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THE WELFARE STATE AND
COMPETITIVENESS

Alberto Alesina
Roberto Perotti

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ABSTRACT

In all modern industrial countries, redistributive expenditures are a larger component of the government budget than consumption of goods and services. In this paper, we use a general equilibrium, two-country model with exportables, importables and nontradables to study redistribution across different types of agents in a world characterized by the presence of labor unions and distortionary taxation. We show that an increase in transfers to, say, retirees, financed by distortionary taxation, can generate a loss of competitiveness (defined as an increase in relative unit labor costs for tradable goods), an appreciation of the relative price of nontradables, and a decrease in employment in all sectors of the domestic economy. The same qualitative effects would also obtain in the case of an increase in transfers towards the unemployed even if financed by non-distortionary taxation. Moreover, all these effects of labor taxation depend in a nonlinear way on the degree of centralization of the wage setting process in the labor market. We then estimate the effects of labor taxation on unit labor costs and the relative price of nontradables in a sample of 14 OECD countries. We find considerable empirical support for the model.

Alberto Alesina
Department of Economics
Harvard University
Cambridge, MA 02138
and NBER

Roberto Perotti
Department of Economics
Columbia University
420 W. 118 St., 10th floor
New York, NY 10027

1 Introduction.

Fiscal policy in industrialized countries is largely about redistribution. Table 1 shows that in the European Community the share of government outlays which can be classified as redistributive was less than government purchases of goods and services in 1960, but it was significantly larger in 1988. Indeed, policymakers struggling with fiscal reforms in OECD countries have to deal primarily with redistributive issues, both within and across generations.

What are the costs of redistribution? A common view in Europe is that the burden of the "welfare state" causes losses of competitiveness.¹ The use and meaning of the word "competitiveness" have recently been questioned on several grounds. Because we define this word without any ambiguity as relative unit labor costs (or, equivalently, as relative price of imports), we feel free to continue to use it despite its academic unpopularity. Moreover, regardless of how they are expressed, the widespread concerns about the effects of redistributive expenditure and of distortionary taxation should not be dismissed too lightly. Despite this, fiscal policy in existing international macro models is concerned mainly with the role of government consumption financed by lump-sum taxation or deficits.² For example, in the *Handbook of International Economics* we could not find a single mention of any other type of fiscal policy.

In this paper we study theoretically and empirically the effects on competitiveness of redistribution financed by distortionary taxation. In order to study this issue we use a two-country model with three main characteristics. First, since we study redistribution, we need to abandon the representative agent world. Thus, we consider a model with three types of agents: employers and workers (some of whom can be unemployed in equilibrium), who together form the productive sector of the economy, and a sector of unproductive individuals, whom we call retirees. We consider redistribution from the productive to the unproductive sector as well as within the productive sector from employed to unemployed

¹For instance, the recent coverages of the Financial Times and the New York Times on European welfare systems have strongly emphasized this point.

²Among the contributions that constitute an exception to this statement, see especially Frenkel and Razin (1987) for a general theoretical treatment of inter-generational redistribution and distortionary taxation in open economies.

Table 1: Government purchases of goods and services and social expenditure in the EEC, as shares of GDP.

	soc. exp. 1960	govt. cons. 1960	soc. exp. 1988	govt. cons. 1988
Belgium	12.3	12.4	27.7	15.2
Denmark	11.1	13.3	29.3	12.57
France	11.7	14.2	28.1	18.5
Germany	13.5	13.4	28.3	19.7
Ireland	10.4(*)	22.4	12.5	16.4
Italy	10.6	12.0	23.1	16.9
Luxembourg	13.1	9.8	26.2	16.3
Portugal	5.5	10.5	17.0	16.0
Spain	4.0	8.3	17.2	14.8
United Kingdom	10.9	16.4	22.1	19.7
average	10.4	12.3	24.7	17.7

(*): 1966. Sources: EUROSTAT (social expenditure) and OECD (government consumption). Social expenditure includes the following types of benefits: sickness; invalidity/disability; employment injury; old age; survivors; maternity; family; unemployment; vocational training; housing.

members of the labor force, both hotly debated issues in many OECD countries.

Second, we consider unionized labor markets. In the presence of unions both types of redistributions we analyze (to unemployed workers and to retirees) have important effects on the cost side of firms because of the use of distortionary taxation to finance the government budget: taxes on labor (income, social security or payroll taxes) affect labor costs and therefore profitability and competitiveness, to the extent that they are not borne entirely by workers. This point is hardly new, but it has received much more attention in policy debates than in academic contributions. In fact, under a common set of assumptions in the literature, i.e. competitive labor markets with inelastic individual labor supplies, these taxes would be completely borne by workers and would have no aggregate effects. By contrast, in the presence of unions the burden of labor taxation will be borne in part by employers and will therefore increase labor costs *even if the individual labor supply is perfectly inelastic*.

The third feature of our model is that we consider differentiated goods produced by monopolistically competitive firms. With differentiated goods, we can have different sectors in the economy. This allows us to study how different types of labor markets influence the effects of fiscal policy. The characteristic of labor markets we focus on is their degree of centralization, defined as the inverse of the number of unions in the economy: in more centralized labor markets, workers are represented by fewer unions, each encompassing more sectors. The degree of centralization is an important determinant of the effects of fiscal policy because large unions can better internalize the negative employment effects of their wage demands, but they also have more monopoly power. Thus, how much wages increase in response to an increase in labor taxation depends on the degree of centralization of labor markets.

The basic idea of the paper is as follows. An increase in, say, income taxes used to finance redistribution to retirees and/or unemployed workers induces the labor unions to increase wage pressure. This effect is magnified if the redistribution to the unemployed increases the union's reservation wage. The increased wage pressure is reflected in higher output prices and therefore induces a loss of competitiveness (the relative price of imports to exports). In turn, the loss of competitiveness causes a reduction in the demand for

exports and a fall in employment in the exportable sector. The same chain of events - from higher wages to higher prices and lower employment - leads to a fall in employment in the nontradable sector. In fact, the price of nontradables increases even more than that of tradables because the former do not face any foreign competition.

We also show that the distortions caused by fiscal policy are a non-linear function of the degree of centralization of labor markets. Intuitively, as the degree of centralization increases and the typical union becomes larger, the monopoly power of each union increases and fiscal policy becomes increasingly distortionary. At some point, however, the unions will become large enough to internalize the negative repercussion effects on demand and employment of an increase in the wage via the current account equilibrium condition. This will induce the union to moderate its wage claims, and the more so the larger it is. Thus, as the degree of centralization increases, the distortionary effects of fiscal policy first increase, then decrease.

The empirical part of the paper tests several of these implications by considering the effects of labor taxation on competitiveness and the relative price of nontradables. In a panel of 14 countries for the period 1960-1990, we find that the results are supportive of our theory. For instance, we find that, when taxes on labor increase by 1% of GDP, unit labor costs in countries with an intermediate level of centralization increase by up to 3% relative to competitors. Labor taxation also has significant negative effects on profit margins and positive effects on the relative price of nontradables. Furthermore, the effects of taxation are indeed a hump-shaped function of the degree of centralization, peaking in countries with an intermediate level of centralization. All these results appear to be quite robust, and the values of the coefficients on the tax variables are generally very stable.

Our paper is related to three quite different strands of research. In international macroeconomics, the study of the effects of fiscal policy in open economies has typically focused on the role of government purchases of goods and services and on its effects on the relative price of nontradables. An extension of the Balassa (1964) model to include the government sector shows that an increase in government spending on goods and services, falling more heavily on labor-intensive nontradable goods, leads to an appreciation of the relative price of nontradables via an increase in the demand for labor. Recent research by Froot and

Rogoff (1991), De Gregorio, Giovannini and Krueger (1993) and De Gregorio, Giovannini and Wolf (1993) finds, to different degrees, empirical support for this theory.

At the intersection of public finance and labor economics, several contributions have looked at the effects of taxation on wages and costs, particularly in closed economies. Examples of these contributions are Knoester and van der Windt (1987) and Padoa-Schioppa (1990). The latter, in particular, is an antecedent to our approach in that it studies the role of labor unions in the shifting of the burden of taxation. An earlier and more general reference for an analysis of this class of problems is Bruno and Sachs (1985).

Finally, our paper is related to the large literature on corporatism, unionization and macroeconomic performance. Calmfors and Drifill (1988) and Freeman (1988) present empirical evidence on the existence of a hump-shaped relation between the degree of centralization in labor markets and unemployment. A large theoretical body of literature has put forward various explanations for this relationship: among others, Calmfors and Drifill (1988), Hoel (1991) and Holden and Raaum (1992) are somehow related to our explanation, which, to our knowledge, remains novel in its emphasis on the effects of the external constraint on the behavior of unions. The list above is far from complete, however: Calmfors (1993) provides an exhaustive survey of the literature on the topic. The closest antecedent to our paper is probably Summers, Gruber and Vergara (1993), who study the relationship between the degree of centralization in labor markets and the effects of distortionary taxation on labor supply decisions.

The paper is organized as follows. Section 2 describes the model. Section 3 presents the main results for the case of two unions in the economy, one per sector. Section 4 shows how the results vary with the number of unions in the economy. In these two sections, we only provide the main intuitions for our results and sketch the solution of the model. A more detailed exposition of the results and all the proofs are in the Appendix. The reader mostly interested in the theory should read this Appendix, which instead can be skipped by the reader mostly interested in the empirical results. Section 5 presents our empirical results. The last section concludes.

2 The model.

2.1 The structure of the economy.

We consider a world composed of two countries that produce traded and non traded goods. In each country, the tradable sector is composed of a total mass 1 of firms, each producing a differentiated good with a constant returns to scale technology, $y(i) = n(i)$, where i refers to the i -th firm and $n(i)$ is employment in the i -th firm in the tradable sector. Similarly, the nontradable sector is composed of a mass 1 of firms, each producing a differentiated good with the same technology: $\bar{y}(i) = \bar{n}(i)$, where a "̄" indicates a non traded good.

We assume, for simplicity, that there are no fixed costs in production. Thus, if we allowed for free entry, the equilibrium number of firms would be indeterminate in this model. Since these issues are not the focus of this paper, we assume that in both countries there is a fixed number of firms each producing a different good.³

Individuals in the home country have the following homothetic preferences over consumption of tradable and nontradable goods (see Dixit and Stiglitz (1977)):

$$U = \left(\int_0^1 \bar{C}(i)^{\frac{1}{\lambda}} di \right)^{\frac{\lambda}{\lambda-1}} \left(\int_0^1 C(i)^{\frac{1}{\lambda}} di + \int_0^1 C^*(i)^{\frac{1}{\lambda}} di \right)^{\frac{\lambda}{\lambda-1}} + (1 - \delta)R, \quad \lambda > 0 \quad (1)$$

In this expression, $\bar{C}(i)$ denotes consumption of the i -th domestic variety of non traded goods, $C(i)$ denotes consumption of the i -th domestic variety of traded goods ("exportables" from now on) and a * denotes a foreign variable, so that $C^*(i)$ is consumption of the i -th foreign variety of traded goods ("importables"). λ is related to the elasticity of substitution between two varieties of traded or non traded goods, σ , through the formula $\sigma = \lambda/(\lambda - 1)$. R is the utility of leisure, and δ is an indicator variable that takes the value of 1 if the individual works and 0 if he does not work. A symmetric expression holds for the utility function of an individual in the foreign country.

According to this utility function, each individual allocates half of his income to the consumption of non traded goods and half to the consumption of traded goods. How much of this second half is devoted to the consumption of exportables depends on their price relative to importables.

³We will discuss these issues later in section 5, where we allow for fixed costs of production.

From the utility function (1) one can derive a dual expression for the price index of nontradables \bar{P} , and tradables, P (see Dixit and Stiglitz (1977)):

$$\bar{P} = \left[\int_0^1 \bar{p}(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}}; \quad P = \left[\int_0^1 p(i)^{1-\sigma} di + \int_0^1 p(i)^{*1-\sigma} di \right]^{\frac{1}{1-\sigma}}; \quad (2)$$

Because of the unit elasticity of substitution between tradables and nontradables, the domestic CPI, \bar{P} , is equal to $P^{\frac{1}{2}} \bar{P}^{\frac{1}{2}}$, and, similarly, the foreign CPI, \bar{P}^* , is equal to $P^{*\frac{1}{2}} \bar{P}^{*\frac{1}{2}}$.

Three different types of agents live in each country: workers, entrepreneurs, and a class of unproductive agents that we call "retirees" as a shortcut. The total mass of workers is $2\bar{n}$. The total mass of entrepreneurs is 2, each owning a firm for the production of a differentiated good. Hence, a total mass 1 of entrepreneurs own a technology for the production of a tradable good, while another total mass 1 own a technology for the production of a nontradable good. Finally, there is a total mass \bar{m} of retirees whose only source of income is a social security benefit. This last class captures what we think is an important feature of modern industrialized countries, namely the existence of a large constituency of agents whose main stake in fiscal policy is to maximize redistribution.

2.2 Fiscal policy.

We consider both redistribution from the productive sector to the unproductive sector ("retirees"), and within the productive sector, from employers and employed workers to unemployed workers. Both policies alter the distribution of income. However, this redistribution *per se* does not affect either the size or the composition of demand, since all agents have the same propensities to spend on the different types of goods. Therefore, all the effects of fiscal policy occur through the cost effects of taxation and / or the distortions induced in the labor market. In the exposition we focus on labor income taxes and social security taxes paid by employees. Social security taxes paid by employers and payroll taxes would have the same qualitative effects in our model.

2.3 The structure of the labor market.

We use the foreign country as a benchmark by assuming that the labor market is perfectly competitive so that full employment always prevails.

By contrast, in the home country the labor force is organized in unions. For simplicity, in this paper we consider the case of monopoly unions that set the wage in their sub-sector in order to maximize the expected utility of their members, while in equilibrium employment is determined by the entrepreneurs given the demand function for the differentiated good they produce.

It is well known that the labor market setting we are analyzing here leads to inefficient wage-employment outcomes. A more general framework, in which the union and the employers bargain over the wage and the employment, leads to exactly the same qualitative conclusions, as we showed in a previous version of this paper. We consider the case of monopoly unions only because it is more intuitive and tractable.

We consider different institutional arrangements, characterized by different degrees of centralization of the wage-setting process. We define the degree of centralization as the inverse of the number of unions, J . We also assume symmetry between the two sectors, so that the number of unions in the exportable sector is the same as the number of unions in the nontradable sector. Therefore, we consider the case of J an even number, plus the case of an economy-wide union encompassing the whole labor force, $J = 1$. We also assume symmetry within each sector, so that when J unions are present, each of them sets the wage for a total mass $1/J$ of firms. Thus, we can identify each union with a sub-sector: each sub-sector corresponds to the union that sets the wage for its firms. Finally, we assume symmetry in union membership: when J unions are present, each union has membership $\bar{n}_J \equiv 2\bar{n}/J$.

The expected utility of a member of the j -th union in the exportable sector can be found as follows. Let n be the mass of employed union members, earning a real after-tax wage $w(1-t)/\bar{P}$, where \bar{P} is the general price level defined in (2) and t is the income tax rate. $\bar{n}_J - n$ is then the mass of union members who remain unemployed. Their utility is \bar{V} , which is determined by the employment opportunities available in the other sub-sectors. The representative union takes \bar{V} as given. In equilibrium, each union member will be employed with probability n/\bar{n}_J , and unemployed with probability $(\bar{n}_J - n)/\bar{n}_J$. From the

utility function (1), the expected utility of a union member is then:

$$V(j) = \frac{n}{\bar{n}_j} \frac{w(1-t)}{P} + \frac{(\bar{n}_j - n)}{\bar{n}_j} \bar{V} \quad (3)$$

As it is customary in the literature, we assume that a monopoly union can prevent non-union members from being hired in its sub-sector before its unemployed members are hired. Whenever the wage set by the other $J - 1$ unions is higher than the wage at which all their members are employed, this assumption implies that the members of the j -th union not employed in the j -th sub-sector cannot be employed in any other sub-sector, either. Thus, in this case the utility of unemployed members of the j -th union is R , the utility of leisure.

In what follows, we consider only symmetric equilibria, in which all unions in a sector set the same wage. Also, for the problem to be interesting at all we will always consider interior solutions to the problem of the representative union, i.e. solutions such that not all its members are employed. Effectively, then this implies that the alternative utility available to unemployed workers, \bar{V} , is always R .

2.4 The current account equilibrium condition.

The model is closed by the condition that the current account between the two countries must be balanced. This requires that the expenditure on importables by domestic residents must be equal to the expenditure on exportables by foreign residents.

3 The equilibrium of the economy.

In this section, we illustrate the working of the model by studying the case $J = 2$, i.e. the case of one union in the exportable and one union in the nontradable sector. In the next section we study how the equilibrium varies with the degree of centralization.

3.1 Equilibrium in the foreign country.

Consider first the equilibrium in the foreign country. From the point of view of an individual firm that takes all other prices as given, the elasticity of the demand for its output is equal

to the elasticity of substitution between any two varieties of goods, σ . Therefore, each firm will price its output at a constant markup $\sigma/(\sigma - 1)$ over the wage. Since the labor market is competitive, the same wage prevails in the two sectors; thus, in a symmetric equilibrium in the foreign country all tradable and nontradable goods have the same price. If the foreign wage is the numeraire of the model and is therefore set equal to 1, the price of all foreign goods is

$$p^* = \frac{\sigma}{\sigma - 1} \quad (4)$$

The value of output in each sector is equal to the output price p^* times total output. By the production function, output is equal to employment. In turn, because of the assumption of perfectly competitive labor markets full employment prevails in both sectors. Thus, the value of output in each sector is equal to $\frac{\sigma}{\sigma - 1}\bar{n}$, and national income in the foreign country is

$$Y^* = 2 \frac{\sigma}{\sigma - 1} \bar{n} \quad (5)$$

Thus, the foreign nominal income and the prices of all foreign-produced goods are constant. If the home country also had a perfectly competitive labor market, analogous conditions would hold at home. The presence of unions makes the analysis of the home country different and richer.

3.2 Equilibrium in the home country.

Consider first the equilibrium in the exportable sector. Because there is only one union, the wage is common to all firms in that sector. Exactly like in the foreign country, each firm takes the sectoral wage as given and prices its output at a constant markup over that wage:

$$p = \frac{\sigma}{\sigma - 1} w \quad (6)$$

The union in the exportable sector maximizes the expected income of its members, (3), by setting the wage w and letting employment be determined by the aggregate demand for labor in the exportable sector.

Because in this model firms do not take the output price as given, the demand for labor is a function of the demand for output. It can be shown that the total demand for

exportables D is:

$$D = \frac{E p^{-\sigma}}{P P^{-\sigma}} \quad (7)$$

where P is the price index for tradables, defined in (2), and E is the total expenditure of the two countries on tradables (that is, exportables plus importables), which is equal to half their incomes by the utility function (1). Expression (7) implies that the demand for exportables has two components. The first is the *real* expenditure on tradables, and is captured by the term E/P . The second is the price of exportables relative to that of importables, and is captured by the term $p^{-\sigma}/P^{-\sigma}$.⁴

The production function $y = n$ implies that in equilibrium $D = n$, so that from (7) the derived demand for labor is

$$n = \frac{E p^{-\sigma}}{P P^{-\sigma}} \quad (8)$$

In setting the wage, the union in the exportable sector takes the total expenditure on tradables E as given but realizes that both p and P are a function of the wage. Contrary to the individual firm with mass 0, the union does not take the price index as given: when it demands a higher wage, it realizes that the price p set by *all* domestic firms in the exportable sector will increase proportionally, and therefore the price index of tradables P will also increase. This affects the aggregate demand for labor in the exportable sector through two channels. First, for a given nominal expenditure on tradables E the real demand for tradables falls, as shown by the term E/P in (8). We call this the *real expenditure* effect of an increase in the wage. Second, consumers substitute away from exportables towards importables, as captured by the term $p^{-\sigma}/P^{-\sigma}$ in (8). This is the *substitution* effect of an increase in the wage.

The union maximizes (3) subject to (8). The solution to the problem of the union gives the real after-tax wage in the exportable sector as a variable markup over the alternative cost of employment to the union, R :

$$\frac{w(1-t)}{P} = R \frac{\epsilon}{\epsilon - 1 + \frac{1}{2}\gamma} \quad (9)$$

⁴This is a rather common result in models of monopolistic competition: see for instance Blanchard and Kyotaki (1987).

where ϵ is the absolute value of the elasticity of the aggregate demand for labor to the wage as perceived by the union (i.e., taking the aggregate expenditure on tradables E as given), and γ is the elasticity of the price index for tradables, P , to the wage in the exportable sector (or equivalently to the price in the same sector).

To understand expression (9), note that except for the term $\frac{1}{2}\gamma$ in the denominator, the expression on the r.h.s. of (9) is analogous to a mark-up solution for a monopolist (the union) "producing" labor at a constant marginal (opportunity) cost, R . The term $\frac{1}{2}\gamma$ in the denominator reduces the mark-up charged by the union. This term arises from the consideration that an increase in wages has an effect on the general price level. The union takes into account that an increase in wages in its sector is reflected in the output price of that sector, and therefore in the general price level. The increase in the general price level in turn reduces the real wages of union members. This effect leads to a moderation of wage demands relative to the partial equilibrium case of a monopolist taking all other prices as given.

Now consider the equilibrium in the nontradable sector. The objective function of the union is the same as in the exportable sector. The only difference is that now no substitution is possible towards foreign goods; consequently, the union knows that exactly half of domestic income is spent on nontradables. The derived demand for labor in the nontradable sector is therefore:

$$\tilde{n} = \frac{Y}{2\bar{p}} \quad (10)$$

The problem leads to the same implicit expression for the real wage as (9), with two crucial differences. First, the elasticity of the price index for nontradables \bar{P} to the wage, $\bar{\gamma}$, is now equal to 1. Second, from (10) $\tilde{\epsilon}$ (the elasticity of the demand for labor in the nontradable sector) is now equal to 1, and therefore lower than ϵ , because no substitution is possible towards foreign-produced goods. Hence, the real after-tax wage in the tradable sector is a constant markup over R :

$$\frac{w(1-t)}{\bar{P}} = 2R \quad (11)$$

3.3 Fiscal policy in the home country.

We now study the effects of fiscal policy on competitiveness, the relative price of non-

tradables, and employment in the home country. We focus on purely redistributive fiscal policies, defined as policies that would not affect either the composition or the size of demand *at the existing prices*. We analyze first the case of an increase in transfers to retirees and then to unemployed workers.

Because the transfer to retirees *per se* does not alter the size or composition of demand, it would have no effects at all if financed through a non-distortionary tax.⁵ When taxation is distortionary, however, an increase in transfers to the retirees does have important macroeconomic effects: it causes a decrease in competitiveness, an increase in the price of nontradables and a decrease in employment in both sectors.

The intuition for our main result is as follows. When the tax rate increases, the unions in both sectors shift part of the burden of taxation on to the employers by demanding a higher nominal wage. Hence, the output price in both sectors increases because firms mark-up over the nominal wage. Since the output price abroad is constant, the home country experiences a loss of competitiveness. This leads to a fall in employment for two reasons. First, for a given nominal demand E the demand for exportables falls because of the real expenditure and the substitution effects (see (8)). Second, to preserve the equilibrium in the current account, the national income and therefore the nominal demand E must fall. In fact, the current account equilibrium condition requires that the nominal expenditure on importables by domestic residents be equal to the nominal expenditure on exportables by foreign residents. From (7), the current account equilibrium condition then implies:

$$\frac{Y p^{*1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} = \frac{Y^* p^{1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} \quad (12)$$

From this condition one gets:

$$Y = Y^* p^{1-\sigma} p^{*\sigma-1} \quad (13)$$

Thus, the national income Y decreases when p increases: the reason is that, to ensure a balanced current account, the domestic demand for importables must fall. Even at constant relative prices, this would require a fall in the home national income. *A fortiori*, the home

⁵In our model, a corporate income tax is one such tax: in each firm, the output price is the same markup over the wage, and the problem of the union is not affected by the presence of the tax. Thus, a corporate income tax is non-distortionary, since there is no capital in this model and the owners of the firms are immobile.

national income must decrease because the relative price of importables has fallen. Since $E = (Y + Y^*)/2$, and Y^* is fixed in nominal terms, E too decreases. We call this effect the *nominal expenditure* effect of an increase in the wage of the exportable sector.

In addition, if the elasticity of substitution between goods is high enough, the relative price of nontradables appreciates according to the following mechanism. The increase in both sectors' output prices causes the general price level \bar{P} to increase, thereby reducing the real wage. This last effect induces the unions in both sectors to moderate their wage claims. In the nontradable sector, the price index for nontradables and therefore the general price level increase in the same proportion as the wage. In the exportable sector, on one hand the price level increases less than proportionally to the wage, as consumers shift consumption away from exportables. This induces the union in the exportable sector to make higher wage demands than in the nontradable sector. On the other hand, as the union increases the wage, the elasticity of the demand for labor increases; this induces the union in the exportable sector to demand a lower markup of the real wage over R than in the nontradable sector. If the elasticity of substitution between goods is large enough ($\sigma > 2$ in our model), the second effect prevails:⁶ thus, while both the wage and therefore the price in the nontradable and exportable sectors increase, the former increases proportionally more than the latter. We can now state:

Proposition 1:

An increase in redistribution to the retirees financed by an increase in the income tax rate leads to:

- (i) an increase in the price of exportables, i.e. a decrease in competitiveness;
- (ii) an increase in the relative price of nontradables, provided the elasticity of substitution between goods is sufficiently high ($\sigma > 2$);
- (iii) a decrease in employment in both sectors.

Proof:

See the Appendix.

⁶Note that the condition $\sigma > 1$ is typically a necessary condition for equilibrium in model of monopolistic competition (see e.g. Blanchard and Kiyotaki (1987)). Here we have a more restrictive condition to ensure the expected effects of tradables versus nontradables.

We now turn to the second type of fiscal policy by considering redistribution within the productive sector, from employed workers and entrepreneurs to unemployed workers. Suppose that the unemployed receive an unemployment benefit B which is indexed to the CPI \bar{P} . Thus, their utility is now equal to the sum of the utility of leisure, R , and the unemployment benefit, B . Suppose also that at least part of tax revenues are used to finance an increase in B .

The union takes R and B as given. Thus, the problem of the union is still given by expression (3), with the only difference that the alternative utility of unemployed workers is $R + B$ rather than R . Similarly, the optimal wage set by the union in the tradable and nontradable sector is still given by expressions (9) and (11) respectively, again with the only difference that the r.h.s.'s are functions of $R + B$ rather than R . When taxes increase, now the wage set by the union increases for two reasons. The first is familiar: the union reacts to the decrease in the after-tax wage by demanding a higher nominal wage. The second reason is specific to the type of redistribution we are considering: because taxes are used to increase B , the alternative utility available to unemployed workers increases, inducing the union to demand a still higher wage. This is the intuition for our second result, that we summarize in the following:

Proposition 2:

An increase in redistribution to the unemployed, regardless of how it is financed, leads to:

- (i) an increase in the price of exportables, i.e. a decrease in competitiveness;
- (ii) an increase in the relative price of nontradables, provided the elasticity of substitution between goods is sufficiently high ($\sigma > 2$);
- (iii) a decrease in employment in both sectors.

Proof:

The proof is an immediate generalization of the proof of Proposition 1 in the Appendix.

In summary, our two propositions emphasize the effects of distortionary taxation and of redistribution on competitiveness and the relative price of nontradables. In the case

of Proposition 1, the crucial feature is the distortionary effects of taxation. In fact, a redistribution to retirees financed by lump-sum taxes would *not* have the effects summarized by Proposition 1. On the other hand, the type of redistribution studied in Proposition 2 would have the same qualitative effects even if it were financed with non-distortionary taxation.

4 Labor markets and fiscal policy.

In this section, we study how the equilibrium illustrated in the previous section varies with the degree of centralization $1/J$.

Because there are $J/2$ unions in the exportable sector, from (8) the demand for labor facing the union in the j -th exportable sub-sector is:

$$n = \frac{2 E p^{-\sigma}}{J P P^{-\sigma}} \quad (14)$$

where the subscript " J " indicates that there are J unions in the economy. The wage set by the union affects the demand for labor in its sub-sector through the three channels described in the preceding section: the *real expenditure*, the *substitution* and the *nominal expenditure* effects.

We assume that only very large unions internalize the last effect. Small unions take the total nominal expenditure E as given. We believe that this asymmetry in the internalization of the different effects of an increase in the sub-sectoral wage and price captures an important aspect of unions' behavior. Internalizing the first two effects requires only two straightforward passages: the union must realize that (i) a higher output price reduces the output demand and (ii) a higher wage is reflected in a higher output price. Internalizing the third effect, that operates via the current account, requires taking into consideration an equilibrium condition and the corresponding repercussion effects between two countries. It seems realistic to assume that only large unions will internalize this effect. In particular, and only for expository purposes, we assume that only a large, economy-wide union that encompasses the whole labor force internalizes this effect. In the Appendix, we generalize this result by showing that our results hold for the generic case where unions internalize

the nominal expenditure effect whenever the number of unions is less than an arbitrary number J' .

We first consider the equilibrium in labor markets where the unions take the total nominal expenditure E as given. The solution to the problem of the representative j -th union has the familiar form:

$$\frac{w(1-t)}{\bar{P}} = R \frac{\epsilon_J}{\epsilon_J - 1 + \frac{1}{2}\gamma_J} \quad (15)$$

where ϵ_J is the elasticity of the aggregate demand for labor to the wage in the j -th exportable subsector when there are J unions in the economy, and γ_J is the elasticity of the price index for exportables P to the wage in the same sub-sector.

Clearly, the larger the typical union - the lower J - the higher is the effect of an increase in the union wage on the general price level, represented by the term $\frac{1}{2}\gamma_J$. This effect then implies that the wage should be higher in more decentralized labor markets. However, the demand for labor ϵ_J too depends on the number of unions J : larger unions face a less elastic labor demand. The intuition is the following: when a very small union increases the wage, the resulting increase in the output price of that sub-sector implies a loss of market to all the other domestic sub-sectors in the exportable sector and to all foreign producers. As the union gets larger and encompasses more domestic producers, the output price of more and more domestic producers move together. In the extreme, when one union organizes all the labor force in the exportable sector, the union must only worry about substitution towards importables, since all the substitution *within* the exportable sector is eliminated. Therefore, this second effect implies that the elasticity of the demand for labor facing a union is higher in more decentralized labor markets. This effect then implies that the real wage should be lower in more decentralized labor markets.

As long as the unions take E as given, an increase in the degree of centralization has therefore two contrasting effects on the wage set by unions. When the elasticity of substitution between goods is sufficiently large ($\sigma > 2$ in our model) the second effect, whose magnitude is directly related to the elasticity of substitution between goods, prevails.

Following the same intuition, it is relatively straightforward to show that in the non-tradable sector too the wage increases with the degree of centralization of the labor market.

In addition, and exactly like in the case of one union per sector analyzed in section 3, it is still true that, for any given J and any given wage the elasticity of the price index for nontradables to the wage in the j -th nontradable sub-sector is lower than in the exportable sector: $\tilde{\gamma}_j < \gamma_j$. This difference implies that in a symmetric equilibrium the wage and the output price in the nontradable sector will always be higher than in the exportable sector.

Now consider a highly centralized labor market, where a single union that encompasses all $2\bar{n}$ workers sets the same wage in both the exportable and nontradable sector. Besides internalizing all the effects on prices of the wage it sets, this large union also internalizes the effects on the aggregate nominal demand E that occur through the current account equilibrium condition. This labor market arrangement leads to the lowest equilibrium wage and the highest level of employment. There are two reasons for this, both working in the same direction. First, the elasticity of the demand for labor perceived by the union, ϵ_j in expression (15), is higher than in any decentralized labor market, since now the union realizes that E falls when the economy-wide wage increases. Second, the elasticity of the price level \bar{P} to the union wage is the highest of all labor market arrangements, since all domestic wages and prices increase together. Thus, in a centralized labor market the wage in the exportable sector is lower than in any other type of labor market. In addition, the difference between the equilibrium wages in the exportable and importable sector is the lowest - and it is actually 0 - because the wage is the same in the two sectors.

More generally, consider two labor markets, both with the same number J of unions. In the first labor market the unions take E as given, while in the second they do not. Then it is easy to show that the wage in both sectors will be lower in the second labor market. In addition, once the unions start internalizing the nominal expenditure effect, the wage set by the unions becomes lower as the degree of centralization increases. The reason is that whenever a union internalizes the effects of an increase in their wage on E , the elasticity of the demand of labor ϵ_j is always σ , independently of the size of the union. However, the elasticity of the price level \bar{P} to the wage is higher the larger the union. Thus, from (15), as the number of unions increases the wage they demand decreases, because larger unions internalize more fully the effects of their wage demands on the real wage of their members.

As long as unions do not internalize the nominal expenditure effect, however, as we

showed above the wage *increases* as the number of unions decreases. This implies that, if the unions start internalizing the *nominal expenditure* effect when there are J' unions in the economy, the wage will first increase as J increases and then, after the number of unions exceeds J' , it will start declining as J increases. Thus, the relation between the degree of centralization $1/J$ (the number of unions J) and the wage has a U-shaped (hump-shaped) behavior.⁷

The following proposition summarizes the results of this section:

Proposition 3:

- (i) the relation between competitiveness and the degree of centralization of the wage-setting process is U-shaped: as the degree of centralization increases, competitiveness first decreases, then increases.
- (ii) the relation between the relative price of non-tradables and the degree of centralization of the wage-setting process is also U-shaped: as the degree of centralization increases, competitiveness first decreases, then increases.
- (iii) the relation between unemployment and the degree of centralization of the wage-setting process is hump-shaped: as the degree of centralization increases, unemployment first increases, then decreases.

Proof:

See the Appendix.

5 Estimation results.

Our model hinges on the relationship between two variables, competitiveness and labor taxation. In the model, the driving force behind all price movements is labor costs. Ac-

⁷Note that the main results of this section agree with a recent empirical literature that has found a hump-shaped relationship between the level of unemployment and the degree of centralization in wage bargaining in OECD countries: see Calmfors and Drifill (1989) and Freeman (1989). We are not the first to formalize this hump-shaped relationship between the degree of centralization and the wage: see Calmfors (1993) for a survey of the recent theoretical literature on the topic. To our knowledge, however, our explanation is novel.

cordingly, our first measure of competitiveness is unit labor costs in manufacturing. The *Intersectoral Database* contains data on employment, the capital stock, total compensation, indirect taxes and value added at current and constant prices, from 1960 to 1990, for 14 countries⁸ and 20 sectors. We use this dataset to construct series on unit labor costs, value added deflators, and total factor productivity in the tradable and nontradable sectors. The advantage of this source is that it provides a consistent dataset for all the price and cost variables we need.

The measure of taxation that comes conceptually closest to that of the paper is "Direct taxes paid by households" in the "Accounts for household and private unincorporated enterprises" of the OECD *National Income Accounts*. This variable includes almost exclusively labor income taxation. Moreover, because the breakdown between labor and other income taxation is available only for a few countries, we take this variable as our proxy for direct labor income taxation. If direct taxation were proportional, social security contributions paid by employees (which are usually proportional) would be equivalent to direct taxation from the point of view of a union. Thus, a second definition of labor taxation would include social security taxes paid by employees in addition to income taxation. A third, still more general definition of labor taxation would also include social security taxes paid by employers and payroll taxes. We test our model using all three definitions of labor taxation. In each case, we obtain a measure of the average labor tax rate by dividing tax revenues by GDP. For future reference, we call this class of measures of tax rates GDP-based tax rates. As a further check, we estimate our model using a second definition of the average labor tax rate, obtained by dividing the three different definitions of tax revenues given above by total wages and salaries rather than by GDP. We call this second class of tax rates wage-based tax rates.

Regardless of the tax measure used, our central hypothesis is that an increase in labor taxation causes an increase in relative unit labor costs, i.e. a loss of competitiveness. Moreover, the effect of taxation on unit labor costs are hump-shaped: they are largest in countries with an intermediate degree of centralization in labor markets.

⁸The countries are: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherland, Norway, Sweden, United Kingdom, United States.

To measure the degree of centralization of labor markets, we use the index constructed by Calmfors and Driffill (1988), which we reproduce in Table 11. This index ranks countries in descending order of centralization, with the most centralized country (Norway) receiving a score of 1 and the most decentralized (Canada) receiving a score of 14.⁹ Relative to other indices available in the literature, the Calmfors-Driffill index has the advantage that it measures exactly the feature we highlight in our paper, the number of unions in each country.¹⁰ Its rationale is very similar to that used by Cameron (1984) in constructing his index, which we also report in Table 11. The two indices are indeed very similar, and they give very similar results. In fact, in general we obtain stronger results when we use the Cameron index, although for lack of space we only report results based on the more commonly used Calmfors-Driffill index.

We use two different approaches to test the hump-shaped effect of labor taxation on unit labor costs. First (Tables 2 and 6) we interact our tax variable with the index of centralization and with the square of the same index. According to our model, the first interactive term should have a positive coefficient and the second a negative one: as the index increases and labor markets become more decentralized, the effect of an increase in income taxation on costs first rises, then falls. The second approach (Tables 7 to 10) consists in dividing our sample of countries in three groups, according to the Calmfors-Driffill index, and allowing for a different coefficient of the tax variable for each group. The second group should have the highest coefficient.

In Table 2 the dependent variable here is multilateral unit labor costs in manufacturing. For each country, this variable is defined as the ratio of its own unit labor costs to a geometric average of the unit labor costs of all the other countries in the sample, with weights equal to their GDP shares in 1980. The r.h.s. variables are defined the same way. The tax variable is our first GDP-based tax rate, direct taxes paid by household divided by GDP. Since our sample stretches over different exchange rate regimes and year-to-year variations in nominal exchange rates not related to fundamentals might introduce some

⁹Three countries that appear in the Calmfors-Driffill index - Austria, New Zealand and Switzerland - are not present in our sample. We re-ranked the countries from 1 to 14 after excluding these countries.

¹⁰For the same reasons, this is the index used by Summers, Gruber and Vergara (1993).

noise in our estimates, we include year as well as country dummies in our regressions.

Columns (1) to (4) present various estimates of the most basic specification: relative unit labor costs depend on total factor productivity, TFP , and on the two tax variables, $INCTAX * I$ and $INCTAX * I^2$, where I denotes the centralization index.¹¹ In column (1) no other regressors appear on the r.h.s.; in column (2) we add country dummies, and in column (3) year dummies; finally, in column (4) (and all subsequent regressions) we add both country and year dummies. In all these regressions, the coefficients of the productivity and tax variables have the expected sign, are highly significant, and are remarkably stable. The coefficients of $INCTAX * I$ and $INCTAX * I^2$ imply that the cost effect of an increase in income taxation is highest when $I = 6$, almost exactly the middle point of the range spanned by I , which goes from 1 to 14.

In column (5) we control for demand factors in the regressions. The demand proxies we choose are the ratio of non-wage government consumption to GDP, $CGNW$,¹² and the ratio of government transfers to GDP, $TRANSFERS$,¹³. Both variables are insignificant, economically and statistically,¹⁴ and their inclusion in the regression does not affect the estimates of the coefficients of the tax variables.

In column (6) we control for the aggregate unemployment rate, $UNEMPL$. Its coefficient has the expected sign, although it is not significant at the 10% level: when conditions in the labor market deteriorate, unit labor costs decrease. Needless to say, one should be careful in drawing any strong conclusions from this regression because of the endogeneity

¹¹Productivity can easily be introduced in the model developed so far by rewriting the production function as $y = \alpha n$, where α is productivity. Unit labor costs then can be written as $ULC = w/\alpha$. It can easily be shown that in our model the gains of an increase in productivity are appropriated partly by the union in the form of higher wages and partly by entrepreneurs in the form of higher profits. Therefore, unit labor costs decrease when productivity improves. Because of the presence of monopoly power, we estimate total factor productivity growth using the formula $TFP = dy - \mu' \cdot s_L dl - (1 - \mu' \cdot s_L) dk$, where y , l and k are the logarithms of value added, labor and capital respectively, s_L is the share of labor in value added and μ' is the value-added-based mark-up. We constructed μ' from the formula $\mu' = \frac{\mu(1-s_M)}{1-\mu s_M}$, where μ is the output-based markup and s_M is the share of intermediate input in output. We assumed a value of 1.57 for μ , which is the average value obtained by Hall (1988) for manufacturing, and $s_M = .5$, which is also typical in this literature. We also experimented with lower values of μ , and the results did not change substantially.

¹²Non-wage government consumption typically represents between one third and one fourth of total government consumption. We do not include the wage component of government consumption because of obvious endogeneity problems in a regression that has unit labor costs as the dependent variable.

¹³This variable is the sum of social security payments and other transfer payments by the government.

¹⁴The lack of significance of these two variables is not due to their collinearity: virtually the same point estimates and t-statistics obtain when the two variables are included separately.

of the rate of unemployment. Notice, however, that the coefficients of the tax variables remain largely unaffected by the introduction of the unemployment rate.

A possible problem in the regressions of Table 2 is that the average tax rate might be correlated with the rate of inflation. Because the tax system is progressive and income tax brackets are in general not indexed, during periods of high inflation many taxpayers tend to be pushed up to higher brackets merely because their *nominal* income increases. As a result, the average tax rate increases. To the extent that wage and price inflation are correlated, this effect might bias our estimates of the coefficient of the average income tax rate away from 0. We have addressed this problem by reestimating all our regressions excluding all years for which the rate of change of the GDP deflator was higher than 10% in at least one country. A typical estimate is shown in column (7) of Table 2, which replicates the regression of column (4). As one can see, excluding high-inflation years does not affect the coefficients of the tax variables.

What is the economic significance of the results that emerge from Table 2? The average share of personal income taxes in GDP in the sample is 12.1%, with a standard deviation of 5.56%. The estimate of the coefficient of $INCTAX * I$ in Table 2 when country and year dummies are included is always .12, and the estimate of the coefficient of $INCTAX * I^2$ is always -.01. Thus, the largest effect of taxation on unit labor costs occur when $I = 6$, which implies an elasticity of unit labor costs to the tax rate of .36 ($.36 = .12 * 6 - .01 * 6^2$). Using this value, when the average share of personal income taxes in GDP increases by 1% to 13.1%, the loss of competitiveness in manufacturing is 2.98% ($2.98 = .36 / .121$). When the share of personal income taxes in GDP increases by one standard deviation, competitiveness falls by a sizable 16.54%. These values are economically significant, if one considers that it is not uncommon to observe movements in the average income tax rate of several percentage points, particularly in countries that are adjusting their budgets.

Table 3 is similar to Table 2, except that now the tax variables include social security and payroll taxes, in addition to direct income taxation. In the first two columns labor taxation includes social security taxes paid by employees; in the two remaining columns, it also includes social security taxes paid by employers and payroll taxes. ¹⁵

¹⁵Because data on social security and payroll taxes are available only from 1965, the sample period is,

The results in Table 3 are very similar to those of Table 2; the sizes of the coefficients are now slightly higher, as one would expect since the values of the tax variable are larger than in Table 2, and still significant.

We now turn to the issue of sub-sample stability. In all the relations estimated so far, the effects of taxation turn out to be stronger if the 80's are left out of the sample. A likely explanation is that the year-to-year variability of the multilateral nominal exchange rate increased substantially in the 80's. This is demonstrated in Table 4, which shows, for each country, the variance of the annual rate of change of the nominal exchange rate in three periods: the 60's and 70's (column (1)), the 1973-1980 period (column (2)), and the 80's (column (3)). Columns (4) and (5) display the ratio of the third to the first and of the third to the second, respectively. It is clear that the variance of the annual rate of change of the multilateral exchange rate was much higher in the 80's than in the two previous decades (column (4)), and this remains true even if the comparison is between the 80's and the 1973-1980 period (column (5)); furthermore, this applies even to the countries that entered the EMS in the '80's.¹⁶ One important underlying cause of the pattern displayed in Table 4 is the strong fluctuations of the dollar in the first half of the 80's. In fact, it is interesting to note that the countries that experienced the highest variability of the rate of change of the exchange rate in the '80's relative to the 1973-1980 period are the European countries that pegged their currency to the D-Mark most closely.

We illustrate the implications of the discussion above for the stability of the estimates of the model using the second definition of the tax rate, with total wages and salaries rather than GDP as the denominator. However, everything we say here applies to the analysis of the first definition of the tax rate that we have used so far.

We also checked the robustness of our results by defining the tax variables as tax revenues divided by wages rather than GDP. Consider the simplest regression we have displayed so far, in column (1) of Table 2, where the tax variable on the r.h.s. was constructed as tax revenues divided by nominal GDP. The dependent variable is constructed as total

effectively, 1965-90.

¹⁶Recall that these figures refer to the annual variance of the nominal exchange rate, and therefore reflect the frequent, discrete realignments within the EMS until 1987. This is entirely consistent with the nominal exchange rate being less variable in the 80's in European countries at higher frequencies.

nominal compensation divided by real value added in manufacturing. To the extent that nominal GDP and real value added in manufacturing are correlated, the positive estimated relationship between the tax rate and unit labor costs might be influenced by the fact that two highly correlated variables appear at the denominator of the two variables on the two sides of the regression.

By defining the tax rate as tax revenues divided by total wages and salaries, now we have the opposite feature: two highly correlated variables - total wages and salaries the economy and total compensation in manufacturing - appear at the denominator and the numerator, respectively, on the r.b.s. and the l.h.s. If variations in wages and salaries dominate the behavior of unit labor costs and of the tax rate, one should now expect that a *negative* relation between the two will be picked up by our estimates. If instead the estimated effect of the tax rate is still positive, one can feel confident that the relation being estimated is not caused by the way we constructed the tax variables.

Thus, in Table 5 the tax base is total wages and salaries.¹⁷ The dependent variable is always multilateral unit labor costs. In column (1) the sample is the entire 1965-90 period and the labor tax rate is calculated as direct taxes paid by households (the same measure that appears in Tables 2) divided by total wages and salaries. All coefficients are very similar to those of column (5) in Table 2, which represents the same regression but with the GDP-based definition of the tax rate. However, because the sample average of the wage-based definition of the tax rate is higher than for the GDP-based definition, these coefficients represent smaller effects of the tax rate on unit labor costs than the coefficients in Table 2. This too was to be expected in light of the considerations we developed above. Furthermore, the t-statistics on the coefficients of the tax variables are lower.

The next three columns of Table 5 display the results of regressions over the 60's and 70's only. In each column, the tax rate is constructed from different concepts of tax revenues. The denominator is always total wages and salaries; however, in column (2), the numerator is direct taxes only, as in column (1); in column (3), it is direct taxes plus social security taxes paid by employees; finally, in column (4) it is direct taxes paid by households plus

¹⁷We define the tax base as total compensation less payroll taxes and social security taxes paid by employers. The estimated coefficients are very similar when social security and payroll taxes are not subtracted from total compensation.

total social security taxes (paid by employees, employers and self-employed) and payroll taxes.

Regardless of the definition of the tax variable, the pattern that emerges from these estimates is very clear. In all the three columns, both the size of the coefficients and the t-statistics increase substantially relative to those of column (1).

In Table 6 we estimate the effects of taxation on the relative price of nontradables. The model predicts that an increase in the average labor tax rate should cause the price of nontradables to rise relative to that of tradables. Our measure of the price of nontradables is the value added deflator in construction and in transportation, always from the *Intersectoral Database*. The reason why we consider only these two sectors among services is one of availability of data: for instance, if we had included retail trade in our measure, the number of observations would have dropped drastically. By using only the value added deflator in construction and transportation we lose only two countries, Italy and Netherlands, relative to the regressions we have presented so far.

The results broadly confirm the predictions of the model.¹⁸ Because of space constraints, we present only results pertaining to labor taxation defined as income, social security and payroll taxes; the other two, less comprehensive definitions give very similar results. Also, we divide tax revenues by GDP in the first two columns, and by total compensation less payroll and social security taxes paid by employers in the last two columns.

One might argue that inflation is typically associated with an appreciation of the relative price of nontradables because the price of tradables is less flexible upward due to international competition (see for instance De Gregorio, Giovannini and Wolf (1993)). To address this issue, in columns (2) and (4) we include the rate of change of the GDP deflator among the regressors.

The coefficients of the average labor tax rates always have the expected signs, and are always strongly significant at the 5% level. Notice only that, as usual, the size and significance level of the coefficients of the tax rates fall slightly in regressions using the

¹⁸To construct total factor productivity growth in the nontradable sector, we used the same formula as in footnote 10, but with a value for μ' , the value-added-based markup, of 2.35, the same used by, among others, Benabou (1992) for the retail sector and derived from an estimate of μ , the output-based markup in the retail sector, of 1.40 in Hall (1988). Again, the results were not sensitive to other values of μ' in the same range.

wage-based definition of the tax rate. Overall, the results are strongly supportive of our hypothesis: there is a positive effect of labor taxation on the relative price of nontradables, and this effect has the hypothesized inverted-U shape as a function of the degree of centralization. Moreover, in all cases the labor tax variables are the only significant variable, besides relative total factor productivity.

A second way to estimate the relationship between the degree of labor market decentralization and fiscal policy is to group the countries in three categories, with high, intermediate and low centralization of labor markets as measured by the Calmfors-Driffill index, and allow for a different coefficient of the tax variable for each group. The first group of countries comprises Norway, Sweden, Denmark, and Finland; the second group includes Germany, Netherlands, Belgium, Australia, and France, and the third group the U.K., Italy, Japan, U.S., and Canada. One advantage of this approach is that it imposes fewer restrictions on the shape of the relationship between labor market decentralization and effects of taxation. In the regressions of Tables 2 to 6, the same two coefficients governed the change in the shifting of taxation when going from values of the Calmfors-Driffill index of, say, $I = 1$ to $I = 2$ as when going from $I = 13$ to $I = 14$. Ideally, of course, with enough observations one would estimate a different coefficient for each country. Grouping our countries in three categories is a compromise in this direction.

Therefore, in Tables 7 to 10 we estimate the same regressions as in Table 2, 3, 5 and 6 respectively, except that now the tax variables on the r.h.s. are $INCTAX * I1$, $INCTAX * I2$ and $INCTAX * I3$, where $I1$, $I2$ and $I3$ are dummy variables taking the value of 1 in correspondence of countries of the first, second and third group, respectively.

Since these tables, apart from the different use of the labor tax variables, are identical to the tables we have already analysed, here we just highlight the main new conclusions one can draw from them. First, all of tables 7 to 10 are again consistent with the theory: in countries with an intermediate degree of centralization labor taxes have stronger effects on unit labor costs than in the other two types of countries. The interesting contribution of this second set of tables is that the shifting of taxes is much higher in highly centralized countries (associated with $I1$) than in highly decentralized countries (associated with $I2$). In fact, in highly decentralized countries the coefficient is always very close to 0 (and in several cases,

negative) and never statistically different from 0, while in highly centralized countries it is positive and close to that of countries with intermediate degrees of centralization. Moreover, the estimate of the coefficient of $INCTAX * I1$ often is not statistically different from that of $INCTAX * I2$, while that of $INCTAX * I3$ is. Interestingly, this result is exactly consistent with our model. In fact, recall the main mechanism that leads to less shifting of taxation in highly centralized labor markets: the unions internalize the external constraint, and this effect offsets the tendency towards *more* shifting associated with more centralization, *which is still present in all these countries*. Our estimates therefore show that in highly centralized labor markets the internalization of the external constraint just prevents the effects of this tendency towards more shifting of taxation, but does not bring the wage and competitiveness back to the level of a very decentralized labor market. Note also that, in general, only the coefficients $INCTAX * I2$ are statistically significant, which is again consistent with the model.¹⁹

Second, the point estimates of the coefficients too are highly consistent with those in the previous set of tables. For instance, the estimated coefficient of the tax variable in the second group of countries in column (1) of Table 6 is .35, which is practically identical to estimate of the coefficient at the top of the inverted-U curve estimated in column (1) of Table 2. Overall, we conclude that the results of Tables 7 to 10, while providing some interesting new information, confirm the robustness of the results of Tables 2 to 6.

6 Conclusions.

In industrial countries, redistributive expenditures represent a larger fraction of government budgets than purchases of goods and services. This paper provides theoretical underpinnings and empirical support for the view that redistributive fiscal policies affect the competitiveness of open economies. This is a burning issue in policy debates: discussions about reforms of the "welfare state" to alleviate the burden on the productive side of the economy are everywhere. However, standard competitive macro models of open economies

¹⁹The exceptions is Table 10, where the dependent variable is the relative price of nontradables: here, when labor taxation is divided by GDP, all three coefficients of the tax variable are significant.

with representative individuals cannot fully address these problems.

We have presented a model that departs from standard assumptions in three ways: (i) we do not have a representative agent but, instead, three groups of individuals with different interests; (ii) we consider unionized labor markets; (iii) we have a monopolistically competitive economy. These assumptions give rise to a tractable but relatively rich model well equipped to address a variety of issues related to fiscal redistribution. We have begun to study some of these issues in this paper, but the same modelling structure can be applied to other problems.

A particularly important point that we left out of our discussion is the endogenous determination of policies. In our paper redistributive fiscal policies are exogenous. A more complete treatment should show how the different groups interact to generate such policies in a political equilibrium. Our model, that implies meaningful conflicts of interest among groups and sectors, can be a useful stepping stone in this direction.

This model also lends itself to the study of different fiscal policy problems, in particular related to fiscal adjustments and fiscal reforms. Because the crucial politico-economy issue in fiscal adjustments has to do with redistributions, our model seems well equipped to capture, albeit in a simplified manner, some important aspects of the problem.

Table 2:

	(1)	(2)	(3)	(4)	(5)	(6)	(7) ^(a)
	60-90	60-90	60-90	60-90	60-90	60-90	60-90
<i>TFP</i>	-.28 (-3.04)	-.37 (-3.79)	-.29 (-3.14)	-.39 (-3.93)	-.40 (-3.77)	-.34 (-3.08)	-.34 (-2.99)
<i>INCTAX * 1</i>	.10 (2.62)	.11 (2.90)	.11 (2.47)	.12 (2.77)	.12 (2.80)	.12 (2.83)	.11 (2.32)
<i>INCTAX * 1 ** 2</i>	-.008 (-2.36)	-.01 (-2.74)	-.009 (-2.21)	-.01 (-2.58)	-.01 (-2.68)	-.01 (-2.66)	-.01 (-2.35)
<i>TRANSFERS</i>					.006 (.04)		
<i>CGNW</i>					.19 (1.46)		
<i>UNEMPL</i>						-.04 (-1.20)	
year dummies?	no	no	yes	yes	yes	yes	yes
country dummies?	no	yes	no	yes	yes	yes	yes
<i>adj. R²</i>	.05	.06	.06	.07	.07	.07	.06
<i>NOBS</i>	305	305	305	305	301	304	250

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. ^(a): excludes observations with inflation higher than 10%.

Table 3:

	(1)	(2)	(3)	(4)
	65-90	65-90	65-90	65-90
<i>TFP</i>	-.42 (-3.65)	-.37 (-3.04)	-.39 (-3.37)	-.34 (-2.80)
<i>INCTAX * I</i>	.11 (2.19)	.12 (2.21)	.13 (2.27)	.14 (2.35)
<i>INCTAX * I ** 2</i>	-.01 (-2.04)	-.01 (-2.01)	-.01 (-1.95)	-.01 (-1.98)
<i>TRANSFERS</i>	.006 (.05)		-.002 (-.01)	
<i>CGNW</i>	.12 (.88)		.09 (.69)	
<i>UNEMPL</i>		-.03 (-.88)		-.03 (-.89)
<i>adj. R²</i>	.07	.07	.07	.07
<i>NOBS</i>	281	284	281	284

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. All regressions include year and country dummies. Tax rate in columns (1) and (2): direct taxation plus social security taxes paid by employees divided by GDP. Tax rate in columns (3) and (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes divided by GDP.

Table 4:

	(1)	(2)	(3)	(4)	(5)
	60-80	73-80	80-90	(3)/(1)	(2)/(1)
Australia	.0106	.0057	.0101	.95	1.76
Belgium	.0006	.0007	.0086	13.50	11.93
Canada	.0027	.0053	.0048	1.81	.92
Denmark	.0007	.0020	.0072	9.75	3.54
Finland	.0029	.0024	.0027	.92	1.09
France	.0018	.0034	.0077	4.23	2.24
Germany	.0011	.0012	.0062	5.58	5.02
Italy	.0025	.0038	.0072	2.85	1.92
Japan	.0029	.0070	.0072	2.45	1.03
Netherlands	.0007	.0017	.0046	1.87	.86
Norway	.0008	.0017	.0015	1.87	.86
Sweden	.0008	.0019	.0046	5.88	2.39
United Kingdom	.0029	.0071	.0034	1.18	.48
United States	.0008	.0016	.0055	6.92	3.42

Column (1): variance of rate of change of multilateral nominal exchange rate in 1960-80 (Column (1)), 1973-80 (Column (2)), and 1980-90 (Column (3)). Column (4): ratio of corresponding entry of Column (3) to corresponding entry of Column (1). Column (5): ratio of corresponding entry of Column (2) to corresponding entry of Column (1).

Table 5:

	(1)	(2)	(3)	(4)
	65-90	65-80	65-80	65-80
<i>TFP</i>	-.44 (-3.83)	-.53 (-3.62)	-.53 (-3.63)	-.53 (-3.55)
<i>INCTAX * I</i>	.10 (1.92)	.17 (2.58)	.17 (2.30)	.22 (2.56)
<i>INCTAX * I **2</i>	-.01 (-2.09)	-.016 (-2.68)	-.016 (-2.32)	-.02 (-2.61)
<i>TRANSFERS</i>	-.003 (-.02)	-.09 (-.57)	-.08 (-.49)	-.08 (-.52)
<i>CGNW</i>	.18 (1.27)	.11 (.71)	.11 (.64)	.07 (.43)
<i>adj. R²</i>	.06	.12	.10	.11
<i>NOBS</i>	281	149	149	149

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. All regressions include country and year dummies. Tax rate in columns (1) and (2): direct taxation divided by total wages and salaries. Tax rate in column (3): direct taxation plus social security taxes paid by employees, divided by total wages and salaries. Tax rate in column (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by total wages and salaries.

Table 6:

	(1)	(2)	(3)	(4)
	65-90	65-90	65-90	65-90
<i>TFP</i>	-.21 (-5.31)	-.21 (-5.37)	-.20 (-4.99)	-.20 (-5.09)
<i>INCTAX * I</i>	.075 (3.42)	.077 (3.50)	.063 (2.42)	.063 (2.53)
<i>INCTAX * I ** 2</i>	-.005 (-2.49)	-.005 (-2.58)	-.005 (-2.09)	-.005 (-2.18)
<i>TRANSFERS</i>	-.01 (-.19)		-.02 (-.36)	
<i>CGNW</i>	.006 (.11)		.05 (.89)	
<i>INFL</i>		.002 (.30)		.003 (.44)
<i>adj.R²</i>	.32	.32	.28	.28
<i>NOBS</i>	243	243	243	243

Dependent variable: relative price of nontradables. t-statistics in parentheses. Tax rate in columns (1) and (2): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by GDP. Tax rate in columns (3) and (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by total wages and salaries.

Table 7:

	(1)	(2)	(3)	(4)	(5)	(6)	(7) ^(a)
	60-90	60-90	60-90	60-90	60-90	60-90	60-90
<i>TFP</i>	-.28 (-3.11)	-.37 (-3.82)	-.30 (-3.23)	-.40 (-3.98)	-.40 (-3.78)	-.35 (-3.15)	-.34 (-3.02)
<i>INCTAX * I1</i>	.30 (2.62)	.29 (2.90)	.29 (2.47)	.28 (2.77)	.26 (2.80)	.29 (2.83)	.20 (2.32)
<i>INCTAX * I2</i>	.35 (2.60)	.35 (2.62)	.36 (2.57)	.37 (2.60)	.38 (2.63)	.37 (2.60)	.36 (2.09)
<i>INCTAX * I3</i>	-.02 (-.14)	-.07 (-.58)	-.01 (-.06)	-.06 (-.43)	-.10 (-.77)	-.07 (-.50)	-.18 (-1.03)
<i>TRANSFERS</i>					-.02 (-.20)		
<i>CGNW</i>					.19 (1.49)		
<i>UNEMPL</i>						-.03 (-1.16)	
year dummies?	no	no	yes	yes	yes	yes	yes
country dummies?	no	yes	no	yes	yes	yes	yes
<i>adj.R²</i>	.06	.06	.07	.07	.08	.08	.05

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. ^(a): excludes observations with inflation higher than 10%.

Table 8:

	(1)	(2)	(3)	(4)
	65-90	65-90	65-90	65-90
<i>TFP</i>	-.42 (-3.65)	-.37 (-3.09)	-.39 (-3.41)	-.35 (-2.89)
<i>INCTAX * I1</i>	.23 (1.26)	.27 (1.49)	.28 (1.45)	.32 (1.69)
<i>INCTAX * I2</i>	.41 (2.19)	.39 (2.12)	.57 (2.56)	.54 (2.48)
<i>INCTAX * I3</i>	-.11 (-.56)	-.07 (-.36)	-.01 (-.06)	-.04 (-.21)
<i>TRANSFERS</i>	-.02 (-.14)		-.01 (-.10)	
<i>CGNW</i>	.13 (.93)		.10 (.71)	
<i>UNEMPL</i>		-.03 (-.87)		-.03 (-.85)
<i>adj. R²</i>	.07	.07	.07	.08
<i>NOBS</i>	281	284	281	284

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. All regressions include year and country dummies. Tax rate in columns (1) and (2): direct taxation plus social security taxes paid by employees divided by GDP. Tax rate in columns (3) and (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes divided by GDP.

Table 9:

	(1)	(2)	(3)	(4)
	65-90	65-80	65-80	65-80
<i>TFP</i>	-.43 (-3.80)	-.52 (-3.56)	-.52 (-3.53)	-.52 (-3.48)
<i>INCTAX * I1</i>	.11 (.56)	.29 (1.17)	.21 (.79)	.24 (.90)
<i>INCTAX * I2</i>	.31 (1.77)	.42 (2.05)	.54 (2.16)	.74 (2.44)
<i>INCTAX * I3</i>	-.24 (-1.56)	-.22 (-1.36)	-.35 (-1.35)	-.25 (-1.16)
<i>TRANSFERS</i>	-.02 (-.12)	-.09 (-.54)	-.10 (-.61)	-.06 (-.41)
<i>CGNW</i>	.16 (1.20)	.09 (.57)	.12 (.70)	.07 (.43)
<i>adj. R²</i>	.06	.11	.11	.11
<i>NOBS</i>	281	149	149	149

Dependent variable: multilateral unit labor costs. t-statistics in parentheses. All regressions include country and year dummies. Tax rate in columns (1) and (2): direct taxation divided by total wages and salaries. Tax rate in column (3): direct taxation plus social security taxes paid by employees, divided by total wages and salaries. Tax rate in column (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by total wages and salaries.

Table 10:

	(1)	(2)	(3)	(4)
	65-90	65-90	65-90	65-90
<i>TFP</i>	-.21 (-5.16)	-.20 (-5.22)	-.20 (-4.97)	-.20 (-4.94)
<i>INCTAX * I1</i>	.16 (2.23)	.16 (2.26)	.11 (1.32)	.10 (1.27)
<i>INCTAX * I2</i>	.21 (2.44)	.21 (2.53)	.19 (2.14)	.18 (1.80)
<i>INCTAX * I3</i>	.19 (2.06)	.18 (2.10)	.10 (.77)	.02 (.20)
<i>TRANSFERS</i>	-.02 (-.34)		-.03 (-.50)	
<i>CGNW</i>	.01 (.17)		.06 (1.06)	
<i>INFL</i>		.003 (.49)		.004 (.57)
<i>adj. R²</i>	.30	.30	.28	.26
<i>NOBS</i>	243	243	243	243

Dependent variable: relative price of nontradables. *t*-statistics in parentheses. Tax rate in columns (1) and (2): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by GDP. Tax rate in columns (3) and (4): direct taxation plus social security taxes paid by employees and employers plus payroll taxes, divided by total wages and salaries.

Table 11:

Indices of centralization

Calmfors-Driffill		Cameron	
1	Norway	1	Sweden
2	Sweden	2	Norway
3	Denmark	3	Belgium
4	Finland	4	Finland
5	Germany	5	Denmark
6	Netherlands	6	Netherlands
7	Belgium	7	Germany
8	Australia	8	U.K.
9	France	9	Australia
10	U.K.	10	Italy
11	Italy	11	Canada
12	Japan	12	U.S.
13	U.S.	13	France
14	Canada	14	Japan

Higher values of the indices indicate more decentralized wage setting processes.

Appendix.

In this Appendix we develop more fully the model sketched out in sections 2, 3 and 4. We first describe the full solution to the case presented in section 3, which assumes $J = 2$, i.e. one union in each of the exportable and non-tradable sectors.

The union in the exportable sector maximizes the expected utility of its members, (3), subject to the aggregate demand for labor in the same sector. To derive this function, consider first the demand for the output of the i -th domestic firm in the exportable sector.

$$D(i) = \frac{E p(i)^{-\sigma}}{P^{1-\sigma}} \quad (\text{A.1})$$

Exactly like the typical foreign firm in the tradables sector, the representative domestic firm in the exportable sector maximizes profits by setting the wage as a constant mark-up over the wage: $p(i) = \sigma w / (\sigma - 1)$. The derived demand for labor by the representative firm can then be obtained by substituting this expression for its output price in (A.1), and by recalling that according to the production function output is equal to employment: $D(i) = n(i)$. The derived demand for labor by the i -th firm is therefore:

$$n(i) = \frac{E \left(\frac{w(i)\sigma}{\sigma-1} \right)^{-\sigma}}{P^{1-\sigma}} \quad (\text{A.2})$$

Note that, because the firm takes E and all other prices as given, its derived demand for labor has elasticity σ , the same as its output demand. This is an obvious consequence of the fact that the production function has constant returns to scale in the only factor, labor, and the wage is a constant proportion of the output price

The aggregate derived demand for labor in the exportable sector can be obtained by integrating the expression for the demand for labor in the representative firm, eq. (A.2), over all the firms in that sector, and by recalling that in a symmetric equilibrium all firms set the same output price:

$$p = \frac{w\sigma}{\sigma-1} \quad (\text{A.3})$$

Thus, the aggregate demand for labor facing the union in the exportable sector is

$$n = \frac{E p^{-\sigma}}{P^{1-\sigma}} \quad (\text{A.4})$$

where p and P are functions of w through the price formula (A.3) and the price index (2).

Using (A.3) and (2), one can write (A.4) as a function of the wage in the exportable sector only:

$$n = \frac{E \left(\frac{\sigma w}{\sigma - 1} \right)^{-\sigma}}{\left(\frac{\sigma w}{\sigma - 1} \right)^{1-\sigma} + \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma}} \quad (\text{A.5})$$

The union maximizes (3) subject to (A.5). The solution to the problem of the union is:

$$\frac{w(1-t)}{P} = R \frac{\epsilon}{\epsilon - 1 + \frac{1}{2}\gamma} \quad (\text{A.6})$$

where ϵ is the elasticity of the aggregate demand for labor to the wage as perceived by the union (i.e., taking the aggregate expenditure on tradables E as given), and γ is the elasticity of the price index for tradables, P , to the wage in the exportable sector (or equivalently to the price in the same sector):

$$\gamma = \frac{w^{1-\sigma}}{w^{1-\sigma} + 1} = \frac{p^{1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} > 0 \quad (\text{A.7})$$

Two observations are crucial for an intuitive understanding of (A.6). The first was emphasized in section 3: if γ were 0 the union would be charging the markup $\epsilon/(\epsilon - 1)$ times the "cost" of producing labor. The term $\frac{1}{2}\gamma$ captures the fact that an increase in wages increases the general price level and therefore reduces the real wages of union members. This effect leads to a moderation of wage demands.

The second observation is that ϵ , the elasticity of the aggregate demand for labor, is less than σ , the elasticity of the firm's labor demand. The intuition is straightforward. An increase in the price of a single exportable good induces substitution *within* the exportable sector (i.e. towards other exportables) and *toward* the importable sector (i.e. towards all importables). This substitution occurs with an elasticity σ , which is also the elasticity of the firm's demand for labor. On the other hand, because the union sets a uniform wage for all firms in the sector, when the wage in that sector increases *all* prices of exportables increase in the same proportion. Consequently, the intra-sectoral substitution is eliminated, and only the substitution towards importables remains. More formally, from (A.5), ϵ can be written as:

$$\epsilon = \sigma - (\sigma - 1)\gamma < \sigma \quad (\text{A.8})$$

This expression can be interpreted by looking at the expression for the demand for labor (A.4). As discussed above, an increase in w has two effects on labor demand. First, it causes a fall in the aggregate real demand for exportables E/P by increasing p and therefore the price index of tradables P . Second, it causes substitution towards importables, by increasing the relative price of exportables, as captured by the term $p^{-\sigma}/P^{-\sigma}$. Now suppose there are no importables: then the price index of tradables P would be equal to the price of exportables p (see (2)), and γ would be identically equal to 1. From (A.8), the elasticity of the demand for labor in the exportable sector to the wage would be equal to 1. This is obvious by looking at (A.4): when w and therefore p increase in the exportable sector, there is no substitution to foreign competitors. The only effect on the demand for exportables and therefore on employment comes from the fact that given the *nominal* amount allocated to exportables, E , the *real* demand for exportables falls in proportion to the increase in the price p .

Conversely, consider the other extreme case and suppose the mass of producers of exportables tends to 0: for expositional purposes only, assume there is just one domestic producer of exportables. Then the price index for tradables would consist only of importables, aside from the single exportable good. The elasticity of the price of tradables to the price of exportables, γ , would be 0, and from (A.8) the elasticity of the demand for labor in the exportable sector would be σ . Again, this can easily be interpreted by reference to the expression for the demand for labor (A.4). When the wage in the exportable sector increases the price of the exportable good increases in proportion, but the prices of all competitors - the importable goods - remain constant. Since the only domestic producer has mass 0, the *real* demand for tradables E/P does not change. *All* the effect of the increase in the wage now comes from the substitution towards importables, represented by the term $p^{-\sigma}/P^{-\sigma}$, whose elasticity to p and therefore w is clearly σ .

We now show that the wage in the nontradable sector is higher than in the tradable sector. As we showed in section 3, in the nontradable sector the wage set by the union is:

$$\frac{\bar{w}(1-t)}{\bar{P}} = 2R \tag{A.9}$$

On the one hand, the lower elasticity of labor demand in the nontradables sector induces

the union there to set a higher wage than in the exportable sector. On the other hand, the elasticity of the price index for non-tradables \bar{P} to the wage is higher than the corresponding elasticity in the exportable sector. Hence, the elasticity of the price level \bar{P} to the wage is also higher in the nontradable sector. This second effect works toward restraining wage demands more in the nontradables sector.

However, it is easy to show that the first effect prevails if the elasticity of substitution between goods is sufficiently high ($\sigma > 2$). In fact, under this condition the right hand side of (A.6) is an increasing function of γ (recall that ϵ is a decreasing function of γ); since $\bar{\gamma} > \gamma$ for any value of w or \bar{w} , necessarily $\bar{w} > w$. The intuition runs as follows: contrary to the exportable sector, in the nontradables sector it is not possible to substitute towards a whole class of goods (importables). When the elasticity of substitution between goods is sufficiently high ($\sigma > 2$) this fact has a larger impact on the behavior of the union in the nontradables sector than the fact that the elasticity of the price level to the wage is higher than in the exportable sector.

We can now prove Proposition 1 in section 3:

Proof of Proposition 1:

From eq. (A.6) and (A.3) one obtains, in a symmetric equilibrium:

$$p = \frac{\sigma}{\sigma - 1} \frac{R\bar{P}}{1 - t} \left[\frac{\sigma - (\sigma - 1)\gamma}{\sigma - (\sigma - 1)\gamma - 1 + \frac{1}{2}\gamma} \right] \quad (\text{A.10})$$

Similarly, in the nontradables sector one obtains

$$\bar{p} = 2 \frac{R\bar{P}}{1 - t} \quad (\text{A.11})$$

Denoting the terms in brackets on the r.h.s. of (A.10) by H , one can write:

$$d \log p = d \log \bar{P} - d \log(1 - t) + \frac{d \log H}{d \log \gamma} \frac{d \log \gamma}{d \log p} d \log p \quad (\text{A.12})$$

$$d \log \bar{p} = d \log \bar{P} - d \log(1 - t) \quad (\text{A.13})$$

where

$$d \log \bar{P} = \frac{1}{2} d \log P + \frac{1}{2} d \log \bar{p}; \quad d \log P = \gamma d \log p \quad (\text{A.14})$$

Combining all these expressions, one obtains:

$$\frac{d \log \bar{p}}{d \log(1-t)} = -2 + \gamma \frac{d \log p}{d \log(1-t)} \quad (\text{A.15})$$

and

$$\frac{d \log p}{d \log(1-t)} = \frac{d \log \bar{p}}{d \log(1-t)} \left[1 - \frac{d \log H}{d \log \gamma} \frac{d \log \gamma}{d \log p} \right]^{-1} \quad (\text{A.16})$$

Now denote the term in brackets in (A.16) as X : since $d \log H / d \log \gamma$ is positive for $\sigma > 2$ and $d \log \gamma / d \log p$ is negative, $X > 1$. Therefore, solving (A.15) and (A.16):

$$\frac{d \log p}{d \log(1-t)} = -\frac{2}{X-\gamma}; \quad \frac{d \log \bar{p}}{d \log(1-t)} = -\frac{2X}{X-\gamma} \quad (\text{A.17})$$

Because $\gamma < 1$, $d \log p / d \log(1-t)$ is negative, which proves part (i) of the proposition. In addition, since $X > 1$, from (A.17) $d \log p / d \log(1-t)$ is smaller in absolute value than $d \log \bar{p} / d \log(1-t)$. *A fortiori*, then, the relative price of nontradables increases. In fact, from (A.15):

$$\frac{d \log(\bar{P}/P)}{d \log(1-t)} = \frac{d \log \bar{p}}{d \log(1-t)} - \frac{d \log P}{d \log(1-t)} = \frac{d \log \bar{p}}{d \log(1-t)} - \gamma \frac{d \log p}{d \log(1-t)} > 0 \quad (\text{A.18})$$

This proves part (ii) of the Proposition.

To prove part (iii), consider the expressions for labor demand (and therefore employment) in the two sectors in a symmetric equilibrium. Letting n and \bar{n} denote total employment in the exportable and non-tradable sector respectively, we have:

$$n = \frac{E p^{-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} \quad (\text{A.19})$$

The trade balance equilibrium condition requires that the nominal expenditure by domestic residents on importables be equal to the nominal expenditure by foreign residents on exportables:

$$\frac{Y}{2} \frac{p^{*1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} = \frac{Y^*}{2} \frac{p^{1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}} \quad (\text{A.20})$$

and therefore

$$Y = Y^* \frac{p^{1-\sigma}}{p^{*1-\sigma}} \quad (\text{A.21})$$

and since E is equal to $(Y + Y^*)/2$ we obtain

$$E = \frac{Y^*}{2} \frac{p^{1-\sigma} + p^{*1-\sigma}}{p^{*1-\sigma}} \quad (\text{A.22})$$

which yields

$$n = \frac{Y^* p^{-\sigma}}{2 p^{*1-\sigma}} \quad (\text{A.23})$$

Because Y^* and p^* are constant, employment in the tradable sector decreases when the income tax rate and therefore p increases. Similarly, using (A.21) and the fact that $\bar{E} = Y/2$, one obtains in the nontradable sector

$$\bar{n} = \frac{Y}{2\bar{p}} = \frac{Y^* \bar{p}^{1-\sigma}}{2\bar{p} p^{*1-\sigma}} \quad (\text{A.24})$$

which again decreases as t and therefore p and \bar{p} increase. Also, because \bar{p} increases more than p , \bar{n} decreases more than n . \square

We now prove Proposition 3 in section 4:

Proof of Proposition 3:

We only prove part (i); the other two parts can be proved similarly, following the proof of Proposition 1. In turn, we prove part (i) in three parts. (i.a): we first prove that, as long as the unions do not internalize the nominal expenditure effect, the wage in the exportable sector increases as the number of unions decreases; (i.b): we then prove that, given the number J of unions, the wage in the exportable sector is lower if the union internalizes the nominal expenditure effect than if it does not; (i.c): finally, we show that, once the unions start internalizing the nominal expenditure effect, the wage in the exportable sector *decreases* as the number of unions decreases.

(i.a) We can define the elasticity of P and \bar{P} to the wage set by a union in the exportables and nontradables sector as a function of J , the number of unions (note that there are $J/2$ unions in each sector):

$$\gamma_J = \frac{2}{J} \frac{p^{1-\sigma}}{p^{1-\sigma} + p^{*1-\sigma}}; \quad \bar{\gamma}_J = \frac{2}{J} \quad (\text{A.25})$$

The first order condition for the problem of the j -th union when J unions are present in the economy gives, for the exportable sector:

$$\frac{w_J(1-t)}{\bar{p}} = RX_J \quad (\text{A.26})$$

where

$$X_J \equiv \frac{\epsilon_J}{\epsilon_J - 1 + \frac{1}{2}\gamma_J} \quad (\text{A.27})$$

and

$$\epsilon_J = \sigma - (\sigma - 1)\gamma_J \quad (\text{A.28})$$

In the nontradable sector the first order condition gives:

$$\frac{\tilde{w}_J(1-t)}{\bar{P}} = R\tilde{X}_J \quad (\text{A.29})$$

where

$$\tilde{X}_J \equiv \frac{\tilde{\epsilon}_J}{\tilde{\epsilon}_J - 1 + \frac{1}{2}\tilde{\gamma}_J} \quad (\text{A.30})$$

and

$$\tilde{\epsilon}_J = \sigma - (\sigma - 1)\tilde{\gamma}_J \quad (\text{A.31})$$

Using the formula for \bar{P} , (2), one obtains from (A.26):

$$\frac{w_J(1-t)}{\frac{\sigma}{\sigma-1} [w_J^{1-\sigma} + 1]^{\frac{1}{\sigma(1-\sigma)}} \tilde{w}_J^{\frac{1}{2}}} = RX_J \quad (\text{A.32})$$

and from (A.29):

$$\frac{\tilde{w}_J^{\frac{1}{2}}(1-t)}{\frac{\sigma}{\sigma-1} [w_J^{1-\sigma} + 1]^{\frac{1}{\sigma(1-\sigma)}}} = R\tilde{X}_J \quad (\text{A.33})$$

From (A.32) and (A.33) we obtain

$$H \equiv \frac{w_J^{1-\sigma}}{w_J^{1-\sigma} + 1} - \left[\frac{\sigma}{\sigma-1} R^2 X_J \tilde{X}_J \right]^{1-\sigma} = 0 \quad (\text{A.34})$$

Since both X_J and \tilde{X}_J are increasing in γ_J , and the latter is decreasing in J for any given p , we have $\partial H/\partial J < 0$. Also, given that $w_J^{1-\sigma}/(w_J^{1-\sigma} + 1) = \frac{J}{2}\gamma_J$, for any given J it is clear that $\partial H/\partial w_J < 0$. Therefore, $\partial w_J/\partial J$ is negative: as the number of unions increases, the wage decreases. We can then use expression (A.33) to show that \tilde{w}_J is also decreasing in J . In fact, when J increases γ_J decreases and the r.h.s. of (A.33) decreases; also, as w_J decreases, the denominator of the l.h.s. decreases. Necessarily, then, \tilde{w}_J must decrease as J increases.

(i.b) Assume that there are J unions in the economy. Consider a union that internalizes the nominal expenditure effect. Substituting the current account equilibrium condition (13) into the expression for the demand for labor for the j -th union (14), one obtains:

$$n_j = \frac{2 Y^* p^{-\sigma}}{J 2 p^{1-\sigma}} \quad (\text{A.35})$$

Therefore, when the unions internalize the nominal expenditure effect the elasticity of the demand for labor ϵ_j is σ , while as we showed above it is $\sigma - (\sigma - 1)\gamma_j$ when the unions do not internalize the same effect. The elasticity of the price index of tradables to the wage, γ_j , is the same in the two cases. Thus, in both cases the implicit expression for the wage in the exportable sector in a symmetric equilibrium is given by expression (A.30). For any given w and \tilde{w} , the r.h.s. of (A.30) is lower when the unions internalize the nominal expenditure effect, because ϵ_j is higher in that case. Because the l.h.s. is increasing in w and the r.h.s. is decreasing in w , for any given \tilde{w} the wage in the exportable sector w is lower when the unions internalize the nominal expenditure effect. In addition \tilde{w} can also easily be shown to be lower when unions internalize the nominal expenditure effect: *a fortiori*, then, w will also be lower.

(i.c) To show that, once unions internalize the nominal expenditure effect, the wage in the exportable sector decreases as the number of unions in the economy J decreases, note that the elasticity of the demand for labor ϵ_j is now always equal to σ , and is therefore independent of J . The elasticity of the price of exportables γ_j , however, increases as J decreases for any given w . Therefore, for any given w the r.h.s. of (A.30) decreases as J decreases. As usual, following a similar reasoning it can be shown that \tilde{w} too decreases as J decreases; therefore, both w and \tilde{w} decrease as J decreases.

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