Potential output: How does Portugal compare with the euro area over the last 40 years?

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Abstract
Model-based comparisons suggest that Portugal, *vis-à-vis* the euro area, witnessed (i) a steeper deceleration of potential output since the 1990s, driven primarily by investment and productivity, but with an important labour contribution over the last decade; (ii) a pervasively higher volatility in labour and product markets; and (iii) an interruption of convergence trends in the 2000s. The 2007–2009 financial turmoil and the euro area sovereign debt crisis comprised (iv) a trend and a slack component in both economies, including an abnormal fall in Portuguese potential output. Finally, (v) annual potential output growth differentials, relatively to the euro area, are systematically negative since 2003—an outcome that should motivate some reflection. All results are model and data dependent, which emphasizes the need to enlarge the current information set to account for a more encompassing and robust comparison. (JEL: C11, C30, E32)

Introduction

The Portuguese economy experienced important transformations over the last decades. A major change was brought about in 1999 when Portugal became a founding member of the euro area—a monetary union with which the country has been establishing deeper and more complex economic bonds, real and financial. The relative behaviour of both economies has always been an input to assess macroeconomic performances, policy stances, or to discuss alternative market institutions. Standard analysis include relative developments in Gross Domestic Product (GDP), employment, output prices, wage adjustments, financing conditions, etc.

The economic position and outlook assessment of a particular country is often incomplete, however, without an overview of key unobserved variables, notably potential output. Both the level and growth rate of potential output can provide valuable information to assess past, current and future developments. In the short run, output may be above or below potential signalling scenarios of over- or under-utilization of resources, a gap often interpreted as an indicator of the business cycle that remains relevant to derive policy implications.[1] Given the different implications in terms of inflationary pressures, expansion periods when the economy is operating above potential should not be mistaken, conceptually, with recovery periods featuring negative output gaps. Over longer horizons, social well-being depends on sustainable economic growth, often envisaged as a situation where GDP and potential output levels and growth rates are identical.

Our main goal in this article is to compare the performance of Portugal *vis-à-vis* the euro area based on relevant latent forces—not observed—, such as potential output or underlying unemployment rates, with a particular interest on low-frequency movements over the last 40 years.

We are aware that potential output is a controversial object hindered by model and data uncertainty. It is thus essential to clarify what we mean by potential output. We go back herein to the theoretical concept laid down by Arthur Okun in his Presidential Address of 1962: it is the maximum level of production, with full employment, that does not trigger inflationary pressures above the "social desire for price stability and free markets." More precisely, it represents a point of balance between "more output" and "greater price stability," which is distinct from the output level that could be generated with any amount of aggregate demand. We also borrow his famous "law," which establishes that if output is above potential (positive output gap), then unemployment is below its underlying level (negative unemployment gap)—they are mirror images.[2] Underlying unemployment is defined herein as the Non-Accelerating Wage Rate of Unemployment (NAWRU), *i.e.* the unobserved unemployment rate that does not trigger excessive wage pressure.

We offer model-based estimates for Portugal and the euro area using a unified theoretical approach, which favours comparability. Our main reference is Szörfi and Tóth (2019). In their model potential output is obtained with a Cobb-Douglas production function where the underlying inputs are unobserved variables jointly estimated with the remaining unknowns. This synthetic approach contrasts with the more common use of production functions outside the model, or alternatively with the use of potential output

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[1] See, for instance, Blanchard and Portugal (2017).

[2] See Okun (1962). Okun's law validity has been recently evaluated by Ball, Leigh, and Loungani (2013) or Lafourcade *et al.* (2016).

as another latent variable following simple statistical laws of motion. The model is completed with more standard approaches in which reduced-form theoretical equations decompose observed data into unobserved trends and cycles that are subject to simultaneous restrictions, including dynamic price and wage equations, and a version of Okun's law. Expectations take an adaptive form. Nominal targets determined by monetary policy, as well as international spillovers are absent.[3]

We departed from Szörfi and Tóth, nevertheless, in key dimensions. The differences include an alternative price inflation equation, which introduces a flexibility component that allows us to easily cope with pre- and post-1999 data; an alternative labour market tightness indicator, measured by the labour input gap, which simultaneously uses the headline labour force component, as in Andrle *et al.* (2015), average hours worked and unemployment; and alternative trend dynamics, in which unobserved variables are partially influenced by the information content of low frequency movements in observed data. We placed a special focus on the relative dynamics of long- and short-term unemployment, which to our knowledge is a novelty in the literature. By using hours worked we abstract from identifying if households and firms adjust average hours or number of workers in the face of changing cyclical conditions. All details can be found in Duarte, Sazedj, and Maria (2019).

The models for Portugal and the euro area are parametrized using Bayesian techniques. Results suggest, firstly, a steeper deceleration of potential output in Portugal than in the euro area since the 1990s, driven primarily by investment and productivity, but with an important labour contribution over the last decade.

Secondly, there has been a pervasively higher volatility in Portuguese labour and product markets. Economic cycles, measured by output or unemployment gaps, have higher amplitudes and wage and price dispersion has been substantially higher. In the 1980s and a large part of the 1990s Portugal experienced a substantial disinflationary period, both in terms of actual and trend inflation. There is some parallel with the euro area, but the decrease was more pronounced in Portugal. In the post-1999 period actual and trend inflation rates remained higher in Portugal. There are some signs that the Portuguese nominal response to the business cycle position has been more aligned with the euro area in labour than in product markets. In a small open economy, such as Portugal, product market prices are highly conditioned by the external environment.

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[3]See Maria (2016) for a model featuring common inflation objectives, international spillovers and rational expectations. Theoretically the model requires, however, a well-defined monetary union, including a unique central bank. See Jarociński and Lenza (2018) for a recent alternative model where deviations of output from trend are consistent with inflation developments.

Thirdly, convergence trends were interrupted in the 2000s and in particular after the 2007–2009 financial turmoil and the euro area sovereign debt crisis. This period comprised a trend and a slack component in both economies.

Fourthly, while results suggest that Portuguese potential output grew persistently above the euro area in the first part of the sample, this picture was reverted during the last 15 years. Annual potential output growth differentials are systematically negative since 2003—an outcome that should motivate some reflection.

Finally, a word of caution is needed. Robustness checks lead us to conclude that output gap estimates, and most importantly their signs, are model dependent and conditional on the law of motion of unobserved variables, for instance on alternative orders of integration for the NAWRU. Confirming the output gap sign, negative or positive, requires a comprehensive economic assessment that should not be based on a single model. Changes in the output gap, and therefore in potential output, are less uncertain.

This article is organized as follows. The next section overviews the model, and briefly presents the database and some Bayesian estimates. Results are reported in the third section, while uncertainty issues are briefly addressed in the fourth section. The last section concludes.

An unobserved components model

The unobserved components model used herein is a multivariate filter that decomposes observed data into unobserved trends and cycles. Details are available in Duarte *et al.* (2019).

Following Szörfi and Tóth (2019), the model features a production function as a central organizing piece. An advantage in using a production function is that developments in potential output can be interpreted in the light of changes in production factors and their productivity. As in D'Auria *et al.* (2010), we assume that labour and capital inputs are conditional on utilization rates and efficiency levels. More exactly, we assume that actual output Y is produced using a Cobb-Douglas technology $Y = \mathcal{A}\mathcal{L}^{\iota}\mathcal{K}^{1-\iota}$, where $\mathcal{A}$ represents disembodied total factor productivity, $\mathcal{L} \equiv (U_L E_L)L$ and $\mathcal{K} \equiv (U_K E_K)K$ are labour and capital inputs, respectively, and $0 \leqslant \iota \leqslant 1$. Identifiers U_i and E_i, $i = \{L, K\}$, measure the utilization rate and the degree of efficiency of total hours worked L and capital K, respectively.[4] Potential output $\bar{Y}$ follows an identical technology.

In terms of notation, bars ($\bar{}$) denote trend variables that are necessary to produce $\bar{Y}$, $\Delta X_t = X_t - X_{t-1}$, and small-case letters represent variables in

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[4]Adjustments in labour quality are also implemented, for instance, in the Conference Board's Total Economy Database.

log terms, *i.e.* $x_t = ln(X_t)$. For example, the (log) level of potential output at time t is given by $\bar{y}_t$, the output gap by $(y_t - \bar{y}_t)$, and the unemployment gap by $(U_t - \bar{U}_t)$. The system of equations defining the growth rate of $\bar{y}_t$, after collecting all terms, is given by

$$\Delta\bar{y}_t = \Delta\overline{tfp}_t + \iota\Delta\bar{l}_t + (1-\iota)\Delta\bar{k}_t, \tag{1}$$

$$\Delta\overline{tfp}_t \equiv \Delta\bar{a}_t + \iota(\Delta\overline{u_{Lt}} + \Delta\overline{e_{Lt}}) + (1-\iota)(\Delta\overline{u_{Kt}} + \Delta\overline{e_{Kt}}) \tag{2}$$

$$\Delta\bar{l}_t = \Delta\bar{h}_t + \Delta ln(1 - \bar{U}_t), \tag{3}$$

$$\Delta\bar{k}_t = \Delta k_t, \tag{4}$$

where $\Delta\overline{tfp}_t$ is defined as the growth rate of the "adjusted" trend total factor productivity (TFP), $\Delta\bar{l}_t$ is the change in the trend component of total hours worked; and $\Delta\bar{k}_t$ is the change in observed capital. Note that (i) $\bar{a}_t = ln(\bar{\mathcal{A}}_t)$ should be distinguished from $\overline{tfp}_t$, where the latter captures TFP levels that are adjusted for unobserved utilization rates and efficiency levels; and that (ii) $\Delta\bar{l}_t$ comprises a trend labour force component $\Delta\bar{h}_t$ (measured in hours), and changes in $\bar{U}_t$ (the NAWRU).

The model decomposes real GDP into potential output and the output gap, and the unemployment rate into the NAWRU and the unemployment gap. This is done with the help of theoretical economic relationships, namely equations (1)–(4), a dynamic version of Okun's law, and equations linking output gaps and labour input gaps to nominal developments.

Several latent variables are estimated by taking into account information of low frequency movements in observed data. More precisely, the model uses the Hodrick-Prescott filter to computed the trends in the gap between long and short-term unemployment (which influences NAWRU estimates), in the actual labour force (with an impact on trend labour force estimates), and in the Solow residual (with an impact on the adjusted trend TFP).[5] Unobserved variables can deviate from these low frequency movements due to exogenous shocks.

Output and unemployment gaps are linked through a dynamic version of Okun's law, which in its simplest form states that the latter—a proxy for the

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[5] The "actual" Solow residual is the term that would be needed for the production function to match output after accounting for actual labour and capital inputs

level of underutilised resources in the economy—is inversely related with the output gap.

The wage equation takes a dynamic form and assumes that hourly wage growth, adjusted for inflation expectations and trend labour productivity, is conditional on overall labour input gap $(l_t - \bar{l}_t) = (h_t - \bar{h}_t) - (U_t - \bar{U}_t)$, which includes labour force gaps $(h_t - \bar{h}_t)$ and unemployment gaps $(U_t - \bar{U}_t)$. In turn, the price equation determines that inflation responds to inflation expectations and the output gap. Wage and price expectations are treated herein as trend variables, interchangeably, *i.e.* as components that are long-run attractors and around which actual values oscillate. Changes in these trend variables are conditional on past developments and exogenous disturbances.

The long run equilibrium of the model has several appealing characteristics, namely (i) output and labour market slacks are nil; (ii) actual and potential output growth rates are identical; (iii) price and wage inflation are constant; and (iv) the labour share is constant, *i.e.* real wages grow in line with labour productivity.

The model was parametrized with Bayesian techniques for Portugal and the euro area. To improve comparability we kept their structure as identical as possible. For instance, the lag structure is virtually identical. An exception is that the output gap follows an autoregressive process of order 2 for Portugal and of order 1 for the euro area. Sign restrictions, when present, are identical.

Although prior distributions are also identical, there is enough information in the data to distinguish the two economies, both in terms of parameter uncertainty and of selected parameter estimates. In some cases priors take a highly informative nature. The most striking case is ι, which by design is not allowed to substantially deviate from a reasonable labour's share on income.

Data were collected from several sources, notably Banco de Portugal, Eurostat, AMECO, OECD, and the Area Wide Model database (Fagan *et al.* 2001). Observables include quarterly GDP, employment, unemployment, hours worked and the capital stock; the nominal side includes price and wage inflation, which are measured by the annualised growth rates of GDP deflator and nominal hourly compensation of employees (seasonally adjusted), respectively. The euro area corresponds to official 19 member-state data, or to an aggregation computed with representative figures.

Posterior distributions were computed with 1980Q1–2018Q2 quarterly data for Portugal and 1985Q1–2018Q2 for the euro area. Posterior medians were afterwards selected to compute unobserved components over 1980–2017. To reduce end-of-period biases these figures take into account an extension with projections up to 2021 for Portugal (taken from Banco de Portugal) and up to 2020 for the euro area (taken from AMECO). Unobserved euro area components over the 1980–1985 period were extrapolated by fixing all 1985–2020 previously-computed unobserved components. All unobserved time series are smoothed estimates computed with the Kalman filter.

Potential output in Portugal and in the euro area

Output market

Figure 1 illustrates developments in actual and potential output for the Portuguese economy and the euro area between 1980 and 2017. Although with different amplitudes, actual output evolves around potential in both economies, as expected. In Portugal, however, there is a considerable negative gap between 2003 and 2017, while in the euro area this phenomena only takes place with the onset of the international financial crisis in 2008–2009.[6] Estimates suggest an actual drop in Portuguese potential output, with no parallel in the euro area. Both economies witnessed output gaps close to zero in 2017.

Figure 2 presents output gap estimates (left), and developments in observed and trend price inflation (right). Darker shaded areas highlight periods where GDP fell simultaneously in both economies and lighter areas highlight periods where GDP fell in Portugal. No observations exist where GDP fell solely in the euro area. Portugal has gone through 7 years of recessions since 1980—four of which common to the euro area—and requested
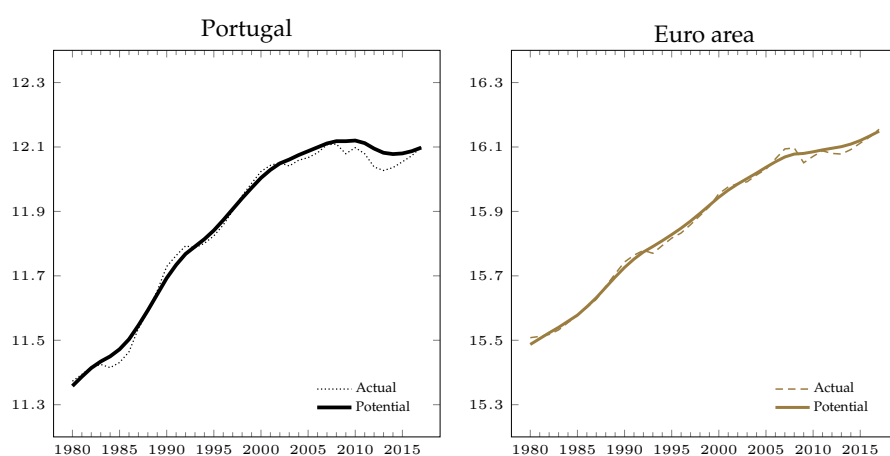

FIGURE 1: Actual GDP and potential output | In logarithm

Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors'calculations.

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[6]Quarterly data reveals, nevertheless, close to nil gaps during 2007. Blanchard and Portugal (2017) classify the 2002-2007 period as a time when the Portuguese economy entered into a slump. A historical overview containing the path of the Portuguese economy towards the economic and monetary integration of 1999 can be assessed, for instance, in Amador (2003).
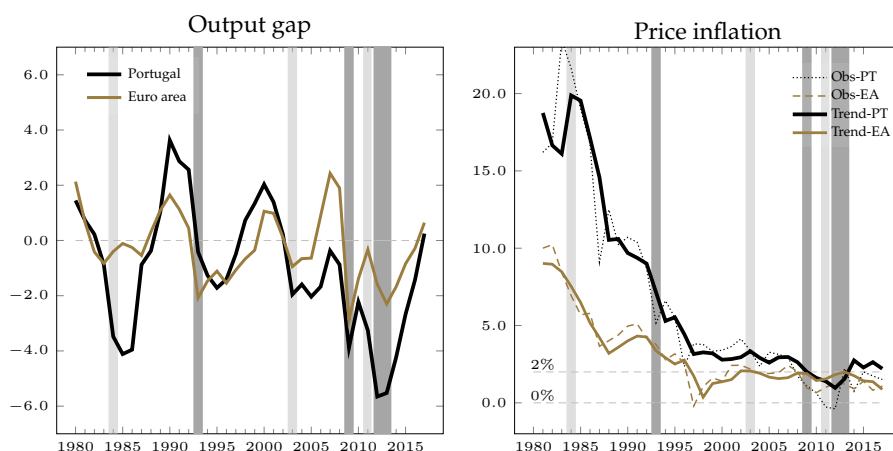
FIGURE 2: Output gap and price inflation

Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors'calculations.

Notes: Darker shaded areas highlight periods where GDP fell simultaneously in Portugal (PT) and the euro area (EA); lighter areas highlight periods where GDP fell in Portugal. The ouput gap and price inflation are computed with differences in logarithms.

for international assistance on two occasions (1983–84 and 2011–14).[7] Over the last 15 years, we estimate larger negative output gaps than in the euro area and a -5.7% gap at the trough of the most recent international crisis, without parallel in the euro area.

The Portuguese economy was characterized until 2003 by high output gap volatility, albeit converging to the euro area, and a strong disinflation process—in particular until the late 1990s—, which blurs direct interpretations of price developments in light of the price equation of the model. Portuguese output gaps ranged between -4.1 and 3.6%, which compares with -2.1 and 2.1% in the euro area; inflation rates decreased approximately 12 percentage points (pp)—almost 5 pp more than in the euro area—and we estimate larger exogenous price shocks in Portugal.

Despite noticeable disinflationary trends, price inflation in the early 1990s had only reached euro area levels of the early 1980s. In addition, trend price inflation remained above the euro area counterpart over almost the entire sample and above the reference value of 2% during most of the post-1999 period, while the euro area converged to levels close to 2% since the inception of the euro (both in terms of actual and trend values). The most recent crisis

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[7]A brief comparison of the Portuguese recessions of 1984, 1993 and 2003 can be found in Banco de Portugal (2004).
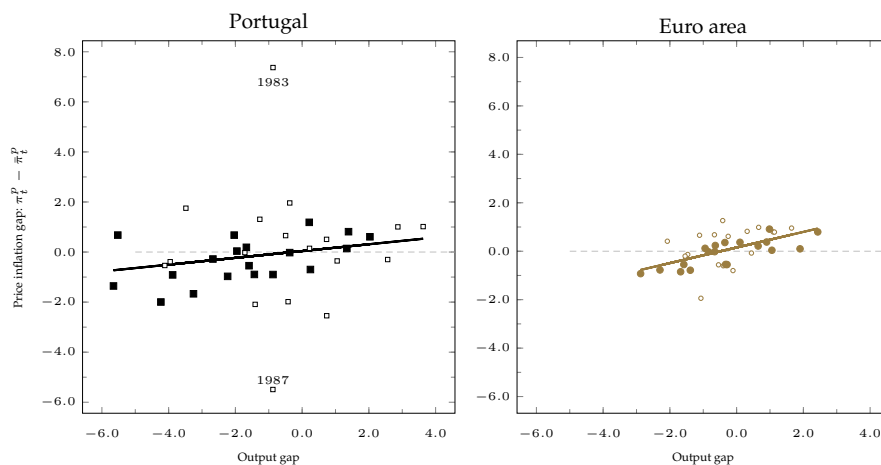
FIGURE 3: Output gap and price inflation gaps

Source: Authors' calculations.

Notes: White squares and circles refer to pre-1999 data. The price inflation gap is defined as the difference between actual π_t^p and trend $\bar{\pi}_t^p$ price inflation. The ouput and price inflation gaps are computed with differences in logarithms.

period was the only exception, with Portuguese actual price inflation falling below both its trend and euro area levels, in line with large negative output gaps.

A simple and static relation between output gap estimates and price inflation gaps is illustrated in Figure 3. This simple exercise helps to further highlight the main differences between the two economies, which can be summarized as follows: (i) a much higher dispersion in the Portuguese economy; (ii) outliers in 1983 and 1987, in Portugal, where a similar negative output gap was associated to an increasing and to a steep drop in inflation, respectively; and (iii) a lower slope in the case of the Portuguese economy, suggesting that increasing output gaps seem less correlated with inflationary pressures. With increasing openness to trade over the last decades, notice that Portugal is a small open economy subject to several external nominal shocks that can weaken the link between domestic output markets and price developments, thus contributing to a flatter curve and sporadic outliers. It should also be noted that the model does not isolate the impact of tax changes on prices.

Labour market

Figure 4 depicts developments in the observed unemployment rate and in the NAWRU. Over the 1980s and the 1990s, the estimated average level of

Portuguese NAWRU was 5.5%, in line with previous empirical literature (Centeno *et al.* 2009; Esteves *et al.* 2004). Since 2002–03, model-based estimates point towards an increasing trend. After having peaked at almost 11% in 2013, the NAWRU is estimated to have declined, though remaining at a fairly high rate in 2017 (8.7%). These estimates are influenced by persistent effects of the economic crisis and possibly by labour market reforms. Following our NAWRU specification, long-term unemployment increased persistently more than short-term unemployment between 2003–15, leading to an increase in the indicator used in NAWRU estimations. These figures compare to very modest increases in euro area estimates over the entire sample period, and to a smaller impact of the crisis. Notice, however, that the euro area presented persistently higher unemployment rates over the first three decades of the sample. Therefore, the developments observed in the Portuguese labour market imply that both observed and trend unemployment approached euro area levels.

Figure 5 (left) presents unemployment gap estimates. As expected, the estimates for Portugal point towards a higher volatility, with a persistently positive and large unemployment gap during the last 15 years, mirroring the estimated negative output gaps, in line with Okun's Law. This component of the labour input gap has been decreasing in both economies over the last 4 years, which mirrors output gap developments (Figure 2).

Figure 5 (right) illustrates developments in observed and trend wage inflation. Similarly to price inflation developments, Portugal experienced a sharper reduction in wage growth and higher wage inflation (both actual and
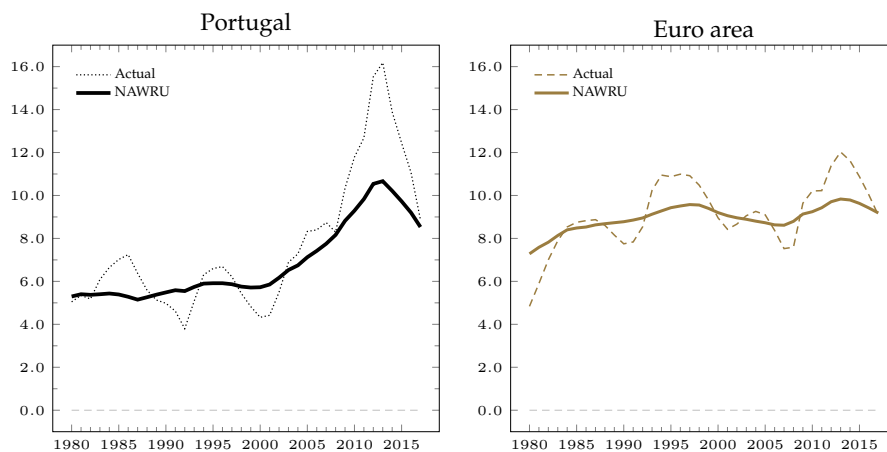

FIGURE 4: Unemployment and the NAWRU ∣ In percent of the labour force

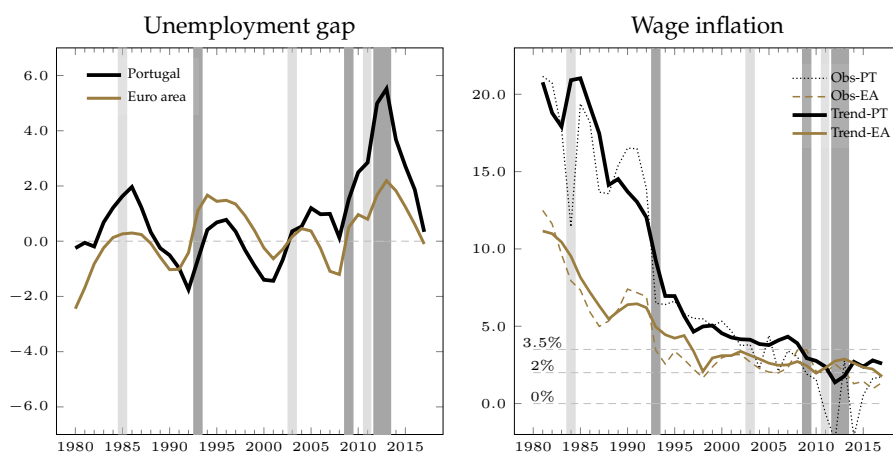Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors' calculations.

FIGURE 5: Unemployment gap and wage inflation

Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors'calculations.

Notes: Darker shaded areas highlight periods where GDP fell simultaneously in Portugal (PT) and the euro area (EA); lighter areas highlight periods where GDP fell in Portugal. The unemploymnet gap and wage inflation are computed with differences in logarithms.

trend) than the euro area during most of the sample, the exception being the recent crisis period. Since the late 90s, trend wage inflation evolved between 2 and 3.5% in the euro area, while in Portugal it stayed above 3.5% until 2009.

The persistent Portuguese labour market slack since 2003, also including the labour force gap, translated into negative wage inflation gaps. Indeed, Portugal registered some episodes of actual temporary wage decreases. Comparing the developments in the labour market to the output market in the period between 2003 and 2017, we find that: (i) contrary to prices, wage inflation fell below its trend during most of the period; (ii) the adjustment in wage inflation was much larger than in the euro area.[8]

The simple and static relation between overall labour input gap and wage inflation gaps is depicted in Figure 6. While we find, once again, a greater dispersion in the Portuguese economy, the slope of the wage static relation is higher than the price relation and is more comparable to the euro area. These results indicate that the link between the labour input gap and wage inflation seems stronger than the counterpart link in product markets, which may signal an incomplete pass through between markets. For instance, the

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[8]Wage decreases in the Portuguese economy during the economic and financial assistance programme of 2011–14 were largely driven by the public sector, due to several policy measures. In 2014, however, private sector compensation per employee has also decreased (around 1%).
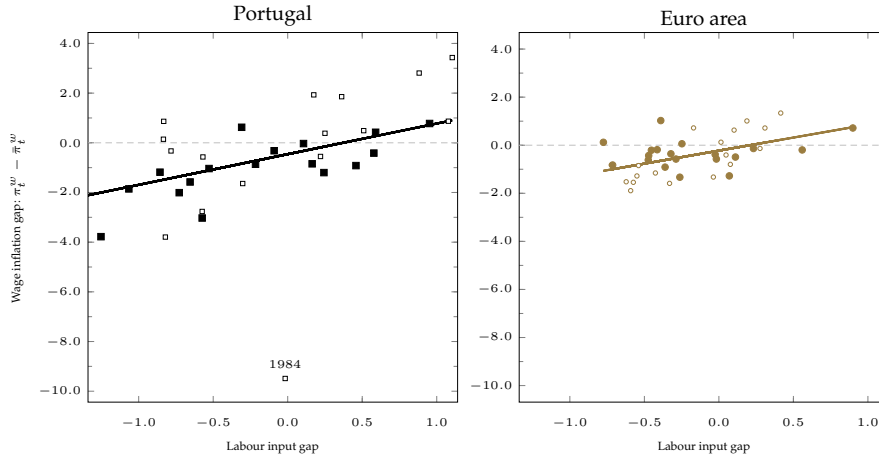
FIGURE 6: Labour market tightness and wage inflation gaps

Source: Authors' calculations.

Notes: White squares and circles refer to pre-1999 data. The labour input gap is measured by the total hours worked gap, namely $(l_t - \bar{l}_t) = (h_t - \bar{h}_t) - (U_t - \bar{U}_t)$. The wage inflation gap is defined as the difference between actual π_t^w and trend $\bar{\pi}_t^w$ wage inflation. The labour input and price inflation gaps are computed with differences in logarithms.

positive unemployment gap after 2003, together with the negative labour force gap, led to downward adjustments in wages, with no parallel, in terms of amplitude, in price inflation. We register an outlier in 1984, when in face of a nil labour input gap, wage inflation registered a drop of more than 6 pp, while trend inflation increased 3 pp.

By considering both the labour force slack and the unemployment gap, notice that we introduce the possibility of having two adjustment channels. Indeed, during the recent crisis, slack in the labour market was greater than what the unemployment gap indicates, due to a negative labour force gap.[9]

Potential output growth, factor inputs and productivity

Figure 7 (left) illustrates the annual change in actual and potential output for the Portuguese economy between 1981 and 2017 and a breakdown of potential output growth rates.

Results suggest that the high potential growth rates estimated for the Portuguese economy for the 1980s were mainly driven by contributions from adjusted trend TFP, but also the capital stock. During the 1990s,

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[9]The simple and static relation between the unemployment gap and wage inflation gaps is not reported but is available from the authors upon request.
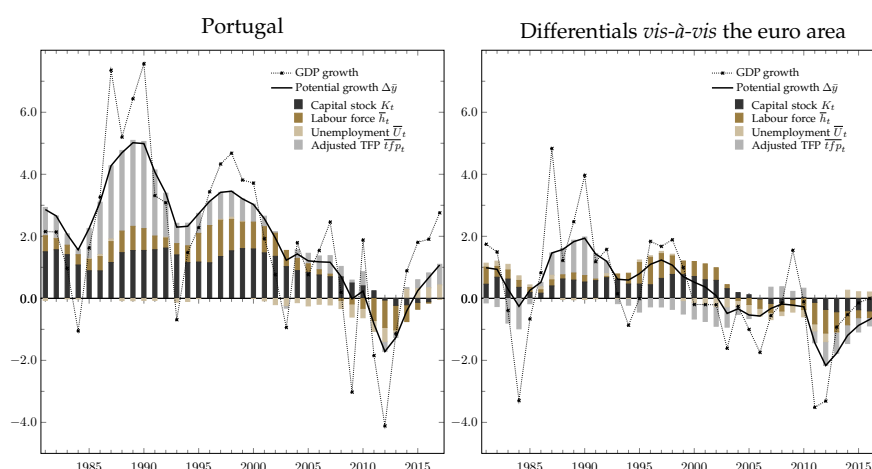
FIGURE 7: Breakdown of potential output growth

Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors'calculations.

Note: All computations are made with differences in logarithms.

Portugal sustained high investment rates, which resulted in persistent positive contributions to growth from the capital stock, while less favourable developments in adjusted trend TFP led to a strong drop in potential output growth rates.

The labour input is identified as also contributing to the deceleration of potential output recorded in the first half of the 2000s, and subsequent decline during the more recent crisis. More specifically, the labour input accounted for approximately 1 pp of potential output growth in the late 1990s, while its contribution decreased to -1 pp during the most recent crisis. Until the late 2000s, the trend labour force was still growing enough to compensate for the increasing NAWRU. This picture was reverted in 2007, when the fall in the working-age population seems the main explanation behind a decreasing trend labour force, which together with the significant rise in the NAWRU resulted in negative contributions from the labour input and a decline in potential output.

The previous downward pressures on potential growth were aggravated by observed developments in the capital stock, which decelerated gradually since the early 2000s and has actually contracted after 2012, suggesting that investment rates were not sufficient to offset the depreciation of installed capital. Despite a significant recovery in investment rates during the last years, particularly in business investment, these have been insufficient to propel the capital stock contributions, due to its slow moving nature.

Currently, potential growth is supported by favourable adjusted trend TFP developments, together with a decreasing NAWRU. Notice, however,

that adjusted trend TFP growth is still far below the values estimated for the beginning of the sample.

Figure 7 (right) illustrates the differentials in growth rates (actual and potential) and in contributions to potential growth *vis-à-vis* the euro area. Given that the estimates for the euro area are more stable throughout the entire sample, the differentials are dominated by the developments in the Portuguese economy.

Despite a steeper deceleration in Portugal, particularly after the 1990s, the model suggests that Portuguese potential output grew persistently at a faster pace than the euro area in the first part of the sample, mainly due to higher contributions from both the capital stock and the labour input.[10] Additionally, Portugal witnessed considerably higher contributions from TFP during the late 1980s, which gradually decreased to below euro area levels. Potential output grew on average around 3% in Portugal during the first two decades of the sample, almost 1 pp more than in the euro area.

The above-mentioned picture was, however, reverted between 2003–17. Not only TFP contributions remained below euro area levels, but also decreasing capital and labour inputs contributed to negative differentials. During the recent crisis period, potential output did not decline in the euro area, despite decelerating from above 2% in the early 2000s to an almost stabilization at the trough of the crisis. Over the last years of the sample, the model points to some common features: both economies have (i) negative output gaps; (ii) actual growth rates are above potential, and finally (iii) potential growth approaches pre-2007 estimates.

Uncertainty

Robustness checks lead us to conclude that output gap estimates, and most importantly their signs, are data and model dependent. For instance, in the case of Portugal we used the database of Banco de Portugal for data before 1995. The results would be somewhat different if, instead, we had used the AMECO database, namely in the case of the NAWRU, as the historical unemployment rate is higher in the AMECO database. Moreover, results are conditional on the sample period, namely on the estimation from 1980 for Portugal and 1985 for the euro area. Starting the estimation in 1995 for both economies would change the results, in particular the Portuguese NAWRU.

Results are also conditional on the law of motion of unobserved variables, for instance on alternative orders of integration for the NAWRU. Choosing between an integration order of 1 or 2 (henceforth I(1) and I(2), respectively),

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[10]Coimbra and Amador (2007) claimed that low levels of capital per worker place Portugal on a segment of the world production frontier that does not grow significantly as a result of technological progress.
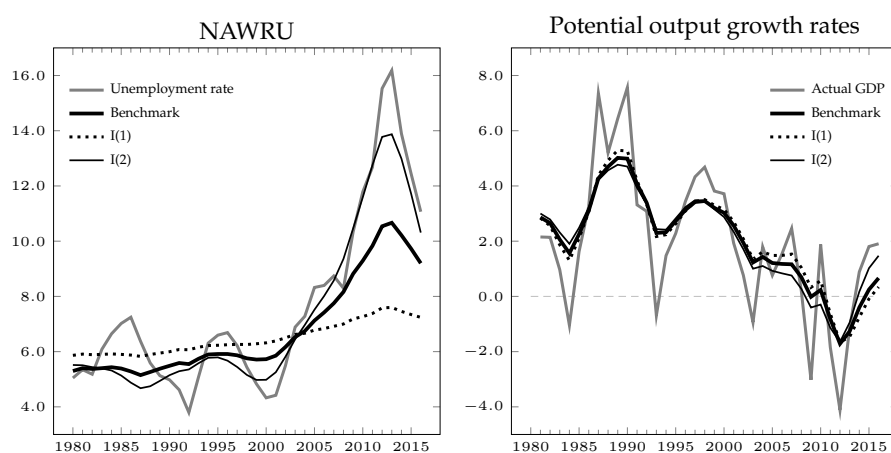
FIGURE 8: Model uncertainty

Sources: Statistics Portugal, Banco de Portugal, Area-wide model database, Eurostat and authors'calculations.

Notes: The benchmark figures retrive the results used in previous sections. Unemployment rates are in percent of the labour force; growth rates are computed with differences in logarithms.

changes the NAWRU's level and volatility, particularly in the Portuguese case, where the pure I(2) specification generates highly volatile results after the 2000s (see Figure 8, left). The higher the NAWRU volatility the lower the unemployment gap and also, by design, the output gap. With the I(2) specification, for instance, the recent Portuguese economic crisis ceases to feature the largest output gap over the sample period. In contrast, model uncertainty around the growth rate of potential output is less pronounced. Higher NAWRU volatility also results in higher volatility in potential output growth rates but outcomes remain relatively contained around central estimates (see Figure 8, right).

From the robustness exercises we can draw three main conclusions: (i) the analysis laid out herein is subject to a considerable degree of uncertainty; (ii) confirming the sign of the output gap requires a comprehensive economic assessment and should not be based on a single model; and (iii) changes in the output gap, and therefore in potential output, are in contrast more robust than NAWRU and potential output levels.

Concluding remarks

Model-based results suggest that Portugal failed to sustain high growth rates of potential output over the last 40 years. The country was unsuccessful in interrupting a steeper deceleration of potential output *vis-à-vis* the euro area,

namely after the 1990s, or in avoiding negative potential growth differentials over 2003–17.

The 2008–09 international financial crisis and ensuing euro area sovereign debt crisis had unparalleled impacts in Portugal, with an important negative contribution to potential growth from labour. Resuming a long-lived catching-up process with sustainable increases in output—given the medium-term demographic trends—requires policy makers' commitment to promote structural reforms that are aligned with best practices.

The Portuguese total factor productivity is an important component behind the potential output acceleration over the last five years and behind the recent attenuation in growth differentials *vis-à-vis* the euro area. Pursuing adequate legal and institutional frameworks designed to facilitate the best possible resource allocation and the emergence of firms able to compete worldwide may also contribute to boost productivity.

It is important to mention that point estimates carry a substantial uncertainty, which highlights the need to promote a comprehensive monitoring of the economy if the goal is to achieve a robust assessment of the cyclical position of the Portuguese economy. The presence of important transformations over the sample period, not considered in the model, is one source of uncertainty that may give rise to further work.

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