COMMON CURRENCIES OR MONETARY INDEPENDENCE

A CONTRIBUTION TO THE DISCUSSION

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One of the most discussed topics in professional circles as well as in the public at present is the integration process of Slovakia and the other candidate countries into the European Union and subsequently accession to EMU (Economy and Monetary Union). Here we encounter a wide range of opposing views and differing opinions as to the possible impacts of accession to EMU on the candidate countries' economies. This article is intended as a small contribution to this ongoing discussion.

Monetary policy in an environment of an open economy may take various forms. Depending on the degree of coordination of the monetary policies of individual countries we can speak of independent monetary policy as being characterised by the situation where each country retains its own currency and the monetary policy of each country attempts to optimise the welfare of its inhabitants. The opposite of independent monetary policy is the complete coordination of monetary policies: a participating country gives up its own currency in favour of the common currency and monetary policy is common for the whole union. In reality there may be a degree of coordination of monetary policies between these two extremes, i.e. monetary policy is partially coordinated as is the case at present in the block of candidate countries and EMU countries. Each candidate country has its own currency and sets its own monetary policy, which however is relatively tightly limited by the Maastricht criteria.

What degree of monetary policy coordination is the most beneficial for participating countries? Writers on this matter generally prefer the coordination of monetary policies (see [1]), while acknowledging that coordination is hard to achieve, since the central banks as guarantors of monetary policy have a tendency to deviate from the agreed rules, thereby achieving greater welfare for their own inhabitants to the detriment of inhabitants of other participating countries. There are however many other authors who claim that coordination brings very small or no advantages (see [2] and [3]) and some authors even state that coordination can lead to a reduction in a society's welfare.

In this article we will attempt to show that the existence of various currencies leads to a competition between the monetary policies of the individual countries and that this results in higher interest rates and higher inflation and subsequently a reduction in the welfare of the participating countries. We will demonstrate the results in models of two open asymmetric economies, one of which is larger and more developed, and there other smaller and less developed. This model is a modification of the model of two homogenous symmetric countries derived in [4].

For the production of goods in each country two inputs are necessary, one of which is produced domestically and the other imported from abroad. The central bank's monetary policy instrument in both countries is the ability to determine the level of nominal interest rates. A restrictive monetary policy is thus represented by an increase in interest rates, manifested in a shortage of liquidity in the economy and subsequently a slowdown in production growth. In the case of a closed economy, where both inputs necessary for production are produced domestically, a fall in production would be the only consequence of a restrictive monetary policy. We can thus state that in a closed economy maximum economic activity is achieved where the nominal interest rate is minimal, i.e. zero. This is known as Friedman's rule. In an open economy however there is also another channel, by which monetary policy may influence economic activity, this being via the exchange rate. Any increase in the interest rate strengthens the real exchange rate, having the consequence of an increase in domestic production and a subsequent increase in economic activity. Monetary policy thus in our model has conflicting effects on a country's economic growth and subsequently the welfare (consumption) of its society:

Liquid effect – an increase in the interest rate in the domestic country decreases the economic activity and welfare of the domestic country

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Terms of trade effect – an increase in the interest rates improves terms of trade in the given country (appreciation of the domestic currency), which increases domestic production and also consumption and welfare. The fact that an appreciated exchange rate increases the economic activity of the given country may seem controversial. In our model, however, the import is of capital goods. Demand for import increases also the demand for domestic intermediate product, since both are necessary for production. The increased import thus increases economic activity.

The terms of trade effect has the consequence of a conflict of interests between both countries, where this is manifested in the competition existing between both states' monetary policies. This competition in our model leads to an increase in interest rates, higher inflation and lower consumption, i.e. welfare, in both countries.

This theoretical conclusion, which is the outcome of our model, is supported by experience from Western European countries in their establishment of European Monetary Union. Increasing the coordination of these countries' monetary policies has been accompanied by a reduction and convergence of interest rates and inflation.

In the following text we describe the model of two open asymmetric economies; deriving their theoretical solution and, following calibration, evaluate the model also in terms of quantitative results. For this we have used a program created in Matlab.

Model

In each of the two countries there are three subjects: households, businesses and the central bank, which is responsible for the given country's monetary policy..

Households: Since the population of both countries is homogenous, the size of the first country's population (which we shall term the home country) may be normalised, i.e. the home country has one inhabitant, who works in their own business full-time and consumes the quantity c of goods produced in this business, which brings him the utility *u(c)*. The size of the population in the second country (which we shall term the foreign country) is m, for example μ=2 means that there are twice as many inhabitants and businesses in the second country than in the first.

Businesses: The business produces the final product and for doing so needs two types of intermediate products; one of which is produced in the home country, the second is imported from aboard. The quantity of goods produced in the first country is given by the production function.

$$y_1 = A_1 (x_{11}^{\varepsilon} + \phi \cdot x_{12}^{\varepsilon})^{\frac{\nu}{\varepsilon}}$$

where A_1 is the technological level of the home country, x_{11} is the domestic intermediate product and x_{12} is the intermediate product produced abroad (the import). In the whole work the first index always indicates the country in which the intermediate product is used and the second index the country in which the intermediate product is produced. The production function of the second country has an analogical form nevertheless with the technology level A_2. We make the assumption that the production function parameters n and e fulfil the following conditions: $\nu<1$ and $\varepsilon<\nu$. We will specify the values of the model's parameters later in the calibration section of the model.

Business financing and monetary policy

For purchasing intermediate products businesses borrow money from banks. The nominal interest rate for credit in the first country is R_1 and in the second country is R_2. Let $\in$ mean the nominal exchange rate, i.e. how many units of the domestic currency buy one unit of the foreign currency. Let P_1 mean the price level in the first country and P_2 mean the price level in the second country, where both price levels are expressed in their respective currency[1]. The real exchange rate e then equals $\in P_2 / P_1$. As we have already mentioned the nominal interest rate is the only monetary policy instrument in both countries. The equilibrium interest rate value in both countries is the resultant of the strategic action of both central banks, which may be described as follows. The first country's central bank taking into consideration the level of R_2 interest rate in the other country sets R_1 at a rate that maximises the welfare (consumption) of the first country's inhabitants. The central bank in the second country also acts similarly. This process, termed Nash strategic scheme results in an equilibrium value termed the Nash Equilibrium.

Solution

we solve the model in two steps. Since the level of the interest rates R_1 and R_2 cannot be influenced by businesses, we at first deduce how businesses behave depending on these values. Secondly we describe the process of central banks' Nash strategic scheme and derive the level of the equilibrium interest rates in both countries.

Business behaviour

Since the businesses are owned by households, the maximum profit of a business means at the same time also the maximum consumption and thus welfare of the

[1] Since there is only one type of good in each country, the price level in the country will equal the price of goods

society. The optimal allocation of resources in the first country, for the given values, R_1 and R_2, can be calculated through maximisation of the following problem:

$$\max_{x_{11},x_{12}} \left\{ P_1 \left[A_1 (x_{11}^{\varepsilon} + \phi_1 \cdot x_{12}^{\varepsilon})^{\frac{\nu}{\varepsilon}} - (x_{11} + e \cdot x_{12})(1 + R_1) \right] \right\}$$

The solution to this problem is as follows:

$$x_{11} = \left(\frac{\nu A_1}{1 + R_1} \right)^{\frac{1}{1-\nu}} \left[1 + \phi_1 \left(\frac{\phi_1}{e} \right)^{\frac{\varepsilon}{1-\varepsilon}} \right]^{\frac{\nu-\varepsilon}{\varepsilon(1-\nu)}}$$

$$x_{12} = \left[\left(\frac{\phi_1}{e} \right)^{\frac{1}{1-\varepsilon}} \right] x_{11}$$

These equations represent the demand of one firm in the first country for domestic and foreign intermediate product. As can be seen this demand depends positively on the technological level of the domestic country and negatively on the level of the interest rate R_1. Furthermore, a lower value of the real exchange rate e, i.e. an appreciation of the domestic currency increases demand for both intermediate products and thus has an expansionary effect on the domestic economy.

The solution for the foreign business is analogous with this, where instead of A_1, R_1, e, and ϕ_1 in the equations for demand we have A_2, R_2, $1/e$, and ϕ_2.

Since our model is one of general equilibrium, we presume that the market for goods is in equilibrium and thus the fact that aggregate demand equals aggregate supply[2], i.e.

$$Y_1 = C_1 + X_{11} + X_{21}$$
$$Y_2 = C_2 + X_{22} + X_{12}$$

The total production of domestic goods (Y_1) equals its total consumption (C_1) and its use by domestic (X_{11}) as well as foreign (X_{21}) businesses. The same applies for foreign goods.

We also assume that trading between both countries is balanced, i.e.

$$e \cdot X_{12} = X_{21}$$

These equations may be rewritten in of per capita terms as follows:

$$y_1 = c_1 + x_{11} + \mu \cdot x_{21}$$
$$\mu \cdot y_2 = \mu \cdot c_2 + \mu \cdot x_{22} + x_{12}$$
$$e \cdot x_{12} = \mu \cdot x_{21}$$

Through combining these equations with the equations for demand we get the following relationships for the consumption of domestic and foreign goods and for the real exchange rate:

$$c_1 = \left(\frac{\nu A_1}{1 + R_1} \right)^{\frac{1}{1-\nu}} \left(\frac{1 + R_1 - \nu}{\nu} \right) \left[1 + \phi_1 \left(\frac{\phi_1}{e} \right)^{\frac{\varepsilon}{1-\varepsilon}} \right]^{\frac{\nu(1-\varepsilon)}{\varepsilon(1-\nu)}}$$

$$c_2 = \left(\frac{\nu A_2}{1 + R_2} \right)^{\frac{1}{1-\nu}} \left(\frac{1 + R_2 - \nu}{\nu} \right) \left[1 + \phi_2 (\phi_2 e)^{\frac{\varepsilon}{1-\varepsilon}} \right]^{\frac{\nu(1-\varepsilon)}{\varepsilon(1-\nu)}}$$

$$\left(\frac{\phi_1}{\phi_2} \right)^{\frac{1}{1-\varepsilon}} \left[\frac{A_1 (1 + R_2)}{A_2 (1 + R_1)} \right]^{\frac{1}{1-\nu}} = \mu \cdot e^{\frac{1+\varepsilon}{1-\varepsilon}} \left[\frac{1 + \phi_2 (\phi_2 e)^{\frac{\varepsilon}{1-\varepsilon}}}{1 + \phi_1 \left(\frac{\phi_1}{e} \right)^{\frac{\varepsilon}{1-\varepsilon}}} \right]^{\frac{\nu-\varepsilon}{\varepsilon(1-\nu)}}$$

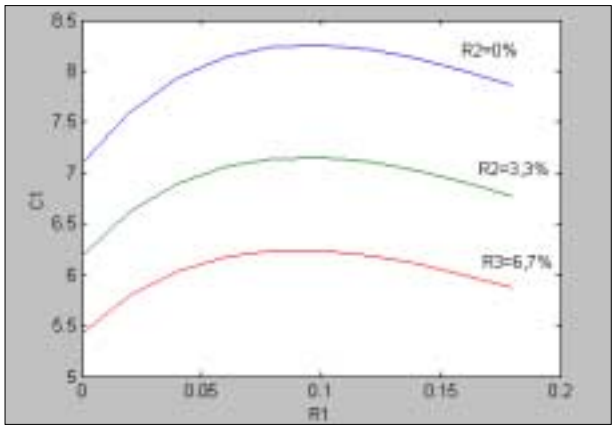
These equations describe the equilibrium state of the model for a given R_1 and R_2. Through analysing these equations we find that:

(a) by maintaining a constant exchange rate, an increase in interest rates in the domestic country increases production costs, causing a reduction in production and subsequently also consumption and resultantly the welfare of the domestic population (liquidity effect)

(b) An increase in the domestic interest rate improves business conditions in the domestic country; foreign intermediate product becomes cheaper and thus demand for it increases. Since also domestic intermediate product is essential for the production of goods, demand for this too increases, having the consequence of a recovery in domestic production as well as consumption (terms of trade effect).

The resulting effect of an increase in the domestic interest rate depends on which of the above-mentioned channels holds dominant. Through a calculation we find that the terms of trade channel is dominant for lower values of the interest rate, whereas for a higher interest rate the liquidity channel is dominant. Therefore with an increase in the domestic interest rate domestic consumption too first rises and then falls. In Figure 1 we can see the consumption level in the domestic country depicted as a function of the domestic interest rate at three different interest rate values in the foreign country.

Figure 1

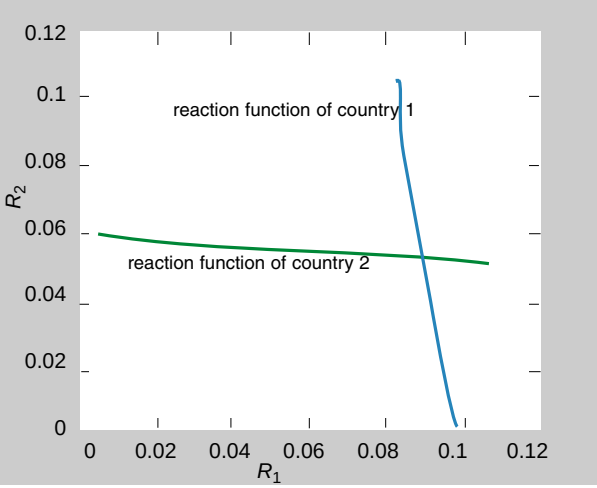


[2] We will indicate aggregated variables by capital letters in contrast to variables for an individual, which we shall indicate with lower-case letters.

The two-country Nash strategic scheme

In this part we describe the process by which interest rates in both countries settle at certain equilibrium values. The central bank can set the interest rate level only in its own country and sets it so as to maximise consumption and thus welfare in the country. On the basis of the equations derived we can for each value of R_2 calculate the optimal value for R_1. This dependence of the variable R_1 on the variable R2 we term the reaction function of country 1. However country 2 acts similarly strategically and for each value of R_1 reacts through optimally setting the respective value of R_2. In this way we reach the reaction function of country 2. The Nash Equilibrium is then the intersection of the graphs of both functions. As we can see in Figure 2, the Nash Equilibrium is characterised by non-zero interest rate values in both countries. The existence of different currencies in both countries leads to competition between monetary policies resulting in an equilibrium state of non-zero nominal interest rates and subsequently a lower rate of consumption in both countries.

Figure 2



Quantitative analysis of the model

We will quantitatively analyse the following three scenarios:

a) a model of two symmetric homogenous countries
b) a model of two asymmetric homogenous countries
c) a model of two asymmetric heterogeneous countries

For a quantitative evaluation of the model we need to know the values of the parameters appearing in it. This procedure is termed calibration. Some parameters will have equal values for all three scenarios; others will be specific to a given scenario.

The first group includes e, which expresses the rate of substitution between the domestic and foreign intermediate products. Elasticity of substitution equalling $1 / (1 - \varepsilon)$ is according to various studies close to 1.6, meaning that $\varepsilon = 0.375$.

We set the value of the parameter n so that the ratio of liquid money, i.e. money used for purchasing goods, to the total money supply equals $1 - \nu$. If we take liquid money to mean the monetary aggregate M1 and all money assets to mean the monetary aggregate M3, then ν = 1-M1/M3 = 0.9. This value is based on the average of monetary aggregates of EMU countries. Other parameters will be specified for each scenario.

a) a model of two symmetric homogenous countries

This scenario describes the interaction of two symmetric homogeneous countries. Since the countries are symmetric, the parameters A_1, A_2 characterising the technological level are equal and we set them as $A_1 = A_2 = 1$.

By homogeneity we mean an equally sized population in both countries and thus μ=1.

The remaining parameters ϕ_1, ϕ_2 are also identical and we set their size so that the openness of the economy i.e. the total value of the export and import equals 50% of the total production.

We now make a quantitative experiment, in which we compare the equilibrium values of the interest rates and the welfare level at two states. In the first case both countries use a common currency, meaning that they perfectly co-ordinate their monetary policies, leading, as we have already mentioned, to the setting of zero-value interest rates in both countries (Friedman's rule). In the second case both countries retain their own currency and do not co-operate at all in creating monetary policies, they behave strategically.

In Table 1 we depict the equilibrium value of the interest rate and the percentage loss of consumption if the countries switch over from cooperation (a common currency) to strategic competition (various currencies).

Table 1:

Elasticity of substitucion	1/(1-ε) = 1,5		1/(1-ε) = 1,6		1/(1-ε) = 1,7	
	Country 1	Country 2	Country 1	Country 2	Country 1	Country 2
Common currency						
Interest rates (%)	0	0	0	0	0	0
Different currencies						
Interest rate (%)	7.2	7.2	6.8	6.8	6.4	6.4
Loss in consumption (%)	14.2	14.2	13.2	13.2	12.1	12.1

Despite the fact that an optimal monetary policy is a zero interest rate, in the case of the existence of two different currencies it is difficult to maintain this state, since each country has a tendency to increase its interest rate, whereby business conditions for the given country and thereby also consumption are improved. This would apply only in the case where only one country were to be acting in this way. If, however, the countries behave strategically, the result is that the interest rate ends up at a non-zero equilibrium value and we see a fall in consumption in both countries. This result is robust enough with regard to the elasticity of substitution between domestic and foreign product.

b) a model of two asymmetric homogeneous countries

We will look now at the case of two equally large countries (μ=1), one of which is more developed than the other. We characterise the level of the country's development by means of the level of per capita production. This we achieve through the setting of parameters A_1, A_2. Let us set A_1 = = 0.9, A_2 = 1. In the case of these values production per capita in the second country is double that in the first. Let us also assume that the first country is more dependent on trading than the second, meaning that the first country's economy is more open as regards the second economy than is the case vice-versa. We select the parameters ϕ_1 =0.5 , ϕ_2 = 0.7 so that the openness of the first less developed economy is double that of the second more developed economy.

Table 2:

Elasticity of substitution	1/(1-ε) = 1,5		1/(1-ε) = 1,6		1/(1-ε) = 1,7	
	Country 1	Country 2	Country 1	Country 2	Country 1	Country 2
Common currency						
Interest rate (%)	0	0	0	0	0	0
Different currencies						
Interest rates (%)	7.8	7.1	7.6	6.6	7.4	6.2
Loss in consumption (%)	13.8	16.1	12.2	15.2	11.3	14.5

Also in this table we can see that if countries do not co-ordinate their monetary policies and behave strategically, then the equilibrium state of interest rates ends up at non-zero values and both countries experience consumption loss. In this case the effect is asymmetric; a greater loss in consumption is recorded by the more developed, less open economy. This is caused by the fact that the negative liquid effect is more important for this country than the positive terms of trade effect. This point is manifested even more markedly in the following third case, where we shall analyse it in more detail.

c) a model of two asymmetric heterogeneous countries

We will now try to model the case of two countries, the first of which is formed by the Central European candidate countries, i.e. Poland, the Czech Republic, Hungary and Slovakia, and the other the block of EMU countries. This means that the first country is less developed (production per capita is roughly half); the size of the population is roughly one-fifth that of the EMU countries and their economy is much more open. We reach this state through the following choice of parameters: μ=5, A_1 = 0.7, A_2 = 1, f1 =0.4 , ϕ_2 = 0.7.

Table 3:

Elasticity of substitution	1/(1-ε) = 1,5		1/(1-ε) = 1,6		1/(1-ε) = 1,7	
	Country 1	Country 2	Country 1	Country 2	Country 1	Country 2
Common currency						
Interest rate (%)	0	0	0	0	0	0
Different currencies						
Interest rates (%)	9.1	4.5	11.3	3.7	11.8	3.1
Loss in consumption (%)	2.6	17.5	-1.4	19.8	-3.4	19.6

We see that the enlargement of the disproportion between both countries leads to a greater equilibrium interest rates differential and similarly that the interest rate differential increases with an increase in elasticity of substitution. A sufficiently large interest rate differential causes an increase in consumption (negative loss) in the first country. In other words if domestic and foreign goods are interchangeable, then a reduction in consumption (welfare) may occur in the first country in the changeover to a common currency. This is caused by the fact that for the first country, which is smaller and much more open, mutual trade is far more important than it is for the other country. Therefore also the terms of trade effect is dominant over the liquid effect in the first country. Since the terms of trade effect increases with an increase in the exchange rate, the first country has an interest in increasing it. The second country cannot match the first in increasing interest rates, since for it the liquidity effect is dominant. As we know this has a negative effect on the country's welfare and increases with an increase in the interest rate.

Conclusion

In this article we have dealt with the question of what impact the creation of monetary union may have on the welfare of the participating countries. For this we used a model of two open economies. The monetary policy in both countries is set via the interest rate level and this level increases productions costs experienced by businesses.

We compared two scenarios: both countries fully coordinating their monetary policies (i.e. the creation of monetary union) versus each of the two countries endeavouring to improve the welfare of their inhabitants through an independent monetary policy (i.e. the countries behave strategically).

We reached the following conclusion:

If the countries are sufficiently similar in terms of their economy's size, openness and efficiency, the creation of a monetary union will lead to a low interest rate, to a recovery of production and subsequently to higher welfare in both countries.

If, however, the two countries are different, meaning that one country's economy is substantially smaller, more open and less efficient, then it may be more advantageous for such a country to keep its own currency in the case that the products produced in both countries are marked by a high degree of substitution. It is this outcome that may be the cause of the pressure from EMU on candidate countries to begin as soon as possible following accession to the EU to fulfil the Maastricht criteria and subsequently enter EMU. If, however, the rate of substitution falls, then even for a smaller country the adoption of the common currency becomes more advantageous.