

# Output Persistence in Portugal

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**Abstract** - The measurement of output persistence in Portugal is the main goal of this paper. By the use of a non-parametric methodology, it is shown that the level of output in Portugal exhibits a relatively high degree of persistence. This result is essential from a (contractionary/expansionary) policy point of view as the magnitude and duration of policy effects depend upon the level of persistence in output.

**Keywords:** *Output, Persistence, Portugal.*

## 1. Introduction

The recent world economic and financial crises have been mitigated by several kinds of economic policies, in particular by fiscal measures designed to obtain immediate growth through countercyclical stimulus or to make the economy grow after a period of austerity. Plainly, the success of those policies, in particular the contractionary ones, depend upon the reaction of economic agents, in particular, and of the whole economy, in general.

The presence of persistence, here understood as inertia, can substantially change the reaction of the economy to a policy shock or to innovations. Persistence can reduce the incidence, length, and severity of shocks and of changes in economic conditions. Furthermore, measuring the response of output to a shock is also important because it may show when it is more essential to act to overcome the harmful effect of a shock.

Traditionally, macroeconomic policies play the dominant role in smoothing the business cycle, but the effectiveness of those policies depends upon the economy's resilience. That is, the success of those policies depends upon the ability of the economic system to absorb the policy shocks and to return to the baseline. Therefore, given the presence of persistence in output, the key question is whether it is viable and effective to design countercyclical policies that act through expenditures, even if they are optimal.

The literature on the importance of persistence in macroeconomics is inexplicably insufficient. The first macroeconomic studies incorporating the issue of persistence appeared only in the early 1980s, and only recently did a factual interest, from an empirical

point of view, in the phenomenon emerge. The importance and the need to (theoretically and empirically) study the phenomenon are further strengthened by the current economic and financial crisis, in which the persistence of the recession is a central issue.

The first studies that explicitly considered the importance of persistence were of a macroeconomic nature and began by highlighting the role of both staggered wage-setting and staggered price-setting as a source of persistent real effects of monetary shocks (Taylor, 1980; Rotemberg and Woodford, 1997; Huang and Liu, 2002; see also Ascari (2003) for a critique of the real role of staggered wage-setting and staggered price-setting as sources of inertia). On the other hand, given the alleged inability of standard real business cycle models to reproduce the evolution of output shown under real-world conditions (Cogley and Nason 1995), the inertial hypothesis was also used to explain the (strong) persistence of output that was observed in reality (Bouakez and Kano, 2006; Maury and Tripier, 2003). However, this development did not lead to a consensus, and the possibility of monetary policy shocks affecting aggregate output remained central to the debate. Indeed, the persistence of shocks on aggregate output has been, and still is, one of the issues most often subject to examination, and this will probably be the case for some time.

Multiple theoretical explanations have been proposed for the empirical evidence that monetary policy shocks can have a permanent effect on aggregate output (or unemployment). These explanations include imperfect information and short-run nominal price stickiness (Kiley, 2000; Wang and Wen, 2006). Furthermore, Jonsson (1997), Lockwood (1997) and Svensson (1997) have analyzed the consequences of inflation contracts on output or unemployment persistence. All these studies share the idea that whether or not price rigidity is responsible for output or unemployment persistence, this should be seen as an empirical issue rather than a theoretical one.

Another interesting consequence of output persistence is that it may invert the political business cycle, which is typically associated with depressions at the beginning of the mandate followed by pre-election inflationary expansion (Gärtner, 1996, 1999; Caleiro, 2009). Quite recently, increased interest in

analyzing the persistence of output and inflation has been registered, and this has included studies of their relationship with the degree of openness of the economies (Guender, 2006), the exchange-rate regime (Giugale and Korobow, 2000) or the structural changes in the preferences of consumers, firms or policy-makers. For the case of consumption in Portugal see Belbute and Caleiro (2009).

The goal of the paper is to contribute to the understanding of the effects of the policy measures recently taken in Portugal in the aftermath of the financial aid requested in May 2011. We do so by measuring the degree of persistence in output through the use of a non-parametric methodology proposed by Marques (2004) and Dias and Marques (2010). This new measure of persistence can be defined as the unconditional probability that a stationary stochastic process will not cross its mean during period  $t$ .

Our results show that the level of output in Portugal exhibits a fairly high degree of persistence. Plainly, this result is essential from a (contractionary/expansionary) policy point of view as the magnitude and duration of policy effects depend upon the level of persistence in output.

The remaining of the paper is organized as follows. In Section 2, some methodological notes about persistence are offered. Section 3 presents the data. Section 4 is fulfilled with the empirical results. Section 5 concludes the paper.

## 2. Methodological notes about the persistence

Starting with a simple definition, persistence is the speed with which a certain variable, such as output, returns to baseline (its previous level) after, say a shock, i.e. some event (for instance, a fiscal policy measure) that provoked an increase (or decrease) in output. This definition, in other words, implies that the degree of output persistence is associated with the speed with which output responds to a shock. When the value is high, output responds quickly to a shock. On the contrary, when the value is small, the speed of adjustment by output is low. To put it clearer, a variable is said to be the more persistent the slower it converges or returns to its previous level, after the occurrence of a shock.

Quantifying the response of output to a shock is indeed important not only because it may allow assessing the effectiveness of economic policy measures but also because it may, indeed, show at what time is more essential to act, through those measures, in order to overwhelm a harmful effect of a shock over output. By definition, quantifying the response of output to shocks implies evaluating the persistence of output.

As the estimates of persistence at time  $t$  will express how long we expect that a shock to output will take to die off (if ever), given present and *past* output, authors have proposed to obtain those estimates by the use of *autoregressive models*. As it is well known, a univariate AR(k) process is characterised by the following expression:

$$f_t = \mu + \sum_{j=1}^k \alpha_j f_{t-j} + \varepsilon_t \quad (1)$$

where  $f_t$  denotes output at moment  $t$ , which is explained by a constant  $\mu$ , by past values up to lag  $k$ , as well as by a number of other factors, whose effect is captured by the random variable  $\varepsilon_t$ . Plainly, (1) can also be written as:

$$\Delta f_t = \mu + \sum_{j=1}^{k-1} \delta_j \Delta f_{t-j} + (\rho - 1)f_{t-1} + \varepsilon_t \quad (2)$$

where

$$\rho = \sum_{j=1}^k \alpha_j \quad (3)$$

$$\text{and } \delta_j = - \sum_{i=j+1}^k \alpha_i .$$

In the context of the above model (1), or (2), persistence can be defined as the speed with which output converges to its previous level after a shock in the disturbance term that raises output at moment  $t$  by 1%.<sup>1</sup>

The techniques allowing for measuring the persistence are based on the analysis of the autoregressive coefficients  $\alpha_j$  in (1) or (2), which are subject to a statistical estimation. Plainly, the most simple case of the models (1) or (2) is the so-called AR(1) model:

$$f_j = \mu + \alpha_1 f_{j-1} + \varepsilon_j . \quad (4)$$

Clearly, the variable  $\varepsilon_t$  in this kind of models has a particular importance given that it may be associated with policy measures leading to a shock in

<sup>1</sup> Given that the persistence is a long-run effect of a shock to output, this concept is intimately linked to a concept usually associated to autoregressive models such as (1) or (2), i.e. the impulse response function of output, which, in fact, is not a useful measure of persistence since its infinite length.

output. A positive shock, at moment  $t$ , will significantly last for future moments the higher is the autoregressive coefficient  $\alpha_1$ . Following this approach, Andrews and Chen (1994) proposed the

sum of the autoregressive coefficients,  $\rho = \sum_{j=1}^k \alpha_j$ ,

as a measure of persistence.<sup>2</sup> The rationale for this measure comes from realizing that for  $|\rho| < 1$ , the cumulative effect of a shock on output is given by  $(1-\rho)^{-1}$ .

Quite recently, Marques (2004) and Dias and Marques (2010) have suggested a non-parametric measure of persistence,  $\gamma$ , based on the relationship between persistence and mean reversion. In particular, Marques (2004) and Dias and Marques (2010) suggested using the statistic:

$$\gamma = 1 - \frac{n}{T}, \quad (5)$$

where  $n$  stands for the number of times the series crosses the mean during a time interval with  $T + 1$  observations, to measure the absence of mean reversion of a given series, given that it may be seen as the unconditional probability of that given series not crossing its mean in period  $t$ .<sup>3</sup>

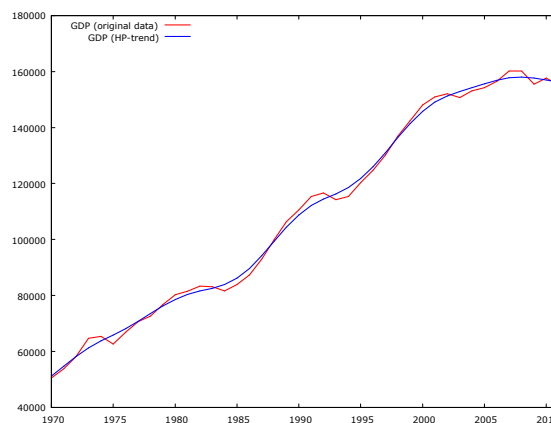
As Dias and Marques (2010) have shown, there is a one-to-one correspondence between the sum of autoregressive coefficients,  $\rho$ , given by (3) and the non-parametric measure,  $\gamma$ , given by (5), when the data are generated by an AR(1) process, but such a one-to-one correspondence ceases to exist once higher order autoregressive processes are considered. In other words, only in the particular case of a first-order autoregressive model, AR(1), either one of the two measures can be used to quantify the level of persistence, as both transmit the same result, but as soon as higher order autoregressive models are considered, *i.e.*, AR( $k$ ) with  $k \geq 2$ , the monotonic relationship between  $\rho$  and  $\gamma$  no longer exists, therefore leading to possibly crucial differences when measuring persistence in the series.

As Dias and Marques (2010) show, using the alternative measure of persistence,  $\gamma$ , given by (5),

has some important advantages.<sup>4</sup> Given its nature, such measure of persistence does not impose the need to assume a particular specification for the data generation process, therefore does not require a model for the series under investigation to be specified and estimated.<sup>5</sup> This is so given that  $\gamma$  is indeed extracting all the information about the persistence from the data itself. As it measures how often the series reverts to its means and (high/low) persistence exactly means that, after a shock, the series reverts to or crosses its means more (seldom/frequently), one does not need to specify a particular form for the data generation process.

### 3. The data

We use annual data for the period from 1970 to 2011 for Portuguese GDP, measured in millions of euros, at constant prices, OECD base year = 2005 (see Figure 1).



**Figure 1: The evolution of GDP (source OECD) and its HP-trend**

The smooth line in Figure 1 corresponds to the trend – obtained by the Hodrick-Prescott filter, to be described below – clearly identifies a relatively long-lasting period of generalized growth, followed by a decline in output after 2007. Naturally, around this trend, some cyclical component can also be (easily) identified.

### 4. The Level of Output Persistence in Portugal

Clearly, the time series of GDP exhibits a non-stationary behavior, which makes it necessary to use a non-parametric measure of persistence, such as given by (5). In order to compute the estimative  $\gamma$ , the

<sup>2</sup> Authors have, indeed, proposed other alternative measures of persistence, such as the largest autoregressive root, the spectrum at zero frequency, or the so called half-life. For a technical appraisal of these other measures see, for instance, Marques (2004) and Dias and Marques (2004).

<sup>3</sup> As acknowledged in Marques (2004), values close to 0.5 indicate the absence of any significant persistence (white noise behaviour) while figures significantly above 0.5 signal significant (positive) persistence.

<sup>4</sup> The statistical properties of  $\gamma$  are extensively analysed in Marques (2004) and Dias and Marques (2010).

<sup>5</sup> In technical terms, this means that the measure is expected to be robust against potential model misspecifications and given its non-parametric nature also against outliers in the data.

mean has to be computed. As suggested in Marques (2004) and Marques and Dias (2010), a time varying mean is more appropriate than the simple average for all the period under investigation. In our case we followed that suggestion by using the well-known Hodrick-Prescott (HP) filter in order to compute the mean (Hodrick and Prescott, 1981).

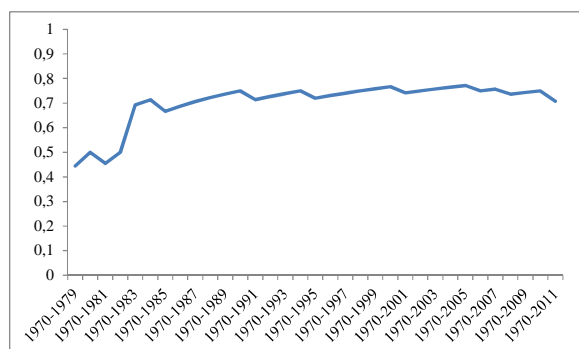
As it is well known, the HP filter defines the trend or mean,  $g_t$ , of a time series,  $f_t$ , as the solution to the minimisation problem:

$$\min_{\{g_t\}} \left\{ \sum_{t=1}^T (f_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} ((g_{t+1} - g_t) - (g_t - g_{t-1}))^2 \right\}$$

i.e. the HP-filter seeks to minimise the cyclical component ( $f_t - g_t$ ) subject to a smoothness condition reflected in the second term. The higher the parameter  $\lambda$ , the smoother will be the trend and the less deviations from trend will be penalised. In the limit, as  $\lambda$  goes to infinity, the filter will choose  $(g_{t+1} - g_t) = (g_t - g_{t-1})$ , for  $t = 2, \dots, T-1$ , which just amounts to a linear trend. Conversely, for  $\lambda = 0$ , the original series is obtained.

Obviously, the HP-filter is a very flexible device since it allows us to approximate many commonly used filters by choosing appropriate values of  $\lambda$ . Given that the data is of yearly frequency, authors have suggested using values for  $\lambda$  around 6 (Ravn and Uhlig, 2002). Considering this value for  $\lambda$ , the measure of persistence,  $\gamma$ , given by (5) was computed recursively, augmenting one year to the sample, in the case starting with the time period [1970,1979], and ending with [1970,2011]. This amounts to say that the original series,  $f_t$ , was decomposed in a HP-trend,  $g_t$ , and a remaining cyclical component, from which a change in sign identify a year where output has crossed its mean; see (5).

Figure 2 shows the results of that procedure, in terms of the values registered by the non-parametric measure of persistence,  $\gamma$ , given by (5).



**Figure 2: The level of output persistence in Portugal**

As it can be seen, the Portuguese GDP exhibits a fairly high level of persistence, whose non-parametric measure has apparently stabilized at around 0.75.

## 5. Conclusion

This paper has explored the question of output persistence in Portugal. It is used a new methodology proposed by Marques (2004) and Dias and Marques (2010) to measure persistence using a model that is non-parametric and broader in scope than other measures used in the literature, particularly the sum of the autoregressive coefficients.

The main conclusion is that the Portuguese GDP is characterized by a quite high level of inertia, which seems to have stabilized. This result calls the attention for the long-lasting effects of economic policies, whether of contractionary or expansionary nature.

As directions for further research we would like to further explore the possible asymmetry in the effects of shocks to output (Beaudry and Koop, 1993; Elwood, 1998).

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