INFLATION DIFFERENTIAL AND REAL CONVERGENCE IN PORTUGAL*

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This work is intended to measure how real convergence observed in Portugal in the 1990s may have contributed to explain the inflation rate differential recorded during this period. This quantification is developed through the simulation of a two-sector neo-classical growth model. This model estimates that the differential associated with the real convergence process stood probably between 1 and 2 percentage points in 1990 and between 0.4 and 0.6 percentage points in 1999.

1. INTRODUCTION

The convergence of the Portuguese inflation rate to the inflation rate prevailing in the group of countries with which a fixed parity has been maintained was started in October 1990, the date on which the escudo pegging strategy was initiated. However, this nominal convergence was not complete. Currently, there is still a significant differential between the Portuguese inflation rate and that of the mentioned group. The persistence of this differential is becoming more relevant as membership of Monetary Union implies a strictly single monetary policy.

Eliminating all types of different nominal rigidities, which could explain short-term changes in prices in Portugal vis-à-vis the euro area, the inflation differential seems to be due to real forces. These “real explanations of inflation differential” attempt at explaining the different pace of the general price index of a given country vis-à-vis a reference zone through changes in relative prices of the different goods. Thus, these real phenomena should only explain “inflation” if the persistence of their effects in the price differential were considerable.

There have been several attempts at explaining the differential through these relative price changes. One of the explanations, known as Balassa-Samuelson effect, identifies different levels of development with a growth rate differential of technological progress between sectors. As a result of such differential, the relative price of non-tradable goods increases in developing countries while remaining unchanged in developed economies. Another real factor related to the latter but consistent with equal technological progress among goods is directly related to the real convergence notion. In the real convergence process, economy is in the course of transition to a steady-state path, since the capital-labour ratio is below the steady-state value of this variable. Throughout this transition path, the relative price of non-tradable goods rises, for parameter values which describe the performance of the economy.

Real convergence is frequently seen as a cause for the inflation differential prevailing in Portugal in the past ten years. However, the most interest-

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ing issue is not whether this is a reasonable cause for the differential, but its relevance in quantitative terms for this phenomenon. Hence this article attempts at quantifying to what extent real convergence in Portugal (convergence meaning the above mentioned transition to a steady-state path) is responsible for the inflation differential observed from 1990 to 1999, by estimating which part of this differential can be attributed to real convergence(1).

Inflation differential in Portugal for the period from 1990 to 1999 is presented in Chart 1. The index used is the Harmonised Index of Consumer Prices (HICP) and the reference group is EU-11(2).

With a view to quantifying the relevance of real convergence to explain the inflation differential, a model will be used, able to simultaneously describe real convergence and the pace of relative price between non-tradable and tradable goods. This model will be adjusted to the Portuguese economy, with the major objective of replicating the pace of real output recorded in the past decade. After this calibration, the model will be able to respond to the pace of relative prices. This quantification effort is particularly attractive because it imposes discipline on the model, a discipline represented by replicating real convergence, i.e. the transition path undergone by Portuguese economy in the past decade.

2. THE EXERCISE

As mentioned above the objective of this article is the quantification of the inflation differential caused by the different position of Portugal in the growth path when compared to the remaining countries of the group. Thus, it will be assumed that the reference group is undergoing a balanced growth path thereby isolating the transition effect of the Portuguese economy. The preferences of the representative consumer may be represented as follows:

$$U = \sum_{i=0}^{n} \beta^{i} u(C_{t}, N_{t}), \quad 0 < \beta < 1$$

where $u$ is weakly separable into aggregate consumption, $C$, and working hours, $N$,

$$C_{t} = (C^{T})^{\gamma} (C^{N})^{1-\gamma}$$

where $C^{T}$ represents tradable goods consumption and $C^{N}$ non-tradable goods consumption.

If inflation is measured by a consumer price index, this index, $IP$, will be described as follows:

$$IP_{t} = (P_{t}^{T})^{\gamma} (P_{t}^{N})^{1-\gamma}$$

where $P^{T}$ represents tradable goods price and $P^{N}$ non-tradable goods price.

Inflation rate as measured by this index will be

$$\pi_{t} = \dot{P}_{t}^{T} + (1-\gamma) \dot{P}_{t}^{N}$$

where $P = \frac{P_{t}^{N}}{P_{t}^{T}}$ represents the relative price of non-tradable goods and $\dot{P}$ describes the growth rate of $P$.

Given the assumption of the balanced growth of the reference group, the inflation of the group, $\pi^{*}$, is measured by the rise of tradable goods prices, i.e. it is assumed that there are no persisting effects in the relative price of tradable goods vis-à-vis non-tradable goods. In this case the inflation differential, $DIF$, will be given by

$$DIF_{t} = \pi_{t} - \pi^{*}_{t} = (1-\gamma) \dot{P}_{t}^{N}$$

(1) An alternative tentative study of the inflation differential is made in Costa, S. “Inflation differential between Portugal and Germany”, published in this bulletin.

(2) If the reference group were EU-15 the description would be very similar.
This exercise consists in identifying the path of the variable DIF from 1990 to 1999, in a general equilibrium model calibrated so as to replicate the performance of the output per capita in Portugal during that period.

2.1 The model

The base model describes the general equilibrium of an economy over time, in which the level of the output per capita in each period is below the steady-state level of this variable for the same period. The long-term growth of the economy is exogenous, and the economy tends to a situation of balanced growth. The “small open economy” is considered to be the best analogy to describe the Portuguese economy in the period under review. There is one single tradable good. If we abstract from changes in terms of trade, we obtain a marketable asset whose price is exogenous for this economy. This price will make it possible that the economy converges to a balanced growth.

The economy is composed of agents whose preferences are described by

$$U = \sum_{t=0}^{\infty} \frac{\beta}{1 - \sigma} \left( 1 - \sigma X_t N_t \right)^{1-\sigma} - 1$$

where C is the consumption aggregate previously described, and X represents the level of technological progress.

There are three production factors in this economy: capital (K), labour, (N), and land, (T). In the model, two of these factors are specific: the technology of tradable goods production uses capital and labour and the technology of non-tradable goods uses labour and land.

The technological progress is exogenous in both technologies and is related across sectors in such a way that the model converges to the steady state after extracting the trend. Therefore, it is not possible to impose technological progress distinguishing these two sectors permanently, in which case the “Balassa-Samuelson” pure effect is eliminated. The identification of the inflation differential percentage due to this channel raises some problems, since there are neither direct measures of the different rates of technological progress nor aggregated behaviours from which these rates may be inferred.

Technologies are described by the tradable and non-tradable goods production functions

$$Y_t^T = AK_t^{1-a} \left( X_t N_t^T \right)^a$$
$$Y_t^N = X_t T^{1-\gamma} \left( N_t^N \right)^\gamma$$

and by the capital accumulation technology. As it is well known in this type of models, the existence of a transition period implies an accumulation technology in which there are costs of adjustment of the capital stock. Thus

$$K_{t+1} = \phi \left( \frac{I_t}{K_t} \right) K_t - (1 - \delta) K_t$$

Investment, I_t, is a tradable good.

The government has tradable and non-tradable goods consumption, financed by non-distortionary taxes. There are competitive markets for final goods, labour, capital input and external asset.

The stages for the resolution of this model are as follows(3):

- Formalisation of the problem of the planner equivalent to the competitive general equilibrium in stationary variables;
- Description of the conditions describing the competitive equilibrium;
- Calibration of the model;
- Numeric resolution of the model in order to obtain the DIF path. With this purpose, the growth path is initiated through the deviation of the capital stock per capita that permits to replicate the path observed for the output. The resolution of the model permits to calculate the paths of the endogenous variables of the model over the ten following years. Among these, the relevant variables are output and the relative price of non-tradable goods vis-à-vis tradable goods. The growth rate of this relative price permits to reply to the issue in question, i.e. the subsequent calculation of the inflation differential.

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(3) These stages will be described in detail in a Working Paper by the same authors, to be published shortly by the Banco de Portugal.
2.2 Calibration

There are two different levels of calibration. The first one, which tries to replicate the steady-state of the economy, is conventional in models of real business cycles. In this exercise, in which the observed pace of the economy must be interpreted as a transition to that steady-state, more than an attempt at replicating data, international regularities were followed. In the calibration of the steady-state, a 1.75 per cent output growth rate per capita was considered, i.e. it was considered that the long-term growth rate of Portuguese economy is identical to the growth rate of the economies characterised by a balanced growth over this century. This is, for instance, the figure for the United States during the 1870-1994 period, in which a linear trend with this slope permits a good adjustment to data(4).

The second calibration level, specific to the issue in question, attempts at replicating the pace of output per capita of the Portuguese economy over the past ten years. The pace of output per capita in Portugal is broken down into the long-term path and the path of transition to that long term.

The second calibration level uses this transition path, as measured by percentage deviations from the path in which Portugal would stand, should it have pursued a balanced growth. The model is calibrated as explained below, mainly through the initial capital stock deviation, but also through the parameter of adjustment costs and weight of non-tradable goods, in order to replicate the path identified as the transition path of Portuguese economy.

With a view to identifying the transition path from Portuguese economy data, a series of real output per capita in Portugal from 1975 to 1999 was used. This series was obtained from the output per capita figure for 1975, at 1975 prices, a figure to which real output growth rates from 1976 to 1999 were applied.

The Hodrick-Prescott filter was applied to this series, so as to separate high from low frequencies. The resulting smooth series was then broken down into the trend and the transition to the trend. For the calculation of the trend it was necessary, in addition to the figure of 1.75 per cent steady-state growth rate, to derive the steady-state output level per capita. It was decided to chose as exogenous variable the level of output per capita of the group of reference countries and to define the percentage deviation of the steady-state output per capita in Portugal vis-à-vis the output per capita of the reference group. The transition path obtained for Portuguese economy is described in Chart 2, which presents the percentage deviations of the output per capita to the trend. This path permits to identify a real convergence calculated for Portugal. It should be noted that the convergence to the group of reference countries is not being measured but instead the convergence to the steady-state path in Portugal. It can be concluded from the transition path described in Chart 2 that over the ten years in question, Portugal nearly halved the distance recorded in 1999 from its steady-state: in 1990, Portugal was 22 per cent below its steady-state, while in 1999 it stood at 12 per cent of the steady-state path. The model will be adjusted so as to replicate over 10 periods the real convergence of output per capita, described by that transition.

(4) Other figures used for the steady-state calibration were the following: discount rate of the stationary model: 0.96, percentage of the time used in the labour market 0.18, \( \alpha = 0.15, \gamma = 0.6, \sigma = 1, \mu = 2.7, \delta = 0.05 \).
The output convergence path given by the model is derived by

\[ y = y^T \left( \frac{Y^T}{Y} \right)^{SS} + (y^N + p) \left( \frac{Y^N}{Y} \right)^{SS} \]

The characters in small letters represent percentage deviations from the variables vis-à-vis the steady-state, and \( \frac{Y^T}{Y} \) and \( \frac{Y^N}{Y} \) represent the weights of the tradable and non-tradable goods in steady-state.

2.3 The quantification

The calibration of the convergence path is only possible when the capital adjustment costs are different from zero, as mentioned above. The manipulation of the adjustment cost parameter, on the basis of the values normally used, does not affect significantly the convergence of the model\(^{(5)}\).

The first quantification was carried out on the assumption that the weight of non-tradable goods, \( 1 - \gamma \), is 0.4. In this case the model replicates the pace of the product when, in 1990, the capital stock is 50 per cent below the steady-state level and when the output steady-state level in Portugal is 80 per cent of the steady-state level of the reference group.

In this case the output path given by the model is represented in Chart 3. This chart describes the percentage deviations for the real output trend derived by the model.

Chart 4 describes the DIF pace. Hence, the inflation differential explained by the model for this calibration would be 0.9 percentage points in the beginning of the period and 0.36 percentage points at the end.

Several tests of sensitivity to these results were carried out. The main feature is the robustness of the pace of relative price, once it is controlled for the transition path of output per capita.

The parameter that most significantly changes quantification is the weight of non-tradable goods in aggregate consumption, and in the price index. A value of \( 1 - \gamma = 0.4 \) was used for this weight in the calibration described. When this parameter is increased to 0.6, the inflation differential accounted for by real convergence widens. For a smaller initial deviation of the capital stock, the output path is reasonably replicated, (Chart 5), and the inflation differential stands at 1.5 percentage points in the initial period and at 0.6 percentage points in 1999.

\[^{(5)}\] The parameter in question represents elasticity of \( \frac{1}{\phi} \) (in which \( \phi \) represents the derivative of \( \phi \), i.e., of the so-called Tobin’s \( q \), in relation to \( \frac{I}{K} \).
3. CONCLUSIONS

This work aims at measuring how real convergence in Portugal, characterised by a transition to steady-state capital per capita, contributes to the inflation differential between Portugal and a group of reference countries. Using a reasonable range for the value of the weight of non-tradable goods, Chart 6 answers this question: this chart describes the inflation differential band which, according to the model used, may have been caused by real convergence in Portugal.

In the first years of the period in question real convergence cannot easily account for the inflation differential. However, these early years are certainly heavily influenced by the direct impact of the exchange rate stabilisation policy, which is not being taken into consideration in this work. The wealth effects caused by the stabilisation lead to a price increase in non-tradable goods to be considered together with the effect described in this model. As these effects are more relevant in the early periods it can tentatively be said that, from 1995 onwards, real convergence is largely responsible for the inflation differential. In the last year of the study approximately 0.5 percentage points of the inflation differential are accounted for by the real convergence phenomenon. Unless there are other persistent shocks, this differential, by its own nature, will narrow in the next decade.