The cost of tax increases in the EU*

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Abstract

A number of EU countries are striving to increase their tax revenues in order to restore budgetary balances in the wake of the global financial crisis. At the same time EU countries´ fiscal policy strategies need to minimize their potential negative effects on the still fragile economic recovery. Whenever tax increases are contemplated, these should seek to favour growth by minimizing economic distortions. However it remains unclear what strategy each individual Member States should adopt and to what extent national tax policies should be coordinated to minimize economic distortions. The existing empirical literature is rather inconclusive in these respects and suggests that the optimal tax strategy depends on a variety of elements such as the degree of trade openness, the starting level of public expenditure, the degree of existing economic distortion, the level of public debt and deficits and the position in the business cycle. This paper´s contribution is to show that the spillovers emanating from tax measures can be sizeable and should be considered in order to minimize distortions related to these tax increases. We base our analysis on a widely-used measure of tax distortion, namely the marginal cost of public funds (MCF) which has proved a valuable metric for analysing tax strategies in a wide various of field of public and fiscal policy. To do so we use CGE model calibrated on EU social accounting matrices in order for the model to reflect as closely as possible the tax systems of EU countries and potential inter-linkages. We compare the distortionnary effects of tax increases for two tax categories: a direct tax with a relatively high weight on EU economies, namely labour taxes, and an indirect tax with a relatively low weight, namely energy taxes. Our results suggest that the efficiency losses related to tax increases (as measured by the MCF) are significantly larger for the labour tax than for the energy tax. However the degree of cross-EU countries spillovers is also higher for energy taxation calling for coordinated tax strategies despite the low starting level of this tax category. Furthermore, these economic costs are also likely to be reduced with a higher degree of flexibility of the labour market, especially so in the case of labour taxes but also, although to a lower extent, for energy taxes.

** The views expressed in this paper should not necessarily be seen as those of the European Commission.*

Introduction

In the wake of the global finance crisis EU Member States are confronted with the need to consolidate their public finances while promoting economic growth. This implies raising taxes or reshuffling the tax systems towards less distortive taxes, which may entail complex distortionary effects on production costs and consumption prices and thus on market outcome and economic activity at large. Things become especially complicate in the EU where economies are intrinsically inter-dependent and common wisdom suggests that tax strategies should be coordinated although little can be said exactly on what gains coordination would entail. The existing empirical literature is rather inconclusive regarding the optimal tax strategy in such context. From a EU perspective the case for coordination depends primarily on the tax category considered. The arguments generally advocated refer to the destination and residence principle for indirect and direct taxation respectively. For instance some tax categories are known to be more mobile across borders than other and taxes are likely to distort what would otherwise be considered as optimal from an EU perspective (i.e. capital should flow to countries with the highest return to capital, etc.). Direct taxation should therefore be collected in the country of residence of the factor concerned, see Sorensen (2001) Also indirect taxation should fulfil the destination principle (i.e. goods are taxed in the country of consumption) in order not to interfere with the equalisation of producer-prices to be expected from greater integration of the Single EU market, see Sorensen (2001). Beyond these general principles a variety of elements are likely to play a role to justify tax coordination. These ranges from the degree of openness and economic integration, the starting level of public expenditure and degree of distortion in markets, especially in the labour market, see Andersen and Sorensen (2012) for a review.

In this paper we argue that given the level of economic integration in the EU, the economic costs of tax increases should be appraised in the wider European context, as these may partly depend on the degree on economic and tax policy coordination. We first gauge the size of potential cross-country tax spillover effects by calculating the marginal cost of public funds (MCF) of tax increases concerning two types of tax categories, namely labour taxes and energy taxes. Second we analyse the extent to which tax-related distortions are influenced by the degree of labour market distortions which play a central role in the economic reforms called for in a number of EU countries.

The question of coordination of tax policy measures have regained momentum in the current EU policy debate following the outbreak of the financial crisis although much of the discussion has to date has essentially focused on the need to coordinate corporate taxation. In particular the Pact for the Euro adopted at the end of 2011 specifically recognises the need to pursue tax policy coordination within the EU. While these objectives are not new in the EU economic policy debate ever since the Treaty of Rome, see in particular Sorensen (2001), their relevance has been magnified in the aftermath of the global financial crisis and the euro-crisis in particular since some countries have seen their tax revenues shrink dramatically and led to substantial deterioration of their public finances. While the need to restore sound fiscal balance represent a cornerstone of EU policy making, the debate remains however largely untouched regarding the extent to which coordinated tax measures would help meeting the budgetary objectives and possibly whether some guidance could be drawn for the optimal tax policy strategy literature. A key objective of tax policy making in this context should be to minimise the distortionary effect of taxation, in particular in order to favour the economic recovery.

In this paper we consider this objective from a EU-wide perspective in order to fully take into account cross-country spillovers emanating from national tax strategies. As mentioned previously, the case for coordinated tax policies or even harmonisation of these has often been made by advocating the destination/residence principles in the context of the Single Market. In this paper we also adopt a similar EU/Single Market perspective although we depart somewhat from traditional analyses by focusing instead on the efficiency losses from marginal tax increases and considering a direct tax category (namely labour tax) and an indirect one (namely energy tax). In doing so we therefore analyse the extent to which national tax strategies may or may not interfere and possibly change the economic efficiency loss to be expected from taxation, especially in presence of imperfect labour markets.

Our choice of tax categories is not innocuous. First, we chose labour taxation because of its relatively high level in most EU countries and because it is well known to have wide-ranging effects spilling well beyond fiscal outcomes. More than any other tax category, labour taxation are directly embedded into country-specific economic and social institutions thus reflecting underlying economic structures, see Blundell et al. (1999). Second, energy taxation offers interesting scope for analysis in the current EU context as it is often advocated for as potential instrument for shifting the tax systems in order to make them both more employment friendly and environment-friendly, see Saveyn et al. (2011). Because energy taxation enters the indirect tax category and is in most EU countries relatively low, resorting to it is also likely to have lower detrimental effects on economic efficiency although it may have non-negligible effects onto the low-income categories of the population.[1] Energy taxation may also have direct effect on energy efficiency and thus help minimize the corresponding efficiency losses to be expected from an increase in tax rates. Third we also chose these two tax categories because they are generally not invoked as candidates for coordination across EU counties according to the destination/residence principles. The case for cross-country tax spillovers in labour market usually appears rather limited. Analysts often consider that, more than coordination of tax policies across countries, the reduction of structural rigidities in national labour markets or the integration of the tax and social benefit systems are the most urgently needed reforms. As such there is a priori less scope for implementing coordinated tax policies to the extent that the tax basis (i.e. labour) is relatively immobile across EU countries, thus tax policies are less likely (than e.g. institutions) to interfere with market outcome. The case for coordinated tax policies seems more relevant for indirect taxation although here distortions stem more from the existence of country-specific exemptions and fraud impinging on intra-EU trade, see Cnossen (2003) for a discussion in the EU context. The case for coordinated energy taxation can be made on the ground that a greater harmonisation of tax systems is needed not to alter the functioning of the Single Market, as illustrated by the recent Commission proposal to revise the EU Energy Tax Directive, see European Commission (2011).

This paper seeks to shed new light on these questions by analysing specifically the degree of distortion introduced by tax hikes for labour and energy taxation and whether these tax

[1] See Speck (1999) for a disvcussion. In this paper we do not deal with inequlity issues.

increases are likely to lead to cross-country spillovers, the latter calling for coordinated tax policies. In order to do so we base our analysis on the calculation marginal cost of public funds which provides a metric of tax distortions and that is used widely in the literature on optimal fiscal policies. The marginal cost of public funds (MCF) measures the ratio of the welfare loss (or benefit) in relation to the corresponding tax increase and is a widely-used tool for the evaluation of the distortionary effects of tax reforms, public expenditure programs and other public policies (see in particular Dahlby, 2008). A large number of studies have considered the existence of cross-country tax spillovers although only some have used the MCF as main analytical tool, see Andersen and Sorensen (2012) for recent review. These studies consider the influence of externalities related to tax measures by comparing successively two cases: unilateral tax increases and simultaneous (multilateral) tax increases where countries implement the same marginal tax hike individually or at the same time respectively. However, such an approach provides a partial view on the true economic distortions represented by unilateral tax increases, ignoring the tax spillover effects. Contrary to the existing literature, in this paper we set out to calculate the MCF in the case of unilateral tax increases by considering the effect of tax hikes on the level of welfare and tax revenues of third (i.e. other EU) countries. Such an approach allows us to provide a more complete picture of the potential efficiency losses related to tax hikes from an EU-wide perspective.

We calculate the MCF for two different tax categories, namely labour taxes and energy taxes for EU countries. The analysis is performed for all EU countries (except Cyprus, Malta and Luxembourg). Our results show that the efficiency losses related to tax increases (as measured by the MCF) are significantly larger for the labour tax than for the energy tax. However the degree of cross-EU countries spillovers is also higher for energy taxation calling for coordinated tax strategies despite the low starting level of this type of taxation. Furthermore, these economic costs are also likely to be reduced with a higher degree of flexibility of the labour market, especially so in the case of labour taxes but also, although to a lower extent, for energy taxes.

The rest of the paper is organised as follows. In section 1 we review the existing literature on tax policy spillovers, focusing specifically on studies using the MCF as analytical tool as in our paper. In Section 2 we present the model and analytical approach used (Annex 1 provides more details on the main equations of the model). Section 3 provides the main results while Section 4 presents some robustness tests to check the sensitivity of our results to the main hypotheses of the model, especially regarding the degree of rigidities in the labour market. Section 5 concludes.

1. Modelling approach

1.1 The GEM-E3 model for tax analysis

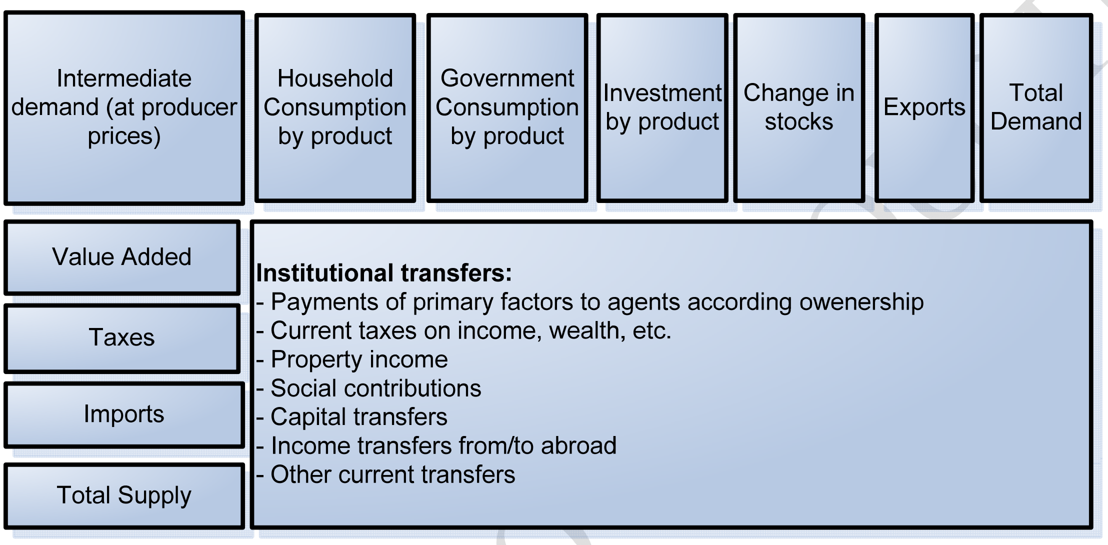
The model GEM-E3 models the interactions between the economy, the energy system and the environment at country and EU level. GEM-E3 (General Equilibrium Model for Energy-Economy-Environment interactions). The model has been developed as a multinational collaboration project, partly funded by the European Commission, (DG Research, 5th Framework programme) and by national authorities.[2] Applications of the model have been carried out mainly in relation to energy environmental issues although it has also been used in order field as well. It covers all production sectors (aggregated to 26) and institutional agents of the economy. It is an empirical, large-scale model, written entirely in structural form. The model computes the equilibrium prices of goods, services, labour and capital that simultaneously clear all markets under the Walras law. The model is dynamic, recursive over time, driven by accumulation of capital and equipment. Technology progress is explicitly represented in the production function, either exogenous or endogenous, depending on R&D expenditure by private and public sector. Moreover it is based on the backward looking expectations of the participant agents. It formulates separately the supply or demand behaviour of the economic agents which are considered to optimise individually their objective while market derived prices guarantee global equilibrium. Annex 1 provides the main building blocks of the model for further details.

For the sake of the analysis carried out in the present paper, the model GEM-E3 appears to be especially appropriate for at least three important reasons. First, the calibration of the

(2) The GEM-E3 model was built under the auspices of European Commission (DG-Research) by a consortium involving BUES, ERASME, NTUA, KUL, PSI, ZEW and at the beginning of the project CORE, Univ. Strathclyde and CEA. The GEM-E3 model is hosted by the Institute for Prospective Technological Studies (IPTS) of the European Commission Joint Research Centre. For more information regarding this model, see www.gem-e3.net.

GEM-E3 model is based on social accounting matrices (SAM) for 2005. As a result, the tax rates are calibrated as an effective rate, i.e. the ratio between the tax revenues and the corresponding tax basis for each tax category as reported in the SAMs, which provides a fairly reliable picture of the economy and the tax system in order to simulate the effects of policy changes. Figure 1 sketches out the main elements of these country-specific SAMs.

Figure 1: Social Accounting Matrix representation as used in GEM-E3



Source: European Commission (2012).

The Social Accounting Matrix (SAM) provides a disaggregation of factors, activities, commodities and explicitly formulates demand and supply relationship. The model is calibrated to a base year data (2005) set that comprises a full Social Accounting Matrix for each EU country that is built by combining input-output tables (as published by EUROSTAT) with national accounts data. Bilateral trade flows are also calibrated for each sector represented in the model, taking into account trade margins and transport costs. Consumption and investment are built around transition matrices linking consumption by purpose to demand for goods and investment by origin to investment by destination. The initial starting point of the model, therefore, includes a detailed treatment of taxation and trade. Total demand (final and intermediate) in each country is optimally allocated between domestic and imported goods, under the hypothesis that these are considered as imperfect substitutes (the "Armington" assumption). The production level is modelled through CES KLEM (capital, labour, energy and materials) production functions involving many factors (all intermediate products and two primary factors -capital and labour). Technical coefficients in production and demand are flexible in the sense that producers can alternate the mix of production not only regarding the primary production factors but also the intermediate goods. At the same time consumers can also endogenously decide the structure of their demand for goods and services. Their consumption mix is decided through a flexible expenditure system involving durable and non-durable goods. The specification of production and consumption follows the generalised Leontief type of models.

Second, the GEM-E3 model offers a great level of detail regarding tax systems as it distinguishes between nine categories of government receipts, namely indirect taxes, environmental taxes, direct taxes, value added taxes, production subsidies, social security contributions, import duties, foreign transfers and government firms. These receipts are coming from product sales (i.e. from branches) and from sectors (i.e. agents) as described in the SAM. The receipts from product sales in value, which include indirect taxes, the VAT, subsidies and duties, are computed from the corresponding receipts in value, given the tax base and the tax rate. The receipts from agents are computed from the tax base and the tax rate (social security contributions, direct taxation), share of government in total capital income (for government firm's income) or exogenous (transfers from and to the RW). It is important to note that in the calibration the unemployment benefits are part of the transfer from the government to the household sector which is a single aggregate in the SAM. We thus use observed unemployment benefit transfers to the household sector for the year 2005 which also include all non-unemployment transfer related to the unemployment status (e.g. child benefit) as reported by the OECD in 2005. The latter is in particular relevant to take into account the potential income loss from becoming unemployed.

Third, the GEM-E3 model comprises all sectors of the economy broken down into 18 sectors while private consumption is divided among 13 durable and non-durable goods. Such level of detail allows for a consistent evaluation of the distributional effects of tax policy changes for the different sectors of activity and economic agents. Despite their analytical appeal, the use of CGEs to estimate the MCF is subject to a number of caveats. In particular, despite the relative high degree of disaggregation a CGE model remains an abstraction of the real world. For instance in most countries "capital taxation" is very complex and it cannot be perfectly mimicked in a CGE model. Second, the EU Member States are linked through bilateral trade; however, cross-border shopping is not modelled.

It is important to note that the version of the GEM-E3 model used here includes labour market imperfections including involuntary unemployment. Due to these imperfections, employees enjoy a wage premium on the top of the wage rate that would result from non-distorted labour markets (see Appendix for further details). We follow the approach of Shapiro and Stiglitz (1984) suggesting a negative correlation between wages and labour productivity, see also Blanchflower and Oswald (1994) for empirical evidence.

The introduction of labour market imperfections has two important implications when it comes to estimating the MCF and comparing the results of labour taxes versus other tax categories. First the degree of labour market "imperfection", i.e., the gap between the efficiency wage and the wage that would result from a perfect labour market where potential supply matches labour demand is likely to influence the MCF. A large wage premium should result in a greater distortive effect of labour taxation in particular. Labour market imperfections could also magnify trade-related tax spillovers effects to the extent that wages are set in some countries by partly taking into account evolutions in the main trading-partner countries (e.g. in as Belgium).

1.2 The calculation of the marginal cost of public funds

The estimation of the MCF can be undertaken using a general equilibrium approach encompassing all the potential market effects of a given tax increase as well as the interactions between economic agents and resulting changes in the tax bases. The MCF can be calculated using the following formula:

$$MCPF_{i,k} = \frac{\Delta W_{i,k}}{\Delta TR_i} \tag{1}$$

where $\Delta W_{i,k}$ is the welfare loss due to the increase of tax *k* in country *i* and is calculated as the change in consumer utility based on the indirect utility function in order to give it a monetary value. It could be conceptualised as the reduction in consumption relative to a benchmark case of no-policy change, where prices and incomes are fixed at their "no-policy-change" benchmark level. This technically corresponds to the "equivalent" variation. Alternatively, using the "compensating" variation would imply using the prices and income corresponding to "policy change" scenario. See Dahlby (2008) and Schöb (1994) for a discussion. The term ΔTR_i in equation (1) represents the corresponding change in tax collection in country *i* (including all tax revenues).

The MCF provides a metric for the loss in welfare (the efficiency loss) per unit of tax revenue gain. If the MCF equals one, then the tax is merely a lump-sum transfer from the households to the government with no distortion. Typically, however, the MCF is greater than one such that MCF $=1+\alpha$, with $\alpha>0$ representing the cost of the distortion. This means that for every euro that goes into the government's purse, the economy pays an efficiency cost of α euros. The higher the MCF, the larger the distortive cost vs. the tax revenue gains.

As mentioned above, the externality modelled in GEM-E3 stems from bilateral trade relationships. A given tax policy change will affect bilateral trade flows and, thus, economic activity (i.e. production and consumption). It will also impact on tax revenues via two channels: tax changes will affect both i) relative prices of domestically produced vs. foreign goods and services and ii) disposable income through changes in price levels and purchasing power. Tax changes will also spill through the production chain: for instance countries importing intermediates from a country implementing a tax increase will face higher production costs if substitution possibilities (i.e. import from alternative suppliers) are limited. Tax changes also affect demand for intermediates produced abroad. A country implementing a tax increase will thus face a competitiveness loss as well as lower purchasing power. Furthermore, partner countries may benefit on the one hand from a price-competitiveness gain if their exports are close substitutes of the goods and services produced by the tax-increasing country. On the other hand, partner countries may eventually lose if their exports are complementary to those of the tax-increasing country or if the lower economic activity in the tax-increasing country reduces its imports from the partner country. In addition, as noted by Andersen and Sorensen (2012) an increase in any of these taxes may also have positive effects such that the distortion of a labour tax increase does not need to increase with trade integration. Andersen and Sorensen (2012) consider a simple trade model and identify two types of positive effects related to a labour tax increase: a trade gain effect as domestic producer must realise productivity gain to counter the increase in factor costs; and a terms-of-trade gain effects as domestic exporters obtain a higher price for the product sold. The combination of these trade-gains, factor cost and demand effects thus result in a net effect of tax change on trading partners which can be either positive or negative.

Alternatively one can also derive a measure of the MCF where tax-related spillovers are taken into account by considering unilateral tax increases as indicated in equation (3) below:

$$MCPF_{i,k} = \frac{\Delta W_i}{\Delta R_i + \sum_{j,j\neq i} \Delta R_j} + \frac{\sum_{j,j\neq i} \Delta W_j}{\Delta R_i + \sum_{j,j\neq i} \Delta R_j} \qquad (2)$$

where *i* is the country implementing a given tax change while *j* are the other countries (not implementing any tax change). The second term of equation (2) represents the spillover effect which can be compared to the first term of equation (2) which represents the impact of a tax change for the country implementing it only. The average MCF for unilateral tax increases calculated as in (1) can then compared to the average value of the MCF for unilateral tax increases including the impact of unilateral tax increases on other countries welfare and tax revenues as calculated in (2).

The results presented here provide estimations of the MCF for a very small tax increase of 0,05 percentage points of the effective tax rate in 2005. The tax increase in the case of labour tax concerns total social total security contribution (thus leaving out income taxation). In doing so we aim at focusing on the labour "price" effect of taxation specifically although obviously income taxes (including other types of income as well) are also likely to influence the marginal cost of taxation and indirectly labour supply. The energy taxes considered here concerns Energy Tax for households per petajoule of energy (which is the measure commonly used to express energy consumption by large customers groups such as countries). It is important to note that the effects of an energy tax increase on the consumer utility level as a result of a greater abatement of CO2-emission (which is modelled in GEM-E3) is cancelled out here such that the resulting utility variation stems essentially from the traditional price and income effects of a price change of each product consumed by the representative consumer. The small tax increment is intended to capture the marginal nature of the tax change. In practice the proceeds of a given tax increase are used to finance policy objectives such as an increase in public expenditure, a subsidy, or to repay public debt. As the impact of the allocation of tax proceeds is beyond the scope of this paper, the estimate of the MCF of a given tax increase is isolated by allocating the (small amount of) additional tax revenues to the rest of the world (i.e. outside the EU). It is important to note also that when changing the level of taxes we fix the level of leisure to a given level. This is done in particular in order to isolate specifically the effect of labour taxes on hours spent in employment and in unemployment. Given the labour market setting used, this means also that unemployment is never voluntary and thus neutralises the substitution effect of hours worked with time spent in leisure.

2. Results.

The MCF as in equation (1) is calculated for a unilateral tax increase for each EU country separately. Columns 1 of Table 1 depict the results by country. Column (2) and (3) provide in addition the EU-wide MCF and the size of the spillover effect based on equation (2). The values obtained are roughly of the order of magnitude obtained in the existing literature, namely between 1 and 3 and in most cases around the EU mean (weighted in terms of GDP) value which is 1.9. The latter indicates that in order to raise 1 euro of extra revenues, the EU economy would experience a 0.9 euros efficiency loss. The efficiency loss related to a marginal labour tax increase is therefore nearly as high as the extra-tax revenue which is to be collected. This result is rather uniform across EU countries according to the relatively low value of the standard deviation expressed in percentage of the simple (i.e. unweighted) mean value. Some countries have especially high values: Denmark, France, Sweden and Slovakia whereby others, have relatively low values, this is the case in particular of Estonia, Romania, Ireland or Latvia where labour taxes are also significantly lower.

The size of the spillover effect is relatively low however, on (weighted) average only 3.6% across EU countries. The diversity of results across countries is much more pronounced here, however. As indicated by the last three rows of Table 1, the average value of the spillover component of the MCF is only 0.07. This figure indicates that for each extra-euro of labour tax collected by a given country, on average the existence of tax spillover yield an efficiency loss of 7 cents. The size of these spillover effects varies a lot depending on the country considered, however. It is in particular much more pronounced in cases such as Belgium, where the spillover effect represent 13.5% of the total MCF which amount to 30 cents of efficiency loss due to cross country spillovers which must be added on top of the (already high) 98 cents when considering country-effects only. The same applies also to some extent for countries such as Denmark (+24 cents), the Netherlands (+12 cents) and Slovenia (+12 cents). Given that these countries are also largely open to intra-EU trade then these results would tend to indicate that the competitiveness effect of a labour tax increase is especially pronounced in these countries.

The MCF as defined in equations (1) is a ratio between the change in the welfare (based on the equivalent variation approach) and the change in tax revenues following a marginal increase in the tax rate. Equation (2) aims at quantifying the effect of EU-wide spillovers on this measure. However the results reported in Table 1 do not allow us to say anything about the importance of each country on the magnitude of the tax spillover effects, i.e., if any specific EU country has a particular role, either positive or negative on the size of tax spillovers, especially if the different elements in both the numerator and denominator of the MCF vary in opposite directions. In addition to the values of the MCF we therefore also need to analyse separately the variation in welfare and the variation in tax revenues provoked by EU-wide tax spillovers. This is done in Table 2 reporting the welfare variation from labour tax change of a tax increase undertaken by each EU country separately. Table 3 in turn provides similar results for the change in tax revenues. The first important result from these two tables is that EU-wide spillovers act negatively on both the tax revenue and welfare variations and this is especially pronounced for the welfare measure. This result thus indicates that the extra-tax revenue collected by a specific country in most cases acts negatively on third countries welfare and tax revenues. Some countries have a more prominent role because of their size (Germany, France and the UK are the salient cases) or because of their degree of openness to the rest of EU economies (which is the case for Belgium or the Netherlands).

We now turn to the case of energy taxation. The results for the MCF concerning this tax category are depicted in Table 4. As a matter of comparison the MCF for energy appears to be significantly lower than for labour tax: 1.08 euro on average for the EU vs. 1.90 euro for labour tax. Because the value of the MCF for energy is close to 1, at least on (weighted) average for the EU, the energy tax appears less distortionary. As the energy tax can be assimilated to a lump-sum transfer, this may explain why it appears to be less distortionary than a tax affecting a production factors such as the labour tax. This result also appears to be rather homogenous across countries as indicated by the value of the standard deviation expressed in percentage of the simple average value. The cross-country differences thus appear to be comparable to the ones observed in the case of labour taxes. The size of the spillover effects appears to be larger for energy taxes however compared to the labour tax case. Cross-country spillovers account for 8.1% of the MCF in the case of energy tax against 3.6% for labour tax as indicated previously. This result can be directly linked to the size of labour taxes vs. energy taxes: energy taxes are in most cases very low across EU countries. At the same time an energy tax increase would lead to more homogeneous cross-country spillovers as indicated by the lower dispersion of cross-country spillovers in the case of energy tax vs. labour tax (see last row of Table 4). As for labour taxes the corss-country spillovers are especially relevant for small open economies for for a larger number of them, e.g. beside Belgium, Slovenia or the Netherlands as in the case of labour taxes, countries such as Ireland, Lithuania, Hungary, Austria for instance, also experience significantly large spillovers from an tax increase in energy products. Looking at the role of each separate country on the EU-wide spillovers considering separately positive and negative effects on welfare (Table 5) and tax revenues (Table 6) we, as in the case of labour taxes, again observe that the large EU countries generate most of the spillovers although here some relatively small albeit open countries tend to play a bigger role (e.g. Belgium and the Netherlands in particular). The sign of the spillover effect is predominantly negative, however as indicated by the last row of Table 5 and Table 6.

Last we now turn to compare more directly the distortionary effect of labour tax increase vs. energy tax increase. This is done in Figure 1 which plots the values of the country-specific MCF against the share of total government tax revenues on GDP (as given by the 2005 value used in the calibration of our model). The link between the starting level of tax pressure appears to be strong and positive in the case of labour taxes indicating that the distortionary effect of labour taxation grows with total tax levels as measured in percentage of GDP. The correlation between the MCF and the tax revenue to GDP share is indeed positive as indicated by a simple OLS regression reported in this Figure. On the contrary the relationship between the tax to GDP ratio and the MCF on the energy tax does not seem to display a specific pattern.

These first results provide some important messages. First the economic distortion provoked by labour taxes is significantly larger than for energy tax. At first glance this result would then advocate for an energy-tax rather than a labour tax oriented fiscal consolidation when it comes to minimize related tax distortion (assuming that both tax increases would yield the same tax revenues). Nevertheless the cross-country tax spillover effects are more pronounced (in relative terms) for the energy taxes vs. the labour taxes suggesting that, while advisable from an economic efficiency perspective, the use of energy taxes for fiscal consolidation also call for close coordination across EU countries.

3. The role of labour market flexibility

We now turn to the question of whether the degree of labour market flexibility can influence the results obtained from the MCF. The degree of labour market flexibility reflects the extent to which a change in prices resulting from a tax increase affects the wage setting. By setting different degrees of labour market imperfection we therefore address the question of whether the real wage follows exactly the change in the marginal product of labour or whether wage rigidity linked to labour market imperfection hinders such an adjustment, see in particular Boeters and Savard (2011) for a review of the literature and Hutton and Ruocco (1999) for an example of analysis of the impact of tax change with efficiency wages in a CGE model. With some degree of labour market imperfection one would thus expect a given tax change to have different impact depending on the degree of labour market imperfection. In the labour market setting adopted here, this means that the tax change will not be fully reflected in the real wage because of the existence of a wage premium of workers. In such a context the interaction between the tax system and the labour market setting can be non-negligible, especially so although not exclusively, when considering labour tax change. In principle a high degree of labour market flexibility (i.e. low wage premium) should lead workers to experience a higher level of welfare loss as a result of a change of a specific tax rate. With perfect competition in the product market, price changes resulting from a given tax increase should lead to lower production and factor demand and thus result in lower wages and lower consumption and welfare. A low degree of flexibility would instead result in lower welfare loss as wages adjust less to the lower labour demand. It is important to note that in our model there is only one representative individual and only one tax rate for each tax category based on the calibration using the information contained in the SAMs. For the labour market in particular we thus consider only one country average effective tax rate for each tax category. The progressivity of tax systems (and in particular the difference between a change in the average tax rate and a change in the tax rate of a specific income or wage bracket) is therefore not accounted for while in practice, existing studies tend to show that the labour tax progressivity (including income taxes) can have non-trivial (and even opposite) effects on labour supply and therefore on the MCF, see in particular Lockwood and Manning (1993).

The degree of flexibility of labour market is measured by adjusting the parameter *eg* indicated in equation (A.2.8) as indicated in Appendix 2. A high *eg* indicate a higher degree of labour market flexibility, i.e., according to equation (A.2.8) the higher the transmission of the quit rate and the lower the impact of unemployment changes on the real wage level. There is arguably no specific reason for choosing a specific value of the *eg* value against another one as the highly stylised representation of the labour market used in the version of GEM-E3 allow us to say little about whether this convenient or not. One could argue for instance that since the *eg* parameter should represent as closely as possible the degree of flexibility of the labour market then country-specific values should be set in accordance to "estimated", e.g., by the labour market literature. In fact, this is only partly true in the labour market setting outlines in Appendix 2 given that, while the parameter *eg* is set at an ad-hoc value, the level of unemployment used is taken from observed data. Instead of trying to stick to some ad-hoc country-specific measure of labour market flexibility we chose instead to keep the same value of this parameter across countries and rather to check whether the MCF estimates change when the degree of flexibility is higher or lower than in our benchmark cases without inferring too much about whether this degree of flexibility reflects the reality of EU countries labour markets. In adopting this approach we are therefore more interested in the change in the value of the MCF *on average* across EU countries rather than on whether the country-specific degrees of "flexibility" are correctly reflected.

Tables 7 and 8 provide the results of running our model for two different scenarios (the high and low labour market flexibility cases) and for the labour tax and energy tax respectively. A direct comparison of the EU-wide results for these two tax categories (indicated in the first row of these two tables) shows that the degree of labour market flexibility hinges on the MCF estimates primarily for labour taxation. While this result should not come as a surprise given that labour market flexibility affects directly the way the wage cost rise (including social security contribution which is used here to model the tax hike) is transmitted to employment level. The rise in MCF is very pronounced in most EU countries in the case of labour taxes as a result of "doubling" the level of labour market inflexibility. Little should be read from the country-specific results, however given that in some cases the efficient wages assumption does not necessarily capture the degree and nature of rigidity of the labour market (e.g. Spain experiences barely experience a change in its MCF while this country is known to have especially distorted labour market). By comparison, the effect of labour market flexibility on the MCF for energy taxes is much less pronounced. On average for the EU, the MCF rises by 4.62% when the degree of labour market "inflexibility" is doubled and is only reduced by 3.27% when it is halved. While the country-specific results should be interpreted with care, it remains that in some cases the rise in the MCF are non-negligible. This is the case in particular for France and Germany.

4. Conclusions

In this paper we analyse the efficiency losses related to tax increases in the EU by calculating the marginal cost of public funds (MCF) using a CGE model calibrated on the EU economies. Our main objective is to analyse the extent to which cross-country tax spillovers and labour market flexibility can affect the efficiency loss related to tax increases. In analysing these questions we aim to shed light on current discussions regarding the optimal strategies EU Member States should follow to minimise the cost of potential tax increases, especially in a context of low growth and still fragile economic recovery. By adopting a EU-wide perspective and resorting to a well known measure of distortionary impact of tax policies such as the MCF we aim to analyse whether, whenever required, tax increases would be (i) better suited if they concerned specific tax categories given their lower distortionary effect on economic activity and whether (ii) potential cross-country spillovers are sizeable and should eventually be considered to guide national tax strategies. In considering labour and energy taxes we also aim to illustrate the above question for two very different tax categories: a direct tax (i.e. labour tax) which has a relatively high burden in most EU countries and is known to have wide-ranging consequences on economic activity; and an indirect tax with a relatively low burden in most EU countries and which is likely to display lower distortionary effects. The extent to which both these taxes may or may not have cross-country effects remains unclear however.

Our results show that the economic distortion provoked by labour taxes is significantly larger than for energy tax. At first glance this result would advocate for an energy-tax (or other indirect-taxes like) rather than a labour tax oriented fiscal consolidation when it comes to minimize related tax distortion for a given level of additional tax revenues. Nevertheless the cross-country tax spillover effects are more pronounced (in relative terms) for the energy taxes vs. the labour taxes suggesting that, while advisable from an economic efficiency perspective, the use of energy taxes (and possibly of any kind of indirect taxes with relatively low weight on GDP) for fiscal consolidation also call for closer coordination of tax strategies across EU countries. In addition the efficiency losses associated with labour taxes are also likely to be greater when labour markets are less flexible (from an efficiency-wage perspective) and lower although still present and in some cases sizeable for energy taxes suggesting that even the use of this type of taxes should not exempt EU countries from undertaking structural reforms (especially on the labour market side) in order to minimize the efficiency losses entailed by tax-driven fiscal consolidations.

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Tables

Table 1: The Marginal cost of Public Funds of labour tax increase

	Country	Labour EU	Spillover effect*
Austria	1.82	1.91	4.30%
Belgium	1.98	2.29	13.52%
Bulgaria	1.56	1.59	1.77%
Czech rep.	1.49	1.50	0.97%
Germany	1.96	2.04	3.63%
Denmark	2.31	2.56	9.69%
Estonia	1.30	1.36	4.20%
Greece	1.59	1.60	0.88%
Spain	1.79	1.84	2.37%
Finland	1.61	1.66	2.77%
France	2.41	2.50	3.71%
Hungary	1.53	1.58	3.71%
Ireland	1.33	1.41	5.27%
Italy	1.68	1.68	-0.19%
Lithuania	1.45	1.49	2.47%
Latvia	1.42	1.49	4.27%
Netherlands	1.57	1.69	7.00%
Poland	1.63	1.63	-0.36%
Portugal	1.82	1.93	5.34%
Romania	1.43	1.42	-0.56%
Sweden	2.06	2.15	4.37%
Slovenia	1.66	1.78	6.80%
Slovakia	2.19	2.22	1.46%
United Kingdom	1.81	1.86	2.76%
EU (GDP Weighted)	1.90	1.97	3.6%
Simple average	*1.73*	*1.80*	*7.3%*
Std. Deviation / average	*17.38%*	*18.99%*	*101.62%*

* Calculated as the percentage of the second term in the right hand side of equation (2) divided by the MCPF measured for the EU. The change in the labour tax concerns total social security contribution paid by the employers and the employees. The tax increase is equal to 0.05 percentage point.

Table 2: Welfare variation in Labour tax change: the sign and size of EU-wide tax spillovers

EU percentage of total change that is +ve or -ve	positive effect (percentage of total effect)	negative effect (percentage of total effect)
	5.78%	94.22%
	% of positive EU-wide effects	% of negative EU-wide effects
Austria	1.76%	2.29%
Belgium	0.00%	7.88%
Bulgaria	0.22%	0.10%
Czech rep.	3.39%	0.46%
Germany	0.82%	20.05%
Denmark	0.00%	3.04%
Estonia	0.28%	0.16%
Greece	3.24%	0.57%
Spain	10.00%	6.91%
Finland	0.33%	1.00%
France	2.30%	19.40%
Hungary	1.48%	1.11%
Ireland	0.27%	1.75%
Italy	54.19%	2.61%
Lithuania	0.45%	0.18%
Latvia	0.28%	0.20%
Netherlands	0.00%	6.28%
Poland	8.93%	0.34%
Portugal	0.58%	2.39%
Romania	6.71%	0.28%
Sweden	0.00%	3.52%
Slovenia	0.33%	0.57%
Slovakia	1.37%	0.23%
United Kingdom	3.07%	18.69%

Table 3: Tax revenue variation in Labour tax change: the sign and size of EU-wide tax spillovers

	% of positive EU-wide effects	% of negative EU-wide effects
Austria	1.69%	1.56%
Belgium	1.87%	9.71%
Bulgaria	0.20%	0.07%
Czech rep.	1.06%	0.31%
Germany	17.43%	21.87%
Denmark	0.88%	4.02%
Estonia	0.17%	0.16%
Greece	1.64%	0.35%
Spain	9.06%	3.20%
Finland	1.36%	1.02%
France	13.45%	19.62%
Hungary	1.10%	0.90%
Ireland	1.48%	1.10%
Italy	13.98%	1.67%
Lithuania	0.27%	0.14%
Latvia	0.18%	0.17%
Netherlands	3.53%	7.79%
Poland	2.22%	0.32%
Portugal	1.49%	2.44%
Romania	1.03%	0.24%
Sweden	2.46%	4.44%
Slovenia	0.30%	0.49%
Slovakia	0.28%	0.13%
United Kingdom	22.88%	18.29%
EU	16.62%	83.38%

Table 4: The Marginal cost of Public Funds of Energy tax increase

	Energy		
	Country	EU	Spillover effect (% of total MCF)
Austria	0.87	1.07	18.3%
Belgium	0.63	0.87	27.9%
Bulgaria	0.62	0.64	4.6%
Czech rep.	0.81	0.87	6.5%
Germany	1.14	1.24	8.2%
Denmark	0.86	0.93	6.5%
Estonia	0.79	0.92	13.5%
Greece	0.85	0.90	5.5%
Spain	0.89	0.98	9.5%
Finland	0.63	0.70	10.6%
France	1.42	1.54	7.7%
Hungary	0.86	1.01	14.6%
Ireland	0.62	0.88	29.5%
Italy	1.10	1.14	3.6%
Lithuania	0.84	0.95	11.8%
Latvia	0.82	0.84	2.1%
Netherlands	0.83	0.97	14.4%
Poland	1.26	1.27	1.1%
Portugal	0.93	1.06	12.9%
Romania	0.89	0.95	6.0%
Sweden	0.87	0.95	8.0%
Slovenia	0.95	1.10	13.7%
Slovakia	1.06	1.17	9.5%
United Kingdom	1.13	1.17	3.6%
EU (GDP Weighted)	1.08	1.17	8.1%
Simple average	*0.90*	*1.00*	*0.10*
Std. Deviation / average	*22.21%*	*19.02%*	*64.41%*

* Calculated as the percentage of the second term in the right hand side of equation (2) divided by the MCPF measured for the EU. The change in the Energy tax concerns the energy consumption by households (in real terms). The tax increase is equal to 0.05 percentage point.

Table 5: Welfare variation in Energy tax change: the sign and size of EU-wide tax spillovers

EU percentage of total change that is +ve or -ve	positive effect (percentage of total effect)	negative effect (percentage of total effect)
	4.07%	95.93%
	% of positive EU-wide effects	% of negative EU-wide effects
Austria	3.17%	4.77%
Belgium	0.02%	9.50%
Bulgaria	5.74%	0.66%
Czech rep.	14.55%	3.88%
Germany	0.00%	18.55%
Denmark	7.54%	0.84%
Estonia	1.60%	0.40%
Greece	2.17%	1.18%
Spain	0.30%	7.46%
Finland	1.04%	1.13%
France	0.05%	16.44%
Hungary	0.00%	2.29%
Ireland	0.05%	3.26%
Italy	1.15%	4.78%
Lithuania	0.74%	0.64%
Latvia	2.64%	0.16%
Netherlands	24.37%	7.73%
Poland	17.26%	1.70%
Portugal	0.36%	1.82%
Romania	5.96%	2.34%
Sweden	0.65%	1.21%
Slovenia	1.88%	0.79%
Slovakia	7.94%	1.94%
United Kingdom	0.81%	6.53%

Table 6: Tax revenue variation in Energy tax change: the sign and size of EU-wide tax spillovers

	% of positive EU-wide effects	% of negative EU-wide effects
Austria	3.49%	5.05%
Belgium	0.00%	11.17%
Bulgaria	2.37%	0.86%
Czech rep.	17.42%	3.74%
Germany	0.65%	20.46%
Denmark	6.61%	1.28%
Estonia	5.10%	0.48%
Greece	4.74%	0.62%
Spain	0.42%	5.74%
Finland	0.94%	1.27%
France	0.03%	16.37%
Hungary	0.00%	2.28%
Ireland	0.01%	2.96%
Italy	3.87%	3.12%
Lithuania	1.25%	0.34%
Latvia	2.65%	0.18%
Netherlands	12.16%	9.15%
Poland	19.85%	1.18%
Portugal	0.35%	2.31%
Romania	4.45%	1.30%
Sweden	0.06%	1.45%
Slovenia	0.89%	0.77%
Slovakia	11.39%	1.69%
United Kingdom	1.28%	6.22%
EU	8.77%	91.23%

Table 7: The Marginal Cost of Public Funds and labour market flexibility: the case of Labour tax

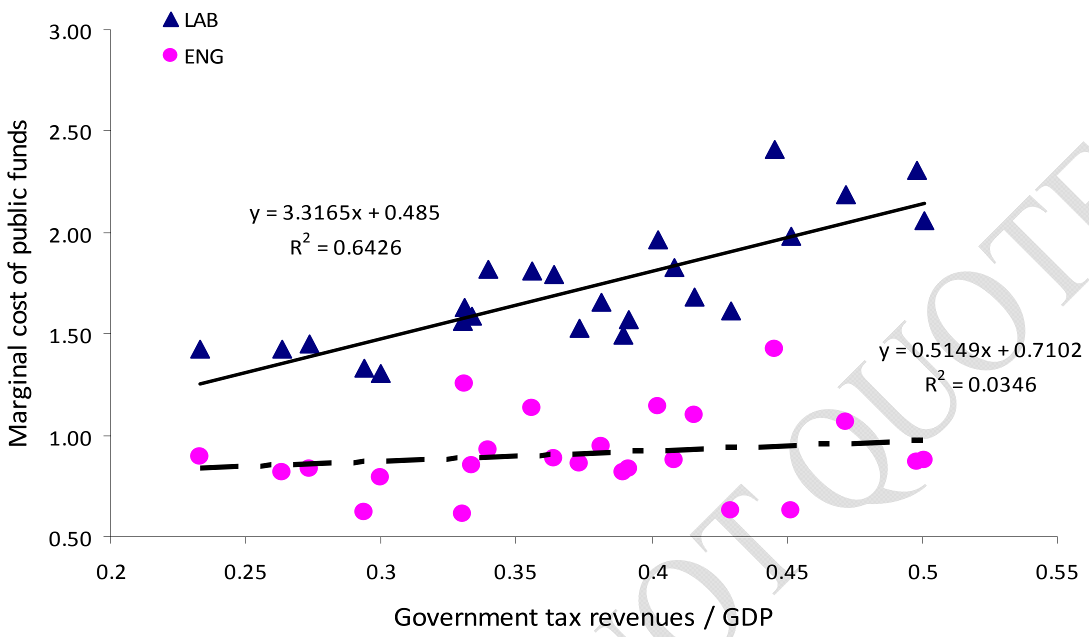
		EU-results	
	MCF, benchmark case	***Less flexible Labour market***	***More flexible Labour market***
EU	***1.90***	***2.54***	***1.64***
% change vs. benchmark		***+33.59%***	***-13.63%***
		Country-results	
	MCF, benchmark case	***Less flexible Labour market***	***More flexible Labour market***
Austria	1.82	2.41	1.60
Belgium	1.98	2.98	1.64
Bulgaria	1.56	1.51	1.60
Czech rep.	1.49	1.63	1.42
Germany	1.96	3.07	1.56
Denmark	2.31	4.85	1.75
Estonia	1.30	1.29	1.33
Greece	1.59	1.77	1.43
Spain	1.79	1.80	1.80
Finland	1.61	1.77	1.52
France	2.41	3.64	1.91
Hungary	1.53	1.70	1.43
Ireland	1.33	1.27	1.38
Italy	1.68	1.92	1.52
Lithuania	1.45	1.44	1.47
Latvia	1.42	1.44	1.41
Netherlands	1.57	2.43	1.31
Poland	1.63	1.78	1.53
Portugal	1.82	2.05	1.66
Romania	1.43	1.40	1.46
Sweden	2.06	2.57	1.79
Slovenia	1.66	1.84	1.55
Slovakia	2.19	2.30	2.13
United Kingdom	1.81	2.00	1.66

Table 8: The Marginal Cost of Public Funds and labour market flexibility: the case of Energy tax

		EU-results	
	MCF, benchmark case	***Less flexible Labour market***	***More flexible Labour market***
EU	***1.08***	***1.13***	***1.04***
% change vs. benchmark		***+4.62%***	***-3.27%***
		Country-results	
	MCF, benchmark case	***Less flexible Labour market***	***More flexible Labour market***
Austria	0.87	0.88	0.87
Belgium	0.63	0.61	0.65
Bulgaria	0.62	0.61	0.64
Czech rep.	0.81	0.82	0.82
Germany	1.14	1.24	1.07
Denmark	0.86	0.87	0.88
Estonia	0.79	0.81	0.93
Greece	0.85	0.87	0.84
Spain	0.89	0.86	0.92
Finland	0.63	0.61	0.65
France	1.42	1.55	1.33
Hungary	0.86	0.87	0.85
Ireland	0.62	0.59	0.65
Italy	1.10	1.13	1.07
Lithuania	0.84	0.87	0.88
Latvia	0.82	0.83	1.02
Netherlands	0.83	0.85	0.82
Poland	1.26	1.29	1.23
Portugal	0.93	0.93	0.91
Romania	0.89	0.86	0.91
Sweden	0.87	0.88	0.84
Slovenia	0.95	0.96	0.94
Slovakia	1.06	1.06	1.06
United Kingdom	1.13	1.16	1.11

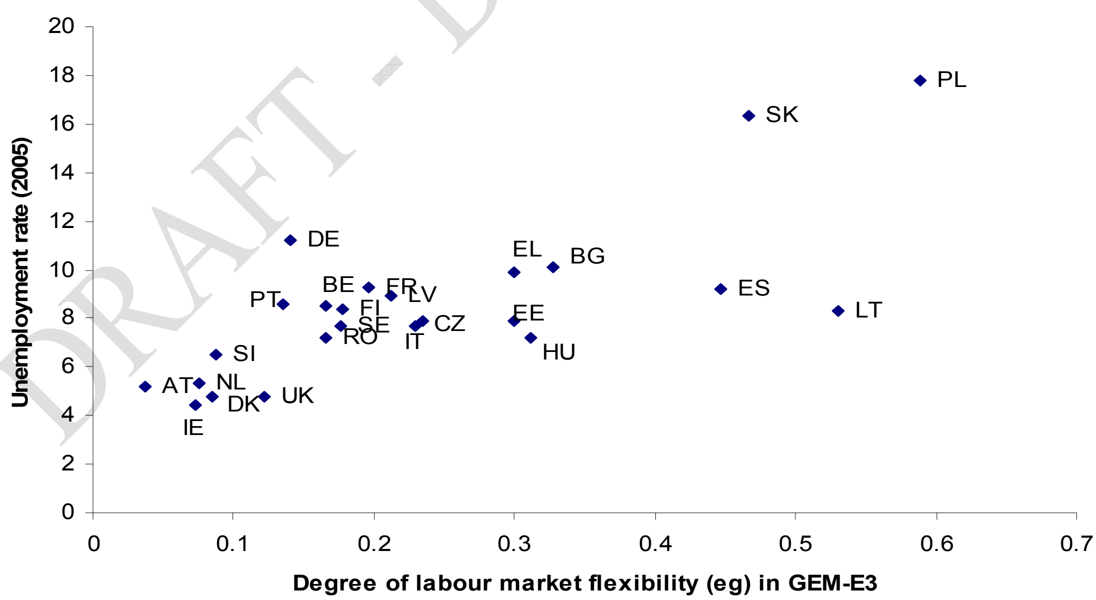
Graphs

Graph 1: The Marginal cost of Public Funds vs. total tax revenues



Sources. GEM-E3 simulations

Graph 2: Labour market flexibility in GEM-E3 and actual unemployment rates (in 2005)



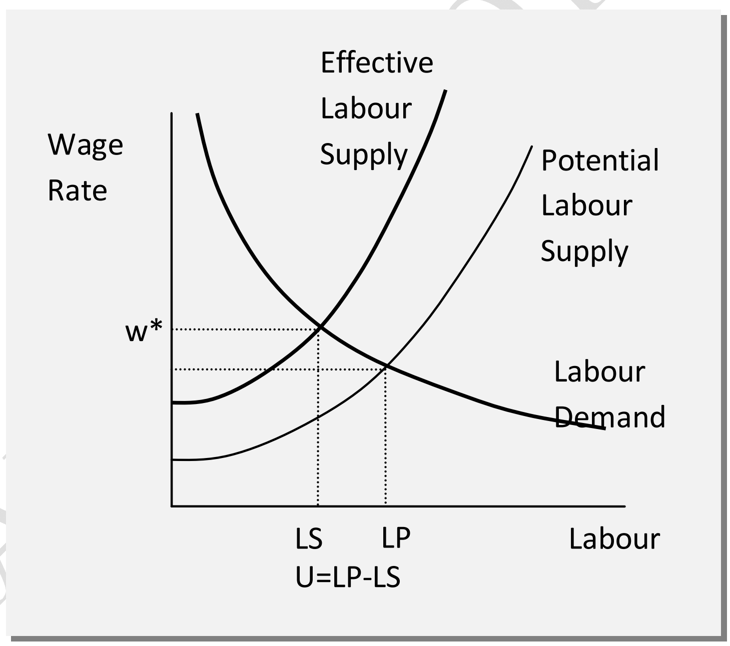
Sources. GEM-E3 calibration and Ameco (European Commission, DG Ecfin)

Appendix: **Equilibrium unemployment in GEM-E3**

The core version of GEM-E3 adopts a market equilibrium approach for the modelling of the labour market. The wage rate is derived from balancing labour supply with labour demand. Potential labour supply derives from utility maximisation of households and labour demand derives from profit maximisation of firms depending on relative prices of factors and factor productivities. This model version corresponds to the perfect labour market postulate and has been extended by introducing the equilibrium unemployment mechanism.

The model extension consists in introducing rigidities and imperfections in the labour market, which shifts utility-derived labour supply to the left and upwards. Wages drive the balancing of the shifted labour supply with labour demand. Thus involuntary unemployment arises as a result of the distorted labour market equilibrium. It is assumed that, due to labour market imperfections and frictions, the employees enjoy a wage premium (a wage rent) on top of the wage rate that would correspond to equilibrium between potential labour supply and labour demand. The wage rate premium leads to a displacement to the left of the potential labour supply curve. The displaced supply curve corresponds to effective labour supply.

Figure A1: Illustration of equilibrium unemployment



The wage rate premium is endogenous in the model and is assumed to be the consequence of the existence of Principal-Agent relations: the firms are obliged to pay a wage premium to induce employees not to shirk; as a result effective labour supply is determined through efficiency wages. The balancing of labour demand with effective, rather than potential, labour supply implies that equilibrium unemployment is determined as the difference between potential and effective labour. This is illustrated in Figure, which shows unemployment U as difference between potential equilibrium labour LP and effective labour equilibrium LS, corresponding to wage rate w* which includes the wage rent reflecting market imperfections.

An approach for simulating involuntary unemployment relates to the assumption that there is a negative correlation between wages and unemployment. This approach is consistent with the efficiency wages theory of Shapiro & Stiglitz (1984) which states that productivity/quality of labour has a positive correlation with wages. In periods with high unemployment firms are not motivated to offer high wages to attract higher quality labour or to increase productivity of existing workers. On the contrary at low unemployment rates it is efficient for firms to offer wages above their equilibrium level, because they seek for increases in labour productivity and for reducing the probability of someone quitting the job and hence reducing costs from the recruitment of new personnel; see Phelps (1994), Campbell and Orszag (1998). In the GEM-E3 model the efficiency wage approach was finally selected to be the default option for representing involuntary (equilibrium) unemployment. This modelling approach was preferred because of its empirical validation, by using for example Blanchflower and Oswald (1994), its simplicity, and the fact that it is parsimonious in parameters. The specification of efficiency wages in GEM-E3 is shown below and it is based on Shapiro & Stiglitz and Annabi (2003) approaches.

The utility function of a "shirker" worker U_s is defined as:

$$r \cdot U_s = w - (q + b) \cdot (U_s - U_u) \qquad \text{(A.2.1)}$$

where *q* is the efficiency related parameter, *b* quit from job rate, *r* interest rate, w the wage and U_u *the* utility function of the unemployed. The utility function of a "non shirker" is:

$$r \cdot U_n = w - e - b \cdot (U_n - U_u) \qquad \text{(A.2.2)}$$

where $e \geq 0$ is the disutility from working (for the "shirker" is $e = 0$). The utility function of the unemployed is:

$$r \cdot U_u = \overline{wr} + a \cdot (U_n - U_u) \qquad \text{(A.2.3)}$$

Where $\overline{wr}$ is the unemployment benefit and *a* the probability to get a job.

A worker decides not to be productive when $U_n \geq U_s$. This is the efficiency condition. Replacing the utility functions of the shirker and non shirker the efficiency condition can be re written as:

$$w \geq \overline{wr} + e + \frac{e \cdot (a + b + r)}{q} \qquad \text{(A.2.4)}$$

Thus efficiency wage is an increasing function of quit rate, the probability of finding a job, the interest rate, the unemployment benefit. In equilibrium the number of workers that are unemployed should equal the number of workers that fill a vacancy

$$b \cdot L = a \cdot (LS - L) \qquad \text{(A.2.5)}$$

The unemployment rate is defined as

$$u = \frac{LS - L}{LS} \qquad \text{(A.2.6)}$$

Thus the efficiency condition (unemployment wage functions) becomes:

$$w = \overline{w}r + e + \frac{e}{q}\cdot\left(\frac{b}{u} + r\right) \qquad \text{(A.2.7)}$$

The efficiency condition is the labour supply function in the version of GEM-E3 used in this paper. The condition was adjusted so as to incorporate real wages. This replaces the labour market equilibrium condition, i.e. $LAV^s = LAV^D$ from which the equilibrium wage rate would be derived. In a perfect labour market setting. *PCI* is the consumer price index and *eg* an adjustment parameter to reflect the different labour market flexibility conditions that prevail in each country.

$$w\cdot\frac{PCI}{\overline{PCI}} - \overline{wr} + e + \frac{e}{q}\cdot\left[\left(\frac{b}{u}\right)^{eg} + r\right] \qquad \text{(A.2.8)}$$

The implementation of involuntary unemployment in the GEM-E3 model required additional data (i.e. unemployment levels, minimum wages etc.) that were extracted mainly from the CESifoDICE and EUROSTAT databases.

The equation (A.2.8) is used to compute the unemployment rate while the equilibrium condition (A.2.9) in the labour market is used to compute the wage rate, which is the average nominal wage rate used to derive the labour cost PL_{PR}[3] and leisure cost PLJ_{PR}

$$POPV - LJV - \sum_{PR} LAV_{PR} = \left(POPV - LJV\right)\cdot UNRT \qquad \text{(A.2.9)}$$

Where:

$$POPV = POP \cdot TOTTIME$$

POP : the population of each region

$TOTTIME$: the total available time for leisure or labour.

[3] Other model variants include a Philips curve, fixed labour supply and fixed wages.