2

Banco de Portugal Economic Studies

Volume V

BANCO DE PORTUGAL
EUROSYSTEM

2

Banco de Portugal Economic Studies

Volume V

Please address correspondence to
Banco de Portugal, Economics and Research Department
Av. Almirante Reis 71, 1150-012 Lisboa, Portugal
T +351 213 130 000 | estudos@bportugal.pt

BANCO DE PORTUGAL
EUROSYSTEM

Lisboa, 2019 • www.bportugal.pt

Banco de Portugal Economic Studies | Volume V – no. 2 | Lisbon 2019 • Banco de Portugal Av. Almirante Reis, 71 | 1150-012 Lisboa • www.bportugal.pt • Edition Economics and Research Department • Design Communication and Museum Department | Design Unit • ISSN (*online*) 2183-5217

Content

Non-technical summary

April 2019

This issue of Banco de Portugal Economic Studies includes three articles, whose non-technical summaries are presented below, and a synopsis titled "Credit and the economy: lessons from a decade of research at Banco de Portugal".

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

Cláudia Duarte, José R. Maria and Sharmin Sazedj

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.

However, the economic position and outlook assessment of a particular country is often incomplete 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.

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 offer model-based estimates for Portugal and the euro area using a unified theoretical approach, which favours comparability. The euro area corresponds to official 19 member-state data, or to an aggregation using representative figures.

Our results suggest that, firstly, potential output decelerated more steeply 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.

Thirdly, convergence trends were interrupted in the 2000s and in particular after the 2007–2009 financial turmoil and the euro area sovereign debt crisis. In this period, both economies experienced a downturn. Potential output was also affected. However, whereas in the euro area potential output decelerated, in the case of Portugal estimates show an abnormal decrease.

Fourthly, 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 underlying unemployment rate. Confirming the output gap sign, negative or positive, requires a comprehensive economic assessment and should not be based on a single model-dependent outcome. In turn, changes in the output gap, and therefore in potential output, are less uncertain.

A new methodology for the calculation of cyclically adjusted budget balances at Banco de Portugal

Cláudia Braz, Maria Manuel Campos and Sharmin Sazedj

The analysis of public finances typically relies on several indicators, such as the overall and primary budget balances and the government debt. Beyond these more standard indicators, estimates of cyclically adjusted budget balances (CABs), which correct headline government balances for business cycle fluctuations, have gained prominence in the last decades, particularly in the context of the European fiscal surveillance framework. When assessed in levels, CABs are a good measure of the underlying fiscal position of a country. Its changes represent a rough proxy for governments' discretionary action and, as such, are considered indicators of the fiscal stance. CABs are computed by many institutions, including the European Commission, the IMF and the OECD, in each case according to specific methodologies and respective parameters.

Since 2001, the analysis of structural fiscal developments undertaken by Banco de Portugal has relied on commonly agreed methodologies developed and adopted by the ESCB. These methodologies were recently reviewed to overcome some of the limitations that emerged over the course of time. This

article synthetically describes the new ESCB methodologies in order to present its application to Portuguese public finances.

Similarly to methods adopted by other institutions (most notably, the European Commission), the new ESCB methodology for the computation of CABs is aggregated, i.e. the cyclical component of the budget balance is determined by the product between a budgetary semi-elasticity and the output gap. In the case of Portugal the semi-elasticity of the budget balance relative to the economic cycle was estimated at 0.54. As such, an increase (decline) by 1 pp in the output gap is estimated to result in a 0.54 improvement (deterioration) in the headline balance as a ratio to GDP. The output gap is computed by Banco de Portugal, using a production function approach to estimate potential GDP. The resulting structural balance (i.e. the CAB excluding the impact of temporary measures) for Portugal hovered around -4% of potential GDP since EMU accession and up to the onset of the crisis. It reached a minimum of -8.5% in 2009 and then sharply increased during the Programme. Since 2015, the structural deficit recorded a small improvement and is estimated to have stood at 0.9% of potential GDP in 2017.

Although the new ESCB semi-elasticity largely coincides with that recently obtained by the European Commission, the distinct measurements of the cyclical position of the economy and temporary measures yield differences in structural balances' estimates. However, the assessment of the fiscal stance (as measured by the change in the structural primary balance) is broadly similar.

Inflation expectations in the Survey of Professional Forecasters: An exploratory analysis

Joana Garcia and Nikolay Iskrev

Expectations about future inflation play an important role in decision-making by private agents, and can have a significant impact on economic outcomes, including realised inflation. It is therefore crucial for central banks, whose goal is maintaining price stability, to pay close attention to measures of the private sector's inflation expectations. This article provides an overview of one of the main sources of information about inflation expectations in the euro area – the Survey of Professional Forecasters (SPF). The survey is conducted by the European Central Bank and, in its 20 years of existence, has become a valuable point of reference regarding the private sector's expectations to both policymakers and academic researchers.

The article has two objectives. The first one is to describe the evolution of inflation expectations over the last 20 years, and highlight some of the salient features that have emerged during that period. We present the survey results both in terms of the forecasters' point forecasts, as well as in terms of their subjective density forecasts, and discuss some ways in which information

obtained from these sources can used to gain insights about the nature of inflation expectations. Second, we try to shed light on some of the drivers behind the observed dynamics of SPF inflation forecasts. To that end, we exploit the fact that, in addition to their inflation forecasts, the SPF participants are also asked to provide information about their underlying assumptions with respect to the future values of the price of oil, USD/EUR exchange rate, and wage growth. Using pairwise correlation analysis, we assess the link between revisions in the forecasters' assumptions about these variables, and the revisions in their forecasts of inflation. Our results show that a significantly larger number of forecasters appear to update their outlook for inflation in the short-term when new information about the price of oil becomes available, compared to those who do that following news about the USD/EUR exchange rate, or wage growth. Using a similar approach, we also assess the relationship between revisions in short and long-term inflation forecasts. The existence of such a link might be interpreted as a sign of a potential de-anchoring of long-term inflation expectations. We find evidence of a significant relationship for a only small fraction of the SPF participants.

A particular question we are interested in and explore is whether there are significant differences in the properties of inflation forecasts in the periods before and after 2013. In the later period, inflation in the euro area has been relatively low when compared with the ECB's objective, which raised concerns that low inflation becomes entrenched in expectations. Our results suggest that, along the dimensions we explore, there has not been a fundamental change in the relative role of assumptions with respect to the formation of inflation expectations, or in the relationship between short and long-term expectations.

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

Cláudia Duarte
Banco de Portugal

José R. Maria
Banco de Portugal

Sharmin Sazedj
Banco de Portugal
Nova SBE

April 2019

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.

Acknowledgements: We would like to thank all members of the Potential Output Task Force of the Eurosystem, and in particular Béla Szörzi and Máté Tóth. We also acknowledge helpful discussions with Paulo Júlio and Carlos Robalo Marques. The opinions expressed in this article are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

E-mail: cfduarte@bportugal.pt; jrmaria@bportugal.pt; ssazedj@bportugal.pt

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

[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.

[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 ($^{-}$) 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

[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

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

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

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

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

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 $\Delta\overline{h}_t$ (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

[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

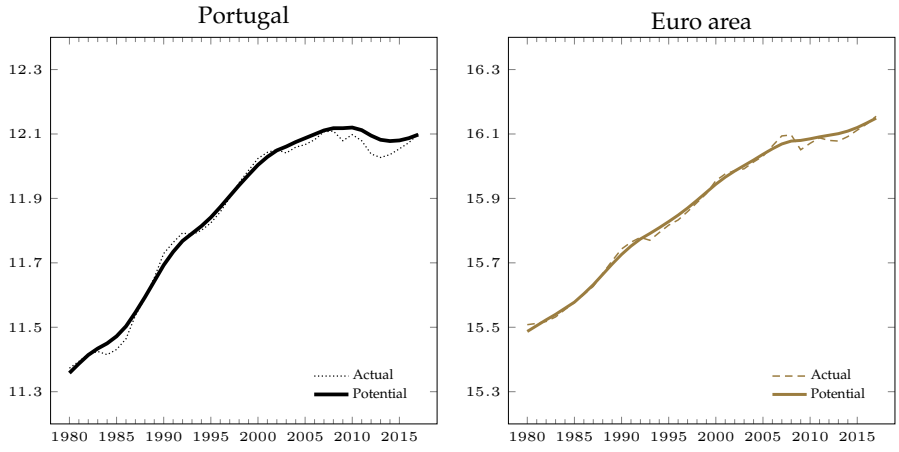


FIGURE 1: Actual GDP and potential output | In logarithm

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

[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).

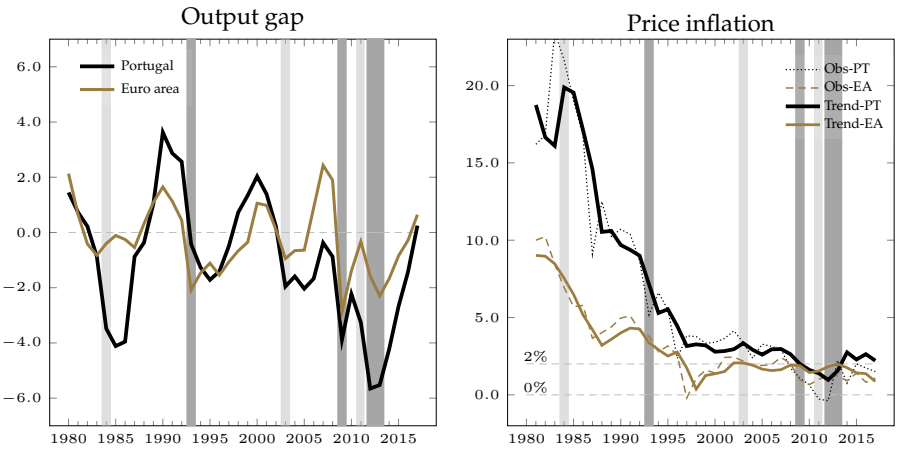


FIGURE 2: Output gap and price inflation

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

[7] A brief comparison of the Portuguese recessions of 1984, 1993 and 2003 can be found in Banco de Portugal (2004).

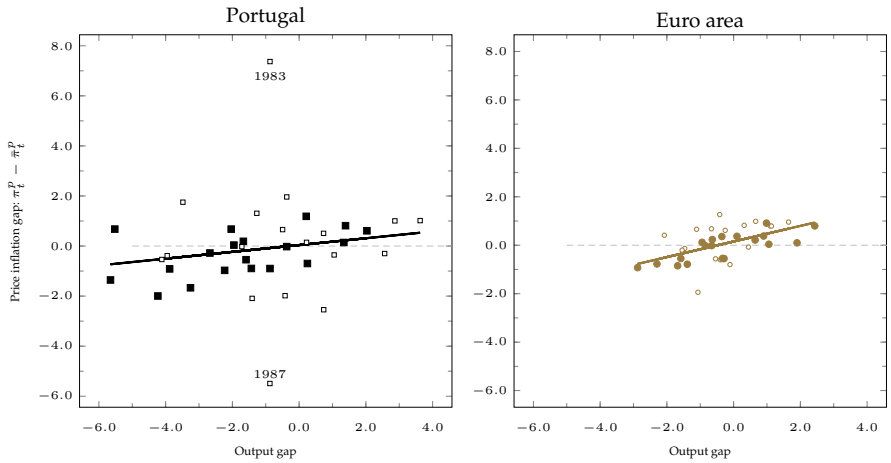


FIGURE 3: Output gap and price inflation gaps

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

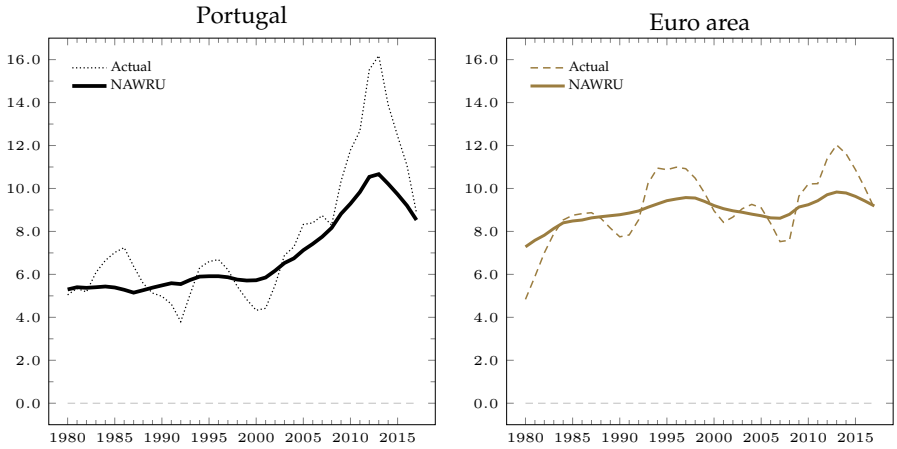


FIGURE 4: Unemployment and the NAWRU | In percent of the labour force

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

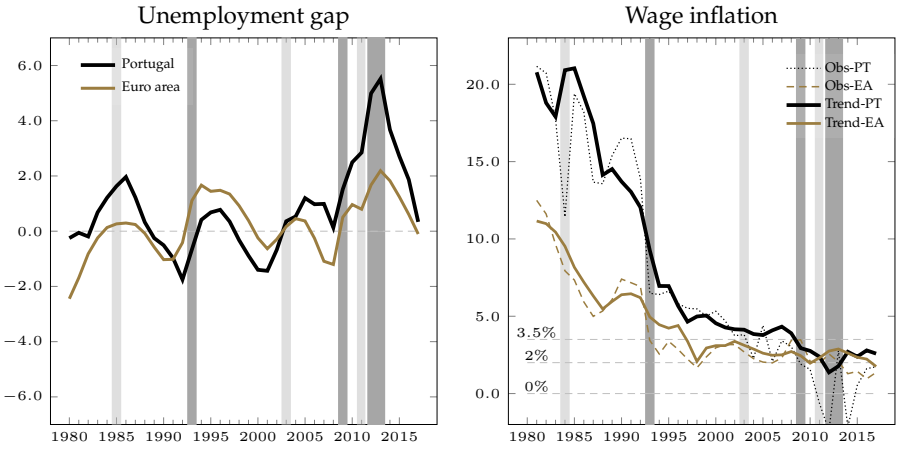


FIGURE 5: Unemployment gap and wage inflation

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

[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%).

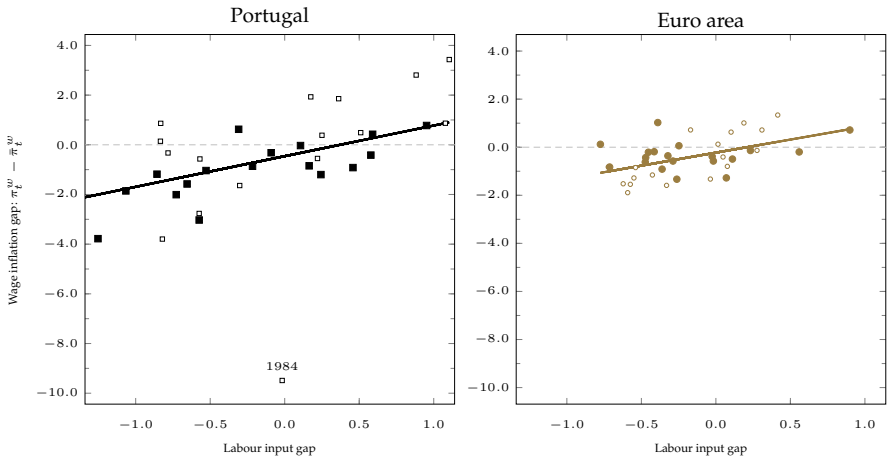


FIGURE 6: Labour market tightness and wage inflation gaps

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, namelly $(l_t - \bar{l}_t) = (h_t - \bar{h}_t) - (U_t - \bar{U}_t)$. 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,

[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.

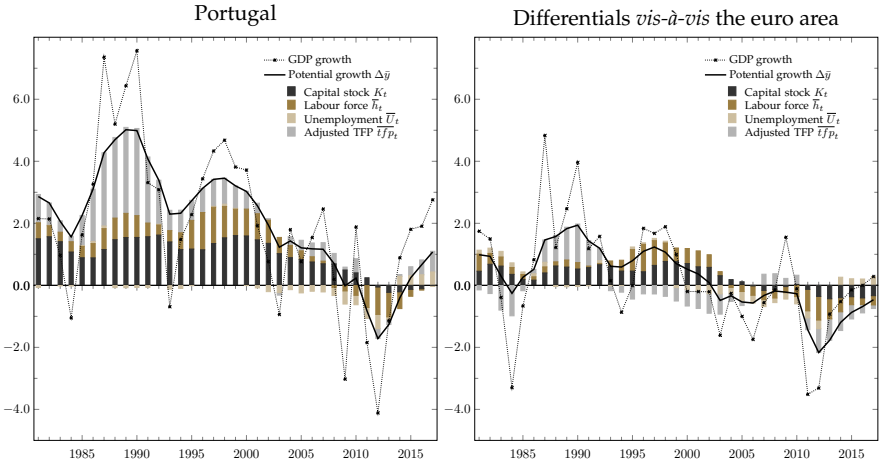


FIGURE 7: Breakdown of potential output growth

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),

[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.

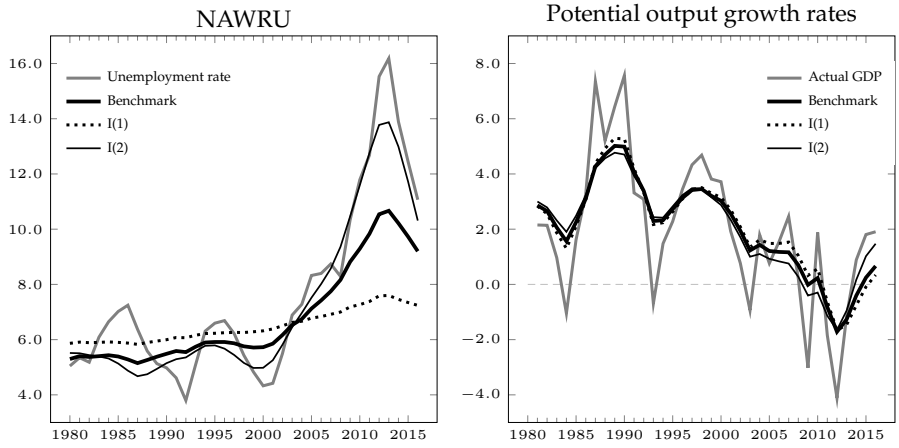


FIGURE 8: Model uncertainty

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.

References

Amador, João (2003). "The path towards economic and monetary Integration: the Portuguese experience." *Czech Journal of Economics and Finance*, 53(9-10), 413–429.

Andrle, Michal, Patrick Blagrav, Pedro Espaillat, Keiko Honjo, Benjamin Hunt, Mika Kortelainen, René Lalonde, Douglas Laxton, Eleonara Mavroeidi, Dirk Muir, Susanna Mursula, and Stephen Snu (2015). "The flexible system of global models – FSGM." IMF Working Papers 15/64, International Monetary Fund.

Ball, Laurence M., Daniel Leigh, and Prakash Loungani (2013). "Okun's law: Fit at fifty?" NBER Working Papers 18668, National Bureau of Economic Research, Inc.

Banco de Portugal (2004). "Box: Some factors underlying the 1984, 1993 and 2003 recessions." *Annual Report 2003*, (December), 14–18.

Blanchard, Olivier and Pedro Portugal (2017). "Boom, slump, sudden stops, recovery, and policy options. Portugal and the Euro." *Portuguese Economic Journal*, 16(3), 149–168.

Centeno, Mário, José R. Maria, and Álvaro Novo (2009). "Unemployment: Supply, demand, and institutions." In *The Portuguese economy in the context of economic, financial and monetary integration*, pp. 215–258. Banco de Portugal.

Coimbra, Carlos and João Amador (2007). "Characteristics of the portuguese economic growth: What has been missing?" Working Papers 8, Banco de Portugal.

D'Auria, Francesca, Cécile Denis, Karel Havik, Kieran Mc Morrow, Christophe Planas, Rafal Raciborski, Werner Roger, and Alessandro Rossi (2010). "The production function methodology for calculating potential growth rates and output gaps." European Economy - Economic Papers 2008 - 2015 420, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Duarte, Cláudia, Sharmin Sazedj, and José R. Maria (2019). "Comparing trends and cycles in Portugal and the euro area: the *U* model." Working Paper forthcoming, Banco de Portugal.

Esteves, Paulo, Ricardo Mourinho Félix, and Francisco Craveiro Dias (2004). "Revisiting the NAIRU estimates for the Portuguese economy." *Economic Bulletin and Financial Stability Report Articles and Banco de Portugal Economic Studies*.

Fagan, Gabriel, Jerome Henry, and Ricardo Mestre (2001). "An area-wide model (AWM) for the euro area." *European Central Bank, Working Paper no.42*.

Jarociński, Marek and Michele Lenza (2018). "An inflation-predicting measure of the output gap in the euro area." *Journal of Money, Credit and Banking*, 50(6), 1189–1224.

Lafourcade, Pierre, Andrea Gerali, Jan Brůha, Dirk Bursian, Ginters Buss, Vesna Corbo, Markus Haavio, Christina Håkanson, Tibor Hlédik, Gábor

Kátay, Dmitry Kulikov, Matija Lozej, and José R. Maria (2016). "Labour market modelling in the light of the financial crisis." Occasional Paper Series 175, European Central Bank.

Maria, J. R. (2016). "Output and unemployment, Portugal 2008–2012." Working Paper 3, Banco de Portugal.

Okun, Arthur M. (1962). "Potential GNP: Its Measurement and Significance." Cowles Foundation Paper 190, Cowles Foundation. Reprinted from the 1962 Proceedings of the Business and Economic Statistics Section of the American Statistical Association.

Tóth, Máté (2019). "An unobserved components model for estimating potential output in the Euro Area." *forthcoming*.

The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case

Cláudia Braz
Banco de Portugal

Maria Manuel Campos
Banco de Portugal

Sharmin Sazedj
Banco de Portugal
Nova SBE

April 2019

Abstract
The analysis of public finance developments relies, amongst other indicators, on estimates of cyclically adjusted budget balances (CABs), which correct headline government balances for business cycle fluctuations. The European System of Central Banks (ESCB) endorsed in late 2018 a new aggregate methodology for the calculation of CABs, developed by Bouabdallah *et al.*, 2019. This article presents the application of this new methodology to the Portuguese case, providing details on the calculation of the underlying fiscal-to-base and base-to-output elasticities. Additionally, it describes the output gap estimations used to assess the cyclical position of the economy. The article also presents the analytical tool developed by Bouabdallah *et al.*, 2019 to disentangle the drivers of structural fiscal developments, providing details on its application to Portugal. (JEL: E62, H20, H60)

Introduction

In the last decades, the analysis of public finance developments has been relying, amongst other indicators, on estimates of cyclically adjusted budget balances (CABs), which correct headline government balances for business cycle fluctuations. When measured in levels, CABs are a good indicator of the underlying fiscal position of a country. Its changes represent a rough proxy for the discretionary action by governments and, as such,

Acknowledgements: This article draws extensively on the work developed by a working team composed of fiscal experts of National Central Banks and the European Central Bank (ECB) - coordinated by Othman Bouabdallah (ECB), Richard Morris (ECB) and Lukas Reiss (Central Bank of Austria) - in the context of the Working Group on Public Finance, a sub-committee of the Monetary Policy Committee. The authors thank comments and suggestions by colleagues of Banco de Portugal Economics and Research Department. The opinions expressed in this article are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

E-mail: crbraz@bportugal.pt; mmcampos@bportugal.pt; ssazedj@bportugal.pt

are considered indicators of the fiscal stance. CABs are computed by many institutions, including the European Commission, the IMF and the OECD, in each case according to specific methodologies and respective parameters. The Commission estimates are used in the context of the European fiscal surveillance framework since the 2005 reform of the Stability and Growth Pact.

The European System of Central Banks (ESCB) adopted a methodology for the calculation of CABs in 2001 (Bouthevillain *et al.*, 2001). The measurement of the cyclical component relied on a trend/cycle decomposition of different macroeconomic variables, with the aim of better approximating the main bases of selected fiscal items. As such, it differed from the methodologies followed by other institutions, which gauge the cyclical component by applying a budgetary semi-elasticity to an aggregate output gap. Since then, Banco de Portugal has been following Bouthevillain *et al.*, 2001, presenting estimates of CABs for Portugal in its regular publications and other ad-hoc analysis (Neves and Sarmento, 2001, and Braz, 2006, provide further details on the application to the Portuguese case). Subsequently, in 2006, a disaggregated framework for assessing public finances was introduced, anchored in the ESCB CAB methodology (Kremer *et al.*, 2006). This framework proved to be a valuable tool in fiscal analyses, both in terms of past developments and projections, as it allowed for a detailed breakdown of the drivers of the structural change of revenue and expenditure items.

Over the course of time, several issues have emerged when using the ESCB methodology adopted in 2001, justifying its review. This review culminated in the adoption of a new aggregated method to compute CABs, similar to those used by other institutions, at the end of 2018. Bouabdallah *et al.*, 2019, present the developed methodology. It should be noted that the authors preserve the detailed analysis of structural developments through an adaptation of the previous disaggregated framework (see also Morris and Reiss, 2019). Technical details on the application to the Portuguese case of the new CAB and disentanglement frameworks may be found in Braz *et al.*, 2019.

The present article provides a brief overview of the new ESCB methodologies and illustrates its use to analyse the Portuguese public finances. It is structured in two main sections. The first one briefly describes the previous methodology and presents the new CAB method, including details on the estimation of both fiscal-to-base and base-to-output elasticities and the calculation of potential GDP underlying the output gap. A second section elaborates on the revised disaggregated framework, illustrating its application with the 2015-17 fiscal developments in Portugal.

The new ESCB cyclical adjustment method

Overview

Since 2001, the analysis of fiscal developments undertaken by Banco de Portugal has relied on a commonly agreed methodology for the estimation of CABs developed by the ESCB Working Group on Public Finance (WGPF)[1] and presented in Bouthevillain *et al.* (2001). Its application to the Portuguese case is summarized in Braz (2006).

Differently from most alternative methods, the ESCB methodology was disaggregated in the sense that, rather than focusing solely on GDP, it assumed that there is a set of other variables that provide better proxies for the macroeconomic bases driving fiscal developments. These macroeconomic variables were defined in real terms and, for each of them, the trend path was obtained using a Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997) with a smoothing parameter λ equal to 30.[2] As typically assumed in cyclical adjustment methods, the former ESCB framework also considered that revenue from taxes and social contributions and expenditure on unemployment benefits are the only fiscal items affected by macroeconomic developments.

The possibility to account for composition effects was one of the key advantages of the former ESCB method. These were assessed as the difference between the cyclical component computed with the ESCB methodology and that based on an aggregate semi-elasticity. Indeed, the former ESCB methodology still allowed the derivation of the semi-elasticity of the budget balance, calculated as described in Bouthevillain *et al.* (2001). At that time, the resulting figure for Portugal stood at 0.5, which was very close to the semi-elasticities used by the European Commission and the OECD (respectively 0.51 and 0.54).[3]

In addition, the former ESCB methodology presented a number of other merits. The fact that it was based on relationships between cyclical budgetary items and specific macroeconomic variables allowed for a detailed structural analysis of both past and projected fiscal developments, as described in Kremer *et al.* (2006). Moreover, reliance on the statistical HP-filter ensured that the breakdown of the series into trend and cyclical

1. The Working Group on Public Finance is a sub-committee of the Monetary Policy Committee composed by representatives of the National Central Banks of the European Union and the European Central Bank.

2. A value of 30 for the λ parameter is consistent with the assumption of 8 years for the average duration of business cycles.

3. However, it should be noted that using a derivation formula consistent with that underlying the new methodology, but with data, elasticities and weights used at that time, the semi-elasticity would be slightly revised upwards from 0.5 to 0.53.

components was transparent, easy to replicate and not subject to changes in technical assumptions. Finally, the HP-filter yields trend deviations that are symmetric by construction, minimizing risks of optimistic biases towards the underestimation of structural deficits.

In practice, however, the limitations of the former cyclical adjustment methodology were also manifold. First, the composition effect was found to exhibit a counter-cyclical behaviour, resulting in an underestimation of the cyclical component of budget balances. This effect might have been reinforced in the recent period by the inability of the HP-filter to adequately break down between trend and cycle the severe recessions experienced in many member states. Moreover, the measurement of the composition effect in the former ESCB methodology was sensitive to the choice of deflators. Finally, a more fundamental limitation of the former ESCB method is that it relied on an assessment of the cyclical position of the economy that was based on a statistical filter.

In light of the aforementioned limitations, the WGPF conducted a review and adopted a new methodology to be implemented as of 2019 (Bouabdallah *et al.*, 2019). In the new ESCB methodology the CAB (*i.e.*, the budget balance that would prevail if the economy was at its potential level) is determined by an aggregate procedure. Indeed, it is obtained by subtracting the cyclical component of the budget balance – computed as the product of the semi-elasticity and the output gap – from the headline budget balance in percentage of GDP. Formally:

$$cab_t = \frac{BB_t}{Y_t} - \varepsilon^{BB} \times og_t, \tag{1}$$

where $\frac{BB_t}{Y_t}$ stands for the headline balance in percentage of GDP, ε^{BB} is the budgetary semi-elasticity and og_t is the output gap obtained on the basis of a production function approach for calculating potential output. Variable cab_t should be interpreted as the ratio of the cyclically adjusted balance to nominal potential GDP, given that the semi-elasticity captures the impact of the business cycle both on the numerator and the denominator[4]. This budgetary semi-elasticity is obtained as the difference between the semi-elasticity of revenue (ε^R) and the semi-elasticity of expenditure (ε^E). The elasticities of total revenue and expenditure to the output gap can be defined as a product between a fiscal-to-base elasticity (η^{RB} and η^{EB}, measuring the response of revenue and expenditure to changes in the respective macroeconomic bases) and a base-to-output elasticity (η^{BY}, measuring the response of

4. Nominal potential GDP is obtained using real potential GDP estimates and the actual GDP deflator. Throughout this article *ratios to potential GDP* should be interpreted as *ratios to nominal potential GDP*.

each macroeconomic base to changes in the output gap). In particular, the budgetary semi-elasticity can be expressed as

$$\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} = \left(\eta^{RB}\eta^{BY} - 1\right) \cdot \bar{r} - \left(\eta^{EB}\eta^{BY} - 1\right) \cdot \bar{e}, \tag{2}$$

where $\bar{r}$ and $\bar{e}$ stand for the 10 year average share of total revenue and expenditure in GDP.

Furthermore,

$$\varepsilon^{BB} = \varepsilon^{R} - \varepsilon^{E} = \sum_{i} \varepsilon_{i}^{R} - \sum_{j} \varepsilon_{j}^{E}, \tag{3}$$

where ε_{i}^{R} and ε_{j}^{E} represent each revenue and expenditure item contribution to the overall semi-elasticity (respectively i and j), whether assumed to be cyclical or non-cyclical. Four revenue categories and one expenditure item are considered to be sensitive to the business cycle: i) direct taxes paid by households (split into personal income tax and other current taxes); ii) direct taxes paid by corporations; iii) taxes on production and imports (split into VAT and other indirect taxes); iv) net social contributions (split into paid by employers and employees and by self- and non-employed); and v) unemployment benefits. For the remaining non-cyclical revenue and expenditure items, the contribution to the aggregate semi-elasticity stems only from a denominator effect, as the base-to-output elasticities are nil.

It should be noted that in the new ESCB cyclical adjustment method the calculation of the semi-elasticity takes into account two sorts of time lags: those related to the tax code and the way it defines tax collection (relevant when taxes are levied on aggregates referring to the previous year – referred to as the collection lag)[5]; and those stemming from a lagged response of the macroeconomic bases to cyclical fluctuations (referred to as the cyclical lag). As explained below, in the case of Portugal, only the cyclical lag is considered.

Data

The estimation of base-to-output elasticities for the calculation of the budgetary semi-elasticity draws on various sources of information. Most data concerning the macro bases are collected from the main annual national accounts aggregates, which are then complemented with annual sector accounts. All variables are expressed in nominal terms. On the income approach to GDP, gross operating surplus and mixed income is split by the main sectors (households and NPISH, general government and corporations)

5. For each revenue item, the methodology allows the definition of the share of the tax which is levied with a collection lag, constant over time or time-varying.

and other aggregates, like net entrepreneurial income of corporations and property income received by households, are used. On the expenditure approach to GDP, imputed rents are excluded from households' private consumption[6] and gross fixed capital formation on dwellings is identified.

The fiscal database is also mostly drawn from official national accounts, national tax lists[7] and government expenditure by function data (COFOG), the latter regarding old age and survivors' pensions and unemployment benefits. Information concerning the impact of discretionary measures largely corresponds to official estimates made public in government documents, although they are in some instances adjusted by expert judgement. Additionally, data of *Taxation Trends* and the VAT gap published by the European Commission (DG-TAXUD) are used for the weighting of the fiscal items (European Commission, 2017; Poniatowski *et al.*, 2017).

Base-to-output elasticities

For each relevant macroeconomic base, the base-to-output elasticities η_i^{BY} have been estimated using a standard regression specified in log-differences to account for non-stationarity. The regressions include one lag in order to capture the possibility that some macroeconomic bases respond to business cycle fluctuations with a delay (the cyclical lag). Similar regressions have been run for three blocks: i) GDP – income approach; ii) GDP – expenditure approach; and iii) labour market. By default, all elasticities have been obtained pooling data from a panel of EU countries for the period from 1995 to 2017. The panel regressions have been conducted with country fixed effects (and cross-sectional weights) but, because they may still fail to capture country-specific elements, individual, country-specific estimates were also obtained. The choice between panel and country-specific as the most plausible base-to-output elasticities was ultimately made on the basis of informed judgement by country experts. In any case, the chosen set of elasticities should broadly meet aggregation constraints, which is in principle made easier by making a consistent choice within each block. In the case of Portugal, panel estimates were adopted for the GDP-income and labour market blocks, while country-specific estimates were used for the GDP-expenditure block. In the country-specific regressions, coefficients referring to the lagged response of macroeconomic variables to changes in the output gap were found to be

6. Imputed rents are transmitted by member states to Eurostat under the reporting of final consumption expenditure of households by consumption purpose. In the new CAB methodology, they are also deducted from operating surplus of households and NPISH on the income approach to GDP.

7. The questionnaire on national tax lists is sent by member states to Eurostat and contains detailed information on taxes and social contributions according to national classifications.

non-significant. As such, in the GDP-expenditure block the base-to-output elasticities do not include a lagged component.

With regard to the choice of the appropriate macro bases for each fiscal item, alternatives are suggested for some taxes. These suggestions provide an harmonized solution for possible data unavailability of the true bases or the poor fit of some less straightforward proxy bases.[8] In the case of Portugal, we opted for gross operating surplus and mixed income of the total economy as the base for direct taxes paid by corporations and personal income tax with respect to capital and business incomes, while the default option for VAT was maintained (households' consumption excluding imputed rents). There is also room for country-specific adjustments on the basis of economically-sound arguments. For instance, in the case of Portugal the suggested base for the stamp duty (investment on dwellings) is not applicable as it gives a negligible contribution to this tax's revenue which is mostly driven by financial and commercial transactions. Instead, nominal GDP is found to provide a better proxy for the macroeconomic base of the stamp duty. Finally, other current taxes paid by households and other taxes on production, together with social contributions payable by the self-employed, are considered non-cyclical.

Fiscal-to-base elasticities

Regarding the choice of fiscal-to-base elasticities, these are widely considered "structural" elasticities resulting from the tax code. In most cases, this would imply an elasticity equal to 1, with the exception of progressive taxes such as the personal income tax or, in some countries, social contributions. Usually, when tax elasticities appear to be cyclical it is due to a mis-measurement of the base. The first-best strategy followed in this methodology is to address this issue with the estimation of the base-to-output elasticities. In particular, the aim is to approximate as well as possible the base and adjust, when necessary, the corresponding elasticity. By prioritizing the estimation of the base-to-output elasticities, we avoid the problem of changes to the tax system distorting the estimation of fiscal elasticities. Notwithstanding, given that it is not always possible to approximate the tax base reasonably, direct fiscal-to-output elasticities were also estimated (correcting for the expected impact of tax changes) as additional information, in order to cross-check the plausibility of the final results.

In the case of Portugal, given that most taxes are broadly proportional, unit elasticities have been assumed in line with the suggested default option. The only exceptions refer to: i) personal income tax on earnings ($\eta^{RB} = 1.07$); ii)

8. The methodology suggests that whenever one of the alternative macro bases is chosen to replace the "true" base, the fiscal elasticity should be adjusted to avoid impacting the aggregate semi-elasticity.

direct taxes paid by corporations ($\eta^{RB} = 1.95$); iii) VAT on households final consumption ($\eta^{RB} = 1.26$) and iv) stamp duty ($\eta^{RB} = 2.27$).

For the personal income tax (on average earnings, business income, capital income and social benefits), given its progressive nature, the corresponding elasticity should be preferably derived from the tax code and income distributions. In face of data unavailability, the default elasticities are those calibrated by the OECD (Price *et al.*, 2015). The fiscal-to-base elasticity of personal income tax with respect to total earnings is calculated as a weighted average of the elasticity of personal income tax with respect to average earnings ($\eta^{RB} = 2.22$, OECD) and the unit elasticity of the number of employees. For the remaining components of this tax (on business income, capital income and social benefits) we have deviated from the default option of using the OECD elasticities due to a poor fit of the considered macro bases. To avoid additional distortions, a simplifying but reasonable assumption of unitary fiscal elasticities was adopted.

For direct taxes paid by corporations, the true base is considered to be the net entrepreneurial income and therefore a tax elasticity of 1 is the default option suggested for this base. However, given the unavailability of projections for this series, we have opted to use the suggested proxy for the base, namely gross operating surplus and mixed income of the total economy. Therefore, we have adjusted the fiscal-to-base elasticity by the ratio between the base-to-output elasticities, such that the contribution of this revenue item to the budget semi-elasticity is not affected by the choice of the proxy base.

Given that different VAT rates are applied to different types of goods and services consumption, an elasticity above unity is assumed to gauge the effect of shifts in the composition of household consumption over the economic cycle. With regard to the stamp duty, it was necessary to allow the fiscal-to-base elasticity to diverge from unity, despite being a proportional tax, because of the unavailability of data on the actual base.

Finally, as mentioned, it was decided not to include collection lags. In the Portuguese tax system the main taxes collected with some lag are the corporate and personal income taxes. In the case of the former, data regarding the most recent years confirms that the final settlement of the tax regarding the previous year's revenue, which could be considered the share of the tax which is collected with a lag, represents in net terms a minor proportion of the total yearly tax receipt. Furthermore, this share has shown a strong volatility in the last years, complicating the assessment of an "average" collection lag for the entire period. With regard to the personal income tax, despite the withholding rates, a part of the tax is settled with a lag, following the filling of the income declaration of the previous year. Due to the unavailability of data and high

volatility of these refunds net of additional payments regarding previous year income, the collection lag was assumed to be zero.[9]

Potential output

The calculation of cyclically adjusted budget balances based on an aggregate approach requires the estimation of the output gap, *i.e.* the deviation of actual output from its potential level. The latter is an indicator of the overall supply of an economy, measuring the quantity it can produce when all resources are fully employed, following a sustainable and non-inflationary path. While potential output is an important tool for analysis and informed policy advice, it is an unobservable variable that requires caution in its use, given that its estimation involves various sources of uncertainty.[10]

In the methodology presented in this article, the computation of potential output follows a production function approach. Rather than focusing on simple statistical trends, this methodology gives some economic structure to the analysis, allowing to relate the quantity produced by an economy to the quantity of production factors and their productivity. Potential output is obtained as the outcome of the production function, when the quantity and productivity of the factors of production are at their reference value – or at their sustainable maximum levels. A Cobb-Douglas production function is used, where real GDP (Y_t) is determined by the contributions of labour (L_t), capital (K_t), as well as their productivity (A_t). The production function takes the form:

$$Y_t = A_t L_t^{\alpha} K_t^{(1-\alpha)} \tag{4}$$

The constants α and $(1-\alpha)$ correspond to the elasticity of output with respect to labour and capital, respectively. Under the assumption of perfect competition, α can be calibrated to match the empirical average labour income share. We use a share of 64% as estimated and described in Félix and Almeida (2006).

Total factor productivity is an unobserved variable with an encompassing nature, including factors such as the level of technology, human capital or the institutional framework. Indeed, A_t captures the share of production which is associated to any factor other than the quantities of the employed inputs. The actual value of this variable is usually computed as a residual, known as the *Solow residual*. The labour input is measured by the total number of hours

9. These simplifying assumptions imply that any extraordinary developments in these lagged components will be reflected in the residual of the disaggregated analysis described in Section 3.

10. For a thorough discussion of uncertainty surrounding potential output estimates see Banco de Portugal (2017).

actually worked in the economy and is further decomposed into: working age population (between 15 and 64 years); participation rate, defined as the ratio of the labour force over the working age population; total hours worked per worker; employment rate, defined as function of the unemployment rate; and an adjustment term that considers the gap between national accounts employment and the implied level of employment of the Labour Force Survey.

Regarding the benchmark values for the estimation of potential output, in the case of the capital stock the standard assumption of a nil contribution to the output gap is considered, *i.e.* that actual values coincide with the potential capital stock. The benchmark level of the labour supply is computed on the basis of the reference value of its various components. More specifically, the actual value of working age population is taken on board – as the population level is not deemed a cyclical variable – and HP-filters are applied to the series of the participation rate, average hours per worker and the adjustment term. Finally, the benchmark unemployment rate, commonly referred to as NAWRU (non-accelerating wage rate of unemployment) – when estimated in a context of stable wage growth rates – corresponds to model-based estimates computed as described in Duarte *et al.* (2019).

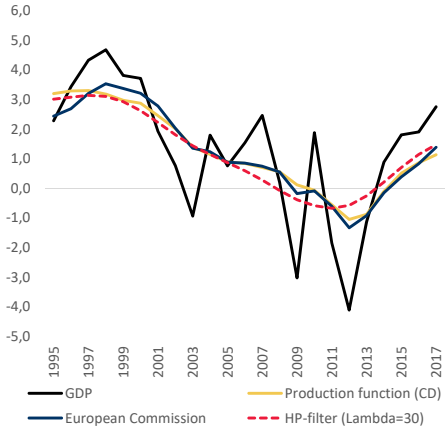
Lastly, the calculation of potential output also requires an estimate for trend total factor productivity, which is computed as the HP-filtered *Solow residual*, following Félix and Almeida (2006). As for the smoothing parameter of the HP-filter, it was set to $\lambda = 7680$, also according to Félix and Almeida (2006), and in line with a $\lambda = 30$ for annual data.[11]

The estimates presented in this article were obtained using a quarterly dataset, which relies on Statistics Portugal and Banco de Portugal databases. It includes official national accounts data regarding real GDP, employment and hours worked; and Labour Force Survey data about working age population and the labour force. The capital stock series is from the Banco de Portugal database and was built using the perpetual inventory method. Whenever the HP-filter is applied to a series, historical data (prior to 1995) and projections from Banco de Portugal are considered.

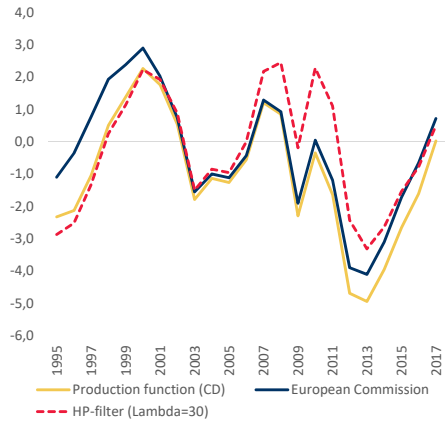
Figure 1A illustrates actual GDP and potential output growth rates for the Portuguese economy. This figure depicts potential output estimates for the period 1995-17 obtained as described above, an HP-filtered GDP series (with a smoothing parameter of 30) and official European Commission estimates (Autumn 2018 forecast).

All methods point towards similar developments, in particular as regards the Banco de Portugal production function approach and the European Commission method. Broadly, all approaches suggest that potential output was decelerating since the beginning of the sample, reaching negative growth

11. Notice that the HP-filter is applied to the logarithm of each of the variables and that the exponentiated trend is then plugged into the production function.



(A) GDP and potential output growth rates in Portugal | In percentage



(B) Output gaps in Portugal | In percentage

FIGURE 1: Potential output and the output gap

Sources: Statistics Portugal, AMECO and authors' calculations.

rates during the last recession. In the most recent period, however, potential growth rates have been recovering. For 2017, the estimates lie between 1 and 1.5%, clearly below the figures estimated for the mid-nineties.

Figure 1B presents the output gap estimates implicit in the same three methods. Despite the small differences in growth rates, as these accumulate, they translate into more considerable differences in terms of output gap estimates. While there is a notable gap between estimates based on our production function and the Commission's in the beginning of the sample, this gap narrows significantly since the early 2000s until the trough of the crisis, when differences become again relevant. In particular, the European Commission approach points towards more negative potential growth rates during the crisis (see Figure 1A), resulting in lower potential output estimates and therefore smaller output gaps.[12]

Close to the end of the decade starting in 2000, the HP-filtered output gap has been diverging from the production function-based estimates, culminating in much smaller output gaps during the recent crisis, similarly to other statistical filters with no economic structure (see Banco de Portugal, 2017). In particular, around 2009, the HP-filter points towards a closed output gap, while the production function-based estimates point towards a negative gap of around 2%. The zero output gap is not a credible estimate during

12. The European Commission estimates a much higher trend impact of the crisis on unemployment, translating into higher NAWRU levels and therefore lower potential output estimates.

the economic and financial crisis, suggesting a better performance of the production function approach in cyclical turning points.

In the recent past, all methods suggest that GDP levels approached potential output levels, such that the negative output gap vanished by 2017.

Results

The semi-elasticities of revenue, expenditure and the balance with respect to the output gap are obtained by plugging-in the weight of each fiscal item in GDP, the base-to-output and fiscal-to-base elasticities into equations (2) and (3). The results are presented in Table 1.

As expected, the semi-elasticity of revenue is close to zero (standing at -0.01). This reflects the fact that most tax revenues are highly cyclical (as shown by their fiscal-to-base elasticities equal or above unity). Thus, revenue *as a ratio to GDP* is relatively constant across the cycle (because the numerator and denominator move closely together). The small magnitude of the semi-elasticity of revenue implies that the respective cyclical component, *i.e.* the product between the semi-elasticity and the output gap, is also small. As such, the difference between actual revenue (as a percentage of GDP) and the cyclically adjusted revenue (as a ratio to potential GDP) is very modest (Figure 2).

By contrast, on the expenditure side only unemployment benefits are assumed to respond to cyclical developments. Since they account for a minor share of overall spending (and only 1.2% of GDP), the bulk of expenditure is unresponsive to the cycle. This yields a relatively large semi-elasticity with a negative sign (-0.56), mirroring the counter-cyclical behaviour of overall expenditure *as a ratio to GDP*. Therefore, in the case of the expenditure ratio, the cyclical component assumes a larger magnitude than in the case of revenue and exhibits stronger counter-cyclical fluctuations.

The combination of the semi-elasticities of revenue and expenditure yields an aggregate semi-elasticity of the budget balance of 0.54 (bottom right corner of Table 1). This implies that a 1 pp increase (decrease) in the output gap is estimated to induce a 0.54 improvement (deterioration) in the headline balance as a ratio to GDP.

Figure 3 plots the estimates for the CAB obtained on the basis of this semi-elasticity against the actual headline balance and the output gap. It shows that the headline balance tends to improve in peaks and to deteriorate in troughs. This is essentially driven by the counter-cyclicality of the expenditure ratio which illustrates the functioning of automatic stabilizers: in "bad" times, the headline balance deteriorates because the expenditure ratio rises and stimulates domestic demand, smoothing the cyclical fluctuations. In turn, the CAB exhibits both smaller fluctuations and a weaker, and negative, correlation with the output gap, implying an average counter-cyclicality. These features

Fiscal Item	Weight in GDP	Base	Base to output		Fiscal to base	Semi-elasticity		
			T	(T-1)		T	(T-1)	Total
i, j	$\bar{r}_i, \bar{e}_j$	B	η_0^{BY}	η_1^{BY}	η^{RB}, η^{EB}	ε_0	ε_1	ε
Current taxes on income and wealth	**9.8%**					**0.02**	**-0.01**	**0.01**
Direct taxes paid by corporations	3.2%	Gross operating surplus & mixed income	1.25	-0.34	1.95	0.05	-0.02	0.02
Direct taxes paid by households								
Personal income tax	6.2%					-0.02	0.01	-0.01
on earnings	3.6%		0.59	0.31	1.07	-0.01	0.01	0.00
w.r.t. employees		Employees	0.53	0.33	1.00			0.00
w.r.t. average earnings		Compensation per employee	0.07	-0.02	2.22			0.00
on business income	0.4%	Gross operating surplus & mixed income	1.25	-0.34	1.00	0.00	0.00	0.00
on capital income	1.0%	Gross operating surplus & mixed income	1.25	-0.34	1.00	0.00	0.00	0.00
on social benefits	1.3%	Pensions	0.00	0.00	1.00	-0.01	0.00	-0.01
Other current taxes	0.4%	Not cyclical / nominal trend GDP	0.00	0.00	1.00	0.00	0.00	0.00
Taxes on production and imports	**13.9%**					**0.06**	**0.00**	**0.06**
VAT	8.1%					0.05	0.00	0.05
on HH final consumption	6.4%	HH consumption excl. imputed rent	1.35	0.00	1.26	0.05	0.00	0.05
on govern. and NPISH consumption	1.0%	Government intermediate consumption and social transfers in kind	0.00	0.00	1.00	-0.01	0.00	-0.01
on GFCF	0.7%	Gross fixed capital formation	3.32	0.00	1.00	0.02	0.00	0.02
Other indirect taxes	5.9%					0.01	0.00	0.01
Stamp duties	1.1%	Nominal GDP	1.00	0.00	2.27	0.01	0.00	0.01
Other taxes on products	3.6%	HH consumption excl. imputed rent	1.35	0.00	1.00	0.01	0.00	0.01
Other taxes on production	1.2%	Not cyclical / nominal trend GDP	0.00	0.00	1.00	-0.01		-0.01
Net social contributions	**11.8%**					**-0.05**	**0.04**	**-0.01**
Paid by employers and employees	11.5%		0.59	0.31	1.00	-0.05	0.04	-0.01
w.r.t. employees		Employees	0.53	0.33	1.00			0.00
w.r.t. average earnings		Compensation per employee	0.07	-0.02	1.00			0.00
Paid by self- and non-employed	0.3%	not cyclical / nominal trend GDP	0.00	0.00	1.00	0.00	0.00	0.00
Other (non-cyclical) revenue	**7.2%**		**0.00**	**0.00**	**0.00**	**-0.07**		**-0.07**
TOTAL REVENUE (1)	**42.7%**					**-0.04**	**0.02**	**-0.01**
Unemployment benefits	1.2%	Unemployment	-3.80	-2.24	1.00	-0.06	-0.03	-0.08
Non-cyclical expenditure	47.5%					-0.47		-0.47
TOTAL EXPENDITURE (2)	**48.6%**					**-0.53**	**-0.03**	**-0.56**
OVERALL BALANCE (3)=(1)-(2)						**0.49**	**0.05**	**0.54**

TABLE 1. Computation of the aggregate semi-elasticity of the budget balance

Source: Authors' calculations.
Notes: No collection lags are assumed in the computation of the budgetary semi-elasticity. As such, it is assumed that there is no response of fiscal items to the output gap of $t-2$.

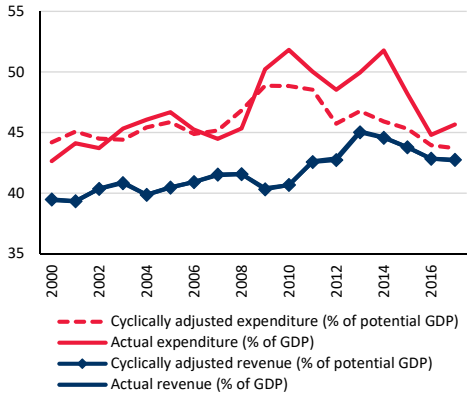


FIGURE 2: Actual and cyclically adjusted revenue and expenditure

Sources: Authors' calculations.
Note: The differences between the actual and the cyclically adjusted lines represent the cyclical components.

are reinforced when focusing on the structural balance, which is corrected also for the impact of temporary measures.

According to the new ESCB methodology, since EMU accession and up to the onset of the crisis, the Portuguese structural balance hovered around -4% of potential GDP. It rock-bottomed at -8.5% in 2009 and then sharply increased during the Economic and Financial Assistance Programme (Programme, henceforth), while the output gap was declining further into negative territory. Since 2015, the structural deficit recorded a small improvement and is estimated to have stood at 1% of potential GDP in 2017.

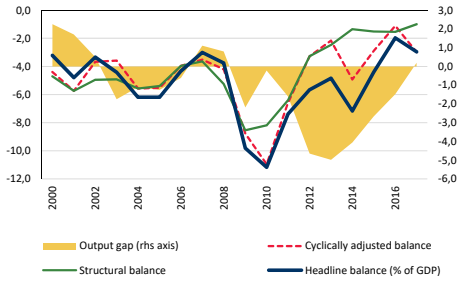


FIGURE 3: The cyclically adjusted and structural budget balances in the new ESCB methodology | In percentage of potential GDP

Sources: Authors' calculations.

The 0.54 semi-elasticity is slightly higher than the one implicit in the former ESCB cyclical adjustment method (0.50 recomputed to 0.53). Across EU

countries, the new semi-elasticities of the budget balance range from 0.32 to 0.64. Although there are some exceptions, lower semi-elasticities are typically associated with Eastern European countries, whereas higher semi-elasticities generally refer to economies with relatively large public sectors. The figure obtained for Portugal stands slightly above the EU (simple) average (0.46, see Figure 4).

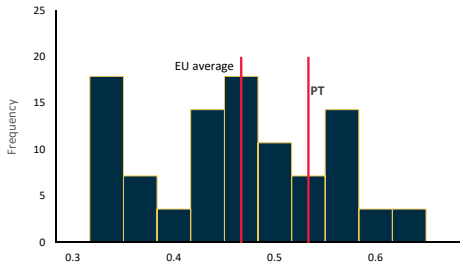


FIGURE 4: Empirical distribution of semi-elasticities across EU countries | In percentage

Sources: ESCB estimates and authors' calculations.

The new ESCB semi-elasticity for Portugal largely coincides with that recently obtained by the European Commission in the context of the regular update of the semi-elasticities used for fiscal surveillance (European Commission, 2019). Indeed, the most recent estimate by the Commission stands at 0.54, also revised up from the 0.51 figure obtained in 2014 (Mourre *et al.*, 2014). In spite of the relatively similar semi-elasticities, the fact that the ESCB and the European Commission rely on distinct assessments of the cyclical position of the economy yields differences also as regards CABs. In particular, CABs in *levels* estimated by the Commission are lower than those obtained on the basis of the new ESCB method throughout the whole 2000-17 period. Since the trough of the crisis the differential is larger, as the difference in the output gaps estimated by the two institutions is also wider (Figure 5).

In addition to the differences stemming from the assessment of the output gap, the ESCB and the European Commission also use distinct criteria to identify the temporary measures (and one-off factors) that are netted-out of the CAB to obtain the structural balance. Nonetheless, the assessments of the fiscal stance (as measured by the *change* in the structural primary balance, which further excludes the impact of interest payments) based on these two methodologies largely coincides. In particular, both assessments point to a broadly neutral stance of fiscal policy in the post-Programme years (Figure 6).

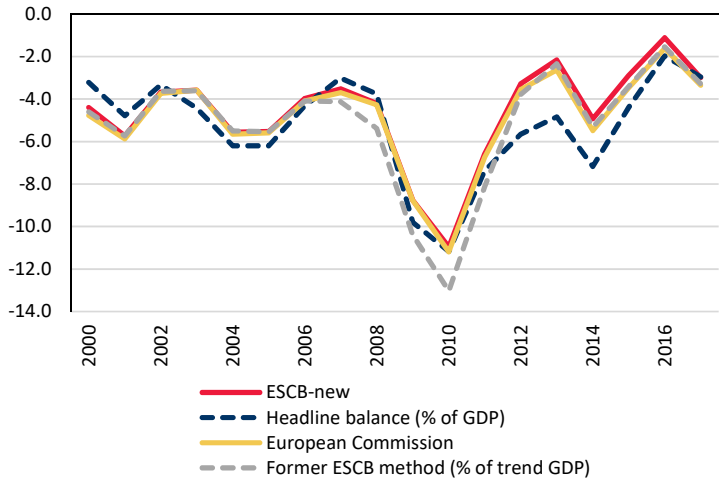
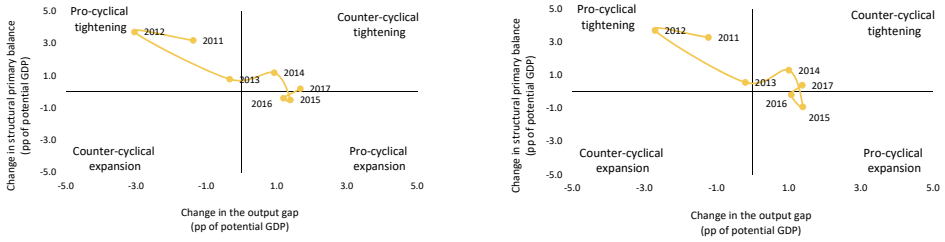


FIGURE 5: Estimates for the cyclically adjusted balance in Portugal: ESCB *vs* European Commission | In percentage of potential GDP

Sources: European Commission (AMECO data base and European Commission, 2019) and authors' calculations.
Notes: Figures referring to the European Commission were obtained using this institution's estimates for the output gap and the updated semi-elasticity published in European Commission (2019). Figures referring to the former ESCB cyclical adjustment method were obtained on the basis of (confidential) projections compatible with the December 2018 ESCB Broad Macroeconomic Projection Exercise.



(A) ESCB methodology

(B) European Commission methodology

FIGURE 6: Fiscal policy stance according to the methods adopted in the ESCB and the European Commission | In percentage points of potential GDP

Sources: European Commission (AMECO database and European Commission, 2019) and authors' calculations.
Note: This comparison can only be made as of 2011 because information on the temporary measures and one-off effects considered by the European Commission is only available as of 2010.

A revised disaggregated framework for the analysis of fiscal developments

Overview

Since 2006, the ESCB has been implementing a framework for a detailed analysis of structural public finance developments, explained in Kremer *et al.*

(2006). As a standardised method, it allowed a transparent and effective cross-country analysis of both past and projected fiscal developments. It identified the structural path of the main expenditure and revenue items, separating the effects of fiscal policy decisions from those of other factors and excluding the impacts of transitory elements beyond those of the economic cycle (such as temporary measures). The new ESCB CAB methodology allows the continuation of this analysis but it requires an adaptation of the framework. This section sheds light on the new adapted framework, developed in Bouabdallah *et al.*, 2019, and Morris and Reiss, 2019. An illustration for Portuguese public finances is also provided, with a particular emphasis on the 2015-17 period.

On the revenue side, the overall structural change as a ratio to potential GDP encompasses changes in revenue referring to taxes (and social contributions) assumed to be cyclical, as well as in items that are unresponsive to the cycle.

For each tax revenue item deemed to be sensitive to cyclical fluctuations, the change in structural revenue as a ratio to potential GDP can be decomposed into four components:

- The impact of **permanent discretionary measures** as a ratio to GDP. As aforementioned, this impact is largely based on official quantifications for the yield of measures presented in government documents. Nonetheless, in some cases, it is adjusted on the basis of expert judgement.

- A (expected) **fiscal drag**, usually associated with tax progressivity, which emerges in the context of the personal income tax reflecting the non-indexation of tax brackets of the withholding tables. It is computed on the basis of potential GDP growth, which corresponds to the macro base's potential growth in the new methodology. It should, however, be noted that the growth of average income induces fiscal drag but growth in employment does not. As such, for calculating the fiscal drag it is assumed that the potential growth rate of average wages is identical to the potential growth rate of GDP per person employed. In some cases, the fiscal-to-base elasticity is higher than one due to the use of a proxy for the macro base (as with using gross operating surplus and mixed income instead of net entrepreneurial income for corporate income tax), or as a result of structure effects in the relation of a fiscal item and its macro base (like in VAT, for which the average rate stemming from consumption of durables is higher than that associated with consumption of non-durables). In these cases, the fiscal drag is assumed to be inexistent.

- Residuals from (unexpected) **composition effects**. These correspond to the impact on tax revenue of macro bases not behaving according to the naive prediction yielded by the base-to-output elasticities, reflecting

different types of shocks to the economy.

- Other (unexpected) **residuals**, which capture the remaining developments of structural revenue. It is clearly more difficult to interpret and it may show deviations between the evolution of tax revenue and the naive estimate based on the tax to base elasticities and/or reflect mismeasurement errors in the other components.

Regarding other (non-cyclical) revenue, the structural ratio to potential GDP can be subsequently broken down into somewhat narrower sub-items on the basis of the observed share of each item in overall other revenue, excluding temporary measures. The difference in each of these ratios vis-à-vis the previous year corresponds approximately to the simple annual change in ratios to potential GDP. As such, values differing from zero in the disaggregated analysis will show up, whenever, after excluding the impact of temporary measures, the growth of the non-tax item is not aligned with that of potential GDP.

On the expenditure side, unemployment benefits have a similar treatment to cyclical tax revenue. However, in this case there is no fiscal drag and the composition effect is computed on the basis of the difference between the growth rate of the respective macro base (number of unemployed) and what would be naively expected given the estimated elasticity, as described above. Moreover, as the macro base is defined in volume, the composition effect is computed on the basis of the potential growth rate of employment, instead of the growth rate of potential GDP.

For the other items of expenditure, which are considered non-cyclical, a similar treatment to non-tax revenue is applied. After computing the structural ratio to potential GDP of non-cyclical expenditure, the result is split according to the weight of the non-cyclical expenditure item in overall non-cyclical expenditure observed in each year, with both the numerator and denominator adjusted for the impact of temporary measures.

Results

The objective of this subsection is to apply the revised disaggregated methodology to past Portuguese public finance developments as a way of illustration. Although some charts present the data for the 2000-17 period, for the sake of conciseness, the descriptive analysis will focus on the three years after the end of the Programme for which outturn data is currently available, *i.e.* 2015 to 2017.

As shown in Figure 3, the structural balance in Portugal, computed in accordance with the new ESCB methodology, improved slightly from -1.4% of potential GDP in 2014 to -0.9 in 2017. However, as the ratio of interest payments to potential GDP declined by 0.9 pp in the same period due to the significant reduction in the implicit interest rate on public debt, the structural

primary balance deteriorated by 0.3 pp. This evolution is explained by a strong reduction in the structural revenue ratio (by 1.9 pp) that more than offset the decline in structural primary expenditure, which reached 1.5 pp (Figure 7).

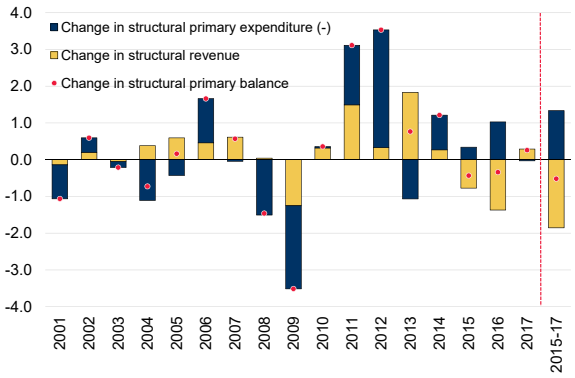
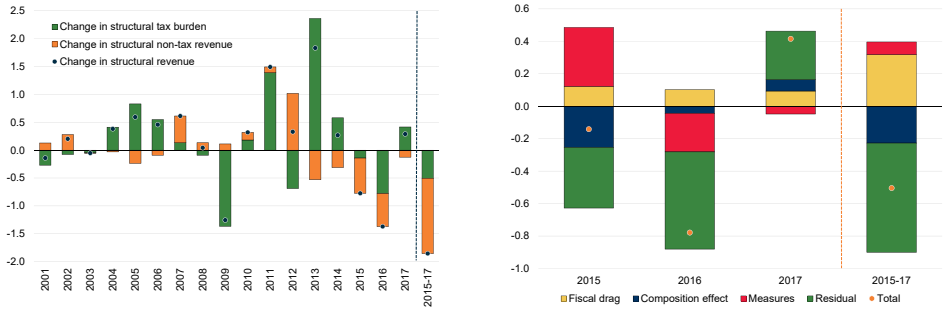


FIGURE 7: Change in the structural primary balance: revenue and expenditure contributions | In percentage points of potential GDP

Sources: Authors' calculations.
Note: An increase (reduction) in structural primary expenditure should be read as negative (positive) in the figure.

Figure 8A shows that the bulk of the reduction in the structural revenue ratio in 2015-17 stems from the behaviour of non-tax revenue. Indeed, interest received by general government declined in this period, in a context of decreasing market interest rates, and so did receipts from EU funds recorded as government revenue (an expected development in the first years of an EU support framework). Regarding the structural tax burden, the cumulative drop in the ratio to potential GDP is mostly explained by a negative residual and, to a smaller extent, a negative composition effect. By contrast, discretionary measures and the (personal income tax) fiscal drag contributed positively to the evolution of structural tax burden but these effects were not enough to offset the drop in the other two aforementioned components (Figure 8B).

The revised disaggregated methodology allows even a finer breakdown of the change in the structural tax burden by category (see Figure 9). Regarding the impact of (permanent) discretionary measures, the positive effect stems almost entirely from rises in indirect taxation. This especially refers to the tax on oil products but also to several other smaller taxes/fees. By contrast, there was in this period a decline in the VAT rate applicable to some restaurant



(A) Tax and non-tax revenue contributions 2001-17

(B) Breakdown of the change of the structural tax burden 2015-17

FIGURE 8: Breakdown of the change in structural revenue | In percentage points of potential GDP

Sources: Authors' calculations.

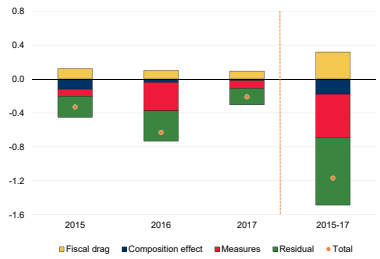
services that negatively affected this tax's collection in both 2016 and 2017. This effect was reinforced by significant permanent discretionary changes in the context of the personal income tax: the 2015 reform and the elimination of a surcharge introduced during the Programme which yielded a non-negligible drop in revenue.

In this period the cumulative impact of the fiscal drag, relevant only in the case of the personal income tax, reached 0.3 pp of potential GDP. Although small, as it should be expected, this effect may be overestimated as it is assumed in its computation that there was no regular update of the tax brackets of the withholding tables. As significant modifications were introduced in the personal income tax in 2015-17, it is difficult to disentangle the impact of the regular update from that related to the changes in the tax code, particularly in the absence of a detailed analysis based on micro data.

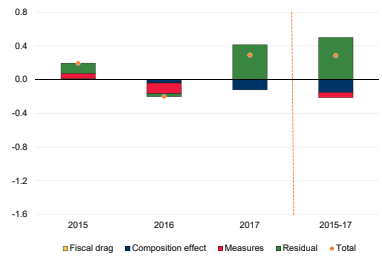
The composition effect is relatively small in each of the four main tax categories. Cumulatively over the period under analysis, it is broadly neutral regarding the taxes on production and imports. This reflects the fact that the behaviour of the main macro base for this aggregate – households' private consumption excluding imputed rents – was close to what could be expected on the basis of the naive prediction. Gross operating surplus and mixed income of the total economy exhibited, cumulatively over the three years, a slightly more mitigated evolution than the benchmark expectation. This affects taxes on income and wealth paid by corporations, but also the personal income tax levied on business and capital incomes, yielding a negative composition effect for these tax components. Finally, the composition effect associated to the compensation of employees of the economy as a whole, visible in the breakdown of social contributions and underlying the splitting

of taxes on income and wealth paid by households, is positive but small over the 2015-17 period.

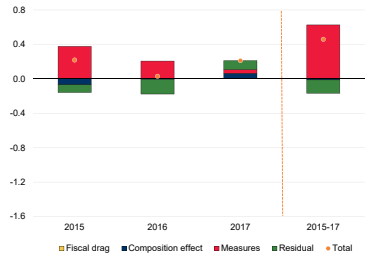
The residual component shows a significant negative magnitude over 2015-17, stemming to a large extent from direct taxes paid by households. This captures the fact that in this period there was an increase in net refunds in personal income tax, much concentrated in 2016, as well as a substantial drop in personal income tax collection on interest income, associated to the steep decline in interest rates. The positive residual in direct taxes paid by corporations reflects the difficulties in obtaining a good fit for developments in actual receipts using a constant fiscal elasticity and a macro base. Indeed, in the case of Portugal, corporate income tax revenue is much concentrated in a relatively small number of large firms which justifies its considerable volatility and disconnection from its theoretical macroeconomic base. Taxes on production and imports also show a negative cumulative residual, which is partly attributed to the performance of the tax on real estate property. Also, the possibility of an overestimation of discretionary measures' impact should not be excluded as an explanatory factor. Lastly, the negative residual of social contributions stems entirely from the evolution of imputed contributions.



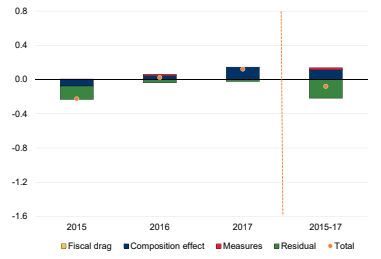
(A) Taxes on income and wealth paid by households



(B) Taxes on income and wealth paid by corporations



(C) Taxes on production and imports

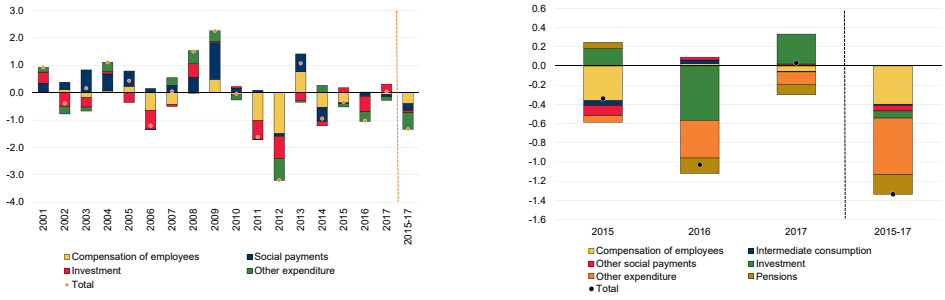


(D) Social contributions

FIGURE 9: Breakdown of the change of the structural tax burden by category | In percentage points of potential GDP

Sources: Authors' calculations.

On the expenditure side, all main items reduced their ratio to potential GDP in the 2015-17 period as a whole (Figure 10). The main contribution to the decline came from "other expenditure", which encompasses reductions in both subsidies and current transfers. Compensation of employees in the public sector also played a role, in spite of the small increase in the number of public employees and the impact of the reversal of some wage cuts introduced just before and during the Programme. Pension expenditure also grew below nominal potential GDP as the increase in the number of pensioners and the annual update of pensions were rather limited. Investment has shown in the three years under analysis a volatile profile, which translated into a small reduction as a ratio to potential GDP. The contribution of the other items (intermediate consumption and other social payments) to changes in overall structural primary expenditure was negligible.



(A) Main primary expenditure items contributions 2001-17

(B) Finer breakdown of the change of the structural primary expenditure 2015-17

FIGURE 10: Breakdown of the change in structural primary expenditure | In percentage points of potential GDP

Sources: Authors' calculations.

Concluding remarks

The new ESCB methodology is broadly similar to aggregate cyclically adjustment methods adopted by other institutions, most notably the European Commission. Nonetheless, it presents a number of advantages compared to alternative frameworks. First, it takes time lags into account. Second, it allows for the disentanglement of the various drivers of structural fiscal developments, with an emphasis on the improved estimation of composition effects. Finally, the estimation of fiscal-to-base and base-to-output elasticities introduces a number of refinements.

Additionally, the new ESCB methodology relies on more informed estimates of the output gap, departing from a purely statistical trend/cycle

decomposition. Moreover, the new potential output estimates are subject to a peer review and ensure the consistency between the views of macro and fiscal experts on the cyclical position of the economy. This integration between macroeconomic and fiscal analysis is also beneficial from the point of view of communicating policy advice.

According to the new ESCB methodology, the semi-elasticity of the budget balance with respect to the economic cycle stands at 0.54 in the case of Portugal. This result stems almost exclusively from the larger cyclical component of total expenditure as a ratio to GDP, as the semi-elasticity of the total revenue ratio is close to zero. When correcting the estimated cyclically adjusted balance for the impact of temporary measures, it is shown that since EMU accession and up to the onset of the crisis, the Portuguese structural balance hovered around -4% of potential GDP. It reached a minimum of -8.5% in 2009 and then sharply increased during the Programme. Since 2015, the structural deficit recorded a small improvement and is estimated to have stood at 1% of potential GDP in 2017.

The new ESCB semi-elasticity for Portugal largely coincides with that recently obtained by the European Commission in the context of the regular update of the semi-elasticities used for fiscal surveillance. However, the fact that the ESCB and the European Commission rely on distinct assessments of the cyclical position of the economy and temporary measures yields differences also as regards structural balances' estimates. The differences in levels can be significant in some years, particularly in the more recent period. However, the assessment of the fiscal stance (as measured by the change in the structural primary balance) is broadly similar.

Regardless of the methodology adopted, quantifying the effect of fluctuations in economic activity on public finances is inherently complex and requires several assumptions. All cyclical adjustment methodologies rely on unobservable variables. This, together with frequent *ex post* revisions, has lead to heightened criticism on the use of CABs in several *fora*. These views, however, are much centered on the fact that CABs (or more specifically, structural balances) are indicators on the basis of which fiscal targets are set and assessed in the context of the European fiscal surveillance mechanism. At the margins of this debate, CABs continue to be an useful and functional fiscal indicator, provided that the underlying methodology is well understood, allowing a proper interpretation of results.

References

Banco de Portugal (2017). "Potential output: challenges and uncertainties." *Economic Bulletin*, December, Special Issue, 39–64.

Bouabdallah, O., R. Morris, and L. Reiss (2019). "The new ESCB methodology for the calculation of cyclically adjusted budget balances." Occasional

paper, ECB. Forthcoming.

Bouthevillain, C., P. Cour-Thimann, G. Van den Dool, P. Hernández de Cos, G. Langenus, M. Mohr, S. Momigliano, and M. Tujula (2001). "Cyclically adjusted budget balances: an alternative approach." Working Paper 77, ECB.

Braz, C. (2006). "The calculation of cyclically adjusted balances at Banco de Portugal: an update." Winter issue, Economic Bulletin of Banco de Portugal.

Braz, Cláudia, Maria M. Campos, and Sharmin Sazedj (2019). "The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case." Working paper, Banco de Portugal.

Duarte, Cláudia, José R. Maria, and Sharmin Sazedj (2019). "Potential output: How does Portugal compare with the euro area over the last 40 years?" *Banco de Portugal Economic Studies*, Vol 5, N2.

European Commission (2017). "Taxation trends in the European Union: 2017 edition." Taxation trends, Directorate General Taxation and Customs Union, European Commission.

European Commission (2019). "Public Finances in EMU." Institutional Paper 095, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Félix, Ricardo Mourinho and Vanda Almeida (2006). "Computing Potential Output and the Output Gap for the Portuguese Economy." *Economic Bulletin*.

Hodrick, Robert J and Edward C Prescott (1997). "Postwar U.S. Business Cycles: An Empirical Investigation." *Journal of Money, Credit and Banking*, 29(1), 1–16.

Kremer, J., C. Braz, T. Brosens, G. Langenus, S. Momigliano, and M. Spolander (2006). "A disaggregated framework for the analysis of structural developments in public finances." Working Paper 579, ECB.

Morris, Richard and Lukas Reiss (2019). "A disaggregated analysis of structural revenue developments for euro area member states." Mimeo.

Mourre, G., C. Astarita, and S. Princen (2014). "Adjusting the budget balance for the business cycle: the EU methodology." European Economy - Economic Papers 2008 - 2015 536, Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Neves, P. and L. Sarmento (2001). "The use of cyclically adjusted balances at Banco de Portugal." September issue, Economic Bulletin of Banco de Portugal.

Poniatowski, G., M. Bonch-Osmolovskiy, and M. V. Belkindas (2017). "Study and Reports on the VAT Gap in the EU-28 Member States: 2017 Final Report." Case reports, CASE-Center for Social and Economic Research.

Price, R., T. Dang, and J. Botev (2015). "Adjusting fiscal balances for the business cycle: New tax and expenditure elasticity estimates for OECD countries." OECD Economics Department Working Papers.

Inflation expectations in the Survey of Professional Forecasters: An exploratory analysis

Joana Garcia
Banco de Portugal

Nikolay Iskrev
Banco de Portugal

April 2019

Abstract
We explore the inflation forecasts of the respondents to the Survey of Professional Forecasters, and assess the role of the conditioning variables in driving their dynamics. (JEL: E31, E52, E58)

Introduction

Expectations about future inflation play an important role in decision-making by private agents, and can have a significant impact on economic outcomes, including realised inflation. For instance, higher expected future inflation may induce households to demand higher wages for their labour, and businesses to raise the prices of their goods and services. It is therefore crucial for central banks, whose goal is maintaining price stability, to pay close attention to measures of the private sector's inflation expectations.

Measures of inflation expectations come in several forms: market-based measures, derived from the prices of financial securities, survey-based measures, obtained from forecasts or expectations by professionals or households, and model-based measures, extracted from estimated structural models of the economy. Each of these measures has advantages and disadvantages, and is used as a complementary indicator in central banks' continuous assessment of the inflation outlook and the accompanying risks.

In this article we present an overview of one of the main sources of information about inflation expectations in the euro area – the Survey of Professional Forecasters. The survey (SPF hereafter) is conducted by the European Central Bank (ECB) and, in its 20 years of existence, has become a valuable point of reference regarding the private sector's expectations to both policymakers and academic researchers.

Acknowledgements: The opinions expressed in the article are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors. The authors thank Ildeberta Abreu, João Valle e Azevedo, António Antunes and Nuno Alves for helpful comments and discussions.

E-mail: jomgarcia@bportugal.pt; niskrev@bportugal.pt

Our objective in the article is twofold. We first describe the evolution of inflation expectations over the last 20 years, and highlight some salient features that have emerged during that period. Second, we try to shed light on some of the drivers behind the observed dynamics of SPF inflation forecasts. To that end, we exploit the fact that, in addition to their inflation forecasts, the SPF participants are also asked to provide information about their underlying assumptions with respect to future values of a number of relevant variables. We examine and assess the role these variables have played in driving the survey's results.

A particular question we are interested in and explore is whether there are significant differences between the behaviour of inflation forecasts in the periods before and after 2013. As we discuss in more detail below, after 2013 inflation in the euro area has been relatively low when compared with the ECB's objective. This has raised concerns that low inflation becomes entrenched in expectations, with potentially highly disruptive effects in the effectiveness of policy. Our results suggest that, along the dimensions we explore, there has not been a fundamental change in the relative role of assumptions with respect to the formation of inflation expectations. Furthermore, the association between developments in inflation and longer-term expectations appears limited both before and after 2013.

The rest of the article is organised in four sections. The first provides some background information about the SPF and the dataset of individual responses, with a particular emphasis on features of the survey that we explore in the article. The second section describes the evolution of the SPF inflation forecasts for different horizons, and offers some historical context on developments in the euro area during the sample period. We present survey results both in terms of point forecasts, as well as density forecasts, and discuss the ways in which information obtained from these distinct sources can be helpful to gain insights about the nature of inflation expectations. In the third section we evaluate the relationship between inflation expectations and the assumptions of survey respondents about future values of conditioning variables. We also consider the extent to which movements in short-term inflation expectations influence long-term expectations. The last section offers some concluding remarks.

The ECB's Survey of Professional Forecasters

In this section we provide a brief description of the ECB's SPF and the dataset of survey responses, which will serve as a background for the analysis in the rest of the article. More detailed information about the survey can be found in Garcia (2003).

The SPF was launched in the first quarter of 1999, and since then has been conducted on a quarterly basis. The results from the surveys are publicly

available and the sample we use in this article includes all surveys up to the 2018Q4 survey.[1] While the main aim of the survey is to gather forecasts for the euro area harmonized index of consumer price inflation (HICP) – the price index over which the ECB defines its price stability objective –, each respondent is also asked to report forecasts for the euro area real GDP growth rate and for the euro area unemployment rate.

The majority of respondents to the survey are expert economists working in financial institutions, although a significant number of non-financial institutions also contribute. On average, each SPF round has about 60 respondents, which is a relatively high number compared to other surveys. Importantly, even though the respondents are anonymous, their responses can be identified by a unique number assigned to each one of them. The participation in the survey is, however, irregular, and even respondents who reply on a regular basis often fail to submit replies to some of the questions, which creates recurrent gaps in the dataset. We do not attempt to interpolate any missing observations. Working with such an unbalanced panel poses nevertheless challenges to our analysis.

In each survey round, respondents provide three types of forecasts. The first is a "calendar horizon" forecast for the current and for the following two calendar years.[2] For instance, in 2018Q1 respondents were surveyed about their forecasts for 2018, 2019 and 2020. The second type of forecasts is a "rolling horizon" forecast for two specific months (quarters for the GDP growth rate) one and two years ahead of the latest available data for the respective variables. To be specific, for example in 2018Q1 the survey was sent out after the official release of the December 2017 figure for HICP inflation, 2017Q3 figure for GDP growth and November 2017 figure for the unemployment rate. Each forecaster was thus surveyed about her inflation forecast for December 2018 and December 2019, her GDP (y-o-y) growth forecast for 2018Q3 and 2019Q3, and her unemployment rate forecast for November 2018 and November 2019. Finally, forecasters are asked to provide forecasts for a "long-term horizon" set as four calendar years ahead in the Q1 and Q2 survey rounds, and five calendar years ahead in the Q3 and Q4 rounds. The aim is to gather information about private sector expectations for long-term GDP growth and unemployment rate, as well as to get an idea of the level of longer-term inflation expectations, which provides an indication on forecasters' confidence in the ECB being able to achieve its inflation objective.

To gather information about the uncertainty surrounding point forecasts for inflation, GDP growth and the unemployment rate, forecasters are also asked to provide probability distributions around their forecasts. These

1. The data is available on the web site of the ECB – https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/index.en.html

2. Until 2012, the survey asked for the two-year ahead forecasts only twice a year (in Q3 and Q4 survey rounds).

distributions are expressed in terms of the probabilities assigned to the variable being within specific ranges in the future. For example, in the 2018Q1 survey, forecasters were asked about the probability of inflation being below -1%, between -1% and -0.6% , between -0.5% and -0.1%, and so on. This distribution reflects quantitatively how uncertain forecasters are about their point forecasts, and is helpful to assess how forecasters gauge the risk of the actual inflation outcome being above or below the most likely value.

Specifically for inflation forecasts, the SPF also requests information about the assumptions underlying the survey participants' forecasts. In particular, forecasters are asked to report their expectations about the interest rate on Eurosystem's main refinancing operations, the price in US dollars of Brent crude oil, the USD/EUR exchange rate, and the annual rate of change of compensation per employee.

How have inflation expectations evolved?

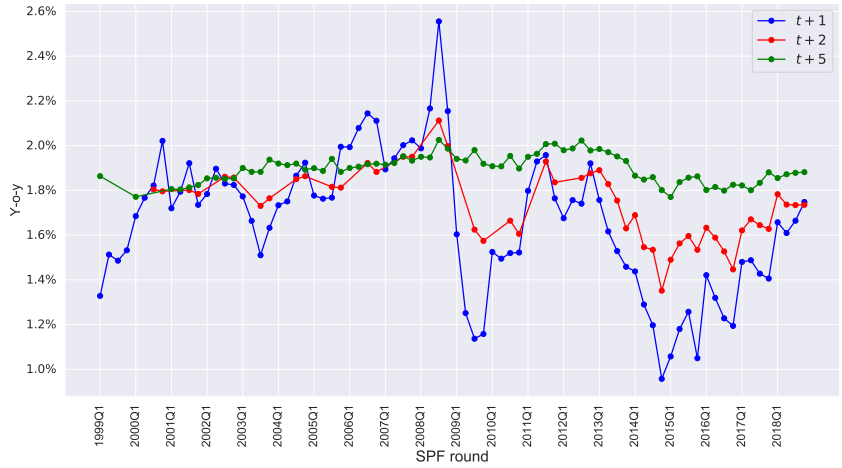
Point forecasts

Figure 1a shows the evolution over time of SPF inflation expectations for three calendar horizon targets: the next calendar year $(t+1)$, two years ahead $(t+2)$ and the long term $(t+5)$.[3] While expectations for one and two-year ahead inflation show frequent and often large movements over the entire sample period, long-term expectations have been relatively stable until the end of 2012, and have not moved closely with either shorter term expectations, or with actual inflation outcomes. This remains true even in the period 2008-2010, when realised inflation fluctuated significantly (Figure 1b). The fact that long-term expectations remained stable is in line with the notion that, if agents are confident that the ECB will achieve its price stability objective, long-term expectations should be insensitive to temporary shocks driving fluctuations in current inflation.

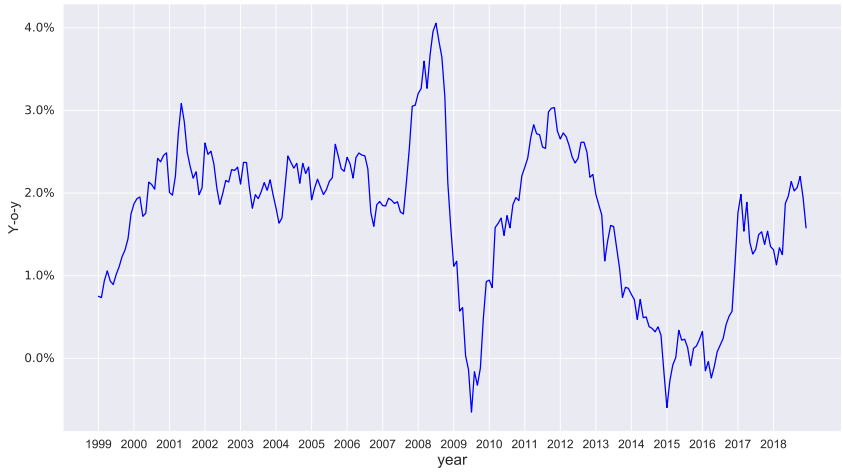
However, in the beginning of 2013, long-term expectations started to decline in tandem with those for shorter horizons and actual inflation, and reached a historical low in the beginning of 2015. These developments were followed closely by the ECB. In September 2014, faced with increased risks of persistent low inflation and inflation expectations potentially becoming de-anchored,[4] the ECB launched two asset purchase programmes of private

3. Long-term expectations refer to year $t+4$ in Q1 and Q2 survey rounds, and to $t+5$ in Q3 and Q4 rounds. For simplicity, we label them as $t+5$.

4. In September 2014, the ECB dropped the sentence "Inflation expectations for the euro area over the medium to long term continue to be firmly anchored in line with our aim of maintaining inflation rates below, but close to, 2%" from the introductory statement to the press conference that follows the Governing Council monetary policy meetings.



(A) Inflation expectations for one, two, and four/five-year ahead horizons



(B) Euro area HICP inflation

FIGURE 1: SPF inflation expectations and euro area HICP inflation

Sources: ECB and Eurostat.

sector assets: covered bonds (CBPP3) and asset-backed securities secured by claims against the euro area non-financial private sector (ABSPP). In January 2015, in a context of continued low inflation and a further fall of inflation expectations, it was considered that the degree of monetary accommodation already achieved was insufficient, and the ECB announced the Expanded Asset Purchase Programme (APP), encompassing the existing

purchase programmes for asset-backed securities and covered bonds and a new Public Sector Purchase Programme.

As can be seen in Figure 2, the APP announcement coincided with the reversal of the decline of medium and long-term inflation expectations.[5] In fact, Bulligan (2018) finds that the APP announcement led to a statistically significant upward revision of medium-term inflation expectations, as was the conviction of the president of the ECB at that time: "We believe and are convinced and have good arguments to think that the monetary policy measures that we have decided today will contribute to lift inflation expectations"(ECB (2015)). Since then, expectations, as well as realised inflation, have recovered, but stand below their pre-crisis averages. As a consequence, concerns remain regarding the convergence of inflation towards a path consistent with the ECB's objective in a sustained manner. Moreover, risks of a potential de-anchoring of long-term expectations continue to be carefully monitored.

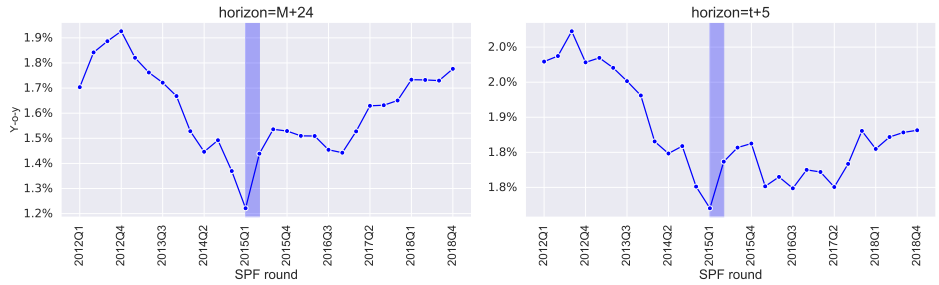


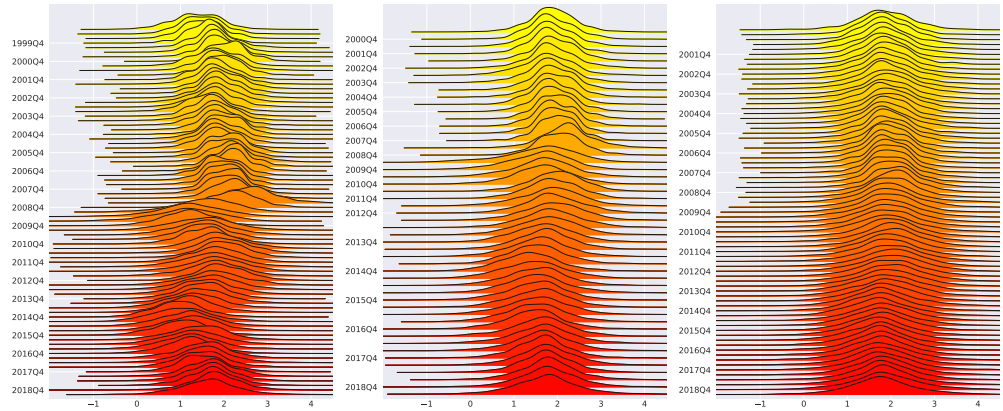
FIGURE 2: Inflation expectations for the medium and long term

Source: ECB.

Density forecasts

In addition to point forecasts, SPF respondents provide an additional valuable source of information about their views on future inflation: an inflation histogram, i.e., the probabilities that they assign to different inflation outcomes in the future. The density curves obtained from those histograms have experienced significant movements since the survey inception, especially those for shorter-term inflation, as illustrated in Figure 3.

5. Throughout the article, we consider medium and long-term horizons when we discuss the APP impact, as these two horizons are more relevant for evaluating the effectiveness of monetary policy. Medium-term expectations refer to the month two years ahead from the latest available HICP data ($M + 24$). Long-term expectations refer to four/five years ahead.



(A) $t + 1$ inf. expectations (B) $t + 2$ inf. expectations (C) $t + 5$ inf. expectations

FIGURE 3: Aggregate probability distributions
Sources: ECB and authors' calculations.

Note: Gaussian kernel densities obtained from individual inflation histograms. Colour gradient reflects evolution over time.

In particular, distributions for two and four/five-year ahead expectations have shifted to the left after 2013. As a consequence, the probability of inflation outcomes in the medium and long term below those consistent with the ECB's objective has increased significantly until the beginning of 2015, as seen in Figure 4.[6] From 2015Q2 onwards this probability stopped increasing and even declined sharply in the case of medium-term expectations. A plausible explanation for this reversal in the trend is the APP announcement, indicated in the figure. This is corroborated by Bulligan (2018), which finds that the APP announcement shifted the individual probability distributions to the right.

Individual distributions can be used to make a quantitative assessment of uncertainty and risks surrounding inflation forecasts. In particular, in this section we look carefully at two moments of those distributions, the variance and the asymmetry, to investigate how both the individual uncertainty and the balance of risks associated with point forecasts have evolved over time.

With respect to uncertainty, for each forecaster we compute the standard deviation of the probability distribution and divide it by the respective

6. The ECB aims at inflation rates of below, but close to, 2% over the medium term. Taking into account the lower and upper bounds of the bins for which the forecasters are asked to assign probabilities, we sum the probabilities assigned to the outcomes up to 1.5%, given that the next bin ends at 1.9%.

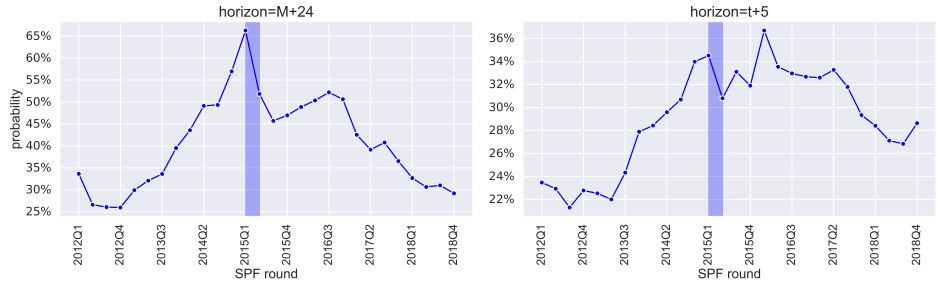
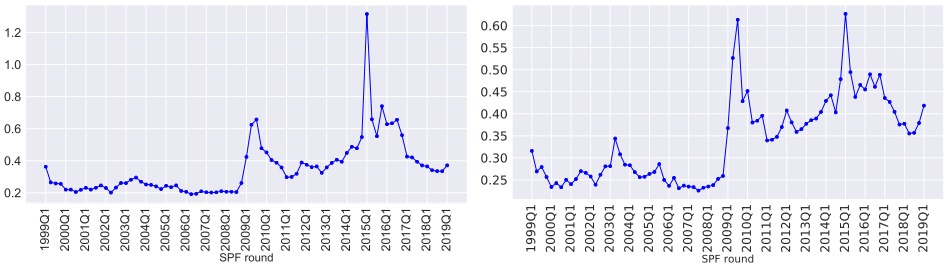
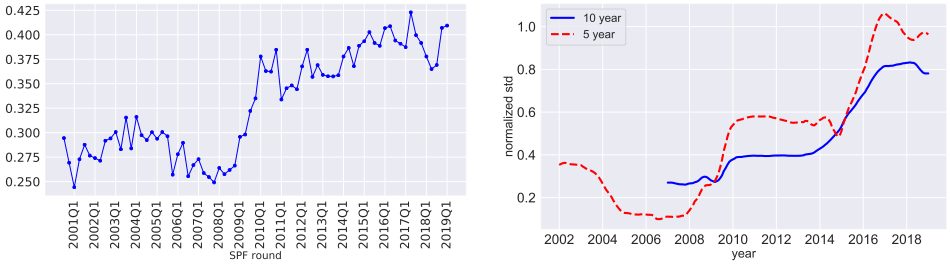


FIGURE 4: Probability of inflation outcomes below 1.5% in the medium and long term

Sources: ECB and authors' calculations.



(A) Uncertainty – $M + 12$ inf. expectations (B) Uncertainty – $M + 24$ inf. expectations



(C) Uncertainty – $t + 5$ inf. expectations (D) Euro area HICP inflation volatility

FIGURE 5: Uncertainty measures and euro area HICP inflation volatility

Sources: ECB, Eurostat and authors' calculations.
Note: Inflation volatility is defined as the standard deviation of HICP y-o-y inflation divided by the mean; the figure shows 5 and 10-year moving averages.

probability distribution mean.[7] Subsequently, we average this statistic across

7. We normalise the standard deviation by the mean because the means have changed significantly over time, making the standard deviations at different points in time less comparable.

forecasters. As uncertainty tends to increase with the forecast horizon, a careful analysis requires having uncertainty measures for target periods that are equally distant. Therefore, we use expectations for rolling horizons $M + 12$ and $M + 24$ and for the long term.[8]

Figures 5a, 5b and 5c show that in general uncertainty has been at historically high levels over the low-inflation period. The significant rise of uncertainty occurred however at the time of the financial crisis. In part, the higher uncertainty about future inflation relative to the pre-crisis period might reflect the higher volatility of actual inflation outcomes since mid-2007. In fact, a visual inspection of Figure 1b shows that before that period inflation fluctuated only slightly around values close to 2%, while afterwards the volatility has been significantly higher, to some extent due to strong fluctuations in oil and other commodity prices. This is corroborated by Figure 5d, which shows that average volatility of actual y-o-y HICP outcomes – measured by the rolling standard deviation over the mean – is now substantially higher than it was before the crisis. Experiencing volatile inflation outcomes might explain at least in part why forecasters seem to be more uncertain about inflation in the future.

With respect to the balance of risks associated with point forecasts, for each respondent we first compute the difference between the mean of the probability distribution and the point forecast, and divide that difference by the standard deviation of the probability distribution. This statistic, akin to the Pearson's coefficient of skewness, gauges whether each respondent assesses the risk of the actual inflation outcome to be above or below the point forecast. Subsequently, we compute two different measures: (i) the average of that statistic across forecasters; (ii) the share of forecasters for which that statistic is below zero, i.e., the share of forecasters that see risks on the downside.

Figure 6 presents the first aforementioned measure – the average balance of risks across forecasters. As this measure is quite volatile, we average it by year. We can see that over the low-inflation period the balance risks has been in general skewed to the downside over the different horizons. Moreover, while some improvements are observable in the last two years, after historically low levels in 2016, our measure remains at relatively low levels, especially when compared to the pre-crisis period.

The assessment of the balance of risks as skewed to the downside in recent years has been quite generalised across forecasters: for the three horizons considered the majority of respondents sees risks on the downside (Figure 7). The share of respondents seeing downside risks is particularly high by past standards for the two-year ahead horizon.

8. The evolution of inflation expectations for year $t + 1$ and month $M + 12$ is not fundamentally different over time, and the same holds for expectations for year $t + 2$ and month $M + 24$.

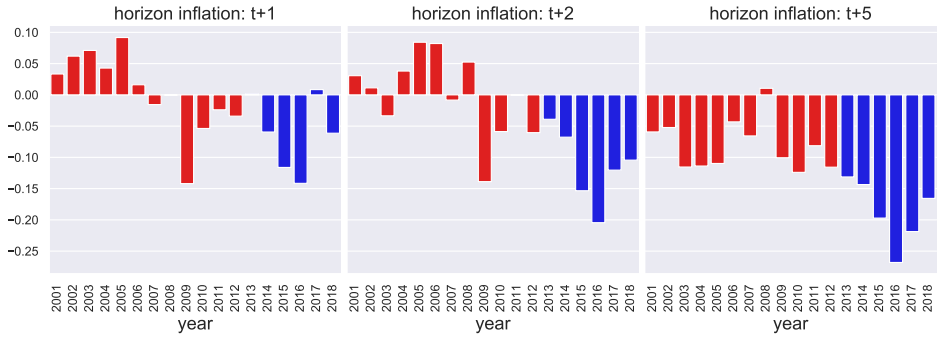


FIGURE 6: Balance of risks: average across forecasters

Sources: ECB and authors' calculations.
Note: Results for years before and during the low-inflation period are shown in red and blue, respectively.

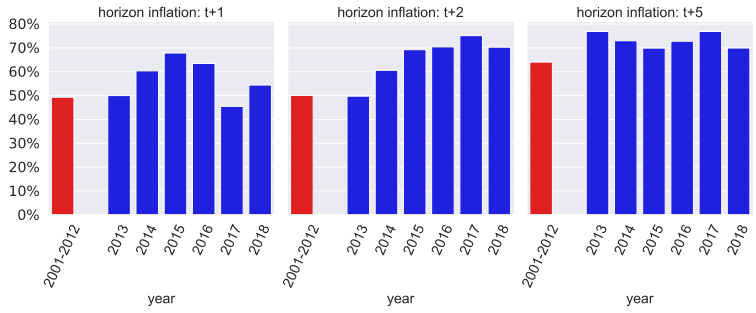


FIGURE 7: Percentage of forecasters seeing risks on the downside

Sources: ECB and authors' calculations.
Note: See the note to Figure 6.

Overall, while most forecasters still see risks on the downside, the balance is now less negative than it was in 2016 for the three horizons considered.

What drives the dynamics of inflation forecasts?

So far, we have described the historical evolution of euro area inflation forecasts, and have discussed some of the ways in which the SPF results on inflation point forecasts and probability density distributions can be informative about the private sector's perceptions about future inflation. Our aim in this section is to gain some insights about the factors that have affected SPF inflation expectations, and their dynamics over time.

We know that inflation is influenced by many different variables, which are in turn driven by a complex interplay between exogenous shocks and endogenous responses of economic agents to those shocks. Consequently, there are many observable variables that could be potentially useful sources of information about future inflation. Clearly, sophisticated forecasters, such as the participants in the SPF, closely monitor a wide variety of economic variables and use that information to produce their forecasts. Furthermore, different forecasters are likely to have very different forecasting models; that would further obscure the relationship between their inflation forecasts, on one hand, and the underling factors, on the other. Here we will not attempt to evaluate all variables that may be influencing the forecasts of SPF participants. Instead, our objective is to assess the degree to which forecasters' expectations about several conditioning variables, which are part of the survey, have played a role in determining their inflation forecasts.

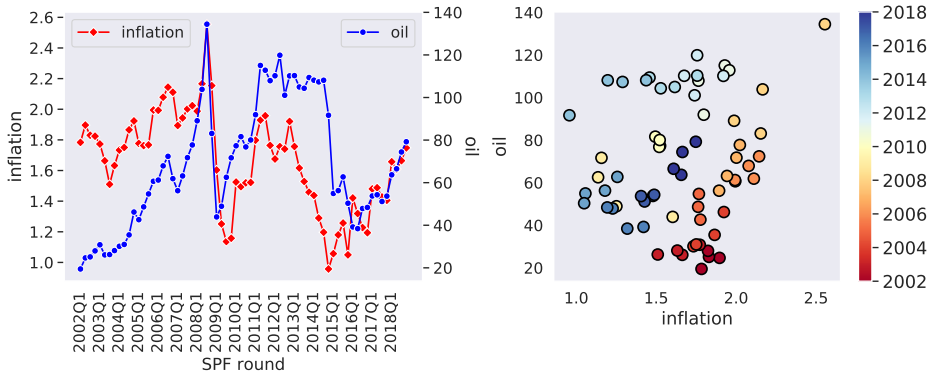
As was mentioned earlier, a feature of the ECB's SPF is that the survey includes questions about the participants' assumptions with respect to future values of oil prices, the USD/EUR exchange rate, and annual growth in compensation per employee (henceforth referred to as wage growth). The stated reason for asking these questions is to collect information on the main drivers underlying each respondent's expectations about inflation. Therefore, our goal is to analyse to what extent each one of those variables has played a role in forming inflation expectations.[9] This is the subject of the first part of this section. In the second part we extend the analysis by examining the relationship between short and long-term forecasts.

The role of assumptions

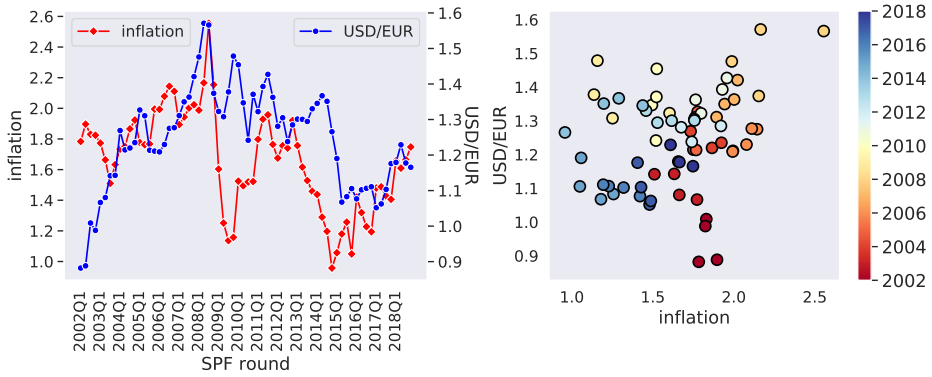
This section seeks to answer three questions: (1) have assumptions about the price of oil, USD/EUR echange rate, and wage growth played a role in driving inflation expectations? (2) how much heterogeneity is there among forecasters in terms of the role of different assumptions? (3) are there notable differences before and after 2013 with respect to the first two questions?

We start by plotting the time series of each conditioning variable together with those of inflation forecasts. The plots appear in Figure 8, where inflation forecasts are shown for the next calendar year, while the assumptions are for the current quarter in the case of oil price and exchange rate, or the current year in the case of wage growth. In addition to the time series plot, in each case we also show a scatter plot of the two variables.

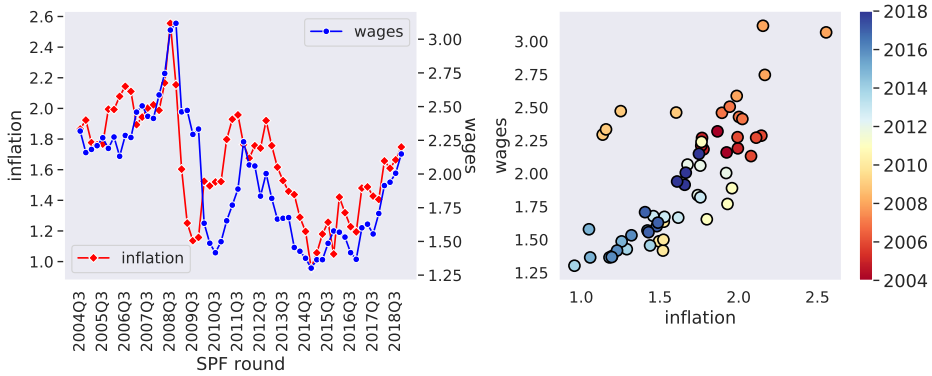
9. The survey questionnaire also asks about the participants' assumptions with respect to future values of the Eurosystem's main refinancing operations rate. However, since the end of 2014, the interest rate assumptions have remained very stable at close-to-zero levels, and do not display any meaningful relationship with inflation expectations. Therefore, in this section we will not discuss the relationship between the interest rate assumption and inflation expectations.



(A) Inflation expectations for the next year and oil price assumption for the current quarter



(B) Inflation expectations for the next year and USD/EUR assumption for the current quarter



(C) Inflation expectations for the next year and wage growth assumption for the current year

FIGURE 8: Inflation expectations and underlying assumptions

Sources: ECB and authors' calculations.

At first sight, the plots suggest a fairly strong association of inflation expectations with the wage growth series, and a much weaker one with the oil price and the exchange rate series. However, a closer examination of the patterns, facilitated by the color coding of the scatter plots, reveals a significant time variation in the relationships. This is most apparent in the case of oil prices, where there are distinct parallel shifts over time in what appears to be otherwise a linear pattern. While it is historically unusual to see any relationship between the *level* of oil prices and the *rate of change* in consumer prices (expected or realised) the fact that such an empirical relationship emerged in the recent years has been well documented and has been a reason for concern to policy makers.[10]

Instead of exploring relationships between the levels of the variables, an alternative approach, which we adopt for the remainder of this section, is to examine the relationship between revisions in inflation expectations and revisions in the values of the underlying assumptions. Since the survey asks for successive forecasts of inflation for several different calendar years in the future, we can compute forecast revisions as the changes in the forecasts for a given target that occurs between two consecutive survey rounds. We consider inflation forecast revisions for one, two and four/five-year ahead horizons. Similarly, we define revisions in assumptions as the changes in the expected values between two consecutive surveys. For oil price and the exchange rate we focus on revisions, expressed as per cent changes, with respect to the values for the current quarter, i.e. the expected value for this quarter compared to the expected value for the one quarter ahead reported in the previous survey. For wage growth we consider revisions with respect to the expected value for the current year.[11]

In principle, we could also consider revisions in assumptions for longer horizons, e.g. one, two or three quarters ahead – for oil price and exchange rate, or one, two, or four/five years ahead – for wage growth. The main reason why we do not is that data availability becomes a serious problem when we perform analysis at individual level: forecasters do not always respond to all survey questions, and to the extent that they do provide expected values for assumptions, they are far more likely to do so for shorter horizons. Also, as can be seen in Figures A.1 and A.2 in the Appendix, revisions in oil prices and exchange rate assumptions for longer horizons tend to be very highly correlated to revisions in the expected values for the current quarter. Therefore, the additional information content in those revisions with respect to inflation expectations is very limited. At the same time, Figure A.3 in the

10. A possible explanation is that the real price of oil is indicative of global economic activity, in particular aggregate demand, which has implications for inflation. For more details, see Sussman and Zohar (2018) and the references therein.

11. The revision of expected wage growth in the first survey round in a given year is computed relative to the last survey's response for the expected value for the next calendar year.

Appendix shows that revisions of assumptions about wage growth at different horizons are less correlated. We leave the exploration of the implications of this for inflation expectations for future work.

An appealing feature of working with forecast revisions is that they can be explained in terms of new information that becomes available to forecasters after the original forecast was made. If new information about the conditioning variables is deemed relevant for future inflation, this should result in the survey participants revising their earlier forecasts. In what follows we examine to what extent this has been the case for each one of the three conditioning variables. We also try to establish whether there has been a change in the observed relationships before and after 2013. We start by examining the relationship between forecasts and assumptions at the aggregate level, where revisions are computed using the average response across forecasters. Then, we proceed with additional analysis of the same relationships at the level of individual forecasters.

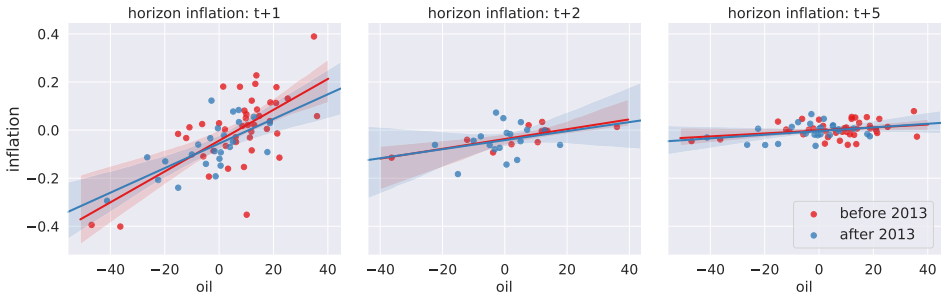


FIGURE 9: Revisions in the oil price assumption and in inflation expectations across surveys

Sources: ECB and authors' calculations.
Note: The shaded areas represents the uncertainty around each regression line (95% confidence interval computed using bootstrap).

Oil price. Figure 9 shows scatter plots of the aggregate revisions in assumptions about oil prices and the revisions in inflation forecasts for one, two, and four/five years ahead. Note that we have significantly fewer observations for the two-year ahead inflation forecasts. As mentioned earlier, this is due to the fact that until 2012 the survey asked for that horizon only twice a year, which leaves us with only one revision per year. Nevertheless, the results clearly suggest a stronger positive relationship for near-term inflation expectations, which weakens monotonically with the horizon of inflation, and is essentially zero for the long-term expectations. This patterns holds both before and after 2013, although, for the shorter-term expectations, the relationship between revisions in forecasts of inflation and oil prices appears to have weakened slightly in the later period.

These results are not surprising because of the well-understood positive pass-through of oil prices into consumer prices, which normally spills over into shorter-term inflation expectations. While this pass-through is complex and involves many factors, including the tax system and structural aspects of the economy, changes in the oil price tend to impact inflation in the same direction, both directly through the impact on consumer energy prices, and indirectly through the impact of energy prices on producer and distribution costs (ECB (2010)). At longer horizons, no meaningful relationship is expected, unless second-round effects extend the impact of the shock to oil prices.[12]

While the relationship between inflation forecasts and oil price revisions is in line with economic intuition, it is important to remember that variables themselves are a result of mechanical aggregation of different individual responses. In general, aggregation may distort or obscure the underlying relationships as well as conceal existing heterogeneity among forecasters. Therefore, next we examine whether and how related these revisions are at the level of individual forecasters. We start by counting the number of forecasters

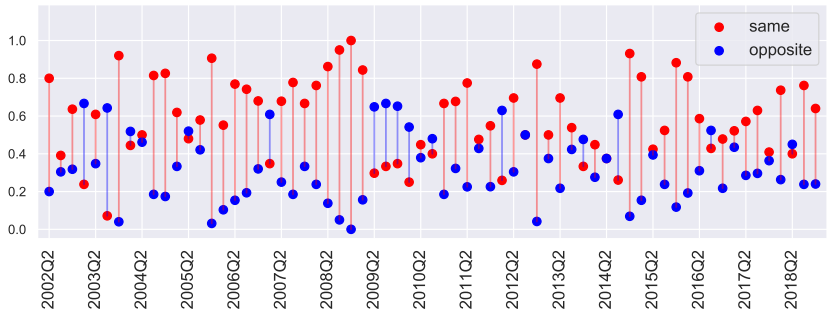


FIGURE 10: Fraction of forecasters revising the oil price assumption and inflation expectations (for the next calendar year) in the same or in opposite directions in each survey

Sources: ECB and authors' calculations.
Note: The dots show the fraction of forecasters revising in the same (red) or the opposite (blue) direction in a given survey. The lines connecting them change colour depending on which fraction dominates.

who update their inflation and oil price forecasts in the same or in the opposite direction in each survey. In Figure 10 we show, for revisions in forecasts for the next year's inflation, the fraction of forecasters from each group in the total

12. Second-round effects refer to reactions of wage and price-setters to first-round effects in an attempt to keep real wages and profits unchanged, respectively.

pool of respondents in every survey round.[13] The results show that, with a few exceptions, more respondents revise their forecasts in the same direction. On average, more that 40% of the forecasters are in that group, while only about 20%, on average, revise inflation and oil price forecasts in the opposite direction. The time-variation of these results is quite evident, and it would be interesting to investigate what the underlying causes might be, and whether similar patterns are found in the case of longer-term expectations. However, these questions are outside the scope of the present article. Instead, here we only examine the empirical distribution of each fraction over the two sample periods – before and after 2013, and for different inflation horizons – one, two, and four/five years ahead.

FIGURE 11: Distributions of the fractions of forecasters revising their oil price assumption and inflation expectations in the same direction (red) or the opposite direction (blue) across all SPF surveys

Sources: ECB and authors' calculations.
Note: The large box represents the interquartile range – the difference between 75th and 25th percentiles (the median is marked with a horizontal line). The smaller boxes represent additional percentiles.

The results are shown in Figure 11, where each distribution is summarised using a box plot. The results for inflation horizon $t + 1$ show us what we already know from Figure 10 – that in both periods there are far more forecasters who revise oil prices and inflation in the same direction than in the opposite direction. There is also a notable although much less pronounced

13. We count only those respondents who make a revision in their oil price forecasts. Note that some of them keep their inflation forecasts unchanged, which explains why the sum of the "same" and "opposite" fractions in Figure 10 do not always sum up to 1.

difference in the distributions for inflation horizons $t + 2$ and, even less for $t + 5$, in the period before 2013, where again we find that a larger number of survey participants revise their oil price and inflation forecasts in the same direction. It is worth remembering that far fewer forecasters make revisions in their longer-term forecasts of inflation, especially for $t + 5$. Moreover, we have fewer observations after 2013 since that part of the sample is much shorter. Hence, the difference we see in the figure should not be interpreted as evidence for a change in the way forecasts and oil price assumptions are revised in the more recent period.

The above results by themselves do not show that all or even any individual forecasters revise their inflation forecasts in response to revisions in their assumptions about the price of oil. It is possible, that for some survey respondents the two sets of forecasts are unrelated, i.e. inflation forecasts are produced without taking into account the outlook for oil prices. In statistical terms, this would imply that the variables are independent. A simple way to establish if two variables are related, and to determine the sign of the relationship, is to compute correlation coefficients, and check whether they are statistically significant. Therefore, to find out if inflation and oil price forecast revisions are indeed related, we use the individual-level data to calculate correlation coefficients for each survey participant, and then count the number of those for whom the correlation (positive or negative) is statistically significant. We do this for both sample periods, and

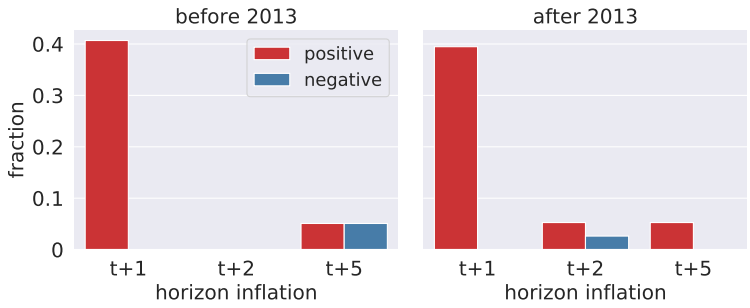


FIGURE 12: Fraction of forecasters for whom revisions in inflation expectations and assumptions about oil prices are statistically significantly correlated

Sources: ECB and authors' calculations.
Note: We use three correlation measures (Pearson, Spearman, and Kendall-τ) and the height of each bar shows the largest fraction obtained.

the results are presented in Figure 12. To allow for a possible non-linearity in the relationship, we consider two rank correlation measures – Spearman, and Kendall-τ, in addition to the standard linear (Pearson) correlation coefficient. Rank correlation measures are better able to capture monotonic relationships,

which may not be linear.[14] In the figure we show only the maximum number of forecasters for whom a significant relationship is detected across the three measures, as a fraction of the number of all forecasters in our sample.[15] The results suggest that for about 40% of the survey participants in each subperiod, new information about oil prices has an impact on their revisions of $t+1$ inflation forecasts. For all of them the relationship is positive. In the case of two-year ahead and long-term inflation expectations, there is a significant relationship for between 5% and 10% of the forecasters, and the relationship is positive for almost all of them.

A necessary caveat to the above results is that the number of forecasters, as well as their composition, changes between the two subperiods. In the sample before 2013 we have 59 forecasters, while after 2013 we have 38 forecasters for whom we have enough observations to compute correlations, and test for significance.[16] Also, as already mentioned, some forecasters drop out from the survey, while others have joined only more recently. Thus, the pool of forecasters changes over time. The only conclusion we are able to draw from these results is that for a substantial number of forecasters revisions in oil price expectations appear to have played a role with respect to updates of their $t+1$ inflation forecasts, and that the relationship is positive. For very few of them such a relationship also exists in the case of $t+2$ and $t+5$ expectations.

To summarize, our results show that revisions in oil prices and $t+1$ inflation expectations tend to be positively related, which is in line with the expected pass-through from oil prices into consumer prices. Moreover, that relationship does not seem to have changed fundamentally after 2013. The apparent lack of a significant relationship in the case of longer-term expectations is in contrast to what has been documented for inflation expectations extracted from financial instruments, in the more recent period, both in the euro area and in the United States (see for example Elliott *et al.* (2015)). The two types of expectations are not necessarily comparable, however, due to, for instance, very different frequencies of observations (quarterly vs. daily – in the case of market-based expectations), as well as the presences of various premia in market instruments.[17]

14. This is similar to what we have done in Figures 10 and 11 where we counted revisions in the same direction and in the opposite direction without regard to the size of revisions.

15. The results are only marginally different if we use any one of the correlation measures. In most cases Spearman and Kendall-τ coefficients give the same answer with respect to significance or lack thereof, while the test for linear correlation tends to show significance in fewer cases.

16. We set, admittedly without any formal justification, the minimum number of observations at 10.

17. For a more detailed explanation of the differences between survey and market-based measures of inflation expectations, see for example Ciccarelli *et al.* (2017).

USD/EUR exchange rate. Figure 13 reports scatter plots of the revisions in aggregate assumptions about the USD/EUR exchange rate and inflation forecasts. To be clear, an increase in the USD/EUR exchange rate implies an appreciation of the euro. Unlike with the aggregate oil price assumptions, there does not appear to be any discernable relationship between the two series. From the regression lines displayed in the plots we can infer a relatively weak positive relationship before 2013, and similarly weak but negative relationship in the later period, in the case of both one and two-year ahead inflation expectations. However, the uncertainty in both cases is very large, and does not rule out a lack of systematic relationship between the variables.

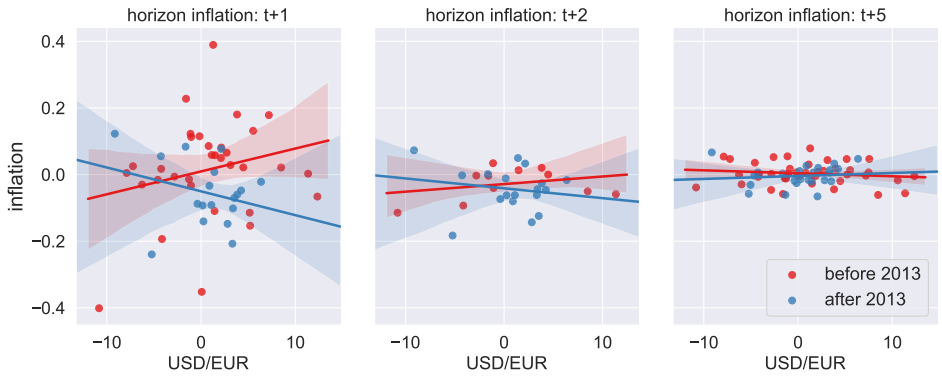


FIGURE 13: Revisions in the exchange rate assumption (USD/EUR) and in inflation expectations across surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 9.

Figure 14 shows the empirical distributions of the fractions of respondents who update their inflation forecasts and exchange rate assumptions in the same or the opposite directions. We see an increase, after 2013, in the fraction of respondents who revise their one-year ahead forecasts in the opposite direction of their exchange rate assumptions. In the earlier part of sample, the two fractions are approximately equal. A similar change is found with respect to the two-year ahead forecasts, for which there are relatively more forecasters revising in the same direction before 2013, but the fraction of those revising in the opposite direction is larger in the more recent period.

In Figure 15, we show the fractions of forecasters for whom revisions in inflation expectations are significantly related to revisions in the assumption about the exchange rate. We see that, in either period, the relationship is significant for very few forecasters. The sample sizes are 58 and 37 before and after 2013, respectively. Therefore the largest number of forecasters in either subperiod – those whose revisions of inflation forecasts for $t+1$ are significantly related to exchange rate assumption revisions, is 9, 5 of which

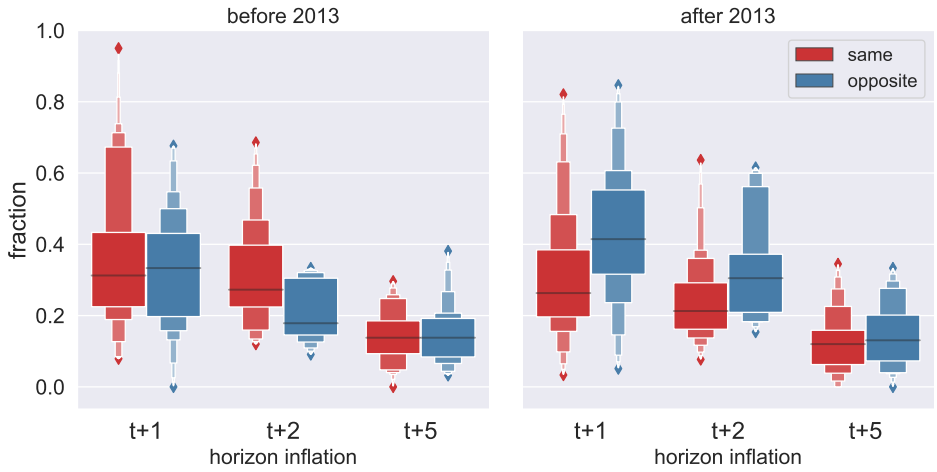


FIGURE 14: Distributions of the fraction of forecasters revising their exchange rate assumption and inflation expectations in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 11.

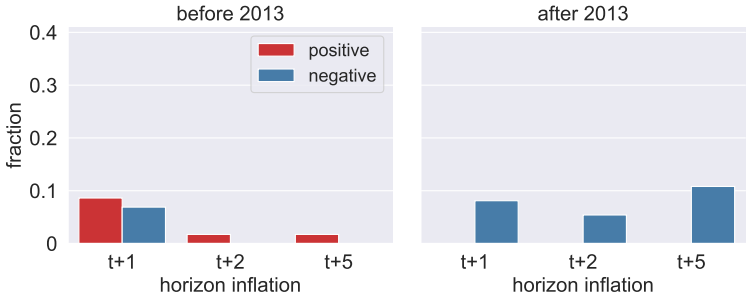


FIGURE 15: Fraction of forecasters for whom revisions in inflation expectations and assumptions about USD/EUR exchange rate are statistically significantly correlated

Sources: ECB and authors' calculations.
Note: See the note to Figure 12.

show positive relationship, and the other 4 – a negative one. After 2013, the sign is negative in all cases, but the number of forecasters showing a significant relationship is even smaller – between 2 (for inflation in $t+2$) and 4 (for inflation in $t+5$).

The finding that USD/EUR exchange rate assumptions do not seem to have much of an impact on the inflation expectations for the large majority of SPF participants might be puzzling. From a theoretical point of view, a

depreciation of the euro, i.e. a decrease in the USD/EUR rate, is expected to lead to higher inflation. The effect can be both direct – from the impact on the import prices of final consumer goods, or indirect – stemming from higher production costs, and other real channels, which again cause upward pressure on consumer prices (ECB (2016)). One possible explanation is that the limited set of observations we have does not allow us to detect a role for the exchange rate assumption even though they do play an important role with respect to inflation forecasts. Dividing the sample into two parts exacerbates this problem as it further limits the number of observations used to test for significance. However, our main result does not change when we redo the analysis using the full sample – again at most around 10%, i.e 6 or 7 forecasters, show a significant relationship, and for the majority of them the relationship is positive, i.e. the opposite of what would be implied by theory.

Wage growth. Lastly, we explore the relationship between revisions in inflation expectations and the forecasters' assumptions about wage growth. A scatter plot of the two variables, in terms of averages across forecasters, is shown in Figure 16. There is no apparent association before 2013, and a relatively strong positive relationship, including for long-term expectations, after that. There is also some suggestion of a negative relationship for two-year ahead expectations before 2013. However, this result should be discounted due to the very few observations in that sample.

FIGURE 16: Revisions in the wage growth assumption and in inflation expectations across surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 9.

The individual-level data, shown in Figure 17, appears consistent with the aggregate-level result: after 2013, there are substantially more forecasters who revise expectations about wage growth and inflation in the same direction

than in the opposite direction. This is true for all horizons although the differences are smaller for longer-term expectations.

FIGURE 17: Distributions of the fraction of forecasters revising their wage growth assumption and inflation expectations in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 11.

Figure 18 shows the fraction of forecasters for whom we find a significant correlation between the revisions in inflation and wage growth expectations. The number of forecasters in the two subperiods – before and after 2013, is 35 and 24 respectively.[18] Similar to the results for the exchange rate, relatively few forecasters appear to revise their inflation expectations taking into account new information about wage growth. There is no substantial difference in the results before and after 2013: a relatively larger number of forecasters show a significant relationship for revisions in $t+1$ inflation – 4 respondents in the first, and 6 in the second period, for 1 of which the relationship is negative. In both subperiods, there are also a few forecasters (4 in the first and 2 in the second) whose revisions in long-term inflation expectations are related to changes in the assumptions about wage growth. These results do not change in any significant way if we use the full sample.

A positive relationship, like the one that appears to be relatively more prevalent in our results, is what one would expect from economic theory. Wages are an important part of firms' cost structure, and are thus tied to

18. Questions about wage growth assumptions only started being asked in 2004Q3. This is the main reason why we have a smaller number of forecasters here compared to the oil price or exchange rate assumptions, for which we have data since 2002Q1.

their pricing decisions. Households also take into account the expected price dynamics when negotiating wages. Of course, neither of these arguments suggests that there is a causal link, and it is a very challenging task to establish such a relationship empirically.

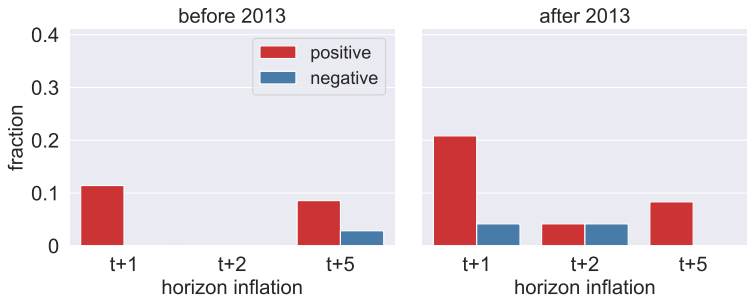


FIGURE 18: Fraction of forecasters for whom revisions in inflation expectations and assumptions about the wage growth are statistically significantly correlated

Sources: ECB and authors' calculations.
Note: See the note to Figure 12.

The role of shocks to current inflation

As already mentioned earlier, current developments in realised inflation have tended to be accompanied by changes in shorter-term inflation expectations. This is easily explained by the fact that shocks to inflation normally have a persistent effect, which takes some time to fade away. At the same time, if medium and longer-term expectations are well-anchored, deviations of inflation from the central bank's objective should be transitory, and inflation should gradually converge to the central bank's objective. Therefore, a useful metric to assess the central bank's ability to anchor inflation expectation is to assess whether there is no significant association between revisions in short-term inflation expectations and revisions in long-term ones (for a more thorough discussion of this see Bowles *et al.* (2007) and Castelnuovo *et al.* (2003)).

In this section we examine the relationship between short and long-term inflation expectations, and again compare the period before and after 2013. In particular, we are interested in understanding whether the fears of a de-anchoring that emerged around 2013 and may have prompted additional policy actions by the ECB, can be justified or explained on the basis of developments in SPF expectations.

In Figure 19 we plot revisions in the average value of inflation expectations for the current year and revisions in average long-term inflation expectation across all surveys. For the period before 2013, there is a weak positive

association between the two variables. After 2013, the association appears to have remained unchanged, but is surrounded by even more uncertainty.

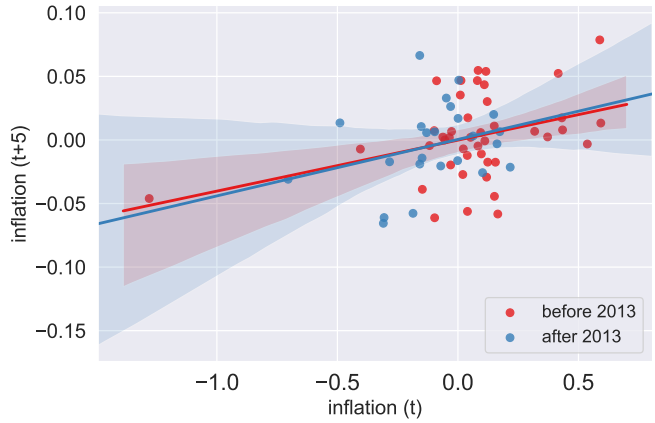


FIGURE 19: Revisions in inflation expectations for the current year and for the long term across surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 9.

Individual-level data also suggest a relatively limited association between short and long-term expectations. In Figure 20 we can see that the distribution of the fraction of forecasters revising in the same direction shifted towards slightly higher values after 2013, while that for forecasters revising in the opposite direction shifted to somewhat lower values. Yet, in general the share of forecasters revising short and long-term expectations in the same direction remained at relatively low levels.

It is worth highlighting that relatively few survey respondents revise their point forecasts for long-term inflation in any given survey. This is why the sum of the fractions of "same" and "opposite" is typically much less than 1. Moreover, it is possible that even when forecasters make changes in their long term inflation forecasts, the changes are not related to their revisions of the short-term inflation forecast. We report, in Figure 21, the fraction of forecasters for whom we find such a relationship. In the period before 2013 there are 7 forecasters, in a sample of 59, i.e. about 12%, with statistically significant correlation coefficients. For all but one of them the relationship is positive. After 2013, our sample has only 36 forecasters with enough observations, and a significant positive relationship is found for 5 of them, while for 1 the relationship is negative.

The fact that over the last years long-term expectations have remained in the range of 1.8% to 2.0% – a range broadly consistent with the ECB' objective –, despite the strong volatility of HICP inflation outcomes and

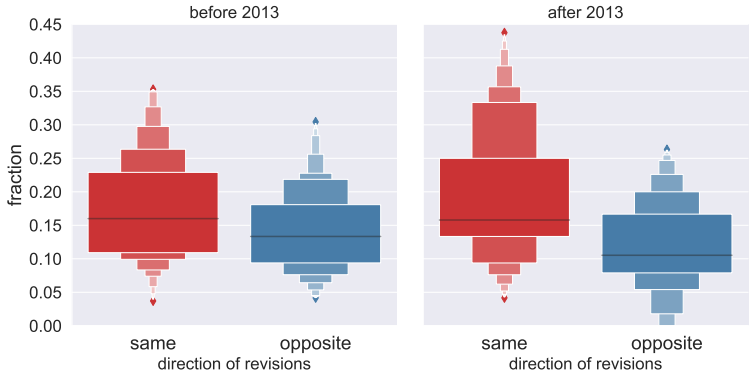


FIGURE 20: Distributions of the fraction of forecasters revising their inflation expectations for the current year and for the long term in the same direction (red) or the opposite (blue) direction across all SPF surveys

Sources: ECB and authors' calculations.
Note: See the note to Figure 11.

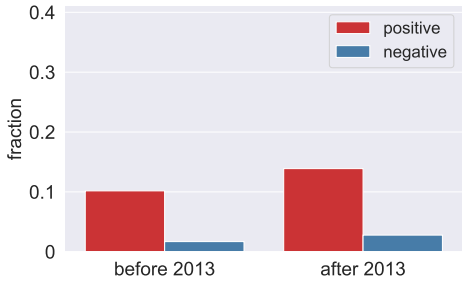


FIGURE 21: Fraction of forecasters for whom revisions in short and long-term inflation expectations are statistically significantly correlated

Sources: ECB and authors' calculations.
Note: See the note to Figure 12.

shorter-term expectations, and the fact that the ECB's objective continues to be referred by survey participants as the main factor informing long-term expectations (ECB (2019)) also suggest that SPF expectations remain relatively anchored. Notwithstanding, some researchers have found empirical evidence of spillovers from short to long-term inflation expectations in the current period of low inflation, especially when using inflation expectations extracted from financial market instruments (see for example Antunes (2015)). In particular, Łyziak and Paloviita (2017) use SPF data and find that longer-term inflation expectations have become more sensitive to shorter-term ones after

the crisis. A major difference relative to our approach is that the relationship is investigated using the level of expectations, and not revisions.

Concluding remarks

The SPF conducted by the ECB is an important source of information about inflation expectations in the euro area. In this article we provided an overview of the results of the survey, and illustrated some of the ways in which it is used to inform us about the evolution of expectations over time and the professional forecasters' assessment of risks and uncertainty around the expected path of inflation. We also examined the role of assumptions about future values of variables included in the survey – the price of oil, USD/EUR exchange rate, and wage growth, have played in driving the dynamics of inflation expectations. Our results suggest that updates in the value of only one of these variables – the price of oil, appear to have had a significant impact on the revisions of shorter-term inflation expectations throughout the sample period. The manifestation of such an impact at the aggregate level, as well as the absence of a significant effect from revisions in the other two variables, is due to differences at the level of individual forecasters. A significantly larger number of them appear to update their outlook for inflation when new information about the price of oil becomes available, compared to those who do that due to news about the exchange rate or wage growth. Further, we do not find significant differences in these results before and after 2013.

Our findings, however, should be interpreted with caution: the available data for individual-level responses is quite sparse, due to changing composition of the pool of forecasters, and intermittent lack of responses to survey questions, in particular regarding assumptions. It is, therefore, conceivable that our failure to find a significant role of exchange rate and wage growth revisions on inflation is due not to absence of underlying relationships, but to insufficient number of observations for us to detect it.

References

Antunes, António (2015). "Co-movement of revisions in short-and long-term inflation expectations." *Banco de Portugal Economic Studies*, 1(1), 1–19. Available at https://www.bportugal.pt/sites/default/files/anexos/papers/re201501_e.pdf.

Bowles, Carlos, Roberta Friz, Veronique Genre, Geoff Kenny, Aidan Meyler, and Tuomas Rautanen (2007). "The ECB survey of professional forecasters (SPF) - A review after eight years' experience." Available at https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp59.pdf?ab8a9ba29a75d778a70a4811a1804143.

Bulligan, Guido (2018). "The effect of the Eurosystem expanded Asset Purchase Programme on inflation expectations: evidence from the ECB Survey of Professional Forecasters." Questioni di Economia e Finanza (Occasional Papers) 455, Bank of Italy, Economic Research and International Relations Area. Available at http://www.bancaditalia.it/pubblicazioni/qef/2018-0455/QEF_455_18.pdf.

Castelnuovo, Efrem, Sergio Nicoletti Altimari, and Diego Rodriguez-Palenzuela (2003). "Definition of price stability, range and point inflation targets: The anchoring of long-term inflation expectations." Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=457572.

Ciccarelli, Matteo, Chiara Osbat, Elena Bobeica, Caroline Jardet, Marek Jarocinski, Caterina Mendicino, Alessandro Notarpietro, Sergio Santoro, and Arnoud Stevens (2017). "Low inflation in the euro area: Causes and consequences." Available at https://www.ecb.europa.eu/pub/pdf/scpwps/ecbop181.en.pdf.

ECB (2010). "Energy Markets and the Euro Area Macroeconomy." *Occasional Paper Series*, 113. Available at https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp113.pdf.

ECB (2015). "Introductory statement to the press conference (with Q&A), 22 January 2015." Available at https://www.ecb.europa.eu/press/pressconf/2015/html/is150122.en.html.

ECB (2016). "Exchange rate pass-through into euro area inflation." *Economic Bulletin*, 7. Available at https://www.ecb.europa.eu/pub/pdf/other/eb201607_article01.en.pdf.

ECB (2019). "Results of the third special questionnaire for participants in the ECB Survey of Professional Forecasters." Available at https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/ecb.spf201902_specialsurvey~7275f9e7e6.en.html#toc1.

Elliott, David, Chris Jackson, Marek Raczko, and Matt Roberts-Sklar (2015). "Does oil drive financial market measures of inflation expectations?" *Bank of England, Bank Underground*, 20. Available at https://bankunderground.co.uk/2015/10/20/does-oil-drive-financial-market-inflation-expectations/.

Garcia, Juan A (2003). "An introduction to the ECB's survey of professional forecasters." *ECB Occasional Paper Series*, 8. Available at https://www.ecb.europa.eu/pub/pdf/scpops/ecbocp8.pdf.

Łyziak, Tomasz and Maritta Paloviita (2017). "Anchoring of inflation expectations in the euro area: recent evidence based on survey data." *European Journal of Political Economy*, 46, 52–73. Available at https://www.sciencedirect.com/science/article/pii/S0176268016302786.

Sussman, Nathan and Osnat Zohar (2018). "Has inflation targeting become less credible?" BIS Working Papers 729, Bank for International Settlements. Available at https://ideas.repec.org/p/bis/biswps/729.html.

Appendix: Additional Figures

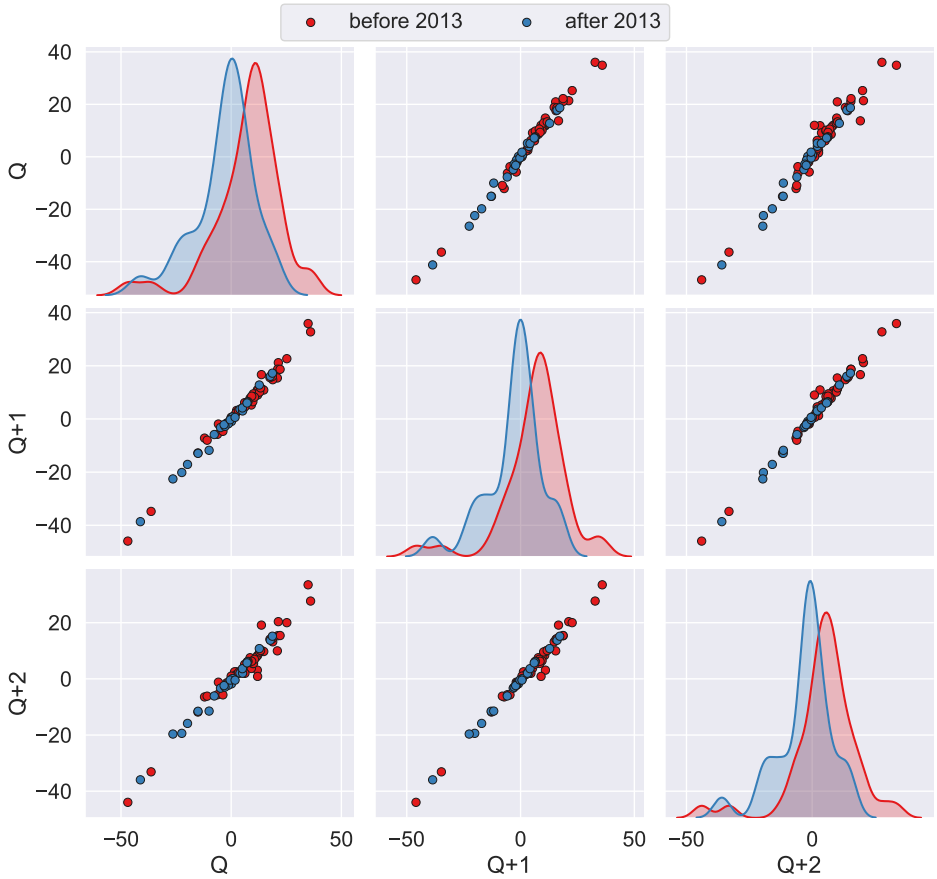


FIGURE A.1: Revisions in aggregate expectations about oil prices for different horizons

Sources: ECB and authors' calculations.
Note: The plots on the diagonal show Gaussian kernel density estimates of the distribution of the revisions in the expected price of oil for a given horizon.

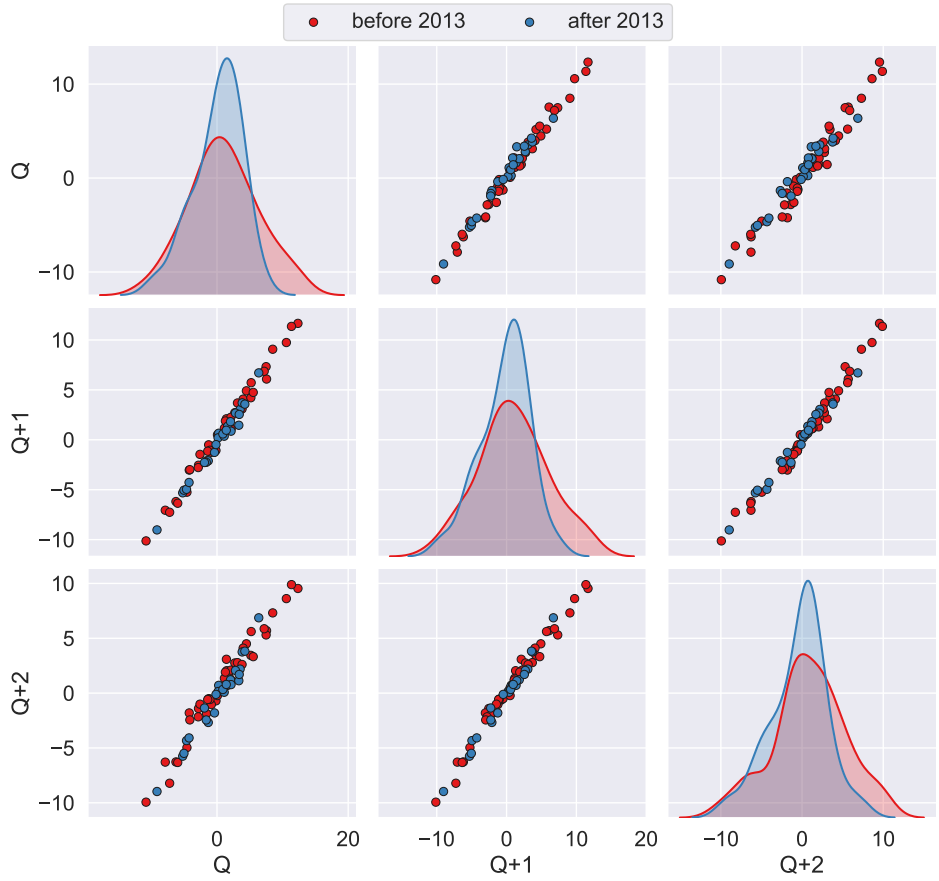


FIGURE A.2: Revisions in aggregate expectations about USD/EUR exchange rate for different horizons

Sources: ECB and authors' calculations.
Note: See note to Figure A.1.

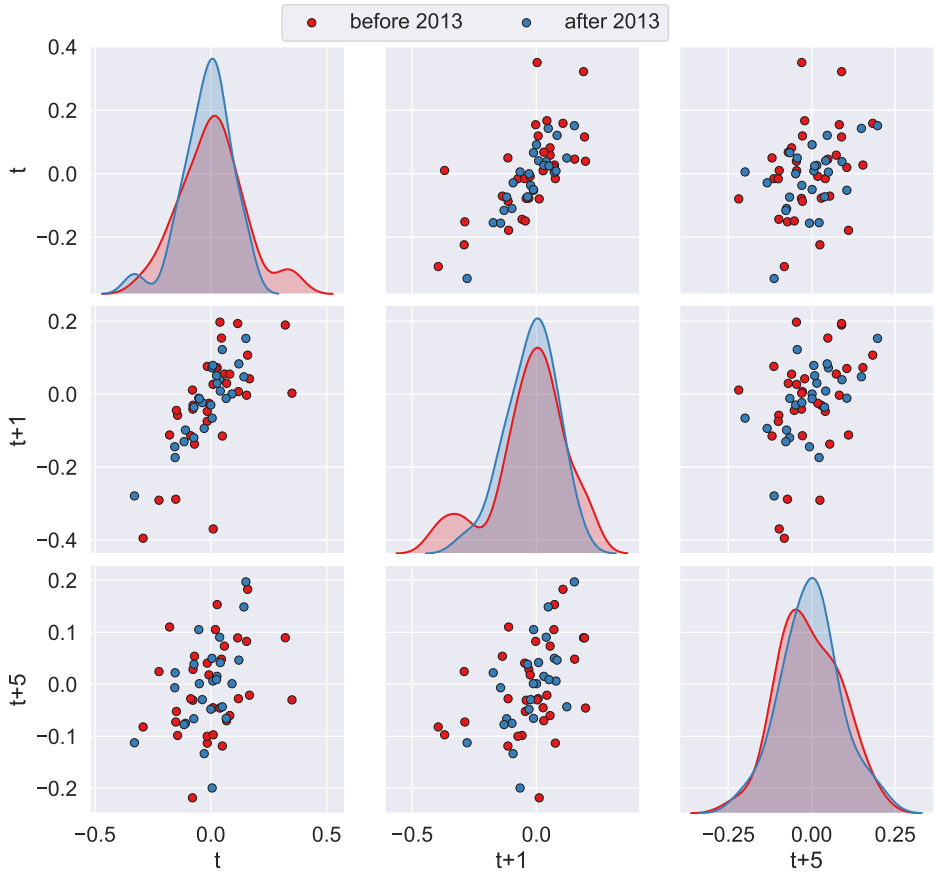


FIGURE A.3: Revisions in aggregate expectations about wage growth for different horizons

Sources: ECB and authors' calculations.
Note: See note to Figure A.1.

Economics Synopsis

Credit and the economy: lessons from a decade of research at Banco de Portugal

Diana Bonfim
Banco de Portugal
Católica-Lisbon SBE

Luísa Farinha
Banco de Portugal

Sónia Félix
Banco de Portugal
Nova SBE

April 2019

"Three decades ago, skepticism in the economics profession about the relevance of financial factors for real economic activity prevailed. This view stemmed from the implications of Modigliani and Miller (1958) that in frictionless markets, a firm's cost of capital is independent from its financial structure. Since then, most economists have accepted that the presence of information asymmetries and bankruptcy risk imply that financial factors matter for real economic decisions. Most of the debate is now centered on the quantitative importance of these frictions and the channels through which they operate. The recent global financial crisis, and the global deleveraging process that ensued, offers perhaps the most convincing evidence to date of the economic relevance of financial frictions and their real effects."

Laeven and Valencia (2013)

Introduction

Under the strict hypotheses of perfect capital markets and perfect information, Modigliani and Miller (1958) capital structure irrelevance proposition established that arbitrage between investors should keep

Acknowledgements: The authors would like to thank comments and suggestions from Nuno Alves, António Antunes, Sónia Costa, Renata Mesquita, Pedro Moreira, António Ribeiro dos Santos, and Nuno Silva, and from participants in an internal seminar. The opinions expressed in this article are those of the authors and do not necessarily coincide with those of Banco de Portugal or the Eurosystem. Any errors and omissions are the sole responsibility of the authors.

E-mail: dbonfim@bportugal.pt; lfarinha@bportugal.pt; scfelix@bportugal.pt

the value of a firm independent from its leverage. This provoking theory encouraged a vast literature devoted to refuting the irrelevance proposition in both theoretical and empirical grounds. Theoretical research has shown that in the presence of elements such as taxes, transaction costs, bankruptcy costs, agency costs, asymmetric information, adverse selection and other frictions the original irrelevance result disappears. An important insight of these models is that external finance is more expensive than internal finance. The influential paper of Fazzari, Hubbard, and Petersen (1988) and many subsequent studies have found that firms' balance sheet positions affect their willingness to invest. Models with financial frictions have brought credit and the role of banks to the analysis of economic variables. Holmstrom and Tirole (1997) for example show that firms with weaker balance sheets are more affected by a reduction of credit supply.

The analysis of the relation between credit and the real economy regained importance since the global financial crisis of 2007–2009 and the subsequent sovereign debt crisis. Financial crises always motivate an increase in research on these topics. The recent crisis added important novel aspects arising from the complexity of today's financial institutions and instruments and the remarkable degree of global financial integration. Several interesting questions were raised by economists, policy makers and the general public in the aftermath of the crisis. Which vulnerabilities were responsible for the crisis? Could the crisis have been prevented? What have been the main shocks? How have bank shocks been transmitted to lending to firms? How has the disruption in credit affected the economy? Were there heterogeneous effects among firms? What role did monetary policy play in the process? What role did regulation play? Were there side effects of the monetary policy and regulation? It is economists' responsibility to try to provide the answers to these crucial questions.

Initial contributions to identify the effects of the 2007–2009 financial crisis used data from the syndicated loans for the US. Empirical research using large-scale, comprehensive and good quality data is much less abundant. The availability of rich micro data sets is essential to evaluate the heterogeneous effects of the crisis. This is one of the reasons why Portugal, a bank-dependent economy severely affected by the crisis, is considered an interesting laboratory to study the effects of bank shocks on real outcomes. The Portuguese Credit Register that covers the universe of loans at the bank/firm level can be merged with firm balance sheet and firm/worker databases through common identification codes for firms. Credit Register data can also be merged with bank-level balance sheet data using the common bank identifier. The richness of these databases has been crucial to develop a plausible narrative around the building of imbalances in the Portuguese economy, the impact of the crisis that severely hit the banks and the subsequent adjustment process under regulatory changes, unconventional monetary policy and intrusive prudential

supervision. This article reviews the research developed at Banco de Portugal during the last decade, creating a basis for this narrative.

The remaining of the article (i) briefly overviews recent developments in the Portuguese economy; (ii) reviews the research on misallocation; (iii) presents the research on credit restrictions; (iv) presents the studies on the effects of bank shocks in the economy; (v) reviews the research on the role of monetary policy during the crisis; and (vi) offers some final remarks.

A very brief overview of the Portuguese economy

Over the last twenty years the Portuguese economy has gone through several phases (Blanchard and Portugal, 2017). The Portuguese boom that started in the mid–1990s was characterized by large capital inflows, declining nominal and real interest rates, and strong domestic demand, reflecting the low perceived sovereign debt risk and the expectations of future growth emerging from the Portuguese participation in the euro. This triggered a strong and fast increase in households' and corporate debt.

In the beginning of the 2000s, trend growth declined and the future expected growth did not materialize. From 2002 to 2008, the accumulation of private debt was mostly channeled to non-tradable sectors and coexisted with anemic economic growth, low productivity growth, and a decline in investment. During this period external imbalances cumulated to unprecedented levels.

In the subsequent years the Portuguese outlook substantially worsened. The global financial crisis and the European sovereign debt crisis led to a dramatic increase in the cost of funds, with Portuguese banks and the sovereign loosing access to international debt markets. Most of the capital flows in the Portuguese economy were intermediated by banks, which were severely hit by the crisis.[1] This sudden stop implied that Portugal had to ask for international financial assistance in 2011. Between 2011 and 2013 the Portuguese economy went through a severe recession. Concomitantly, there was a sizeable structural adjustment in prevailing imbalances, including an increase in the degree of openness of the economy and marked improvements in the fiscal position.

Since 2014, the Portuguese economy has been recovering, in line with the expansion in the euro area. The position of the Portuguese banking system improved, with banks increasing substantially their solvency and profitability

1. Chen, Milesi-Ferretti, and Tressel (2012) estimate that in 2007 banks accounted for approximately half of the Portuguese foreign debt. Silva (2010) shows that the financial sector had a central role in the way different sectors of the Portuguese economy were connected before the crisis.

ratios. Even though the non-performing loans (NPL) ratio is still high, it has been decreasing steadily over the recent years.

In sum, the Portuguese economy in the last two decades provided material of great interest to evaluate the importance of financial frictions and their effects on the economy. The sequence of developments since the onset of the euro area, with the accumulation of vulnerabilities that clearly showed up during the crisis, until the adjusting process of the economy, stimulated several strands of empirical research. The richness and good quality of the Portuguese data, in particular the granular data at the firm/bank level, was a powerful instrument of analysis. The objective of this article is to present the research conducted in the last decade at Banco de Portugal in a structured (albeit possibly not exhaustive) way. Still, there is no obvious and unique way to achieve this objective. The developments summarised above posed distinct questions for which empirical research tried to find answers. The article is organized around some key questions and tries to build a narrative on the distinct phases the Portuguese economy went through.

Credit (mis)allocation

Over the last years a growing literature on credit misallocation and productivity differentials has emerged. Banerjee and Duflo (2005) review macroeconomic evidence suggesting that capital misallocation due to credit constraints and institutional failures is an important source of productivity differences across countries. The evidence suggests that credit market imperfections can lead to both selection and misallocation effects that may prevent some productive firms from operating or may limit the amount of capital that some productive firms have access to. Restuccia and Rogerson (2013) summarize the empirical evidence on the role of capital misallocation in explaining cross-country differences in productivity. Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez (2017) use firm-level data for European countries and show that scarce capital in South European countries was increasingly misallocated to low productivity firms in the period between 1999 and 2012.

Two of the main questions addressed in the literature on misallocation and financial frictions are the following. First, how is bank credit allocated to firms with different degrees of fragility? And second, what are the implications of credit misallocation for productivity growth?

In order to answer the first of these questions the fragile firms have to be identified. Credit scores, which evaluate the risk that a debtor defaults on its obligations, are an important tool to assess firms' financial fragility especially in the context of the sharp accumulation of corporate debt. Credit scores are important to evaluate the monetary policy transmission mechanism and to assess the quality of the allocation of credit, which has

non-negligible implications for the economy at an aggregate level. Also, credit risk assessment tools are important to identify viable firms that are financially constrained. These tools are of utmost importance during economic downturns, when the materialization of credit risk is higher (Bonfim, 2009).[2]

Antunes and Martinho (2012b) develop an econometric model to explain the probability of default based on idiosyncratic characteristics of Portuguese firms. The estimated model suggests that larger, more profitable, and more liquid firms have lower probabilities of default and shows that the estimated z-score is substantially heterogenous across sectors. In turn, more indebted firms have a higher predicted probability of default. Some years later, Antunes, Gonçalves, and Prego (2016) revisited the scoring model and developed a more complex framework to assess the creditworthiness of the Portuguese non-financial firms. This methodology is used to classify firms in terms of one-year probability of default in bank debt. According to the estimated models, firms are mostly allocated to low rating classes and micro-firms have higher probabilities of default. The estimates also suggest that firms in the construction and real estate sectors have on average higher probabilities of default.

The materialization of credit risk ultimately affects the economy. The extent of this impact largely depends on what happens to firms that default on credit. The increase in credit defaults in the aftermath of the financial crisis made this question even more relevant. Bonfim, Dias, and Richmond (2012) show that after loan default, many firms are permanently excluded from credit markets, especially if they were borrowing from only one bank. With a different perspective Antunes, Mata, and Portugal (2010) also study firms' probability of exit. The authors distinguish failure and voluntary exit and analyze the effect of credit upon these two modes of exit. The authors find that leverage and the reliance on short-term debt affect the probability that a firm goes bankrupt, though leverage also affects voluntary exit.

Building on credit score models, Santos and Silva (2019) estimate a credit risk model for the loan portfolio of Portuguese banks. Using a one-period simulation-based multi-factor model, the authors estimate the loss distribution and other risk metrics for the period between 2006 and 2017. The model differs from the Basel IRB framework by explicitly incorporating sector concentration and interdependencies between economic sectors. In particular, this study suggests that the high level of portfolio concentration on

2. The research summarized in this article is focused on the corporate sector. However, credit risk for households has also been studied by Farinha and Lacerda (2010), who found that borrowers with mortgages are less likely to default than those that only have non-mortgage debt. Using data from the Household Finance and Consumption Survey from 2010, Costa and Farinha (2012) show that low income and young households who have taken mortgages are the most vulnerable groups, for which the probability of materialisation of credit risk is higher. Using the same database, Costa (2012) shows that the occurrence of adverse shocks to the households' financial situation is a necessary, though not sufficient, condition for credit default events.

the construction and real estate sectors has led to an increase in the probability of banks registering large losses, something that end up occurring. In the last years, the results point to diversification gains thanks to a lower concentration in the construction sector and not due to an allocation into sectors with lower interdependency.

The question of credit allocation to firms with different degrees of financial fragility is of primary interest in Portugal. Azevedo, Mateus, and Pina (2018) use a measure of fragility based on productivity and show that in the period between 2008 and 2016 the share of credit granted to low productivity firms was substantial, peaking at 44% in 2013. The authors also find that misallocation is associated with slower reallocation, *i.e.* the change in credit growth towards more productive firms is substantially lower in sectors and banks with larger shares of misallocated credit in their loan portfolios.

Dias and Marques (2018) analyse the effect of the financial crisis on productivity dynamics. Using firm-level data the authors show that the Portuguese financial crisis had a cleansing effect on productivity. The authors also show that the crisis reduced the probability of survival for both high and low productivity firms, but hit low productivity firms disproportionately harder, in line with the cleansing hypothesis. Also, the probability of exit increased disproportionately for firms operating in more financially dependent industries, but there is no evidence of a scarring effect on productivity stemming from changing credit conditions.

At the center of the discussion on misallocation are the banks. Weak banks are often associated with lending to low productivity firms, contributing to amplify the problem of misallocation by reducing the ability of productive firms to expand. Reis (2013) argues that the Portuguese slump was the combined result of the large capital flows that followed the participation in the euro and the underdeveloped Portuguese financial market. The author argues that the weaknesses of the Portuguese financial system caused the capital flows to be largely misallocated, leading to the expansion of low productivity sectors. More recently, Blattner, Farinha, and Rebelo (2018) provide evidence that a weak banking sector has contributed to low productivity growth following the European sovereign debt crisis. Portuguese banks that were affected by new capital requirements in 2011 responded not only by cutting back on lending but also by reallocating credit to firms in financial distress. The partial equilibrium analysis suggests that the factor misallocation accounts for 20% of the decline in productivity in 2012.[3]

3. There is further evidence on the impacts of a weak banking sector. Bonfim, Nogueira, and Ongena (2016) show that bank branch closures have negative implications on firms' financing costs, though not on their access to credit. The effect comes essentially from a shock in the information privately shared between borrowers and lenders. Beck, Da-Rocha-Lopes, and Silva (2017) analyze the effect of bank bail-ins and find that the most affected Portuguese banks decreased credit supply, leading to negative effects on investment and employment.

In this context, a crucial question is: what is the role of bank supervision in limiting credit allocation to low productivity firms? Bonfim, Cerqueiro, Degryse, and Ongena (2019) use Portuguese data to explore the role of on-site inspections in mitigating zombie lending and find evidence that following an on-site inspection, the probability of granting credit to a zombie firm decreases on average by 3 to 6 p.p.

Overall, the empirical evidence for Portugal suggests that frictions in the banking system induced credit misallocation and slower productivity growth in the aftermath of the crisis. Importantly, bank supervision can limit the allocation of credit to low-productivity firms. This evidence brings into closer focus the importance of policies that affect banks' health, bank supervision, and productivity growth.

Credit restrictions

Were Portuguese non-financial corporations credit constrained during the economic and financial crises? The amount of credit granted to non-financial corporations sharply decreased in the aftermath of the financial crisis. According to the Bank Lending Survey (BLS), the credit decline was a result of increased restrictiveness in credit standards and conditions applied on loans as well as of decreased loan demand by firms. Understanding the importance of demand-side and supply-side conditions in explaining credit developments becomes a central question.

Antunes and Martinho (2012a) use credit registry data and develop a method to examine the presence of credit restrictions in the period between 1995 and 2012. Even though this analysis does not allow the authors to unequivocally identify the relative contribution of credit demand and credit supply in explaining the credit decline, the results suggest that the access to credit by Portuguese firms worsened after 2009 and that credit restrictions were particularly relevant for firms seeking credit for the first time.

Farinha and Prego (2013) examine the relationship between firms' financial health and their investment decisions and find evidence of financing constraints. The authors find that firms' investment, particularly for the smaller firms, is negatively affected by their debt burden and positively affected by their profitability. The authors also find that these results were amplified during the crisis. Farinha and Prego (2014) analyse liquidity management decisions by firms as a tool to investigate firms' financial constraints. Firms facing funding constraints need to accumulate more cash in order to insure against the possibility of not being able to finance viable investment projects in the presence of negative shocks. The authors show that the share of liquid assets in total assets is positively affected by current cash flows and its past volatility, which suggests that Portuguese firms are in fact subject to liquidity constraints. In addition, the results suggest that the need

to accumulate funds as a protection against future shocks is more pronounced for the smallest firms.

Farinha and Félix (2015) estimate a disequilibrium model for the period between 2010 and 2012 and document that approximately 15% of Portuguese small and medium-sized enterprises (SMEs) were partially credit constrained. In particular, the smaller and the younger firms were the most credit constrained in this period. Moreover, the authors estimate that Portuguese SMEs searched for bank loans mainly to finance their operational activity and not for investment. The smaller firms and those with smaller amounts of internal resources are estimated to have higher demand for bank loans. In turn, firms with a higher capacity to generate cash-flows and pay their debt and with more assets to pledge as collateral are estimated to borrow more from banks. These findings contrast with the evidence presented by Kremp and Sevestre (2013) for French SMEs. These authors show that French SMEs do not appear to have been strongly affected by credit rationing in the crisis period. Two possible explanations can be put forward to explain this divergence: first, the sharp decrease in bank credit granted to Portuguese SMEs has no parallel in France;[4] and second, Portuguese SMEs seem to rely significantly more on bank loans as source of financing than their French counterparts.[5]

The implications of borrowing constraints for firm dynamics, namely investment and firm survival, are well established in the literature. Firms may be forced to operate at a smaller scale than desired, may forego investment opportunities, and may not be able to overcome temporary liquidity needs in the presence of negative shocks. Amador and Nagengast (2016) use the framework proposed by Amiti and Weinstein (2018) to decompose loan growth rates into bank, firm, industry, and economy-wide components in the period between 2005 and 2013 and show that granular shocks in the banking system account for approximately 20% of the variation in aggregate lending and between 20 to 40% of aggregate investment dynamics in Portugal. Félix (2018) estimates how firm's investment and probability of survival responded to the firm's credit conditions in Portugal in the period between 2010 and 2012. The results suggest that financial market frictions are important to explain firms' dynamics. Firms that were estimated to have been partially credit constrained are less likely to survive, *ceteris paribus*. The estimates also suggest that a firm's investment is negatively correlated with the presence of financing constraints. Carneiro, Portugal, and Varejão (2014) and Martins (2016) show that financing restrictions had a key role in explaining job destruction in Portugal during the financial crisis. More recently, Blattner, Farinha, and

4. The annual rate of change of total credit granted to Portuguese SMEs was about 10% by the end of 2008 and -5% in mid–2012.

5. The ratio between bank loans and total assets equals 0.27 and 0.18 for the sample of Portuguese and French SMEs in 2010, respectively.

Rebelo (2019) proxy debt frictions by an index based on different debt-to-earnings ratios and show that the response of firms to an investment tax credit is very heterogenous and non-linear. Firms in the lower two quartiles of the debt-to-earnings index distribution have roughly equal predicted take-up probabilities, while for firms in the third quartile predicted take-up drops by 50%. Moreover, firms in the highest debt-to-earnings quartile have a predicted take-up rate close to zero.

All in all, the available evidence for Portugal suggests that credit conditions worsened in the wake of the global financial crisis and, more importantly, the euro area sovereign debt crisis. This evidence highlights the importance of a diversification of the sources of corporate financing.

Bank liquidity and capital shocks

The global financial crisis reminded us that the financial system plays a key role in the smooth functioning of an economy. An unstable and mal-functioning financial system does not allow the financing of corporate activities, the consumption smoothing over the life-cycle for households or, in the case of severe disruptions, the ability to store savings and make payments. This has led to a clear understanding that the financial sector has crucial linkages with the economy, having a role both as a trigger of shocks and as a vehicle for their propagation. As a consequence, research on these links has significantly expanded in the last decade.

Macro models have changed in order to take on board more explicitly the role of the financial system as a trigger and propagation mechanism for shocks. The New-Keynesian dynamic general equilibrium model of Gomes (2017) is an example of this new trend in macro modelling. The author uses the EAGLE-FLI (Euro Area and Global Economy with Financial Linkages) model and calibrates it to the Portuguese economy. The model includes financial frictions and country-specific banking sectors and allows for the assessment of domestic and cross-country macroeconomic effects of financial shocks. The author shows that the impact of monetary policy shocks can be amplified due to the presence of financial frictions. Júlio and Maria (2017) present a medium-scale small-open DSGE model encompassing a financial accelerator mechanism and find that the 2011–2013 recession was precipitated by financial and fiscal factors. More recently, Júlio and Maria (2018) present a DSGE model for a small euro area economy comprising a banking sector empowered with regulatory capital requirements, defaulted loans and occasionally binding endogenous credit restrictions. The authors show that under moderately-sized "bad" financial-based shocks, defaulted loans increase and banks' value drop. As a result, credit supply becomes constrained for some time, severely amplifying and protracting output downfalls.Endogenous inertia implies a

slow recovery in banks' capital and thus an enduring fragility of the banking system.

The granular and high quality data available in Portugal on lending allowed for the development of a deep analysis of how financial shocks affected the real economy, both as a source of instability or as a propagation mechanism. We can group these contributions around two types of shocks: liquidity and capital.

On liquidity shocks, Iyer, Peydró, da Rocha-Lopes, and Schoar (2013) were the first to explore the granularity of the data to study the effects of the collapse of interbank markets in the summer of 2007 on lending to Portuguese firms.[6] The authors find that banks that obtained more funding from interbank markets before this liquidity shock decreased their credit supply more during the global financial crisis. The contraction in loan supply is stronger for firms that are smaller and that hold weaker relationships with banks. Looking into the effects at the firm level, the authors find that small firms are not able to substitute the lost bank funding with other sources of debt. The authors also show that banks with lower capital ratios are more affected by this liquidity shock.

Barbosa (2017), Buera and Karmakar (2018) and Farinha, Spaliara, and Tsoukas (2019) examine liquidity shocks in a later period: the euro area sovereign debt crisis (2010–2012). Barbosa (2017) explores the heterogeneity between banks in their funding structure, sovereign exposures, solvency, and availability of collateral. The author finds that firms' investment and employment decisions were significantly affected if their lenders relied more heavily on interbank and wholesale market funding. By looking into assets that are eligible for collateral in monetary policy operations, the author also documents the existence of sovereign-bank links, showing that a deterioration in the sovereign creditworthiness affects the real economy through the banking sector.

Buera and Karmakar (2018) also analyze the real effects of the sovereign debt crisis on the Portuguese economy, emphasizing the role of heterogeneity in the way financial shocks influence firms' behavior. They examine this question both from a theoretical and an empirical perspective. They show that firms with high leverage ratios and with a larger share of short-term debt were more affected by the euro area sovereign debt crisis. The authors use this evidence to develop a standard model that looks into the conditions under which leverage and the maturity of debt affect firms' investment decisions when faced with financial shocks. The authors find that the empirical findings are consistent with the existence of long-term investment projects and frictions on the ability to issue long-term debt.

6. For details on the implications of the crisis in interbank markets in Portugal, see Saldanha and Soares (2015).

Finally, Farinha, Spaliara, and Tsoukas (2019) also look into the consequences of the euro area sovereign debt crisis in Portugal, focusing on firms' survival. The authors confirm that liquidity shocks have led to a contraction in credit supply. Firms that borrow from the banks that are more exposed to these liquidity shocks are significantly more likely to fail. Again, the granularity of the data allows the authors to uncover the heterogeneity behind these aggregate effects. The authors find that the effects of a negative funding shock for banks are stronger for younger and riskier firms, as well as for those that have exhausted their potential lines of bank credit.

Sforza (2018) takes a different perspective on the role of liquidity shocks and compares the effects of a credit shock (stemming from the global financial crisis) to the effects of a trade shock (coming from the entry of China in the World Trade Organization). The author matches employer-employee data with firm loans and bank balance sheets and finds that firms' internal organizational structure is a key channel in the transmission of shocks to the real economy. The effects are different for credit and trade shocks. On the former, firms reduce employment of high-skilled workers, but there is no adjustment on wages. In contrast, a trade shock affects the entire hierarchy of the firm. Firms rescale the organization and reduce employment at all levels of the hierarchy.

Portuguese banks also suffered sizeable capital shocks, both as a consequence of tighter regulation during and after the crisis, as well as due to the accumulation of losses. Augusto and Félix (2014) examine the impact of bank recapitalizations during the euro area sovereign debt crisis and find that bank bailouts during the adjustment program contributed to mitigate the contraction of credit supply to firms. The effect is larger for banks with a lower capital buffer (before the recapitalization). The results are valid for firms in the manufacturing and trade sectors, but not in the construction sector, which was more significantly affected during the recession.

Degryse, Karapetyan, and Karmakar (2018) study the impact of the 2011 EBA capital exercise, which required some banks to build additional capital buffers against sovereign risks, on banks' decision to grant collateralized loans rather than uncollateralized ones. The shock makes secured lending more attractive, given that it requires less regulatory capital. The authors find that banks that had to increase their capital are more likely to require collateral when granting loans. However, relationship borrowers are more insulated from this shock.

Barbosa, Bilan, and Celerier (2019) examine another type of capital shocks, stemming from a change in accounting norms. This change affected the value of pension obligations of Portuguese banks, thus affecting banks' capital ratios. The authors identify the effects of this credit shock on the ability of firms to attract and retain skilled workers. By matching bank/firm credit exposures with employer/employee data, the authors show that firms borrowing from banks affected by the capital shock are able to borrow less and

decrease employment, most notably of more skilled workers. These workers become more likely to exit affected firms (and less likely to join these firms). This shows that credit shocks may have long-term effects on firm productivity and growth.

The role of monetary policy

Monetary policy plays a key role in the link between credit and the economy. Banks are central in the transmission of monetary policy, most notably through their lending decisions. According to the bank lending channel, when monetary policy tightens, bank reserves will shrink, thus reducing banks' willingness to grant loans (Bernanke and Gertler, 1995; Kashyap and Stein, 2000).

Against this background, there is an undisputable consensus in the theoretical and empirical literature that monetary policy decisions affect credit growth. These effects can even spill over across borders, as shown in a recent paper by Barbosa, Bonfim, Costa, and Everett (2018). The authors show that monetary policy decisions adopted in the US and in the UK affect credit growth in Portugal and in Ireland. The authors find that before the sovereign debt crisis, funding frictions play a role in the cross-border transmission of monetary policy in both economies. In this period, banks in these two countries borrowed extensively in international wholesale debt markets, thus enhancing the pass-through of foreign monetary policy decisions to domestic markets. Banks that held more liquid assets were better able to offset the impact of funding shocks driven by changes in foreign monetary policy. When looking into the crisis period, the authors find that the cross-border transmission of monetary policy changes in many dimensions. The two countries analyzed, Portugal and Ireland, were in the eye of the storm during the euro area sovereign debt crisis. A strong deleveraging trend in the two banking systems, combined with ample provision of central bank liquidity, significantly reduced the influence of the cross-border transmission of monetary policy during the crisis.

The shocks that hit the financial system since 2007/2008 led to a major overhaul in the way monetary policy is conducted. Central bankers were called in to adopt unprecedented measures to restore the smooth functioning of the financial system. Alves, Bonfim, and Soares (2016) illustrate the critical role played by the ECB in avoiding a collapse in the Portuguese financial system when banks suddenly lost access to international wholesale debt markets in the Spring of 2010. Banks were heavily reliant on this type of funding. The loan-to-deposit ratio stood at values close to 160%. After Greece and Ireland asked for a bailout, in the early days of the euro area sovereign debt crisis, international investors believed that Portugal would be the next country to request financial assistance and became entirely unwilling to

rollover the maturing debt of Portuguese banks. The ECB played a key role as a lender of last resort. In a very short time-window, the equivalent of around 20% of Portugal's GDP was refinanced through the ECB. The authors show that despite the magnitude of this shock, credit continued to flow to the economy without any major disruptions.

The monetary policy toolkit adopted by the ECB and other central banks in advanced economies during the crisis was substantially enhanced. A wide array of unconventional monetary policy measures was adopted and researchers have been analyzing their impacts (see for example Acharya and Mora, 2015; Chodorow-Reich, 2014; Morais, Peydro, and Ruiz, 2019). Using granular data on loans and securities in the balance sheet of Portuguese banks, Blattner, Farinha, and Nogueira (2016) study the effects of quantitative easing. The authors find that the ECB's Expanded Asset Purchase Program (EAPP) led to a drop of 64 b.p. in the interest rates on loans granted by banks exposed to this program. The identification comes from the fact that not all banks were exposed to the EAPP, given that they did not hold eligible securities for the program. They also find that loans granted to existing customers increase by 1 p.p. more for exposed banks, relative the non-exposed ones. At the extensive margin, banks that held securities eligible for this asset purchase program became 1 p.p. more likely to grant loans to new corporate customers. Together, these results show that by purchasing assets, the ECB was able to promote loan growth and to decrease funding costs in the economy, in line with what has been found in other countries.

More recently, Jasova, Mendicino, and Supera (2018) studied the impact of a decrease in Portuguese banks' rollover risk on their credit supply decisions. The authors analyse the impact of the provision of long-term funding by the ECB in 2011 through the Very Long-Term Refinancing Operations (vLTRO). Again, using granular data on loans and security holdings, the authors find that the extension of bank's debt maturity has a positive impact on bank lending, in line with what has been found in other European countries (see for example Andrade, Cahn, Fraisse, and Mésonnier, 2019; Carpinelli and Crosignani, 2018; Darracq-Paries and De Santis, 2015; Garcia-Posada and Marchetti, 2016). Loan growth was stronger for smaller, younger and riskier firms, as well as for firms with shorter lending relationships. This additional lending is able to generate real effects, fostering employment and investment in small firms. However, the authors document that unrestricted liquidity provisions allowed banks to purchase more securities, instead of channeling all the additional liquidity to the firms and households. This supports the use of more targeted monetary policy tools, such as the Targeted Long-Term Refinancing Operations (TLTRO).

Crosignani, Faria-e-Castro, and Fonseca (2019) also study the vLTROs in Portugal. Their results emphasize the side effects documented by Jasova,

Mendicino, and Supera (2018). The authors find that the provision of long-term funding by the ECB provides incentives for banks to purchase high-yield short-term securities. The authors argue that banks purchased these securities to pledge them as collateral to obtain even more central bank liquidity (collateral trade effect).

The side effects of monetary policy documented by Jasova, Mendicino, and Supera (2018) and Crosignani, Faria-e-Castro, and Fonseca (2019) have further support on the literature on the risk-taking channel of monetary policy. It has been extensively documented that when monetary policy is (too) accommodative, banks tend to adopt riskier lending strategies (see for example Bruno and Shin, 2015). Bonfim and Soares (2018) show that this risk-taking channel is at work also in Portugal. By examining the transmission of monetary policy before the global financial crisis, the authors find that when interest rates are low, ex ante riskier borrowers are more likely to receive funding. However, when examining the ex post performance of the loans granted in low interest rate periods, they do not find significant differences in their performance, thus suggesting that the risk-taking channel does not entail sizeable risks to financial stability. However, the loans granted in periods of very low and stable interest rates show higher default rates once interest rates start to increase. This finding has relevant policy implications for what we might expect once monetary policy becomes tighter in the euro area, after a long period of ample liquidity and extremely low funding costs.

Final remarks

Recent research has made significant progress in dealing with the difficulty in establishing a causal link between bank shocks and real economic variables. Khwaja and Mian (2008) draw the attention to the importance of separating the bank lending channel and the firm borrowing channel in understanding how bank shocks affect lending to the economy. This paper influenced many other papers in a strand of the literature that has tried to find shocks that reproduce "natural experiment" conditions. Using the "exogenous" variation in banks' liquidity generated by the 2007–2009 crisis, many papers robustly find that banks affected by shocks decrease lending (see for example Ivashina and Scharfstein, 2010). Other studies, such as the Chodorow-Reich (2013) seminal paper, analyse the causal effects of bank supply shocks on real variables.

Despite the importance of these concerns there is a trade-off between a precise identification of the shocks and the generality of the results. It is important to understand whether the conclusions apply only in a particular scenario or whether they may have general implications. This is why observing non-causal patterns in the data can be an important complement of the analysis, even though policy decisions should ideally be anchored on

the identification of causal effects. In any case, the availability of good quality micro data is essential when the presence of heterogeneity is relevant.

This article surveys the empirical research that has been developed at Banco de Portugal in the last decade, most of which uses the micro databases available. Some of these studies focus on the identification of causal relationships between bank shocks, credit and real economic variables. Other studies analyse non-causal patterns and relationships between these variables and also make important contributions to the understanding of the adjustment process of the Portuguese economy. Overall, this research documents that bank liquidity and capital shocks during the crisis had a negative impact on investment, employment, human capital, firm survival and productivity. These impacts were heterogeneous in the sense that they vary with the characteristics of the firms and the banks. During the adjustment period, very low monetary policy rates induced some risk-taking behaviour by the banks but unconventional monetary policy measures reduced the roll-over risk and avoided disruption in the financing of the Portuguese economy. Moreover intrusive supervision under the adjustment program mitigated zombie lending.

For sure many important questions remain unanswered and researchers, both inside and outside Banco de Portugal, continue to thoroughly examine the available data to address them.

References

Acharya, V.V. and N. Mora (2015). "A Crisis of Banks as Liquidity Providers." *Journal of Finance*, 70(1), 1–43. https://ideas.repec.org/a/bla/jfinan/v70y2015i1p1-43.html.

Alves, Nuno, Diana Bonfim, and Carla Soares (2016). "Surviving the perfect storm: the role of the lender of last resort." Banco de Portugal Working Paper, 201617. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201617.pdf.

Amador, João and Arne Nagengast (2016). "The effect of bank shocks on firm-level and aggregate investment." *ECB Working Paper*. https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1914.en.pdf.

Amiti, Mary and David E Weinstein (2018). "How much do idiosyncratic bank shocks affect investment? Evidence from matched bank-firm loan data." *Journal of Political Economy*, 126(2), 525–587. https://www.journals.uchicago.edu/url/pdfplus/10.1086/696272.

Andrade, P., C. Cahn, H. Fraisse, and J-S. Mésonnier (2019). "Can the Provision of Long-Term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's 3-year LTROs." *Journal of the European Economic Association*, forthcoming. https://academic.oup.com/jeea/advance-article/url/10.1093/jeea/jvy020/5035663.

Antunes, António, Homero Gonçalves, and Pedro Prego (2016). "Firm default probabilities revisited." *Banco de Portugal Economic Studies*, II(2), 21–45. https://www.bportugal.pt/sites/default/files/anexos/papers/re201605_e.pdf.

Antunes, António and Ricardo Martinho (2012a). "Access to credit by non-financial firms." Financial Stability Report, 2012, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201202_e.pdf.

Antunes, António and Ricardo Martinho (2012b). "A scoring model for Portuguese non-financial enterprises." Financial Stability Report, 2012, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201206_e.pdf.

Antunes, António, José Mata, and Pedro Portugal (2010). "Borrowing Patterns, Bankruptcy and Voluntary Liquidation." Banco de Portugal Working Papers 2010-07. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201027.pdf.

Augusto, Francisco and Sónia Félix (2014). "The impact of bank recapitalization on firms' access to credit: evidence from Portugal." *Banco de Portugal Financial Stability Papers*, 2. https://www.bportugal.pt/sites/default/files/anexos/papers/fs201402.pdf.

Azevedo, Nuno, Márcio Mateus, and Álvaro Pina (2018). "Bank credit allocation and productivity: stylised facts for Portugal." Banco de Portugal Working Papers 201825. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201825.pdf.

Banerjee, Abhijit V and Esther Duflo (2005). "Growth theory through the lens of development economics." *Handbook of economic growth*, 1, 473–552. https://www.sciencedirect.com/science/article/pii/S1574068405010075.

Barbosa, Luciana (2017). "Lending relationships and the real economy: evidence in the context of the euro area sovereign debt crisis." Banco de Portugal Working Papers, 201708. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201708.pdf.

Barbosa, Luciana, Andrada Bilan, and Claire Celerier (2019). "Credit supply and human capital: Evidence from bank pension liabilities." Mimeo. https://www.dropbox.com/s/mr685u7syb8zqv6/BarbosaBilanCelerier_ECBWP_12Feb2019.pdf?dl=0.

Barbosa, Luciana, Diana Bonfim, Sónia Costa, and Mary Everett (2018). "Cross-border spillovers of monetary policy: What changes during a financial crisis?" *Journal of International Money and Finance*, 89, 154–174. https://www.sciencedirect.com/science/article/pii/S0261560618305059.

Beck, Thorsten, Samuel Da-Rocha-Lopes, and André Silva (2017). "Sharing the Pain? Credit Supply and Real Effects of Bank Bail-ins." CEPR Working Paper 12058. https://drive.google.com/file/d/1erToKqHvvJ5CG2Wi5Y4My7jR9qtANmJk/view.

Bernanke, Ben S and Mark Gertler (1995). "Inside the black box: the credit channel of monetary policy transmission." *Journal of Economic Perspectives*, 9(4), 27–48. https://www.aeaweb.org/articles?id=10.1257/jep.9.4.27.

Blanchard, Olivier and Pedro Portugal (2017). "Boom, slump, sudden stops, recovery, and policy options. Portugal and the Euro." *Portuguese Economic Journal*, 16(3), 149–168. https://link.springer.com/article/10.1007/s10258-017-0139-8.

Blattner, Laura, Luísa Farinha, and Gil Nogueira (2016). "The effect of quantitative easing on lending conditions." Banco de Portugal Working Papers 201608. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201608_0.pdf.

Blattner, Laura, Luísa Farinha, and Francisca Rebelo (2018). "When losses turn into loans: the cost of undercapitalized banks." Banco de Portugal Working Papers, 201816. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201816.pdf.

Blattner, Laura, Luísa Farinha, and Francisca Rebelo (2019). "Debt or demand: which holds investment back? Evidence from an investment tax credit." Mimeo.

Bonfim, Diana (2009). "Credit risk drivers: Evaluating the contribution of firm level information and of macroeconomic dynamics." *Journal of Banking and Finance*, 33(2), 281–299. https://www.sciencedirect.com/science/article/pii/S0378426608001854.

Bonfim, Diana, Geraldo Cerqueiro, Hans Degryse, and Steven Ongena (2019). "Inspect what you expect to get respect: can bank supervisors kill zombie lending." Mimeo.

Bonfim, Diana, Daniel A. Dias, and Christine Richmond (2012). "What happens after corporate default? Stylized facts on access to credit." *Journal of Banking and Finance*, 36(7), 2007 – 2025. https://www.sciencedirect.com/science/article/pii/S0378426612000696.

Bonfim, Diana, Gil Nogueira, and Steven Ongena (2016). "Sorry, We're Closed: Loan Conditions When Bank Branches Close and Firms Transfer to Another Bank." Banco de Portugal Working Papers 7-2016. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201607.pdf.

Bonfim, Diana and Carla Soares (2018). "The Risk-Taking Channel of Monetary Policy: Exploring All Avenues." *Journal of Money, Credit and Banking*, 50(7), 1507–1541. https://onlinelibrary.wiley.com/url/pdf/10.1111/jmcb.12500.

Bruno, Valentina and Hyun Song Shin (2015). "Capital flows and the risk-taking channel of monetary policy." *Journal of Monetary Economics*, 71, 119 – 132. https://url.org/10.1016/j.jmoneco.2014.11.011.

Buera, Francisco and Sudipto Karmakar (2018). "Real effects of financial distress: the role of heterogeneity." Banco de Portugal Working Paper, 201806. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201806.pdf.

Carneiro, Anabela, Pedro Portugal, and José Varejão (2014). "Catastrophic job Destruction during the Portuguese Economic Crisis." *Journal of Macroeconomics*, 39, 444 – 457. https://url.org/10.1016/j.jmacro.2013.09.018.

Carpinelli, Luisa and Matteo Crosignani (2018). "The Effect of Central Bank Liquidity Injections on Bank Credit Supply." mimeo. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2930063.

Chen, Ruo, Mr Gian-Maria Milesi-Ferretti, and Mr Thierry Tressel (2012). *External imbalances in the euro area*. 12-236, International Monetary Fund. https://www.imf.org/external/pubs/ft/wp/2012/wp12236.pdf.

Chodorow-Reich, Gabriel (2013). "The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis." *The Quarterly Journal of Economics*, 129(1), 1–59. https://academic.oup.com/qje/article/129/1/1/1899226.

Chodorow-Reich, Gabriel (2014). "Effects of Unconventional Monetary Policy on Financial Institutions." *Brookings Papers on Economic Activity*, 48(1), 155–227. https://www.brookings.edu/bpea-articles/effects-of-unconventional-monetary-policy-on-financial-institutions/.

Costa, Sónia (2012). "Households' Default Probability: An Analysis Based on the Results of the HFCS." Financial Stability Report, November 2012, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201205_e.pdf.

Costa, Sónia and Luísa Farinha (2012). "Households' indebtedness: a microeconomic analysis based on the results of the Households' Finance and Consumption Survey." Financial Stability Report, May 2012, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/

ar201201_e.pdf.

Crosignani, Matteo, Miguel Faria-e-Castro, and Luís Fonseca (2019). "The (unintended?) consequences of the largest liquidity injection ever." *Journal of Monetary Economics*. Forthcoming. https://www.sciencedirect.com/science/article/pii/S0304393218302605.

Darracq-Paries, Matthieu and Roberto A. De Santis (2015). "A non-standard monetary policy shock: The ECB's 3-year LTROs and the shift in credit supply." *Journal of International Money and Finance*, 54(C), 1–34. https://www.sciencedirect.com/science/article/pii/S0261560615000261.

Degryse, Hans, Artashes Karapetyan, and Sudipto Karmakar (2018). "To Ask or Not To Ask? Collateral versus Screening in Lending Relationships." Banco de Portugal Working Papers 201819. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201819.pdf.

Dias, Daniel A and Carlos Robalo Marques (2018). "Every cloud has a silver lining: micro-level evidence on the cleansing effects of the portuguese financial crisis." Banco de Portugal Working Papers 201818. https://www.bportugal.pt/sites/default/files/wp201818.pdf.

Farinha, Luísa and Sónia Félix (2015). "Credit rationing for Portuguese SMEs." *Finance Research Letters*, 14, 167–177. Https://www.sciencedirect.com/science/article/pii/S1544612315000458.

Farinha, Luísa and Ana Lacerda (2010). "Household credit delinquency: does the borrowers' indebtedness profile play a role." Financial Stability Report, November 2010, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201005_e.pdf.

Farinha, Luísa and Pedro Prego (2013). "Investment decisions and financial standing of Portuguese firms: recent evidence." Financial Stability Report, May 2013, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201302_e.pdf.

Farinha, Luísa and Pedro Prego (2014). "Cash holdings determinants in the Portuguese economy." Financial Stability Report, May 2014, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201401_e.pdf.

Farinha, Luísa, Marina-Eliza Spaliara, and Serafeim Tsoukas (2019). "Bank shocks and firm performance: New evidence from the sovereign debt crisis." *Journal of Financial Intermediation*, forthcoming. https://www.sciencedirect.com/science/article/pii/S1042957319300208?via%3Dihub.

Fazzari, Steven, R Glenn Hubbard, and Bruce Petersen (1988). "Investment, financing decisions, and tax policy." *American Economic Review*, 78(2), 200–205. http://www.jstor.org/stable/1818123.

Félix, Sónia (2018). "Borrowing constraints and firm dynamics." *Banco de Portugal Economic Studies*, IV(3), 77–84. https://www.bportugal.pt/sites/default/files/anexos/papers/re201809_e.pdf.

Garcia-Posada, M. and M. Marchetti (2016). "The bank lending channel of Unconventional Monetary Policy: the impact of the VLTROs on

credit supply in Spain." *Economic Modelling*, 58, 427–441. https://www.sciencedirect.com/science/article/pii/S0264999316301274.

Gomes, Sandra (2017). "A model with financial frictions and a banking system for the Portuguese economy." *Banco de Portugal Economic Studies*, III(3), 67–92. https://www.bportugal.pt/sites/default/files/anexos/papers/ree201710_e.pdf.

Gopinath, Gita, Şebnem Kalemli-Özcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez (2017). "Capital allocation and productivity in South Europe." *The Quarterly Journal of Economics*, 132(4), 1915–1967. https://academic.oup.com/qje/article/132/4/1915/3871448.

Holmstrom, Bengt and Jean Tirole (1997). "Financial intermediation, loanable funds, and the real sector." *the Quarterly Journal of economics*, 112(3), 663–691. https://academic.oup.com/qje/article/112/3/663/1926881.

Ivashina, Victoria and David Scharfstein (2010). "Bank lending during the financial crisis of 2008." *Journal of Financial Economics*, 97(3), 319–338. https://www.sciencedirect.com/science/article/pii/S0304405X09002396.

Iyer, Rajkamal, José-Luis Peydró, Samuel da Rocha-Lopes, and Antoinette Schoar (2013). "Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007–2009 crisis." *The Review of Financial Studies*, 27(1), 347–372. https://academic.oup.com/rfs/article/27/1/347/1573768.

Jasova, Martina, Caterina Mendicino, and Dominik Supera (2018). "Rollover Risk and Bank Lending Behavior: Evidence from Unconventional Central Bank Liquidity." CEPR Working Paper. https://cepr.org/sites/default/files/40021_Supera_roll_over_risk_and_bank_lending_behavior.pdf.

Júlio, Paulo and José R. Maria (2017). "The Portuguese post-2008 period: A narrative from an estimated DSGE model." Banco de Portugal Working Papers 201715. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201715.pdf.

Júlio, Paulo and José R. Maria (2018). "An integrated financial amplifier: the role of defaulted loans and occasionally binding constraints in output fluctuations." Banco de Portugal Working Papers 201813. https://www.bportugal.pt/sites/default/files/anexos/papers/wp201813.pdf.

Kashyap, Anil K and Jeremy C Stein (2000). "What do a million observations on banks say about the transmission of monetary policy?" *American Economic Review*, 90(3), 407–428. https://www.aeaweb.org/articles?id=10.1257/aer.90.3.407.

Khwaja, Asim Ijaz and Atif Mian (2008). "Tracing the impact of bank liquidity shocks: Evidence from an emerging market." *American Economic Review*, 98(4), 1413–42. https://www.aeaweb.org/articles?id=10.1257/aer.98.4.1413.

Kremp, Elizabeth and Patrick Sevestre (2013). "Did the crisis induce credit rationing for French SMEs?" *Journal of Banking and Finance*, 37(10), 3757–3772. https://www.sciencedirect.com/science/article/pii/S0378426613002537.

Laeven, Luc and Fabian Valencia (2013). "The real effects of financial sector interventions during crises." *Journal of money, credit and banking*, 45(1), 147–177. https://www.jstor.org/stable/pdf/23320080.pdf.

Martins, Fernando (2016). "How the Portuguese firms adjusted to the economic and financial crisis: main shocks and channels of adjustment." *Banco de Portugal Economic Studies*. https://www.bportugal.pt/sites/default/files/anexos/papers/re201603_e.pdf.

Modigliani, Franco and Merton H Miller (1958). "The cost of capital, corporation finance and the theory of investment." *American Economic Review*, 48, 261–297. https://www.jstor.org/stable/pdf/1812919.pdf.

Morais, Bernardo, Jose Luis Peydro, and Claudia Ruiz (2019). "The International Bank Lending Channel of Monetary Policy Rates and QE: Credit Supply, Reach-for-Yield, and Real Effects." *Journal of Finance*, 74(1), 55–90. https://onlinelibrary.wiley.com/url/full/10.1111/jofi.12735.

Reis, Ricardo (2013). "The Portuguese slump and crash and the euro crisis." *Brookings Papers on Economic Activity*, (46), 143–193. https://www.brookings.edu/bpea-articles/the-portuguese-slump-and-crash-and-the-euro-crisis.

Restuccia, Diego and Richard Rogerson (2013). "Misallocation and productivity." *Review of economic dynamics*, 16, 1–10.

Saldanha, Sofia and Carla Soares (2015). "The Portuguese money market throughout the crisis: What was the impact of ECB liquidity provision?" *Banco de Portugal Economic Studies*. https://www.bportugal.pt/sites/default/files/anexos/papers/re201512_e.pdf.

Santos, António and Nuno Silva (2019). "Sectoral concentration risk in Portuguese banks' loan exposures to nonfinancial firms." *Banco de Portugal Economic Studies*, V(1), 1–18. https://www.bportugal.pt/sites/default/files/anexos/papers/re201901_e.pdf.

Sforza, Alessandro (2018). "Shocks and the organization of the firm: Who pays the bill." Mimeo. https://drive.google.com/file/d/0ByQcl7SXliImeEpMdGUtS3RGLXM/view.

Silva, Nuno (2010). "Inter-sector relations in the Portuguese economy: An application of contingent claim analysis." Financial Stability Report, November 2010, Banco de Portugal. https://www.bportugal.pt/sites/default/files/anexos/papers/ar201004_e.pdf.

www.bportugal.pt