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Abstract: We apply the business cycle methodology proposed by Chari, Kehoe, and McGrattan (2007) to identify the sources of Spanish business fluctuations during two outstanding cyclical episodes: the recession alongside the transition to democracy in 1977 and the great recession of 2008. We find that the labor wedge plays a key role during both recessions and that taxes and labor market institutions are likely behind the wedge movements. We conclude that any model that tries to understand the causes of recessions that occurred in the last three decades should focus on the labor wedge.

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1 Introduction

We apply the *business cycle accounting* methodology (BCA) proposed by Chari, Kehoe, and McGrattan (2007) to identify the sources of Spanish business fluctuations during two pronounced cyclical episodes: the recession alongside the transition to democracy in 1977 and the great recession of 2008. The BCA methodology uses the equilibrium conditions of a prototype closed economy model to point out the main distortions that account for movements in output, hours worked, and investment.[1] The distortions can be classified into four categories: (i) those affecting the resource constraint of the economy—the feasibility wedge, (ii) those affecting the production function of the economy—the efficiency wedge, (iii) those affecting the intratemporal condition that substitutes consumption and leisure—the labor wedge, and (iv) those affecting the intertemporal substitution of consumption—the investment wedge.

We show that the labor wedge plays a key role in accounting for Spanish business cycles. In the recession episodes under consideration, the fluctuations induced by the labor wedge essentially replicate the observed movements in output, hours worked, and investment. Using regression analysis, we find that the labor wedge evolution is correlated with several institutions that were created under the rubric of the *Welfare State* after 1976: a notable increase in the level of taxation, unemployment benefits, the temporary employment rate, and the relative distribution of power in collective bargaining. Other factors that could also have an impact over the labor wedge, such as credit constraints or labor union coverage, are found not to be statistically significant in the estimated regressions.

The efficiency wedge (which can also be interpreted as total factor productivity (TFP)) plays little to no role in accounting for the observed fluctuations. Moreover, a growth accounting exercise reveals that the trend component in TFP suffered a considerable change during the mid-1990s. We conclude that the role of efficiency should not be regarded as a cyclical phenomenon but as a permanent component. Consistent with other studies (e.g. Chari et al. 2007), the business cycle fluctuations induced by the investment and feasibility wedges account for a minimum fraction of the observed movements in Spanish time series.

[1] The BCA methodology has been successfully applied to other countries. See, for example, the papers by Ahearne, Kydland, and Wynne (2006) for Ireland, Kobayashi and Inaba (2006) for Japan, and Lama (2011) for a subset of South American countries.

We verify the validity of our results using a simple exercise where we calibrate the prototype model to the Spanish economy and simulate it considering two shocks only: one to the efficiency wedge and another to the labor wedge. We find that an important bulk of the variability in output and hours can be accounted for by the shock to the labor wedge. Such a simulation produces a negative correlation between wages and productivity, which is a fact observed in the Spanish economy.[2]

In an influential contribution, Boldrin, Conde-Ruiz, and Díaz-Giménez (2010) conclude that the neoclassical growth model is not a good framework for explaining Spanish business cycles. Our findings suggest that the neoclassical growth model is indeed usable in helping to understand Spanish business cycles, but only if paired with a careful specification of shocks: any model that tries to understand the causes of recessions in Spain in the last three decades should focus on the labor wedge.

The rest of the paper is organized as follows: Section 2 performs both a growth accounting and a business cycle exercise that allows us to identify trends and patterns of fluctuations in output, productivity, and hours worked. Section 3 offers a description of the BCA methodology, which we put to use in Section 4. Section 5 puts forward a two-shock model in order to verify the extent to which labor and efficiency shocks can replicate some well-known business cycle facts in Spain. In Section 6 we try to identify the institutions and indicators that can help explain the particular evolution of the labor wedge in Spain. Section 7 concludes and suggests some policy implications.

2 Growth and business cycle facts, 1976:3-2012:3

In this section we study some of the properties of economic growth and employment and characterize the cyclical phases of the period under consideration, 1976:3-2012:3, using a Hodrick-Prescott (HP) filter.

Growth accounting exercise To study the long-run properties of Spanish GDP according to a growth accounting methodology, we start by assuming a Cobb-Douglas production function of the form

$$Y_t = K_t^{\theta} \left(Z_t H_t\right)^{1-\theta} = A_t K_t^{\theta} H_t^{1-\theta}, \tag{1}$$

[2] In the online appendix we also perform a second robustness check: we extend the BCA methodology to consider an open economy specification following Lama (2011). See section C in that document for details.

where Y_t denotes output, $A_t \equiv Z_t^{1-\theta}$ denotes TFP, K_t represents the stock of capital, and H_t the labor input. In turn, labor represents total hours worked, i.e. $H_t = h_t L_t$, with h_t being the average hours worked per worker and L_t being the number of workers at time t.

From (1), output per hour worked can be decomposed into TFP times the contributions from the capital-to-labor ratio:

$$\frac{Y_t}{H_t} = A_t \times \left(\frac{K_t}{H_t}\right)^{\theta}. \tag{2}$$

Let P_t denote population over 16. Output per capita can now be written as

$$\begin{aligned}\frac{Y_t}{P_t} &= A_t^{1/(1-\theta)} \times \left(\frac{K_t}{Y_t}\right)^{\theta/(1-\theta)} \times \frac{H_t}{P_t} \\ &= Z_t \times \left(\frac{K_t}{Y_t}\right)^{\theta/(1-\theta)} \times \frac{H_t}{P_t}. \end{aligned} \tag{3}$$

Equation (3) shows that the capital to output ratio (K_t/Y_t) and the total hours per capita (H_t/P_t) must be constant along the balanced growth path.[3] (Section A in the online appendix describes the dataset and details the construction of the variables used in our exercise.) Using the EU KLEMS database we calibrate a capital income share of $\theta = 0.3638$.

After log-linearization and differentiation, equations (1) through (3) can be expressed in growth terms. The three decomposition exercises are reported in Table 1 using quarterly observations for 1976:3-2012:3 ($\gamma's$ denote growth rates) where all the values are expressed in annualized terms. The sample is split into three periods: the transition to democracy, 1976 to 1985; the entry to the European Economic Community (EEC), 1986 to 1994; and the final period of transition and adoption of the Euro, 1995 to 2012.

[**Table 1 here**]

The fourth column in the upper panel of Table 1 shows that output has steadily grown at a rate of 2.24% across the entire period. During the years following the advent of democracy (also characterized by a low degree of openness and globalization), the growth rate was lower than the long term average at 1.47%. About two thirds of this long term growth can be attributed to capital input. While the contribution of labor was negative during the transition to democracy, it

[3] In this respect we follow Kehoe and Prescott (2007). A recent application of the growth accounting methodology to Spain (using annual-frequency observations) can be found in Boldrin et al. (2010).

increased (still to a low value) after Spain's entry into the EEC, and remained high during the years that followed the EMU, when a large number of jobs were created. Regarding TFP, two phases are evident. The first one covers 1976 to 1994 and is characterized by a positive growth rate. The second phase, currently ongoing, is characterized by a negative growth rate.

The middle panel of Table 1 decomposes productivity (GDP per hour) according to (2). While enjoying a high growth rate at the beginning of the sample (4.36%) productivity slowed after 1986: the growth rate for the period 1995 to 2012 was remarkably low at 0.59%.[4] For 1976 to 1985, growth in the capital to labor ratio accounts for a sizable fraction of productivity growth. As the Spanish economy opened up after its EEC entry (1986), the role of capital became increasingly smaller as the inflow of capital increased.

The bottom panel of Table 1 shows that the dynamic of GDP per capita (according to (3)) is disconnected from that of productivity. This can be seen in more detail in Figure 1, which reports GDP per capita, GDP per hour, and TFP (all first observations have been normalized to one). Figure 1 shows that the growth rate of output per capita accelerated after 1986, increasing from 0.17% to 1.82% (from Table 1) and remained at 1.18% after 1995. The bulk of the GDP per capita growth rate can be accounted for a stable contribution from the capital to output ratio, which implies a sustained divergence from the balanced growth path. The average contribution of the ratio, 1.05%, was stable across the sample; this is a discrepancy with respect to the neoclassical growth model, as highlighted by Boldrin et al. (2010).

Hours worked and employment Let N_t denote the labor force. Hours per capita h_tL_t/P_t can be decomposed as the product of hours per worker, the employment rate, and the participation rate:

$$\frac{H_t}{P_t} = \frac{h_tL_t}{P_t} = h_t \times \frac{L_t}{N_t} \times \frac{N_t}{P_t}.$$

The series may offer some insights about an agent's decision to participate in the labor market. Figure 2 presents the evolution of the hours per capita h_tL_t/P_t, the weekly average hours per worker h_t, the activity rate N_t/P_t, and the employment rate, L_t/N_t (all first observations have been normalized to unity). There was a significant fall in hours per worker, the employment rate, and the activity rate between 1976 and 1986, while the unemployment rate increased from 4.6% to 20.5% in the same period. Hours per capita and the employment rate started on an upward

[4] The 1994 productivity downturn has been documented by several authors: see Mas and Quesada (2006) and Jimeno, Moral, and Saiz (2007). On section A of the online appendix we incorporate our own analysis of structural breaks in the series of productivity using the tests of Andrews (1993) and Andrews and Ploberger (1994). We find support for three breaks: 1985:2, 1994:4, and 2006:3.

trend in the early 1990s (most likely as a side effect of the expansions at the end of the 1980s and after the Euro adoption in 1999) yet this has clearly reversed in the last quarters of the sample as an effect of the great recession.

The participation rate declined slightly in the first ten years of the sample, displaying a sluggish recovery from 1987 to 1996 (which can be attributed to the increase in female participation in the labor market) and a vigorous upward trend during the last years of the sample (which can be associated with an increase in female and immigrant participation). During the great recession, the pattern of this relationship changed: the participation rate continued to grow while the employment rate declined.

Unemployment rates Table 2 presents unemployment rates for Spain and seven other countries (France, Germany, Ireland, Italy, Japan, the United Kingdom, and the United States) at relevant periods in our analysis. The evolution of the Spanish unemployment rate contrasts with that of the other countries: throughout the 1970s, unemployment rates were quite low and below average for the remaining countries. A decade later (1986) the rate was four times higher and almost twice the average at 20.5%; the Spanish unemployment rate has been by far the highest one since that time. By 2007:2 the rate had converged toward the levels of the remaining countries, 7.95%. However, by 2009:2 the rate was again hovering around 18%, and reached 26% in 2012:4.

[**Table 2 here**]

Spanish business cycle facts Our business cycle analysis starts with a brief look at the growth rates of GDP, employment, and the real wage. The series are plotted on Figure 3 in yearly terms. For the nominal wage, we use an index of wages negotiated under collective bargaining divided by the consumer price index (CPI). In Spain, the percentage of workers whose wages result from collective bargaining increased from 65% in 1976 to about 90% currently. As we highlighted previously, GDP has grown at a rate of 2.24% during this period. Figure 4 plots the (log of) GDP together with its trend, estimated using the HP filter. The trend follows a downward pattern after 2008, when GDP swings below it.

Referring back to Figure 3, the dashed line represents the growth rate of employment, which clearly exhibits procyclical behavior and more volatile dynamics. This phenomenon points out to the fact that employment sluggishly grows on expansions and abruptly diminishes during the early quarters of a recession. Finally, the dotted line in Figure 3 shows the real wage growth rate.

The series seems to be disconnected from the evolution of GDP, especially after 1994. As an example, real wages grew by 3% during 2009 and 2010, while GDP and employment were falling by a similar amount. The overall conclusion from Figure 3 is that the wage mechanism has played an inadequate role in absorbing fluctuations.

The trend and observed GDP series shown in Figure 4 allow us to identify three cycles. The first is a long recession from 1981:1 through 1987:2, when the Spanish economy underwent its major structural reforms (such as the entry into the EEC and the consolidation of democracy). Although output fluctuated above its trend at the beginning of the sample, output per capita remained flat during the period (see Figure 1); for this reason, we prefer to examine the entire transition to democracy period, 1976:1-1985:4. The recession has an associated expansion that takes place at the time of the EEC entry and the Single European Act, 1986:1 to 1992:1. The second is a short-lived recession lasting from 1992:2 to 1994:4, and also affected the rest of other European countries; the corresponding expansion coincides with the launch of the Euro in 1999. Finally, we identify the current recession, which for Spain began in 2008:2 (after a peak in 2007:2). We apply the BCA methodology to analyze the first and the last of the three recessions: the transition to democracy recession in 1976 and the great recession of 2008.

We take the series discussed so far, HP-filter them, and calculate their basic statistical properties in Tables 3 and 4. The first and second columns in Table 3 present the absolute standard deviations, σ, and the standard deviations relative to that of output, σ/σ_y, while the remaining columns show the cross-correlations with output at several leads and lags. For the trade balance, we take the ratio over GDP, both in nominal terms. In Table 4, we report several correlations of interest for the entire sample and several of its subsets.

The autocorrelation of cyclical output is 0.94 at one lag, pointing to a substantial persistence in Spanish business cycles. Private consumption and investment are strongly procyclical. Moreover, consumption volatility is 23% higher than that of GDP, while investment volatility is four times larger.[5] Public consumption is weakly procyclical and lags the business cycle: the correlation with GDP increases from 0.26 to 0.47 with the lead of output. Exports and (especially) imports are procyclical and lead output fluctuations.

Labor force, employment, workers, and total hours worked are strongly procyclical and more

[5] The fact that consumption is more volatile than GDP contradicts the life cycle hypothesis; this feature of the Spanish consumption series was noted by Dolado, Sebastián, and Vallés (1993) and Licandro and Puch (1999), and can be blamed on the fact that the measure of consumption combines nondurable goods and services together with durable goods.

volatile than output. Although the real wage is acyclical when considering the complete sample, Table 4 shows that the same correlation takes positive values for the first two subsamples (although somewhat decreasing), but becomes negative after 1995. Another important issue (not shown in the Table) is that the relative volatility of the real wage decreases after the mid-1980s, from 1.78 to 0.55.

The correlations of the real wage with employment and with total hours worked have changed over time (see Table 4). They hovered around 0.5 from 1976:3 to 1985:4, declined to 0.25 from 1986:1 to 1994:4, and turned negative, -0.25, during 1995:1-2012:3. The productivity gains at the beginning of democracy, combined with low elasticity in the labor supply, led to an upward adjustment in wages but weak job creation. After 1995 productivity came to a halt, the relative volatility of wage declined after 1986, and movements in employment were led by increases in the labor force: immigration and female labor market participation.[6] Licandro and Puch (1997) suggest introducing other shocks than those related to TFP in applications of the real business cycle (RBC) model to Spain to better understand the changing correlation between hours worked and productivity. As is well known, the standard RBC model predicts a positive correlation between the real wage and hours worked.

The most remarkable result, already noted by Boldrin et al. (2010), is that the correlations of output with both TFP and productivity per hour worked are negative throughout the sample, contrasting the experience of other advanced economies. Boldrin et al. (2010) note that this fact is a relatively new occurrence in Spanish business cycles, as the correlations were positive during the 1960s and turned negative at some point by the end of the 1970s.

[**Tables 3-4 and Figures 1-4 here**]

3 The BCA methodology

In this section we present a brief description of the BCA methodology of Chari, Kehoe, and McGrattan (2006, 2007). The BCA methodology has two components, an *equivalence result* and an *accounting procedure*. The equivalence result shows that virtually any dynamic economic model can be mapped to a prototype stochastic growth model. The prototype economy is augmented by several wedges that represent distortions over the agents' decisions; the wedges play a key role in the analysis, as will be shown below.

[6]For example, the immigrant population in Spain increased from nearly 600 thousand in 1998 to 5.7 million in 2011, accounting for 1.5% and 12.2% of total population in these years.

In a second step, the accounting procedure uses the prototype model's equilibrium conditions and real-world observations to measure the wedges. The wedges are then plugged back to the prototype model, allowing us to quantify how many of the observed movements in output, labor, and investment can be attributed to each wedge.

3.1 The benchmark prototype economy

The prototype economy consists of three agents: a representative household of size P_t, a representative firm, and a government. The mass of population grows at a constant rate γ_P. At each period t, the economy experiences one of many states denoted by s_t. Denote the history of said states by $s^t = \{s_0, \ldots, s_t\}$. Let $\pi_t(s^t)$ be the time-0 probability of history s^t. We take the initial state s_0 as given.

The economy has four exogenous stochastic wedges: efficiency $A_t(s^t)$, labor $\omega_{lt}(s^t)$, investment $\omega_{xt}(s^t)$, and feasibility $g_t(s^t)$. Note that all of these variables are functions of the state s_t.

Discretionary expansions of government spending or a shock affecting the trade balance are examples of the feasibility wedge. A shock that makes total factor productivity differ from its trend can be identified as a shock to the efficiency wedge. Examples of the labor wedge may include indirect taxation of consumption or direct taxation of labor income (or a combination of both) that affect the slope of the budget and the substitution between consumption and leisure; or labor market institutions that alter the number of hours worked (days of vacations, holidays) and/or the decision to participate in the labor market. Other examples include institutions that cause the real wage to move rigidly in response to a negative productivity shock, such as the market power of labor unions and firms; or, as recently proposed by Jermann and Quadrini (2012), credit constraints and financial frictions. Finally, an example of the investment wedge is taxation of capital or a shock to investment specific technological change, both of which affect the marginal product of capital.

Household The representative household chooses per capita consumption c_t, labor l_t, and investment x_t to maximize its infinite lifetime expected utility

$$\sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi_t(s^t) U(c_t(s^t), l_t(s^t)) P_t. \tag{4}$$

Household optimization is subject to the real budget constraint

$$c_t(s^t) + (1 + \omega_{xt}(s^t))x_t(s^t) = (1 - \omega_{lt}(s^t))W_t(s^t)l_t(s^t) + R_t(s^t)k_t(s^{t-1}) + T_t(s^t) \tag{5}$$

and the law of motion for the per-capita capital stock k_t

$$(1+\gamma_P)k_{t+1}(s^t) = (1-\delta)k_t(s^{t-1}) + x_t(s^t). \tag{6}$$

In the above, β is a discount factor, W_t is the real wage rate, R_t is the rental price of capital, T_t are per capita transfers, and δ is the depreciation rate.

Firm The representative firm has access to the constant returns to scale technology

$$A_t(s^t)F(k_t(s^{t-1}), z_t l_t(s^t)), \tag{7}$$

where $z_t \equiv (1+\gamma_z)^t$ represents labor-augmenting technical progress that grows at rate η. The firm chooses capital and labor inputs to maximize profits:

$$A_t(s^t)F(k_t(s^{t-1}), z_t l_t(s^t)) - W_t(s^t)l_t(s^t) - R_t(s^t)k_t(s^{t-1}). \tag{8}$$

Equilibrium A competitive equilibrium in the prototype model is characterized by four equations. First, a resource constraint, including by the feasibility wedge $g_t(s^t)$:

$$y_t(s^t) = c_t(s^t) + x_t(s^t) + g_t(s^t). \tag{9}$$

We refer to $g_t(s^t)$ in (9) as the feasibility wedge (rather than government wedge, as in Chari et al. 2007) given that it is also influenced by the trade balance. In Spain, exports and imports represent an important percentage of GDP.

Second, the production technology, affected by the efficiency wedge $A_t(s^t)$:

$$y_t(s^t) = A_t(s^t)F(k_t(s^{t-1}), z_t l_t(s^t)). \tag{10}$$

In what follows, let F_{jt} denote the partial derivative of the production function with respect to the production input $j = k, l$ and let U_{jt} denote the marginal utility of $j = c, l$. We also need to add an intratemporal condition, affected by the labor wedge $\omega_{lt}(s^t)$:

$$-\frac{U_{lt}(s^t)}{U_{ct}(s^t)} = (1-\omega_{lt}(s^t))A_t(s^t)z_t F_{lt}(s^t), \tag{11}$$

and an intertemporal Euler equation, affected by the investment wedge $\omega_{xt}(s^t)$:

$$(1+\omega_{xt}(s^t))U_{ct}(s^t) = \beta \sum_{s^{t+1}} \pi_t(s^{t+1}|s^t) U_{c,t+1}(s^{t+1}) \left[A_{t+1}(s^{t+1}) F_{k,t+1}(s^t) + \right. \\ \left. +(1-\delta)(1+\omega_{x,t+1}(s^{t+1})) \right] \quad (12)$$

3.2 The accounting procedure

Functional forms and decision rules To make the accounting procedure operational, we select functional forms for household utility and the production technology. We assume that the utility function takes the form

$$U(c,l) = \log(c) - \psi \frac{l^{1+1/\upsilon}}{1+1/\upsilon}, \quad (13)$$

where parameter υ stands for the Frisch iso-elasticity of labor supply. Although this choice is standard in the literature, it differs from the log-log utility proposed by Chari et al. (2007). The log-log functional form is consistent with an unusually elastic labor supply, which makes it ill-suited for the Spanish labor market. In practice, we select a low value for this elasticity: $\upsilon = 1/3$ (the details of calibration are given in Section B of the online appendix). We let the production technology follow a Cobb-Douglas specification as in equation (1).

After substituting the functional forms in (9)–(12) we can derive (log-linear) decision rules following standard perturbation methods. Denote the rules for output, hours, and investment by $y(s_t, k_t)$, $l(s_t, k_t)$ and $x(s_t, k_t)$.

Estimating the transition process Assume that s^t follows a Markov process of the form $\pi(s_t|s_{t-1})$ and that the map from s^t to the wedges is both one to one and onto.

In what follows, let y_t^d, l_t^d, x_t^d and g_t^d denote real-world observations (in terms of a state-space representation, these are our observable variables). We use these values to estimate the parameters of the Markov process $\pi(s_t|s_{t-1})$; for this purpose, we specify a VAR for s_t of the form

$$s_{t+1} = P_0 + P_1 s_t + \epsilon_{t+1}, \quad (14)$$

where ϵ_t is iid normal with mean zero and variance-covariance matrix V. In practice, we actually estimate the lower triangular matrix Q, where $V = QQ^\top$. This implies a particular order of variables that cannot be viewed as the orthogonality conditions needed to identify structural shocks, like in a SVAR approach. Instead, this is used to guarantee that V remains positive semidefinite.

We use a standard maximum likelihood estimation procedure to obtain estimates of P_0, P_1, and V of process (14). As is standard, we combine the model's decision rules to form the likelihood function and use the data on output, investment, hours, and government expenditure as observable variables.

Uncovering the state Next, we identify the state s_t by measuring the realized wedges. We can directly measure the feasibility wedge as the sum of observed government spending plus net exports, both in per capita terms. The remaining wedges are obtained using the observed data and the model's decision rules: the realized series s_t^d should solve

$$y_t^d = y(s_t^d, k_t), \quad l_t^d = l(s_t^d, k_t), \quad x_t^d = x(s_t^d, k_t), \tag{15}$$

where k_t follows from equation (6) using the values for x_t^d and a period-0 (observed) capital stock k_0^d. We solve for the remaining elements of s_t by using (10)–(12). Once this is done, we have actually identified the states.

Considered simultaneously, the four wedges account for all of the movements in the observable variables. Plugging the wedges into the decision rules in (15) and using $g_t\left(s_t^d\right) = g_t^d$ together with the law of motion for capital (6) yields the original real-world observations.

Identifying the wedges' marginal effects The last step of the BCA methodology requires us to isolate the marginal effects of the wedges. We allow one wedge to fluctuate while keeping the others constant. Starting from k_0^d, we take s_t^d, the decision rules, and the law of motion for capital to construct the realized sequences of output, labor, and investment when the particular wedge under analysis (and only that wedge) changes. We can then compare the predicted values to observed ones, and assess the relative importance of the wedges over the economy. A variant of the identification exercise allows a subset of three wedges to fluctuate while keeping the remaining one constant. The predicted values show the importance of the omitted wedge in replicating observed data movements.

The BCA exercise we perform differs from a traditional SVAR decomposition, where a researcher estimates a VAR given some identifying (or orthogonality) restrictions provided by a model. The orthogonality conditions allow for a direct identification of the set of *structural* innovations affecting the VAR. Once this has been accomplished, it is straightforward to execute a variance decomposition exercise in order to assess the relative importance of the shocks.

The methodology we follow does not require orthogonality conditions. The BCA exercise identifies the source of frictions and distortions within the model that generate the fluctuations, i.e. the *wedges*. We use the VAR in (14) to derive a law of motion for the state variables that, when paired with the relevant policy functions and observed data, allows us to back out the state values. We can then feed each measured wedge to the model while keeping all other constant. (For a through exposition of the differences between the BCA and SVAR methodologies see Chari et al. 2007, p. 824.)

4 Results

We show the identified wedges in Figures 5 through 8 and the graphical analysis of the BCA exercise in Figures 9 and 10. We split the sample into two datasets, 1973:3-1994:4 (first dataset) and 1995:1-2011:2 (second dataset), in order to overcome possible biases induced by the observed break in the TFP trend after 1994 (see Figure 1 and Table 1). The datasets also match the episodes under consideration: the transition to democracy recession (Figure 9) and the great recession of 2008 (Figure 10). (See Section A of the online appendix for a discussion of the possible presence of break points in productivity trend on 1985 and 1994.)

4.1 Wedges, 1976:3-2011:2

We present the efficiency wedge, estimated as the Solow residual (i.e. TFP), in Figure 5. As we saw in Tables 3 and 4, the behavior of the efficiency wedge is weakly countercyclical. We plot the labor wedge in Figure 6: we can see a significant increase in this distortion from 1975 to 1985 that decreases in the subsequent years. When the great recession starts in 2008, the labor wedge increases, so that it is almost on par with the average values of the late 1980s and early 1990s. The remaining two figures (7 and 8) display our estimates of the investment and feasibility wedges which, according to our BCA analysis, play a minor role in accounting for Spanish fluctuations.

[**Figures 5-8 here**]

4.2 The transition to democracy recession, 1976:3-1985:4

Throughout this section we refer to Figure 9. In the left hand side of the figure we present observed output per capita, hours worked per capita, investment as percentage of output, and the predictions of a model using *only one* of the four wedges. On the right hand side, we present the observed series and the model predictions when one of the wedges is excluded.

As shown in the top set of graphs, the labor wedge has a key role in the evolution of output and hours worked. Output per capita began to fall in the first half of 1978; the prediction of the model with a labor wedge follows the trend in the data although the predicted output tends to overstate the observed decline. By 1985, observed output per capita is nearly 10% below trend yet the model with a labor wedge predicts almost 25% below trend. When we feed the investment wedge into the model, output per capita stays in trend throughout the sample. The prediction of the model with a feasibility wedge sends output per capita in an opposite direction to the data, pointing to a small expansion (about 1% above trend) in the 1980s. Finally, the model with an efficiency wedge predicts a sizable expansion in output per capita: about 20% above trend by 1985.

Looking at the prediction of the model with all but one wedge we can confirm that the labor wedge is the key element in the analysis. The model without a labor wedge predicts a large expansion in output per capita, about 15% above trend by 1985. The predictions of a model without an investment or a feasibility wedge follow the observed output per capita closely, and so does the model without an efficiency wedge (which, however, tends to overshoot the recession).

The middle set of graphs shows that a model with a labor wedge essentially accounts for all of the movements observed in hours worked per capita. Models with an efficiency or an investment wedge predict a reduction in hours, albeit the fall is not of the right magnitude. A model with a feasibility wedge predicts a small increase in hours for all years in the sample.

Finally, the bottom set of graphs shows that no particular wedge plays a definitive role in the evolution of the investment to output ratio. When feeding the model with each of the wedges, the prediction in some periods overshoots (and in others under predicts) the observed values. In looking at the predictions of the model without a feasibility wedge (right column in Figure 9) we can argue, however, that a model that considers the remaining wedges does a fairly good job at capturing the evolution of the series.

During the four decades of dictatorship, the government intervened heavily in the Spanish economy and a variety of firms were state-owned, many of them managed by the *Instituto Nacional de Industria* (INI).[7] The government guaranteed a wide degree of market power for the firms, either

[7]Some examples are SEAT and ENASA (automobile), Iberia (airlines), AESA and Bazán (civil and military shipyards), ENSIDESA (metallurgy), Santa Bárbara (weapons and explosives), and HUNOSA (coal mining). Other public non-INI firms were RTVE (broadcasting), CAMPSA (oil refinery and fuel distribution), RENFE (railroad

in the form of monopoly or monopsony. After 1981, the INI and the rest of the public industrial sector were dismantled through gradual privatization that ended in the second half of the 1990s, known as *la reconversión industrial*. The restructuring operation involved severe reforms to the management of key public industrial firms. Thousands of workers moved to other activities, largely in the service sector. Thus, the expansion predicted by the efficiency wedge in the mid-1980s points to the industrial restructuring. It seems reasonable to assume that the mobility of factors motivated by the restructuring implied efficiency gains that manifested by way of the efficiency wedge but failed to materialize as increases in output or hours worked.[8]

Statistical properties of the wedges and model Table 5 summarizes several statistical properties of the accounting exercise for the first dataset. Consider first the top panel in the table: the second column displays the standard deviation of the fluctuations in output that can be attributed to each wedge, relative to that of observed output. Fluctuations arising from the efficiency wedge are 69% of observed output and those directly attributable to the labor wedge add up to 98%. The value for the investment and feasibility wedges are considerably lower at 20%. Columns 3-7 show that all but the feasibility wedge fluctuations are positively correlated with output contemporaneously and at several (± 2) leads and lags. The prediction of the model with a labor wedge has a contemporaneous correlation of 79% with output (and similarly large values for leads and lags), far larger than the corresponding value for the other wedges.

The bottom panel in the table exhibits a rather general fact: the fluctuations generated by the wedges are negatively correlated between each other. Other than the positive correlation between the labor and the investment wedge, the remaining ones are either negative or close to zero.

[**Figure 9 and Table 5 here**]

4.3 The great recession, 2007:2-2011:2

Throughout this section we refer to Figure 10. We find that the labor wedge can account for the observed fluctuations in output, hours, and investment.

transport), Tabacalera (tobacco) and Telefónica (telecommunications).

[8] The firms affected by the industrial restructuring were severely hit by the oil price shocks of the 1970s and the privatization of public firms started during this period. In the oil refinery, broadcasting, and telecommunications sectors, liberalization preceded privatization. When considered together, all of these factors positively affected the levels of efficiency (see Nicoletti and Scarpetta 2003).

The prediction of a model using *only* the labor wedge can capture the direction of output per capita, hours and investment fairly well. The model implies a deeper recession for output and hours, but a more moderate decline in investment. The labor wedge predicts no change in the investment ratio up to the end of 2008 when the model starts predicting a decline.

When considering only the efficiency wedge, the model predicts a mild and rather brief recession: output and hours go only 2% below trend. For the investment rate, a model using only the efficiency wedge predicts a decline during the first stretch of the recession, and an upward correction after 2009:3.

Figure 10 shows that a model with a feasibility wedge predicts output at 2% above trend rather than a recession, as well as a 4% boom for hours. As can be seen in the set of graphs on the right side, a model with all wedges except the feasibility wedge can account for the observed movements with reasonable accuracy. Right after the great recession started, the Spanish government responded by using fiscal stimulus, while structural reforms or supply policies were postponed. The loss of monetary sovereignty has made fiscal policy the government's unique way of countering the recession: the public deficit exceeded 11% of GDP as of December 2009.

Finally, the investment wedge produces counterfactual predictions in the three variables.

Statistical properties of the wedges and model Table 6 replicates Table 5 but does so for the second dataset. The second column in the table's top panel shows that fluctuations attributable to labor are considerably more volatile (at 124%) than output itself while those coming from the investment wedge represent a fairly small fraction of output variance. As was the case in Table 5, fluctuations generated by the labor wedge are highly correlated with output, both contemporaneously and through leads and lags. The same values when considering the efficiency wedge are positive but smaller, while the values for the investment and feasibility wedges are negative and considerably large. The bottom panel presents a similar picture to that in Table 5. Most of the cross-correlations are negative except for the investment and feasibility wedge pair. Note that the efficiency and labor wedge pair is virtually orthogonal both contemporaneously and through leads and lags.

[**Figure 10 and Table 6 here**]

5 Simulations

In this section we adopt a more traditional approach using previous findings. We simulate the model by taking the wedges that emerged as relevant in the BCA exercise, as though they were affected by exogenous fundamental stochastic processes. Section 2 showed that the standard RBC model fails to reproduce some key Spanish business cycle facts, namely, the negative correlations between wages and productivity and between output and productivity. The labor wedge was found to be the key factor in producing Spanish economic cycles.

For the US economy, models governed by productivity shocks have been successful in accounting for a broad set of business cycle facts. In particular, the cyclical volatility of hours and output and the majority of the movements in hours worked can be associated to such shocks. This is not the case for Spain. A model that only considers an efficiency wedge predicts an upward trend in output during the first recession, 1977 to 1985, although it may have had some role in accounting for the output drop in the first quarters of the great recession. The remaining wedges (investment and feasibility) were not found to be quantitatively significant in accounting for the Spanish fluctuations.

The simulation exercise allows us to (i) gauge whether the prototype model can do a better job in reproducing the empirical regularities for Spain, and (ii) compute how much of the simulated variances can accounted by the orthogonal shocks hitting the wedges.

Let us assume that the efficiency wedge and the labor wedge are governed by a stationary AR(1) process:

$$\begin{aligned} \omega_{jt} &= \rho_j \omega_{j,t-1} + \sigma_j \eta_{jt}, \\ \eta_{jt} &\sim \mathcal{N}(0,1). \end{aligned} \tag{16}$$

with $j = z, l$ and (importantly) $E(\eta_{zt}\eta_{lt}) = 0$. The two fundamental shocks (η_{zt}, η_{lt}) now have a structural interpretation. The AR framework renders wedges with mean values that are nil in the steady state, as we focus on fluctuations. For the efficiency wedge, we take the cyclical component of the Spanish TFP, using an HP filter. As long as the filter produces a non-linear trend, we avoid the structural break that occurs in the productivity series in the mid-1990s (Figure 1). To calculate the labor wedge values, we use the static first order condition (11) together with the utility function in (13). Both wedges have been demeaned before the estimation of (16).

The parameters involved in (16) have been estimated using OLS and are presented in Table 7. Both the persistency parameter and the variability are higher for the labor wedge, as compared to the efficiency wedge. The standard deviation of the shock to the labor wedge is four times larger than that of the efficiency wedge.

Additionally, the prototype model needs five more parameters that can be determined from the calibration of the Spanish economy: $\beta = 0.961$, $\psi = 117.3$, $\nu = 1/3$, $\delta = 0.042$, $\theta = 0.364$. Section B in the online appendix details the logic behind the calibration exercise. Using these parameters and the estimates in Table 7, we simulate the prototype model. The relevant simulated moments (standard deviations and correlations) are shown in Table 8, while Table 9 presents the decomposition of the simulated variances.

The first column in Table 8 shows the simulated moments when considering both shocks $(\eta_{z,t}, \eta_{\ell,t})$. The following two columns report the moments when the model is simulated with only one shock. In the last column we report the moments observed in Tables 3 and 4. The simulation with two shocks produces a good approximation for the variances of output and investment.

When we only allow the TFP shock to operate, the simulation results are consistent with those found in standard RBC models, namely smoother consumption and positive correlations between output and productivity and between productivity and the real wage. In absolute terms, the standard deviations are well below those reported in Tables 3 and 4.

When the labor wedge shock is the only one in operation, the correlation of productivity with the rest of the variables becomes negative. Movements in wages and hours are now caused by movements along the labor demand curve, which results in a high negative correlation between these two variables.

Table 9 shows that shocks to the labor wedge can help understand a sizable fraction of the simulated fluctuations. More than two thirds of the output variance can be accounted for by shocks to the labor wedge, while the two shocks seem to have equal importance in explaining the investment variance. The simulated variances of hours worked and the real wage are almost fully accounted for by shocks to the labor wedge. Finally, the variance in productivity is still dominated by shocks to the TFP: the dynamic of productivity in Spain closely follows that of TFP (see Figure 1 and Table 4).

As expected, the model fails to reproduce the relative consumption volatility noted in Table 3, although it can produce a negative correlation between productivity and the real wage.

[**Tables 7, 8 and 9 here**]

6 Labor wedge and institutions

In this section we explore whether the labor wedge can be linked to Spanish institutions. For this purpose we regress the change in the labor wedge on a variety of indicators that proxy institutional changes occurring in Spain since 1976. We include the following indicators in our analysis: temporary rate, employment protection, unemployment benefits, unionization and collective bargaining, tax rates, financial frictions, and a set of other unmeasured factors.[9]

The labor wedge LW_t is regressed on a set of indicators reported earlier, namely Allard's (2005a) employment protection index, the temporary rate; the OECD's collective bargaining centralization and coordination indexes, the labor union coverage rate, unemployment benefits, a measure of the tax wedge, and the financial reforms index of Abiad et al. (2008). For the unemployment benefits, we use alternatively those of OECD and Allard (2005b). All variables have been first-differenced. As long as the union coverage evolves alongside a quasi-linear trend, we include it in the regression alternatively with a constant, in order to avoid multicolinearity. Allard's (2005a) index of employment protection and the Abiad et al. (2008) index of financial reforms are log-transformed.

The regression study is reported in Table 10. In the first three regressions (columns (i) to (iii)), we start by including the OECD's benefit replacement rates as a proxy for unemployment benefits. In column (i), we exclude the change in union coverage and include a constant, and in column (ii) we instead include the change in union coverage, but none of the coefficients seem to be altered significantly. We remove from the regression those variables with a p-value below 0.20, and reach the results in column (iii). We find that employment protection, unemployment benefits (OECD), and the tax wedge appear to be positively correlated to the labor wedge. The temporary rate is negatively correlated, although it is not very statistically significant.

In columns (iv) through (vii), we substitute the OECD measure with Allard's (2005b) estimate of unemployment benefits. Columns (iv) and (v) differ in the inclusion of a constant *versus* the change in union coverage, but the results do not hinge on it. The variables that appear significantly correlated to the wedge are: centralization of collective bargaining, unemployment benefits, and the tax wedge. These two last are highly significant. The temporary rate is weakly significant and negatively correlated to the labor wedge. We do not find employment protection as significant, as in the case of columns (i)-(iii), when the OECD estimate for unemployment benefits was used

[9] See section E of the online appendix for a description of these indicators and their sources.

instead of that of Allard (2005b). Getting rid of the variables with a p-value below 0.20, we confirm that the tax wedge and unemployment benefits are highly correlated with the labor wedge, and to a lesser extent the centralization of collective bargaining.

The financial reforms index is negatively correlated to the labor wedge, although the coefficient is statistically non significant. As the regressions are limited to 1976-2003, the regression analysis excludes the recent events occurring in the Spanish banking industry, characterized by intense credit expansion until 2007 and tight credit restrictions thereafter. The Abiad et al. (2008) index of financial reforms is likely an imperfect estimator of credit restrictions. In a recent paper, Bentolila, Jansen, Jiménez, and Ruano (2013) estimated the extent to which the 2008 credit collapse could have generated pronounced employment adjustments in Spain.

In summary, we find that the labor wedge seems to respond to the evolution of taxation and unemployment subsidies. To a lesser extent, the structure of collective bargaining and the employment protection of workers under permanent contracts are some factors that help explain the evolution of this wedge in Spain. The timing of events can be traced as follows: from 1976 to 1986 the increase in the tax wedge can be attributed to changes in labor income taxation, remaining relatively constant afterward. This argument is proposed by Conesa and Kehoe (2005) to explain the fall in hours worked for the period following the advent of democracy. The regression finds that the labor wedge is specially sensitive to tax increases. The VAT was increased in January 2010 and September 2012.

Second, unemployment benefits increased from 1976 to 1986, and in view of our indices, they stabilize afterward. Unemployment benefits, which usually produce a longer period of unemployment, have been found to be positively correlated to the labor wedge (see Tatsiramos (2009), and Carrasco and García (2012)).

Third, after the Moncloa Pacts in 1978, several policies were gradually introduced in order to strengthen employment protection, at the cost of creating a duality in the Spanish labor market. The labor reforms of 1984 and 1994 overprotected tenured contracts workers, while temporary workers ended up under-protected. As a result, the temporary rate is highly procyclical while the wage became counter-cyclical after 1995 (see Table 4). The negative correlation of the temporary rate with the labor wedge helps understand the labor wedge increases during the great recession.

Finally, in the mid-1980s, and parallel to the enhanced openness of the Spanish economy and labor reforms, the collective bargaining system was reduced from a highly centralized level to a sector level (Ochel 2000 and Flanagan 1999). Given the positive correlation between centralization and the labor wedge, this helped to reduce the labor wedge.

[**Table 10 here**]

7 Conclusions

In this paper, we have characterized two Spanish recessions that have occurred since the inception of democracy, using the methodology proposed by Chari, Kehoe, and McGrattan (2007). In the logic of this methodology, we conclude that any model that tries to understand the causes of recessions occurring in the last three decades should focus on the labor wedge. The feasibility wedge (labeled as government wedge in Chari et al.'s (2007) original work) has a minimal impact on output and hours per capita, as is the case with the investment wedge. The evolution of the efficiency wedge cannot only be regarded as a cyclical problem but as an issue dealing with the permanent component of productivity. These results are robust when we use an open economy version of BCA methodology. Hence, the actual downturn in output and the large increase in the Spanish unemployment rate should be related to the domestic factors behind the labor wedge.

The prototype model has been calibrated for the Spanish economy, and simulated under a shock to the TFP, in the vein of the RBC tradition, and a shock to the labor wedge, reflecting our previous findings from the BCA exercise. We find that the inclusion of a shock to the labor wedge helps to explain the observed negative correlations between wages and productivity, and between output and productivity. Standard RBC models cannot reproduce these cyclical regularities for Spain (Boldrin, Conde-Ruiz, and Díaz-Giménez (2010)).

Taxation, labor market rigidities, and credit constraints are natural candidates to account for movements in the labor wedge. When confronting our estimate of the labor wedge against a variety of indicators in a regression analysis, we find a high sensitivity with respect to taxes and unemployment benefits and, to a lesser degree, employment protection, and the degree of centralization in collective bargaining. All these institutions have been created and developed in Spain's recent history.

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Appendix

Following is an appendix containing six sections, labeled from A to F. Section A presents a description of the dataset and how these data have been transformed: We merge different Spanish series of national accounts, and we explain how the quarterly capital stock has been calculated. In this Section we also include econometric tests to detect possible structural breaks of productivity per hour worked in Spain. The results of these test are used in the business cycle analysis in Section 2. Section B describes the logic of the calibration of the prototype model for the Spanish economy. This calibration is used for a simulation exercise in Section 5 of the paper. Section C extends the BCA methodology to an open economy framework, following Lama (2011). This complements the standard BCA analysis of Sections 3 and 4 in the paper. Some statistical properties of the wedges can be found in Section D. A detailed description of the variables used in the regression analysis in Section 6 can be seen in Section E. In Section F, finally, we give a detailed description of the software codes used in the BCA anlaysis.

A Dataset

National accounts and sample selection We split the analysis into two disjoint samples, 1976:3-1994:4 and 1995:1-2011:2. The reason for this is twofold. First, as Jimeno, Moral, and Saiz (2007) have documented, there is a clear break in Spain's productivity that happened around 1994. See also our own break analysis at the end of the current Section.[10] We want to avoid having our estimation procedure produce biased parameter values if estimation is done for a sample that overlaps the break.

Second, Spain's *Instituto Nacional de Estadística* (INE)[11] does not offer a single backward-compatible database that goes back all the way to 1976:3. Instead, we have three different databases to work with. The first (denoted `CNTR86`) starts in 1976:3 and ends in 1998:4, with base year 1986. The second (denoted `CNTR00`) starts in 1995:1 and ends in 2011:2, with base year 2000. The third (denoted `CNTR08`) starts in 2000:1 and is currently ongoing; the base year is 2008. Given that these databases are not directly comparable, we restrict the estimation procedure to using a single database for each episode. We use the first database to examine the transition

[10] There is evidence of another break around 1985-86, which coincides with the openness process that followed Spain's EEC entry and an important policy reforming the public industrial sector, *la reconversión industrial*. As a robustness check, we redid the analysis of Section 4.1 after considering only the 1976:3-1985:3 subsample; we found that the conclusions reached above are not altered in any way.

[11] See `http://www.ine.es/`.

recession, and the second database to examine the great recession.

The growth rates for GDP, consumption, and investment are plotted in figures A.1 to A.3, all in real terms. There are no stark differences in the three INE databases for the periods where there is an overlap. Both consumption and investment are procyclical. GDP has been growing at an annual rate of 2.24%. As expected, investment is the most volatile component of GDP.

Figure A.4 shows the sum of government expenditures and net exports, relative to GDP. The discrepancy between the CNTR86 and CNTR00 databases during their overlapping period (1995:1-1998:4) can be attributed to differences in relative prices. This ratio is decomposed in figures A.5 to A.8, where we plot government expenditures, exports, imports, and the trade balance. We use nominal rather than real ratios. The upward trend in the first three series reflects the growing importance of the public sector after the advent of democracy and the openness process of the Spanish economy, mostly after the admission to the EEC in 1986. The trade balance, shown in Figure A.8, is usually negative and spikes up after the devaluations of the Spanish peseta (there is an obvious exception for the surplus in 2012).

Fig. A.1: GDP growth 1970:1-2012:3

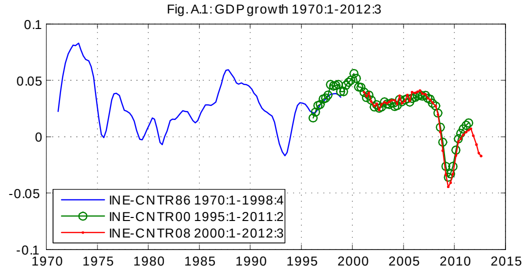


Fig. A.2: Consumption growth 1970:1-2012:3

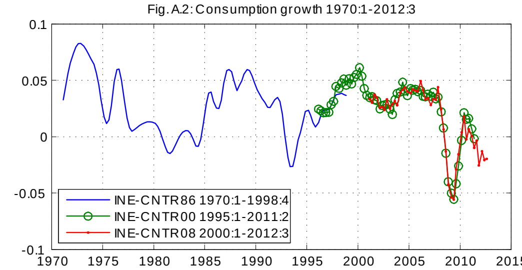


Fig. A.3: Investment growth 1970:1-2012:3

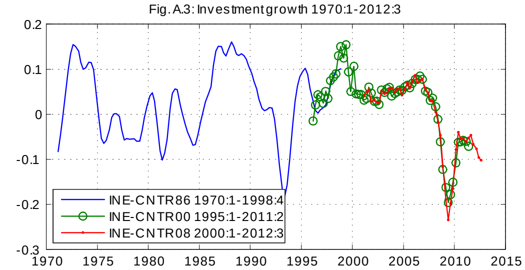


Fig. A.4: (G+NX)/Y 1970:1-2012:3

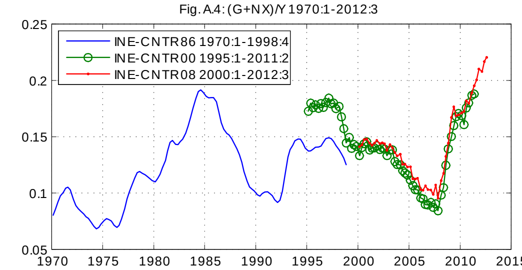


Fig. A5: Governmentexpenditures over GDP

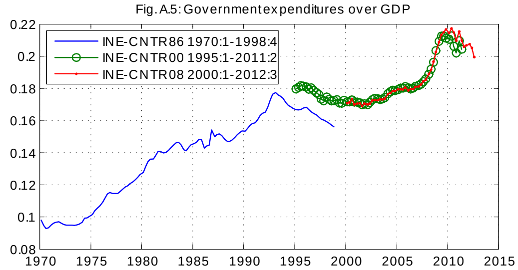


Fig. A6: Exports over GDP

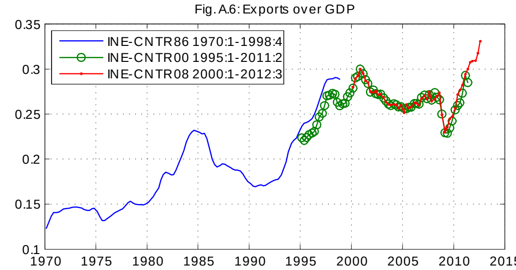


Fig. A7: Imports over GDP

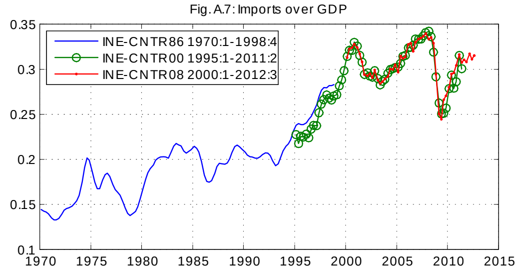
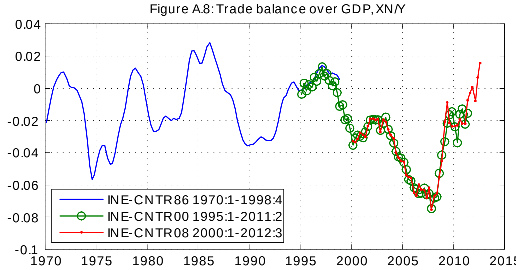


Figure A.8: Trade balance over GDP, XN/Y

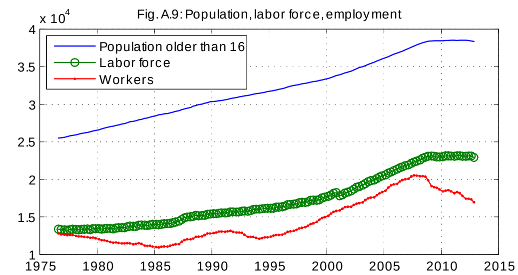


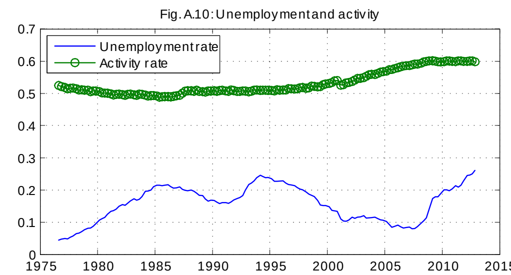
Labor, hours and wages The labor series are obtained from the INE's *Encuesta de Población Activa* (EPA, or Current Population Survey) at a quarterly frequency, from 1976:3 to date. We use data on the civilian population, labor force, employed and unemployed workers, and average hours worked per worker. We controlled for changes in the EPA methodology, so that all series are homogenous. The *hours per worker* series has been seasonally adjusted using Banco de España's software package TRAMO-SEATS.

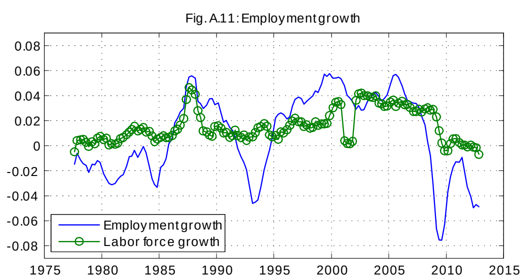
For the nominal wage, we use an index of wages negotiated under collective bargaining. The real wage is calculated dividing the nominal wage index by the CPI. In Spain, the fraction of workers whose wages are the result of collective bargaining has grown from 65.0% in 1976 to about 90.0% currently. The source of the wage index is Ministry of Employment (*Ministerio de Empleo, SGAM, Área de Mercado Laboral*). The source for the consumption price index CPI is INE.

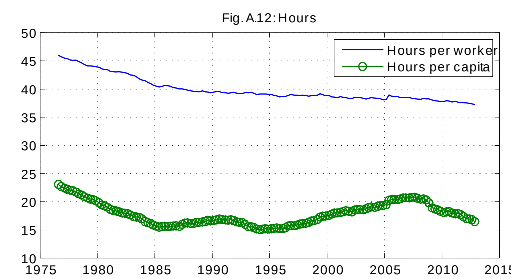
Figures A.9 through A.12 plot these series. Both working-age population and labor force have been growing over time (see Figures A.9 and A.11). Note that there was an increase in population during the 2000s due to an influx of immigrants of nearly 6 million people. In Figure A.10, the activity rate displays a flat evolution until the end of the 1990s. Moreover, employment shows a flatter trend than that of the labor force (see Figures A.9 and A.12). The unemployment rate, seen in Figure A.10, is countercyclical and widely surpasses the 20% borderline on three occasions.

Finally, Figure A.12 presents the series of hours per worker and hours per capita (i.e. total hours worked over working age population). Hours worked fall during the first decade of democracy. Hours per capita show a change in trend due to the increase in the activity rate between the mid-1990s and the start of the recession in 2008.









Capital and investment The EU KLEMS database[12] provides an annual series of capital, investment, capital compensation, and output for 1970 to 2007. We use these series as a benchmark to build our quarterly capital stock series.

In the database, assets are classified as belonging to one of eight categories: (1) hardware, office equipment, and peripherals; (2) communication equipment; (3) software licenses; (4) transport equipment; (5) machinery; (6) other equipment; (7) structures, and (8) residential investment.

We use a Törnqvist index to aggregate the growth rates of these eight assets, using their

[12] See `http://www.euklems.net/`.

nominal capital shares:

$$\gamma(K_t) = \sum_{j=1}^{8} 0.5\left(s_{j,t}^{K} + s_{j,t-1}^{K}\right)\gamma(K_{j,t}) \tag{17}$$
$$\gamma(K_{j,t}) = \left(K_{j,t} - K_{j,t-1}\right)/K_{j,t-1},$$

where $s_{j,t}^{K}$ is the nominal capital share of asset j in year t,

$$s_{j,t}^{K} = \frac{CAP_{j,t}}{\sum_j CAP_{j,t}}.$$

with $CAP_{j,t}$ being the nominal capital compensation of asset j in year t, also provided by the EU KLEMS dataset (note $\sum_j s_{j,t}^{K} = 1$).

The *annual* capital growth rates from (17) are used to target the *quarterly* series of capital from INE. According to the method of perpetual inventories, the growth rate of capital is given by

$$\frac{K_{t+1}}{K_t} = 1 + \gamma(K_{t+1}) = 1 - \delta^{year} + \frac{I_t}{K_t}. \tag{18}$$

with δ^{year} being the aggregate yearly depreciation rate of capital. We report the geometrical depreciation rates of the eight assets given in the EU KLEMS dataset, δ_j^{year}, in Table A.2. Using the nominal share of investment in 1970, $s_{j,1970}^{I}$, we obtain an aggregate depreciation rate

$$\delta_{1970}^{year} = \sum_j s_{j,t}^{I}\,\delta_j^{year} = 0.069.$$

The annual growth rate of aggregate capital for 1971 ($\gamma(K_{1971})$) is 0.053. From expression (18) the initial capital-to-investment ratio for 1970 becomes

$$\frac{K_{1970}}{I_{1970}} = \frac{1}{\gamma(K_{1971}) + \delta_{1970}^{year}} = 8.19.$$

Given the quarterly series of gross investment from the INE, and the initial capital to investment ratio for 1970, we aggregate the capital stock using a time-varying depreciation rate such that the growth rates in the quarterly series of capital equal the growth rates obtained in (17) from the EU KLEMS data base. For instance, given the initial capital stock estimated for 1970:4 and the growth rate of capital $\gamma(K_{1971})$ =0.053, the quarterly depreciation rate δ is selected to match the following equation:

$$K_{1971:4} = (1-\delta)^4 K_{1970:4} + I_{1971:4} + (1-\delta) I_{1971:3} + (1-\delta)^2 I_{1971:2} + (1-\delta)^3 I_{1971:1}, \tag{19}$$

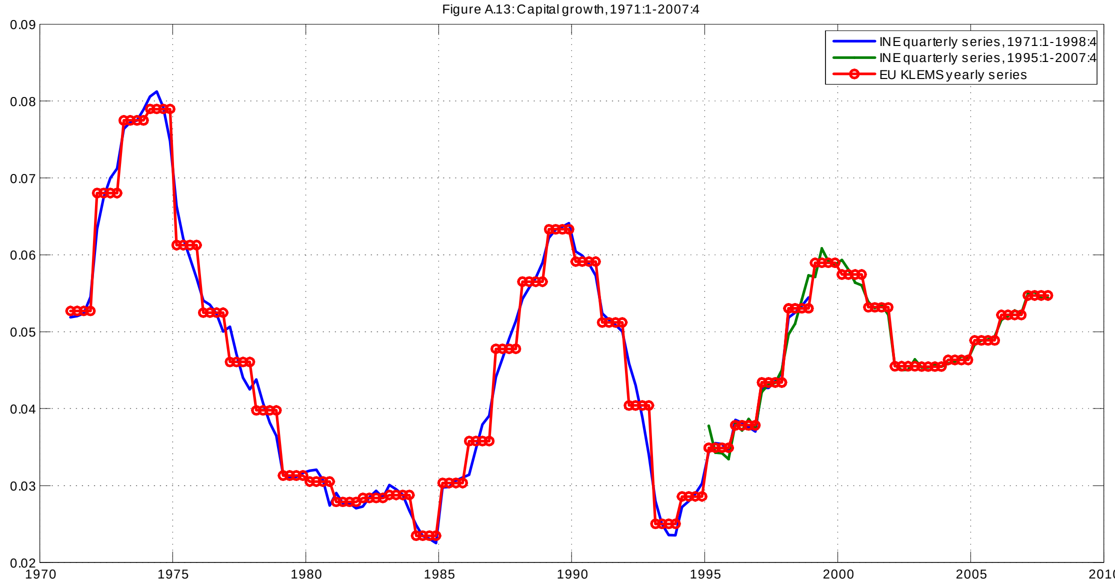
with $\{I_{1971:q}\}_{q=1}^{4}$ being the flow of 1971 INE quarterly investment estimates. The time variation in the depreciation rates reflects changes in the composition of the portfolio of physical assets. An analogous method is applied to construct the capital stock series for the second database (1995:1-2011:2). The average depreciation rate over the period is 4.04% on annual terms.

Table A.2: Depreciation rates

Asset:	δ_j^{year}	$s_{j,1970-2007}^{I}$
Computing equipment	0.315	0.027
Communications equipment	0.115	0.037
Software	0.315	0.022
Transport equipment	0.159	0.087
Other machinery and equipment	0.115	0.180
Non-residential structures	0.028	0.339
Residential structures	0.011	0.297
Other assets	0.123	0.011

Note that from the EU KLEMS database we can calculate growth rates through 2007. For the following years, 2008 to 2012, we extend the series of capital using a constant depreciation rate and the method of perpetual inventories. In Figure A.13 we merge and plot these estimates of the capital growth rates. On average, capital stock has grown 4.5% annually.

Figure A.13: Capital growth, 1971:1-2007:4



Income shares From the EU KLEMS database we use the labor compensation (LAB_t) and capital compensation (CAP_t) series to calculate the income shares in the following way:

$$\text{capital income share} = \frac{CAP_t}{CAP_t + LAB_t}.$$

Labor and capital compensation add up to nominal gross value added. On average, the capital income share is 0.364 and fluctuates within the range [0.333, 0.399]:

$$\sum_{t=1970}^{2008} \frac{CAP_t}{CAP_t + LAB_t} = 0.364.$$

Structural break tests We apply the structural break tests of Andrews (1993) and Andrews and Ploberger (1994) in our series of productivity per hour in Spain. Both tests assume the break point is unknown.

Let us denote $\overline{y}_t = \ln(Y_t/H_t)$ as the productivity per hour worked, and assume it to be governed by an $AR(p,r)$, which can change with a regime denoted as r:

$$\overline{y}_t = \mu^{(r)} + \gamma^{(r)} t + \sum_{j=1}^{p} \phi_j^{(r)} \overline{y}_{t-j} + e_t, \tag{20}$$

with $e_t \sim \text{iid}\,\mathcal{N}(0,\sigma^2)$, where $\left\{\mu^{(r)}, \gamma^{(r)}, \left\{\phi_j^{(r)}\right\}_{j=1}^{p}\right\}$, is the set of parameters under regime r. A structural break occurs whenever some of the elements in the set alter at some point in time which we denote by $\overline{T}$.

We estimate equations of the form

$$\overline{y}_t = D_{1t}\left(\mu^{(1)} + \gamma^{(1)} t + \sum_{j=1}^{p} \phi_j^{(1)} \overline{y}_{t-j}\right) + D_{2t}\left(\mu^{(2)} + \gamma^{(2)} t + \sum_{j=1}^{p} \phi_j^{(2)} \overline{y}_{t-j}\right) + e_t, \tag{21}$$

where D_{1t} and D_{2t} are defined as

$$D_{1t} = \begin{cases} 0 \text{ if } t \leq \overline{T} \\ 1 \text{ if } t > \overline{T} \end{cases} \tag{22}$$

$$D_{2t} = 1 - D_{1t}, \tag{23}$$

The structure in (21) assumes only one break. A test of no structural break implies constancy of parameters. That is $\mu^{(1)} = \mu^{(2)}$, $\gamma^{(1)} = \gamma^{(2)}$ and $\left\{\phi_j^{(1)} = \phi_j^{(2)}\right\}_{j=1}^{p}$. The tests search for a change in regime where $\overline{T}$ is absent under the null hypothesis. This implies that the LM, LR and Wald tests of equality of coefficients do not have standard asymptotic properties.

Andrews (1993) and Andrews and Ploberger (1994) develop tests for cases where the nuisance parameter $\overline{T}$ is present under the alternative but not under the null. They consider the function $\mathcal{F}_T\left(\overline{T}\right)$, where T is the number of observations, defined as the Wald or LM statistic of the hypothesis of constancy of parameters, for each possible value of $\overline{T} \in [0.15T, 0.85T]$.

Andrews (1993) shows the asymptotic properties of the statistic:

$$\sup_{\overline{T}\in[0.15T,0.85T]} \mathcal{F}_T = \sup \mathcal{F}_T\left(\overline{T}\right), \tag{24}$$

and reports the asymptotic critical values.

Andrews and Ploberger (1994) propose two additional statistics:

$$\exp \mathcal{F}_T = \ln\left(\frac{1}{1+0.85T-0.15T}\right)\sum_{\overline{T}=0.15T}^{0.85T}\exp\left[\frac{1}{2}\mathcal{F}_T\left(\overline{T}\right)\right], \quad (25)$$

$$\text{ave}\mathcal{F}_T = \left(\frac{1}{1+0.85T-0.15T}\right)\sum_{\overline{T}=0.15T}^{0.85T}\mathcal{F}_T\left(\overline{T}\right). \quad (26)$$

We use the approach suggested by Hansen (2000) for the p-values associated with these three statistics. The results of the tests are shown in Table A.3.

Using the LR test, we identify three lags for the AR order of the complete sample (i.e. $p = 3$ on (20)), 1976:3-2012:3. When the tests (24), (25), and (26) are applied for the complete period 1976:3-2012:3, a break is identified at 2006:3, as its associated p-values are below the critical value of 0.10. The test for joint significance points out a break in 1995:4.

Taking for granted the break on 2006:3, the tests are again applied within the sample 1976:3-2006:2. The null hypothesis is rejected by the three tests, with 1994:4 the identified break point for the joint test (the p- values are below the critical 10% level). An additional break is also identified for 1985:2.

Thus, we find support for three changes in regime: 1985:2, 1994:4 and 2006:3.

Table A.3: Structural break tests, Spanish productivity

Sample: 1976:3-2012:3	Break $\overline{T}$	sup-LM	p-value	exp-LM	p-value	ave-LM	p-value
Joint	1995:4	26.207	0.0022	10.880	0.0006	15.581	0.0006
$\mu^{(1)} = \mu^{(2)}$	2006:3	20.694	0.0002	7.413	0.0000	6.405	0.0015
$\phi_1^{(1)} = \phi_1^{(2)}$	2006:3	21.443	0.0001	7.523	0.0000	5.869	0.0030
$\phi_2^{(1)} = \phi_2^{(2)}$	2006:3	21.714	0.0001	7.641	0.0000	5.884	0.0029
$\phi_3^{(1)} = \phi_3^{(2)}$	2006:3	21.806	0.0001	7.681	0.0000	5.846	0.0031
$\gamma^{(1)} = \gamma^{(2)}$	2006:3	21.458	0.0001	7.499	0.0000	5.620	0.0040
Sample: 1976:3-2006:2	Break $\overline{T}$	sup-LM	p-value	exp-LM	p-value	ave-LM	p-value
Joint	1994:4	16.009	0.1029	6.035	0.0506	10.532	0.0182
$\mu^{(1)} = \mu^{(2)}$	1985:2	8.048	0.0645	1.633	0.0831	1.921	0.1218
$\phi_1^{(1)} = \phi_1^{(2)}$	1985:2	9.756	0.0295	1.828	0.0651	1.860	0.1297
$\phi_2^{(1)} = \phi_2^{(2)}$	1985:2	9.602	0.0317	1.784	0.0651	1.840	0.1323
$\phi_3^{(1)} = \phi_3^{(2)}$	1985:2	9.538	0.0326	1.739	0.0687	1.791	0.1394
$\gamma^{(1)} = \gamma^{(2)}$	1985:2	9.965	0.0268	1.857	0.0727	1.803	0.1376

B Calibration

All variables are assumed to evolve according to the following pattern

$$\begin{aligned} \widetilde{u}_t &= (1+\gamma_u)^t \times \exp(\widehat{u}_t) \times u_{ss} \\ &= (1+\gamma_u)^t \times u_t, \end{aligned}$$

so that any tilde variable $\widetilde{u}_t$ has a deterministic long run growth pattern, $(1+\gamma_u)^t$, a cycle $\widehat{u}_t$, and a stationary value, u_{ss}. As usual, we assume that cycles are nil when this variable meets its growth path ($\widehat{u}_t = 0$).

From the feasibility condition we have that output, consumption, investment, and the feasibility wedge will share the same growth rate. The law of motion for capital implies that capital will grow at the same rate as output, $\gamma_k = \gamma_y$. Finally, the production function implies that the balanced growth rate of output is

$$\left(1+\gamma_y\right) = (1+\gamma_z)(1+\gamma_h), \tag{27}$$

where γ_z is the growth rate of TFP and γ_h is the growth rate of the labor input.

We have five standard parameters: $\mathcal{P} = \{\beta, \psi, \upsilon, \theta, \delta\}$. We need to add the productivity and the population growth rates, which we choose according to the estimated trends of output and total hours worked, γ_y and γ_n. In annual terms, the growth rates are shown in Table B.1. The growth rates for TFP and labor force meet the requirement (27). As we saw earlier, we estimate an annual GDP growth rate of 2.24% across the entire period. Productivity growth was high and employment growth was weak during the first period, 1976:3-1994:4; the opposite scenario happens for the second period, 1995:1-2012:3, where there was high employment growth and low productivity.

Table B.1: Targets (annual terms)

	1976:3-1994:1	1995:1-2012:3
Output growth, γ_y	2.24%	2.24%
TFP growth, γ_z	1.48%	0.54%
Employment growth, γ_h	0.75%	1.69%

The steady-state equilibrium satisfies a system of four equations:

$$\psi l_{ss}^{1+1/\upsilon} = (1-\theta)\frac{y_{ss}}{c_{ss}}, \quad (28)$$

$$(1+\gamma_z)(1+\gamma_l) = \beta\left[1-\delta+\theta\frac{y_{ss}}{k_{ss}}\right], \quad (29)$$

$$(1+\gamma_z)(1+\gamma_l) = 1-\delta+\frac{x_{ss}}{k_{ss}}, \quad (30)$$

$$y_{ss} = A_0 k_{ss}^{\theta} l_{ss}^{1-\theta}, \quad (31)$$

that when solved yield the value of the three parameters for our targets of the steady-state values. The targets we choose are:

1. The fraction of time devoted to market activities: $l_{ss} = 0.31$.
2. The steady-state consumption-output ratio: $c_{ss}/y_{ss} = 0.585$.
3. The steady-state investment-output ratio: $x_{ss}/y_{ss} = 0.225$.
4. The capital-output ratio in yearly terms $k_{ss}/y_{ss} = 3.49$.

5. Steady state output, $y_{ss} = 1$.

Given the steady-state conditions (28)-(31), the five targets, a labor income share 0.636, and a Frisch elasticity of labor supply $1/3$, we report the equilibrium values of the parameters in Table B.2.

Table B.2: Parameters

Definition	**Parameter**	**Value**
Subjective discount rate (yearly)	β	0.9613
Willingness to work	ψ	117.7374
Frisch elasticity	υ	0.3333
Depreciation rate (yearly)	δ	0.0422
Capital income share	θ	0.3638
Technology	A_0	0.8076

C An open economy framework

This section presents a robustness check of the BCA methodology. We extend the BCA methodology to consider an open economy specification following Lama (2011).

The household's budget constraint is rewritten as

$$\begin{aligned} c_t(s^t) + x_t(s^t) + b_{t+1} = (1 - \omega_{lt}(s^t))W_t(s^t)l_t(s^t) + (1 - \omega_{kt}(s^t))R_t(s^t)k_t(s^{t-1}) + \\ + (1 + \omega_{bt}(s^t))(1 + r_t^*)b_t + T_t(s^t), \end{aligned} \tag{32}$$

where b_t is an international bond, r_t^* is the return on holding the asset, and ω_{kt}, ω_{bt} denote the capital wedges and bond wedge, respectively. Note that international financial frictions can manifest through the bond wedge and will have a direct impact on the trade balance TB_t, since

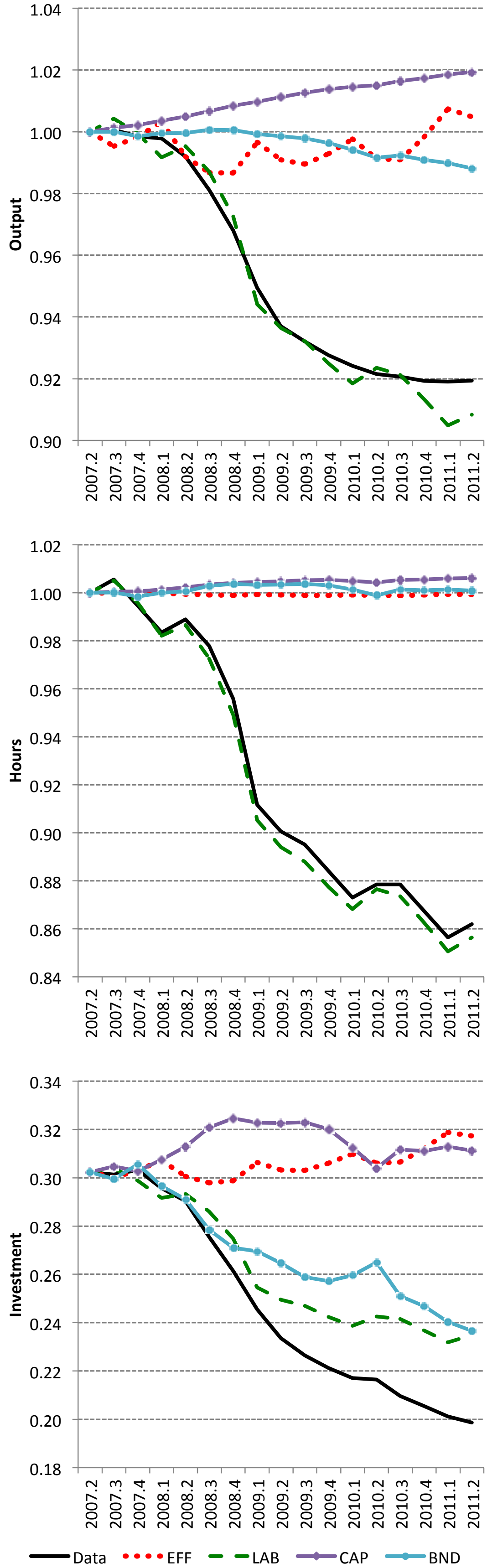
$$TB_t = b_{t+1} - \left(1 + \omega_{bt}(s^t)\right)\left(1 + r_t^*\right)b_t. \tag{33}$$

The investment wedge should also be reinterpreted with respect to its standard version in the household's budget set. In this new formulation, the capital wedge in (32) collects any frictions distorting the decision from holding the physical asset k_t. The bond wedge can be interpreted as a tax on international debt, so that taxes are paid on the interest from international borrowing.

The results are shown in Figure C.1. The fluctuations induced by the labor wedge have an almost perfect match with observed movements in the output and hours worked. The wedge does a fairly good job in accounting for movements in the investment to output ratio but deviates from the observed fluctuations after 2009.

The bond wedge has a negligible impact in accounting for output and hours, but it can capture some of the movements in investment, at least up to 2008. We conclude that the foreign sector cannot be made responsible for the increase in unemployment: models that attempt to explain the current recession should focus on the labor wedge, regardless of whether the model specifies a small open economy or a closed one. The frictions that originate the labor wedge can be of different natures and include a large set of distortions: taxation, labor market institutions, credit constraints, or the competitiveness in the goods markets.

Figure C.1: Data and model with one wedge, 2007:2-2011:2. Open economy.



D Statistical properties of the wedges

Tables D.1 and D.2 present the statistical properties of the model predictions using the measured wedges, for the two samples we use. The main message to take from the tables is that the labor wedge is highly correlated (contemporaneously and through leads and lags) with output.

Table D.1: Properties of the wedges, 1976:3-1994:4

A. Summary statistics						
		Correlation with output, lag $k =$				
Variable	Relative SD	$+2$	$+1$	0	-1	-2
Efficiency	0.65	0.11	0.15	0.13	-0.01	-0.13
Labor	6.77	0.67	0.76	0.81	0.80	0.72
Investment	1.40	0.31	0.32	0.28	0.31	0.31
Feasibility	8.54	-0.43	-0.49	-0.48	-0.53	-0.54
B. Cross correlations						
		Cross-correlation X_t, Z_{t-k}, lag $k =$				
Variable X	Variable Z	$+2$	$+1$	0	-1	-2
Efficiency	Labor	-0.10	-0.26	-0.45	-0.42	-0.36
Efficiency	Investment	-0.29	-0.35	-0.36	-0.34	-0.37
Efficiency	Feasibility	0.09	0.19	0.27	0.29	0.34
Labor	Investment	0.52	0.55	0.52	0.50	0.47
Labor	Feasibility	-0.60	-0.66	-0.65	-0.63	-0.57
Investment	Feasibility	-0.57	-0.82	-0.93	-0.87	-0.68

Table D.2: Properties of the wedges, 1995:1-2011:2

A. Summary statistics						
		Correlation with output, lag $k =$				
Variable	Relative SD	$+2$	$+1$	0	-1	-2
Efficiency	0.54	0.08	0.10	0.10	0.03	-0.04
Labor	6.78	0.75	0.85	0.87	0.77	0.60
Investment	0.65	-0.73	-0.82	-0.79	-0.67	-0.47
Feasibility	8.36	-0.83	-0.80	-0.68	-0.51	-0.32

B. Cross correlations						
		Cross-correlation X_t, Z_{t-k}, lag $k =$				
Variable X	Variable Z	$+2$	$+1$	0	-1	-2
Efficiency	Labor	-0.01	-0.19	-0.36	-0.26	-0.12
Efficiency	Investment	-0.07	0.09	0.24	0.12	-0.03
Efficiency	Feasibility	0.16	0.15	0.20	0.25	0.29
Labor	Investment	-0.52	-0.76	-0.91	-0.80	-0.60
Labor	Feasibility	-0.48	-0.64	-0.81	-0.88	-0.89
Investment	Feasibility	0.43	0.57	0.66	0.75	0.74

E Description of regressors

Temporary rate The temporary employment rate is defined as the ratio of the number of wage earners under a fixed-term contract relative to the total number of workers (i.e. those workers under fixed-term contracts plus those under tenured or permanent contracts). The series of the number of workers under both types of contract are available from the INE from 1987:2 to date, on a quarterly basis. Before the labor market reform of 1984, fixed term contracts were limited to some seasonal activities such as agriculture or services associated with tourism. We have looked back and extended (1970 to 1987) the series of temporary workers using the annual labor series in the EU KLEMS database. From the EU KLEMS database, we calculate the ratio of the number of low skilled workers in the primary and in the hotel and restaurant services sectors relative to the total number of workers. The fraction is used as a proxy for the temporary rate for the years 1977 to 1986, since the series from INE lacks this information. For the two years 1985 and 1986, we interpolate the values using our estimate for 1984 and the INE rate for 1987. On average, the temporary rate was 10.37% between 1976 and 1984, which is near those estimated by some authors, such as Dolado, García-Serrano, and Jimeno (2002). Our estimate is summarized in Table E.1.

Table E.1: Temporary rate 1976-1987

	1976	**1977**	**1978**	**1979**	**1980**	**1981**
Ratio	0.111	0.107	0.105	0.104	0.103	0.102
	1982	**1983**	**1984**	**1985**	**1986**	**1987**
Ratio	0.105	0.103	0.102	0.127	0.152	0.178

Figure E.1 presents the temporary employment rate, defined as the proportion of wage earners with a temporary contract. The evolution of the temporary rate documents an essential feature of the Spanish labor market: a dual system of labor contracts. The duality might have its origins in the labor market reform of 1984, which allowed firms to hire workers under a temporary contract characterized by lower and clearly defined firing costs (relative to tenure contract workers). Before 1984, the use of temporary contracts was limited to some seasonal activities such as agriculture and tourism. The temporary rate increased beginning in the mid-1980s onward, and mostly in the private sector. Throughout the 1990s and before the great recession, the temporary rate always exceeded 30%. The sharp drop in the rate after the start the Great Recession can be explained by firms eliminating temporary jobs as an adjustment mechanism.

Employment protection Figure E.2 presents the employment protection indices proposed by Blanchard and Wolfers (2000) and by Allard (2005a). Both indices are constructed upon that of the OECD, which considers a variety of permanent and temporary worker protections and collective dismissals.[13] Blanchard and Wolfers (2000) combined the OECD index with Lazear's (1990) index. Allard (2005a) extended the OECD methodology for a longer horizon (1950 to 2003) and takes account of other aspects of protection that constrain firms' hiring and firing decisions, such as the scope of bargaining in substituting official legal protection and the role of private litigation.

Both the OECD and the Blanchard and Wolfers' indices indicate a high level of employment protection in Spain, which slightly decreases after the 1980s. Allard's index, in contrast, reports an increase in protection during the 1970s, a peak in 1983 followed by a decline after the 1984 labor market reform; the reform mainly affected hiring decisions related to temporary contracts (Segura 2001 and Dolado, García-Serrano, and Jimeno 2002). Allard's index also captures the effects of the second labor market reform of 1994, which eased the terms of dismissal for permanent workers.[14] Although the standards of both reforms were aimed at introducing flexibility, in practical terms they have accounted for a duality problem in the Spanish labor contract: while severance pay for temporary workers is low and certain, they are high and subject to a huge risk of litigation for tenured workers. Firms have all the incentives to rely on temporary workers during booms and to dismiss them during the early months of recessions.[15]

Unemployment benefits Figure E.3 introduces measures of unemployment benefits estimated by the OECD and Allard (2005b).[16] Unemployment benefits were low before the advent of the democracy, and started growing during the 1980s. These benefits were reduced in 1992, affecting the eligibility conditions under which benefits could be obtained. The empirical literature finds that unemployment benefits discourage workers from looking for work and leaving unemployment, which

[13] For instance, with respect to permanent employment, there are three items under consideration: contract legislation, notice periods for individual dismissals and severance pay, and penalties for unfair dismissals.

[14] The 1994 reform also allowed for more flexibility inside the firms (the workweek, the functional and the geographical mobility) and reformed some other labor market institutions (e.g. collective bargaining and the INEM, *Instituto Nacional de Empleo*).

[15] Dolado et al. (2002) have summarized the effects of temporary contracts and employment protection on several labor markets issues. Regarding the effects of the labor wedge, the authors provide the following evidence related to the dual labor market in Spain: (i) higher wage pressure as long as labor unions tend to overprotect tenured workers in collective bargaining; (ii) a positive effect on long-term unemployment when the relative employment protections regarding permanent and temporary workers are relaxed; and (iii) a slightly positive effect on unemployment after the 1997 labor market reform.

[16] The OECD's gross benefit replacement rates refer to the first year of benefits averaged over three family conditions and two earnings levels before taxes. In addition, Allard (2005b) uses further information on the taxation of the subsidy, its duration, and the conditions of eligibility.

produces longer periods of unemployment (see Meyer 1990; Bover, Arellano, and Bentolila 2002; Tatsiramos 2009, and Carrasco and García 2012). Tatsiramos (2009) finds that the disincentives of unemployment benefits and their effects on unemployment duration are directly proportional to the generosity of the system. Countries with generous unemployment insurance systems, such as Denmark, France, or Spain, suffer longer unemployment spells, compared to countries such as Greece or Italy, which are less generous.

Unionization and collective bargaining Figure E.4 reports union density (aggregate percentage of workers who are members of a union) and union coverage (share of workers whose earnings are affected by collective bargaining agreements between labor unions and employers). The values are borrowed from Nickell's (2006) database. Union density slowly increased after the advent of democracy, peaking in 1994; density stands at about 14% in 2003. The union coverage ratio amounts to about 80% in 2003. For Japan and the U.S. the coverage ratio is small (18% and 14%) and meets the density ratio closely, given that unions operate at the plant level. Flanagan (1999) surveys a variety of studies and analyzes correlations between union density and variables such as inflation and the unemployment rate. The general finding points toward no correlation.

Figure E.5 presents a collective bargaining centralization index estimated by Ochel (2000), which ranges within the [1,3] interval. For Spain, the index presents values between 2 and 3, meaning that collective bargaining takes place at the sector level (value 2) or at the upper central level (value 3). Flanagan (1999) discusses how macroeconomic performance can be related to the collective bargaining system: an increase in wage bargaining decentralization allows firms to adapt to changing circumstances. Then, the theory predicts that centralization may help moderate wage formation. According to Ochel's (2000) indices, Figure E.5 reflects that a change in the Spanish collective bargaining system took place in the mid-1980s, on par with an increase in openness (coming from the 1986 EEC membership) and the 1984 labor market reform. Throughout the same period, there was a downturn in the level of collective bargaining coordination, affecting factors such as common contract expiration dates and federation, or government influence on setting wage.

Figure E.1: Temporary contracts rate 1987:1-2012:3

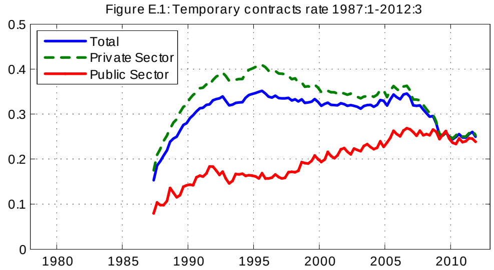


Figure E.2: Employment protection indexes

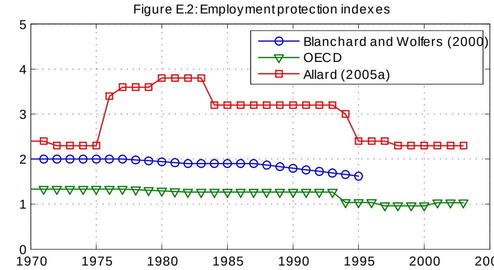


Figure E.3: Unemployment benefits

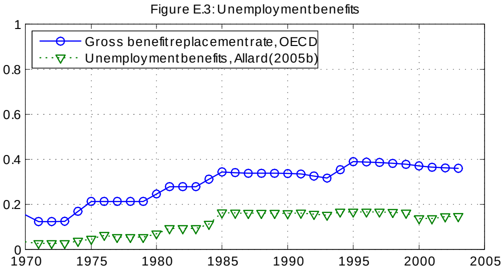
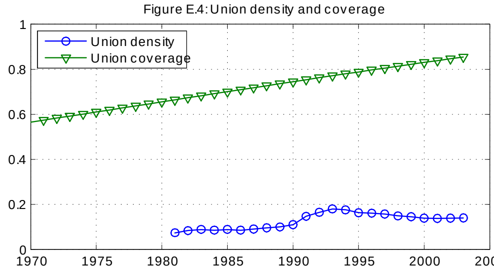


Figure E.4: Union density and coverage



Tax rates Boscá, García, and Taguas (2008) provide annual estimates of the labor income tax rate, the capital income tax rate, and the consumption tax rate using the methodology proposed by Mendoza, Razin, and Tesar (1994). Figure E.6 displays these rates in the case of Spain. The labor income tax rate increased from 1976 until 1986 when Spain entered the EEC. The taxation of consumption increased in 1986, but not as much as that of labor income. We can use the information contained in Figure 2 in the main text to conclude that the fall in average hours worked ran in parallel with an increase in the tax rate affecting the intratemporal condition, consistent with a gradual substitution of consumption for leisure (see Conesa and Kehoe 2005 and Prescott 2004).[17] Using the tax rates displayed in Figure E.6, let TW_t denote the tax wedge defined as:

$$TW_t = 1 - \frac{1 - \tau_{Lt}}{1 + \tau_{Ct}}, \tag{34}$$

[17] Conesa and Kehoe (2005) suggest that the decline in hours worked during the first two decades of democracy might have been related to the increase in taxes and the labor reforms enacted after the Moncloa Pacts. Such an increase in taxation was gradual, not drastic. First, there was an increase in labor income taxation after the creation of the Income Tax (IRPF) in 1978. Second, the indirect taxation code was reformed in 1985 with the creation of the Value Added Tax (VAT), which followed Spain's entry into the EEC. The IRPF was reformed in 1991, 1998, and 2006. The VAT was homogenized with that of other EEC countries, synthesizing a collection of indirect taxes. VAT reforms occurred in 1992 and 1998.

where τ_{Lt} denotes the labor income tax rate and τ_{Ct} denotes the consumption tax rate. The tax wedge expression (34) stands for an overall measure of existing tax pressure. When both τ_{Lt} and τ_{Ct} are zero, the tax wedge (34) is nil.

Financial frictions Jermann and Quadrini (2012) find that financial restrictions, such as credit access, can have a decisive role in propagating business cycles. The labor wedge could reflect this financial friction, being the main channel through which financial shocks are transmitted to the real sector. Our study includes the index of financial reforms constructed by Abiad, Detragiache, and Tressel (2008), which serves as a proxy for the evolution of financial frictions. Despite being an overall index of financial reforms, it contemplates the effect of seven dimensions of financial sector policies: (i) credit controls and high reserve requirements, (ii) interest rate controls, (iii) entry barriers, (iv) state ownership in the banking sector, (v) capital account restrictions, (vi) prudential regulations and supervision of the banking sector, and (vii) securities market policies. The index averages these indicators and is normalized to [0,1]. Figure E.7 shows the evolution of the index for Spain, which equals 0.37 in 1973 and reaches unity in 1998.[18] The growth in the index describes an intense process of reforms within this sector. According to the index, most of the reforms occurred after Spain's entry into the EEC in 1986 and the Single European Act in 1987.

Other unmeasured factors Our regression analysis is limited to 1976 to 2003, the period for which we have a common set of observations for the labor wedge and the set of indicators described above.[19] In spite of this limitation, the period under consideration includes a considerable number of institutional reforms in Spain's recent history. As an illustration, in Figure E.8 we report the overall index of world economic freedom for Spain proposed by Gwartney, Lawson, and Hall (2012) and some of its components therein: legal system and property rights, credit market regulation, and freedom to trade internationally. In the case of regulation, a higher index should be associated with fewer regulations in the credit market. Both the overall index and the three sub-items evince an increase in economic freedom up to 2000, when apparently many of the reforms came to a halt in Europe. For an interpretation of the halt in reforms in the Eurozone see Fernández-Villaverde, Garicano, and Santos (2013).

Apart from the indicators outlined above, we need to mention the important effect of the 1978 Constitution and the 1978 Moncloa Pacts. These institutions promoted the creation of the

[18] For comparison purposes, the values of the index for the United States were 0.63 in 1973 and unity in 1998.

[19] This analysis lacks an aggregate indicator for the degree of market power in the goods market, as a source of distortions manifesting through the labor wedge. Although the OECD provides some measures, these are limited to a few years or to a small sample of sectors.

Estatuto de los Trabajadores as a benchmark for labor factors affecting the wage mechanism and the labor supply: a legal minimum wage, weekly rest for at least one day and a half, fourteen holidays during the year, and thirty days of vacations per worked year. Labor unions, the freedom to unionize, and strikes were legalized in 1977.

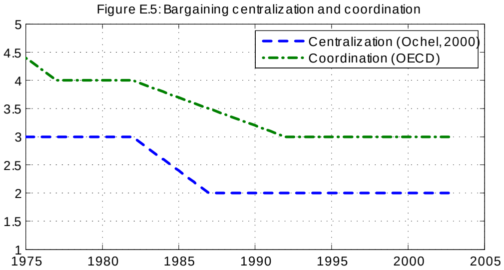


Figure E.5: Bargaining centralization and coordination

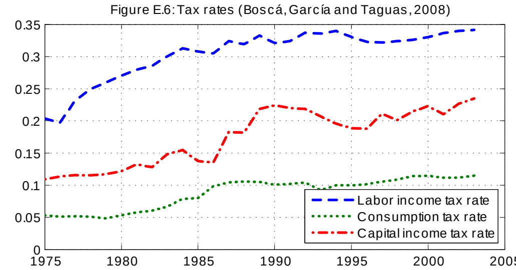


Figure E.6: Tax rates (Boscá, García and Taguas, 2008)

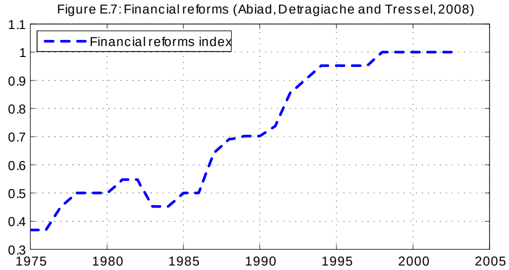


Figure E.7: Financial reforms (Abiad, Detragiache and Tressel, 2008)

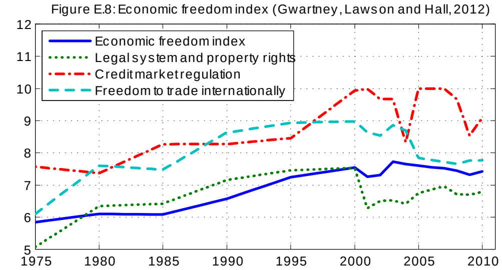


Figure E.8: Economic freedom index (Gwartney, Lawson and Hall, 2012)

F MATLAB files

Matlab and data files can be downloaded from http://www.macalester.edu/∼msolisga.

F.1 Closed-economy business cycle accounting

Below we present a brief discussion of the relevant Matlab files. All files are based on Ellen McGrattan's publicly available code, which can be found in ftp://ftp.mpls.frb.fed.us/pub/research/mcgrattan/sr328/mleqtrly/. We advise downloading the contents of the folder and overwriting the files to the ones specialized for Spain. (Some optimization routines are not included in this folder but can be easily found in ftp://ftp.mpls.frb.fed.us/pub/research/mcgrattan/mfiles/.)

SPADATA.M This script prepares the Matlab MAT files that are used in the business cycle accounting exercise. The input file is SPADATA.XLSX. There are two output files, DATA1.MAT and DATA2.MAT. The former is used to analyze the 1976:3-1994:4 sample, while the latter does so for the 1995:1-2011:2 sample

Besides the observable variables that are used in the maximum likelihood estimation (MLE) procedure, key parameters are the population and output per capita (gross) growth rates, denoted fp and fy, respectively. (For control purposes we also calculate the output growth rate, denoted fY.) These rates are calculated at a quarterly frequency; the values are used directly in the files MLEQ.M, MLESEQ.M, and FIXEXP.M:[20]

Table 1: Quarterly growth rates used in the BCA exercise.

Rate	1976:3-1994:4	1995:1-2011:2
fp	1.0030	1.0030
fy	1.0025	1.0035
fY	1.0055	1.0065

RUNMLE.M This script runs the MLE procedure that estimates the parameters of the state variable VAR. The input is the MAT file that comes from SPADATA.M (this is, DATA1.MAT or DATA2.MAT depending on the episode under analysis). The output is a vector of parameter estimates x and a log-likelihood value L. (These values are not stored; this is not necessary as long as PWBCA.M is executed immediately after RUNMLE.M.) The script sets three global variables, namely, (1) FULL_EST: sets whether the estimation is done on the full vector of parameters or we restrict the $\mathbf{P}$ and $\mathbf{Q}$ matrices to be diagonal (more on this below), (2) DATASET: sets the particular dataset (episode) that is being used, and (3) ZVAR: stores the data vector used.

We allow the estimation to be done on a restricted set of parameters—we impose $\mathbf{P}$ and $\mathbf{Q}$ to be diagonal matrices—in order to obtain reasonable guesses for the full estimation. We have found that this strategy reduces the probability of starting at a wrong set of parameters and eases

[20]These rates differ slightly from the ones in Section A; this is a consequence of the change in the sample under analysis.

up the computational burden. We set FULL_EST=0 if we want to restrict the matrices as

$$\mathbf{P} = \begin{bmatrix} P_{11} & 0 & 0 & 0 \\ 0 & P_{22} & 0 & 0 \\ 0 & 0 & P_{33} & 0 \\ 0 & 0 & 0 & P_{44} \\ \end{bmatrix} \quad \mathbf{Q} = \begin{bmatrix} Q_{11} & 0 & 0 & 0 \\ 0 & Q_{22} & 0 & 0 \\ 0 & 0 & Q_{33} & 0 \\ 0 & 0 & 0 & Q_{44} \\ \end{bmatrix}$$

(where non-zero entries are estimated by the MLE procedure) and FULL_EST=1 otherwise:

$$\mathbf{P} = \begin{bmatrix} P_{11} & P_{12} & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{32} & P_{42} \\ P_{31} & P_{32} & P_{33} & P_{43} \\ P_{41} & P_{42} & P_{43} & P_{44} \\ \end{bmatrix} \quad \mathbf{Q} = \begin{bmatrix} Q_{11} & 0 & 0 & 0 \\ Q_{21} & Q_{22} & 0 & 0 \\ Q_{31} & Q_{32} & Q_{33} & 0 \\ Q_{41} & Q_{42} & Q_{43} & Q_{44} \\ \end{bmatrix}.$$

We set DATASET=1 if we want to estimate the VAR in the first episode (1976:3-1994:4) and DATASET=2 if we want to do so for the second episode (1995:1-2011:2). (ZVAR is automatically set based on the value of DATASET.)

MLEQ.M, MLESEQ.M, RES_WEDGE.M Auxiliary files for the RUNMLE.M script. MLEQ.M and MLESEQ.M use the growth rates calculated in SPADATA.M as well as model parameters that have been calibrated previously. These two files calculate the log-likelihood and are used to directly estimate parameter values and to calculate the standard errors. RES_WEDGE.M contains the residuals from the model's equilibrium conditions; it is used to derive the policy functions which are required to calculate the likelihood.

PWBCA.M This script uses the parameter estimates (vector x from RUNMLE.M) to plot the wedges and the model predictions using only one wedge and all but one wedge. The file should be executed immediately after running RUNMLE.M.

Executing PWBCA.M provides six graphs that are relevant for the paper. Figure 1 presents output and measured wedges; Figures 2 and 3 present the observed data and the model predictions using only one wedge; Figures 4-6 present the observed data and the model predictions using all but one wedge. Depending on the value of DATASET the graphs present a different time range;

for DATASET=1 the time axis covers 1976:3 to 1985:4 (base period 1976:3=1), consistent with the transition recession. For DATASET=2 the time axis covers 2007:2 to 2011:2 (base period 2007:2 = 1), consistent with the great recession.

FIXEXP.M, RES_WEDGE2.M Auxiliary files for the PWBCA.M script. FIXEXP.M uses the growth rates calculated in SPADATA.M as well as model parameters that have been calibrated previously. This file calculates the log-likelihood and is used to directly estimate parameter values and to calculate the standard errors. RES_WEDGE2.M contain the residuals from the model's equilibrium conditions; these are used to derive the policy functions which are required to calculate the likelihood.

KPSTATS.M Calculates the standard set of summary statistics (à la Kydland-Prescott) based on the wedges calculated by PWBCA.M. The output consists of two tables. The upper one calculates relative volatilities and cross-correlations between output and the measured wedges. The lower one calculates the same set of statistics with a different set of variables, namely, output and the model predictions using only one wedge.

F.2 Open-economy business cycle accounting

The open-economy exercise uses the codes prepared by Lama (2011), which can be downloaded from the website http://www.EconomicDynamics.org/codes/09/09-88/RED-09-88R1_Ruy_Lama.zip. There are no major changes to the code structure needed to replicate our results.

Table 1: Growth accounting 1976:3-2012:3

Output growth decomposition			1976:3-2012:3	1976:3-1985:4	1986:1-1994:4	1995:1-2012:3
Output growth	γ_Y	$(a_1+a_2+a_3)$	2,24	1,47	2,90	2,27
TFP growth	γ_A	a_1	0,57	2,13	0,79	-0,35
Capital contribution	$\theta\cdot\gamma_K$	a_2	1,50	1,18	1,64	1,54
Labor contribution	$(1-\theta)\cdot\gamma_H$	a_3	0,17	-1,84	0,46	1,07
Productivity growth decomposition			**1976:3-2012:3**	**1976:3-1985:4**	**1986:1-1994:4**	**1995:1-2012:3**
Productivity growth	$\gamma_Y - \gamma_H$	(b_1+b_2)	1,97	4,36	2,17	0,59
TFP growth	γ_A	b_1	0,57	2,13	0,79	-0,35
Capital/Labor contribution	$\theta\cdot(\gamma_K - \gamma_H)$	b_2	1,40	2,24	1,38	0,93
Output per capita growth decomposition			**1976:3-2012:3**	**1976:3-1985:4**	**1986:1-1994:4**	**1995:1-2012:3**
Output per capita growth	$\gamma_Y - \gamma_P$	$(c_1+c_2+c_3)$	1,10	0,17	1,82	1,18
TFP contribution	$\gamma_A/(1-\theta)$	c_1	0,90	3,34	1,25	-0,54
Capital/Output contribution	$(\theta/(1-\theta))\cdot(\gamma_K - \gamma_Y)$	c_2	1,05	1,02	0,93	1,13
Labor/Population growth	$\gamma_H - \gamma_P$	c_3	-0,85	-4,19	-0,36	0,59

Table 2: Unemployment rates

	1970	1976	1986	1992	1996	2004	2007:2	2009:2	2012:4
France	1,7	4,3	10,3	10,0	12,0	9,9	8,1	9,2	10,2
Germany	0,6	3,9	6,6	4,8	7,2	9,8	8,6	7,8	6,6
Ireland	6,9	9,1	17,0	15,3	11,5	4,4	4,8	12,2	13,7
Italy	3,2	4,7	11,2	10,9	11,5	8,0	5,7	7,3	11,2
Japan	1,1	2,0	2,8	2,3	3,3	4,7	3,8	5,2	4,0
Spain	2,0	4,6	20,5	18,9	21,8	11,0	8,0	18,0	26,0
U.K.	n.a.	n.a.	11,1	9,5	7,9	4,6	5,3	7,7	7,7
U.S.A.	4,9	7,8	6,8	7,1	5,3	5,5	4,4	9,1	7,5
Mean	2,9	5,2	10,8	9,8	10,1	7,2	6,1	9,6	10,9
Std.dev.	2,3	2,4	5,7	5,4	5,7	2,7	1,9	4,0	6,8

Source: OECD labour market statistics database, IMF-IFS and own calculations. Figures for 1976, 1986, 1993 and 1996 represent a centered three year moving average.

Table 3: Correlogram with respecto to cyclical GDP (HP-1600 filtered), 1976:3-2012:3

Variable	σ	σ/σ_Y	-4	-3	-2	-1	0	1	2	3	4
GDP, Y	0,0106	1,00	0,48	0,65	0,81	0,94	1,00	--	--	--	--
Consumption, C	0,0131	1,23	0,49	0,65	0,77	0,85	0,86	0,78	0,66	0,52	0,38
Investment, X	0,0462	4,35	0,58	0,71	0,81	0,89	0,89	0,81	0,67	0,51	0,33
Government, G	0,0124	1,17	-0,11	-0,05	0,04	0,14	0,26	0,33	0,37	0,42	0,47
Exports	0,0305	2,87	0,23	0,33	0,41	0,43	0,36	0,22	0,04	-0,13	-0,27
Imports	0,0472	4,44	0,59	0,71	0,80	0,81	0,74	0,60	0,42	0,24	0,07
Trade balance	0,0104	0,98	-0,43	-0,53	-0,61	-0,64	-0,61	-0,52	-0,40	-0,28	-0,16
Workers, L	0,0170	1,60	0,54	0,68	0,80	0,89	0,92	0,87	0,75	0,62	0,47
Total hours, H = h*L	0,0185	1,73	0,55	0,68	0,78	0,85	0,88	0,82	0,70	0,57	0,42
Real wage, W	0,0078	0,73	-0,01	-0,04	-0,04	-0,03	0,02	0,08	0,15	0,20	0,26
Labor force, N	0,0065	0,61	0,26	0,31	0,33	0,36	0,38	0,37	0,32	0,24	0,19
GDP per hour, Y/H	0,0104	0,98	-0,49	-0,54	-0,56	-0,55	-0,54	-0,49	-0,41	-0,34	-0,26
TFP, A	0,0062	0,58	-0,13	-0,13	-0,11	-0,10	-0,11	-0,15	-0,20	-0,26	-0,31

Table 4: Correlations (HP-cycles)

	Complete sample	Sub-samples		
	1976:3-2012:3	1976:3-1985:4	1986:1-1994:4	1995:1-2012:3
corr(Output,Workers)	0,92	0,76	0,96	0,92
corr(Output,Hours)	0,88	0,72	0,95	0,87
corr(Output,Wage)	0,02	0,43	0,16	-0,31
corr(Output,Productivity)	-0,54	-0,40	-0,71	-0,52
corr(Output,TFP)	-0,11	-0,18	-0,11	-0,10
corr(Workers,Hours)	0,98	0,96	0,99	0,98
corr(Workers,Wage)	0,09	0,49	0,23	-0,27
corr(Workers,Productivity)	-0,79	-0,85	-0,87	-0,78
corr(Workers,TFP)	-0,43	-0,72	-0,32	-0,43
corr(Hours,Wage)	0,12	0,48	0,25	-0,24
corr(Hours,Productivity)	-0,87	-0,93	-0,89	-0,87
corr(Hours,TFP)	-0,54	-0,80	-0,38	-0,53
corr(Wage,Productivity)	-0,19	-0,39	-0,34	0,09
corr(Wage,TFP)	-0,39	-0,41	-0,59	-0,23
corr(Productivity,TFP)	0,83	0,96	0,70	0,84

Table 5

Properties of the output components, 1976:3-1994:4

A. Summary Statistics

		Cross-correlations with y^d_t, j =				
Wedge $y(\omega_{a,t-j})$	$\sigma(y(\omega_a))/\sigma(y^d)$	-2	-1	0	1	2
Efficiency	0,69	0,23	0,30	0,27	0,17	0,08
Labor	0,98	0,63	0,73	0,79	0,77	0,67
Investment	0,20	0,33	0,33	0,29	0,30	0,29
Feasibility	0,20	-0,31	-0,35	-0,34	-0,41	-0,46

B. Cross correlations

Variables		Cross-correlations $(y(\omega_{a,t}), y(\omega_{b,t-j}))$, j =				
$y(\omega_{a,t})$	$y(\omega_{b,t-j})$	-2	-1	0	1	2
Efficiency	Labor	0,02	-0,15	-0,35	-0,27	-0,13
Efficiency	Investment	-0,02	0,02	0,04	-0,01	-0,16
Efficiency	Feasibility	-0,26	-0,29	-0,27	-0,18	0,01
Labor	Investment	0,33	0,30	0,25	0,29	0,37
Labor	Feasibility	-0,31	-0,24	-0,18	-0,21	-0,28
Investment	Feasibility	-0,50	-0,75	-0,87	-0,81	-0,64

Table 6

Properties of the output components, 1995:1-2011:2

A. Summary Statistics

		Cross-correlations with y^d_t, j =				
Wedge $y(\omega_{a,t-j})$	$\sigma(y(\omega_a))/\sigma(y^d)$	-2	-1	0	1	2
Efficiency	0,59	0,41	0,40	0,35	0,22	0,07
Labor	1,26	0,77	0,86	0,87	0,77	0,61
Investment	0,08	-0,67	-0,83	-0,90	-0,84	-0,70
Feasibility	0,30	-0,86	-0,83	-0,70	-0,50	-0,29

B. Cross correlations

Variables		Cross-correlations $(y(\omega_{a,t}), y(\omega_{b,t-j}))$, j =				
$y(\omega_{a,t})$	$y(\omega_{b,t-j})$	-2	-1	0	1	2
Efficiency	Labor	0,27	0,11	-0,06	-0,04	0,00
Efficiency	Investment	-0,38	-0,19	0,00	-0,04	-0,08
Efficiency	Feasibility	-0,12	-0,26	-0,30	-0,17	0,01
Labor	Investment	-0,72	-0,88	-0,94	-0,77	-0,53
Labor	Feasibility	-0,46	-0,60	-0,76	-0,87	-0,91
Investment	Feasibility	0,29	0,43	0,57	0,77	0,88

Table 7: Autoregressions AR(1)

	Estimate	Std. Error	95% conf. band
ρ_z	0,717***	(0,0598)	[0,599,0,836]
σ_z	0,0044***	(3,47*10^-5)	
ρ_ℓ	0,952***	(0,0082)	[0,935,0,968]
σ_ℓ	0,0164***	(7,95*10^-4)	

Note: Estimates are maximum likelihood. *** denote statistical significance at the 1% level.

Table 8: Simulated and observed correlations

	Simulated			
	Two Shocks (η_z,η_ℓ)	One shock η_z	One shock η_ℓ	Observed
corr(Output, Consumption)	0,80	0,57	0,89	0,86
corr(Output, Investment)	0,91	0,96	0,90	0,89
corr(Output, Hours)	0,83	0,86	0,94	0,88
corr(Output, Wage)	0,88	0,99	0,98	0,02
corr(Output, Productivity)	0,29	0,99	-0,29	-0,54
corr(Output, TFP)	0,55	0,98	--	-0,11
corr(Productivity, Hours)	-0,28	0,79	-0,59	-0,87
corr(Productivity, Wage)	-0,17	1,00	-0,45	-0,19
corr(Productivity, TFP)	0,76	0,95	--	0,83

Note: We use a log-linearization of the prototype model given on Section 2, using the estimates of Table 7, and the values calibrated for the Spanish economy given on Appendix B. The length of the simulation is 50000. These correlations are based on logged series.

Table 9: Simulated and observed std. deviations, and decomposition of simulated variances

	Simulated			
	Two Shocks (η_z,η_ε)	One shock η_z	One shock η_ε	Observed
Output, Y	0,0141	0,0078	0,0117	0,0106
		(31.0%)	(69.0%)	
Consumption, C	0,0116	0,0040	0,0109	0,0131
		(11.6%)	(88.4%)	
Investment, X	0,0422	0,0302	0,0295	0,0462
		(51.2%)	(48.8%)	
Hours, H	0,0140	0,0016	0,0139	0,0185
		(1.3%)	(98.7%)	
Wage, W	0,0503	0,0065	0,0499	0,0078
		(1.7%)	(98.3%)	
Productivity, Y/H	0,0081	0,0065	0,0048	0,0104
		(64.7%)	(35.3%)	
Total Factor Productivity, A	0,0063	0,0063	--	0,0062
		(100.0%)	(00.0%)	
Labor wedge, ω_ε	0,0520	--	0,0520	0,0520
		(00.0%)	(100.0%)	

Note: Upper figures represent the simulated and observed standard deviations, and figures into brackets represent the percentage of the simulated variance accounted by the shock.

Table 10: The labor wedge and institutions, 1976-2003

Dependent variable: Labor wedge increase (ΔLW)		*(i)*	*(ii)*	*(iii)*	*(iv)*	*(v)*	*(vi)*	*(vii)*
Constant	Coefficient	0,005	---	---	0,005	---	---	---
	p-value	0,661	---	---	0,695	---	---	---
Δ Employment protection (Allard, 2005a)	Coefficient	0,291	0,293	**0,289***	0,015	0,019	---	---
	p-value	0,124	0,120	0,095	0,930	0,911	---	---
Δ Temporary rate (INE and own calculations)	Coefficient	**-1,265***	**-1,284***	-0,645	-1,107	-1,128	-0,525	---
	p-value	0,104	0,100	0,176	0,169	0,162	0,308	---
Δ Centralization of collective bargaining (Ochel, 2000)	Coefficient	0,121	0,121	---	0,244	0,242	0,178	**0,214***
	p-value	0,373	0,372	---	0,132	0,133	0,168	0,088
Δ Coordination of collective bargaining (Ochel, 2000)	Coefficient	-0,276	-0,271	---	-0,252	-0,247	---	---
	p-value	0,262	0,270	---	0,329	0,339	---	---
Δ Labor union coverage (Ochel, 2001)	Coefficient	---	0,754	---	---	0,738	---	---
	p-value	---	0,596	---	---	0,623	---	---
Δ Unemployment benefits (OCDE)	Coefficient	**2,048*****	**2,034*****	**1,880*****	---	---	---	---
	p-value	0,006	0,006	0,005	---	---	---	---
Δ Unemployment benefits (Allard, 2005b)	Coefficient	---	---	---	**2,068****	**2,051****	**1,915****	**1,844****
	p-value	---	---	---	0,016	0,017	0,013	0,015
Δ Tax wedge (Boscá, García, and Taguas, 2008)	Coefficient	1,763	1,722	**2,557*****	**2,809****	**2,757****	**3,535*****	**3,578*****
	p-value	0,136	0,146	0,001	0,027	0,030	0,000	0,000
Δ Financial reform index (Abiad, Detragiache, and Tressel, 2008)	Coefficient	-0,002	-0,003	---	-0,036	-0,037		---
	p-value	0,985	0,982	---	0,780	0,778		---
	No. Obs.	27	27	27	27	27	27	27
	Prob > F	0,0151	0,0073	0,0004	0,0336	0,0163	0,0008	0,0004
	R-squared	0,5588	0,6203	0,5757	0,5106	0,5788	0,5464	0,5249

Note: All variables are first differenced. The unemployment protection index by Allard (2005a), and the financial reform index by Abiad, Detragiache, and Tressel (2008) have been log-transformed. *, **, and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.F is the F-Snedecor statistic of joint significance.

Figure 1: Quarterly series 1976:3-2012:3

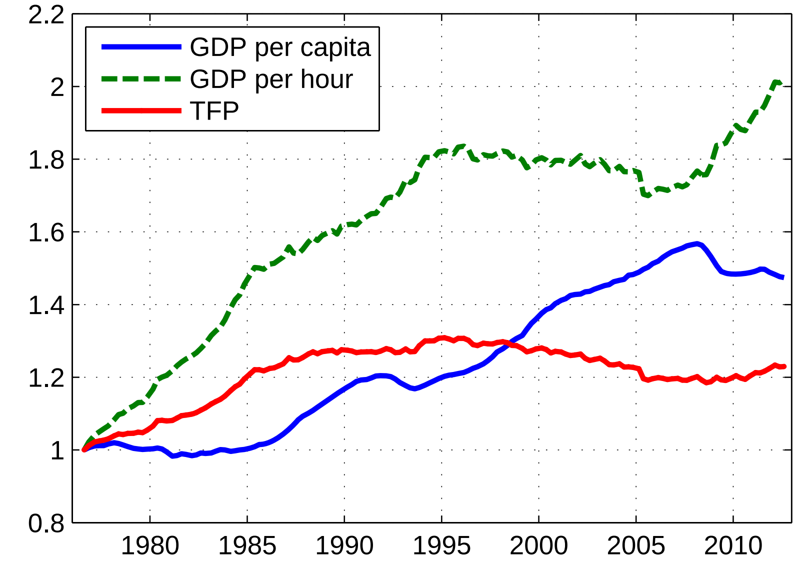


Figure 2: Hours and activity 1976:3-2012:3

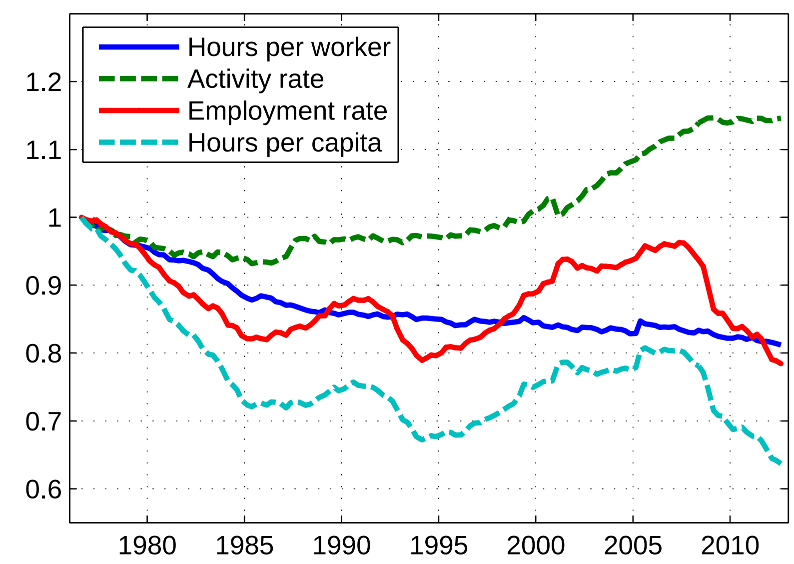


Figure 3: Annual growth rates 1976:3-2012:3

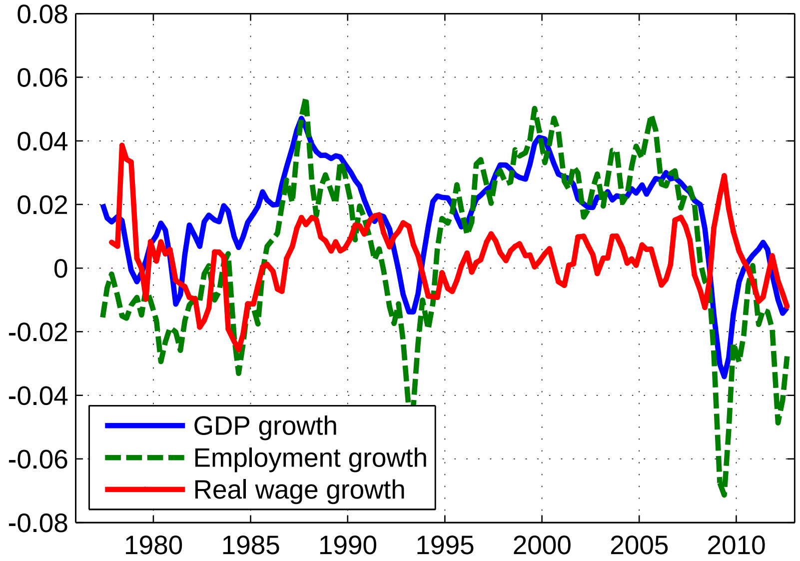


Figure 4: Fluctuations in Spain 1976:3-2012:3

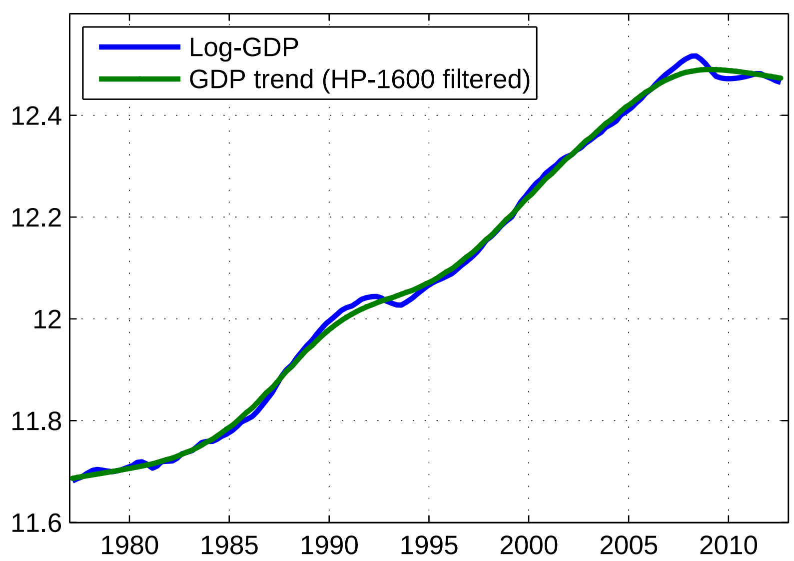


Figure 5: Efficiency wedge 1976:3-2011:2

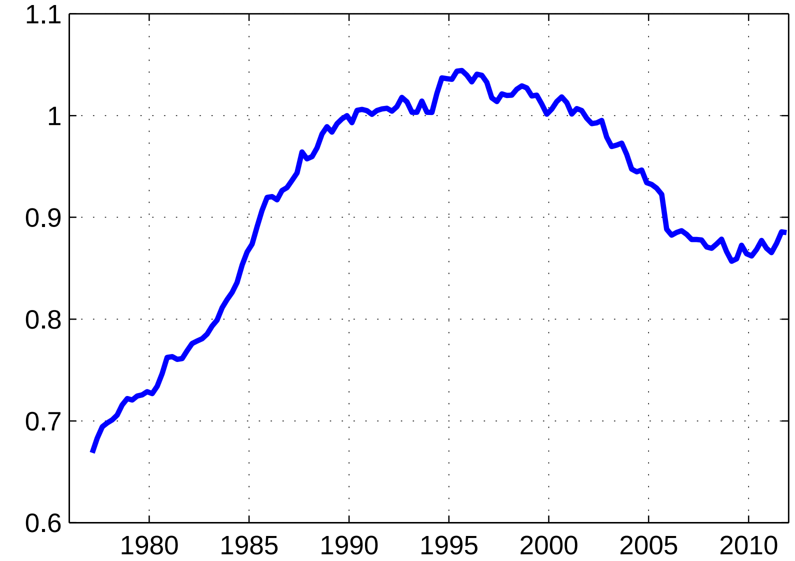


Figure 6: Labor wedge 1976:3-2011:2

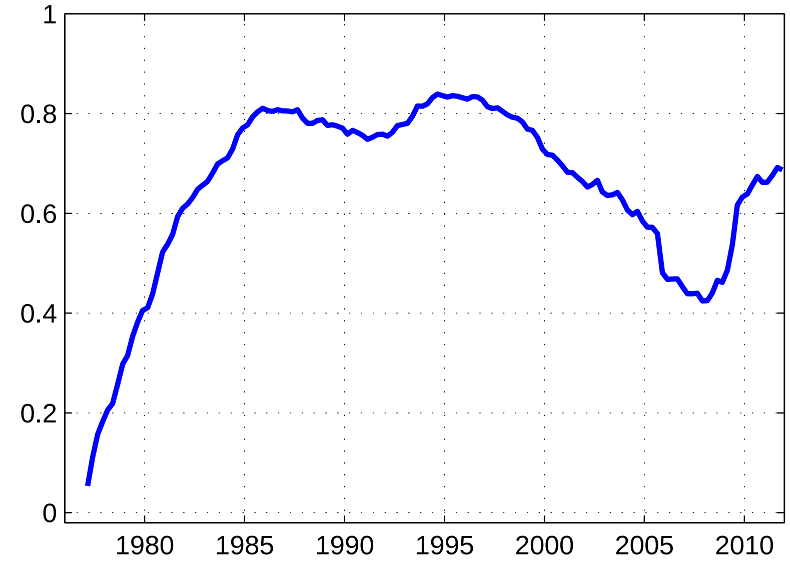


Figure 7: Investment wedge 1976:3-2011:2

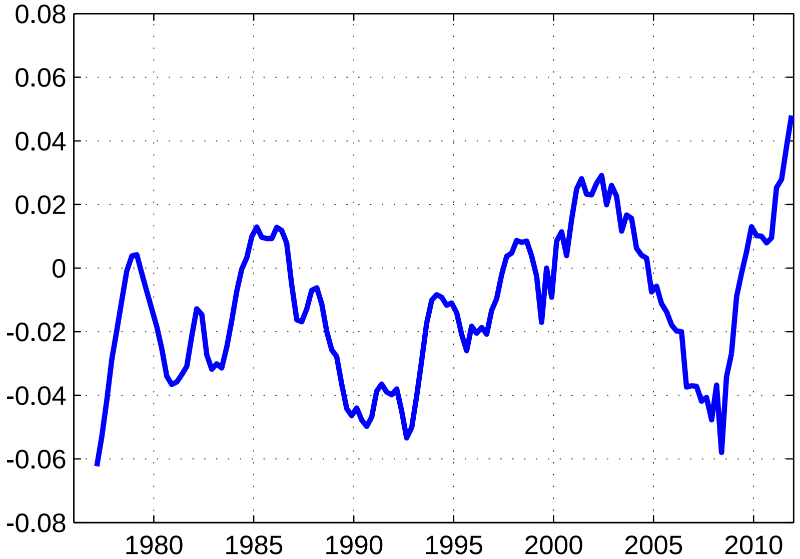


Figure 8: Feasibility wedge 1976:3-2011:2

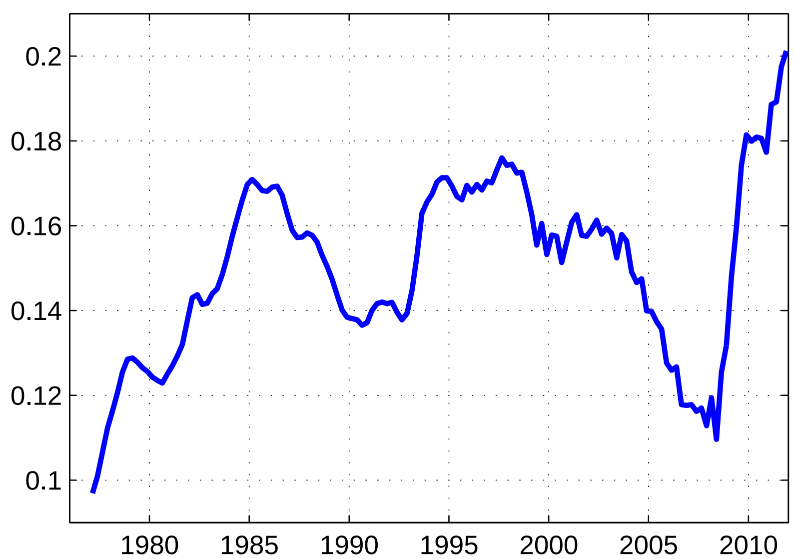


Figure 9: Data and model with (left graph) and without (right graph) one wedge, 1976:3-1985:4.

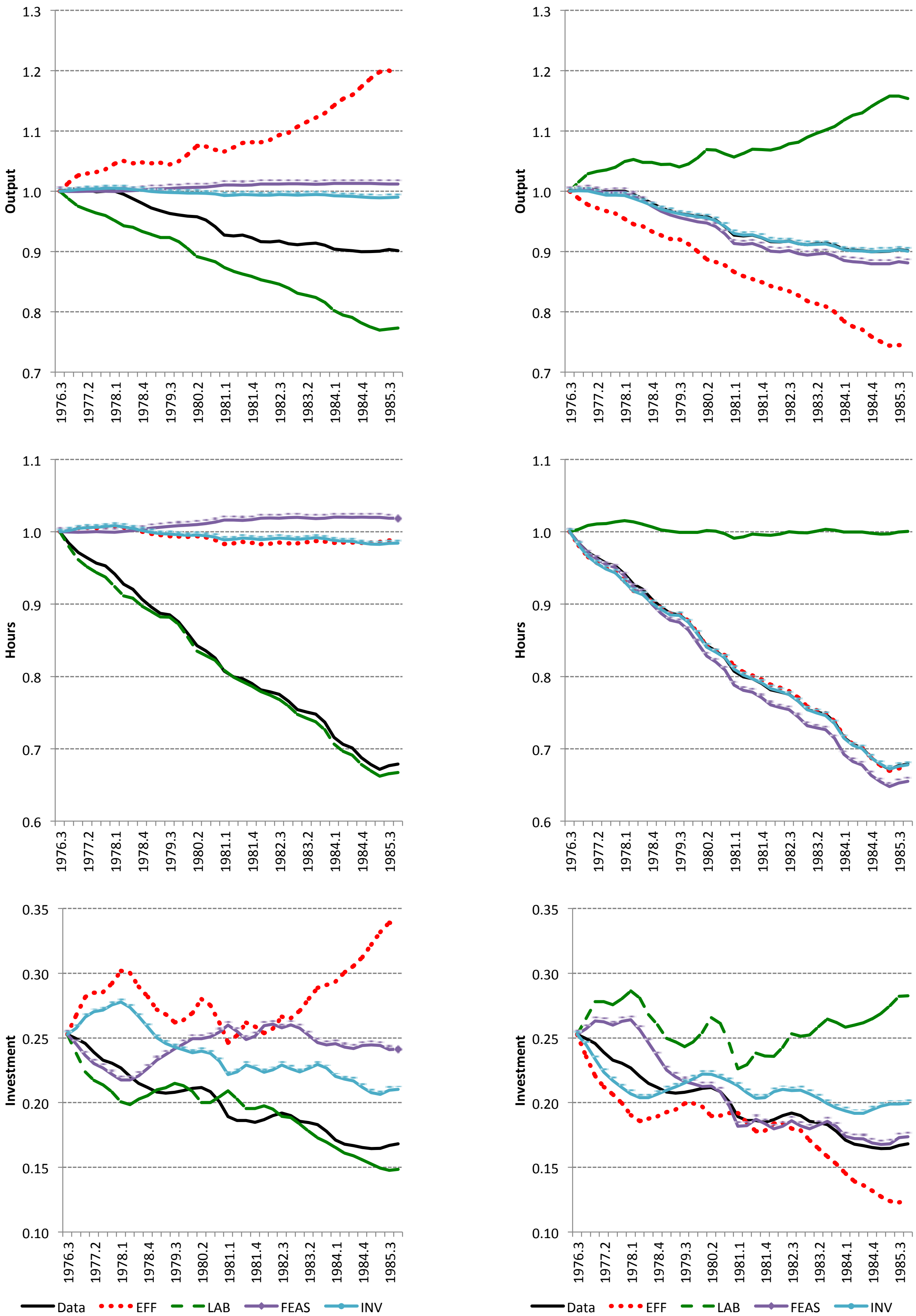


Figure 10: Data and model with (left graph) and without (right graph) one wedge, 2007:2-2011:2. Closed economy.