Working Papers
Pracovní texty

Working Paper No. 2/2003

Inflation after EMU Accession – Selected Issues

Jan Kubíček

INSTITUT PRO EKONOMICKOU A EKOLOGICKOU POLITIKU
A
KATEDRA HOSPODÁŘSKÉ POLITIKY
VYSOKÁ ŠKOLA EKONOMICKÁ V PRAZE – FAKULTA NÁRODOHOSPODÁŘSKÁ

Institut pro ekonomickou a ekologickou politiku
Vysoká škola ekonomická v Praze – Fakulta národohospodářská
Katedra hospodářské politiky

Working Paper No. 2

Inflation after EMU Accession – Selected Issues

Project: GAČR 402/02/1290A

Jan Kubíček

Jan KUBÍČEK – University of Economics Prague, e-mail: kubicek@vse.cz

Abstract

The paper deals with inflation in the candidate countries after their EMU accession. High rates of real appreciation in the candidate countries in recent years have suggested that inflation differentials vis-a-vis the rest of the union could be relatively large. Balassa-Samuelson model is combined with different assumptions about the half-times of real convergence and it is used for evaluating the inflation differentials. The differentials imply lower real interest rates in the new member states as against the rest of the monetary union. This fact is itself quite confusing from the theoretical point of view because the rate of interest should be higher in converging countries due to lower capital stock per labour unit. There are three tentative explanations suggested in the paper that take into account relative price of capital goods, imperfect competition and growth of real wages in converging economies. However, inflation differentials together with corresponding real interest rate differentials could have a wide range of practical implications. Consequences for pension funding are analysed in more detail as an example of such implications.

JEL Codes: E31, E43, F43, O40

Keywords: convergence, inflation differentials, monetary union, real interest rates, pension systems

Contens

1. Introduction

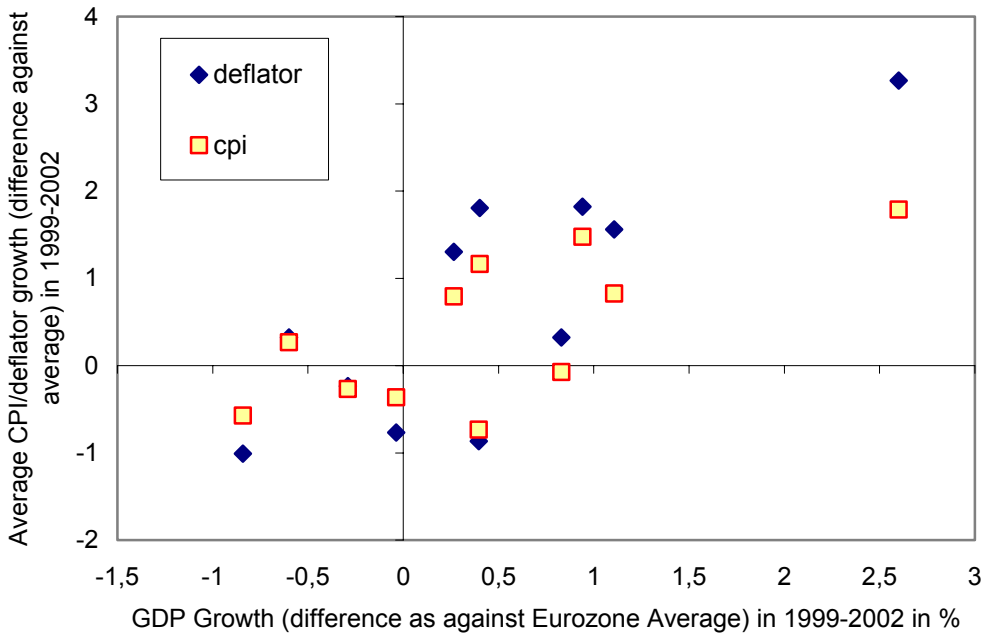
The existence of the European monetary union suppresses the question of differentials in rates of inflation in the member countries. The differentials in HICP inflation rates will be due to unsystematic and one-off events for most of the countries and they will probably eliminate each other in the mid-term. Things will be different, however, in countries with lower output and a substantially lower price level. In this case there are reasons for price level convergence and therefore for a systematic upward inflation bias as compared with the average for the rest of the union. The bigger the initial difference between the national price level and the price level in the rest of the union the bigger will be the consequences of this bias. Therefore considerations concerning the inflation differential are important mainly for the candidate countries, in which price levels are substantially lower than is the European average.
After a brief review of research in this field, theoretical foundations and estimates of inflation differentials follow. Inflation differentials will, however, lead to corresponding differentials in real interest rates in the national countries as compared with the average real interest rate. The long-term existence of inflation differentials will have some redistribution effects. A potential impact of very low real interest rates on pension funding is mentioned as an example of such an effect.

2. The Actual State of Research

The basic theoretical foundation for explaining the differentials is the Balassa-Samuelson model and it will be used here as well. Nearly all authors use Balassa-Samuelson as a starting point but they differ in the modifications they apply on it.
Canzoneri et al. (1998) observed the developments of sectoral productivities in European countries in 1973 – 1995 and drew a conclusion that the Balassa-Samuelson model is sufficient for explaining the real appreciation that took place in some of the countries. If sectoral productivities continued to grow at the same rate as in the past, the inflation differential in the countries with high productivity growth (Belgium, Spain, Italy) could reach up to 2 – 2.5 % per annum as against Germany.
Costia (2000) estimates the inflation differential for Portugal vis-à-vis Germany in the same way as Canzoneri et al. (1998) and her estimate is 1.4% per annum.
Sinn, Reutter (2001) tried to deduce a “minimum” inflation rate for the Eurozone, defining the “minimum” inflation rate as a rate which ensures that no member country suffers from long-term deflation. Such a “minimum” inflation should be around 1% according to their estimate. In this case the country with the lowest inflation (Germany) will have zero inflation and the country with the highest inflation rate (Greece) will have inflation around 4%. The authors also made tentative estimates for potential EMU members and their results are as follow: an inflation differential in the Czech Rep. of 1.7%, in Poland 3% and in Hungary approximately 5.7% in the first years after their accession. However, the results for the transition economies were based on productivity growth data that I do not consider reliable.
Estrada, López-Salido (2001) added long-term changes in mark-ups in tradable and non-tradable sectors to the basic Balassa-Samuelson model. They even argue that the growth of the relative price of non-tradables in Spain in the nineties was due to a mark-up growth in the non-tradable sector and not due to the traditional Balassa-Samuelson effect. They, in fact, transformed the problem of dual inflation into a problem of long-term changes in profit margins the solution of which awaits further research.

Duarte, Wolman (2002) used a model that, apart from the Balassa-Samuelson effect, contains a possible price discrimination in tradable sectors and the relative size of countries. However, their main objective was to explain short-term differentials arising from exogenous productivity shocks rather than long-term convergence of price levels.

Figure 1: Inflation Differential and Real GDP Growth Differentials in 1999-2002



Note: The 2002 data are preliminary for most countries. Luxembourg is not included. A productivity differential was used instead of growth differential in the case of Ireland (2.6 percentage points) because dynamic growth of Irish GDP was strongly influenced by employment growth.

Source: OECD and author‘s results

Alberola, Marqués (1998) note that there are inflation differentials even at the national level. They give the example of differentials between Spanish provinces, their size being relatively small (around 0.5 % per annum) but they can accumulate in the long-term. The authors’ important contribution is their warning that an analogy between inflation differentials within a national monetary union on the one hand and differentials in an international union on the other hand is limited. Again, they use Balassa-Samuelson as a benchmark model, but they remind us that while within an international union the inflation differential is positive if there is a higher than average productivity growth, in national monetary union it is the other way round. The condition *sine qua non* of the Balassa-Samuelson model is that labour is mobile between sectors of the economy but not between regions so that the price of labour does not equate between regions. If, however, the labour costs tend to equate in different regions of the national economy, it implies that those regions, in which there is a higher productivity growth, will have lower inflation rates and regions with lower productivity growth will end up with higher inflation. This conclusion is quite the opposite to the Balassa-Samuelson model. Alberola, Marqués (1998) show that this was really the case for Spanish provinces.

Alberola (2000) notes that inflation differentials can be influenced by differences in weights in the national price indices. Therefore, it is theoretically possible that even if the prices of all items grew at the same rate in all the members of the union, inflation differentials could arise due to differences in weights. This composite effect, however, will be probably rather low. He also takes notice that in cases of excessive wage growth and labour market rigidities a temporary inflation differential may arise, which looks very similar to the one predicted by Balassa-Samuelson (see also Alberola 1999).
Rogers (2001) mentions the Balassa-Samuelson model, but his approach is more empirical. He concludes that prices in Europe do converge to each other even though it is, to a large extent, due to price convergence of tradables. Similarly Bergin stresses that inflation differentials are not caused so much by a change in the relative price of tradables and non-tradables, but by a change in the relative prices of tradables between countries. This can be explained by monopolistic competition and price discrimination. Firms discriminate between national markets and this causes national markets, which are exposed to different extents, to demand relative price shocks of tradables change and this implies an inflation differential.
Hendrikx, Chapple (2002) conclude that inflation differentials within the current EMU were relatively low and they were due to transitory factors. At a theoretical level, they mention an interesting impact of inflation differential on the real interest rate. The differential could have a self-strengthening effect via the change in the real interest rate.
Inflation differentials are explicitly mentioned in Czech literature e. g. by Janáčková (2002) who mentions the specific risks of premature EMU accession for transition economies. Vávra, Cincibuch (2001) estimate the value of central bank seignorage, in which an estimate of inflation differential plays an important role.

3. The Relation between the Rate of Inflation after Monetary Union Accession and Real Appreciation of Domestic Currency

Real appreciation of an independent national currency is composed of its nominal appreciation in the given period and its inflation differential. In the event that the nominal foreign exchange rate is fixed, the nominal appreciation is, by definition, zero. Then the only way how real appreciation can take place is via the inflation differential. Essentially the same situation arises after entering a monetary union. We cannot talk any more about appreciation of a national currency because there is a single currency but this is only a semantic issue. A forecast of long-term real appreciation of domestic currency, in the event that the economy does not enter the monetary union, becomes a forecast of inflation differential in case it does enter the union. In other words, if we want to forecast future inflation differential it suffices to forecast the real appreciation.
If real appreciation continued at the same rate as it did up to 2001 (see table 1), the inflation differentials could be quite substantial in the candidate countries.

Table 1: Average Annual Real Appreciation as against Germany in % in 1995-2001

	Czech Rep.	Hungary	Slovakia	Poland
According to CPI	6,7	4,0	4,7	7,4
According to GDP deflator	6,6	3,2	3,7	6,6
According to PPI	4,3	4,9	3,9	5,4

Source: OECD and author's results

Fast appreciation of national currencies remains, to a large extent, an unexplained phenomenon. Nevertheless, it is important for timing the accession to the single currency. If the candidate countries accessed the monetary union today, their inflation differentials, as against low inflation countries, would probably be somewhere around the values of the actual real appreciation. Given a rate of inflation of around 1% in the low-inflation regions, it implies annual rates of inflation of about 5-8% in the new member states.

The candidate countries will not enter the EMU in 2003 and for more distant periods the past rates of real appreciation need not be a good clue. Therefore a method of estimation based on the Balass-Samuelson model will be used.

For approximate estimates I propose the following hypothesis: the halftime of real convergence will be the same as the halftime of nominal convergence.[1] Let us first show the theoretical justification for this hypothesis. Let κ_t stand for a ratio of output in the converging economy to output in the steady state economy. A share of non-tradables in total product (assumed constant for simplicity) is denoted by α and a ratio of tradables productivity in converging economy to tradables productivity in the steady state is denoted by γ_t. Further simplification concerns productivity in the non-tradable sector. It will be assumed that productivity in the non-tradable sector is the same in the converging economy as in the steady state.

For the ratio of product of the converging economy's to the steady state product κ_t and for the comparable price level in time t (CPL_t) we get simply

$$\kappa_t = \alpha + (1-\alpha)\gamma_t \qquad (1)$$

$$CPL_t = \alpha\gamma_t + (1-\alpha) \qquad (2)$$

The assumption that the real product of the converging economy can be described by means of a constant halftime of convergence can be expressed as follows:

$$\kappa_t = 1 - (1-\kappa_0)e^{-\lambda t} \qquad (3)$$

where $(1-\kappa_0)$ stands for the gap between the steady state product and the converging economy in an initial period. And this gap is reduced in a constant annual rate (λ). However, convergence of the output as a whole is solely due to convergence in the tradable sector because, by assumption, the productivity in the non-tradable sector is already the same. The question is, in what rate the gap between the productivity in tradables in the steady state and productivity in tradables in the converging economy has to diminish so that the gap in total product diminishes by λ?

Let us show that the gap between productivities in the tradable sectors is reduced by rate λ as well. Let us suppose, first, that the gap between productivities is reduced by some rate b so that we can write

$$\gamma_t = 1 - (1-\gamma_0)e^{-bt} \qquad (4)$$

After substituting into (1) we get the ratio of the products in period t

[1] Halftime of convergence is a period of such a length that during this period the difference between the variables in question is reduced to a half.

$$\kappa_t = \alpha + (1-\alpha)\left[1-(1-\gamma_0)e^{-bt}\right] = 1-(1-\alpha)(1-\gamma_0)e^{-bt} \qquad (5)$$

Using the fact that $(1-\alpha)(1-\gamma_0)e^{-bt} = (1-\alpha-\gamma_0+\alpha\gamma_0)e^{-bt} = (1-\kappa_0)e^{-bt}$ and after substituting it into (5) we get

$$\kappa_t = 1-(1-\kappa_0)e^{-bt} \qquad (6)$$

However, at the same time (3) holds for κ_t as well. This implies that really $\lambda = b$, i. e. the rate of reduction of the output gap is the same as the rate, in which the productivity gap in the tradable sector is reduced.[2]

Now we return to the proof, that the price level gap will be reduced by the same rate as the output gap (or, what is the same thing, that their halftimes of convergence are the same). Again let us suppose that the price level gap is reduced by some constant rate c and let us prove that c is the same as λ. For the comparative price level in period t it holds that

$$CPL_t = 1-(1-CPL_0)e^{-ct} = 1-\left[1-(\alpha\gamma_0+(1-\alpha))\right]e^{-ct} \qquad (7)$$

Here we used that $CPL_0 = \alpha\gamma_0 + (1-\alpha)$. According to (4) it holds that $\gamma_t = 1-(1-\gamma_0)e^{-\lambda t}$. After substituting it in (2) we get

$$CPL_t = \alpha\gamma_t + (1-\alpha) = \alpha\left(1-(1-\gamma_0)e^{-\lambda t}\right) + (1-\alpha)$$

$$CPL_t = 1-\alpha(1-\gamma_0)e^{-\lambda t} = 1-(1-CPL_0)e^{-\lambda t} \qquad (8)$$

From the last equation it can be seen that really $c = \lambda$ and so the halftime of price level convergence is the same as the halftime of output convergence.

The hypothesis therefore says that the halftimes of convergence will be roughly the same. If, for example, GDP is at 60% of the steady state level and the price level at 44% of the steady state level, it is supposed that after the halftime of convergence elapses it will reach 80% and 72% respectively. The output gap and the price level gap are both reduced at the same rate, however, the output growth can be different from the comparative price level growth. Table 2 shows predictions of inflation differentials and real growth rates in the first years of convergence, which are implied by the given comparative price levels and halftimes of convergence.

Table 2: Inflation Differentials and Real Growth Rates under Different Halftimes of Convergence (change variables in % per annum)

	CZ	HUN	SK	POL
GDP/EU (2001)	60,0	52,0	49,0	39,0
CPL[a)] (2001)	44,0	47,8	36,4	56,0

[2] The rate in which a gap between two variables is reduced is only a different way for expressing the half-time of convergence. There is the following relation between the half-time of convergence τ and the rate of gap reduction λ: $\tau = \frac{1}{\lambda}\ln 2$

Halftime of Convergence 30 years	Inflation Differential	2,9	2,5	4,0	1,8
	GDP growth [b)]	2,8	3,4	3,7	4,9
Halftime of Convergence 22 years	Inflation Differential	4,0	3,4	5,5	2,5
	GDP growth	3,4	4,2	4,6	6,2
Halftime of Convergence 15 years	Inflation Differential	5,9	5,0	8,1	3,6
	GDP growth	4,4	5,6	6,1	8,5

Note:
[a)] CPL stands for Comparative Price Level, EU in 2001 = 100
[b)] GDP growth is calculated assuming a 1.5% per capita growth in the EU

Source: OECD and author's results

Comparing hypothetical results with real data (see table 3), it can be seen that a halftime of about 30 years seems to be realistic for output convergence, though the real appreciation or inflation differentials do not seem to fit into the scheme of the halftime of convergence. However, this may be partly caused by the brevity of the period in question. Real exchange rates can be misaligned for years and this can obviously substantially influence measured real appreciation if the period under scrutiny is short.

Table 3: Average Annual Real Appreciation and Average Real Growth of Product per Worker in % in 1995-2001

	CZ	HUN	SK	POL
Real Appreciation	6,7	4,0	4,7	7,4
Real Growth per Worker	2,2	3,0	4,2	5,2

Source: OECD and author's results

4. Real Interest Rate in the New Member Country

The inflation differential together with zero or negligible differential in nominal interest rates will imply a differential in real interest rate. Real interest rate will be lower in the new member country, as compared with the rest of the monetary union, by the inflation differential. To my knowledge, research concerning the impacts of inflation differentials on real interest rate differentials and related issues has been rather scanty. Hendrikx, Chappel (2002) and Cecchetti et al. (1998) mention it. Canzoneri et al. (1998) and Costia (2000) note that real interest rate must equalise internationally in terms of tradables. They disregard the implied low real interest rate in the non-tradable sectors in converging economies and its potential implications.

The fact that the real interest rate in the new member countries will be substantially lower than in the rest of the union represents an important theoretical contradiction. The real interest rate equals net marginal product of capital according to neo-classical theory. Marginal product of capital should be higher in the new member countries than in the rest of the union because capital stock per labour unit in these countries is lower. After all, their low price level is mainly due to their lower capital stock per labour unit and it is due to capital stock convergence that the price level convergence can arise. On the whole, the real interest rate should be higher in the converging countries and it should equalise with the rest of the union

only at the moment when real convergence is completed. The traditional growth theory in fact implies a fast transfer of capital into the new member countries until the real interest rate is equalised. This, in theory, leads to an immediate equalisation of outputs and hence of price levels as well. Such consequences are in obvious contradiction with reality and the traditional growth theory is therefore unsatisfactory in this respect.

Relative price of capital goods and real interest rate

A modification of the traditional growth theory that takes into account the relative price of capital goods could shed more light on the question. If the relative price of capital goods is higher in converging countries than in the steady state, the rate of profit will be lower than the traditional neo-classical model predicts. In particular, the rate of return will be as many times lower as many times as the relative price of capital goods is higher (the influence of relative price of capital goods on the rate of return and on real convergence is treated in more detail in Kubíček 2002).
However, this solution is not satisfactory for at least two important reasons. First, there is the question of how it would be possible to keep the relative price of capital goods higher because the capital goods are themselves produced and hence the rate of return would be higher in the capital goods sector. There is another important reason why a higher relative price of capital goods cannot be a satisfactory solution to the problem. With its help we can explain why the rate of return in a converging economy is not as high as the traditional growth theory predicts, however, we cannot explain in this way how the rate of return could be lower in converging economies than in the steady state. But this is exactly what we have to clarify when explaining the presence of a negative differential in real interest rates.

Imperfect competition and real interest rate

An assumption of perfect competition is quite common in neo-classical growth models. However, if it is admitted that competition is not perfect and that the firm does not choose only the produced quantity but that it exerts some influence on its product's price , we get a different result for the real rate of return. We will make a simple conjectural experiment, which will not aim at being a realistic model. Its main objective will be to catch the main influence that imperfect competition can have on real interest rate. Suppose there are N firms in the economy with identical production functions. The production function is supposed to have constant returns of scale so that it is possible to write it in an intensive form, i. e. $y = f(k)$, where y stands for product per unit of labour and k denotes capital per unit of labour. For simplicity let us suppose that the prices are the same in the converging economy as in the steady state.[3]
The marginal rate of return (a crucial factor for loanable funds demand) equals, under monopolistic competition, marginal revenue from capital (MRPK) net of the depreciation rate (δ). Marginal revenue from capital equals marginal physical product multiplied by marginal revenue (MR). It implies that

$$r = MRPK - \delta = MR \cdot f'(k) - \delta ,$$

[3] An explanation of price level convergence is the aim of this paper so by assuming equality in price levels we get rid of our object. The assumption is made here really only to simplify matters and to focus on the influence imperfect competition has on real interest rate.

where r is the real interest rate. The main difference as compared with perfect competition is in the presence of marginal revenue, which influences the marginal rate of return. In order to be able to compare the rate of return in a converging economy r with the rate of return in the steady state r^*, it is necessary to treat the marginal revenue in more detail. Given the assumption of identical production function in all firms (identical even when compared in a converging economy with the production function in the steady state), it is natural to suppose that demand functions for all sorts of goods will be identical as well. However, this implies that all the demand functions have unit income elasticity, i. e. if real income is increased by 1%, the demand schedule shifts by 1% as well. One consequence of this is that the demand function in the steady state is in fact only a multiple of the demand function in a converging economy. If the steady state product is *z* times as high as in the converging economy, the steady state demand schedule for a given product gives *z* times as high demand quantities for each relative price when compared with the demand schedule in the converging economy. Therefore, it holds for the total firm revenue TR that at every price P $TR^*(P) = z \cdot TR(P)$.[4] It implies for the marginal revenue that $MR(P) = \frac{1}{z} MR^*(P)$. For the ratio of gross rates of return (i. e. including the depreciation rate) it follows from this that

$$\frac{r+\delta}{r^*+\delta} = \frac{MR \cdot f'(k)}{MR^* \cdot f'(k^*)} = \frac{f'(k)}{z \cdot f'(k^*)} \qquad (9)$$

If the traditional assumption about decreasing marginal product for a given production factor is made, it implies that the marginal product of capital should be higher in the converging economy than in the steady state. Suppose the marginal product of capital is exactly as many times higher as the product in the converging economy is lower when compared with the steady state, i. e. suppose it holds that $f'(k) = z \cdot f'(k^*)$. This implies according to (9) that the real interest rate is the same for both economies despite the marginal physical product of capital being much higher in the converging economy.
This reasoning can explain why real interest rate could be lower than the traditional theory predicts. Again, I do not consider it to be an adequate explanation. Furthermore, it cannot explain a potentially negative rate of return.

A possibility of negative interest rate

If inflation differentials are high, then the possibility of negative interest rate is not unrealistic. While impossible under perfect competition, I believe the negative interest rate to be theoretically justifiable in a growing economy with imperfect competition. A rigorous theoretical research concerning the rate of return in a converging economy has not, to my knowledge, been done yet. This question comprises in itself lots of theoretical problems and therefore only the main idea will be presented here.
Let us start again with the conjectural experiment made in the previous section and we will focus on a decision made by a representative firm operating under monopolistic competition. The firm is aware of being in a growing economy. The growth of the economy manifests itself by a gradual shift of the demand curve for the firm's product and by a growth of real wages the firm has to pay to its workers. The growth rates of demand and real wages are determined by all of the firms' activities . However, a single firm considers them as exogenous. The firm chooses the volume of its production and of its employment. It also chooses the volume of net

[4] Symbols with an asterix will denote steady state variables.

increment to its capital stock for a future period during which the firm will face both a higher demand curve and higher wages. Let us consider the two extreme choices the firm has:
A: the firm retains employment at its previous level, increases capital stock per worker and production per worker to such an extent that the increased demand is satisfied at the former (relative) price. Higher capital stock per worker increases the marginal physical product of labour and higher demand implies higher marginal revenue. On the whole, marginal revenue from labour is increased and the firm (in line with its maximization effort) can hire labour for higher wages.
B: the firm does not increase its total capital stock and it reduces the volume of employment instead. Higher demand makes it possible to raise the relative price of the firm's product. The reduction of employment and the relative price increase imply higher marginal revenue from labour (MRPL). This, again, enables the firm to pay higher wages.
In both choices the firm increases its capital stock per unit of labour but in A it also increases its total capital stock. The firm compares profit in A and B. It will choose A only if this choice is so much more profitable than B that it will cover at least the costs of borrowing the additional capital. If, however, B is more profitable, the firm will choose A only if the real interest rate is negative.
We can make a fictitious example for comparing the two choices. Suppose the following holds for the representative firm in period zero:

Production = 100
Relative price of its product = 1
Capital = 300
Labour costs = Employment x Wage = 60 x 1 = 60
Profit = Production – Labour costs – Capital depreciation = 100 - 60 - 20 = 20

Suppose that demand and wages are both increased by 10% (the firm considers these rates as given). Furthermore, let us suppose that the marginal product of a unit of capital equals 1/3. It means that if the production is to be increased by 10%, the capital stock must be increased by 30%.

A: Production = 110
Relative price = 1
Capital stock = 390
Labour costs = Employment x Wage = 60 x 1,1 = 66
Profit = Production in terms of Money – Labour costs – Capital depreciation = 110 - 66 - 26 = 18

B: Production = 95
Relative price = 1,06
Capital stock = 300
Labour costs = Employment x Wage = 55 x 1,1 = 60,5
Profit = Production in terms of money – Labour costs - Capital depreciation = 100,7 – 60,5 - 20 = 20,2

However, wages and demand will grow by 10% and the total volume of employment will be retained only if the representative firm chooses A. It will choose A only if it can borrow the additional capital of 90 for a negative price. In other words, A will be chosen if the firm gets a kind of a subsidy of at least 2.2 units for enlarging the capital stock by 90 units. It follows

from the example given above that in a growing economy with monopolistic competition, the negative real interest rate is at least theoretically possible not only temporarily.
The presented argument was only a conjectural experiment, in which we considered behaviour of the "representative firm". In equilibrium, the representative firms behave identically so no relative price changes could take place. However, relative price changes caused the inflation differential and hence the negative real interest rate. Therefore a more complex model that would allow for a permanent relative price change would be necessary for a satisfactory explanation of negative real interest rate.

5. Redistribution Consequences of the Monetary Union Accession for the Pension System

On the whole, the issue of real interest rate in a converging economy is not satisfactorily solved. It has important implications for economic policy, though. Consider the example of a pension system. In recent years, most economists have recommended pension systems on a fund basis rather than pay-as-you-go schemes. When considering the form of pension system, it is usually assumed that the real interest rate retains some secular level. It is not assumed that the real rate could be potentially negative for more than a decade. (This, however, could be the case in the monetary union, if the real interest rate in the rest of the union is lower than real domestic appreciation).
Let us consider a pension system that is financed purely on a fund principle. Suppose an individual saves a fraction s of his or her income Y_t in every year of the T years, during which he or she saves for his or her pension. We will suppose that the fraction s is such that the individual has in period $T+1$ a particular multiple x of his or her income of the last year when economically active.[5] More formally, we will assume that s will be such that the individual will have saved $x(1-s)Y_T$ after T years of saving.
A representative agent in a converging economy will have to save a bigger fraction of his or her income than in a steady state economy in order to end up with savings that represent a given multiple of his or her last year's annual income. It is due to both the lower real interest rate and faster economic growth in the converging economy. The question is, how many times the fraction that is saved in the converging economy s^D has to be higher than in the steady state economy s^F in order that the multiple x is the same for both economies.[6]
First, let us express the volume of pension savings in the converging economy. By assumption an individual saves $s^D Y_t$ every year. These savings earn interest during $T-t$, but the real interest rate is not constant in the growing economy. A gradual convergence of price levels reduces real interest rate as compared with the real rate in the steady state economy (denoted i). Real value of savings saved in period t is changed due to real interest and to price level convergence in period T into $s^D Y_t e^{(T-t)i} \frac{CPL_t}{CPL_T}$, where the term $\frac{CPL_t}{CPL_T}$ measures the influence of price level convergence. Real income in the converging economy can be expressed as a product of real income in the steady state and of a ration κ_t of the converging economy income to steady state income. Assuming a constant secular growth rate g for

[5] Net of the pension savings.
[6] Real values of the amounts saved will not be the same. It is only required that the values are the same relative to the last incomes.

income per worker in the steady state, we can express income per worker in the converging economy as follows

$$Y_t^D = \kappa_t e^{gt} Y_0^F \tag{10}$$

For total pension savings S^D saved in periods $t = 0, 1, \cdots, T$ it holds that

$$S^D = s^D \sum_{t=0}^{T} \kappa_t e^{gt} Y_0^F e^{(T-t)i} \frac{CPL_t}{CPL_T} = s^D Y_0^F e^{Ti} \sum_{t=0}^{T} \kappa_t e^{(g-i)t} \frac{CPL_t}{CPL_T} \tag{11}$$

It holds for total pension savings in the steady state economy that they are simply a sum of savings made in particular years increased by compound real interest. The steady state income Y_t^F can be again expressed using the secular growth rate g. Therefore we get for pension savings S^F that

$$S^F = s^F Y_0^F e^{Ti} \sum_{t=0}^{T} e^{(g-i)t} \tag{12}$$

The individual pension savings in the converging economy S^D can be expressed as the last net individual income multiplied by some x^D, i. e.

$$S^D = x^D \left(1 - s^D\right) \kappa_T e^{gT} Y_0^F \tag{13}$$

The individual pension savings in the steady state can be expressed by analogy as

$$S^F = x^F \left(1 - s^F\right) e^{gT} Y_0^F \tag{14}$$

The question to which we are searching for a solution is: "How many times s^D is bigger than s^F given the condition that $x^D = x^F$?" Expressions (11) and (13), (12) and (14) respectively, imply the following for s^D and s^F:

$$\begin{aligned} s^D &= \frac{\kappa_T x^D e^{(g-i)T} CPL_T}{\kappa_T x^D e^{(g-i)T} CPL_T + \sum_{t=0}^{T} \kappa_t e^{(g-i)t} CPL_t} \\ s^F &= \frac{x^F e^{(g-i)T}}{x^F e^{(g-i)T} + \sum_{t=0}^{T} e^{(g-i)t}} \end{aligned} \tag{15}$$

Using the condition $x^D = x^F$, we finally get

$$\frac{s^D}{s^F} = \frac{x + \sum_{t=0}^{T} e^{(i-g)(T-t)}}{x + \sum_{t=0}^{T} \frac{\kappa_t CPL_t}{{}_T{}_t CPL_{T_t}} e^{(i-g)(T-t)}} \tag{16}$$

Quantitative results will depend on the value chosen for the secular growth rate of economy g, for the long-term real interest rate i. It will also depend on what halftime of convergence is realistic in the new member countries. Let us choose realistic values of $g = 1{,}5\%$ and $i = 2{,}5\%$. It is not clear, however, what the halftime of convergence is in Central European economies. The ratio S^D / S^F seems to be relatively robust vis-à-vis changes in the initial price level and the relative income per head. Substituting real 2001 data for κ_t, CPL_t and choosing $T = 36$ for all the four economies under scrutiny, it follows that the ratio is in the range between 1.3 to 1.4 even if half-times of convergence are in the range of 15 to 30 years.
Let us suppose an individual will save for 36 years and he or she will demand to have savings that will amount to at least 10 times the income in the last year of economic activity. In the case of the steady state economies, a saving rate of 18.3% is sufficient. A saving rate of about 25% will be necessary for achieving the same multiple in the converging economies.
So far it has been supposed that the saving rate remains the same for all the years. If a rational agent could change it, he or she would tend to have a lower saving rate in his or her youth (because at this stage both the real interest rate and real income are low) and raise his or her saving rate when approaching retirement. In this case the saving rate would have to be higher than the estimated s^D's and values reaching about 40% would probably not be an exception. Of course, it is doubtful that when making the choice concerning his or her saving rate the agent will be as rational as to be able to save a required multiple of last year's current income (consumption). The agent would have to be able to form correct expectations concerning the halftimes of convergence. This is not likely because not even economists are able to do so. Simply put there is a threat that the individual will end up with a far lower value of real savings than had been expected.

6. Conclusions

The issue of inflation differential after joining a monetary union is closely connected with the the real appreciation of the candidate countries' national currencies. The empirical development of real appreciation is a puzzle to a large extent because the usual explanations using the Balassa-Samuelson model and terms-of-trade changes can be shown to explain a relatively small part of the appreciation. Therefore we can think of the Balassa-Samuelson effect as being the lower bound of the inflation differential.
The inflation differential will cause the real interest rate in the new member states to be lower than in the rest of the union. This itself is a substantial theoretical problem. However, it may also have a range of practical implications. One potential practical implication was treated here in more detail - an implication for financing the pension system. Individuals might erroneously estimate their optimal saving rate due to a low real interest rate (or it might be erroneously estimated by economic policy makers if the saving rate was obligatory) and this could imply substantial social problems.
On the whole we can say that considerations about inflation after monetary union accession should be taken into account when deciding about the timing of EMU accession and, among other things, about pension reforms in the candidate countries.

References

ALBEROLA, E. (1999): Is there Scope for Inflation Differentials in EMU? Economic Bulletin (January), pp. 69-73, Banco de España.

ALBEROLA, E. (2000): Interpreting Inflation Differentials in the Euro Area. Economic Bulletin (April), pp. 61-70, Banco de España.

ALBEROLA, E. - MARQUÉS, J. M. (2000): On the Relevance and Nature of Regional Inflation Differentials: the Case of Spain. Banco de España, Documento de trabajo n. 9913.

BERGIN, P. R. (2001): One Money One Price? Pricing to Market in a Monetary Union. (http://www.econ.ucdavis.edu/faculty/bergin/research/twop5web.pdf , dat. 18. 1. 2003)

CANZONERI, M. B.- CUMBY, R. E. - DIBA, B. - EUDEY, G. (1998): Trends in European Productivity: Implications for Real Exchange Rates, Real Interest rates and Inflation Differentials. Öesterreichische Nationalbank, Working Paper 27.

CECCHETTI, S. G. - MARK, N.C. - SONORA, R. J. (1998): Price Level Convergence Among United States Cities: Lessons for the European Central Bank. Öesterreichische Nationalbank, Working Paper 32.

CINCIBUCH, M. – VÁVRA, D. (2001): Hodnota emisní banky v tranzitivní ekonomice. Finance a úvěr, 11/2001, pp. 574-590 (in Czech).

COSTIA, S (2000): Inflation Differential between Portugal and Germany. Economic Bulletin (June), pp. 47-57, Banco de Portugal.

DUARTE, M. - WOLMAN, A. (2002): Regional Inflation in a Currency Union: Fiscal Policy vs. Fundamentals. ECB, WP 180

ESTRADA, Á. - LÓPEZ-SALIDO, J. D. (2001): Understanding Spanish Dual Inflation. Banco de España, Documento de trabajo n. 0205.

GRAUWE, P. DE: Economics of Monetary Union. 2000, Oxford University Press

HENDRIKX, M. - CHAPPLE, B. (2001): Regional Inflation Divergence in the Context of EMU. De Nederlandsche Bank.

JANÁČKOVÁ, S. (2002): Rozšiřování eurozóny: některá rizika pro dohánějící země. Politická ekonomie, 6/2000, pp. 759-779 (in Czech).

KUBÍČEK, J. (2002): Příspěvek k teorii reálné konvergence. Politická ekonomie, 5/2002, s. 676-688 (in Czech).

OECD (2003): Main Economic Indicators – online database.

REUTTER, M. – SINN, H. W. (2001): The Minimum Inflation Rate for Euroland. NBER, Working Paper 8085.

ROGERS, J. H. (2001): Price Level Convergence, Relative Prices and Inflation in Europe. Board of Governors of the Federal Reserve System, International Finance Discussion Papers, No. 699.