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Article

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ORIGINAL ARTICLE

Growth and imbalances in Spain: a reassessment of the output gap

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Abstract 'The Great Recession' was preceded by a prolonged period of high growth accompanied by low and stable inflation, the so called 'The Great Moderation'. In Spain, a similar pattern was observed: in fact, potential growth estimates were trending upwards, implying that output gaps remained relatively contained. However, the Spanish economy was progressively accumulating other internal and external imbalances. Standard potential growth estimates, which consider inflation as the only indicator of macroeconomic imbalances, therefore provided misleading signals to the policymakers. In this paper we apply to Spain a new methodology to obtain sustainable growth rates, as an alternative measure to potential growth. Sustainable growth is defined as the output growth that does not widen macroeconomic imbalances, identified through a wide set of domestic and external indicators. We find that sustainable growth rates are more stable than potential growth resulting in an output gap that is substantially larger (in absolute value) both before and after the crisis. Another attractive feature of the results is that our measure of output gap turns out to be more robust to revisions than standard measures when 'The Great Recession' emerged.

Keywords Spain · Sustainable growth · Macroeconomic imbalances · Output gaps · Potential growth

All authors are affiliated with Banco de España. The views expressed in this paper are those of the authors alone and do not necessarily reflect the views of Banco de España or its staff. This paper extends the previous work titled "Growth Beyond Imbalances. Sustainable Growth Rates and Output Gap Reassessment" for the Spanish case. We would like to acknowledge Gabriel Pérez-Quirós, Philip Hill, the participants in Banco de España and IMF seminars and two anonymous referees for their valuable comments. All remaining errors are obviously ours.

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1 Motivation

The global financial crisis of 2008 was preceded by a protracted phase of economic expansion coupled with low and stable inflation. This period came to be known as the 'Great Moderation' (see, for example, Stock and Watson 2002; Bernanke 2004) and it was widely considered that the observed growth was underpinned by solid economic foundations. However, during this period, domestic and external imbalances, many of them closely related to the exuberance of the financial sector, were accumulating. These eventually brought about the worst crisis in decades, which has become known, in contrast to the previous label, as the 'Great Recession'. To be fair, there were warnings from different quarters, that imbalances building up meant that the observed growth rates were unsustainable. For instance, the IMF alerted to the global imbalances (the buildup of increasing current account deficits and surpluses) and the BIS emphasized the risks deriving from asset bubbles and excessive credit growth. In the case of Spain, some of these imbalances were rather evident. For instance, it was ex-ante recognized that the observed current account deficits required quite high long-term growth expectations to be coherent with the intertemporal budget constrain of households (Campa and Gavilán 2006) or that by the mid 2000s the prices of housing were significantly overvalued (Ayuso and Restoy 2006). However, the dominant perception was that the high growth rates—along with mild cyclical oscillations were here to stay. The progressive increase in the estimated potential growth rate contributed to and was a reflection of this perception.

The concept of potential growth plays a key role in the design of the macroeconomic policies. Monetary, fiscal and, more recently, macroprudential policies take into account the output gap estimates—the difference between potential and actual output—to adapt their stance in order to reduce possible macroeconomic imbalances/disequilibria and dampen aggregate fluctuations. This role is even more important for a country like Spain, which cannot rely on a specific monetary policy. Indeed, potential growth has been subject to extensive analysis in the theoretical and empirical literature, but the relevance and usefulness of these concepts for economic policy will depend on two factors. First, the ability of the output gap to reflect and summarise the disequilibria of the economy. And second, the degree of uncertainty surrounding the estimates of the output gap and their robustness to new information.

In that respect, the experience of the crisis reveals the weaknesses of standard potential growth estimates as a tool to capture the sustainable rate of growth of the economy. The main limitation of the potential growth estimates is the consideration of just one indicator to sum up the imbalances of the economy: the inflation rate, which is supposed to capture the deviations of observed from structural unemployment. This approach involves the estimation of potential growth through the Phillips curve, which allows the NAIRU, that is the "potential" unemployment rate, to be calculated.

However, inflation rates, represented by the consumer prices (CPI), seem not to have been a sufficient indicator of the macroeconomic imbalances of the economy during the last decade or so. As can be seen in Fig. 1, advanced economies displayed a statistically

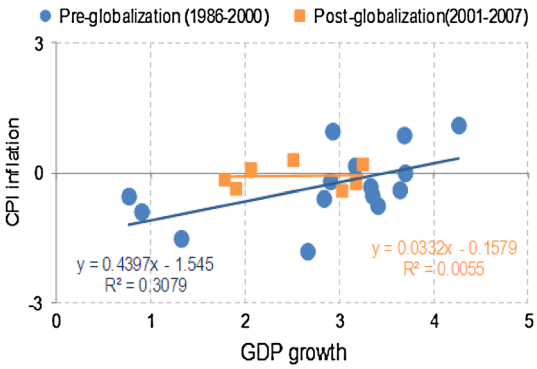


Fig. 1 GDP vs. inflation. Advanced economies (simple averages). Source: IMF (WEO)

significant positive correlation between growth and changes in inflation before 2001. This association mostly disappeared after 2001. Various reasons have been put forward for explaining this result: the success of central banks in controlling inflation and anchoring inflation expectations, reforms in the labor and product markets, or the globalization process, among others (see, for example, WEO, 2013 for a detailed analysis).

At a time when inflation had stabilized, other indicators of imbalances showed a significant widening in many countries. This was especially the case in Spain. For instance, the current account deficits increased significantly, while at the same time, potential growth estimates remained quite strong or even increased (Fig. 2). The same happened with the private and public balance, or with private investment, which was mainly driven by residential investment. It could be argued that part of observed growth in Spain was fostered by the launch of the Monetary Union and the implied gains in terms of macroeconomic stability, financial integration, lowered costs of funding and credibility of monetary policy. This structural change could result in large potential growth and limited inflationary pressures, identified with a process of real convergence. However, the crisis in Spain has shown that in that period observed growth was excessive and its nature pernicious for the stability of the system.

This paper applies a new methodology to obtain estimates of sustainable growth rates for Spain (see also Alberola et al. 2013). The sustainable growth rate is defined as the output growth that does not widen macroeconomic imbalances, which are identified through a wide set of domestic and external indicators (for alternative definitions, see, for example, Basu and Fernald 2009). The methodology is analogous to that used to estimate standard potential growth, with two major modifications. First, several refinements to the components of the production are made in order to obtain a more precise framework to assess cyclical fluctuations related to imbalances. Second, we consider a much richer set of economic and financial variables which may reflect economic imbalances, in order to identify which imbalances drive the business cycle.

On the basis of these elements, we estimate the sustainable growth rate for Spain over the period 1970–2011. As it will be seen, this paper has strong links to the literature related to early warning indicators (Frenkel and Saravelos 2012), which have recently been incorporated to the multilateral supervision mechanisms of Europe (Scoreboard, MIB) and the G-20 (Indicative Guidelines, SA). Insofar as most of the imbalances

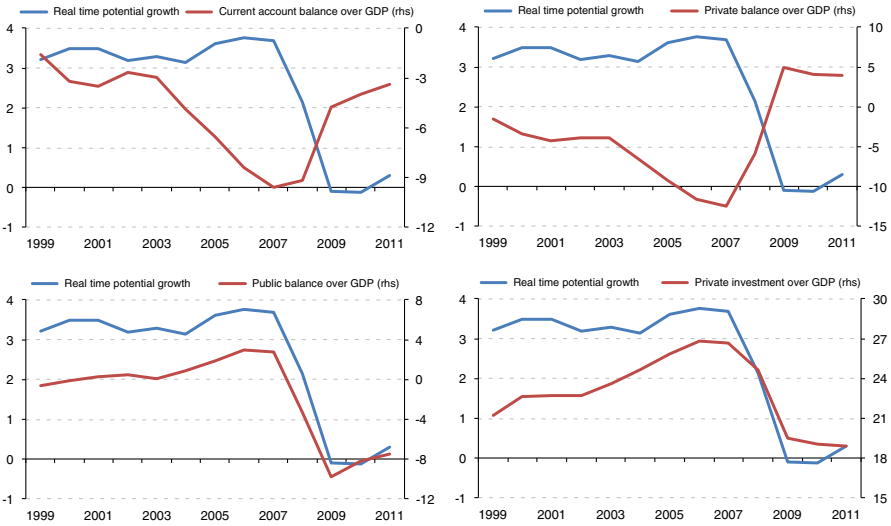


Fig. 2 Spain GDP vs. selected imbalance indicators (%). Sources: European Commission and AMECO

indicators considered have a strong financial component, it also has close links to the literature relating financial and business cycles (Claessens et al. 2011 or Borio and Disyatat 2011). Especially relevant is the recently published working paper by Borio et al. (2013), which reaches very similar conclusions using a somewhat different methodology to refine the traditional output gap estimates. Finally, in the Spanish case, the papers of both Campa and Gavilán (2006) and Estrada et al. (2010) have stressed the relevance of the external imbalances to account for sustainable growth.

The document is organised as follows. In Sect. 2, macroeconomic imbalance indicators are discussed and some stylised facts on their interaction with standard estimates of potential growth are presented. This will show, first, that although potential growth estimates over time (real-time) are not correlated with inflation, they are correlated with some of the indicators of imbalances considered; and second, after the crisis, as imbalances have been corrected, there have been important revisions to the estimates of potential growth. Section 3 presents the methodology used to estimate sustainable growth rates. The overview of the results is presented in Sect. 4, detailing the imbalances indicators relevant for Spain, the contribution of production factors to sustainable growth and the reassessment of the output gap. A brief Sect. 5 presents a preliminary comparison of the revisions in potential and sustainable growth estimates, which shows the lower revisions associated to our methodology. The final section concludes.

2 Economic imbalances and standard measures of potential growth

2.1 Indicators of macroeconomic imbalances

In recent years there has been a significant number of contributions to the literature on imbalance indicators. This is due to the consensus among analysts and policymakers

Table 1 Macroeconomic imbalances

Variable	Description
Real effective exchange rate (first difference)	Real effective exchange rates, CPI-based
CPI (first difference)	National consumer price index (all items, yearly average)
Current account balance/GDP	Net lending (+) or net borrowing (−): total economy
Trade balance/GDP	Real trade balance
Private balance/GDP	Net lending (+) or net borrowing (−): households and non-financial firms
Private savings/GDP	Gross savings: households and non-financial firms
Private investment/GDP	Gross fixed capital formation − gross fixed capital formation of the general government
Residential investment/GDP	Gross fixed capital formation: dwellings
Public balance/GDP	Net lending (+) or net borrowing (−): general government
Public savings/GDP	Gross saving: general government
Public investment/GDP	Gross fixed capital formation: general government
Non-tradable sector value added/GDP	Value added of services and construction
International investment position/GDP	
Private debt/GDP	Private sector gross debt
Public debt/GDP	General government consolidated gross debt

on the relevance of imbalances for explaining the current crisis and the need to correct them before starting a new period of robust, sustainable and balanced growth. In fact, several international organisations have developed various frameworks for the evaluation and early detection of macroeconomic imbalances (European Union or G-20).

Based on these procedures and on the evidence presented, for example, in Frenkel and Saravelos (2012), we have considered the fifteen possible indicators of imbalances shown in Table 1 (for a more detailed definition, see Appendix A). The indicators can be classified in three groups. First, those based on the behaviour of prices, including the real effective exchange rate for the external sector, and the consumer price index (CPI) and the GDP deflator for the domestic sector. All of them are expressed in first differences to capture the level of inflation. Prices are usually the economic variable first reacting to developments in activity. In that respect, they can be considered as the leading indicators of imbalances. However, as earlier demonstrated, for different reasons their response to activity in the past decade has been scant (possible due to the counteracting effects of other shocks), meaning that additional indicators are needed to incorporate other macroeconomic imbalances into the analysis of sustainable growth.

The second group includes real flow variables. These indicators should move in phase with activity, but with much higher volatility, thus facilitating the identification of the cycle. In this category we have analysed the current account from the external perspective, and private and public balances (and their components), housing invest-

ment and the share of the non-tradable sector from the domestic side (all of them as a percentage of GDP).

Finally, the third group of imbalance indicators is real stocks, also as a percentage of GDP. The problem with this group of indicators is that while they show a very high (though lagged) correlation with activity when the cycle is expansionary, the correlation disappears in recessions. The specific indicators considered in this group are net foreign assets for the external sector, and private and public debt for the domestic one (also as a percentage of GDP).

2.2 Stylised facts

The standard potential output methodology considers CPI inflation a sufficient statistic of all macroeconomic imbalances. Therefore, one required property of standard potential output estimates would be for them to be unrelated to other macroeconomic imbalances. Another desirable property of real time potential growth estimates is that they should be unrelated to ex-post output gaps. Both properties would, in principle, entail relatively minor revisions of potential growth estimates when new information arrives. However, the following stylised facts reveal that neither of those desirable properties holds and, therefore, the standard potential growth estimates are providing misleading signals of the magnitude of the economic slack and, ultimately, of the imbalances that the economy faces.

As stated in the introduction, CPI inflation appears not to be a sufficient statistic of economic imbalances and, hence, the estimates of potential output might not be properly reflecting the economic growth that an economy can attain with its resources and technology. To ascertain whether that possibility holds formally, we test to what extent the potential output growth estimates made over time—real time—are systematically associated with the changes in the set of variables defined in Table 1, which are considered to capture economic imbalances.

In order to obtain robust results, we conduct the analysis between potential growth and imbalances not only for Spain, but also for United States, United Kingdom and Germany. We use the real-time estimates of potential growth reported by the European Commission and by the US Congressional Budget Office.[1] The significance of these relationships is assessed by estimating the coefficient of potential growth estimates and the corresponding imbalance indicator using 8-year window rolling bivariate regressions for the pooled data of United States, United Kingdom, Spain and Germany.[2,3]

The coefficients of these rolling regressions and the 95 % confidence bands are displayed in Fig. 3. The first result is that, as expected, real-time potential output is effectively uncorrelated with inflation developments. Second, the ex-post output gap

[1] We also considered OECD's potential growth real time estimates and the stylised facts hold.

[2] As a robustness test, we have also performed similar exercises but regressing real-time potential growth with the cyclical deviations of the imbalances and with the absolute value of the cyclical deviations of these imbalances (instead of with the changes in the imbalances). In overall terms, the same stylised facts hold.

[3] In the rolling regressions, we differentiate these variables until the unit root tests accept they are stationary.

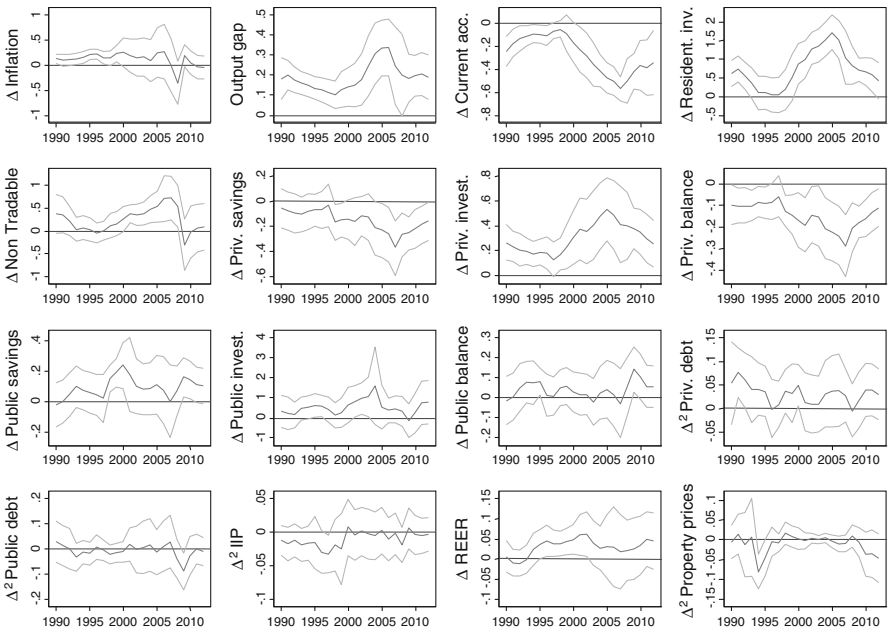


Fig. 3 8 year window rolling bivariate regression coefficient of real-time potential growth (assessed in t+1) with the following imbalance indicators (95 % confidence interval). Source: Own calculations. Note: All variables expressed in GDP terms with the exception of inflation, output gap, real effective exchange rates and property priceslabel

is clearly associated with real-time potential growth,[4] which is an implicit recognition that such potential growth estimates did not fully capture the temporary component of GDP and were largely uncertain.

Third, the estimates of potential growth are correlated with different measures of external (such as the current account balance) or domestic (e.g. private sector balance or residential investment) imbalances. As shown in Fig. 3, this has been particularly acute in the last decade, when inflation developments have been increasingly decoupled from economic slack. The imbalances that present stronger correlations are the current account, residential investment, private investment and private balance, all of them related to asset price inflation and financing needs. In other words, either the financing needs of the country or those of the private sector seem to be those most related to the estimates of potential growth. Both stocks (the accumulation of past imbalances) and prices appear to have a much weaker relationship to potential growth.

Fourth, real-time potential growth estimates tend to increase when imbalances are rising (i.e. larger current account deficits) and to decrease when correcting. This fact is better grasped in the first panel of Fig. 2, which plots the current account balance and potential growth.

Although not shown, these correlations diminish significantly when ex-post potential growth estimates are considered instead of real-time estimates. This suggests

[4] By construction, real-time potential growth and real-time output gaps should be uncorrelated.

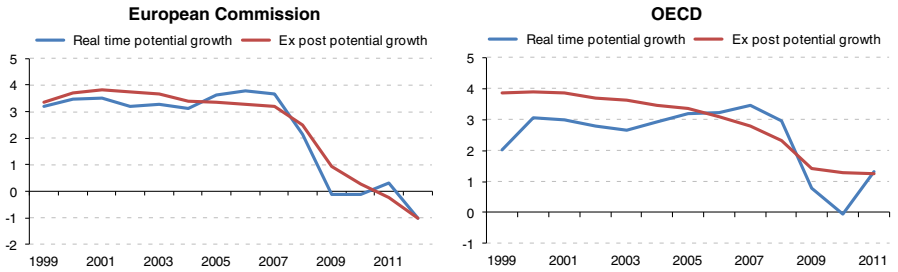


Fig. 4 Spain: real time and ex-post potential growth (%). Source: European Commission and OECD

potential growth tends to be revised substantially ex-post when the fallout from the imbalances is reflected in a correction of the activity. However, for some imbalances the correlations with ex-post potential growth continue to be significant, implying that more than additional information on the GDP behavior is necessary in order to filter out imbalances from potential growth estimations. That said, this is not only an end point problem associated to the two-sided nature of most of the statistical filters used to estimate potential growth, it is a problem of taking into account all the information required to properly identify the maximum growth compatible with balanced growth.

Figure 4 plots the real-time and ex-post potential output growth estimates of the European Commission and the OECD for Spain. For both sources, the revisions of potential growth have been important. This reappraisal of latent economic conditions goes in the expected direction in both cases: there is a downward revision in potential growth before the crisis, when the imbalances were widening, and an upward revision afterwards, when the imbalances were correcting. This implies that real time estimates provide incorrect signals about the cyclical situation of the economy. Besides, this does not seem to be a specific problem of the institution doing the estimates, but of the methodology itself.

In conclusion, the desirable properties of potential growth estimates are: (a) to be unrelated with macroeconomic imbalances and (b) that real time potential growth is unrelated with (ex-post) output gaps and, therefore, that its revisions would be relatively small. The above mentioned stylized facts reveal that it has not been the case in some developed countries, and, especially, in Spain. Therefore, potential growth estimates were providing misleading signals of the magnitude of the economic slack and, ultimately, of the economic imbalances.

3 Methodology

There are various different methodologies available for estimating the output gap and potential GDP growth. They can be classified as univariate or multivariate. The former only use information on the variable to be disaggregated (GDP, industrial production, the unemployment rate, etc.), its trend and the deviations from that trend. This framework is not adequate for the purpose of this paper, as it does not include the information contained in the indicators of imbalances. Multivariate methods should, therefore, be considered instead. Among these, the production function approach seems to be the

most suitable, since it takes into account the technological capacities of the economy and the primary productive factor endowments. Another advantage of this approach for our purposes is that it also allows a breakdown of the contribution of each productive factor to growth, so that it allows any differences in the relevance of the various imbalance indicators to each component of the production function to be detected. This approach is also appealing as it is the one most commonly used by international institutions, such as, for example, the OECD (see Giorno et al. 1995) and, more recently, the European Commission (see D'Auria et al. 2010) to estimate the cyclical and trend components of GDP.

3.1 The production function approach

A production function is a mathematical tool summarising the productive process of an economy. At the aggregate level, it is assumed that production (Y) requires the involvement of two primary inputs, capital (K) and labour (L), and that technological progress (total factor productivity, TFP) is possible. Assuming that the production function presents constant returns to scale and is twice differentiable, the growth rate of production can be expressed as follows:

$$\Delta y = \alpha \Delta l + (1 - \alpha)\Delta k + \Delta tfp \tag{1}$$

where lower case letters represent the corresponding variable in logs, Δ is the first difference and α is the elasticity of output with respect to labour. The first order profit maximization condition of the producing firm implies that, under perfect competition in the input and product markets, α will be equal to the income labour share.

Expression [1] has four observable variables (output, labour, capital and the labour share of income); therefore, under the above conditions, TFP growth can be obtained as a residual. To obtain the series of sustainable growth rates ($\Delta y*$) it is necessary to evaluate the sustainable levels of the primary factors of production and total factor productivity ($\Delta l*$, $\Delta k*$ and $\Delta tfp*$), weighted by the labour share of income. This approach is basically the same as that considered to estimate potential growth. The major differences arise in the identification of the sustainable/standard potential factors of the production function. Table 2 summarises these differences, which are explained in detail below.

3.1.1 Sustainable labour growth

The best measure of the labour used in the productive process is the total number of hours worked. This variable is the product of the number of persons employed (E) and the average number of hours worked per person (H). E can be calculated as the product of three variables: (i) the population of working age (POP); (ii) the participation rate (A); and (iii) one minus the unemployment rate (U). Therefore, the growth of labour can be disaggregated as follows:

Table 2 Methodological differences with respect to the standard approach

	Standard potential	Sustainable
Effective labour		
Working age population	Observed	Filtered*
Participation rate	Filtered*	Adjusted by imbalances
Unemployment rate	Adj. by inflation (Phillips curve)	Adjusted by imbalances
Hours per worker	Filtered*	Adjusted by imbalances
Effective capital		
Productive	Observed	Adjusted by imbalances
Residential	Observed	Adjusted by imbalances
Capacity utilisation	–	Adjusted by imbalances
Total factor productivity	Filtered*	Adjusted by imbalances

* HP filter ($\lambda = 100$ for the sustainable case)

$$\Delta l = \Delta pop + \Delta a + \Delta(1-u) + \Delta h \tag{2}$$

To obtain sustainable labour growth it is necessary to identify the sustainable growth rate of these four variables, as all of them could be influenced by the imbalances. Traditionally, in the estimation of potential labour growth, the potential working age population is proxied by the observed population, insofar as, apart from net immigration, this is a predetermined variable not influenced by the current economic situation. Standard potential participation rate and hours worked per person are estimated by smoothing their observed counterparts with a univariate filter. However, these variables are influenced by economic conditions since, in general, it is easier to adjust hours than workers and population chooses between leave or enter the labor market. Standard potential unemployment is obtained in the context of a Phillips curve estimate, which uses inflation to identify the part of observed unemployment which does not increase the inflation rate (NAIRU). In this paper, using a multivariate (pseudo-) Phillips curve approach (see Sect. 3.2 for the technical details), the four variables determining labour growth are adjusted for the evolution of the (statistically relevant) imbalance indicators presented in the previous section, including inflation.[5]

Once the imbalance-corrected components of these variables are identified, it is possible to obtain the sustainable labour growth rate of the economy by simple aggregation:

$$\Delta l^* = \Delta pop^* + \Delta a^* + \Delta(1-u^*) + \Delta h^* \tag{3}$$

3.1.2 Sustainable capital growth

As in the case of population, the most standard methodology identifies the potential capital stock with actual capital. One reason for this treatment is that the capital

[5] Population is smoothed using an univariate filter as long as only the migration component was sensitive to some of the imbalance indicators (HP smoothing parameter is 100).

stock is constructed by accumulating past investment. Therefore, although investment is a highly pro-cyclical variable in all the countries, the depreciation rate used in the calculations significantly reduces the pro-cyclicality of the stock. However, this approach does not take into account that the capital stock is not always used with the same intensity (see, for example, Nahuis 2003). In fact, most of the countries collect information from surveys on capacity utilisation (CU) in manufacturing, which shows important fluctuations over the business cycle. Although, admittedly, this information does not include the service sector, the synchronisation of the business cycle among sectors suggests it could be a good proxy for the whole economy.

There is an additional difficulty with this productive factor: the capital stock includes both residential and non-residential assets. The residential capital stock, when it is owner occupied, does not produce a monetary income flow, although the National Accounts impute it a certain income stream. Even taking into account these imputed rents, its productivity is much lower than that of the productive capital stock. Insofar as a frequently cited indicator of internal imbalances is housing investment, the disaggregation of non-residential and residential capital stocks could be of interest to identify sustainable growth. Therefore, our observed variable for capital stock will be constructed as follows:

$$k = cu(k_{nr} + \beta k_r) \tag{4}$$

where the sub-index *nr* stands for non-residential, the sub-index r for residential and β is the relative productivity of the residential capital stock. The sustainable capital will be constructed by applying expression [4] to the sustainable counterparts of these three variables, which are obtained with the same methodology as in the case of the employment components:

$$k^* = cu^*(k^*_{nr} + \beta k^*_r) \tag{5}$$

3.1.3 Sustainable total factor productivity growth

Total factor productivity (TFP) growth is closely related to technological progress. This includes product and process innovation, the organisational arrangements of the firm, and, at the aggregate level, the institutional characteristics of the economy, including sectoral specialisation. However, as established above, TFP is not an observable variable, so it has to be obtained as a residual. Therefore, TFP growth captures basically that part of output growth that cannot be explained by the evolution of the primary inputs, for a given production function. As a consequence, measured TFP also includes the deficiencies in the measurement of the primary inputs, justifying some statistical smoothing to obtain the potential counterpart. However, it may also be reasonable to think of the temporary elements of TFP as being related to the imbalance indicators we are considering. In that case, removing the temporary component of total factor productivity (TFP*) as in the previous cases, by considering the informational content of the imbalance indicators, could lead to a more robust proxy of the technological progress of the economy.

Once we have the sustainable counterparts of all the right-hand side variables of the production function, it is straightforward to estimate sustainable growth as follows:

$$\Delta y^* = \alpha \Delta l^* + (1-\alpha)\Delta k^* + \Delta tfp^* \tag{6}$$

3.2 Adjusting the production function components for from imbalances

The next step is to extract the permanent or sustainable component for each production factor. The econometric methodology to extract temporary factors from observed variables (x) taking into account the interaction with (or the informational content of) other stationary variables (imb), following Planas and Rossi (2010), is to use the program GAP for the estimation. Although the statistical details of the implementation of the process can be found in GAP's background documentation note, it is based on state-space models, where parameters are estimated by exact maximum likelihood and the Kalman filter is used to generate the unobserved variables. The starting point of this bivariate framework is that the observed variable to be disaggregated (the components of the production function in this case) is the sum of a non-stationary trend component (p) and a stationary cyclical one (c), as follows:

$$x_t = p_t + c_t \tag{7}$$

The behaviour of the cyclical component is described with a second-order autoregressive process:

$$(1 - \rho_1 L - \rho_2 L^2)c_t = \varepsilon_{ct} \tag{8}$$

where L is the lag operator and ε_{ct} is a white noise innovation with variance V_c.

The proposed specification for the trend component is a first order random walk with drift:

$$(1-L)p_t = \mu_{t-1} + \varepsilon_{pt} \tag{9}$$

$$\mu_t = \mu_c(1-\delta) + \delta\mu_{t-1} \tag{10}$$

ε_{pt} is a white noise innovation with variance V_p.

Finally, the relation between the variable to be disaggregated and the imbalance indicator that will help to identify the cycle is as follows:

$$imb_t = \varphi_{imb} + \gamma(1-L)^x_{t-1} + \sum_{i=0}^{r} \pi_i c_{t-i} + \theta_1 imb_{t-1} + \theta_2 imb_{t-2} + \varepsilon_{imbt} \tag{11}$$

where ε_{mbt} is a white noise innovation with variance V_{imb}. This innovation and those of the cyclical and permanent components are not correlated with each other.

This procedure has a long tradition in estimating the permanent component of growth considering other indicators of imbalances, such as the unemployment rate (see, for example, Clark 1989). However, it also resembles the estimation of the Phillips curve, where the imbalance indicator (inflation) allows the cyclical component of the unemployment rate and, therefore, the potential rate (NAIRU) to be identified. In this

paper, this bivariate framework is applied to all the components of the production function using the imbalance indicators introduced in Sect. 3.1.

As there are various imbalance indicators, the optimal approach would be to develop a multivariate approach to jointly incorporate all the informational content of the indicators. This approach proved to be very cumbersome, although a simplified version of it is being worked on. In the meantime, we have developed a two step procedure that seems to be quite robust, i.e. the gains from a multivariate approach are expected to be low, as explained below.

The first step consists in applying the bivariate methodology to all the production function components and all the imbalance indicators.[6] For every component of the production function, we retained the permanent factor estimates obtained from the imbalance indicators which were relevant in expression [11] (π_I 's statistically significant) and whose cyclical component had good properties (ρ_I 's statistically significant).

In the second step, a common component of all the estimated permanent factors of each production function component is extracted from weighting them according to the root mean square error of that estimate. The correlation among the first differences of estimated permanent factors suggests that the loss of information involved in this step will be minor. In fact, when alternative methodologies, such as principal components, are used, the results are similar, with the advantage that there are confidence bands for the common factor. Finally, these estimates of the sustainable part of the different components of the production function aggregated using expression [6] to obtain sustainable growth and the output gap.

4 Results

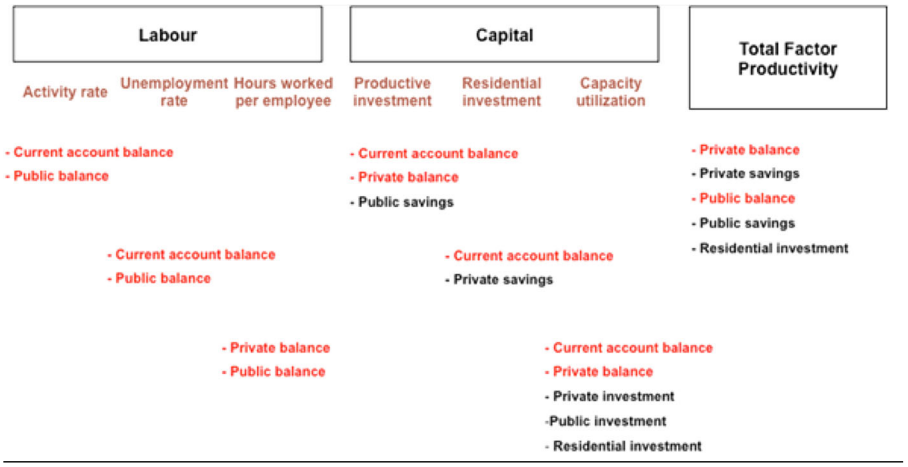
As pointed out in the methodology, the first step of the analysis is to identify those imbalances that help to estimate the sustainable output growth. In Spain, the current account balance, the private sector financing needs and the public sector balance are the most relevant indicators to identify the cyclical and permanent components of output growth (Table 3).[7]

Residential investment, often cited as the main indicator of the Spanish imbalances, seems to be relevant only in the case of capacity utilization and total factor productivity. In the first case, it is probably capturing the boom in manufacturing activity closely related to the construction sector, both producing productive inputs (bricks, cementer,…) and durable consumption goods (basically furniture and appliances). In the case of total factor productivity, it might capture composition effects for the whole economy, as long as labor productivity of housing construction is 80 % lower than that of the rest of private activities and relies mainly on temporary workers. Surprisingly, this imbalance is not relevant in the case of activity and unemployment rates. Residen-

[6] We have disregarded the imbalance indicators based on prices, to stress the differences with respect to the standard potential growth methodology. However, at the end of the paper (Sect. 4.2) we check that our estimates of sustainable growth are not correlated with inflation. In all cases, the stock imbalance indicators were not relevant in the identification of the sustainable component of the factors of the production function.

[7] The details of the most relevant parameter estimated appear in Appendix B.

Table 3 Relevant imbalances by factor



Source: Own calculations. Highlighted imbalance indicators are the most frequently used to indentify permanent factors

tial construction usually employs population with low educational attainments, which tend to have lower activity and higher unemployment rates. Note, however, that an important part of associated labor demand was fulfilled through immigration flows, which offset these effects.

In any case, this set-up does not refute the evidence on the origin of the current crisis in Spain. A financial shock result of the accession to the euro area led to a very rapid increase in the private sector indebtedness—whose financing needs were ultimately satisfied by other euro area countries' savings—which was used to finance residential investment in a higher extent. Public finances improved substantially due to the important increase in demand and the boom in the residential sector, which generated fiscal revenues above the average of the other sectors in the economy. Once the housing boom disappeared and unemployment increased, public accounts registered a large deficit.

In a second step, we summarize the main differences between the estimates of sustainable and of potential output growth (Figs. 5, 6, 7):

- In terms of growth (see left panel Fig. 5), the sustainable growth approach provides a more stable pattern than the standard potential output growth, both estimated by the European Commission and the OECD. Indeed, from 2000–2007, the sustainable growth rate was substantially lower, pointing out that severe imbalances were building in the Spanish economy, not reflected on inflation. However, after the crisis, the correction of these imbalances implied a decline of sustainable growth, far lower than that of potential growth.
- Obviously, this result has important implications in terms of output gaps. When comparing them (see right panel Fig. 5), the differences are substantial since the end of the nineties. First, the output gap was almost continuously increasing until 2007, when it reached 6 %, much larger than the estimates of the European Com-

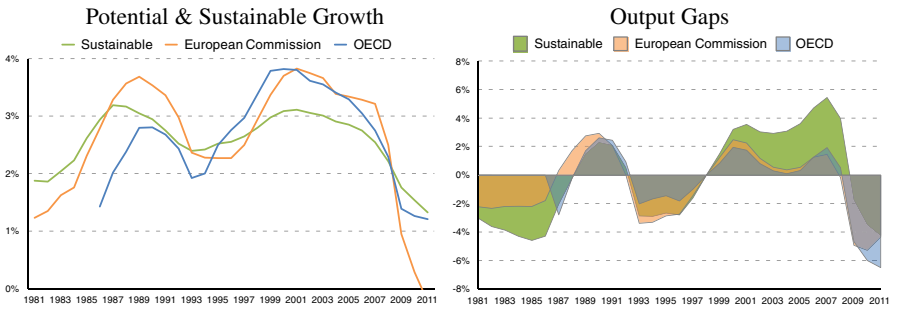


Fig. 5 Permanent growth and output gap. 1981–2011 potential and sustainable growth output gaps. Sources: European Commission, OECD and own calculations. OCDE data start in 1986

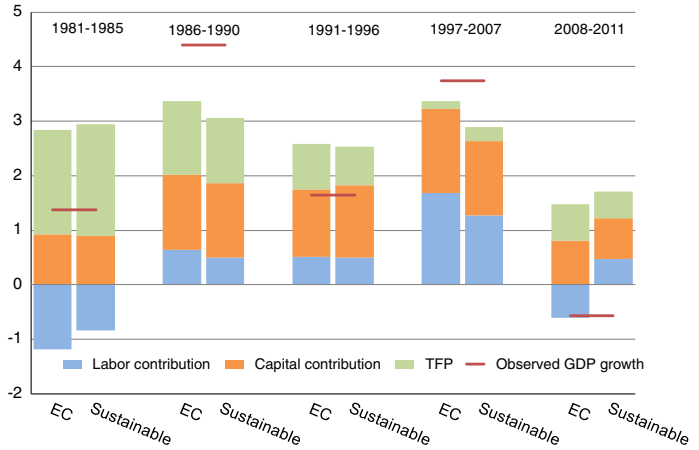


Fig. 6 Contributions to sustainable and potential growth (EC). 1981–2011 (%). Sources: European Commission and own calculations

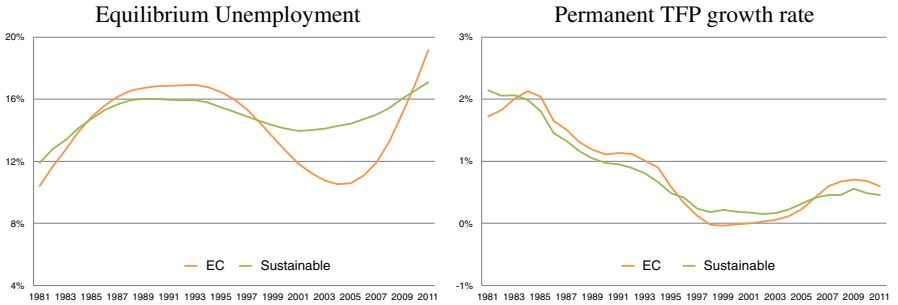


Fig. 7 Permanent components of selected production factors. 1981–2011 equilibrium unemployment permanent TFP growth rate. Sources: European Commission and own calculations

mission and OECD but in line with the findings of Borio et al. (2013).[8] These results imply that in the years 2005–2007, demand pressure was much higher than that of 1999–2001, which appears to be rather reasonable. This modifies to some extent the assessment of the orientation of both fiscal and monetary policies made at that time. Afterwards, there has been a continuous deepening of the recession, which could reach figures close to −6 % in the year 2012, in a midpoint between the European Commission and OECD estimates. These results suggest that, during the crisis, fiscal policy has been more a drag and monetary policy tighter than initially thought.

- The differences in the sources of sustainable and potential growth estimated by the European Commission are shown in Fig. 6. As can be seen in the last cycle, there exists a very different contribution from labor to growth, much lower until 2007 and higher, even positive, after the crisis. The contribution of the TFP is higher in the expansion with the sustainable methodology and lower during the recession. On the contrary, the contribution of the capital stock is always slightly lower in the last fifteen years, as long as in our calculations the housing stock has a much smaller weight in the whole capital stock.
- The different patterns estimated for the labor contribution using both methodologies are basically due to the estimate of the permanent component of unemployment. As can be seen in left panel of Fig. 7, it went from 15.9 % in 1993 to 14.2 % in 2004 and then to 17.1 % in 2011 with the sustainable growth methodology, compared to 16.9, 10.5 and 19.2 %, respectively, with the European Commission potential growth approach. As potential growth methodology does not take into account other imbalances such as the current account, during the expansionary period the stability in nominal wages growth (or inflation) was interpreted as a sign of reductions in the NAIRU, even though the labor market reforms were very timid at that time. Probably, immigration flows played a crucial role in maintaining aggregate wage inflation at moderate levels. However, other imbalances, such as the current account deficit, were increasing, thus limiting the reduction in sustainable unemployment estimated with our methodology. During the crisis the opposite happened. Observed unemployment rose while the nominal wages were much more stable (in part due, again, to compositional effects, but now of opposite sign), being interpreted as an increase in the NAIRU. However, the increase in sustainable unemployment is estimated to be much lower given that the current account deficit diminished from 10 % of GDP to 3 %. This smaller increase in sustainable unemployment has been counteracted both by the increase in population of working age (in the first two years) and in the sustainable activity rate (sustainable hours per worker have remained basically stable) to result on a slightly positive contribution of labor during the recession.
- Right panel of Fig. 7 shows the estimates of the permanent component of total factor productivity growth. First of all, it is necessary to remind that as long as we are weighting the capital stock taking into account the relative productivity of residential investment, we are correcting capital, to some extent, from quality

[8] We have also conducted our procedure directly to the Spanish GDP. Overall, the results are comparable, although there are some differences in the output gap and the richness of imbalance indicators selected. For these reasons, we think the disaggregated approach is much more informative.

improvements. This would imply that, in general, sustainable TFP growth should be lower than using the potential methodology. However, during the expansionary period, the growth rate of sustainable TFP was higher, probably due to compositional effects associated to the booming housing construction, which shows levels of productivity well below those of the rest of the economy. Conversely, in the recession, when housing investment weight substantially diminished, TFP growth rebounded considerably with the potential methodology, but to a minor extent with the sustainable methodology.

5 Robustness of sustainable growth estimates

As we pointed out before, one major drawback of potential growth methodology is that real-time estimates are prone to large revisions when additional information is incorporated, in particular after cyclical inflection points. Since the revisions are correlated with different indicators of imbalances, the methodology presented in this paper is expected to reduce these revisions. If this is confirmed, sustainable growth rates should provide a more reliable signal for real-time policy advice.

In this section, we compare the sustainable and potential growth revisions with the data available before and after the 'Great Recession' (in 2007 and 2011). The pure assessment of real time estimates is highly data consuming, as it requires to reestimate all GDP components with the information available at each point in time. However, the largest revisions arise when there is a turning point in activity, that is, when an accelerating GDP path suddenly turns into a slowdown or a decline.

We reestimate the sustainable growth rates with the information available up to 2007 to compare with our estimates using data up to 2011.[9,10] In 2007, GDP growth was 3.4 % compared to 4 % in 2006 and 1 % in 2008. In 2007, imbalances indicators were peaking: current account deficit reached 9.6 % of GDP and private sector financing needs, 12.5 % of GDP, figures never registered before in Spain. On the contrary, inflation stood at 2.7 %, well below the recent average.

The revisions of sustainable and potential estimates are summarized in Fig. 8 for the years 2004–2007, as changes in the previous years are minor with both approaches. Beginning with the GDP growth (left upper panel), when information from the crisis (years 2008–2011) is included, both potential and sustainable growth rates are revised generally down, but the revisions to sustainable rates are far smaller. In the case of potential growth, the size of the revision is quite even from 2005 to 2007 (around half a point), and somewhat smaller in 2004. In the case of sustainable growth rates, the size of the revision is a quarter of point or less for 2004–2007.

Labor explains the bulk of the GDP revision (see upper right panel). According to potential output methodology, labor contribution was overestimated by 0.8 % per-

[9] When we apply the methodology with information until 2007 we use the imbalances indicators identified as relevant until 2011. Only in one case the imbalance indicator became non-significant (private savings in residential investment).

[10] Note that this comparison is not a pure real-time exercise as long as we consider the current data of all time series (i.e. including revisions), whereas the European Commission is using the data available in 2008. This implies that the changes in the European Commission' potential related variables also include revisions to the underlying data.

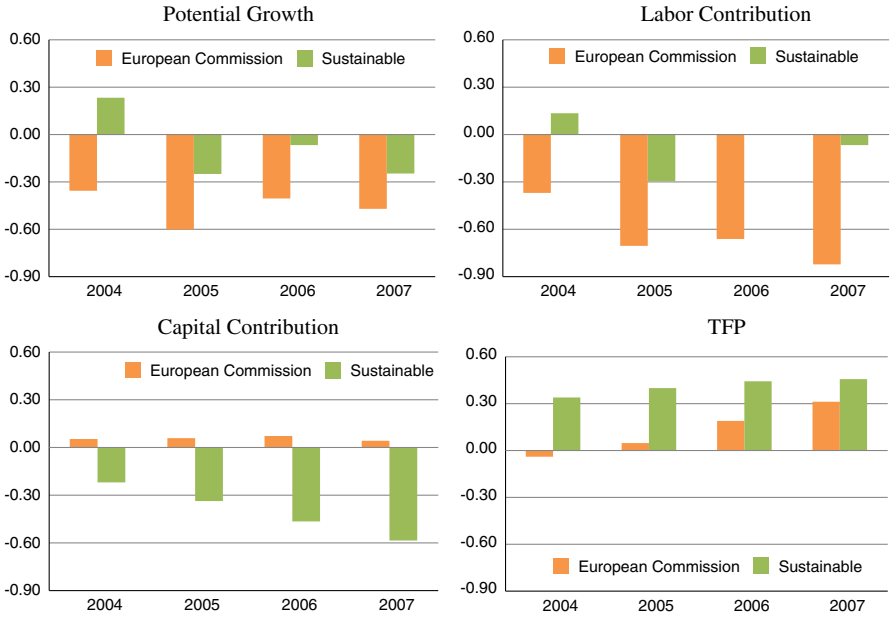


Fig. 8 Revisions to sustainable and potential growth. (Changes in estimates with info up to 2007 and up to 2011). Sources: European Commission and own calculations

centage points in 2007 (out of 1.7 pp.) while in the case of the sustainable growth methodology, the overestimation is much lower (0.1 % points out of 1.2). In the case of the capital contribution (lower left panel), the revisions were negligible with the potential growth methodology, and significantly negative with the proposed methodology. Note that capital measurement is very differently approached in both methodologies. According to potential output one, trend capital is proxied through observed capital (therefore, the only source of revisions is the re-estimation of investment flows in national accounts), the sustainable output also considers the effective use of capital i.e., taking into account the capacity utilization, and the relative productivity of residential and productive capital. Finally, the revisions in the case of TFP growth are slight larger under our methodology, but in both cases upwards; notice, however, that the TFP is not strictly comparable since is calculated from an effectively used capital.

The revisions to output gap under sustainable and standard potential growth methodologies are shown in Fig. 9. In the case of the estimates of potential growth made by the European Commission, the estimated output gap was slightly negative in 2007 using information up to 2007 (−0.4 %) but when all info is added in the estimation output gap in 2007 turned positive (1.5 %). In contrast, the revisions of our estimates are far smaller. The 2007 output gap was estimated to be 5.4 % in 2007 and 5.3 % with the info up to 2011.

6 Conclusions

During the last decade the inflation rate has shown reduced volatility and a scarce response to output developments. Different hypothesis have been raised to explain

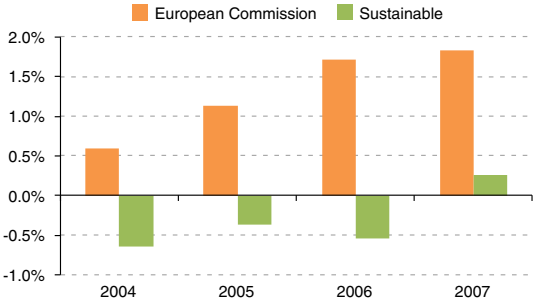


Fig. 9 Output gap revisions. 2004–2007. (Changes in estimates with info up to 2007 and up to 2011). Sources: European Commission and own calculations

this phenomenon, in particular the globalization process and the success of the central banks in pursuing the target of low and stable inflation. However, at the same time, other imbalances, both external and domestic, widened. These imbalances, closely related to the financial sector, suggested that the output growth we were observing at that time was not sustainable, and, in fact, the crisis implied a considerable correction.

Most of the methodologies to obtain trend growth rates are based in the concept of potential growth. In most of the cases, potential growth is estimated in the production function framework, through a traditional Phillips curve linking the evolution of the unemployment rate to inflation. Therefore, these estimates of potential growth focus on one particular imbalance: inflation. As long as inflation has not responded to output developments in the last expansionary period, that potential growth displayed a statistically significant correlation with other indicators of imbalances, and ex-post revision of these potential growth rates are substantial, a reassessment of sustainable growth rates, filtering out the imbalances that the economy incur in the expansionary phases, is granted.

This paper applies to Spain a new methodology to estimate sustainable growth rates. It also builds on the production function framework, but considers the informational content of other imbalance indicators apart from inflation. We call these estimates sustainable growth rates to distinguish it from potential growth. For Spain, as for other countries, the use of different imbalance indicators provides valuable information to identify the cyclical component of the activity. These indicators, contrary to inflation, have fluctuated considerably during the last expansionary period and in the recession.

In particular, the most relevant imbalances are the current account, the private sector balance and the public balance. As expected from the evolution of these relevant imbalances, the estimates of sustainable growth rates before the crisis were lower than potential growth; during the crisis, sustainable growth rates are higher than potential growth given the ongoing correction of the imbalances. As a result, the output gaps resulting from this new methodology were much higher in the expansionary period and lower after the crisis and until the year 2010, signaling more accurately the cyclical situation of the economy, and, thus, the desirable stance of fiscal, monetary and macroprudential policies. Besides, the support that these estimations might have provided to macroeconomic policies is reinforced by the robustness of the output gaps to ex-post revisions, which turn out to be much smaller than with standard potential output measures. This is specially the case in the year 2007, when a turning point was

estimated in activity, the imbalances were at historical highs and our methodology signals a huge output gap, both ex-ante and ex-post.

Appendix A

See Table 4.

Table 4 The dataset

Variable	Description	Source
Nominal gross domestic product	Nominal gross domestic product at market prices. Local currency	AMECO
Real gross domestic product	Real gross domestic product at market prices. Local currency	AMECO
Working age population	Population: 15–64 years	AMECO
Activity rate	Employment + unemployment (national accounts) / Working age population	AMECO
Unemployment rate	Unemployment/active population (national accounts)	AMECO
Hours worked per employee	Total annual hours worked: total economy	AMECO
Productive investment	Real residential investment	AMECO
Residential investment	Residential investment	AMECO
Capacity utilization	Manufacturing capacity utilization	European Commission
Current account balance/GDP	Net lending (+) or net borrowing (−): total economy	AMECO
Trade balance	Real trade balance (real imports-real imports)	AMECO
Private savings /GDP	Gross saving: private sector	AMECO
Private investment /GDP	Gross fixed capital formation–gross fixed capital formation of the general government	AMECO
Residential investment /GDP	Gross fixed capital formation at current prices: dwellings	AMECO
Public balance/GDP	Net lending (+) or net borrowing (−): general government	AMECO
Public savings/GDP	Gross saving: general government	AMECO
Public investment/GDP	Gross fixed capital formation: general government	AMECO
Non-tradable sector	Value added of services and construction over GDP (2005 prices)	AMECO

Table 4 continued

Real effective exchange rate	Real effective exchange rates CPI based	Datastream
CPI inflation	National consumer price index (all-items, yearly average)	AMECO
GDP deflator	Price deflator gross domestic product at market prices	AMECO
Residential property prices		BIS
International investment position/GDP		IFS, IMF
Private debt/GDP	Private sector gross debt	Flow of funds statistics
Public debt/GDP	General government consolidated gross debt	AMECO
Labor income share	Wage share as percentage of GDP at current market prices	AMECO
Productive capital depreciation	Implicit from capital stock series	EUKLEIMS
Residential capital depreciation	Implicit from residential capital stock series	EUKLEIMS
Productive capital	Initial capital stock and depreciation from EUKLEIMS and investment from AMECO	EUKLEIMS & AMECO
Residential capital	Initial capital stock and depreciation from EUKLEIMS and investment from AMECO	EUKLEIMS & AMECO

Appendix B

See Table 5.

Table 5 Details of the estimated parameters

	ρ_1		ρ_2		π_0		π_1		π_2		π_3		σ_c^2	σ_T^2	$\sigma_{\varepsilon imb}^2$
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.			
Labour															
Activity rate															
Current account	1.74	0.11	−0.77	0.11	−0.69	0.40	0.68	0.40					1.83E−05	1.88E−05	2.36E−04
Public balance	1.25	0.26	−0.28	0.23	−0.55	0.94	0.46	0.92					3.20E−05	7.58E−06	9.38E−04
Unemployement rate															
Current account	1.37	0.18	−0.62	0.16	0.73	0.18	−0.66	0.18					1.26E−04	6.00E−05	1.49E−04
Public balance	1.44	0.15	−0.63	0.14	0.86	0.23							1.64E−04	2.26E−05	6.44E−04
Hours worked per employee															
Private balance	0.65	0.09	−0.13	0.07	0.59	0.82	−1.39	0.82					4.11E−06	4.11E−07	6.25E−04
Public balance	0.64	0.08	−0.14	0.07	−0.30	0.47	0.78	0.47					3.73E−06	3.73E−07	2.03E−04
ln productive investment															
Current account	1.31	0.07	−0.70	0.06	−0.20	0.03	0.16	0.03					2.66E−04^r	5.32E−05^r	1.34E−04
Private balance	1.31	0.07	−0.70	0.06	−0.29	0.06	0.31	0.06					2.66E−04^r	5.32E−05^r	4.16E−04
Public savings	1.31	0.07	−0.70	0.06	−0.11	0.04	0.11	0.04					2.66E−04^r	5.32E−05^r	2.34E−04
Capital															
ln residential investment															
Current account	1.42	0.14	−0.66	0.14	−0.17	0.04	0.14	0.03					2.33E−03	2.91E−04	1.39E−04
Private savings	1.66	0.11	−0.70	0.12	−0.09	0.01	0.08	0.01					3.57E−03	2.38E−10	9.73E−05
Capacity utilization															
Current account	0.65	0.12	−0.46	0.12	−0.38	0.09							1.94E−04	3.87E−06	1.78E−04
Private balance	0.66	0.12	−0.45	0.12	−0.75	0.16	0.49	0.16					1.93E−04^r	3.86E−06^r	4.23E−04
Private investment	0.70	0.12	−0.44	0.12	0.46	0.07	−0.20	0.08					1.93E−04^r	3.86E−06^r	9.95E−05
Public investment	0.65	0.12	−0.46	0.12	0.00	0.03	0.07	0.03					1.93E−04^r	3.86E−06^r	1.37E−05
Residential investment	0.65	0.12	−0.46	0.12	0.11	0.03							1.93E−04^r	3.86E−06^r	1.84E−05

Table 5 continued

	ρ_1		ρ_2		π_0		π_1		π_2		π_3		σ_c^2	σ_Γ^2	$\sigma_{\varepsilon imb}^2$
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.			
TFP															
ln TFP															
Private balance	0.95	0.20	−0.16	0.18	1.08	0.51							1.16E−04	8.31E−06	4.18E−04
Private savings	0.85	0.21	−0.16	0.18	0.58	0.24	−0.67	0.24					1.04E−04	9.69E−06	2.25E−04
Public balance	0.87	0.21	−0.17	0.19	−0.47	0.24							1.06E−04	9.90E−06	1.98E−04
Public savings	0.81	0.20	−0.16	0.18	−0.26	0.25	0.64	0.24					1.00E−04	1.03E−05	1.82E−04
Residential investment	0.84	0.21	−0.14	0.19	−0.07	0.08	0.19	0.08					1.03E−04	1.12E−05	2.02E−05
GDP															
Current account	1.58	0.10	−0.80	0.10	−0.92	0.12	1.39	0.16	−0.73	0.18	0.12	0.13	1.63E−04	4.47E−05	2.44E−05
Public balance	1.56	0.10	−0.75	0.10	0.58	0.15	−0.90	0.26	0.30	0.15			2.03E−04	1.72E−11	1.54E−04
Private investment	1.56	0.10	−0.75	0.10	0.63	0.08	−1.52	0.37	0.77	0.38	0.13	0.08	2.01E−04	1.65E−11	3.55E−05
Public investment	1.58	0.09	−0.84	0.09	−0.13	0.04	0.60	0.07	−0.48	0.06			1.34E−04	5.61E−05	3.98E−07

AR and MA terms in equation [11] not shown. ^{r}upper bound of the parameter reached

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