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Is tax coordination efficient in a currency union?

(Patrick ARTUS)

It is most often argued that tax policy coordination, substituting for tax competition, would improve welfare in a currency union — in particular in the euro zone. It is also sometimes argued that “enhanced cooperations” in the field of taxation should be implemented, i.e. setting up sub-groups of countries that coordinate or harmonise their tax policies in some fields, while the other countries refuse to take part in this coordination. We would like to ascertain whether tax coordination for all the countries or a sub-group of countries of a currency area improves welfare.

We show that, if the governments of these countries coordinate their tax policies without taking into account the central bank’s behaviour, in consequence tax coordination can reduce welfare in comparison with a situation of tax competition, and may be as a result counterproductive.

We also show that, in the situation where the non-cooperative equilibrium (between tax policies) is preferable to the cooperative equilibrium, “enhanced cooperation” with respect to tax policies reduces welfare in the countries taking part in the cooperation scheme, improves welfare in the other countries.

Therefore, the idea that refusing to coordinate tax policies in a currency union (between all countries or in a group of countries) leads to a better arrangement than tax policy coordination cannot be ruled out.

Introduction

Recently, **tax competition has become fiercer** within the European Union. Such competition has borne above all on the taxation of corporate profits (**Table 1**) and social security contributions (**Table 2, charts 1A and B**).

Table 1
Corporate tax rate in 2002

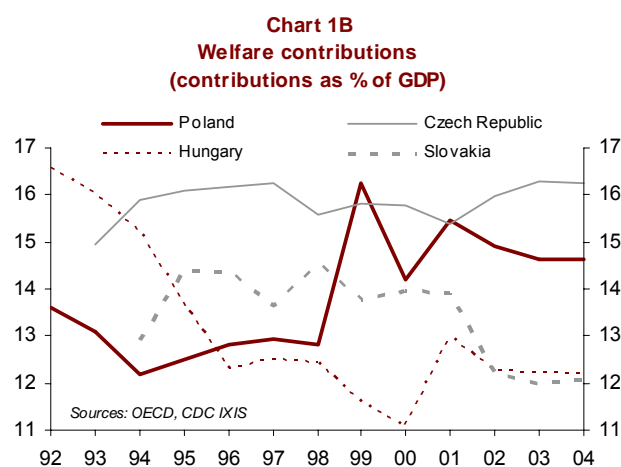
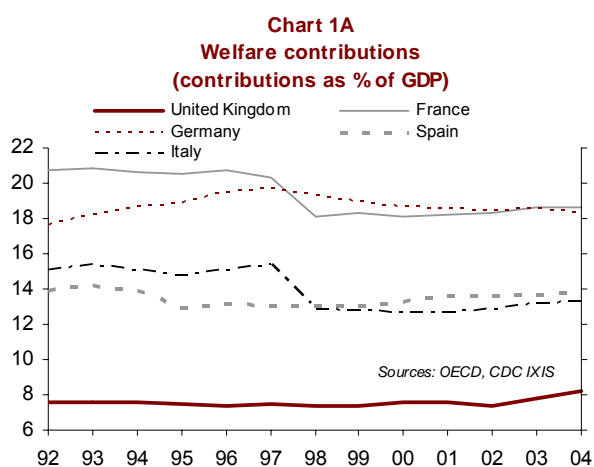
Germany	38.0%	Sweden	28.0%
Austria	34.0%	Bulgaria	15+10% (a)
Belgium	40.2%	Cyprus	25%
Denmark	32.0%	Czech Republic	31%
Spain	35.0%	Estonia	0%
Finland	29.0%	Hungary	16%
France	35.4%	Latvia	15%
Greece	35.0%	Lithuania	15%
Ireland	12.5%	Malta	35%
Italy	34.0%	Poland	19%
Luxembourg	30.0%	Romania	25%
Holland	35.0%	Rep. of Slovakia	25%
Portugal	35.2%	Slovenia	25%
United Kingdom	30.0%	Turkey	30%

(a) 20% in 2001 for profits $\geq 50,000$ Lev, otherwise 15%; for banks and other financial institutions, 15% in 2002
Sources: Eurostat, European Parliament 2003, Dictionnaire permanent fiscal 2001

Table 2
Social security contributions (as % GDP)

	1998	1999	2000	2001	2002	2003	2004
Germany	19.28	18.97	18.63	18.50	18.43	18.57	18.29
Austria	17.19	17.22	16.87	16.72	16.52	16.50	16.44
Belgium	16.55	16.37	16.11	16.44	16.74	16.53	16.51
Spain	13.02	13.08	13.31	13.53	13.57	13.72	13.77
Finland	13.05	13.23	12.31	12.58	12.36	12.27	12.25
France	18.12	18.30	18.14	18.16	18.27	18.64	18.61
Netherlands	16.42	17.12	17.08	15.33	14.93	15.47	15.52
Ireland	5.60	5.64	5.70	5.81	5.70	5.87	5.77
Denmark	2.63	3.21	3.25	3.22	2.69	2.68	2.65
United Kingdom	7.38	7.42	7.56	7.61	7.40	7.84	8.21
Sweden	14.53	13.23	15.12	15.50	15.47	15.22	14.92
Italy	12.84	12.74	12.68	12.61	12.82	13.17	13.23
Portugal	11.24	11.35	11.78	11.90	12.26	12.58	12.22
Greece	13.56	13.67	13.96	13.93	14.08	14.68	14.80
Poland	12.83	16.25	14.21	15.48	14.93	14.63	14.64
Hungary	12.42	11.61	11.09	12.98	12.26	12.20	#N/A
Czech Republic	15.56	15.81	15.79	15.38	15.97	16.28	16.25
Republic of Slovakia	14.50	13.75	13.95	13.94	12.17	12.01	12.07

Source: OECD



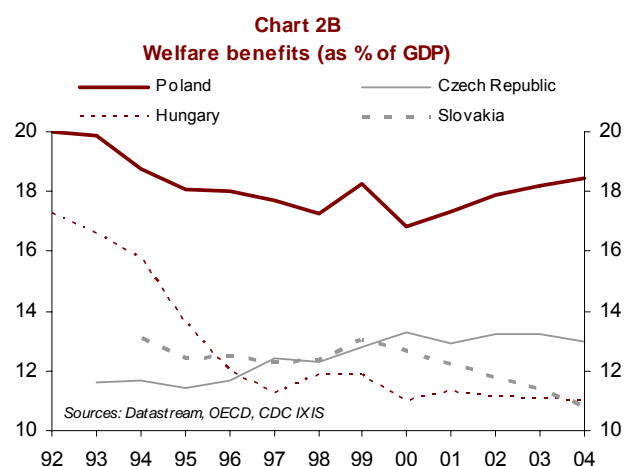
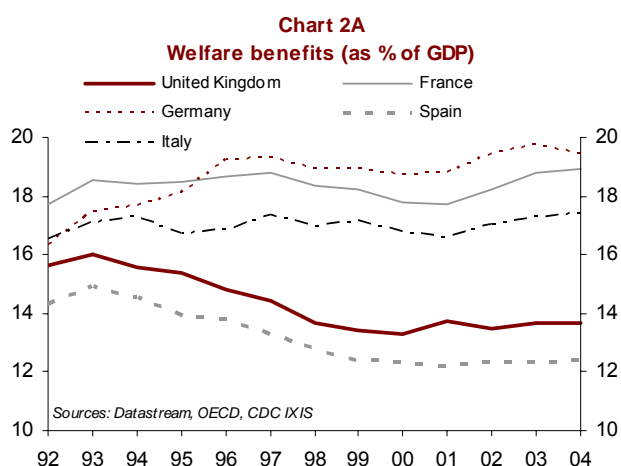
In addition to the expected effects of the trade opening with countries where wages are lower (**table 3**), one therefore has to factor in the effects of tax competition.

Table 3
Average hourly labour costs in manufacturing industry
(in dollars per hour)

	1990	1995	2000	2001
United Kingdom	12.7	13.8	16.4	16.1
Europe	17.2	21.8	18.5	18.4
EU-15	-	25.5	21.0	-
Denmark	-	29.2	27.4	-
Sweden	-	29.3	27.2	-
Germany	-	30.3	23.0	22.9
France	15.5	19.4	15.7	15.9
Italy	17.5	16.2	14.0	13.8
Spain	11.4	12.8	10.8	10.9
Portugal	-	7.5	-	-
Ireland	-	17.2	-	-
Poland	-	2.8	4.1	-
Hungary	-	2.6	3.4	-
Slovenia	-	8.6	8.4	-
Slovakia	-	2.9	2.8	-
Czech Republic	-	2.2	3.0	-

Source: US Department of Labor, BLS, Sept 2002

It is also a type of welfare competition: Apart from Poland, Central European countries have low welfare benefits in comparison with France, Germany or Italy (at the same level as the United Kingdom or Spain, **Charts 2A and B**).



The annual duration of labour is lengthy in these countries (**Table 4**).

Table 4
Annual duration of labour (2003)
Unit: Average number of hours worked

France	1.453
Germany	1.446
Italy	1.591
United Kingdom	1.673
Spain	1.800
Czech Republic	1.972
Poland	1.956
Slovakia	1.814

Source: OECD

The minimum wage is low (Table 5).

Table 5
Minimum wage (2004, EUR)

France	1,173
United Kingdom	1,083
Spain	537
Italy	1,073
Czech Republic	207
Hungary	189
Poland	177
Slovenia	471
Slovakia	148

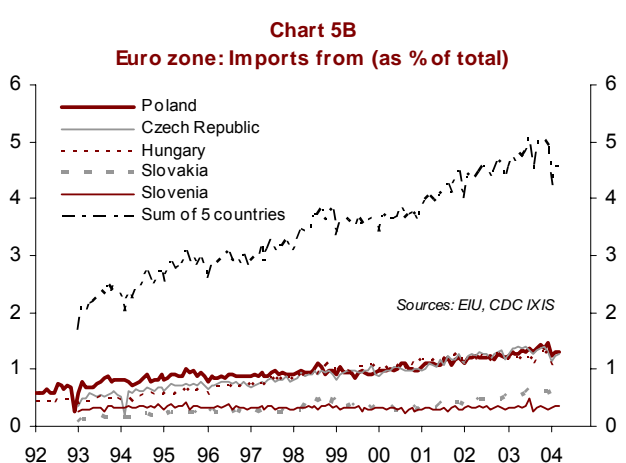
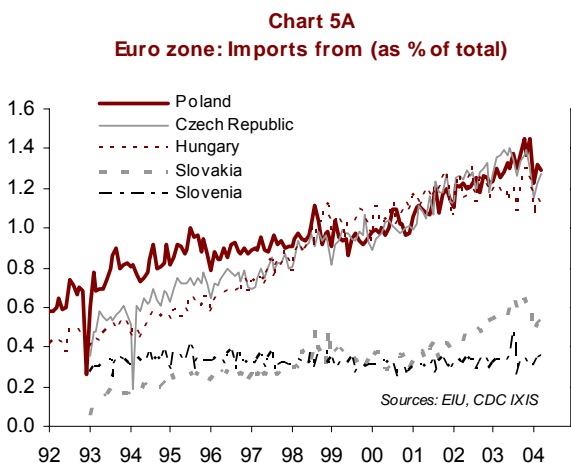
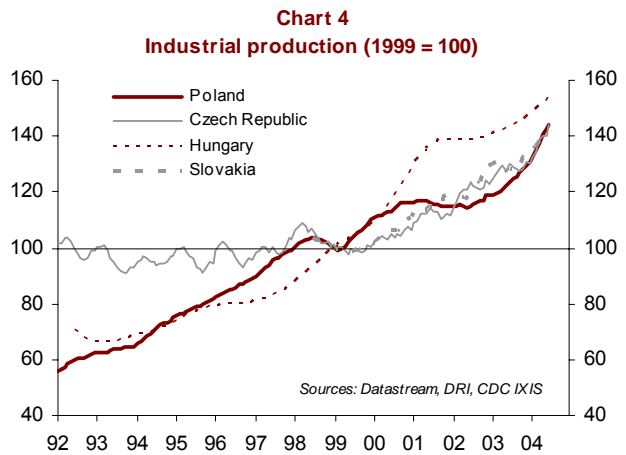
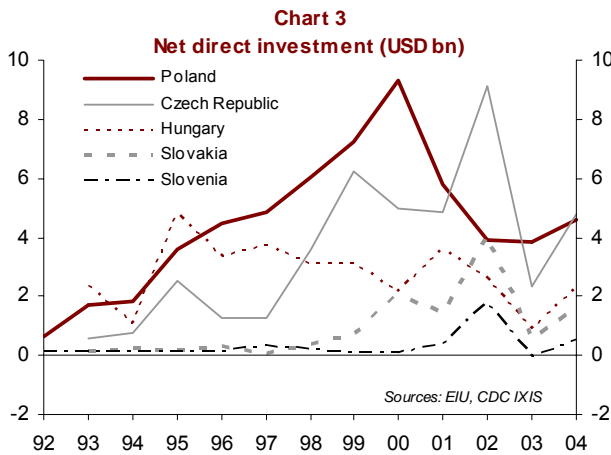
Source: Eurostat

Will it be possible to achieve coordination of tax and welfare policies in the EU-25? This seems very unlikely:

- what credible threat can the countries that want to coordinate tax policies brandish? The harmonisation of tax rates is not a criterion set for joining the euro zone. The amount of structural transfer and regional payments paid to the CEEC has already been decided (i.e. a net EUR 16 bn from 2004 to 2006).
- setting up “enhanced coordination schemes” among countries that want to harmonise the rate (and the base) of corporate tax puts no pressure on countries that refuse such coordination. On the contrary, it may mean that the countries that have chosen this enhanced coordination, which will probably consist in maintaining a quite high taxation rate on profits (and harmonising tax bases) will be even more vulnerable with regard to the aggressive tax policies implemented by the other countries.

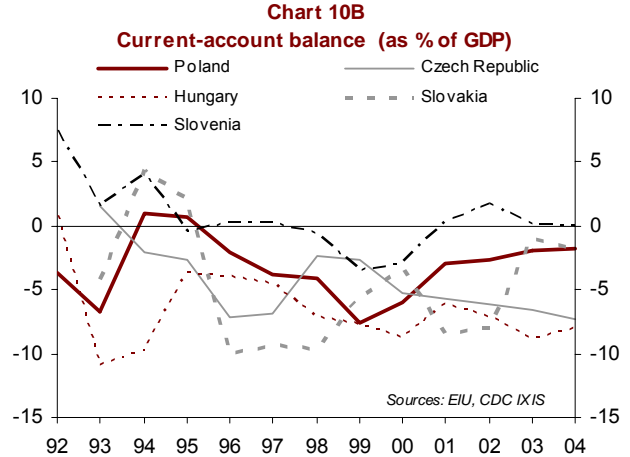
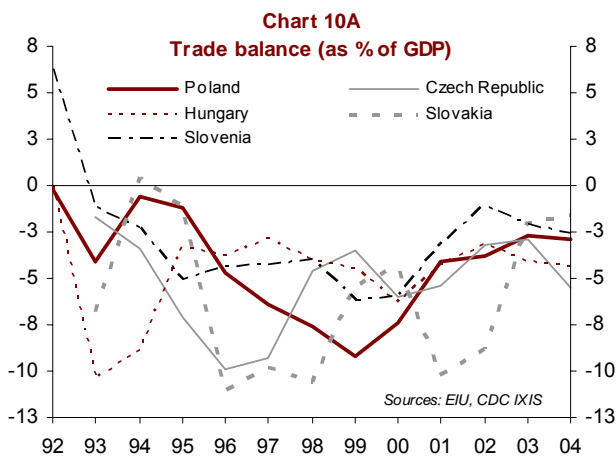
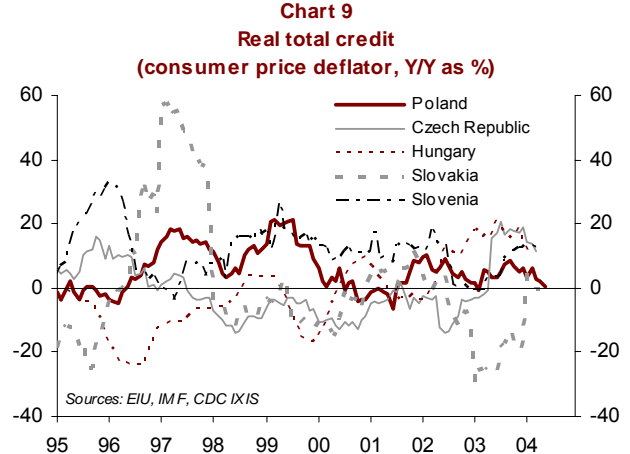
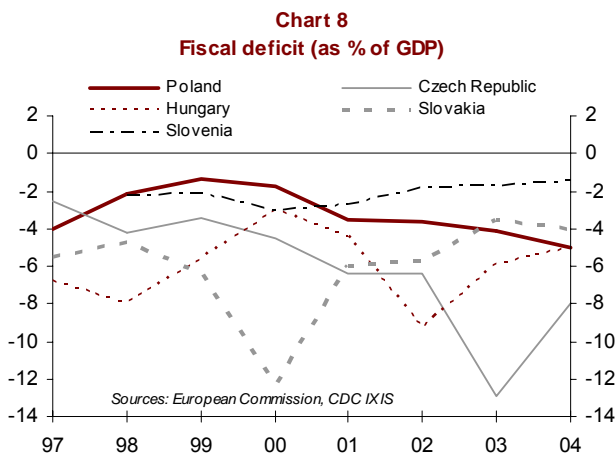
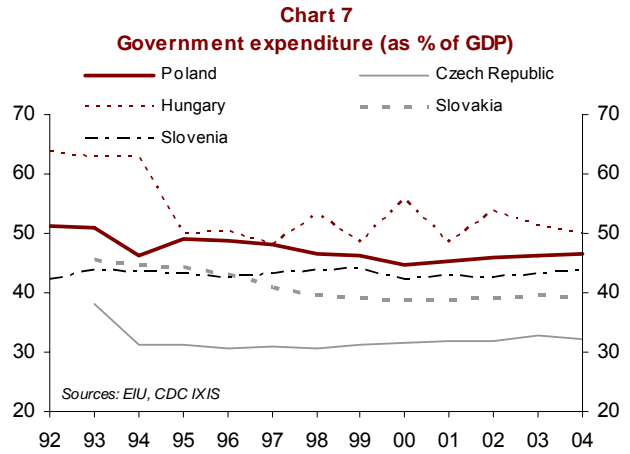
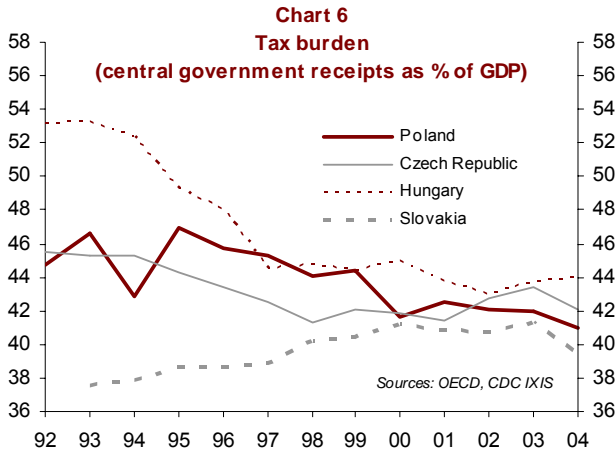
The usually expected consequence from this situation is an acceleration in offshoring into the CEEC, although they will not be justified by one of the normal causes of international specialisation (endowment in factors, etc.), but only because of the tax bias.

We can effectively see substantial direct investment in Poland, the Czech Republic, Hungary, and Slovakia (**Chart 3**); while industrial production has gathered momentum in these countries since 2001-2002 (**Chart 4**), and an increase in the euro zone’s imports from Central European countries (**Charts 5A and B**).



This policy has also worsened financial imbalances in enlargement countries.

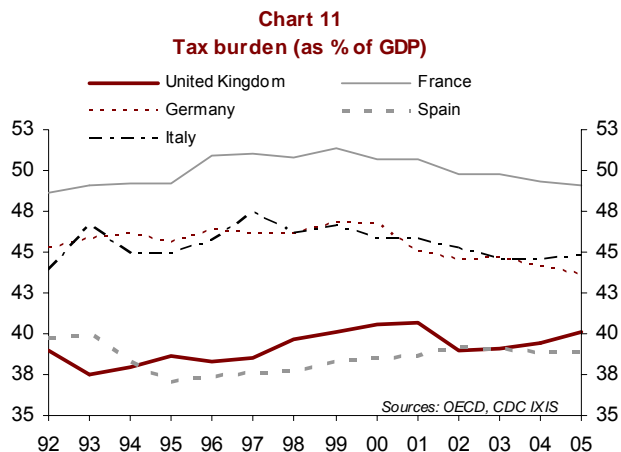
Manifestly, there is a clear-cut downward trend in the tax burden in accession countries (**Chart 6**). These countries are caught between their resolve to cut the tax burden in order to take advantage of the effects of tax competition and the need to increase government expenditure (**Chart 7**) (need to build public infrastructures, finance the qualification for the so-called “*acquis communautaire*”, etc.). As a result, they are running up sometimes substantial fiscal deficits (**Chart 8**) that combines with the rapid increase in consumer credit in several countries (Czech Republic, Slovenia, Hungary, and from 1997 to 2000 in Poland, **Chart 9**), i.e. with the decline in the savings rate, leads to huge **external deficits** huge (**Charts 10A and B**), which are actually impressive in Hungary and the Czech Republic.



Therefore, in the **accession countries, twin deficits** can be expected due to the fiscal deficits, themselves primarily stemming from the determination to reduce the tax burden.

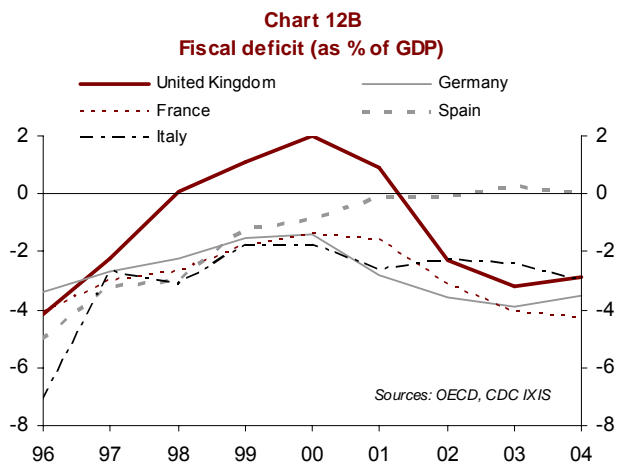
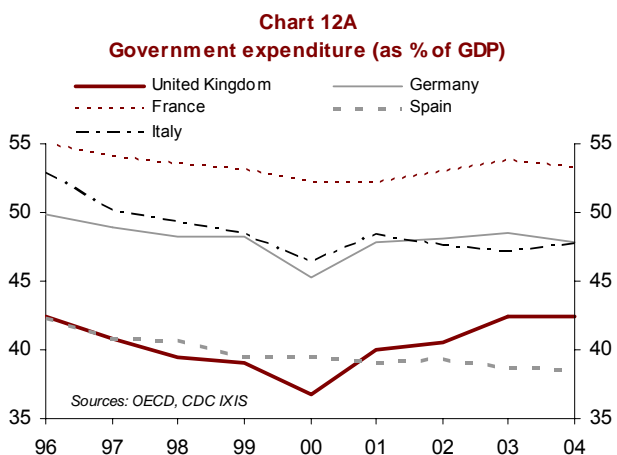
In a parallel way

The major EU countries will be led to reduce their tax burden to weather tax competition from accession countries. This can be seen in France, Germany and Italy, all countries where the tax burden is high (**Chart 11**).



This can have two very negative consequences for these countries:

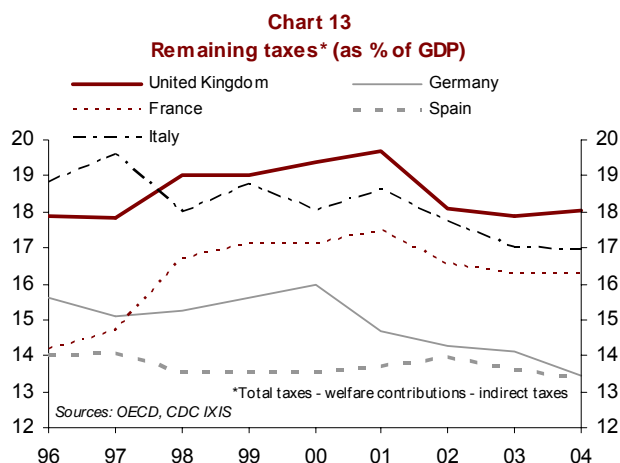
- since simultaneously, they must increase several of their government expenditure items (health, pensions, security, education, military, research, etc.), their fiscal deficits will widen, or they will have to forego these necessary increases in spending (**Charts 12A and B**);



Only Spain is spared for the time being by this process:

- the tax structure of the major EU-15 countries will become unacceptable. These countries must as a priority reduce the tax burden on production factors that can be relocated (capital, skilled labour), and significant taxation would subsist only on the consumption (indirect taxes) of unskilled labour.

- We can see that this dynamics has already set in: Taxes other than welfare contributions and indirect taxes are being cut (**Chart 13**).



A durable situation of tax and welfare competition in the EU, because of the institutional choice that have been made (unanimous voting in such fields as taxation) and to the lack of any credible threat that could be made to accession countries which would force them to cooperate, seems therefore to be unfavourable both for:

- accession countries, where the twin deficits (fiscal and external) would remain substantial;
- and major EU-15 countries, where the necessary reduction in the tax burden would lead them to either see their fiscal deficits widen or have to forego required expenditure, as well as end up with an unacceptable tax structure.

We want to be able to confirm this intuition of a welfare reducing effect of tax competition by a more theoretical analysis, in particular taking into account monetary policy.

We restrict the analysis to the eurozone countries, where tax competition already exists, and because a number of Central European Countries will join EMU before the end of this decade.

The first question that arises concerns the effect of tax competition on welfare. As each country believes it can improve its competitiveness and attract capital, the lack of cooperation normally leads to lower tax rates. As a result, either budget deficits grow or government spending is reduced in an ineffective manner.

But, at this stage, we must take into account the ECB's reaction, with regard to the 12 member countries of the euro zone. The lack of coordination, as it drives down tax rates, usually leads to a decline in inflation, hence a rate cut by the ECB — in itself a positive development. We therefore need to ascertain whether we are in a situation where the coordination of the sub-set of "players" (here the governments and not the ECB) hurts welfare instead of improving it.

The second question concerns decision-making (voting) rules in the European Union. Some countries, e.g. France and Germany, are trying to get the European Union change over to qualified majority voting instead of unanimous consensus for decisions relating to taxation. But other countries, such as the United Kingdom, sharply oppose any move to discard unanimity (i.e. the right of veto). We need to see why they do.

In the light of this opposition, some countries (and the European Commission) have suggested creating “pioneer groups” (or enhanced coordination) between some European countries that accept to harmonise their corporate tax rates.

We would like to look at the effects of this type of coordination which is limited to a sub-group of countries. These countries protect themselves from tax competition within the sub-group, but the threat of tax competition from the member countries that do not belong to the sub-group increases.

The idea of the undesirable nature of tax coordination, if it affects only a few of the agents concerned, has already been drawn upon in the literature. Beetmsa-Bovenberg (2001) shows that tax coordination can be counterproductive if there is no coordination between wage-earners and monetary and fiscal authorities. Beetsma-Bovenberg (1999), Begg (2000), Debrun (2000) reach similar results in the case of a lack of coordination between monetary and fiscal policy.

Our thesis here is slightly different, since we do not exactly introduce the lack of coordination between monetary and fiscal policies of countries of a currency area. Instead we look at a situation where the central bank of the currency area has price stability as an objective and governments do not take into account the central bank’s reaction, but take monetary policy as given there is a Nash equilibrium between governments and the central bank.

We show that in this situation the coordination of tax policies (in our model, the taxation of corporate profits) in all likelihood lowers welfare.

Contrary to what many articles assert (Allsopp-Davies-Vines (1995), Alogoskoufis (1990), Dornbusch (1997), Debrun-Wyplosz (1999), Buitier-Kletzer (1991), Levine-Pearlman (1994), Nordhaus (1994), Bayoumi-Masson (1995), Giovannini-Spaventa (1991), Wyplosz (1991), Kletzer (1997), Jensen (1996), etc.), and in view of our hypotheses that we believe correspond to the EU’s current situation, monetary unification apparently does not reinforce the need for fiscal coordination.

To examine these questions, we construct a 3-country model of a currency union in which the central bank stabilises prices. Taxation of corporate profits is the instrument of economic policy in each country that can be affected by coordination.

In each country, low taxation on profits:

- attracts capital from other countries;
- lowers prices;
- but reduces the admissible level of government spending.

The risk with the lack of coordination is thus that each country may cut its taxes on profits to an excessive extent, while believing it is attracting capital. This does not occur at equilibrium, and therefore each country reduces government spending excessively.

But, on the other hand, as we will see, coordination leads to a higher tax rate. If the central bank’s behaviour is not taken into account, this can induce a rate hike that is not anticipated by the governments.

1- The model

The model is a model **of a currency union made up by three countries of a similar size.**

The interest rate of the currency union is set by the central bank to stabilise prices; each country chooses the corporate tax rate levied on companies located in the country. If it lowers this taxation rate, on the one hand it attracts capital from the other countries of the currency area and, on the other hand, it reduces its prices. However, if it does so, it must also cut its government expenditure to comply with a minimum balance in its budget — to curtail the increase in its fiscal deficit.

The model is written as follows, for example for **country 1**:

Production:

$$(1) \quad y_1 = -\alpha r + g_1 + \beta \left(\frac{p_2 + p_3}{2} - p_1 \right)$$

Production y decreases with interest rate r , grows with government expenditure g , grows with the average price in the two other countries (2 and 3) compared with the price of the country considered (i.e. country 1).

Price:

$$(2) \quad p_1 = \theta y_1 + \mu \left(\tau_1 - \frac{\tau_2 + \tau_3}{2} \right) + \sigma \tau_1$$

The price rises with production y , grows with the excess taxation of corporate earnings in the country in comparison with the average taxation of profits in the two other countries, grows with the taxation of profits in the country. τ_i stands for the corporate tax rate in country i . Let us now explain these relations.

If the taxation of profits in a country increases (i.e. if τ_1 increases), as the country's companies stabilise their after-tax profit margin, they raise their price (i.e. p_1); furthermore, if a country lowers its taxation of profits in comparison with the level prevailing in its competitors, this cut attracts productive capital into the country. In other words, for a given level of demand, this reduces prices.

Government expenditure:

$$(3) \quad g_1 = \bar{g} + \varphi \tau_1$$

A lower corporate tax rate (decline in τ_1) entails reducing government expenditure g_1 to curb the increase in the country's fiscal deficit.

Combining (1) (2) and (3), we obtain:

$$(4) \quad \begin{cases} p_1 + p_2 + p_3 = \theta(-3\alpha r + 3\bar{g}) + (\varphi\theta + \sigma)(\tau_1 + \tau_2 + \tau_3) \\ g_1 + g_2 + g_3 = 3\bar{g} + \varphi(\tau_1 + \tau_2 + \tau_3) \\ y_1 + y_2 + y_3 = -3\alpha r + 3\bar{g} + \varphi(\tau_1 + \tau_2 + \tau_3) \end{cases}$$

A rise in the average taxation (in all three countries) of profits $\left(\frac{\tau_1 + \tau_2 + \tau_3}{3}\right)$ allows average government expenditure $\left(\frac{g_1 + g_2 + g_3}{3}\right)$ to increase, and this increases average production $\left(\frac{y_1 + y_2 + y_3}{3}\right)$. Since higher taxation of profits directly leads to a rise in prices and furthermore increases production, it increases for two reasons the average price $\left(\frac{p_1 + p_2 + p_3}{3}\right)$.

The behaviour of the central bank is aimed at obtaining $p_1 + p_2 + p_3 = 0$.

This implies:

$$(5) \begin{cases} \alpha r = \bar{g} + \frac{(\varphi\theta + \sigma)}{\theta} \left(\frac{\tau_1 + \tau_2 + \tau_3}{3}\right) \\ y_1 + y_2 + y_3 = -\frac{\sigma}{\theta} (\tau_1 + \tau_2 + \tau_3) \end{cases}$$

The interest rate rises with the taxation of profits, and consequently (since the interest rate effect outweighs the government expenditure effect), average production decreases with the taxation of profits.

2- Non-cooperative equilibrium

We suppose in this paper that the central bank and the three countries do not cooperate and the equilibrium is a Nash equilibrium: all four players take the three other instruments of economic policy as given.

The central bank's behaviour is given by (5).

For each country (for example for country 1), we have:

$$(6) \frac{p_2 + p_3}{2} - p_1 = \theta \left(\frac{y_2 + y_3}{2} - y_1\right) + \frac{3\mu}{2} \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right) + \sigma \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right)$$

Hence:

$$(7) y_1 = -\alpha r + \bar{g} + \varphi\tau_1 + \beta\theta \left(\frac{y_2 + y_3}{2} - y_1\right) + \frac{3\beta\mu}{2} \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right) + \sigma\beta \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right)$$

Since $\frac{y_2 + y_3}{2} - y_1 = \frac{y_2 + y_3 + y_1}{2} - \frac{3}{2}y_1$, $y_1 + y_2 + y_3$ is given by (4), we finally have:

$$(8) \frac{y_2 + y_3}{2} - y_1 = -\frac{3}{2}\alpha r + \frac{3\bar{g}}{2} + \varphi/2(\tau_1 + \tau_2 + \tau_3) - 3/2 y_1$$

The foregoing implies:

$$(9) \quad y_1 \left(1 + \frac{3}{2} \beta \theta\right) = -\alpha r \left(1 + \frac{3}{2} \beta \theta\right) + \bar{g} \left(1 + \frac{3}{2} \beta \theta\right) + \varphi \tau_1 + \beta \theta \frac{\varphi}{2} (\tau_1 + \tau_2 + \tau_3) + \left(\frac{3\beta\mu}{2} + \sigma\beta\right) \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right)$$

and

$$(10) \quad \begin{aligned} p_1 \left(1 + \frac{3}{2} \beta \theta\right) &= -\theta \alpha r \left(1 + \frac{3}{2} \beta \theta\right) + \theta \bar{g} (1 + 3/2 \beta \theta) + \theta \varphi \tau_1 + \frac{\beta \theta^2 \varphi}{2} (\tau_1 + \tau_2 + \tau_3) \\ &+ \sigma \left(1 + \frac{3}{2} \beta \theta\right) \tau_1 + \left(\frac{\tau_2 + \tau_3}{2} - \tau_1\right) (\sigma \beta \theta - \mu) \end{aligned}$$

As is evident, the price and production decrease with the interest rate r , and increase in line with the taxation of profits in the country (τ_1).

A rise in average taxation $\tau_1 + \tau_2 + \tau_3$ increases average government expenditure, and therefore increases $\frac{y_2 + y_3}{2} - y_1 = \frac{y_2 + y_3 + y_1}{2} - 3/2 y_1$, and this improves the country's competitiveness.

A rise in the taxation of profits in the two other countries in comparison with the country considered (rise in $\frac{\tau_2 + \tau_3}{2} - \tau_1$) improves the country's competitiveness and increases its production. It attracts capital into the country, and this reduces the price (term $-\mu$) in the country, but the increase in output plays in the opposite direction (term $\sigma\beta\theta$).

We take as the **loss function** L_i of country i ($i=1,2,3$):

$$(11) \quad L_i = (Y - y_i)^2 + A p_i^2 + B(G - g_i)^2; Y > y_i; G < g_i$$

Y is the output target, A the relative weight of the price stability target, B the relative weight of the government expenditure target; G is the optimum level of government expenditure; g_i is given by (3).

Country 1 (for example) chooses τ_1 to minimise L , while τ_2 , τ_3 and r are given.

We have:

$$(12) \quad \begin{cases} \frac{\partial y_i}{\partial \tau_i} = \frac{\varphi + \beta \theta \varphi / 2 - \left(\frac{3\beta\mu}{2} + \sigma\beta\right)}{1 + 3/2 \beta \theta} = C_0 < 0 \\ \frac{\partial p_i}{\partial \tau_i} = \frac{\theta \varphi + \beta \theta^2 \varphi / 2 + (\mu - \sigma \beta \theta) + \sigma (1 + 3/2 \beta \theta)}{1 + 3/2 \beta \theta} = D_0 > 0 \end{cases}$$

At Nash equilibrium, by symmetry, we have $\tau_1 = \tau_2 = \tau_3 = \tau^N$, and:

$$(13) \begin{cases} y^N = -\alpha r^N + \bar{g} + \varphi \tau^N \\ p^N = -\theta \alpha r^N + \theta \bar{g} + \theta \varphi \tau^N + \sigma \tau^N \\ \alpha r^N = \bar{g} + (\varphi + \sigma/\theta) \tau^N \\ g^N = \bar{g} + \varphi \tau^N \end{cases}$$

hence:

$$(13') \begin{cases} y^N = -\sigma/\theta \tau^N \\ p^N = 0 \end{cases}$$

The taxation of profits in each country is given by:

$$(14) -C_0(Y - y_i) + AD_0 p_i - B\varphi(G - \bar{g} - \varphi \tau_i) = 0$$

We suppose that $C_0 < 0$, and this represents a situation where the competitiveness and attraction of capital effect outweighs the effect of government expenditure on production; while we also suppose that $D_0 > 0$, a rise in the taxation of profits increases the price.

At Nash equilibrium, $y_i = y^N$, $p_i = p^N = 0$, $\tau_1 = \tau^N$, hence:

$$(15) \left(B\varphi^2 - C_0 \frac{\sigma}{\theta} \right) \tau^N = C_0 Y + B\varphi(G - \bar{g})$$

This shows that if:

$$(16A) B\varphi^2 - C_0 \sigma/\theta > 0$$

because $B > 0$ is high, then the motive of obtaining substantial government expenditure dominates, and the rate of taxation of profits grows in line with the ex ante insufficiency of government expenditure, $G - \bar{g}$.

If:

$$(16B) B\varphi^2 - C_0 \sigma/\theta > 0$$

because $C_0 > 0$ is high in absolute value terms, the motive of obtaining the production target dominates, and the rate of taxation decreases in line with the output target, since at equilibrium production y decreases with the rate of taxation of profits (common to all three countries) because of the central bank's reaction $\left(y = -\frac{\sigma}{\theta} \tau \right)$.

3- Non-cooperative equilibrium, with countries taking the central bank's behaviour into account

These three countries take into account (5), the central bank's reaction, as well as the fact that $p_1 + p_2 + p_3 = 0$.

We then have (for example for country 1):

$$(17) \quad y_1 = \varphi \left(\frac{2\tau_1 - (\tau_2 + \tau_3)}{3} \right) - \frac{\sigma}{\theta} \left(\frac{\tau_1 + \tau_2 + \tau_3}{3} \right) - \frac{3}{2} \beta p_1$$

hence furthermore:

$$(18) \quad \begin{cases} y_1 \left(1 + \frac{3}{2} \beta \theta \right) = \left(\tau_1 - \frac{\tau_2 + \tau_3}{2} \right) \left(\frac{2}{3} \varphi - \frac{3}{2} \beta \mu \right) - \frac{3}{2} \beta \sigma \tau_1 - \frac{\sigma}{\theta} \left(\frac{\tau_1 + \tau_2 + \tau_3}{3} \right) \\ p_1 \left(1 + \frac{3}{2} \varphi \theta \right) = \left(\tau_1 - \frac{\tau_2 + \tau_3}{2} \right) \left(\frac{3}{2} \varphi \theta + \mu + \frac{2}{3} \sigma \right) \end{cases}$$

The differences with (9)-(10) are significant:

- the average taxation rate of profits drives down — and does not increase production — because of the central bank's reaction;
- the price depends exclusively on the difference in taxation of profits.

We therefore have:

$$(19) \quad \begin{cases} \frac{\partial y_i}{\partial \tau_i} = \frac{2/3 \varphi - 3/2 \beta \mu - 3/2 \beta \sigma - \frac{\sigma}{3\theta}}{1 + 3/2 \beta \theta} = C_1 < 0 \\ \frac{\partial p_i}{\partial \tau_i} = \frac{3/2 \varphi \theta + \mu + 2/3 \sigma}{1 + 3/2 \beta \theta} = D_1 > 0 \end{cases}$$

At equilibrium, we still have $y^N = -\frac{\sigma}{\theta} \tau^N$ and $p^N = 0$, hence:

$$(20) \quad \tau^N \left(B\varphi^2 - c_1 \frac{\sigma}{\theta} \right) = C_1 Y + B\varphi(G - \bar{g})$$

Without ambiguity $C_1 < C_0$; the situation where $B\varphi^2 - c_1 \frac{\sigma}{\theta} > 0$ because $|C_1|$ is high becomes more probable; **there is a lower likelihood that the various countries seek to sustain government expenditure because of the very negative effect, if one takes into account the central bank's reaction, of a rise in the corporate tax rate on production.**

4- Cooperative equilibrium between the three countries

Since the three countries are identical, cooperation between the three countries boils down to taking into account ex ante the fact that at equilibrium $\tau_1 = \tau_2 = \tau_3$ (corporate taxation rates are identical).

We then have (for country 1 for example):

$$(21) \quad y_1 = -\alpha r + \bar{g} + \varphi \tau^c = y^c$$

where τ^c is the common corporate tax rate.

$$(21B) \quad \begin{cases} p_1 = -\theta \alpha r + \theta \bar{g} + (\theta \varphi + \sigma) \tau^c = p^c \\ g_1 = \bar{g} + \varphi \tau^c = g^c \end{cases}$$

4-1 The three countries do not take into account the central bank's reaction

They then minimise:

$$(22) \quad L = (Y - y^c)^2 + A(p^c)^2 + B(G - g^c)^2$$

At equilibrium, we still have $p^c = 0$ and $y^c = -\sigma/\theta \tau^c$, hence:

$$(23) \quad \tau^c (B\varphi^2 - \varphi\sigma/\theta) = \varphi Y + B\varphi(G - \bar{g})$$

The difference here results from the fact that $\frac{\partial y^c}{\partial \tau^c} = \varphi > 0$: the countries do not compete, therefore they know that a rise in corporate tax rates increases government expenditure and therefore increases production, without hurting their competitiveness or their attractiveness.

Previously $C_0 \left(\frac{\partial y}{\partial \tau} \right)$ was negative. Here we have (with cooperation):

$$(24A) \quad \tau^c = \frac{Y + B(G - \bar{g})}{B\varphi - \sigma/\theta}$$

Instead of (without coordination):

$$(24B) \quad \tau^N = \frac{C_0/\varphi Y + B(G - \bar{g})}{B\varphi - C_0/\varphi\sigma/\theta}$$

with $C_0 < 0$ (C_0 is given by (12)).

Without ambiguity $\tau^N < \tau^C$ if $B\varphi - \sigma/\theta > 0$, as we suppose: the coordination of corporate taxation policies, when the central bank's behaviour is not taken into account, increases the corporate taxation rate.

How can we explain this divergence between the taxation of profits according to whether there is coordination between countries or not if the central bank's behaviour is not taken into account?

- without cooperation, each country believes that it can increase its production (via competitiveness gains and its attraction of capital) by lowering corporate tax rates;
- with cooperation, this belief disappears, and each country believes that the way to stimulate production is to increase the taxation of profits to pave the way for higher government expenditure.

The problem is obviously that the central bank reacts to high government expenditure and to higher taxation of profits by increasing interest rates, and this reduces production in all countries. When (below) this central bank's behaviour is taken into account, the idea that output can be stimulated by increasing government expenditure will disappear. Consequently, the difference between cooperation and lack of cooperation will shrink.

4-2 The three countries take into account the central bank's reaction

We then have $y^c = -\sigma/\theta \tau^c$ and $p^c = 0$; the three countries minimise:

$$(25) L = \left(Y + \sigma/\theta \tau^c \right)^2 + B \left(G - \bar{g} - \varphi \tau^c \right)^2$$

hence:

$$(26) \tau^c = \frac{-\sigma/\theta Y + \varphi B(G - \bar{g})}{B\varphi^2 + (\sigma/\theta)^2}$$

Instead of:

$$(27) \tau^N = \frac{C_1 Y + B\varphi(G - \bar{g})}{B\varphi^2 - C_1 \frac{\sigma}{\theta}}$$

where $C_1 < 0$ is given by (19).

σ/θ and $|C_1|$ are not in a non-ambiguous relation (we can have $\sigma/\theta \geq |C_1|$). **This means that the coordination of corporate taxation policies can fail to change the equilibrium to a significant extent if the countries take into account the central bank's behaviour.**

Without coordination, if the central bank's behaviour is taken into account, we have, for example for country 1 (see (18)).

$$(28A) y_1^N \left(1 + \frac{3}{2} \beta \theta \right) = \left(\tau_1 - \frac{\tau_2 + \tau_3}{2} \right) \left(2/3 \varphi - 3/2 \beta \mu \right) - \frac{3}{2} \beta \sigma \tau_1 - \frac{\sigma}{\theta} \left(\frac{\tau_1 + \tau_2 + \tau_3}{3} \right)$$

With coordination:

$$(28B) y_1^c = -\sigma/\theta \tau_1$$

At equilibrium, it can be seen that the difference results exclusively from the term $\left(\tau_1 - \frac{\tau_2 + \tau_3}{2}\right)(2/3\varphi - 3/2\beta\mu)$, since the coefficient's sign is ambiguous. This results from the fact that, because each country knows that $p_1 + p_2 + p_3 = 0$, an increase (for example) in p_1 implies a decline in $p_2 + p_3$, therefore badly hurts competitiveness; a rise in τ_1 in order to increase government expenditure is therefore discouraged by its effect on competitiveness.

The coordination of corporate taxation therefore has few effects if the ECB's reaction is taken into account. This is why we now restrict our analysis to the case where the countries do not factor in the ECB's reaction.

4-3 Welfare and coordination of tax policies (without taking into account the central bank's behaviour)

It is not at all certain here that the coordination of tax policies improves welfare in the countries. For we are dealing with the coordination of a sub-set of players (the three countries) and not coordination among all players (as this would include the central bank).

We have seen above that **when the central bank's behaviour is not taken into account by the countries** (a hypotheses we are now maintaining), **the coordination of tax policies leads to a rise in the taxation of company earnings**, as countries no longer believe they are able to improve their competitiveness by lowering the taxation of profits.

But the rise in the taxation of profits implied by coordination increases inflation, therefore leads to a rise in the interest rate that reduces production. It is therefore not certain that it improves welfare.

With coordination, we have:

$$(29A) \quad \tau^c = \frac{\varphi Y + B\varphi(G - \bar{g})}{B\varphi^2 - \varphi\sigma/\theta}, y^c = -\frac{\sigma}{\theta}\tau^c, g^c = \bar{g} + \varphi\tau^c$$

Without coordination:

$$(29B) \quad \tau^N = \frac{C_0 Y + B\varphi(G - \bar{g})}{B\varphi^2 - C_0\sigma/\theta}, y^N = -\frac{\sigma}{\theta}\tau^N, g^N = \bar{g} + \varphi\tau^N$$

This leads to the following losses:

$$(30) \quad \begin{cases} L^N = \frac{B(B\varphi^2 + C_0^2)}{(B\varphi^2 - C_0\sigma/\theta)^2} (\varphi Y + \sigma/\theta(G - \bar{g}))^2 & \text{(without coordination)} \\ L^c = \frac{B\varphi^2(B+1)}{(B\varphi^2 - \varphi\sigma/\theta)^2} (\varphi Y + \sigma/\theta(G - \bar{g}))^2 & \text{(with coordination)} \end{cases}$$

$L^N > L^c$ (coordination is preferable) if:

$$(31) B\varphi^2(C_0 + \varphi + 2\sigma/\theta) - \left(\frac{\sigma}{\theta}\right)^2 (C_0 + \varphi) - 2\varphi C_0 \sigma/\theta < 0$$

With the hypotheses drawn upon above:

$$\begin{cases} C_0 = \frac{-\left(\frac{3\beta\mu}{2} + \sigma\beta - \varphi - \beta\theta\varphi/2\right)}{1 + 3/2\beta\theta} < 0 \\ B\varphi > \sigma/\theta \end{cases}$$

- If $|C_0|$ is low, (31) is rewritten:

$$(31A) B\varphi^2(\varphi + \sigma/\theta) + \varphi\sigma/\theta(B\varphi - \sigma/\theta) < 0$$

and this is not verified, then $B\varphi - \sigma/\theta > 0$.

- If $|C_0|$ is high, (31) is rewritten ($C_0 < 0$):

$$(31B) B\varphi^2 - (\sigma/\theta)^2 - 2\varphi\sigma/\theta > 0$$

This is true if B (weight on the government expenditure target) is significant ((31B) is not verified for $B\varphi = \sigma/\theta$).

(29 B) shows that τ^N grows in line with C_0 , therefore, since $C_0 < 0$, decreases when $|C_0|$ increases.

When $|C_0|$ is small, τ^N is therefore high, but still lower than τ_c ($\tau^N = \frac{G - \bar{g}}{\varphi}$ for $C_0 = 0$); when $|C_0|$ is high τ^N is close to 0.

We therefore see the reasons accounting for the result:

- When $|C_0|$ is high (note that C_0 is the derivative of production with respect to the corporate tax rate at the non-cooperative equilibrium when the central bank's behaviour is not taken into account), τ^N (taxation rate at non-cooperative equilibrium) is dragged downwards by each country's resolve to gain in competitiveness and attract capital, and this leads to an excessively low taxation rate, hence higher welfare than at the equilibrium where the country cooperates if (31B) is verified, i.e. if the objective of sustaining government expenditure weighs sufficiently.
- When $|C_0|$ is low, the countries do not seek to any noteworthy extent to sustain their production by lowering the corporate tax rate; consequently τ^N is high, and the non-cooperative equilibrium is preferable. The reason why is that, at the cooperative equilibrium, the corporate tax rate is too high, since the countries believe that production grows with the taxation of profits (they believe that $y = -\alpha r + \bar{g} + \varphi\tau$, see (21)), while in reality it decreases, ($y = -\sigma/\theta\tau$) given the central bank's behaviour.

Thus, while the lack of coordination of tax policies does not lead to an excessive decline in corporate tax rates ($|C_0|$ is not too hit), it results in enhanced welfare since it corrects the effects of the lack of taking into account the central bank's behaviour (it leads countries to believe that production decreases with the tax rate).

5- Coordination between two of the three countries

We maintain the hypothesis according to which the countries take the central bank's behaviour as granted, and we examine the **situation where two countries (1 and 2) decide to coordinate their tax policies, while the third (country 3) refuses to do so** (situation of "enhanced cooperation" between the first two countries).

The two countries that coordinate their corporate taxation policy minimise (see (9)-(10)).

$$\begin{aligned}
 L_{12} = & \left(Y - \left(-\alpha r(1 + 3/2 \beta \theta) + \bar{g}(1 + 3/2 \beta \theta) + \varphi \tau + \frac{\beta \theta \varphi}{2} (2\tau + \tau_3) \right. \right. \\
 & \left. \left. + \left(\frac{3\beta\mu}{2} + \sigma\beta \right) \left(\frac{\tau_3 - \tau}{2} \right) \right) / (1 + 3/2 \beta \theta) \right)^2 \\
 (32A) \quad & + A \left[\left(-\theta\alpha r(1 + 3/2 \beta \theta) + \theta\bar{g}(1 + 3/2 \beta \theta) + \theta\varphi\tau + \frac{\beta\theta^2\varphi}{2} (2\tau + \tau_3) + \sigma(1 + 3/2 \beta \theta)\tau \right. \right. \\
 & \left. \left. + \left(\frac{\tau_3 - \tau}{2} \right) (\sigma\beta\theta - \mu) \right) / (1 + 3/2 \beta \theta) \right]^2 + B(G - \bar{g} - \varphi\tau)^2
 \end{aligned}$$

where τ stands for the common taxation rates in the first two countries (which are symmetrical), τ_3 that of the third country.

The third country minimises:

$$\begin{aligned}
 L_3 = & \left[Y - \left(-\alpha r(1 + 3/2 \beta \theta) + \bar{g}(1 + 3/2 \beta \theta) + \varphi\tau_3 + \frac{\beta\theta\varphi}{2} (2\tau + \tau_3) \right. \right. \\
 & \left. \left. + \left(\frac{3\beta\mu}{2} + \sigma\beta \right) (\tau - \tau_3) \right) / (1 + 3/2 \beta \theta) \right]^2 \\
 (32B) \quad & + A \left[\left(-\theta\alpha r(1 + 3/2 \beta \theta) + \theta\bar{g}(1 + 3/2 \beta \theta) + \theta\varphi\tau_3 + \frac{\beta\theta^2\varphi}{2} (2\tau + \tau_3) + \sigma(1 + 3/2 \beta \theta)\tau_3 \right. \right. \\
 & \left. \left. + (\tau - \tau_3) (\sigma\beta\theta - \mu) \right) / (1 + 3/2 \beta \theta) \right]^2 + B(G - \bar{g} - \varphi\tau_3)^2
 \end{aligned}$$

The difference between L_{12} (two first countries) and L_3 (third country) results from the term representing tax competition.

For L_{12} it is $\frac{\tau_3 - \tau}{2}$, and for L_3 it is $\tau - \tau_3$.

This is because, for the first two countries, half of tax competition — the one that results from the other of these two countries, disappears.

The interest rate is set by the central bank at the level given by (5), i.e. here:

$$(32C) \quad \alpha r = \bar{g} + \left(\frac{\varphi\theta + \sigma}{\theta} \right) \left(\frac{2\tau + \tau_3}{3} \right)$$

Given the central bank's reaction, we have:

$$(33) \quad \left(1 + \frac{3}{2} \beta\theta \right) y_3 = -\frac{\sigma}{\theta} \left(1 + \frac{3}{2} \beta\theta \right) \tau + (\tau_3 - \tau) \left[-\left(\frac{3\beta\mu}{2} + \sigma\beta \right) - \frac{1}{3} \left(1 + \frac{3}{2} \beta\theta \right) \frac{\sigma}{\theta} + 2/3 \varphi \right]$$

and

$$(34) \quad \left(1 + \frac{3}{2} \beta\theta \right) y = -\frac{\sigma}{\theta} (1 + 3/2 \beta\theta) \tau + (\tau_3 - \tau) \left[\frac{1}{2} \left(\frac{3\beta\mu}{2} + \sigma\beta \right) - \frac{1}{3} (1 + 3/2 \beta\theta) \frac{\sigma}{\theta} - \frac{1}{3} \varphi \right]$$

And we do have (see (5)): $2y + y_3 = -\frac{\sigma}{\theta} (2\tau + \tau_3)$

A higher corporate tax rate in country 3 ($\tau_3 > \tau$) y reduces production in said country, and can have an ambiguous effect on the output of the first two countries because of the effect on the interest rate.

We also have:

$$(35) \quad \begin{cases} (1 + 3/2 \beta\theta) p_3 = (\tau_3 - \tau) \left(\frac{2}{3} \theta\varphi + \frac{2}{3} \sigma(1 + 3/2 \beta\theta) - (\sigma\beta\theta - \mu) \right) \\ (1 + 3/2 \beta\theta) p = (\tau_3 - \tau) \left(-\frac{1}{3} \theta\varphi - \frac{1}{3} \sigma(1 + 3/2 \beta\theta) + 1/2 (\sigma\beta\theta - \mu) \right) \end{cases}$$

With naturally $2p + p_3 = 0$ (because of the central bank's behaviour).

If the corporate tax rate is higher in country 3 ($\tau_3 > \tau$), then we have $p_3 > 0$ and $p < 0$, the price rises in country 3 and declines in the two other countries.

We rewrite (33) (34) (35) as follows:

$$(36) \begin{cases} y_3 = -\sigma/\theta \tau - E_3(\tau_3 - \tau); E_3 > 0 \\ y = -\sigma/\theta \tau + E_4(\tau_3 - \tau) \\ \text{avec } E_4 = 1/2 E_3 - 1/2 \sigma/\theta; E_4 \geq 0 \\ p_3 = 2F(\tau_3 - \tau); F > 0 \\ p = -F(\tau_3 - \tau) \end{cases}$$

Note that y, p, τ refer to countries 1 and 2.

We also have:

$$(37) \begin{cases} \frac{\partial y}{\partial \tau} = \varphi + \beta\theta\varphi - 1/2 \left(\frac{3\beta\mu}{2} + \sigma\beta \right) = C_0 + \bar{C}_2 \\ \frac{\partial p}{\partial \tau} = \theta\varphi + \beta\theta^2\varphi + \sigma(1 + 3/2 \beta\theta) - 1/2(\sigma\beta\theta - \mu) = D_0 + \bar{D}_2 \end{cases}$$

Where C_0 and D_0 are the derivatives already seen above in the non-cooperative case (see (12)); $C_0 < 0, D_0 > 0$; and where:

$$\bar{C}_2 = \frac{\beta\theta\varphi}{2} + \frac{1}{2} \left(\frac{3\beta\mu}{2} + \sigma\beta \right) > 0$$

$$\bar{D}_2 = \frac{\beta\theta^2\varphi}{2} + 1/2(\sigma\beta\theta - \mu) > 0$$

For country 3, $\frac{\partial y_3}{\partial \tau_3} = C_0, \frac{\partial p_3}{\partial \tau_3} = D_0$, as in the non-cooperative three-country case.

The **conditions of optimality** are accordingly written:

$$(38) \begin{aligned} &(\text{countries 1 and 2}) - (Y + \sigma/\theta \tau - E_4(\tau_3 - \tau))(C_0 + \bar{C}_2) + A(D_0 + \bar{D}_2)(-F(\tau_3 - \tau)) - B\varphi(G - \bar{g} - \varphi\tau) = 0 \\ &(\text{country 3}) - C_0(Y + \sigma/\theta \tau + E_3(\tau_3 - \tau)) + AD_0 2F(\tau_3 - \tau) - B\varphi(G - \bar{g} - \varphi\tau_3) = 0 \end{aligned}$$

Let us denote τ^N the corporate tax rate at non-cooperative equilibrium seen above; τ^N is given by:

$$(39) -C_0(Y + \sigma/\theta \tau^N) - B\varphi(G - \bar{g} - \varphi\tau^N) = 0$$

Let us denote:

$$(40) \begin{cases} U = AF(D_0 + \bar{D}_2) - E_4(C_0 + \bar{C}_2) > 0 \\ V = -C_0 E_3 + 2AD_0 F + B\varphi^2 > 0 \end{cases}$$

We obtain:

$$(41A) \quad \tau \left(-C_0 \sigma / \theta + B\varphi^2 - \frac{\bar{C}_2 \sigma / \theta}{1 + U/V} \right) = C_0 Y + B\varphi(G - \bar{g}) + \frac{\bar{C}_2 Y}{1 + U/V} \quad ; \quad \bar{C}_2 > 0$$

And

$$(41B) \quad \tau_3 - \tau = \frac{1}{V} \left[C_0 Y + B\varphi(G - \bar{g}) + \tau (C_0 \sigma / \theta - B\varphi^2) \right]$$

This shows that:

- $\tau > \tau^N = \frac{C_0 Y + B\varphi(G - \bar{g})}{-C_0 \sigma / \theta + B\varphi^2}$.

The two countries that coordinate their corporate taxation policies choose a higher taxation rate than at the non-cooperative equilibrium between the three countries. As we saw above that the attractiveness of tax competition is reduced for these countries $\left(\frac{\partial y}{\partial \tau} = C_0 + \bar{C}_2 > C_0, C_0 < 0 \right)$ since they do not compete with one another. Consequently, they choose a higher corporate tax rate.

- (41B) shows that without ambiguity $\tau_3 - \tau < 0$, since $C_0 Y + B\varphi(G - \bar{g}) - \tau (B\varphi^2 - C_0 \sigma / \theta) < 0$, since $\tau > \tau^N$.

(41B) also shows that:

$$(42) \quad \tau_3 - \tau^N = (\tau - \tau^N) \left(1 - \frac{(B\varphi^2 - C_0 \sigma / \theta)}{V} \right)$$

$$\text{where: } \begin{cases} V = B\varphi^2 - C_0 E_3 + 2AD_0 F \\ E_3 = \frac{\frac{3\beta\mu}{2} + \sigma\beta + 1/3(1 + 1/3\beta\theta)\sigma/\theta - 2/3\varphi}{1 + 3/2\beta\theta} \end{cases}$$

and this shows that, in all likelihood, $\tau_3 > \tau^N$ (if A and B are high enough).

Let us compare this level of welfare with the one found in previous situations.

At the Nash equilibrium, $\tau = \tau^N$, and $L^N = \frac{B(B\varphi^2 + C_0^2)}{(B\varphi^2 - C_0 \sigma / \theta)^2} \cdot (\varphi Y + \sigma / \theta (G - \bar{g}))^2$

At the cooperative equilibrium (without taking into account the central bank's behaviour), $\tau = \tau^c > \tau^N$, and $L^c = \frac{B\varphi^2(B+1)}{(B\varphi^2 - \varphi\sigma/\theta)^2} (\varphi Y + \sigma/\theta(G - \bar{g}))^2$, and $L^c < L^N$ only if $|C_0|$ is high.

At the equilibrium where only two countries cooperate, τ (countries that cooperate) $> \tau^N$; τ_3 (country that does not cooperate) $< \tau^N$.

- **If we are in the case where the cooperative equilibrium is preferable to the Nash equilibrium** ($|C_0|$ is high), since $\tau^c > \tau^N$, a rise in the taxation rate improves welfare.

In this case, the **two countries that cooperate improve their welfare, while the country that does not cooperate reduces its**.

- **If we are in the case where the non-cooperative equilibrium is preferable to the cooperative equilibrium** ($|C_0|$ is not too high), then — on the contrary — **the two countries that cooperate reduce their welfare, while the third country that does not cooperates improves its**.

Conclusion

We therefore have seen the following points:

- taking into account the central bank's behaviour, without tax policy coordination, leads to a smaller rise in the corporate tax rate, which implies a rise in the interest rate;
- if the countries do not take into account the central bank's behaviour, the coordination of corporate tax policies results in an increase in the tax rate, since cooperation leads to the disappearance of the belief in the idea that each country can increase its production by improving competitiveness gains and attracting capital by reducing the tax rate;
- conversely, coordination of corporate taxation policies when the central bank's behaviour is taken into account hardly modifies the equilibrium, since each country knows, without coordination, that if it changes its price, those in other countries will move in the opposite direction, and therefore fluctuations in competitiveness are drastic;
- if the central bank's behaviour is not taken into account, tax coordination can reduce welfare, because it leads to a rise in taxation rates, and therefore in the interest rate, and this can outweigh the disappearance of the incentive to attract capital;
- if we are in the case where the non-cooperative equilibrium (of tax policies) is preferable to the non-cooperative equilibrium, the implementation of "enhanced cooperation" (group of countries coordinating their tax policies) reduces welfare in the members of the group of countries taking part in the enhanced cooperation scheme, increases welfare in the other countries.

We can therefore see all in all that:

- it is not certain that one should promote the coordination of tax policies, if the reaction of interest rates in the currency area is not factored into the choices made by governments;
- in this case, circumventing the refusal of overall coordination by implementing enhanced cooperation schemes is also a bad idea.

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