	**0.45**	**0.31**
Total labour supply (percentage change)				
Very low	2.63	2.84	2.63	2.83
Low	0.43	0.37	0.41	1.18
Low-middle	-0.50	-0.55	-0.68	-0.38
Middle-high	-1.76	-1.28	-1.68	-3.09
Total	**-0.40**	**0.06**	**-0.18**	**-1.16**
Equivalent variation (percentage change)				
Very low	6.93	5.74	5.53	6.13
Low	5.88	5.29	5.75	5.24
Low-middle	1.42	1.37	1.42	1.89
Middle-high	-3.44	-2.67	-3.14	-4.58
Average[1]	**-0.60**	**-0.26**	**-0.43**	**-1.22**

[1] Percentage variation of the average of individual household money-metric utilities.

39. An alternative way to gauge the robustness of the analytical conclusions is to ask how much should the labour supply elasticities of different groups be altered in order to lead to the same aggregate effects in all countries. In this simulation, Germany is taken as the reference, given that in the main simulation the overall labour supply effect was approximately zero. For the United Kingdom and the United States, the labour supply elasticity of the low paid (those in the very low earnings group) was decreased and the labour supply elasticity of those in the financing region (middle-high earnings group) was increased by the same factor (leaving elasticities of other groups unchanged) up to the point where the

total labour supply effect was close to zero. The reverse was done for Sweden. Results are reported in Table 10.

Table 10. Sensitivity analysis III: total labour supply effect equal to that of Germany

(percentage changes in labour supply elasticities to obtain the same total labour supply response)

Groups	United Kingdom[1]	United States[1]	Sweden[1]
Very low	-25	-20	+11
Middle-high	+33	+25	-10

[1] Baseline elasticities of the middle-high (very low) were multiplied by 4/3 (3/4) for the United Kingdom, 5/4 (4/5) for the United States, and 9/10 (10/9) for Sweden.

40. As shown in the table, the labour supply effects of the *EITC* in the United Kingdom and United States could only match those in Germany if the elasticities in the former two countries were significantly altered: a reduction in the labour supply elasticities of the low paid of about 20-25 per cent has to be assumed, together with an increase of the elasticities of those in the financing region of about 25-30 per cent. In Sweden, the *EITC* could lead to a nil overall labour supply impact (instead of negative) only if the labour supply elasticities of the low paid (and those in the financing region) were increased (reduced) by about 10 per cent. These findings point to the robustness of the country ranking presented in the main simulation under reasonable variations of the labour supply elasticities of the different earnings groups.

Different elasticities of substitution of labour inputs

41. Another important aspect of the sensitivity analysis involves changes in the parameters of the production function, in particular the elasticities of substitution of the different types of labour inputs. In the main simulation, a slight variation from a Cobb-Douglas production function was considered, implying approximately unit elasticities of substitution among different types of labour (see appendix A for more details). Two alternative sets of simulation were performed with elasticities of substitution reduced to 0.5 and raised to 2, respectively, to cover a broad range of estimates provided by the literature.[26] Results are presented in Table 11 and Table 12.

26. For a survey, see Hamermesh (1986).

Table 11. Sensitivity analysis IV: elasticities of substitution equal to 0.5

Groups	Germany	United Kingdom	United States	Sweden
Employment (percentage change)				
Very low	1.72	1.67	1.53	1.60
Low	0.93	0.95	0.89	1.42
Low-middle	0.16	0.16	0.14	0.27
Middle-high	-0.51	-0.11	-0.14	-0.24
Total	0.23	0.52	0.46	0.36
Working time (percentage change)				
Very low	1.04	1.04	0.95	1.00
Low	-0.52	-0.59	-0.51	-0.39
Low-middle	-0.56	-0.57	-0.68	-0.61
Middle-high	-0.77	-0.78	-1.00	-1.78
Total	-0.35	-0.28	-0.41	-1.01
Total labour supply (percentage change)				
Very low	2.76	2.72	2.48	2.60
Low	0.42	0.36	0.37	1.03
Low-middle	-0.40	-0.41	-0.54	-0.34
Middle-high	-1.28	-0.88	-1.14	-2.02
Total	-0.12	0.24	0.05	-0.65

Table 12. Sensitivity analysis V: elasticities of substitution equal to 2

Groups	Germany	United Kingdom	United States	Sweden
Employment (percentage change)				
Very low	2.36	2.54	2.39	2.67
Low	1.17	1.29	1.22	1.95
Low-middle	0.19	0.21	0.19	0.37
Middle-high	-0.52	-0.12	-0.17	-0.28
Total	0.39	0.78	0.71	0.56
Working time (percentage change)				
Very low	1.44	1.62	1.52	1.72
Low	-0.52	-0.62	-0.48	-0.16
Low-middle	-0.57	-0.60	-0.68	-0.39
Middle-high	-0.87	-0.91	-1.23	-2.10
Total	-0.32	-0.21	-0.37	-1.02
Total labour supply (percentage change)				
Very low	3.80	4.16	3.91	4.39
Low	0.65	0.66	0.75	1.79
Low-middle	-0.38	-0.39	-0.49	-0.02
Middle-high	-1.39	-1.03	-1.40	-2.39
Total	0.06	0.57	0.34	-0.46

42. As it can be seen from the Tables, only small variations occur between these simulations and the main one. Variations are in the order of 0.1-0.15 percentage points for aggregate total labour supply. Furthermore, all variations go in the expected direction. Greater complementarity of inputs (elasticity of substitution reduced to 0.5) leads to a smaller labour supply effect amongst the low paid than in the main simulation. This is due to the fact that wages of the low-paid will more responsive to the *EITC*-induced reduction of labour supply in the financing region (*e.g.* high skilled workers). Conversely, in the financing region, the opposite occurs: wages of white collars are higher than in the main simulation, because they are more responsive to the *EITC*-induced increase in labour supply in the other regions. When substitutability is increased (elasticity of substitution equal to 2), the opposite patterns can be observed.

The EITC partially financed by reductions in unemployment benefits

43. A combination of a compressed earnings distribution, high taxes on labour use and a severe unemployment trap largely explains the negative aggregate labour supply and welfare results of the *EITC* simulations in Germany and especially Sweden. The standard *EITC* in these two countries risks to be quite expensive and not effective in boosting employment amongst the low paid, under reasonable assumptions about the labour supply responses of different earnings groups. As an illustration, an alternative simulation scenario was considered for Germany and Sweden in which the *EITC* scheme is partially financed by a 10 per cent across-the-board reduction in the net replacement rate (this scheme is called *EITC+UB* henceforth). Reducing unemployment benefits lowers reservation wages, thereby reinforcing incentives to take up a job. Furthermore, the negative effects of the *EITC* on the labour supply of those in the financing region are smaller as the reduction in unemployment benefits actually covers a significant part of the costs of financing the scheme.[27] Table 13 presents the results of this set of simulations.

27. Germany and Sweden have very similar net replacement rates and consequently the distinction between absolute and relative reductions in net replacement rates does not affect the comparability of results between the two countries.

Table13. Alternative scenario: EITC+UBs in Germany and Sweden

Groups	Germany	Sweden
Employment (percentage change)		
Very low	3.38	4.01
Low	1.70	2.71
Low-middle	0.50	0.82
Middle-high	-0.40	-0.05
Total	**0.77**	**1.04**
Working time per household (percentage change)		
Very low	1.26	1.36
Low	-0.51	-0.19
Low-middle	-0.56	-0.41
Middle-high	-0.57	-1.40
Total	**-0.20**	**-0.71**
Total labour supply (percentage change)		
Very low	4.64	5.37
Low	1.19	2.51
Low-middle	-0.06	0.41
Middle-high	-0.98	-1.46
Total	**0.56**	**0.33**
Equivalent variation (percentage)		
Very low	6.04	4.97
Low	5.63	6.65
Low-middle	1.40	1.91
Middle-high	-2.23	-3.18
Average[1]	**-0.07**	**-0.56**
Unemployment (percentage of labour force)		
Very low	11.5	9
Low	9	7.9
Low-middle	7.4	9
Middle-high	4.9	5.5

[1]Percentage variation of the average of individual household money-metric utilities.

44. As expected, the employment effects in this alternative scenario (EITC+UB) are uniformly higher than those obtained with the simple *EITC* scheme. In the phase-in and phase-out regions the employment effects are much larger due to a greater increase in the reward to work. In the financing region the better employment performance is due to a somewhat smaller increase in taxes needed to finance the *EITC*. In addition, the large drop in hours worked for those in this region in Sweden is somewhat mitigated under this scenario compared with the simple *EITC*, though the country still suffers a large drop.

45. It should also be stressed that while the effects of the simple *EITC* scheme on the unemployment rate of the low paid are of the order of two percentage points, the financing of the *EITC* via reduction in benefits will lead to a reduction around three percentage points. The welfare effects of this mixed policy scenario are less clear-cut. The larger effect on the average equivalent variation in the *EITC+UB* scenario as compared to the *EITC* scenario is due to a less negative equivalent variation for those in the financing region, due to the lower increase in taxes. However, second-order general equilibrium effects have also to

be taken into account. In particular, Table 13 suggests that the less pronounced negative effect on the labour supply of those in the financing region, as compared with the *EITC* scenario, will lead to higher wages for the low-paid which could at least partially compensate the loss of welfare due to the reduction in the replacement rates.

4. Concluding remarks

46. This paper presents simulations of the introduction of a simplified earned-income tax credit system. The simulations are based on a CGE model applied to a stylised closed economy with four representative households, each characterised by a different average level of earnings from work, skill endowment and unemployment risk. The simulations are performed for four OECD countries displaying different labour market conditions and different tax/benefit systems.

47. The results suggest that the effectiveness of an employment-conditional tax credit depends on a number of key aspects, including the *ex-ante* distribution of market earnings, the labour supply elasticities, the tax system as well as the non-employment benefits. Not surprisingly, the *EITC* scheme, where workers with higher earnings finance the tax credits for the low paid, produces better overall effects - both in terms of total labour supply, unemployment and welfare - in countries with wider earnings distribution and lower marginal taxes (*e.g.* the United States and the United Kingdom). By contrast, the combination of compressed earnings distribution, high reservation wages and high taxes on labour makes the introduction of a simple *EITC* scheme costly in Germany, and especially in Sweden, with moderate (or even negative) overall labour supply effects. For these two countries, a combination of *EITC* and some other policy measures geared at reducing unemployment traps (such as a reduction in the generous unemployment benefits) may be required in order to obtain significant and positive effects on labour supply. Moreover, the incidence of unemployment amongst the low paid will be significantly reduced and, even for those who will not be able to find a job, the reduction in net disposable income will be modest.

48. The paper also makes an attempt to shed light on the implicit redistributive objective of governments required to justify the introduction of an *EITC* scheme in the different countries. While for the United States and the United Kingdom only a moderate preference for the income of the low-paid is sufficient to justify the introduction of an *EITC* scheme, the government would have to weight their income more than twice that of workers with higher income in order to justify the introduction of the *EITC* scheme in Sweden. Of course, the required implicit preference for the low paid needed to justify the introduction of the scheme is less pronounced if the *EITC* is partly financed by reducing non-employment benefits.

49. The simulations reported in this paper also indicate the importance of general equilibrium effects - generally ignored in micro-simulation models - while considering a significant reform of the tax/benefit system. According to the results presented in this paper, the positive labour supply effects for the targeted groups will be partially compensated by falls in labour supply for those who are likely to finance the *EITC* scheme. Obviously there are important limitations to the general equilibrium approach, which affect the policy relevance of its conclusions. One of these problems is the sensitivity of results to changes in key parameters. The paper presents a detailed sensitivity analysis that confirms the broad findings of the main scenario within reasonable assumptions about labour supply elasticities of different earnings groups and substitutability of different types of labour. More generally, the results presented in the paper can stimulate policy-makers to look at the broader context in which the employment-conditional scheme will be introduced and in this respect may usefully complement more detailed results from specific microsimulation models or surveys of distinct tax reforms on targeted groups.

Appendix A. Details on the CGE model

A.1 The household's problem

50. The model considers households composed of working-age individuals who have the choice between working - at the wage consistent with their skills - or being unemployed with an unemployment benefit which is a fraction of their potential market earnings. The presence of unemployment benefits induces a non-convexity in the individual's budget set, which is the source of the unemployment trap in this model. At zero hours of work, individual earnings are equal to the unemployment benefit. The benefit is however withdrawn as the individual starts working even a little amount of hours. Therefore, at any positive amount of work, the earnings of the individual are equal to the number of working hours multiplied by the net average hourly wage. In its attempt to maximise utility, the individual will first compute the optimal amount of hours to work (and the resulting utility) in the absence of unemployment benefits, then it would compare the utility thereby achievable with that obtainable without working but living on the benefit. In other words, the household faces a twin-decision (employment/non-employment and work/leisure), where the employment decision is viewed as a result of a comparison between the reservation wage and market earnings corrected for the disutility of working. However, due to a multiplicity of heterogeneous characteristics, each earnings/skill group includes employed and unemployed workers, which results in finite-valued employment elasticities.[28]

51. CGE models are generally calibrated on relatively aggregate data with reference to a few representative agents. If the employment decision is modelled for each single representative individual as a result of as a comparison between the unemployment benefit and market earnings corrected for the disutility of working, each representative individual will have an infinite-valued employment elasticity. Thus, standard CGE models cannot mimic an economy with finite-valued employment elasticities.

52. The model considered in this paper includes four household types, each composed of identical individuals. To deal with the employment-elasticity problem, the model assumes that the decision-maker is the representative household rather than the representative individual. In principles, therefore, nothing forbids the household from having some members employed and some other unemployed; nevertheless, without any further assumption, the optimal solution of the household's problem still rules out this possibility. Thus, in addition, the model assumes that the utility from unemployment benefit differs from that obtained through earnings from work - effectively introducing a third good. In equilibrium each household will optimally choose to allocate its members between employment and unemployment to take advantage of this "third good". In such a way each household will have a finite-valued employment elasticity reflecting how much the share of employed household members increases as wage increases. On a more realistic basis, this assumption can be also justified with reference to a "stigma" attached to benefit income and restrictions on the choice of the consumption bundle allowed to be purchased with benefit income (*e.g.* partial provision of benefits through food stamps). Both decrease the opportunity cost of working. Moreover, there could be other costs related to work, such as commuting to work, rigidity of working schedule etc., which increase the disutility of working.[29]

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28. The employment elasticity expresses how much a percentage increase in the net marginal wage increases the share of people that are employed or belonging to the labour force. The hours elasticity expresses how much a percentage increase in net marginal wage increases the amount of hours provided by each individual.

29. In this framework, any other component of the reservation wage that tends to be lower the higher the amount of working-time provided by the individual can be modelled in the same way. In other words, the "third good" does not need to reflect benefit entitlements only, but can also reflect informal sector earnings, home production, etc.

53. Each representative household *h* has a non-separable *n-stage* constant-elasticity-of-substitution (nested CES or NNCES) utility function.[30] Unemployed household members receive unemployment benefits from the government. The components of the utility function are: 1) leisure; 2) goods and services that can be bought with wage income; 3) goods and services that can be bought with benefit income. The utility function of each representative household can be represented as follows:

$$U(h) = U^h\left(B^h, H^h\left(l^h, x^h\right)\right), \tag{A1}$$

54. where U is utility, B is the aggregate bundle of goods and services accessible through benefit entitlements, l is leisure and x is the aggregate bundle of goods and services that can be bought in the marketplace with wage income. $U^h\left(B^h, H^h\right)$ is a constant-elasticity-of-substitution (CES) function whose elasticity of substitution is calibrated on the employment elasticity, while $H^h\left(l^h, x^h\right)$ is a CES function whose elasticity of substitution is calibrated on the elasticity of the labour supply of hours.

55. Calibration of the elasticities of substitution in the four household utility functions is as follows: First, with knowledge of benchmark quantities and hours supply elasticity, the elasticity of substitution between labour and working time can be derived using a standard formula, based on the expenditure function:

$$\xi = (\zeta - 1)(\sigma - \theta(\sigma - 1) - 1) = (\zeta - 1)\left(\sigma - \frac{(\zeta - 1)}{\zeta}(\sigma - 1) - 1\right) \tag{A2}$$

where ξ is the labour supply elasticity, σ is the elasticity of substitution, θ is the share of leisure in total consumption[31] and ζ is the endowment multiplier (ratio of endowment to benchmark supply of working time - 1.4, as assumed above). Second, benchmark consumption of the composite good H in equation (1), is computed. Third, similarly to the elasticity of substitution between leisure and working time, the elasticity between benefit and good H can be computed using benchmark shares and employment elasticity.

A.2 The firms' problem

56. The production side of the model consists of a single-good perfectly competitive product market. The representative firm has a nested CES production function:

$$x = F\left(MH, G\left(LM, L, VL\right)\right), \tag{A3}$$

30. The generality of the approach is shown by Perroni and Rutherford (1995), by describing a technique through which the NNCES form can be parametrised so as to locally capture any regular configuration of input demands and second-order curvature conditions.

31. Total consumption is equal to the sum of the values of consumption of goods and services and the value of consumed leisure. The share of leisure is equal to 0.4/1.4. This is because prices are set to 1 at benchmark and supplied working time is traded away for consumption. Therefore, the total value of consumption of goods and services is equal to 1 and the value of consumed leisure is equal to 0.4.

where *MH, LM, L, VL* are the labour inputs of the four different representative households (called Middle-High, Low-Middle, Low and Very Low, respectively), the first representing white-collar workers, while the others representing three types of blue-collar workers (see next section). $x = F(MH, G)$ is a CES function with elasticity of substitution equal to 0.9, and $G(LM, L, VL)$ is a CES function with elasticity of substitution equal to 1.15. The rationale for these elasticities (that are only small variations of those of a Cobb-Douglas function) is that there is less substitutability between the high skilled and the low skilled, than that between different types of low skilled workers. Both firms and households are modelled as price-takers also in the labour market. In other words the labour market is modelled as a segmented market with perfectly competitive sub-markets.

57. The model does not explicitly account for the capital stock. As a consequence, simulation results should be interpreted as long-term effects after capital stock adjustment.

A.3 The government

58. The government is only characterised by its budget constraint. It has two sources of expenditure: an exogenous level of consumption, and unemployment benefits, that are endogenous because of the endogeneity of unemployment. Furthermore, the government has two tax instruments to raise the necessary revenue to make the budget balanced: Value-added tax (VAT) on consumption, and progressive income tax.

Appendix B. Data description

59. This appendix describes the data used for the CGE simulations. For all countries the unemployment rates are taken from the OECD *Education at a Glance.*

B.1 Germany

60. The main data source is the German socio-economic panel (GSOEP) equivalent file for 1996. The APW level of the sample is 42,812 DM. The GSOEP sample is re-scaled to a total labour force of 37.172 million people. Data used in the simulation are presented in Table A1.

Table B.1. Germany: Summary statistics, 1996

	Groups			
	Very-Low	Low	Low-Middle	Middle-High
EARNINGS:				
Border-interval in % of APW	Up to 60 %	60 % - 75 %	75 % - 90 %	> 90 %
Interval in DM	10000–25690 DM	25691-32110 DM	32111–38530 DM	>38531 DM
Mean earnings, DM	19204 DM	28814 DM	35539 DM	58947 DM
Mean earnings, in % of APW	44.9 %	67.3 %	83 %	137.7 %
GROUP SIZE AND SHARES:				
Group Shares	21 %	14.9 %	14.3 %	50 %
Group size	7 790 580	5 527 602	5 305 014	18 549 000
TAX RATES and UNEMPLOYMENT:				
Average tax rate	26.6 %	29.6 %	32.4 %	36.7 %
Marginal tax rate	46.7 %	49.6 %	51.2 %	53.9 %
Unemployment rate	14.6 %	10.6 %	7.9 %	4.9 %
Net replacement rate	84.3 %	83.9 %	80.9 %	84.7 %

61. The following constraints are imposed on the sample:

- People younger than 20 and older than 60 years are excluded.
- People working less than 1000 hours a year are excluded.
- People earning (labour income) less than 10000 DM a year are excluded (below 23.3% of APW of the sample).

62. The sample size is 6210 people. The four groups are constructed by using group shares from the sample and the size of the total labour force aged between 20-60 years is 37,172,196 (source: LFS, OECD).

63. The GSOEP contains information about individual labour earnings but not on individual tax payments, because the German tax system is based on household taxation. In GSOEP there is also

information about household labour earnings and household taxes. To make consistent earnings- and tax-variables on a individual basis, household earnings and total household taxes are divided by the number of adults in the household. It has not been possible to compute marginal tax rates from the sample. Therefore, marginal tax rates are taken from the OECD tax model based on the OECD Tax/Benefits database. Employed marginal tax refers to a couple with one child when both are working and earning the APW earnings of that particular group (*i.e.* 45 per cent , 67 per cent, 83 per cent and 137 per cent).

B.2 Sweden

64. The main source of data is the Ministry of Finance, Sweden, 1996. The data used in the simulation are presented in Table B2. Average and marginal tax are taken from data provided by Linda, Ministry of Finance, Sweden, 1996.

Table B2. Sweden, Summary statistics, 1996

	Groups			
	Very-Low	Low	Low-Middle	Middle-High
EARNINGS (1):				
Border-interval in % of APW	Up to 60 %	60 % - 75 %	75 % - 90 %	>90 %
Interval in Skr	52250 – 125400	125400 – 156750	156750 - 188100	>188100
Mean earnings, Skr	94500	126400	163100	266600
Mean earnings, in % of APW	45.2 %	60.5 %	78.0 %	127.6 %
GROUP SIZE AND SHARES:				
Group Shares	9.9 %	19.8 %	20.9 %	49.4 %
Group size	394 575	789 150	832 990	1 968 885
TAX RATES and UNEMPLOYMENT:				
Average tax rate	30 %	32 %	32 %	36 %
Marginal tax rate	37 %	38 %	38 %	47 %
Unemployment rate	12.7 %	10.5 %	9.8 %	5.5 %
Net replacement rate	84.5 %	84.2 %	84.8 %	68.1 %

65. A number of constraints are imposed to the ample:

- People younger than 20 and older than 59 years are excluded.
- People working less than 1039 hours a year are excluded.
- People earning (labour earnings) less than 52,250 Skr per year are excluded (below 25 % of APW of the sample (209,000 Skr.).

Sample size: 9100 individuals. Labour force (20-59): 3,985,600 (1996) (source LFS, OECD).

B.3 The United Kingdom

66. The main sources of data are the British Household panel survey (BHPS) for 1996. Data used in the simulation are presented in Table B.3.

Table B.3 United Kingdom. Summary statistics, 1996

	Groups			
	Very-Low	Low	Low-Middle	Middle-High
EARNINGS (1):				
Border-interval in % of APW	Up to 60 %	60 % - 75 %	75 % - 90 %	>90 %
Interval in £	3900 - 9610	9610 - 12015	12015 - 14420	>14420
Mean earnings, £	7152	10933	13277	23454
Mean earnings, in % of APW	44.6 %	68.2 %	82.9 %	146.4 %
GROUP SIZE AND SHARES:				
Group Shares	26.0 %	15.0 %	12.6 %	46.2 %
Group size	6 656 896	3 811 200	3 201 408	11 738 496
TAX RATES and UNEMPLOYMENT:				
Average tax rate	15.6 %	21.7 %	24.1 %	29.2 %
Marginal tax rate	30.0 %	34.0 %	34.0 %	34.0 %
Unemployment rate	13.4 %	9.8 %	7.4 %	3.7 %
Net replacement rate	83.6	61.8	54.2	41.9

67. The following constraints are imposed on the GSOEP-sample:

- People younger than 20 and older than 60 years are excluded.
- People working less than 1000 hours a year are excluded.
- People earning (labour earnings) less than 3900 £ a year are excluded (below 23.3% of APW of the sample).

Labour force (20-60) is 25,408,000 in 1996 (Source: LFS, OECD).

Average tax is computed from the sample: Average tax = (gross pay - net pay) / gross pay. Marginal tax rate is taken from the Tax/benefit OECD database.

B.4 The United States

68. The main source of data is the PSID Equivalent file 1993. Data used in the simulation are presented in Table B.4.

Table B.4 United States, Summary statistics, 1993

	Groups			
	Very-Low	Low	Low-Middle	Middle-High
EARNINGS (1):				
Border-interval in % of APW	Up to 60 %	60 % - 75 %	75 % - 90 %	>90 %
Interval in US$	6500-16680	16681-20850	20851-25020	>25021
Mean earnings, US$	12 367	18752	22961	42124
Mean earnings, in % of APW	44.5 %	67.5 %	82.6 %	151.5 %
GROUP SIZE AND SHARES:				
Group Shares	26.3 %	14.8 %	14.0 %	44.8 %
Group size	29 998 569	16 881 324	15 968 820	51 100 224
TAX RATES and UNEMPLOYMENT:				
Average tax rate	16.8 %	20.6 %	23.3 %	29.9 %
Marginal tax rate	25.9 %	29.9 %	29.9 %	42.9 %
Unemployment rate	13.5 %	7.2 %	4.6 %	2.9 %
Net replacement rate	73.6 %	70.2 %	68.6 %	59.7 %

69. Sample constraints are the same as for United Kingdom and German data:

- People younger than 20 and older than 60 years are excluded.
- People working less than 1000 hours a year are excluded.
- People earning less than 6500 US$ a year are excluded (below 23.3% of APW of the sample).
- People having negative average tax are excluded.

Sample size: 7131 individuals. Labour force (20-60): 114,063,000 (1993) (Source LFS, OECD).

Computation of earnings and average tax is the same as for Germany.

Appendix C. Changes in average effective tax rates due to the introduction of *EITC*s

70. The following table presents a detailed description of changes in average tax rates induced by the introduction of the *EITC* scheme considered in this paper.

Table C.1 Average Effective Tax Rates for wage-earners before and after the *EITC* reform:

Household type (region in parentheses)	Before reforms	After Reforms
Very Low (Phase-in)	t^a_{VL}	$1-\left(1-t^a_{VL}+eitc_{in}\right)$
Low (Phase-out)	t^a_{L}	$1-\left[\left(1-t^a_{I60}+eitc_{in}\right)\frac{I_{60}}{W_L}+\left(1-t^m_{L}-eitc_{out}\right)\frac{\left(W_L-I_{60}\right)}{W_L}\right]$
Low-Middle (Phase-out)	t^a_{LM}	$1-\left[\left(1-t^a_{I60}+eitc_{in}\right)\frac{I_{60}}{W_{LM}}+\left(1-t^m_{L}-eitc_{out}\right)\frac{\left(I_{75}-I_{60}\right)}{W_{LM}}+\left(1-t^m_{LM}-eitc_{out}\right)\frac{\left(W_{LM}-I_{75}\right)}{W_{LM}}\right]$
Middle-High (Finance)	t^a_{MH}	$1-(1-t^a_{MH}-\Delta t^a_{MH})$

Where:

- t^i_j are tax rates before reforms, with *i=a,m* standing for pre-reform average and marginal, and *j=VL,L,LM,MH,I60, b* standing for Very Low, Low, Low-Middle, Middle-High pre-reform incomes, 60% APW, and income from benefits, respectively.

- Δt^a_{MH} is the change in average tax rate in the financing region, which is computed endogenously by the model in order to balance government budget.

- W_j are gross annual wages of each group, with *j=VL,L,LM,MH*.

- I_{60} and I_{75} are 60% APW and 75% APW, respectively.
- $eitc_{in}$ and $eitc_{out}$ are phase-in and phase-out rates respectively.

Appendix D. Computation of unemployment rates by earnings group

71. The unemployment rate of each earnings group has been approximated on the basis of available information on the distribution of unemployment by educational attainment according to the rule shown in Table D1. The unemployed in each group are assumed to have an unemployment benefit equal to a proportion (*e.g.* the replacement rate) of the household-specific potential market earnings.

Table D1. Computation of unemployment rates by earnings group

	Very low	Low	Low-Middle	Middle-high
Educational attainment	Less than upper secondary + 10 % of this level	50 % of less than upper secondary + 50 % of upper secondary	Upper secondary	Tertiary level of education

Source: *OECD Education at a Glance database*.

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