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Automatic Stabilisers
and Market Flexibility
in EMU: Is There A Trade-
Off?

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ABSTRACT/RÉSUMÉ**Automatic stabilisers and market flexibility in emu: is there a trade-off?**

It is often claimed that tax and welfare reforms that aim at enhancing efficiency may come at the cost of cyclical stabilisation. Reducing the generosity of welfare systems and lowering taxes may boost efficiency and output, and improve market adjustment to shocks. But, by reducing the size of automatic stabilisers, it may also imply less cyclical smoothing. This would be unwelcome in EMU given the loss of national monetary autonomy and the well-known pitfalls of active fiscal management. This paper argues that the alleged trade-off between efficiency/flexibility and stabilisation may not exist. We show that, if the initial level of the tax burden is high, reducing it may lead to higher output stabilisation in the event of a supply shock and higher inflation stabilisation in the event of a demand shock. The threshold level of taxation depends on the preferences of the central bank over inflation and output. Econometric and numerical simulations show that European countries — especially small ones — might have a tax burden close to or even higher than the threshold level.

JEL codes: E52, E61, F42

Keywords: Fiscal Policy, Automatic Stabilisers, Economic and Monetary Union, Shocks

**Stabilisateurs automatiques et flexibilité de marchés de l'UEM.
Y-a-t-il un compromis ?**

On a souvent proclamé que les réformes fiscales et sociales ayant pour objectif d'augmenter l'efficacité économique pouvaient se faire au détriment de la stabilisation des cycles économiques. En effet, la réduction de la générosité des systèmes de sécurité sociale et l'abaissement des impôts tendent à accroître l'efficacité de l'activité économique et à améliorer la capacité d'ajustement des marchés aux chocs. Cependant, réduire la taille des stabilisateurs automatiques peut également impliquer une augmentation des oscillations cycliques. Cela serait contrariant au sein de l'UEM, étant donné la perte d'autonomie monétaire au niveau national, ainsi que les problèmes associés à l'activisme fiscal. Cet article établit que la contradiction potentielle entre efficacité/flexibilité et stabilisation peut ne pas exister. Nous montrons que, lorsque le niveau initial des prélèvements obligatoires est élevé, sa réduction peut renforcer la stabilisation de la production en réponse à un choc d'offre et celle des prix en réponse à un choc de demande. Le seuil d'imposition dépend des préférences de la banque centrale entre l'inflation et la production. Les simulations économétriques et numériques suggèrent également que les pays européens — en particulier les petits pays — puissent avoir un niveau de charges fiscales proche (voire au-delà) du seuil.

Classification JEL: E52, E61, F42

Mots-clés: Politique Fiscale, Stabilisateurs Automatiques, Union Économique et Monétaire, Chocs.

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AUTOMATIC STABILISERS AND MARKET FLEXIBILITY IN EMU: IS THERE A TRADE-OFF?

Marco Buti, Carlos Martinez-Mongay, Khalid Sekkat and Paul van den Noord¹

1. Introduction

1. The issue of how to adapt to shocks in a situation in which countries do not dispose any longer of national monetary policy has been key in the debate on EMU since the early 1990s. It is usually recognised that fiscal policy has to play a more important role in smoothing shocks, especially if they originate on the demand side. However, in order to avoid the typical pitfalls of fiscal fine-tuning, the main focus has increasingly been put on the work of automatic stabilisers. This view is codified in the Stability and Growth Pact whose “fiscal philosophy” implies that countries should set a structural target of close to balance or surplus and simply let automatic stabilisers play. The empirical evidence shows that countries with a more generous welfare state and a large and progressive tax system tend to extract a larger smoothing from automatic stabilisation (European Commission, 2001).

2. However, while the literature focuses on the demand implications of automatic stabilisers, there are a number of ways in which fiscal stabilisers may impinge on the supply side (Van den Noord, 2000). On the positive side, avoiding recurrent large under-utilisation of resources may have favourable supply-side effects if it prevents under-investment in, and failure to maintain, physical and, more importantly, human capital. Moreover, the literature strongly suggests that, in order to reduce distortions, it is better to keep tax rates stable over the cycle, and hence allow automatic fiscal stabilisers to operate, than to adjust tax rates from one year to another. Similar arguments will apply to adjusting spending parameters such as unemployment benefit rates.²

3. But there are also negative supply-side effects involved in using automatic fiscal stabilisers. Automatic fiscal stabilisation is often created by mechanisms that allow people and businesses affected by changing economic circumstances to delay their adjustment to change. Such mechanisms include the functioning of social security systems, labour market institutions and many parts of tax systems. In a world where automatic stabilisers are allowed to operate as a rule, workers are less concerned with possible adverse externalities of high wage demands. Moreover, they may anticipate that pay rises will not prompt any significant increase in labour supply, on the assumption that unemployed workers are “trapped” to a large extent in the social security system which, as noted, is a main vehicle of automatic stabilisation. If this is the case, the wage response to a fall in unemployment or a rise in output may be stronger. To the extent that these negative supply effects prevail, automatic stabilisers may come at a cost in terms of

1. This paper was written by: Marco Buti and Carlos Martinez-Mongay from the European Commission, Khalid Sekkat from the European Commission and the Université Libre de Bruxelles and Paul van den Noord from the OECD. An earlier version of this paper was presented at the European Commission Workshop on Monetary and Fiscal Policy Interactions on EMU, Brussels, 8 March 2002. The opinions expressed in this paper are the authors' only and should not be attributed to the institutions they are affiliated with. The authors would like to thank Mike Artis, Giuseppe Carone, Jorgen Elmeskov, Carl Gjersem, Peter Hoeller, Andrea Montanino, Karl Pichelmann, Werner Roeger, Dennis Snower and Jan in't Veld. The usual caveats apply.

2. Automatic stabilisation can also be justified on the ground that the government faces fewer liquidity constraints and a lower risk premium than the private sector and therefore is likely to be more efficient at consumption smoothing through cyclical downturns than households are.

efficiency. Not only would they negatively affect potential output, but also hinder the appropriate response to supply shocks. As a result these tend to be longer lasting.

4. The flip side of this conclusion is that policy makers' efforts to streamline the welfare state and bringing down the tax burden in the pursuit of better efficiency and more flexible markets would come at a cost in terms of less demand smoothing via the automatic stabilisers. This trade off between stabilisation and efficiency would be particularly unpalatable in EMU countries, since they already have lost national monetary policy and the exchange rate as adjustment mechanisms to country-specific shocks. Indeed, EMU members would ideally aim for both stronger fiscal stabilisation and smoother structural adjustment: the first to tackle temporary demand shocks, the second to respond to lasting supply shocks (Buti and Sapir, 2002, and Buti, von Hagen and Martinez-Mongay, 2002).

5. Fortunately this difficult trade-off may not always be relevant. This paper argues that there may be a critical level of the tax burden beyond which a reduction in taxation may not only yield better efficiency, but, depending of the nature of economic shocks, also render fiscal automatic stabilisers more effective. As a result, under certain circumstances, a reduction in the tax burden might carry a "double dividend" of efficiency gains and better fiscal stabilisation properties. This conclusion draws on evidence that lower taxation improves the terms of the short-run inflation-unemployment trade off (*i.e.* makes the Phillips curve flatter) by reducing the wedge between the marginal cost of labour and the marginal take-home pay. This is encouraging for countries with high tax burdens that are considering a reduction in the size of the public sector.

6. The paper is organised as follows. The next section explains how the tax burden may affect the shape of the Phillips curve. Based on these findings, section 3 introduces a two-country model of a monetary union from which a critical level of the tax burden beyond which automatic stabilisers are destabilising will be derived. Section 4 presents simulations with OECD's INTERLINK model which provide some empirical support for the existence of such a critical tax burden. Building upon these simulation results, section 5 presents several numerical versions of the two-country model to examine the sensitivity of the critical tax burden to assumptions on *e.g.* the openness of the economy and the degree of the distortions introduced by the tax system. The final section concludes.

2. Taxation and the short-run unemployment-inflation trade off

7. The basic tenet of this paper is that automatic stabilisers operate not only on the demand side through their impact on disposable income, but also on the supply side. Distortionary taxes affect the level of equilibrium unemployment and potential output.³ What is important in our analysis, however, is the impact of distorting taxes on the reaction of output to unexpected inflation, that is the slope — not the position — of the aggregate supply curve.

8. A similar result is obtained by Hairault *et al.* (2001) although their purpose is different. They used a dynamic stochastic imperfect competition model to show that introducing some distortive taxation increases both allocation efficiency and stabilisation. The government is assumed to tax firms' input (labor and capital) and to transfer tax revenues to households in a lump sum way. The welfare gain is that such a policy reduces the negative effect of market power on factor demand. They identified the optimal of tax rate that maximize welfare. The authors also showed that when households are averse to work hours' fluctuations, labor supply is increasing in tax (subsidy) rate. On the empirical side, Auerbach and Feenberg

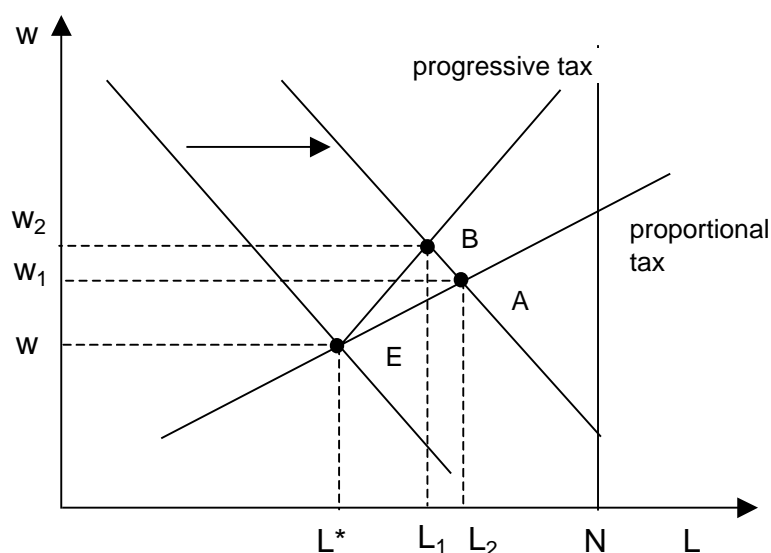
3. See, *e.g.* Kneller, Bleaney and Gemmel (1999), Heady and Van den Noord (2001) and OECD (2002). OECD (2000) estimates that an increase in the tax share in GDP by 1 percentage point reduces output per working-age person in the long run by 0.6 to 0.7 per cent.

(2000) assessed the extent to which a tax system with rates rising with respect to income serve to stabilize output through labor supply conditions. Their results confirm that such progressive income tax may help to stabilise output via its effect on the supply of labor and suggest that this effect may even be of similar magnitude to the more traditional path of stabilization through aggregate demand.

9. Below we will put forward a possible underpinning of a slope-effect stemming from taxation. The marginal tax wedge is well known to raise wages and reduce employment beyond the levels that would exist in a world with non-distorting lump sum taxation. Now the question arises as to whether this effect could also be reflected in the elasticity of the Phillips curve and consequently in the slope of the aggregate supply curve. Our answer is that it does.

10. We assume that workers pass through the cyclical variations in their tax burden at least partly onto employers. This implies that there is “real wage resistance” in an imperfect labour market.⁴ It is consistent with a situation where unemployment benefits, and hence the reservation wage, is fully indexed on the real wage rate (Pissarides, 1998). We argue that the more progressive the tax system is, the stronger will be the impact of (un-)employment on wages. At first sight this contradicts the standard finding in union-wage models that progressive taxation moderates wage claims because it reduces the loss associated with a fall in wage income per worker without affecting the gain in wage income associated with increased employment. However, these models are based exclusively on the behaviour of unions and ignore the impact of progressive taxation on search efforts, consumption-leisure trade-offs and efficiency wages. Taking these mechanisms into account may be shown to change the sign of the impact of progressive taxes on wage claims from negative to positive (Naess-Schmidt, 2002).

Figure 1 The impact of taxation on wage formation



4. Evidence of “real wage resistance” in continental Europe is found by Daveri and Tabellini (2000), but not by Layard (1997) who finds that in the long-run tax neutrality holds. Notice, however, that what is crucial for our analysis is real wage resistance in the short run. Hence the results below are not incompatible with long run neutrality of taxes. For an overview of the debate, see Carone and Salomäki (2001).

11. This is illustrated in Figure 1, which depicts the downward sloping labour demand schedule and an upward sloping wage formation curve. It shows an increase in the marginal product of labour (due for example to a technology shock or a demand shock), represented by an outward shift of the labour demand schedule. Under proportional taxes this is shown to raise employment from L^* to L_1 and the real producer wage from w^* to w_1 . In order to obtain the same result in terms of after-tax wages if taxes are progressive, however, the real employer wage needs to increase by more, from w^* to w_2 , and employment would increase by less, from L^* to L_2 . Hence, if N represents the labour force, the fact that tax is progressive increases the responsiveness of the real producer wage to a change in the unemployment rate from $[(w_1-w^*)/w^*]/[(L_1-L^*)/N]$ to $[(w_2-w^*)/w^*]/[(L_2-L^*)/N]$.

12. To convert these notions into a formal relationship we postulate the following wage formation function:

$$(1) \quad w = f(L) + \gamma T$$

where w is the real producer wage, L is employment and T is the real revenue of distorting tax per worker. We assume the first derivative of the function f with respect to L to be positive, in line with the graphical representation in figure 1. γ is the coefficient of wage resistance: it varies between 0 (all tax increases are borne by labour) and 1 (tax increases are passed through entirely to employers). Rewriting in rates of change (denoted by a dot over a variable) yields:

$$(2) \quad \dot{w}(1 - \gamma \frac{\Delta T}{\Delta w}) = (1 - \gamma \frac{T}{w}) \rho_1 \dot{L}$$

in which $\rho_1 = (df/dL)(L/f(L))$, which is the elasticity of the real wage with respect to (cyclical variations in) employment.

13. Next, we define the average and marginal rates of the distortive tax as, respectively, $t = \frac{T}{w}$ and $t' = \frac{\Delta T}{\Delta w}$.

By replacing t and t' in (2) and defining the tax elasticity with respect to wage earnings ξ as the ratio between the marginal and average tax rate, after some manipulations, we obtain:

$$(3) \quad \dot{w} = \frac{(1 - \gamma)}{(1 - \gamma \xi t)} \rho_1 \dot{L}$$

14. We assume the nominal rate of change of the producer wage to be equal to the expected rate of inflation (π^e) plus the rate of change of the real producer wage and that wages are fully passed into prices (*i.e.* $\pi = \dot{w} + \pi^e$). Moreover, we assume that for every percentage (cyclical) increase in employment, the unemployment rate declines by a ρ_2 percentage points; *i.e.* $u - u^* = -\rho_2 \dot{L}$, where u is unemployment and u^* is the natural rate of unemployment. Under those assumptions the (inverse) expectations-augmented Phillips curve reads (we leave out other explanatory variables):⁵

5. Taxation may also enter in the determination of the natural level of output (see Dixit and Lambertini, 2000), and not only in the slope of the supply function. Since we are interested in analysing the response to shocks, this will not be considered.

$$(4) \quad u = u^* - \frac{(1 - \gamma \xi^t)}{(1 - \gamma)} \chi (\pi - \pi^e)$$

and χ is a positive constant which is equal to the ratio of ρ_2 and ρ_1 .

15. It is easy to see that, provided that taxes are progressive (that is $\xi > 1$) and there is sufficient wage resistance (*i.e.* a relatively large γ), the reaction of unemployment to an inflation surprise is smaller the larger the value of t . In other words, in countries with higher taxes, a value of inflation larger (smaller) than expected will lead to a smaller (larger) reaction of output which corresponds to a steeper supply function in the output-inflation space. The intuition for this result is clear. Take the case of a positive inflation surprise: as employers demand more labour to increase production, they will have to pay higher wages to cover not only for the higher prices but also on account of the fact that wages move up onto a higher tax bracket; this tends to limit the rise in production.⁶

3. The analytical framework

3.1. A simple two-country model of a monetary union

16. The standard model which neglects the effect of taxes on supply predicts that automatic stabilisers stabilise output and inflation in the event of demand shocks and stabilise output, but destabilise inflation under supply shocks (Blanchard, 2000, Brunila, Buti and in't Veld, 2002, and European Commission, 2001). In this standard model, automatic stabilisers operate only on the demand side. Higher stabilisers imply a lower effect of inflation on demand. In the output-inflation space, the aggregate demand schedule is steeper and displays smaller shifts in the event of shocks. The basic difference in our model is that, as stressed earlier, automatic stabilisers operate not only on the demand side, but also on the supply side: higher stabilisers - which means a higher level of taxes - make the supply schedule steeper.

17. We consider a version of the standard AD-AS model of a monetary union composed of two countries and closed *vis-à-vis* the rest of the world. The IS aggregate demand and Lucas-Phillips supply curves for the home country are written as:

$$(5) \quad y^d = \phi_1 d - \phi_2 (i - \pi^e) - \phi_3 (\pi - \pi^*) - \phi_4 (y - y^*) + \varepsilon^d$$

$$(6) \quad y^s = (\omega - \alpha)(\pi - \pi^e) + \varepsilon^s$$

where y is output, d is the budget deficit, π is inflation ('^e' reads 'expected'), i is the nominal interest rate and t is the tax rate. y , d and t are expressed in terms of potential (baseline) output. ε^d and ε^s represent, respectively, uncorrelated temporary demand and supply shocks of zero mean. All the variables are percentage points deviations with respect to the baseline. $\phi_1, \phi_2, \phi_3, \phi_4, \omega$ and α are non-negative parameters. The same equations can be written for the foreign country (for which all variables are marked with '*'). Equation (5) assumes that fluctuations in aggregate demand depend on (changes in) the budget deficit, the real interest rate, competitiveness, absorption and a shock.

6. For this to hold true it must be assumed that governments fail to provide an offsetting tax break to moderate wage demands, *i.e.* do not pursue an incomes policy. But this is consistent with the basic assumption of our analysis: governments solely and fully rely on automatic stabilisers, hence do not modify the tax and spending parameters in response to cyclical fluctuations in economic activity.

18. A crucial assumption is that the slope of the supply function (6) depends on taxes. As argued in section 2, to the extent that taxes reduce wage flexibility, the effects of inflation surprises depend on the tax rate. Hence, α is a parameter capturing the functioning of the labour market: $\alpha = 0$ corresponds to the case of no real wage resistance (in which case the system (5) plus (6) becomes a standard model in which fiscal policy operates only through the demand side) while $\alpha > 0$ implies that employers bear a substantial part of the increased tax burden. For any given α , a rise in distortionary taxes makes the supply curve less elastic. Conversely, for any given tax rate, structural reforms that improve the functioning of labour markets lead to a lower α thereby increasing the elasticity of supply.

19. Aggregate demand and supply equations are complemented with the policy rules followed by the fiscal and monetary authorities. The central bank aims at stabilising inflation and output of the currency area as a whole. We posit a simple Taylor rule of the form:

$$(7) \quad i = \bar{\pi} + \beta \bar{y}$$

where $\bar{\pi} = \lambda \pi + (1 - \lambda) \pi^*$ and $\bar{y} = \lambda y + (1 - \lambda) y^*$ are, respectively, the average inflation and output gap of the currency area (λ and $1 - \lambda$ being the weights of the domestic and the foreign countries in the area) and β is the relative preference of the monetary authority for output over inflation stabilisation. We assume that the monetary authority sets interest rates so as to maintain inflation on target in the “medium run”, which, in this simple setting, means in absence of shocks. Since shocks — regardless of whether they are symmetric or country-specific — are serially uncorrelated with zero average, this implies $\pi^e = \pi^{e*} = 0$.

20. For the fiscal authority, we assume that, in line with the Stability and Growth Pact, the two governments pursue a neutral discretionary policy, which implies that they set a target for the structural budget balance and let automatic stabilisers play symmetrically over the cycle.⁷ The deviation of the actual budget balance from the baseline (the latter being structural balance in absence of shocks) is:

$$(8) \quad d = -ty$$

21. We capture the size of automatic stabilisers via the parameter t which can be interpreted as the average tax rate supplemented by cycle-sensitive spending categories. Since it is usually assumed that the only spending programme that react to the cycle is unemployment insurance (which is very small), we can proxy t with the tax burden.

22. Trade balance consistency implies:

$$(9) \quad \pi - \pi^* = (y - y^*) \phi_5$$

where $\phi_5 = \frac{(\phi_4^* - \phi_4)}{\phi_3 - \phi_3^*}$.

7. This is the definition of a well behaved” fiscal authority, according to Alesina *et al.* (2001). For more sophisticated reaction functions of fiscal authorities in EMU, see, Buti, Roeger and in’t Veld (2001) and Buti and Giudice (2002).

23. Replacing (7), (8) and (9) in (5) and combining it with equation (6) gives the following semi-reduced forms for output:

$$(10) \quad y = -\frac{\omega - \alpha t}{r_t} \phi_6 y^* + \frac{\omega - \alpha t}{r_t} \varepsilon^d + \frac{\phi_2}{r_t} \varepsilon^s$$

where $r_t = \phi_2 + (\omega - \alpha t)[1 - (\phi_6 - \phi_1 t - \beta \phi_2)]$ and $\phi_6 = [\phi_2(1 - \lambda)(\phi_5 + \beta) - (\phi_4 + \phi_3 \phi_5)]$. Inflation can be readily computed by equating (10) and (6) under $\pi^e = 0$.

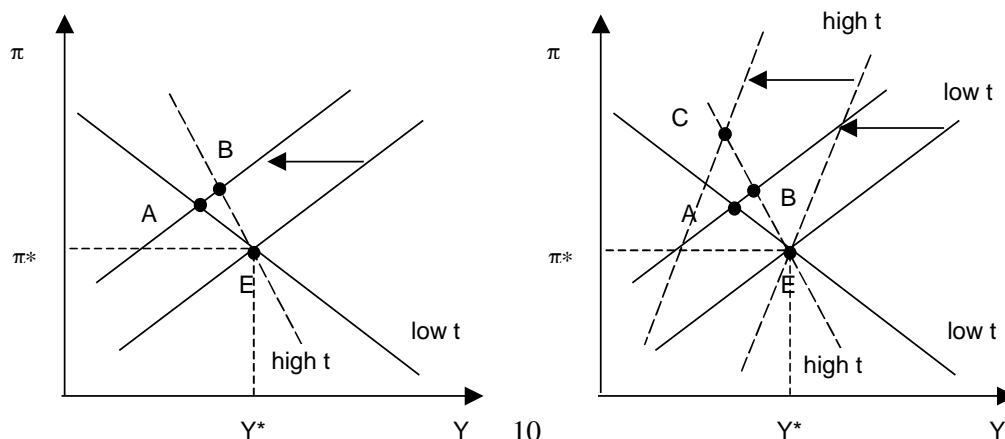
24. We turn now to the analysis of shocks, focusing on asymmetric shocks (in the home country). We are interested in analysing the effects of a change in t on the degree of stabilisation in the event of shocks.

25. While conceptually straightforward, the algebra is cumbersome and it is therefore shifted in Annex I. In line with the intuition in section 3, we show a higher t entails stronger output stabilisation in the event of demand shocks while it is inflation-destabilising in the event of demand shocks. The crucial result concerns output-stabilisation in the event of a supply shock and inflation stabilisation in the case of a demand shock. In the traditional model in which taxes do not affect supply, higher taxes tend to stabilise both variables. In our model, instead, there exists a threshold level of taxation, call it \hat{t} , beyond which a further increase in taxes has perverse stabilisation effects. Hence, for $t < \hat{t}$, a rise in t entails a higher output stabilisation under supply shocks and higher inflation stabilisation under demand shocks. However, for $t > \hat{t}$ a rise in t is output-destabilising in the event of supply shocks and inflation-destabilising in the event of demand shocks. The expression of \hat{t} is the following:

$$(11) \quad \hat{t} = \frac{\omega \phi_1 - \alpha(1 + \beta \phi_2)}{2\alpha \phi_1} + \frac{\phi_6}{2\phi_1} \cdot \frac{\phi_2^* + (\omega^* - \alpha^* t^*)(1 + \phi_1^* t^* + \beta \phi_2^*)}{r_t^*}$$

26. Figure 2 pictures the case of a negative supply shock under “low” and “high” t . The initial equilibrium, E, corresponds to optimal levels of output (Y^*) and inflation. (π^*). The left panel shows that the slope of the demand curve is higher (in absolute terms) with a high t than with a low t . A supply shock induces a shift of the supply curve to the left. The new equilibrium point is now at A with a low t and at B with a high t . One can easily notice that the new equilibrium level of output is further away from the initial level with a low t than with a high t . The reverse emerges for inflation. Hence, in this case an increase in t from a low value to a high one is output stabilising but inflation destabilising.

Figure 2 The effects of a negative supply shock under alternative tax rates

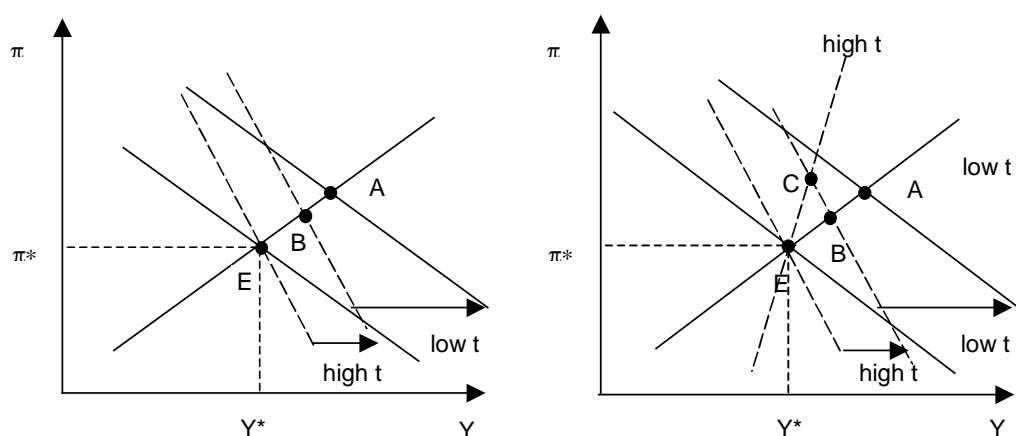


27. The increase of t may become, however, output destabilising if the supply curve also becomes steeper due to high taxation, as shown in the second panel. The new equilibrium point is now at C with a high t . It is clear from the graph that the new equilibrium level of output is further away from the initial level with a high t than with a low t . Inflation is always further away from its optimal level with a higher t .

28. Hence, in this case an increase in t from a low value to a high one is both output destabilising and inflation destabilising. The changes of taxation to become output-destabilising rise with the supply curve becoming steeper.⁸ On the other hand, the output destabilising-effect diminishes as the demand curve become steeper. Since the slope of both curves depends on the level of t , the threshold level for t beyond which further increase of taxation is destabilising for output in the event of a supply shock depends on the relative sensitivity of demand and supply to taxation. This, in turn, may be shown to depend on the openness of the economy: the more open the economy, the lower will be the fiscal demand multiplier and therefore the steeper will be the supply curve relative to the demand curve for a given tax burden. Therefore, small open economies are more likely to face adverse fiscal stabilisation properties in the face of a supply shock than larger, relatively closed economies for a given level of taxation.

29. The case of a positive demand shock is illustrated in Figure 3. Again, the figure pictures the cases under “low” and “high” t . The slopes of both demand and of supply are higher (in absolute terms) with a high t than with a low t . In both cases, the equilibrium, E, corresponds to optimal levels of output (Y^*) and inflation (π^*). A positive demand shock induces a shift of the demand curve to the right.⁹ The new equilibrium points when only the steeper demand curve is considered (left panel) are now at A with a low t and at B with a high t . The new equilibrium level of output is closer to the optimal level with a high t than with a low t . A similar picture emerges for inflation. Hence, in this case an increase in t from a low value to a high one is both output and inflation stabilising.

Figure 3 The effects of a positive demand shock under alternative tax rates



8. In the extreme case where the supply curve becomes vertical the shock would not be smoothed at all and output would fall by the same extent of the shock.

9. Note that the horizontal shift is smaller for higher t 's, as can easily be verified by substituting equation (8) in (5) and re-arranging:

$$y = \frac{1}{1 + \phi_1 t + \phi_4} \left[-\phi_2 (i - \pi^e) + \phi_3 (\pi - \pi^*) + \phi_4 y^* + \varepsilon^d \right]$$

30. Taking into consideration the possibility of the supply curve becoming steeper as well, automatic stabilisation may become, however, inflation destabilising. From the second panel in Figure 3, one can easily notice that this will still lead to a closer output to its optimal level but to a higher inflation. Hence, in this case an increase in t risks becoming inflation destabilising beyond a certain point if the slope of the supply curve is more sensitive to the tax burden than the slope of the demand curve.

31. In sum, through their impact on the supply side, higher automatic stabilisers can lead to a lower output stabilisation under supply shocks, and inflation stabilisation under demand shocks. In terms of policy behaviour, if we assume that fiscal authorities care mainly about output and the central bank about inflation, the risk of a policy conflict becomes more acute in the event of supply shocks and, contrary to the common wisdom, may occur also in the event of demand shocks. The results attained so far are summarised in Table 1.

Table 1. **Effect of a rise in taxes on output and inflation stabilisation**

Initial level of taxes	output		inflation	
	Below \hat{t}	Above \hat{t}	Below \hat{t}	Above \hat{t}
Shocks				
demand shock	–	–	–	+
supply shock	–	+	+	+

– stabilising effect
+ destabilising effect

32. From the above discussion, it emerges that the initial level of taxation is important in assessing the implications for stabilisation of tax and benefit reforms. For at “low” level of taxes, the traditional stabilisers are likely to dominate. However, under a “high” tax burden, a further increase in it may imply perverse stabilisation effects.¹⁰

3.2. Analysis of \hat{t}

33. The expression of \hat{t} in equation (11) is complex. Notice however that, under $\alpha=0$ (in which case taxes do not affect supply), \hat{t} is infinitely high implying that a rise in taxes is always output-stabilising under any type of shocks and inflation-stabilising in the case of demand shocks, as predicted by the traditional model.

10. Similar effects are found also by Galí (1994), in a real business cycle model. Wijkander and Roeger (2002) have also challenged the conventional wisdom that progressivity enhances stability. When comparing the stabilising potential of various components of the budget in France and Germany, these authors conclude that progressive direct taxes on income and wealth, might be less efficient stabilisers than less-distortionary taxation, such as proportional taxes on production.

34. The expression of \hat{t} can be streamlined considerably under a number of simplified assumptions. In the case of a closed economy ($\phi_6=0$), \hat{t} - call it \hat{t}_C - boils down to:

$$(12) \quad \hat{t}_C = \frac{\omega\phi_1 - \alpha(1 + \beta\phi_2)}{2\alpha\phi_1}$$

Lower distortions (that is a lower α) reduce the negative supply effects of taxation, thereby allowing to maintain higher stabilisers. The same effect is found in the case of a more effective fiscal policy (implying a higher ϕ_I). Interestingly, the threshold level of the tax rate above which fiscal policy is destabilising depends on the effectiveness of monetary policy (ϕ_2) and weight of output in the monetary rule (β): \hat{t} will be higher in countries where central bankers are more price-stability prone than in countries where the central bank is more concerned by output stability. A conservative central bank will choke off the inflationary effect of automatic stabilisers and thereby mute their potential for destabilisation. As a central bank focusing primarily on inflation induces a higher \hat{t} , this implies that the incentives to reform the tax system are lower under a conservative central banker, although incentives to reform the tax system on efficiency grounds would remain equally strong.

35. At the opposite side of the spectrum, we can consider a very small open economy in the monetary union, de facto not affecting either the large economy or the central bank ($\lambda=0$). This implies that the monetary policy coefficients and the parameters of the large economy disappear for the expression of \hat{t} . In this extreme case, the threshold level of taxation - call it \hat{t}_S - becomes.¹¹

$$(13) \quad \hat{t}_S = \frac{\omega\phi_1 - \alpha(1 + \phi_4)}{2\alpha\phi_1}$$

Ceteris paribus, a larger openness of the economy (*i.e.* a higher ϕ_4) reduces the threshold level of taxation. The reason is that the demand effects of automatic stabilisers leak out via foreign trade, thereby implying that the negative supply effects arise more quickly, at a lower level of taxation. This, however, does not mean that \hat{t}_S is necessarily smaller than \hat{t}_C : as shown by comparing (12) and (13), that depends on the relative size of the monetary smoothing compared to the foreign trade smoothing. It is therefore an empirical question to which we turn in the next two sections.

4. Are automatic stabilisers stabilising? Demand versus supply effects

36. In order to support our theoretical analysis, this section illustrates the interplay of demand and supply effects of automatic stabilisers, by means of simulations for standard asymmetric demand and supply shocks with the OECD's INTERLINK model. We are particularly interested in the following question: can "sign switches" as shown in table 1 be demonstrated with a mainstream empirical economic model like INTERLINK? Our answer is affirmative.

11. Notice that in this particular case, the trade consistency condition (9) does not hold exactly. This can be rationalised if we consider the rest of the currency area as composed of a large number of countries each one being affected in a negligible way by the foreign trade imbalances of the small (home) economy.

37. We compare a typical small open and a typical large economy in the euro area, on the assumption that, for a given tax burden, the sign switch is more likely to occur for the small economy than for the large one. For this purpose we chose Belgium and France, which have similar fiscal sizes (close to 50 per cent to GDP) but a very different degree of openness. We have modified the supply block of Belgium to bring its structure in line with that of the G7 economies in order to enhance the cross-country comparability (see also Hoeller *et al.*, 2002). The favourable demand shock is a once-and-for all increase in private consumption and exports equivalent to ½ per cent of baseline GDP each and the adverse supply shock is a once-and-for all 1 per cent decrease in labour efficiency. In all simulations monetary policy is assumed to respond according to a Taylor rule whereby interest rates are raised above their equilibrium level if either inflation rises above a target of 1½ per cent or the output gap turns positive. The weights attached to inflation and the gap are fixed at 1.2 and 0.2, respectively, and the equilibrium interest rate is set at 4 per cent. These parameter values are in line with recent studies of the ECB's monetary policy reaction function (see von Hagen and Brückner, 2001). In the case of an asymmetric shock, the weights are multiplied by the Belgian and French shares in euro-area GDP of around 4 and 20 per cent, respectively.

38. The simulations are depicted in Table 2. The results are shown for three different "regimes":

- automatic stabilisers switched off;
- automatic stabilisers switched on; and
- automatic stabilisers switched on, but with the wage responsiveness to unemployment reduced by a factor corresponding to the ratio $(1-\gamma\zeta t)/(1-\gamma t)$; see Annex II).

39. The total impact of automatic stabilisers is measured by the differences between the simulations under the second and first regimes. The simulations under the third regime allow a breakdown of the total impact into demand and supply effects. Specifically, the differences between the simulations under the second and third regimes measure the impact of automatic stabilisers as they operate through the supply channel. Conversely, the differences under the third and first regime represent the impact of automatic stabilisers as they operate through the demand channel. We will discuss the results for each of these three regimes in more detail below.

4.1. The automatic stabilisers switched off

40. In a first set of simulations fiscal stabilisers have been 'switched off' by ensuring that the primary fiscal balance (as a per cent of GDP) always stays at its baseline level. In practical terms this means that the standard supply or demand shock is complemented by a discretionary fiscal policy shock that exactly offsets the endogenous changes in the primary balance stemming from the standard shock. This simulation thus gauges the economy's response to a standard demand or supply shock in the absence of automatic fiscal stabilisers.

41. As expected, under an asymmetric demand shock, real output initially increases relative to baseline, but over time converges towards baseline. This reflects the tendency of actual output to return to potential, which in itself is largely unaffected by the demand shock. The boost to inflation is, in contrast, relatively persistent. Even though the automatic stabilisers are switched off, the fiscal balance (not shown in the table) improves a bit, owing to the initial increase in output and the associated reduction in debt-interest expenditure relative to output. Interest rates increase somewhat initially, but not by enough to result in adverse public debt dynamics.

Table 2. The smoothing impact of automatic stabilisers and the nature of shocks
Changes from baseline

Year	Demand shock ¹						Supply shock ²					
	GDP level (%)			Inflation rate (% points)			GDP level (%)			Inflation rate (% points)		
	1st	2nd	5th	1st	2nd	5th	1st	2nd	5th	1st	2nd	5th
Typical small economy³												
Automatic stabilisers switched:												
A. Off	0.6	0.7	-0.1	0.1	0.5	1.3	-0.1	-0.1	-0.2	0.7	-0.1	0.0
B. On	0.6	0.6	0.0	0.1	0.5	1.4	-0.1	-0.1	-0.2	0.7	-0.1	0.2
C. On, no supply effect	0.6	0.6	0.1	0.1	0.4	1.3	-0.1	-0.1	-0.1	0.7	-0.1	0.1
Total impact (B-A)	-0.1	-0.1	0.2	0.0	0.0	0.1	0.0	0.0	-0.0	0.0	0.1	0.1
Demand impact (C-A)	-0.1	-0.1	0.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Supply impact (B-C)	0.0	0.0	-0.1	0.0	0.1	0.1	0.0	0.0	-0.1	0.0	0.1	0.1
Typical large economy⁴												
Automatic stabilisers switched:												
A. Off	0.9	0.9	0.4	0.1	0.6	0.9	-0.3	-0.4	-0.9	1.4	0.7	0.4
B. On	0.7	0.7	0.4	0.1	0.5	0.8	-0.2	-0.3	-0.8	1.4	0.8	0.5
C. On, no supply effect	0.7	0.7	0.4	0.1	0.5	0.7	-0.2	-0.3	-0.7	1.4	0.7	0.5
Total impact (B-A)	-0.2	-0.2	-0.0	0.0	-0.1	-0.1	0.0	0.0	0.2	0.0	0.1	0.2
Demand impact (C-A)	-0.2	-0.2	0.0	0.0	-0.1	-0.2	0.0	0.0	0.2	0.0	0.0	0.2
Supply impact (B-C)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0

1. A ½ per cent of GDP sustained increase in private consumption and exports.

2. A 1 per cent sustained reduction in labour efficiency.

3. Belgium

4. France.

Source: OECD Secretariat.

42. After an asymmetric supply shock, again as expected, output falls relative to baseline in the short-to-medium run, but this decline is more persistent as potential output falls in concert (the output gap, however, converges to zero). The inflation rate initially sharply increases in response to the hike in unit labour cost, but this effect is gradually eroded as the price level stabilises relative to baseline. It is noteworthy that the inflation effect is much stronger in the large economy, which is expected as the lower import share in demand boosts the cost-price multipliers.

4.2. The automatic stabilisers switched on

43. In a second set of simulations, discretionary fiscal policy responses are removed, allowing the primary budget balance to move freely in response to the variations in economic activity relative to baseline. Comparing these simulations with the previous ones gives an impression as to the extent by which the economic impact of demand or supply shocks is changed by the working of automatic fiscal stabilisers.

44. Not surprisingly, the impact of the demand shock on output is muted by the automatic stabilisers, with, however, the mitigating impact twice as strong in the larger country as compared to the smallest country. The same holds for the impact of the demand shock on inflation. So, these simulations broadly confirm the presumption that automatic stabilisers matter less in a small open economy. In response to the adverse supply shock, output is again falling, but the automatic stabilisers now ensure this fall to be somewhat smaller in the large economy, but not in the small economy where the impact of the automatic stabilisers on output is perverse as predicted by the theoretical model. In both countries inflation increases

by a bit more than compared with a situation where automatic stabilisers are not allowed to operate, confirming that the inflation impact of the automatic stabilisers is perverse in response to a supply shock in both cases.

45. The upshot of these simulation results is that the tax burden must be close to or just beyond its "critical level" in the smallest economy, whereas in the larger economy it is found to be below this critical level. Put differently, and generalising the results, in a typical small economy the critical tax burden would be roughly half of GDP or less, while in a typical large economy it would be more than half of GDP.

4.3. Disentangling the supply-side and demand-side channels

46. In the third set of simulations, we again allow the automatic stabilisers to work freely, but in addition assume the unemployment responsiveness of wages to be lower. In particular, we assume that the semi-elasticity of wage growth with respect to the level of unemployment falls by allowing for the impact of tax progression on wage responsiveness, as explained in section 2 above, in both countries.

47. As the results in table 2 show, the impact of an asymmetric demand shock on output is somewhat muted by the supply-effect of the automatic stabilisers, but the impact is very small and the demand channel clearly dominates. Meanwhile the supply channel reduces the stabilising impact on prices, and in the case of the smaller country is responsible for changing it into a *destabilising* impact. Concerning the adverse supply shock, the supply channel is entirely responsible for boosting the adverse output impact in the small country. By contrast, the supply impact on output is virtually zero in the larger country, explaining why the stabilisation properties of automatic stabilisers on output are preserved. The supply channel is also responsible for the perverse inflation impact in the case of a demand shock affecting the small country.

48. In conclusion, the sign switches that compromise the stabilising impact of automatic stabilisers on inflation and output in a small open economy in response to, respectively, a demand or a supply shock, are entirely due to the operation of the supply channel.

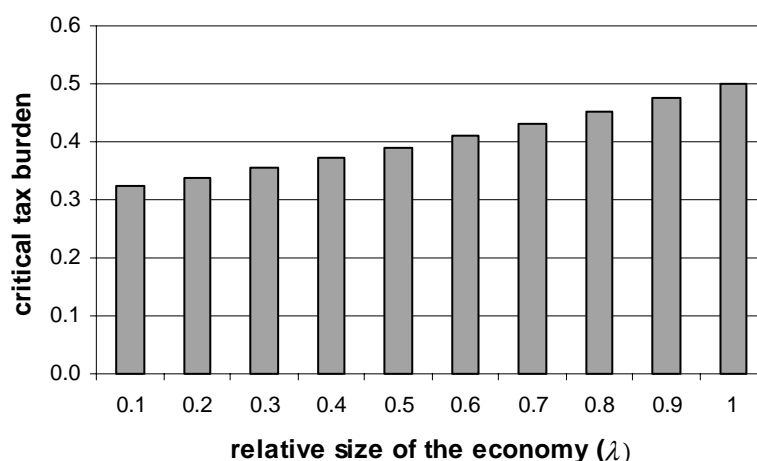
5. How large is \hat{t} ? A numerical analysis

49. The econometric simulations in section 4 seem to indicate that the de-stabilising supply side effects are more likely to prevail in small open economies. However, they do not allow us to quantify \hat{t} . While a fully-fledged analysis is well beyond the scope of this paper, we can nonetheless provide some tentative indication of the possible values of \hat{t} . It goes without saying that these exercises are purely illustrative and one should refrain from drawing policy conclusions from the simple comparison of the estimated \hat{t} with the actual tax burden in euro-area economies. Nevertheless, these calculations are helpful in exemplify our reasoning.

50. We proceed by parametrizing the model attributing reasonable values to the coefficients, broadly in line with the estimated parameters of INTERLINK. In Annex II, we report the chosen the value of the coefficients and, in particular, explain the way in which those related to the supply elasticity are computed. The calculations for the value of \hat{t} are presented in Table 3.

Table 3. Threshold values of taxation

Size	Baseline	Lower β	$\lambda=0.5$	Lower ϕ_1	Lower ϕ_2	Lower t^*	Lower α
Closed	0.45	0.48	-	0.39	0.46	-	0.50
Large	0.41	0.43	Avg size 0.39	0.35	0.43	0.41	0.46
Small	0.31	0.33	Avg size 0.39	0.24	0.35	0.32	0.37

Figure 4 The critical tax burden as λ rises

Note: For the values of the parameters, see Annex II.

51. First of all, we concluded the previous section noting it is not clear in theory whether \hat{t} would be higher in small economy or in an open economy. As shown in the table, empirically, \hat{t} appears to be higher the larger the economy. This implies that the larger the economy, the larger will be the demand impact of automatic stabilisers relative to the supply impact. Hence a large country could "afford" a higher tax burden without jeopardising the stabilisation properties of automatic stabilisers — *i.e.* the higher \hat{t} would be. This result suggests that, in small open economies, adverse stabilisation effects may occur at a size of government that is considerably smaller. Figure 4 shows how the threshold level of taxation increases with the size of the country.

52. As pointed out above, a more "hawkish" central banker (that is a lower β) increases \hat{t} and so does a less effective monetary policy (lower ϕ_2): in both cases, the smaller monetary smoothing allows for a higher smoothing via fiscal policy, thereby pushing away the threshold beyond which supply-side effects dominate. The effect however appears to be relatively small if we assume that the central bank's main priority remains inflation control.

53. Reforms reducing the supply effects of taxes (that is a lower α) allow to maintain a higher tax burden without triggering adverse supply side effects. A reduction in the tax burden in the foreign country tends to increase \hat{t} in the domestic country, meaning that countries may have an incentive to free-ride on each other's reforms. This effect however is non-negligible only in the case of reforms enacted in the larger country.

6. Conclusions

54. This paper challenges the conventional view that high and progressive tax systems are efficiency-decreasing but enhance output stabilisation in the event of shocks.

55. *Ceteris paribus*, progressive tax systems lead to a lower budget deficit (contraction of fiscal policy) in good times, while the deficit would increase in recessions (fiscal expansion). Moreover, large and progressive tax systems usually go hand in hand with more generous systems of social protection. Although social benefit programmes mainly have an equity role, as well as potential efficiency effects when they correct market failures, some of them also act as automatic stabilisers. Unemployment benefits make up the clearest example. Since distorting taxes have a pervasive impact on potential growth, a trade-off between stabilisation and efficiency seems to arise within the standard AD-AS framework. If there is a positive relationship between the size of automatic stabilisers and distortive taxation, any reform aiming at lowering distortions and enhancing efficiency will come at the expense of macroeconomic stability.

56. This issue is at the heart of macroeconomic policy design in EMU. If, as suggested by the standard model, there were a trade off between stability and flexibility, EMU members — having given up national monetary independence — would not dispose of enough policy instruments to deal with idiosyncratic shocks.

57. However, this paper suggests that under certain circumstances such a trade-off might not exist. As marginal tax rates increase in progressive regimes so do average rates. Within our model, rising tax rates enhance market distortions and reduce the output stabilisation in the event of supply shocks and inflation stabilisation in the event of demand shocks. The numerical and econometric simulations presented above tend to support this view.

58. If our conclusions are right, unless there is a clear predominance of demand over supply shocks, one should not worry about the possible adverse effects on stabilisation of the tax reforms that across the EU are lowering marginal and average tax rates across the whole income scale (European Commission 2000a and b, 2001).

59. It goes without saying that the analysis in this paper is far from saying the last word on the relations between efficiency and flexibility, on the one hand, and cyclical stabilisation, on the other hand. Obvious improvements concern the theoretical model (which is overly simple and static in nature) and the description the behaviour of policy makers. Moreover, the empirical evidence is still tentative and should be supplemented by more thorough econometric investigation.

60. An issue that arises naturally is the apparent contradiction between our conclusion that adverse stabilisation effects may arise at lower levels of taxation in smaller economies and the finding that small, open economies tend to have larger governments (see the seminal contribution by Rodrick (1998), and, recently, Martinez-Mongay (2002)). Two explanations can be offered. First, whatever their initial level, higher taxes are output-stabilising in the event of demand shocks. Hence, if output stabilisation is the main goal of fiscal authorities and demand shocks (are expected to) prevail, larger governments would ensue. However, EMU may bring a change in the composition of shocks by increasing the relative frequency of

supply compared to demand shocks.¹² If so, large automatic stabilisers may no longer be optimal. Second, to the extent the tax burden remains below \hat{t} , a rise in it is stabilising, although increasingly less so. This, coupled with a higher exposure to shocks, may imply larger governments in small open economies. Econometric analyses based on past data may capture this effect. However, in recent years, t may have reached or even exceeded \hat{t} .

61. Our analysis indicates that tax reforms aiming at lowering marginal effective tax rates and the tax burden may enhance the stabilisation properties of automatic stabilisers, especially in small euro area economies. Hence they face a lesser dilemma between structural reform and stabilisation policy. This may contribute to explain their greater reform efforts and better performance compared with the big “laggards”. However, to the extent that EMU brings about greater trade integration, the incentives to step up reform efforts would increase also in the large euro area countries.

12. Buti, Pench and Sestito (1999) argue that EMU's macroeconomic framework could lead to less policy-induced demand shocks while the increase in market competition brought about by the euro could entail more supply-related shocks.

ANNEX I

ALGEBRA

We are interested in analysing the effects of a change in t on the degree of stabilisation in the event of shocks. Consider first a country-specific *supply shock* in the home country ($\varepsilon^s \neq 0$, $\varepsilon^d = 0$).

In order to check the effect of a change in the size of the automatic stabilisers, we take the partial derivative of (10) w.r.t. t to find:

$$(A1) \quad \frac{\partial y}{\partial t} = -\phi_2 \varepsilon^s \left[\frac{r_t^* r_t - (\omega - \alpha)(\omega^* - \alpha^* t^*) \phi_6 \phi_6^*}{r_t^*} \right]^{-2} \left[\phi_1 (\omega - \alpha) - \alpha (1 - \phi_6 + \phi_1^t + \beta \phi_2) \frac{\alpha (\omega^* - \alpha^* t^*) \phi_6 \phi_6^*}{r_t^*} \right]$$

An increase in t is stabilising if the coefficient of ε^s in (A1) is negative. The sign however is ambiguous and depends on the size of t . The threshold level of t is found in the text (equation (11))

In the case of inflation, we find:

$$(A2) \quad \frac{\partial \pi}{\partial t} = -\frac{\phi_2 \varepsilon^s}{(\omega - \alpha)^2 B^2} \left[\phi_1 (\omega - \alpha)^2 + \frac{\alpha (\phi_2 - B)^2}{\phi_2} \right]$$

$$\text{where } B = \left[\frac{r_t^* r_t - (\omega - \alpha)(\omega^* - \alpha^* t^*) \phi_6 \phi_6^*}{r_t^*} \right].$$

Since the coefficient of ε_d is always positive, an increase in t is inflation-destabilising.

We turn now to the case of a *demand shock* in the home country ($\varepsilon^s = 0$, $\varepsilon^d \neq 0$). The partial derivative of output w.r.t. t yields the following expression:

$$(A3) \quad \frac{\partial y}{\partial t} = -\varepsilon^d \left[\frac{r_t}{\omega - \alpha} - \frac{(\omega^* - \alpha^* t^*) \phi_6 \phi_6^*}{r_t^*} \right]^{-2} \left[\frac{\alpha \phi_2}{(\omega - \alpha)^2} + \phi_1 \right]$$

As the coefficient of ε^d is negative, increasing t is always output-stabilising in the event of a demand shock.

Turning to inflation, we find:

$$(A4) \quad \frac{\partial \pi}{\partial t} = \frac{\varepsilon^d}{(\omega - \alpha)^2 C^2} \left[2\alpha\phi_1 t + \alpha(1 - \phi_6 + \beta\phi_2) - \omega\phi_1 - \frac{\alpha(\omega^* - \alpha^* t^*)\phi_6^*\phi_6}{r_t^*} \right]$$

$$\text{where } C = \left[\frac{r_t}{(\omega - \alpha)} - \frac{(\omega^* - \alpha^* t^*)\phi_6^*\phi_6}{r_t^*} \right]$$

The sign of the derivative may be positive or negative depending on t . Again, we find the same expression of equation (10) in the text: if $t < \hat{t}$ a rise in t is inflation-stabilising while for $t > \hat{t}$ a rise in t is inflation-destabilising. Again, as in the standard case, if the slope of the supply function is not affected by taxes ($\alpha=0$), a rise in taxation is always price-stabilising (reduces the deviation of inflation from target) in the event of a demand shock.

ANNEX II

QUANTIFYING THE PARAMETERS OF THE MODEL

The numerical calculations in section 5 are carried out by attributing values to the parameters which are broadly in line with those of INTERLINK. In the baseline scenario, we made the following assumptions: $\phi_1=1$; $\phi_2=0.5$; $\phi_3=\phi_4=0.75$ for the small country and 0.25 for the large country, and intermediate values in the case of identical countries; $\lambda=0.8$, $1-\lambda=0.2$; $t^*=0.5$; $\beta=0.2$. As to the sensitivity analysis, the following set of parameters have been used: $\phi_1=0.9$, $\phi_2=0.4$, $\beta=0.1$.

The most challenging task is to quantify ω and α in the supply function. We proceeded as follows.

In order to get rid of the unemployment rate in equation (4) we make use of Okun's law, which says that the output gap must be twice the cyclical unemployment rate:

$$(B1) \quad y^s = -2(u - u^*)$$

Hence equation (4) can be rewritten as:

$$(B2) \quad y^s = 2\chi \frac{(1 - \gamma\xi t)}{(1 - \gamma)} (\pi - \pi^e)$$

Now, let us go back to the supply equation (we leave out the shock term).¹

$$(B3) \quad y^s = (\omega - \alpha)(\pi - \pi^e)$$

A reasonable empirical value for the unemployment semi-elasticity in the Phillips curve is around $\frac{2}{3}$. Now for an economy where the average tax rate t is close to $\frac{1}{2}$ and the tax elasticity $\xi = 1\frac{1}{4}$ we find that χ must be equal to 2, under $\gamma=1$ (see table below). In other words, the semi-elasticity of wages with respect to unemployment declines from $\frac{3}{4}$ to $\frac{1}{2}$ if taxes became lump sum. Assuming lump sum taxes, *i.e.* $t=0$, equation (14) collapses into:

$$(B4) \quad y^s = 4(\pi - \pi^e)$$

1. There are two qualifications to make. First, the t in (A3) referred to all distorting taxes while the t that enters the Phillips curve refers to taxes paid by wage earners, comprising consumer, income and social security tax, hence excluding taxes on wealth and capital income. However, if the tax yield on capital is relatively small and its effective rate (*i.e.* tax paid on the real return on capital) not too different from that on wage income, the t s are approximately the same. Second, in a purely proportional tax system, the percentage changes in net and gross wages are always the same and hence the distortion would not occur. If taxes are proportional, they would still be distorting, but this would not affect the slope of the supply curve, just its position.

In other words, $\omega=4$. Similarly, for $t=1/2$ we find $\omega=3$ which corresponds to the mid range of estimates reported in Clarida, Galí and Gertler (1998). This means that $\alpha t=1$, which for $t=1/2$ implies that $\alpha=2$ which is the value retained in our baseline scenario. However, if lower values for the rate of wage resistance are adopted, the value of α declines. In the extreme case where there is no wage resistance at all ($\gamma=0$), α is nil. This makes perfect sense: since workers would not be able to pass through the effect of tax progression onto employers, taxation has no impact on wages or prices. In the sensitivity analysis, the selected value of α is 1.9.

Quantifying the parameters of the aggregate supply curve¹

γ	1	0.75	0.5	0.25	0
ξ	1.25	1.25	1.25	1.25	1.25
χ	2	1.76	1.64	1.56	1.5
ω	4	3.53	3.27	3.11	3
$\omega - \alpha.t$	3	3	3	3	3
α	2	1.06	0.55	0.22	0

1. Phillips curve semi-elasticity equals $-2/3$ and tax burden equals $1/2$.

The critical tax burdens shown in Figure 4 have been calculated on the basis of the following sets of parameters:

ϕ_1	1	1	1	1	1	1	1	1	1	1
ϕ_2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ϕ_3	0.75	0.688	0.625	0.562	0.5	0.437	0.375	0.313	0.25	0.25
ϕ_4	0.75	0.688	0.625	0.562	0.5	0.437	0.375	0.313	0.25	
ϕ_1^*	1	1	1	1	1	1	1	1	1	
ϕ_2^*	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
ϕ_3^*	0.25	0.313	0.375	0.438	0.5	0.563	0.625	0.688	0.75	
ϕ_4^*	0.25	0.313	0.375	0.438	0.5	0.563	0.625	0.688	0.75	
ϕ_5	-1	-1	-1	-1	-1	-1	-1	-1	-1	
ϕ_5^*	-1	-1	-1	-1	-1	-1	-1	-1	-1	
ϕ_6	-0.45	-0.4	-0.35	-0.3	-0.25	-0.2	-0.15	-0.1	-0.05	
ϕ_6^*	-0.45	-0.4	-0.35	-0.3	-0.25	-0.2	-0.15	-0.1	-0.05	
β	0	0	0	0	0	0	0	0	0	0
ω	4	4	4	4	4	4	4	4	4	4
α	2	2	2	2	2	2	2	2	2	2
t	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ω^*	4	4	4	4	4	4	4	4	4	
α^*	2	2	2	2	2	2	2	2	2	
t^*	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
λ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
r_t	6.35	6.2	6.05	5.9	5.75	5.6	5.45	5.3	5.15	
r_t^*	6.35	6.2	6.05	5.9	5.75	5.6	5.45	5.3	5.15	
\hat{t}	0.32	0.34	0.36	0.37	0.39	0.41	0.43	0.45	0.48	0.50

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