Economic integration, common monetary policy and growth asymmetries

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Abstract

An endogenous growth model with monetary aspects is considered in this paper in order to analyze the effects of a common monetary policy implemented in a context of economic integration. The main objective is to draw conclusions about the consequences a homogeneous monetary policy can have on two heterogeneous countries derived from the asymmetries that the economic integration process generates in the global transmission mechanisms.

1 Introduction

Endogenous growth models have contributed since the mid-eighties in an important way to the knowledge of the factors determining economic development. This has been as a consequence of their ability to explain sustained growth as a result of economic agents' deliberate decisions. However, it is in the possible interaction of these factors where much more work is needed to be done. Two of them are considered in this essay due to their current economic and conceptual relevance: economic integration and monetary policy. The importance nowadays of the interactions between them comes from the experience that is taking place in the European Union. The applied common monetary policy is operating in a context of economic integration and necesarily is influencing the economic growth of the member countries of the European Monetary Union (EMU). Unfortunately, when its implications are considered, they are seen as

merely related to the stabilization policy, neither to the economic growth nor to the economic integration process, phenomena pertaining to the long-run.

The dominant idea, at least at the policy level, according to which the common monetary policy has no growth implication (except those derived from the volatility reduction, following Ramey and Ramey (1995)) is hard to accept from a conceptual point of view. A common policy affecting heterogeneous countries which are experiencing a convergence process where there exists a hierarchical role for each of them has to forcefully face asymmetries in the transmission mechanisms. This will derive in differences in the obtained results, as long as all the countries are treated homogeneously. In this paper we try to find what are the hierarchical roles of the different countries and which are the mechanisms that origin the differences in a simple endogenous growth model where real and monetary factors are considered simultaneously in a context of economic integration. This simple model is not intended to show a complete characterization of the reality but to provide stylized concepts reinforcing the acceptance of a relevant link between a common monetary policy and the growth of the different member countries. Economic aspects usually analyzed isolatedly are put together because the links 'economic growth-economic integration' and 'economic growth-monetary policy' have been considered separatedly in the literature.

Economic growth and economic integration

On one hand, Rivera-Batiz and Romer (1991a, 1991b) and Rivera-Batiz and Xie (1993) were the first studies who dealed with the relationship between economic integration and endogenous growth. In these models innovation is the main factor driving development and permanent effects are derived mainly as a consequence of assuming instantaneous and costless knowledge diffusion. These studies contains as a drawback the presence of the empirically rejected 'Scale Effect' in the growth rate.

Four later contributions analyze the same issue from a more general point of view. Walz (1998) considers an endogenous growth model with three countries where two of them initially constitute a common market and a third one joins it at a later date. It is demonstrated that higher growth is obtained only if trade liberalization takes place at the beginning of the

integration process, being a consequence of resources reallocation. Convergence is achieved and the poorest country specializes in the traditional sector, being the one which obtains the greatest advantage from integration. The caveats of this study are that it does not consider the presence of capital and that it also presents the 'Scale Effect'. Gianetti (2002) explains the presence of convergence in the European Union at a national level, while it is absent at a regional one. However, capital is also not included in her model and technology diffusion is the only way through which integration works. Viaene and Zilcha (2002) study the effects of capital markets integration concluding that production increases in every period while the growth rate is not affected. There exists an 'Implementation Paradox' because the first generation always benefits from the integration and the following ones are always harmed. The problem with this latter work is that resources reallocation through trade is not allowed. Finally, Larramona and Sanso (2005) prove that economic integration through labour mobility also leads to convergence of the poorest countries.

With these latter studies in mind, Sanso et al (2005) develop a model with capital, where 'Scale Effect' in the growth rate is not present, in order to analyze the effects of economic integration through trade and factor flows. Expressions for growth rates are obtained in a way that allow to verify the evolution of the relative prices during the integration process, as well as the productive structure of the countries. They conclude that free factor mobility will never benefit both countries at the same time while common gains can only be derived from trade integration. The probability of these benefits increases with differences in relative capital endowments and in technological levels. It is also shown that integration strengthen convergence of the less developed countries, who are those that obtain the highest gains.

From an empirical point of view, Landau and Vandhout (1999) find no effect of the European Economic Comunity on growth, while Henrekson et al (1997) pointed to a positive one when including control variables following the endogenous growth theory. Badinger (2005) develops an indicator for the integration degree and finds only level (not growth) effects. However, it must be noted that there is an excesive simplification of the link between integration and growth in these empirical models, so there are no clear structural relationships.

In another recent empirical work, Crespo-Cuaresma et al (2004) use the panel-threshold methods developed in Hansen (1999) to show that the growth effect the regional integration has differed from the trade integration one when using openness as a control variable. This additional effect is related to improvements in technology transmission. It is found that there exists convergence as a consequence of integration, but it cannot be concluded that technological spillovers generate sustained growth. This latter work is the only one among those mentioned above that introduces inflation as a factor influencing (negatively) growth jointly with integration processes.

Economic growth and monetary policy

On the other hand, monetary policy plays a key role in determining the inflation rate. Tobin (1965) was the first who analyzed the relationship between inflation and growth and pointed to a positive nexus since reductions in real interest rates encourage capital accumulation. However, most studies establish a negative link (Barro (1996) and Chari et al (1996)) or, at least, argue that this relationship is non-linear and determined by thresholds (Bruno and Easterly (1996), Choi et al (1996), Khan and Senhadji (2001) and Drukker et al (2005)).

From these last references and the previous ones on economic growth and economic integration we can conclude separately that monetary policy has a clear growth effect and that economic integration processes promote convergence. Considering both elements together we must be able to derive the transmission mechanisms that will throw light about the consequences of applying a common monetary policy.

At present, an interesting process of monetary consolidation is taking place in the twelve member countries of the European Monetary Union. A central issue for this initiative is the implementation of a single currency and a common monetary policy instrumented through the pegging of a reference interest rate by the European Central Bank (ECB in what follows). There are many doubts about the effects a common monetary policy can induce in the different countries derived from the asymmetries observed in their macroeconomic variables. The most interesting ones are those related with the inflation and growth rates.

In contrast with the homogeneity in the monetary policy, after the introduction of the Euro in January 2002 there has been an increase in the dispersion of the inflation rates where the less developed countries usually show higher values. It is also observed that growth rates are lower in the central countries while they are higher in the peripheric ones. It cannot be stated the common monetary policy to be in danger if these differences are transitory and deviations are casual (and not systematic as they seem to be nowadays).

Studies developed so far focus mainly on the increase in the inflation rates disparities and the official conclusion is that those asymmetries are as a consequence of both temporal and persistent causes (ECB, 2003). Among those temporal factors they consider the coyuntural business cycle situation of each country, price policies divergences and the starting of the Third Stage of the Monetary Union process. The persistent reasons highlighted are those related to a convergence process in prices and incomes for the less developed countries (Greece, Ireland, Portugal and Spain) and the Balassa-Samuelson effect[1]. The quoted ECB report does not pay much attention to the latter and thinks the convergence effect will eventually dissapear. Finally, it is also pointed out that there are still other permanent factors behind the inflation differentials, as some market rigidities in prices and wages and competitiveness differences in key domestic sectors. It is advanced that persistence in inflation differencials should decrease as progress in structural reforms pushed by the EU takes place. For all these reasons, the report concludes that we should expect the inflation differentials to remain in the future, although following a decreasing path[2].

It is surprising that there is no reference in the previous conclusions to the possible influence of the common monetary policy on those differentials. This publication argues that the monetary authorities have nothing to learn from them and that they have no responsibility in their causes. In line with the emphasis the ECB puts on the inflation as its main target and the idea about the absence of a link between inflation and growth, it only admits a conyuntural one, displayed as a positive temporal correlation: those countries with a higher growth

[1] A faster productivity growth in the tradables than in the non-tradables sector that forces the prices of this latter goods to rise faster than the former.

[2] Other studies, like Lopez-Salido et al (2005) obtain conclusions in line with this general point of view. They conclude for the Spanish case that 'a demand expansion biased towards consumption of non-tradable goods and wage rigidities are...the key determinants of diverging price determinants in Spain'

have also a higher inflation rate, and viceversa. In such a case, a common monetary policy cannot be behind the link.

Economic growth, economic integration and common monetary policy

The issue of the relationship between monetary policy and growth in economies where an integration process is taking place and a common monetary policy is applied, as it is the case of the Eurozone, has never been analyzed. For this reason and according to the recent evidence, we develop a theoretical model to study simultaneously the influence monetary policy can induce over growth and competitiveness in an economic integration and single currency framework. The main objective will be to draw conclusions about the consequences an homogeneous monetary policy can have on heterogeneous countries.

The model we use is the same as in Sanso et al (2005) but with money. This is an endogenous growth model in which growth is due to an externality in the capital to labour ratio. The consequence of using this type of model is that we only have one accumulation sector (physical capital), despite more elaborated models would allow the consideration of two or more (human capital and knowledge, for example). The reason for this option is that we really need the possibility of a permanent improvement in labour productivity and the one used here allows the introduction of monetary aspects in a straightforward way, leading to very clear conclusions on the interactions between monetary policy and the economic integration process.

We try to determine the ways a common monetary policy of the Euro-type can be affecting the asymmetries observed in the inflation and growth rates. It is found they are very varied, most of them transitory, although permanent effects can also be generated.

The case where two countries are starting an economic integration that is mutually beneficial is only considered. Moreover, it has also been assumed that the integration takes place from autarky even it is known this step has not been implemented in such a radical way in the real world. As the objective is to find out stylized concepts instead of real life or quantitative results, we think this is an adequate approach that does not diminish the relevance of the obtained results.

The paper is structured as follows. Section 2 describes the model and how the closed economy works. Section 3 deals with some preliminar questions about economic integration and common monetary policy. Section 4 analyzes trade integration between countries with the same technological level and section 5 introduces a technological gap. Section 6 concludes.

2 The model

It is observed that countries are generally interested in economic integration and that, once integrated, they tend to accept the enrollment of new countries. From a theoretical point of view, Sanso et al (2005) try to determine under which circumstances two countries will obtain benefits from integration. This is done by the analysis of the effects that free factor flows and trade integration have on resources allocations, prices, factor returns, growth and welfare.

Taking the previous work as our starting point we are constructing an extended model where monetary aspects will be considered. We describe it in this section while economic integration and common monetary policy issues will be introduced in the following ones.

2.1 Basic elements

2.1.1 Consumers

We consider an OLG model where every utility-maximizer individual lives two periods (young and old). L individuals are born each period and the utility function of a young consumer in t is given by:

$$U_t = U_t^1 + (1+\delta)^{-1} U_{t+1}^2 \tag{1}$$

Superindices 1 and 2 refer to the periods when the individual is young and old, respectively. The parameter δ denotes the intertemporal discount factor.

Utility derives from the consumption of two partially complementary goods: Y and Z. It is assumed that the contemporaneous utility function is logarithmic in the aggregate consump-

tion ($c_Y^v c_Z^{1-v}$):

$$U_t^j = v \ln c_{Y,t}^j + (1-v) \ln c_{Z,t}^j \qquad j = 1, 2;\ 0 < v < 1 \tag{2}$$

where C_Y and C_Z are the consumption of good Y and Z, respectively.

The intertemporal utility function is:

$$U_t = v \ln c_{Y,t}^1 + (1-v) \ln c_{Z,t}^1 + (1+\delta)^{-1} \left[v \ln c_{Y,t+1}^2 + (1-v) \ln c_{Z,t+1}^2 \right] \tag{3}$$

Young individuals work and receive a salary (w_t) which is used in consumption spending (E_t^1), savings (s_t) and cash-holdings (m_t). Then, the first period budget constraint can be expressed as:

$$w_t = E_t^1 + s_t + m_t = c_{Y,t}^1 + P_{Z,t} c_{Z,t}^1 + s_t + m_t \tag{4}$$

m_t is the real stock of money and it is given by $m_t = \frac{M_t}{P_{Y,t}}$, being M_t the nominal amount of money, P_Z is the relative price of good Z in terms of good Y. Note that good Y is taken as the numeraire in the rest of the essay, so all the real variables will be expresed in units of it, as w_t, E_t^1, s_t and m_t are, with the exception of consumption and production of good Z.

Old people do not work and consume the returns obtained from their savings, so the budget constraint in the second period will be:

$$(1 + r_{t+1}) s_t = E_{t+1}^2 = c_{Y,t+1}^2 + P_{Z,t+1} c_{Z,t+1}^2 \tag{5}$$

where r_{t+1} is the real interest rate in period $t+1$ and E_{t+1}^2 the consumption expending of an individual when old in the same period.

Using the single-period budget constraints in (4) and (5) we can construct the intertemporal one:

$$w_t = E_t^1 + \frac{E_{t+1}^2}{(1 + r_{t+1})} + m_t = c_{Yt}^1 + P_{zt} c_{Zt}^1 + \frac{c_{Yt+1}^2 + P_{zt+1} c_{Zt+1}^2}{(1 + r_{t+1})} + m_t \tag{6}$$

Following Clower (1967), money is introduced in the model through the 'Cash-in-advance' constraint. It considers monetary arrangements and institutions as given and requires individuals to enter their second period of life with money balances enough to finance their purchases of goods. Specifically, consumers must provide cash in a proportion ($0 \leq \gamma \leq 1$) of their expenditure when old. As a consequence of the normalization we are using (in terms of good Y) it can be formulated as[3]:

$$\gamma E_{t+1}^2 \leq \frac{m_t}{\Pi_{Y,t+1}}, \qquad 0 \leq \gamma \leq 1 \tag{7}$$

where $\Pi_{Y,t+1}$ is one plus the inflation rate ($\pi_{Y,t+1}$) of good Y:

$$\Pi_{Y,t+1} = 1 + \pi_{Y,t+1} = 1 + \frac{P_{Y,t+1} - P_{Y,t}}{P_{Y,t}} \tag{8}$$

P_Y is the nominal price of good Y.

This constraint is a way that allows money to flow in the economy. In the first period of their lives consumers make their consumption and savings decisions, so it must be assumed that they have perfect knowledge about the values the variables will take the following period because no uncertainty is present in the model. People know they will have to pay their expenditure when old with money, so keep part of their salary in cash to pay consumption to the productive sector. This is later used by firms to pay young people for they work in the form of a part of their salary.

Note that we are assuming there are no credit constraints so there is always enough money to satisfy consumer´s desires.

2.1.2 Productive sector

Production of goods in the economy combines two factors: capital (K) and labour (L). For simplicity, we avoid time subindices where possible.

[3] This is a way of introducing money in the economy thas has already been used by Hann and Solow (1997) in Chapter 2, page 14.

Production of good Z is driven by a neoclassical function where capital and labour have constant returns to scale. This good is used entirely for consumption:

$$Z = K_Z^{\alpha} L_Z^{1-\alpha}, \quad 0 < \alpha < 1 \tag{9}$$

K_Z and L_Z are the amounts of capital and labour used in the production of good Z. We can redefine these variables in terms of labour ($z = \frac{Z}{L_Z}$, $k_z = \frac{K_z}{L_Z}$) and the technology will be given by:

$$z = k_Z^{\alpha} \tag{10}$$

To obtain good Y capital and labour are combined as follows:

$$Y = K_Y^{\beta} (TL_Y)^{1-\beta}, \quad 0 < \beta < 1 \tag{11}$$

It is assumed good Y to be more technologically 'advanced' than the 'traditional' good Z, so its production function will be more capital intensive ($\beta > \alpha$)[4]. Following Kemnitz (2001), labour productivity in (11) depends on T reflecting a positive externality of the mean capital per worker in this sector. Denoting $T = a^{-1} \frac{K_Y}{L_Y}$ ($a > 0$) it can be derived the following reduced-form expression for the technology used to produce good Y:

$$Y = a^{\beta-1} K_Y \tag{12}$$

Normalizing by the labour employed in sector Y ($y = \frac{Y}{L_Y}$, $k_Y = \frac{K_Y}{L_Y}$) it is obtained that:

$$y = a^{\beta-1} k_Y \tag{13}$$

This expression means that the reduced form of this technology is equivalent to an AK model. Capital is produced one by one with good Y, but the latter is also used in consumption. The AK technology will allow for a continuous capital accumulation at stable rates in steady state and, as a consequence, long-term growth.

[4] This extreme way of modeling tries to reflect differences in productivity. However, it will be relaxed in the following sections.

Finally, it will also be assumed that capital entirely depreciates every period, so its stock available every period will be equal to the total savings in the previous one:

$$K_{t+1} = Ls_t \tag{14}$$

This equality can also be expressed in per capita terms ($k = \frac{K}{L}$):

$$k_{t+1} = s_t \tag{15}$$

2.2 Closed economy equilibrium

2.2.1 Consumers

Consumers maximize the utility function in (2) subject to the constraints in (6) and (7). The Lagrangian of this optimization problem is:

$$\begin{aligned} L &= v \ln c^1_{Y,t} + (1-v) \ln c^1_{Z,t} + (1+\delta)^{-1} \left[v \ln c^2_{Y,t+1} + (1-v) \ln c^2_{Z,t+1} \right] + \\ &+ \lambda \left[w_t - c^1_{Y,t} - P_{Z,t} c^1_{Z,t} - \frac{c^2_{Y,t+1} + P_{Z,t+1} c^2_{Z,t+1}}{(1+r_{t+1})} - m_t \right] + \\ &+ \mu \left[m_t - \gamma \Pi_{Y,t+1} \left(c^2_{Y,t+1} + P_{Z,t+1} c^2_{Z,t+1} \right) \right] \end{aligned} \tag{16}$$

From the first order conditions it can be derived that expenditure in both goods are fixed proportions v and $(1-v)$ over the total:

$$c^1_{Y,t} = vE^1_t \tag{17}$$

$$P_{Z,t} c^1_{Z,t} = (1-v)E^1_t \tag{18}$$

$$c^2_{Y,t+1} = vE^2_{t+1} \tag{19}$$

$$P_{Z,t+1} c^2_{Z,t+1} = (1-v)E^2_{t+1} \tag{20}$$

It can also be obtained how the salary is assigned in the first period to total expenditure,

savings and money:

$$E_t^1 = \frac{1+\delta}{2+\delta} w_t \tag{21}$$

$$s_t = \frac{1}{(2+\delta)\left[1+\gamma\Pi_{Y,t+1}(1+r_{t+1})\right]} w_t \tag{22}$$

$$m_t = \frac{1}{(2+\delta)\left[1+\frac{1}{\gamma\Pi_{Y,t+1}(1+r_{t+1})}\right]} w_t \tag{23}$$

Then, a greater inflation rate of the 'advanced' good affects negatively savings and increase cash holdings[5]. Terms accompanying salary in (21), (22) and (23) add up to unity.

Expenditure in the second period of life is also negatively related to this inflation rate:

$$E_{t+1}^2 = \frac{1}{(2+\delta)\left[\gamma\Pi_{Y,t+1}+\frac{1}{(1+r_{t+1})}\right]} w_t \tag{24}$$

We can try to obtain a dynamic expression for inflation using (7), (23) and (24) but *an indetermination will be found.* That means *there is a need to specify a monetary policy rule to fill this lack of determination. For this reason, we are considering the presence of a monetary authority whose objective is to control inflation. This will be made through the use of some monetary instruments as the nominal interest rate and the money stock growth rate. We deal with this issue below.*

The gross growth rate of expenditure between two consecutive periods of life is equal to:

$$\frac{E_{t+1}^2}{E_t^1} = \frac{1+r_{t+1}}{(1+\delta)\left[1+\gamma\Pi_{Y,t+1}(1+r_{t+1})\right]} \tag{25}$$

Finally, we can think the 'Cash-in-Advance' constraint in (7) not be binding under some circumstances. If this were the case the Lagrange Multiplier μ would be equal to zero. From the first order conditions of (16) we obtain that $\lambda = \mu$, so v must be equal to zero or one for this to hold. Both possibilities are explicitly excluded in our model.

[5] Note that the proportion of the expenditure that is required to be paid by cash (γ) affects the variables in the same direction as inflation. However, this parameter is not relevant for our purposes so we will not pay attention to it in what follows.

2.2.2 Producers

Firms maximize profits. It can be derived both the marginal productivities of labour (W) and capital ($1+r$) in terms of good Y in each sector from the optimization problem:

$$\begin{aligned} W_Z &= (1-\alpha)k_Z^{\alpha}P_Z \quad (26)\\ W_Y &= (1-\beta)a^{\beta-1}k_Y \\ 1+r_Z &= \alpha P_Z k_Z^{\alpha-1} \quad (27)\\ 1+r_Y &= \beta a^{\beta-1} \end{aligned}$$

Wages and interest rates in the two productive sectors are equal in equilibrium. From (26) it is obtained the evolution of the ratio capital/labour in sector Z as a function of its relative price:

$$k_Z^{\alpha-1} = \frac{1}{P_Z}\frac{\beta}{\alpha}a^{\beta-1} \quad (28)$$

Making equal salaries in (26) and using (27) an expression that relates the capital to labour ratio in both productive sectors is derived:

$$k_Y = \frac{1-\alpha}{1-\beta}\frac{\beta}{\alpha}k_Z \quad (29)$$

Since $\beta > \alpha$, it can be concluded that $k_Y > k_Z$.

2.2.3 Market clearing

Good Y is used both for consumption and as productive capital and good Z is entirely devoted to consumption. Using equations (17) to (20) we obtain their corresponding market clearing conditions:

$$\begin{aligned} l_Y y_t &= vE_t^1 + vE_t^2 + k_{t+1} \quad (30)\\ P_{Z,t}l_Z z_t &= (1-v)E_t^1 + (1-v)E_t^2 \quad (31) \end{aligned}$$

q_Z, l_Z and q_Y, l_Y are the proportions of capital and labour used in the production of goods

Z and Y, respectively. Then, market clearing conditions for productive factors imply that $q_Z + q_Y = 1$, $l_Z + l_Y = 1$. From (30) it follows that:

$$\frac{q_Y}{l_Y} = \frac{(1-\alpha)\beta + (\alpha-\beta)q_Y}{\alpha(1-\beta)} \tag{32}$$

Finally, substituting (26), (28) and (22) in (15) the equation reflecting the capital accumulation process between two consecutive periods is the obtained:

$$k_{t+1} = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{t+1}(1+r_{t+1})\right]}\frac{q_Y}{l_Y}k_t \tag{33}$$

2.2.4 Steady state and absence of transitional dynamics

Steady state is characterized by a constant growth rate of capital and output in the economy. In addition, production factors will also be distributed in stable proportions among sectors.

Let g denote the (gross) growth rate of per capita capital. In steady state it will also be the growth rate of per worker capital and, following (26), of the salary, expenditure and consumption in good Y. Considering (28) the relative price of good Z will grow at a rate $g^{(1-\alpha)}$ and its consumption at g^{α} [6].

From (32) and (33) it is obtained a decreasing relationship between the growth rate and q_Y:

$$g_t = \frac{k_t}{k_{t-1}} = \frac{a^{\beta-1}\left[(1-\alpha)\beta - (\beta-\alpha)q_Y\right]}{\alpha(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)\right]} \tag{34}$$

And using the market clearing condition of good Z in (31) it can be derived an increasing one:

$$\beta\frac{1-q_Y}{(1-\alpha)\beta - (\beta-\alpha)q_Y} = \frac{1-v}{2+\delta}\left[1+\delta+\frac{(1+r_t)\beta a^{\beta-1}}{\left[1+\gamma\Pi_{Y,t}(1+r_t)\right]}\frac{1}{g_t}\right] \tag{35}$$

The system formed by these two last expressions allow to solve for the growth rate:

$$g_t = \frac{\left[1-\alpha-v(\beta-\alpha)\right]\beta a^{\beta-1}}{\left\{\beta+\left[\alpha+v(\beta-\alpha)\right](1+\delta)\right\}\left[1+\gamma\Pi_{Y,t}(1+r_t)\right]} \tag{36}$$

This long-run growth rate depends negatively on a implying a greater growth with a

[6] Note that this growth rate is different from the growth in expenditure during an individual lifetime in (25).

greater externality (a greater marginal productivity of capital in the 'advanced' sector). It is also decreasing in the importance of good Y in the utility function (v)[7] since more of this good will be used in consumption instead of as capital, as well as in the intertemporal discount factor (δ). Finally, observe that the growth rate depends negatively on the 'advanced' good inflation rate.

As a (reduced-form) AK model, the economy will always grow at this rate reaching the steady state inmediately if $\Pi_{Y,t}$ is constant. In fact, with a fixed monetary policy leading to a fixed inflation rate in good Y no transitional dynamics will be present. Positive economic growth implies a greater than unity value of g. This will happen if the following condition is satisfied:

$$a^{\beta-1} > \frac{\{\beta + [\alpha + v\,(\beta - \alpha)]\,(1+\delta)\}\,[1 + \gamma\Pi_{Y,t}(1+r_t)]}{\beta\,[1 - \alpha - v\,(\beta - \alpha)]} \tag{37}$$

It implies that positive growth requires high productivity levels and a low inflation rate in the 'advanced' sector of the economy.

From (34) and (35) it can be derived how factors are allocated among productive sectors:

$$q_Y = \frac{1-(1-v)\alpha + v(1+\delta)}{\beta + [\alpha + v(\beta-\alpha)]\,(1+\delta)}\beta \tag{38}$$

$$q_Z = \frac{(1+\beta+\delta)(1-v)}{\beta + [\alpha + v(\beta-\alpha)]\,(1+\delta)}\alpha \tag{39}$$

$$l_Y = \frac{1-(1-v)\alpha + v(1+\delta)}{1-\alpha-v(\beta-\alpha)}\frac{(1-\beta)}{(2+\delta)} \tag{40}$$

$$l_Z = \frac{(1-\alpha)(1-\nu)}{1-\alpha-v(\beta-\alpha)}\frac{(1+\beta+\delta)}{(2+\delta)} \tag{41}$$

All these expressions are positive and smaller than one. The proportion $\frac{q_Y}{l_Y}$ is greater than unity, while $\frac{q_Z}{l_Z}$ is smaller. It is an outstanding result that the allocation in production does not depend on the inflation rate in sector Y. In this sense, money is neutral, although not in the growth rate.

In what follows we are making an additional simplifying assumption that will allow notation to be more clear and appreciate the effects in a greater extent in order to draw more

[7] Provided $\beta > \alpha$ the sensitivity of g to v increases with $(\beta - \alpha)$. In fact, when it is equal to zero g does not depend on v.

accurate conclusions. It consists in establising that both productive sectors have the same capital intensity ($\alpha = \beta$):

$$(g_t)_{\alpha=\beta} = \frac{(1-\beta)\, a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)\right]} \tag{42}$$

$$\left(\frac{q_Y}{l_Y}\right)_{\alpha=\beta} = \left(\frac{q_Z}{l_Z}\right)_{\alpha=\beta} = 1 \tag{43}$$

$$(q_Y)_{\alpha=\beta} = (l_Y)_{\alpha=\beta} = \frac{1-(1-v)\beta+v(1+\delta)}{(2+\delta)} \tag{44}$$

$$(q_Z)_{\alpha=\beta} = (l_Z)_{\alpha=\beta} = \frac{(1+\beta+\delta)(1-v)}{(2+\delta)} \tag{45}$$

$$(P_Z)_{\alpha=\beta} = a^{\beta-1}k^{1-\beta} = \left(\frac{k}{a}\right)^{1-\beta} = T^{1-\beta} \tag{4.46}$$

In this case, the growth rate will be greater and the capital to labour ratio will be the same in both productive sectors. Finally, the relative price of good Z will depend positively on the externality parameter and the capital to labour ratio, being positive the relationship with the overall externality term (T). This reflects the way gains in productivity in the 'advanced' sector are transmitted to the 'traditional' one through relative price[8].

Now, the condition for $g > 1$ is:

$$a^{\beta-1} > \frac{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)\right]}{1-\beta} \tag{46}$$

It states that it is much more feasible a positive growth the lower are a, β, δ and $\Pi_{Y,t}$, i.e., the greater is the technological level and the lower are the capital intensity in the production functions, the intertemporal discount rate and the inflation rate in the 'advanced' sector.

2.2.5 Monetary authority and monetary transmission mechanisms

It will be relevant the introduction of a monetary authority due to the presence of monetary aspects in the economy. Furthermore, it will help to fill the indetermination previously found. It is considered in what follows its main interest to be the evolution of the inflationary process and its policy instrument the nominal interest rate.

[8] This relationship can be understood as a clear description of the 'Balassa-Samuelson' Effect

Due to the normalization chosen, the inflation rate that affects negatively growth in (42) is that corresponding to the 'advanced' good. However, the monetary authority considers as a reference the overall inflation rate (Π_t) which is a weighted average of those corresponding to the two existing goods in the economy.

Let $\Pi_{Y,t}$ denote the 'advanced' good inflation rate in (8) and the one corresponding to the relative price of the 'traditional' good will be equal to $g_t^{1-\beta}$, as can be derived from (4.46). Then, the inflation rate of the nominal price of this latter good ($\Pi_{Z,t}$) will be equal to $\Pi_{Y,t} \cdot g_t^{1-\beta}$. The monetary authority will consider the following Consumer Price Index:

$$\begin{aligned} \Pi_t &= (1+\pi_t) = \frac{(C_{Y,t}^1 + C_{Y,t}^2)\Pi_{Y,t} + (P_{Z,t}C_{Z,t}^1 + P_{Z,t}C_{Z,t}^2)\Pi_{Y,t}g_t^{1-\beta}}{(C_{Y,t}^1 + C_{Y,t}^2) + (P_{Z,t}C_{Z,t}^1 + P_{Z,t}C_{Z,t}^2)} = \\ &= \Pi_{Y,t}\left[v + (1-v)g_t^{1-\beta}\right] \end{aligned} \tag{47}$$

Taking this inflation rate into account, the monetary authority will peg the nominal interest rate and provide all the money demanded by consumers. In the rest of this section it is described how its decisions are transmitted to the relevant variables in the economy.

Our starting point will be equation (42) and the relationship between the 'advanced' good inflation rate with the overall one in (47). Solving for $\Pi_{Y,t}$ in the latter and substituting it in the former it is obtained a non-linear relationship between the monetary policy instrument and the growth rate:

$$g_t = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\frac{\Pi_t(1+r_t)}{v+(1-v)g_t^{1-\beta}}\right]} \tag{48}$$

It is equivalent to:

$$g_t\left[1+\gamma\frac{\Pi_t(1+r_t)}{v+(1-v)g_t^{1-\beta}}\right] = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)} \tag{49}$$

Differencing on both sides with respect to the variables of interest it is derived the effect a change in the nominal interest rate on the growth rate in terms of the parameters in the

model.

$$\frac{dg_t}{d[(1+r_t)\Pi_t]} = \frac{-\gamma g_t}{v\left\{1+\frac{\gamma[(1+r_t)\Pi_t]}{v+(1-v)g_t^{1-\beta}}\right\}+(1-v)g_t^{1-\beta}\left\{1+\frac{\beta\gamma[(1+r_t)\Pi_t]}{v+(1-v)g_t^{1-\beta}}\right\}} \tag{50}$$

This expression will always be negative, provided $g_t > 0$, meaning that an increase in the nominal interest rate will reduce growth, and viceversa.

Proceeding as before, we can substitute the expression for g_t in (42) into (47) and reach another non-linear relationship. In this case, it is established between the nominal interest rate and the inflation rate of the 'advanced' goods:

$$(1+r_t)\Pi_t = \beta a^{\beta-1}\Pi_{Y,t}\left\{v+(1-v)\left[\frac{(1-\beta)a^{\beta-1}}{(2+\delta)(1+\gamma\beta a^{\beta-1}\Pi_{Y,t})}\right]^{1-\beta}\right\} \tag{51}$$

Also differencing and after some algebraical manipulation we obtain the effect a change in the nominal interest rate has on the inflation rate of the 'advanced' goods:

$$\frac{d\Pi_{Y,t}}{d[(1+r_t)\Pi_t]} = \frac{1}{\beta a^{\beta-1}\left\{v+(1-v)\left[\frac{(1-\beta)a^{\beta-1}}{(2+\delta)(1+\gamma\beta a^{\beta-1}\Pi_{Y,t})}\right]^{1-\beta}\left[\frac{1+\gamma\beta^2 a^{\beta-1}\Pi_{Y,t}}{1+\gamma\beta a^{\beta-1}\Pi_{Y,t}}\right]\right\}} \tag{52}$$

Since $\Pi_{Y,t}$ is always positive a reduction in the nominal interest rate will make the inflation rate of the 'advanced' goods lower.

Another relevant variable for the monetary authority is the money stock growth rate $\mu_t = \frac{M_t}{M_{t-1}}$, following the common thought that inflation is a monetary phenomenon. We can relate it with the 'advanced' good inflation:

$$\frac{m_t}{m_{t-1}} = \frac{\mu_t}{\Pi_{Y,t}} \tag{53}$$

Using this last expression jointly with (23) and (26) it is obtained a dynamic relationship between the growth rate, the money stock growth rate and the inflation rate of good Y at period t with this latter variable in t+1:

$$\Pi_{Y,t+1} = \frac{\mu_t}{g_t}\frac{[1+\gamma\Pi_{Y,t+1}(1+r_{t+1})]}{[1+\gamma\Pi_{Y,t}(1+r_t)]} \tag{54}$$

Solving for g_t, equating to (42) and considering $(1+r_t) = \beta a^{\beta-1}$ the following expression that relates positively the money stock growth rate of a given period t with the 'advanced' goods inflation rate in the next one is derived:

$$\Pi_{Y,t+1} = \frac{\mu_t}{a^{\beta-1}} \frac{1}{\left[\frac{(1-\beta)}{(2+\delta)} - \gamma\beta\mu_t\right]} \tag{55}$$

We can think the monetary authority to pursue an inflation objective in several consecutive periods of time, being the nominal interest rate the same over all of them. For example, if the monetary authority chooses a certain nominal interest rate related to a given inflationary objective in periods t and $t+1$ ($\overline{(1+r_t)\Pi_t}$ and $\overline{(1+r_{t+1})\Pi_{t+1}}$) smaller than the existing one, the 'advanced' good inflation will also decrease and, following (55), so will the money growth rate. Since the capital stock in period t is given, the money stock will also decrease given (23) and (26).

Summarizing, the activity of the monetary authority by pegging the nominal interest rate, given that the real interest rate is constant, is equivalent to fix the overall inflation rate and, as a consequence, the growth rate of the economy, the inflation rate of the advanced good, the money growth and the demand for money. The influence of the inflation target on all this variables is positive, except on the growth rate.

3 Economic integration and common monetary policy. Preliminary questions.

3.1 Economic integration between two countries

Once described how the closed economy works, it is time to analyze the effects of a common monetary policy on two countries, namely A ('poor') and B ('rich'), that are undertaking a process of economic and monetary integration. It will be assumed they have similar structural characteristics with respect to preferences (v, δ), productive sectors (α, β) and monetary requirements (γ). Two additional simplifying assumptions will be that both countries have the same population $L^A = L^B = L$ and that $\alpha = \beta$.

Our model lacks 'Scale Effect' so there will be no consequences from the integration between two identical countries. It is considered the main difference between them to be related to the capital to labour ratios. As we are assuming there is a poor and a rich country, the former will have a smaller capital-labour ratio than the latter:

$$k_A < k_B \tag{56}$$

Another difference will be that regarding to the technological level. Two situations will be considered:

1. A first one where two technologically identical countries integrate:

$$a_A = a_B = a \tag{57}$$

2. Another one where the countries differ in their technological levels. In addition to the previous assumption in (56) the rich country will be more technologically advanced:

$$a_A > a_B \tag{58}$$

Economic integration can take place as a process of free factor mobility, openness to trade, or both. Following Sanso et al (2005) it is only analyzed here the case of economic integration through trade since the consideration of free factor flows cannot explain the incentives two countries can have to integrate. Specifically, the rich country will never be interested in the integration through factor mobility in this context.

3.2 A definition of the common monetary policy

Monetary policy implementation by nominal interest rate pegging for a single country can be considered a simple problem because there exist only one instrument and objective. However, when this kind of policy has to be applied to more than one country there exist one instrument and more than one objectives.

If real interest rates (marginal productivities of capital) were the same in both countries, and the inflation rate the result of a process derived merely from the monetary policy, it would be possible to control more than one objective by means of a single instrument. None of these two conditions are satisfied, since the marginal productivity of capital during a process of economic integration will differ and, as long as convergence will be taking place as a consequence of trade integration, inflation rates will be interrelated but clearly differentiated.

These circumstances imply that the inflation rate target should be defined as a weighted average of the inflation rates of the two countries. A common reference nominal interest rate will be applied to them and the two different inflation rates will be derived from it, as well as the different nominal interest rates[9].

An example of monetary policy definition could be as follows, where the nominal interest rate determined by the monetary authority is a weighted average of the national ones:

$$\Pi = \frac{\Pi^A \left(a^{\beta-1}k_A + P_Z k_A^{\beta}\right) + \Pi^B \left(a^{\beta-1}k_B + P_Z k_B^{\beta}\right)}{a^{\beta-1}(k_A + k_B) + P_Z(k_A^{\beta} + k_B^{\beta})} \tag{59}$$

Π^A and Π^B are the corresponding inflation rates of the two countries and Π the common inflation rate target defined. Weights correspond to the respective shares of the GDP[10] over the total.

The monetary policy would be completely determined if both the nominal and real interest rates for the two countries were the same. However, this last conditions are not always possible, so its formulation must be adapted to this more complicated situation. A common nominal interest rate of intervention (R) pegged by the monetary authority means that the countries could obtain at least this nominal remuneration for their assets. Then, consumers in the country with a lower nominal interest rate would demand money till reaching the common value. This is so because the monetary authority will lend or borrow any amount of money at the common rate. In the country with a higher nominal interest rate the activity of the

[9] Due to the different marginal productivities of capital and inflation rates

[10] Another alternative could be their shares of consumption expenditure. We only consider here the weights as an example, in order to clarify the terms we are going to use in the following.

monetary authority will not affect directly. Taking into account that the nominal interest rate in a country could never be below the one warranted by the monetary authority, we can consider the latter to be the one corresponding to the country with the lower nominal interest rate. This can be incorporated into the closed economy optimization problem in (16) through the following constraint:

$$(1 + r_{t+1})\Pi_{Y,t+1} \geq (1 + R_{t+1}) \tag{60}$$

That is how the common monetary policy will be implemented in this model. Due to the existence of a process of economic integration, as the country with the lower interest rate will be country B, it will be equivalent to fix the inflation of the 'advanced' good in this country, given r and R. This is the link between economy and monetary policy. The rest of the real and monetary behavior is completely derived from this choice.

The decision about the value of the common nominal interest rate will take place according to the following process:

1. The GDP share of each country is known by the monetary authority
2. The value of Π^A is a function of Π^B as a consequence of trade integration.
3. Once a target for Π is formulated, the one for Π^B is derived and with it the respective for Π^A.
4. There exists an relationship between Π^B and Π^B_Y.
5. $(1 + r)^B$ is also known for the monetary authority.
6. Once determined $(1+r)^B$ and Π^B_Y, the common nominal interest rate can be established.

3.3 Inflation dispersion dynamics

A phenomenon attracting a lot of attention in the European Monetary Union is the inflation rates dispersion observed after the introduction of the common monetary policy, what can be harmful for its stability. Interest in explaining what is happening is high and there have been many attempts to find out the causes both from an empirical (Ortega (2003), Honohan

and Lane (2003) and López-Salido et al (2005), among others) and theoretical (Duarte and Wolman (2002), Andrés et al (2003) and Altissimo et al (2004)) point of view. We are going to see that in this model, as a consequence of the common monetary policy and the economic integration process, there is a clear dynamic of the inflation rate dispersion that should be taken into account in the formulation of the policy and the observation of its consequences.

3.4 Additional questions

In order to clarify the following discussion about the effects of economic integration, the following considerations should be taken into account:

1. It is interesting to think about the predictability agents have with respect to integration. This issue will not be relevant for the young generation in the economy since they cannot anticipate what will happen in their first period of life. However, trade integration will affect relative prices, the inflation rate and, through monetary policy, the 'advanced' good inflation which affects people expenditure decisions. As in the previous section, it will be assumed that agents have perfect predictability about variables in the first period after integration.

2. Nominal prices in closed economy have not been considered but they become relevant when countries integrate. Since the number of cases that can be analyzed is very high, only one likely situation will be considered: common monetary policy is only possible with a single currency, which is introduced under some criteria referring to the situation before integration. *It is going to be assumed the common currency to be created such that the nominal price of the 'advanced' good is the same in both countries*[11]. This will allow us to derive the evolution of the two nominal prices and the corresponding inflation rates after the integration.

3. We are not dealing with the effect of a common monetary policy in comparison to the previous one. When appropriate, comments will be made in this respect.

[11] Also note that it is considered the inflation rate previous to integration to be the same in both countries.

4 Trade integration between countries with the same technological level

If economic integration is translated into free factor mobility the capital to labour ratios of the corresponding countries are modified. However, the only presence of trade openness does not induce any kind of adjustment and a corner solution with productive specialization is achieved. In this section the case where trade integration takes place between two countries with the same technological level ($a_A = a_B = a$) and under a common monetary policy is analyzed.

Given production technologies and since $k_A < k_B$, country A cannot produce both goods in the economy. If country B produces them, the relative price of good Z will be determined by its supply: $P_{Z,t} = a^{\beta-1} k_{B,t}^{1-\beta}$.

Global market clearing condition for the 'traditional' good will be given by:

$$P_{Z,t}k_{A,t}^{\beta} + l_Z P_{Z,t}k_{B,t}^{\beta} = (1-v)[\frac{1+\delta}{2+\delta}(1-\beta)P_{Z,t}k_{A,t}^{\beta} + \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[\gamma\Pi_{Y,t}^{A} + \frac{1}{(1+r_t)^A}\right]}k_{A,t-1} \quad (61)$$

$$+(1-\beta)a^{\beta-1}k_{B,t} + \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[\gamma\Pi_{Y,t}^{B} + \frac{1}{(1+r_t)^B}\right]}k_{B,t-1}] \quad (62)$$

Substituting $P_{Z,t}$, operating and denoting $\bar{k} = \frac{k_A}{k_B}$ the following expression for the capital proportion used in the production of good Z in country B after integration is obtained:

$$q_Z = (1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)} + \beta\right] + \left\{(1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)}\right] - 1\right\}\bar{k}^{\beta} \quad (63)$$

It is negatively related to $\bar{k}$ because the term that multiplies $\bar{k}^{\beta}$ is smaller than zero.

We can think under which circumstances this expression takes the extreme values 0 and 1. If country B completely specializes in the production of good Z, q_Z will be equal to unity.

It requires the following condition:

$$\bar{k}^{\beta} = \frac{1-(1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)}+\beta\right]}{(1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)}+\beta\right]-1} = -1 \tag{64}$$

This will never hold since $\bar{k}$ is a ratio between positive magnitudes and cannot be negative.

Country B will only produce good Y (or, equivalently, will not produce good Z) if $q_Z = 0$, what requires:

$$\bar{k}^{\beta} \geq \frac{(1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)}+\beta\right]}{1-(1-v)\left[\frac{(1+\delta)(1-\beta)}{(2+\delta)}+\beta\right]} = Q \tag{65}$$

Q will be very relevant for the conclusions in this work. It increases with the technological parameter β and it decreases when the intertemporal discount factor (δ) and the weight the 'traditional' good has in the utility function ($(1-v)$) increase. Given that q_Z decreases with $\bar{k}^{\beta}$, country B will not produce good Z when $\bar{k}$ is sufficiently high. This is equivalent to say that country B will produce both goods if country A is considerably poor. Finally, note that this expression can be greater or smaller than unity, depending on the numerator to be greater or smaller than 0.5. Given that we are assuming that the capital to labour ratio is greater in country B, complete specialization will only take place if $Q < 1$ and $\bar{k}^{\beta} > Q$.

It is demonstrated in Sanso et al (2005) that there is only one particular situation in which two countries with the same technological level will be mutually interested in a process of economic integration consisting in openness to trade. This happens when the following condition is satisfied:

$$\bar{k} < \bar{k}^{\beta} < Q; \quad Q < 1 \tag{66}$$

In what follows it is described the dynamic process that will take place after the openess to trade of countries A and B. It is assumed condition (66) to hold initially and the succesive stages of the joint evolution of the two economies are analyzed.

First stage: $\bar{\mathbf{k}}^{\beta} < \mathbf{Q}$

Under (66) country A specializes in the 'traditional' good Z, and country B will produce both goods. As a consequence, nothing is modified for this latter country and all changes will affect country A.

In the first period after integration country B grows at a rate:

$$g_t^B = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)^B\right]} \tag{67}$$

while country A grows at:

$$g_t^A = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)^A\right]\bar{k}_t^{1-\beta}} \tag{68}$$

In this same period $(1+r_t)^A = \beta a^{\beta-1}\bar{k}_t^{\beta-1} = (1+r_t)^B\bar{k}_t^{\beta-1} > (1+r_t)^B$. So it can be concluded that growth will be greater in this latter country:

$$g_t^A = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[\bar{k}_t^{1-\beta}+\gamma\Pi_{Y,t}(1+r_t)^B\right]} > g_t^B \tag{69}$$

As the relative price of good Z in country B is greater than the one that would have taken place in country A for the same price level, change in prices will be greater the latter due to a greater inflation rate of this good in the first post-integration period. Inflation in good Y will not change because it is only produced in country B.

$$\frac{P_{Z,t}^B}{P_{Z,t-1}^A} = \frac{a^{\beta-1}k_{B,t}^{1-\beta}}{a^{\beta-1}k_{A,t-1}^{1-\beta}} = \left(\frac{k_{B,t}}{k_{A,t}}\frac{k_{A,t}}{k_{A,t-1}}\right)^{1-\beta} = \bar{k}_t^{\beta-1}(g_t^A)^{1-\beta} > (g_t^B)^{1-\beta} = \frac{P_{Z,t}^B}{P_{Z,t-1}^B} \tag{70}$$

$\Pi_{Y,t}$ will be the same in the two countries and the respective inflation rates in good Z will be given by expressions in (70). Following (47), it can be concluded that overall inflation rate

will be greater in country A:

$$\Pi_t^A = \Pi_{Y,t}\left[v + (1-v)(g_t^A)^{1-\beta}\bar{k}_t^{\beta-1}\right] \quad (71)$$

$$\Pi_t^B = \Pi_{Y,t}\left[v + (1-v)(g_t^B)^{1-\beta}\right] \quad (72)$$

$$\Pi_t^A > \Pi_t^B \quad (73)$$

After this first period nominal prices will be equal in both countries and they will grow at the same rate, so inflation rates will also be equal in both economies. However, nominal interest rate measured with the overall inflation (or with the advanced good inflation) will be higher in country A because of its greater marginal productivity of capital. As long as $\bar{k}^{\beta} < Q$ holds, this difference in the nominal interest rates will continue and country A will grow at a higher rate than country B.

Summarizing, there is a first step (one period) of increase in the inflation rates dispersion as a consequence of trade integration. It is the poor country the one with the higher level and greater rate of economic growth. An attempt of the monetary authority for taking into account this circumstance will be harmful for the rich country because the interest rate will be too high to allow a satisfactory growth rate, compared to the poor country that can admit a higher interest rate with a high growth rate. This represents a clear asymmetry. A second step (many periods) with no inflation dispersion will follow where convergence will continue because the poor country will grow at a higher rate than the rich one and the nominal interest rates will also present some dispersion. As a consequence of this convergence process the relative capital-labour ratio between this two countries will increase until $\bar{k}^{\beta}$ equates Q.

Second stage: $\bar{\mathbf{k}}^{\beta}$= Q

This moment can be considered a transition point where a change of regime takes place: country B will now produce only good Y, so there is complete specialization since each country only produces one good. Conditions of both regimes are satisfied and the relevant variables

depend on Q.

$$
\begin{aligned}
g_t^A &= \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)^A\right]\bar{k}_t^{1-\beta}} = && (74)\\
&= \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[\frac{\bar{k}_t}{Q}+\gamma\Pi_{Y,t}(1+r_t)^B\right]} > g_t^B \\
(1+r_t)^A &= \beta a^{\beta-1}\bar{k}_t^{\beta-1} = \beta a^{\beta-1}\frac{Q}{\bar{k}_t} = (1+r_t)^B\frac{Q}{\bar{k}_t} && (75)\\
P_{Z,t} &= a^{\beta-1}k_{B,t}^{1-\beta} = a^{\beta-1}k_{B,t}^{1-\beta}\frac{k_{A,t}^{\beta}}{k_{A,t}^{\beta}} = a^{\beta-1}\frac{k_{B,t}}{k_{A,t}^{\beta}}Q && (76)
\end{aligned}
$$

Third stage: $\bar{\mathbf{k}}^{\beta}>\mathbf{Q}$ and $\bar{\mathbf{k}}<\mathbf{Q}$

As $\bar{k}$ grows, as a consequence of the convergence process that is taking place the regime will continue until $\bar{k}$ is equal to Q. In this third stage there is still complete specialization and the expressions for g_t^A, $(1+r_t)^A$ and $P_{Z,t}$ are, respectively, those in (74), (75) and (76) where the Q term appears. The corresponding values for country B are the following ones:

$$g_t^B = \frac{(1-\beta)a^{\beta-1}}{(2+\delta)\left[1+\gamma\Pi_{Y,t}(1+r_t)^B\right]} < g_t^A \tag{77}$$

$$(1+r_t)^B = \beta a^{\beta-1} < (1+r_t)^A \tag{78}$$

With the increase in $\bar{k}$ the growth rate gap as well as the one related to the marginal productivity of capital decrease.

The most characteristic feature of this stage is that the growth rate of P_Z decreases with respect the previous one, so the economy becomes less inflationist:

$$\frac{P_{Z,t}}{P_{Z,t-1}} = \frac{g_t^B}{\left(g_t^A\right)^{\beta}} = \left(\frac{g_t^B}{g_t^A}\right)^{\beta}\left(g_t^B\right)^{1-\beta} < \left(g_t^B\right)^{1-\beta} \tag{79}$$

While there was a moderation in the overall inflation jointly with a disappearance of the dispersion in the second step of the first stage, in this third stage the reduction in the inflation rate experiences a push while the absence of dispersion is maintained. The decrease in inflation becomes less severe as $\bar{k}$ approaches Q.

Summarizing, in this third stage country A continues growing at a higher rate than country B. Its marginal productivity of capital is also higher and the nominal price of Z moderates its growth, making the economy less inflationist; much less at the beginning, and returning to the inflation rate of the second step when the economy arrives at the fourth step when $\bar{k}=Q$.

Fourth and final stage: $\bar{\mathbf{k}}^{\beta}>\mathbf{Q}$ and $\bar{\mathbf{k}}=\mathbf{Q}$

In this final stage of the transitional dynamics the economy reaches the steady state when $\bar{k}=Q$. Both countries grow at the same rate and experience the same inflation. The nominal

and real interest rates will also be equal. This means the convergence process to achieve its final point because the gap between the two capital ratios is equal to Q, less than unity. Convergence is not absolute but conditional, and the inequality will be maintained indefinitely.

Note that the relative price of good Z will be lower than before integration in country B. That is the source of gains obtained by this country. Finally, it must be pointed out that, being all the relevant variables equal among countries, this steady state situation is the only one in which the common monetary policy can achieve all its targets with only one instrument.

5 Trade integration between countries with different technological level

This section develops the same analysis as in the previous one but considering the existence of a technological gap between countries.

We will assume the country with a greater capital to labour ratio to be also the more technologically advanced one. Then, in the period of integration the following conditions holds:

$$k_A < k_B; \quad a_A > a_B \tag{80}$$

As before, in this initial period when integration starts country B produces both goods while country A only produces the 'traditional' one. Then, the relative price of this latter good will be determined by the supply conditions of the rich country ($P_{Z,t} = a_B^{\beta-1} k_{B,t}^{1-\beta}$), and its global market clearing condition could be expressed as:

$$\begin{aligned} P_{Z,t}k_{A,t}^{\beta} + l_Z P_{Z,t}k_{B,t}^{\beta} &= (1-v)[\frac{1+\delta}{2+\delta}(1-\beta)P_{Z,t}k_{A,t}^{\beta} + \frac{(1-\beta)a_A^{\beta-1}}{(2+\delta)\left[\gamma\Pi_{Y,t}^{A} + \frac{1}{(1+r_t)^A}\right]}k_{A,t-1} + \\ &+(1-\beta)a_B^{\beta-1}k_{B,t} + \frac{(1-\beta)a_B^{\beta-1}}{(2+\delta)\left[\gamma\Pi_{Y,t}^{B} + \frac{1}{(1+r_t)^B}\right]}k_{B,t-1}] \end{aligned} \tag{81}$$

Proceeding in the same way, expression (63) is also reached, so (64) and (65) are still valid.

With this technological difference there is a wider set of possibilities under which two countries can be mutually interested in economic integration through openness to trade:

1. Without complete specialization at the beginning of the integration process:

$$\bar{k} < \bar{k}^{\beta} < Q; \quad Q < 1 \tag{82}$$

2. Complete specialization at the beginning of the integration process:

$$\bar{k}^{\beta} > Q; \quad Q < 1 \tag{83}$$

we analyze them separately:

5.1 Without complete specialization at the beginning of the integration process

This case has a rough paralelism with that where no technological gap among countries is present. The main differences in the first stage of the process rely on that the technological gap makes the inflation rates dispersion to be greater as well as the difference between growth rates and marginal productivity of capital for country A before and after integration. This two latter effects are still maintained in the second and third stages. The inflation differences between this two periods also increase with the technological gap. Finally, it can be concluded that the gains for both countries are greater in this case: the poor country grows at a higher rate and the rich one pays good Z at a much lower price.

5.2 Complete specialization at the beginning of the integration process

In this case, two differences can be found with respect the one without technological gap. First of all, $\bar{k}$ can be greater or smaller than Q. The second one is that complete specialization takes place from the beginning of the integration process.

The first difference requires an additional condition in order to make integration attractive for the two countries involved. It is assumed to be satisfied in the period when integration

begins and can be expressed as follows:

$$\frac{a_B^{\beta-1}}{a_A^{\beta-1}}\frac{Q}{\bar{k}} > 1 \tag{84}$$

It is only operative when $\bar{k} > Q$.

In this case there are only three steps. When $\bar{k} < Q$ the features of the first one coincide with the previous cases, with the only difference of the existence of complete specialization from the beginning. The two remaining correspond to those previously denoted as third and fourth steps, respectively. The main difference we can point out is that when $\bar{k} > Q$ we have a divergent process instead of a convergent one in the first and second steps. The first one has the opposite features to the first steps in the two previously analyzed cases: a reduction in the overall inflation and a process of divergence where the growth of the rich country will be higher than in the poor country. In contrast, it will be a favourable divergent process for the poor country producing an inflation increase and the third step will correspond to the steady state situation.

6 Concluding remarks and policy recomendations

The model developed in this paper tries to find the growth asymmetries that can be generated as a consequence of a common monetary policy in countries experiencing an economic integration process. Obtained results indicate that the links raised from integration, its dynamics and consequences on growth should not be neglected in the formulation of the monetary policy. The most important asymmetries come from the different roles played by goods and countries and the relative importance of the inflation and growth targets for them.

First, we have the asymmetries in the influence of the countries. The rich country is the protagonist in the inflation and growth processes while the poor country experiences derived rates. These asymmetries are permanent. Second, the goods also have an asymmetric role, where the main one corresponds to the 'advanced' good. Third, the inflation and growth transmission mechanisms reflect the two previously quoted asymmetries. The most important

variable is the inflation rate of the 'advanced' good in the rich country. The growth rate in this country (and, indirectly, in the poor one) is a consequence of this rate while the Consumer Price Index (CPI) depends on both the inflation rate of the 'advanced' good and the growth rate. This coincidence makes possible to reach the same target CPI with high 'advanced' good inflation and low growth or with low inflation and high growth in the rich country, depending on the stage of the transition dynamics. If the authority establishes the target in terms of CPI, there is no opportunity to choose the appropriate growth target.

The nominal interest rate target can imply an excessive inflation rate for the rich country and lead to a permanent asymmetry. Poor countries are benefited from the formulation of the common monetary policy because the interest rate is not a problem for them since convergence favours their relationship between inflation and growth. Then, it would be much more clear the formulation of objectives in terms of the inflation of the 'advanced' good.

The integration process encompases a period of increase in the inflation dispersion that dissapears later. During the transitional period the poor country grows at a higher rate than the rich one and its capital return is also greater. Growth and inflation rates are the same for the two countries in steady state. A constant inflation target is not justified over all stages of the integration process and the only asymmetry that could exists is the one derived from an inadequate formulation of the target from the point of view of the 'advanced' good in the rich country. Then, we would have a permanent and negative effect.

Nonlinearity in the relationship between inflation and growth is a possible result depending on the situation. A poor country can see simultaneously an increase in inflation and growth while a rich country always experiences a negative relationship.

Finally, note that we have considered only the integration in a two-countries world. The consideration of the rest of the world would add limits to the feasible inflation targets because it raises competitiveness as well as other type of questions on the sustainability of the conclusions.

References

[1] Altissimo, F, P. Benigno and D. Rodríguez-Palenzuela, 2004. Inflation differentials in a currency area: some facts and explanations. Mimeo.

[2] Andrés, J., E. Ortega and J. Vallés, 2003. Market structure and inflation differentials in the European Monetary Union. Banco de España Working Paper 0301.

[3] Badinger, H., 2005. Growth effects of economic integration. The case of EU member states (1950-2000). Review of World Economics 141, 50-78.

[4] Balassa, B., 1964. The purchasing power parity doctrine: a reapraissal. Journal of Political Economy 72, 584-596.

[5] Barro, R., 1996. Inflation and growth. Federal Reserve Bank of St. Louis 78, 153-169.

[6] Bruno, M. and W. Easterly, 1996. Inflation and growth: in search of a stable relationship. Federal Reserve Bank of St. Louis 78, 139-146.

[7] Chari, V., L. Jones and R. Manuelli, 1996. Inflation, growth, and financial intermediation. Federal Reserve Bank of St. Louis 78, 41-58.

[8] Choi, S., B. Smith and J. Boyd, 1996. Inflation, financial markets, and capital formation. Federal Reserve Bank of St. Louis 78, 9-35.

[9] Clower, R., 1967. A reconsideration of the microeconomic foundations of monetary theory. Western Economic Journal 6, 1-8.

[10] Crespo-Cuaresma, J., D. Ritzberger-Grunwald and M. Silgoner, 2004. Growth, convergence and EU membership. Mimeo.

[11] Drukker, D., P. Gomis-Porqueras and P. Hernández-Verme, 2005. Threshold effects in the relationship between inflation and growth: a new panel-data approach. Mimeo.

[12] Duarte, M. and A. Wolman, 2002. Regional inflation in a currency union:fiscal policy versus fundamentals. ECB Working Paper 180.

[13] European Central Bank, 2003. Inflation differentials in the Euro Area: potential causes and policy implications.

[14] Gianetti, M., 2002. The effects of integration on regional disparities: convergence, divergence or both?. European Economic Review 46, 539-567.

[15] Hann, F. and R. Solow, 1997. A critical essay on modern macroeconomic theory. MIT Press.

[16] Hansen, B., 1999. Threshold effects in non-dynamic panels: estimation, testing and inference. Journal of Econometrics, 93, 345-368.

[17] Henrekson, M., J. Torstensson and R. Torstensson, 1997. Growth effects of European Integration. European Economic Review 41, 1537-1557.

[18] Honohan, P. and P. Lane, 2003. Divergent inflation rates in EMU. Economic Policy, October, 357-394.

[19] Kemnitz, A., 2001. Endogenous growth and the gains from immigration. Economics Letters 72, 25-218.

[20] Khan, M. and A. Senhadji, 2001. Threshold effects in the relationship between inflation and growth. IMF Staff Papers 48 (1), 1-21.

[21] Landau, D., 1995. The contribution of the European Common Market to the growth of its member countries: am empirical test. Review of the World Economics 131(4), 774-782.

[22] Larramona, G. and M. Sanso, 2005. Migration dynamics, growth and convergence. Journal of Economic Dynamics and Control, Forthcoming.

[23] Lopez-Salido, D., F. Restoy and J. Vallés, 2005. Inflation differentials in EMU: the Spanish case. Banco de España Working Paper 0514

[24] Ortega, E., 2003. Persistent inflation differentials in Europe. Banco de España Working Paper 0305.

[25] Ramey. G and V. Ramey (1995). Cross-country evidence on the link between volatility and growth. American Economic Review 85 (5), 1138-1151.

[26] Rivera-Batiz, L. and P. Romer, 1991a. Economic integration and endogenous growth. Quarterly Journal of Economics 106 (2), 531-555.

[27] Rivera-Batiz, L. and P. Romer, 1991b. International trade with endogenous technological change. European Economic Review 35, 971-1004.

[28] Rivera-Batiz, L. and D. Xie, 1993. Integration among unequals. Regional Science and Urban Economics 23 (3), 337-354.

[29] Samuelson, P., 1964. Theoretical notes on trade problems. Review of Economics and Statistics, 46.

[30] Sanso, M., F. Pueyo and M. Ponz, 2005. Efectos de la integración económica sobre el bienestar, el crecimiento y los flujos de bienes y de factores. Fundación BBVA.

[31] Tobin, J., 1965. Money and economic growth. Econometrica 32, 671-684.

[32] Vandhout, P., 1999. Did the European unification induce economic growth? In search of scale effects and persistent changes. Review of the World Economics 135(2), 193-220.

[33] Viaene, J. and I. Zilcha, 2002. Capital markets integration, growth and income Distribution. European Economic Review 46, 301-327.

[34] Walz, U., 1998. Does an enlargement of a common market stimulate growth and convergence?". Journal of International Economics 45, 297-321.