Employment and Public Capital in Spain[¤]

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Abstract

This paper analyses the e¤ects on employment of increasing the stock of public capital. To this end, we derive a wage equation so that wages are endogenized. This allows us to show that, by means of a higher elasticity of labour demand with respect to wages, a rise in public capital increases employment. The estimation of a structural model for the Spanish private sector tests and con…rms empirically this relationship. The results show that an increase in public capital has a signi…cant and positive direct in-‡uence on employment, and indirect e¤ects derived from lower wages and higher economic growth. Finally, we undertake a simulation exercise to assess the long run e¤ects on employment and economic growth of increasing public capital.

Key Words: employment, wage equation, public capital, economic growth.
JEL Classi…cation Numbers: E24, J38.

1. Introduction

The aim of this paper is twofold: ...rst, to provide a theoretical rationale for which there should be a positive relationship between the stock of public capital and the long-run level of employment; and, second, to illustrate empirically the magnitude of this relationship for the Spanish case.

Theoretical literature has explored the relationship between public capital and growth (see Barro 1990, among others). This literature has also explored the relationship between employment and growth (see Bean and Pissarides 1993, Aghion and Howitt 1994, Eriksson 1997, Daveri and Tabellini 2000, and Daveri and Maffezzoli 1999). However, to the best of our knowledge, theoretical literature has not provided a rationale to explain the observed long-run relationship between public capital and employment.

Empirical evidence has shown that there is a relationship between public capital and growth (see Ashauer 1989, and Lynde and Richmond 1993). Recent empirical evidence has also focused on the relationship between public capital and the labour market. This is the case of Pereira and Roca-Sagales (1999 and 2001), following a VAR approach, and Demetriades and Mamuneas (2000), using a structural model based on a labour demand function derived from pro...t maximization. All of them have shown empirically that public capital positively a¤ects employment. With respect to the former studies, one of the contributions of this paper is that it also considers how changes in public capital a¤ect wages and the accumulation of private capital which, in turn, a¤ect employment.

The theoretical model is built up on the same grounds as the one in Daveri and Tabellini (2000) and has as main ingredients a labour demand function and a wage equation. The wage is set by a central union as a mark-up over the unemployment bene...t, with the feature that this mark-up decreases as the elasticity of labour demand with respect to wages increases. The main di¤erence with the paper by Daveri and Tabellini (2000) is that this elasticity is not constant. More precisely, we show that this elasticity rises when there is an increase in the ratio of public to private capital. In turn, this relationship implies that a rise in this ratio reduces the wage and, hence, increases employment. This e¤ect justi...es the positive relationship between long-run employment and public capital.

From the theoretical model, we derive a production function, a labour demand equation and a wage equation. The relationships among the variables, established in the theoretical setup, are tested using data for the Spanish economy. In particular, we estimate a structural model using three stage least squares (3SLS, henceforth) and ...nd that the predictions emerging from the theoretical model are not rejected by the data. The main ...nding is that, along the wage equation, the negative e¤ect on wages of an increase in the ratio of public to private capital is

strongly supported by data.

As above mentioned, the aim of the paper is to test for the existence of positive long-run e¤ects on employment derived from higher levels of public capital. Since in the long run employment depends on the stock of private capital, we must take into account that increasing public capital modi…es the stock of private capital. Thus, the accumulation of private capital must be endogenized. To this end, we extend the theoretical model by means of introducing consumers that decide between present and future consumption. This decision de…nes savings and thus the accumulation of private capital. The equation that de…nes the accumulation of capital is estimated and we use the results of this estimation to simulate the consequences of increasing public capital.

The simulation, which can be interpreted as a …scal policy exercise, consists in increasing public capital so that the ratio of public to private capital increases 1%. We assume that the rise in the ratio is permanent. We then compare the long-run path of the endogenous variables in the presence and in the absence of the …scal shock and observe that the e¤ects on the labour market can be summarized in a rise on, both, employment and wages. Even if wages grow, there is a rise in employment. Partially, this is due to an increase in the elasticity of the labour demand with respect to wages, which prevents wages to grow rapidly. With respect to the consequences on output there is an increase in the growth rate of GDP. This e¤ect on production is decomposed into a direct e¤ect that is summarized in the rise of Total Factor Productivity (TFP, henceforth) and an indirect e¤ect consisting in the increase of the production factors (private capital and employment).

Concerning the short run e¤ects, we show that the increase in the ratio of public to private capital initially reduces wages. This initial reduction in wages is explained by the increase in the elasticity of the labour demand. This reduction drives the short run paths of employment and output growth that initially overshoot and then decrease as the wage recovers from the initial reduction.

The rest of the paper is organized as follows. In Section 2, we present the theoretical model of the labour market and derive the labour demand and the wage equations. In Section 3, we estimate a structural model for the Spanish economy, which is used in Section 4 for a simulation exercise. Section 5 summarizes the results and concludes.

2. The labour Market

In this section we present a simple theoretical model that provides an explanation for the observed relationship between employment and public capital. To this end, we develop a model where unions set the wage and …rms set the labour demand.

Following the seminal paper by Barro (1990), we define the following aggregate production function:

$$Y_t = \Phi(K_t; N_t; X_t); \quad \Phi_K > 0; \quad \Phi_N > 0; \quad \Phi_X > 0; \quad \Phi_{KK} < 0; \quad \Phi_{NN} < 0; \quad \Phi_{KN} > 0;$$

where Y_t is gross domestic product (GDP, henceforth). We assume that the production function is linearly homogeneous and concave with respect to both the aggregate stock of private capital, K_t; and the number of employed workers in the economy, N_t. Moreover, we also assume that the production function is linearly homogeneous with respect to both K_t and the stock of public capital, X_t: Because of this assumption, the production function can be rewritten as follows

$$Y_t = F(K_t; G_t; N_t) = K_t A(G_t; N_t); \quad F_G > 0; F_K > 0; F_N > 0; \qquad (2.1)$$

where $G_t = \frac{X_t}{K_t}$: Given that the ratio G_t is constant in the long run, the production function is asymptotically an AK production function. This explains sustained growth.

We assume that there is a large number of firms in the economy and, hence, they are price takers. Profit maximization implies

$$r_t = F_K(G_t; K_t; N_t); \qquad (2.2)$$

$$w_t = F_N(G_t; K_t; N_t); \qquad (2.3)$$

where r_t is the real interest rate, F_K is the marginal product of private capital, w_t is the labour income, and F_N is the marginal product of labour.

Equation (2.3) characterizes the labour demand, $N^d(w_t; K_t; G_t)$. Because of the assumptions made on the production function, the following derivatives are satisfied along the labour demand equation: $\frac{\partial N^d}{\partial w_t} < 0$; $\frac{\partial N^d}{\partial K_t} > 0$; and $\frac{\partial N^d}{\partial G_t} > 0$: The first derivative implies that the labour demand is downward slopping. The sign of the other two derivatives follows because both the stock of private capital and the ratio of public to private capital increase the marginal product of labour.

We introduce a central union that sets the wage in order to maximize the workers' income

$$N^d(w_t; G_t; K_t)(1 - \tau_{w;t})w_t + \left(1 - N^d(w_t; G_t; K_t)\right)B_t,$$

where $\tau_{w;t} \in [0; 1)$ is the tax on the labour income, B_t is the unemployment benefit net of taxes that an unemployed worker gets and $1 - N^d(w_t; G_t; K_t)$ is the amount of unemployment. Since we assume that the labour supply is inelastic with respect to the wage, we normalize it to one. Therefore, the wage that maximizes the workers' income is

$$w_t = w(B_t; \tau_{w,t}; \varepsilon_t) = \frac{B_t}{(1 - \tau_{w,t})\left(1 - \frac{1}{\varepsilon_t}\right)}; \tag{2.4}$$

where ε_t is the elasticity of the labour demand with respect to wages, which is equal to

$$\varepsilon_t(G_t; N_t) = \left[-\frac{\partial N^d}{\partial w_t}\frac{w_t}{N^d}\right] = \left[-\frac{F_N(G_t; N_t)}{N_t F_{NN}(G_t; N_t)}\right].$$

Equation (2.4) is the wage equation. Using this equation, we get that $\frac{\partial w}{\partial B_t} > 0$, $\frac{\partial w}{\partial \tau_{w,t}} > 0$ and $\frac{\partial w}{\partial \varepsilon_t} < 0$: The previous derivatives show that an increase in both the unemployment bene…t and the tax rate on labour income increase wages. This occurs because, when either the unemployment bene…t or the tax rate increase, the di¤erence between the income perceived by employed and unemployed workers decreases. As this di¤erence decreases, workers' income maximization implies a larger wage. With regard to the sign on the third derivative, an increase in the elasticity of the labour demand reduces the wage because it makes the labour demand more sensitive to higher wages.

Combining (2.4) and (2.3), we derive the equilibrium equation of the labour market

$$F_N(G_t; K_t; N_t) = w_t = \frac{B_t}{(1 - \tau_{w,t})\left(1 - \frac{1}{\varepsilon_t}\right)}:$$

It is well accepted in the literature that the labour's share in the aggregate income is constant in the long run, i.e. $F_N = \bar{\alpha}\frac{Y_t}{N_t}$: Moreover, we assume that the unemployment bene…t is a constant fraction (v) of per capita income, i.e. $B_t = vY_t$: Using these relationships, the equilibrium equation in the labour market simpli…es to

$$\bar{\alpha}\frac{Y_t}{N_t} = \frac{vY_t}{(1 - \tau_{w,t})\left(1 - \frac{1}{\varepsilon_t}\right)};$$

which can be rewritten as follows

$$N_t = \left(\frac{\bar{\alpha}}{v}\right)(1 - \tau_{w,t})\left(1 - \frac{1}{\varepsilon_t}\right): \tag{2.5}$$

Equation (2.5) implies that a higher level of public capital will increase the long run equilibrium amount of employment if it rises the elasticity of the labour demand.[1] An example of a production function displaying this positive relationship is the constant elasticity of substitution when the elasticity of substitution

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[1] This theoretical result was obtained in a more particular setting by Raurich and Sorolla (2000). In this paper, it is shown that the elasticity will increase or decrease with the ratio of public to private capital depending on the assumptions made on the production function.

is non-unitary, i.e. $\acute{A}(G_t; N_t) = (aG_t^{\frac{1}{2}} + bN_t^{\frac{1}{2}})^{\frac{1}{\frac{1}{2}}}$ and $\frac{1}{2} \ne 0$:[2] Thus, (2.5) suggests a channel through which public capital may increase the equilibrium level of employment.[3] This channel is based on technological changes associated with shifts in the ratio of public to private capital stock.

Existing literature has explained the relationship between public capital and employment as a complementarity between these two inputs. More precisely, public capital enhances the marginal product of labour and this explains the positive e¤ect on employment. However, in our model, this positive e¤ect is o¤set by the long run increase in the reservation wage, which coincides with the unemployment bene…t. Blanchard and Katz (1997) have already argued that increases in productivity do not a¤ect employment in the long run because, in association with the increase in productivity, there is a rise in the reservation wage. Therefore, the only channel through which public capital may increase employment in the long run is by rising the elasticity of the labour demand.

Note that the elasticity of labour demand depends on the ratio of public to private capital. Thus, public capital may a¤ect the elasticity by increasing this ratio. The existence of a positive relationship between the elasticity of the labour demand and this ratio seems to …nd some empirical support in the Spanish case. Using data for more than three decades we compute the percentage change of employment in the private sector with respect to the percentage change in real wages of the private sector. Since we are interested in long-run relationships, we take the permanent component of each series by …ltering them using the Hodrick and Prescott …lter. This gives us a …rst raw approximation to the long-run elasticity of employment with respect to wages in the private sector, which shows to be non-constant through time. Moreover, we also take the permanent components of the public and private capital stock series and compute the long-run path of their ratio. When compared with the long-run elasticity of employment with respect to wages, we identify a positive relationship between the two. This is illustrated by the following raw OLS regression:

$$"_t = \text{¡} \underset{(\text{¡} 5:94)}{0:77} + \underset{(6:76)}{6:21} G_t;$$

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[2] Note that if $\acute{A}(G_t; N_t)$ is a constant elasticity of substitution production function and the elasticity of substitution is non-unitary then F_N does not coincide with $^{-} \frac{Y_t}{N_t}$ unless we consider a more general production function with externalities. As an example consider that $Y_t = K_t^{1\text{i}} {}^{-} \overline{K}_t N_t^{-} \quad aG_t^{\frac{1}{2}} + b\overline{N}_t^{\frac{1}{2}} \quad {}^{\frac{1}{2}}$ where $\overline{N}_t$ and $\overline{K}_t$ are externalities. This production function allows for sustained growth, zero pro…ts, the marginal product of labor is a constant fraction of production at the …rms level, and the elasticity of the labor demand increases with the stock of public capital at the aggregate level. For simplicity, we have not introduced externalities in the theoretical exposition. See appendix for further discussion.

[3] See appendix for further discussion on the wage setting device.

with a $R^2 = 0.60$. Therefore, despite the crudeness of this exercise, at least provisionally we can identify a close relationship between the elasticity and the ratio of public to private capital over the period 1966-1998.

In the following section, we will use (2.1), (2.3) and (2.4) to estimate a multi-equation model for the Spanish economy and carry on the empirical analysis.

3. A Structural Model for the Spanish Economy

To undertake the empirical analysis we have estimated a structural model for the Spanish private sector.[4] Each of the three equations are mirrored in the theoretical model in such a way that the labour demand equation (2.3) gives rise to

$$n_t^{pr} = \beta_0 + \beta_1 n_{t-1}^{pr} + \beta_2 n_{t-2}^{pr} + \beta_3 k_t + \beta_4 g_t + \beta_5 w_t^{pr} + \beta_6 i_t + \beta_7 t + u_{1t}; \quad (3.1)$$

the wage equation[5] (2.4) to

$$w_t^{pr} = \gamma_0 + \gamma_1 w_{t-1}^{pr} + \gamma_2 w_{t-2}^{pr} + \gamma_3 g_t + \gamma_4 x_t + \gamma_5 \mu_t^{pr} + \gamma_6 n_{t-1}^{pr} + \gamma_7 d^{84} + \gamma_8 d^{87} + u_{2t}; \quad (3.2)$$

and the production function (2.1) to

$$y_t^{pr} = \delta_0 + \delta_1 y_{t-1}^{pr} + \delta_2^{pr} y_{t-2} + \delta_3 n_t^{pr} + \delta_4 n_{t-1}^{pr} + \delta_5 k_t + \delta_6 g_{t-1} + \delta_7 t + \delta_8 t^{1.5} + u_{3t}: \quad (3.3)$$

Definitions of the variables are given in Table 1.

[Insert Table 1]

The model is estimated using the ARDL approach which yields consistent estimates of the parameters both in the short and in the long-run (see Pesaran, Shin and Smith (1996), Pesaran (1997) and Pesaran and Shin (1998)). This approach can be applied irrespective of wether the regressors are I(1) or I(0), and avoids the pre-testing problems associated with the standard cointegration analysis[6]. Each of the equations was first estimated individually by OLS and all of them passed the usual misspecification tests and structural stability tests such

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[4] The analysis has been limited to the private sector because the labor demand in the public sector may not be related with the labor marginal product and, hence, the introduction of the public sector in the analysis would distort the results of the estimation.

[5] Note that what we have called x_t in the wage equation (3.2) does not appear in Table 1. The reason is that this variable indicates a double possibility for the wage equation, a first one in which we have b_t^{ss} as exogenous variable, and a second one in which we have ξ_t^d. This distinction allows us to estimate two versions of the model. We justify this procedure below.

[6] "The ARDL approach has the additional advantage of yielding consistent estimates of the long-run coefficients that are asymptotically normal irrespective of wether the underlying regressors are I(1) or I(0)", Pesaran and Shin (1998), page 371.

as the Cusum and CusumQ[7]. The ...nal speci...cation was selected on the basis of either the Akaike Information Criterion or the Schwarz Bayesian Criterion. In a second stage, the system as a whole was estimated by 3SLS. In this way we avoid serial correlation and endogeneity problems.

According to the theoretical setting in Section 2, we introduce (and test) the following restriction to the underlying technology: the estimated production function is a Cobb-Douglas function with constant returns to scale to the production factors[8]. Thus, for consistency, we impose the long-run elasticity of employment with respect to capital stock along the labour demand to be unity, something that is not rejected by the data.[9] Having imposed this restriction, we estimate again the model. This gives rise to the restricted 3SLS estimation, which is the one used in the simulation presented in next section.

One of the econometric requirements for a well speci...ed model is structural stability of the estimated parameters. Considering this, we will use the results of this model to infer in the next section long run relationships, out of the sample period. We are aware this is not the perfect procedure given the theoretical production function postulated in (2.1), but we think our empirical exercise as an illustration of what the long-run relationship among the variables would be taking as a base-run case our sample period estimated parameters.

Tables 2, 3 and 4 below, each of them corresponding to one of the selected equations, show the results of both the OLS and of the restricted 3SLS estimation. For the later we provide two sets of results, each one corresponding to one of the speci...cations of the wage equation.

Table 2 shows that the labour demand in the private sector depends negatively on both real wages and real interest rates. The negative relationship between employment and wages is due to the negative slope of the labour demand function, and the negative relationship between the interest rate and employment summarizes output e¤ects on employment. Employment growth is driven by the private capital stock and the ratio of public to private capital stock, two relationships that were predicted in Section 2. Finally, a trend with a negative sign captures

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[7] The results on these tests are available upon request.

[8] Note that the estimated production function does not correspond exactly to the production function proposed in Section 2. The discrepancy is due to the existence of externalities that for simplicity are not taken into account in Section 2. However, we can also consider the following production function $Y_t = K_t^{-} \hat{K}_t^{1i} {}^{-} N_t^{1i} {}^{-} \hat{A}(G_t; \hat{N}_t)$, where $\hat{K}_t$ and $\hat{N}_t$ are externalities. Equation (3.3) emerges from this function.

[9] A Wald test on the restriction $\frac{\degree_3 + \degree_4 + \degree_5}{1_i \ \degree_{1i} \ \degree_2} = 1$ in the production function could not be rejected at the usual 5% critical value. The Wald test gave a value of 1:50, which has to be compared with a $\hat{A}^2_{5\%} = 3:84$.

The Wald test on the restriction $\frac{\circledR_3}{1_i \ \circledR_{1i} \ \circledR_2} = 1$ in the labor demand equation could not be rejected either. This test gave a value of 1.89, below the standard 5% critical value $\hat{A}^2_{5\%} = 3:84$.

the direct in‡uence of labour-saving technological change on employment.

[Insert Table 2]

Table 3 shows that wages are positively a¤ected by productivity and lagged employment.[10] The later in‡uence arises from an insider-outsider argument by which, the higher the number of new employees (entrants) in past year, the higher the number of insiders in this year. As it is well known, the in‡uence of insiders in the wage setting mechanism is to drive wages up[11]. Though relevant, this relationship has not been considered in Section 2 because of the static nature of the model considered. Two dummies, a ...rst one taking value 1 1984 onwards and a second one taking value 1 1987 onwards, capture the e¤ect of two major institutional events in Spain. The ...rst one is the downward pressure on wages derived from the ...rst labour market reform. This reform was undertaken in 1984 and focused on ...xed-term contracts as a way of enhancing ‡exibility in the labour market. The second one captures the downward pressure on wages derived from the Spanish entry into the EEC in 1986.

[Insert Table 3]

The wage equation deserves two additional remarks. The ...rst one concerns the alternative presence in the wage equation of either Social Security bene...ts per employee[12] or the direct tax rate. Both, a descriptive analysis of these two series and the estimation of di¤erent functional forms for the wage equation indicate that they are essentially capturing the same phenomenon. Our interpretation relates to the build up of a complete welfare state in Spain in last decades, which required the development of a Social Security system almost inexistent before democracy. As a consequence, Social Security bene...ts per employee raised in parallel to direct taxes, which started to grow steadily after a 1978 tax reform aiming to increase public receipts. This was in accordance to the new growing ...nancial needs of the public sector[13].

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[10] The mainstream empirical analysis report the e¤ect of unemployment on wages. However, in this paper, we are just concerned with employment and economic growth. We do not consider a labor supply equation because data on the labor supply is not available for institutional sectors and, thus, we can not take endogenously into account the unemployment rate. Therefore, this variable has to be left out from the analysis.

[11] For a theoretical analysis of this mechanism see Lindbeck and Snower (1988). Karanassou and Snower (2000) report empirical estimates of this sort.

[12] In the theoretical setup we use unemployment bene...ts, which are a fraction of the whole Social Security bene...ts. In the empirical analysis, though, we use the later variable as it better captures the reservation wage.

[13] The rate of public expenditures to GDP raised from less than 25% in the mid seventies, before democracy (which was attained in 1977), to approximately 45% in mid eighties. In

The expansion of the Welfare State introduces an upward pressure on wages because, as mentioned in Section 2, the increase in either Social Security bene…ts or direct taxes reduce the di¤erence between the income earned by employed and unemployed workers and, as a consequence, there is a rise in the wage.

The …rst channel of expansion of the welfare state are Social Security bene-…ts, which is a trended variable. Hence, in order to capture the change in the in‡uence of this variable on wages after the 1978 tax reform, the equation needs a dummy variable. This is the reason why the …rst speci…cation of the wage equation presents b^{ss} and a multiplicative dummy $b^{ssi\ 78}(= b^{ss} \times d^{78})$, both with a positive sign, which shows the upward pressure on wages and the increase in this upward pressure. The second channel are direct taxes, a variable that captures by itself the change in 1978, so that there is no need of a multiplicative dummy. Again, the coe¢cient associated to direct taxes has a positive sign.

The second remark refers to the role of the ratio of public to private capital. An increase in this ratio reduces wages, with a long-run elasticity that does not di¤er much among the two selected functional forms. This is a key result, as it gives empirical evidence in support of our main theoretical claim. Recall that the rationale for this result may arise from changes in the production function that will end up in a higher elasticity of the labour demand with respect to wages. Further on, the in‡uence of this ratio on the wage setting mechanism provides a channel whereby private employment is a¤ected by public capital availability.

Table 4 presents the estimated production function. As noted before, the estimated production function has a Cobb-Douglas functional form displaying constant returns to scale. Output in the private sector depends on the two standard production factors (capital stock and labour, private in both cases) plus di¤erent terms that capture total factor productivity (TFP, henceforth). These terms consist of two trends, a standard linear one with a positive sign, that drives output upwards; and a non-linear one, with a negative sign that takes into account some negative externalities. Finally, still derived from the theoretical set up, g has a highly signi…cant in‡uence on production that shows up by driving upwards the TFP.

[Insert Table 4]

An important remark related to these results refers to the long-run elasticity of output to public capital, which the literature has placed, with some degree of consensus, around 0.2 (see Glomm and Ravikumar, 1997). While in these studies this elasticity (z) is directly taken from the level of public capital stock, in

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parallel, direct taxes raised from less than 4% in the mid-seventies to more than 7% in 1984 and more than 10% 1989 onwards.

this case we evaluate the long-run influence of the ratio public to private capital stock. Therefore, instead of having $z = \frac{\partial Y/Y}{\partial X/X}$, we consider $z' = \frac{\partial Y/Y}{(\partial G/G)}$. Given that $\partial G/G = \partial X/X - \partial K/K$; we can rewrite z' as $z' = \frac{\partial Y/Y}{(\partial X/X) - (\partial K/K)}$. This equation leads to

$$z = z'\left(1 - \frac{\partial K/K}{\partial X/X}\right);$$

which shows that $z = z'$ only if $\frac{\partial K/K}{\partial X/X} = 0$. As in our sample period $\frac{\partial K/K}{\partial X/X} = 0.59$[14] and in the OLS estimation $z' = 0.47$, $z = 0.19$, a value in the lower range of the estimates given by the literature.

Even if it requires a further analysis, the finding of a positive and significant effect of g on both private output and employment, and a negative effect on wages introduces a new insight on the debate surrounding public activity. Taxes have been blamed to be responsible for higher unemployment rates (see Daveri and Tabellini 2000, among others), but the allocation of tax revenues on public capital may have a positive impact on economic activity that will end up in higher levels of production and employment. Next section further explores this issue.

Summing up, in meeting all the theoretical and econometric requirements, we think the estimated structural model provides a first piece of empirical evidence on the positive influence that a higher ratio of public to private capital stock has on private employment due to different channels: the first one being a direct positive effect on the marginal productivity of employment that enhances the labour demand; the second one, stressed in Section 2, a negative effect on real wages that will -indirectly- enhance hirings; and a third one being a positive effect on production by means of a higher TFP. The third effect, as we will show in next section, implies an acceleration in the accumulation of private capital that also enhances the labour demand, and thus employment in the long run.

The former analysis provides us with a benchmark where to conduct a simulation exercise to further study the long-run implications of increasing public capital. We undertake this simulation exercise in next section.

4. Assessing the Long-Run Effects of Public Capital on Employment and Growth

Employment and output growth depend on the stock of private capital. Therefore, the long run effects of government policies will also depend on the effects that these

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[14] This value was obtained following different steps: 1) taking the annual growth rate of public and private capital stock ($\partial K_t/K_t$ and $\partial X_t/X_t$); 2) computing the annual ratio of the two growth rates $[(\partial K/K)_t = (\partial X/X)_t]$; 3) taking the sample period mean of the annual ratio $\overline{(\partial K/K)_t = (\partial X/X)_t}$:

government policies have on the accumulation of private capital. This means that in order to simulate the long run effects on employment and growth of increasing public capital we must first consider how agents' decisions on savings are affected by government policies, then, relate savings with the accumulation of private capital and finally relate private capital growth with output growth. To this end, we start extending the theoretical model of Section 2, considering a simple overlapping generations model where agents live for two periods. In the first period, agents inelastically supply one unit of time, they receive an income I_t, and they save. This income coincides with the wage net of taxes, $w_t(1 - \tau_{w,t})$, when agents are employed and it coincides with the unemployment benefit, B_t, when agents are unemployed. In the second period, they consume the savings accumulated in the first period.

We assume that agents derive utility from their consumption in each period. We also assume that agents' preferences are homothetic so that savings are a constant fraction of income, $s \in (0,1)$. Moreover, because present savings will be the future stock of capital, it follows that the aggregate stock of capital is

$$K_{t+1} = s\left[(1 - \tau_{w,t})w_t N_t + B_t(1 - N_t)\right]. \tag{4.1}$$

This equation shows that aggregate capital is a constant fraction of the agent's income obtained in their first period of life. From (4.1), the growth rate of capital is

$$\frac{K_{t+1}}{K_t} = \frac{(1 - \tau_{w,t})w_t N_t + B_t(1 - N_t)}{(1 - \tau_{w,t-1})w_{t-1}N_{t-1} + B_{t-1}(1 - N_{t-1})}.$$

Let us define the gross growth rate of wages as $\gamma_t = \frac{w_t}{w_{t-1}}$; the gross growth rate of the unemployment benefit as $\beta_t = \frac{B_t}{B_{t-1}}$; and the gross growth rate of population as $n_t = \frac{N_t}{N_{t-1}}$. Using these transformed variables, the previous equation can be rewritten as follows

$$\frac{K_{t+1}}{K_t} = \frac{\frac{(1-\tau_{w,t})\gamma_t n_t}{B_{t-1}} + \beta_t \frac{(1-N_t)}{N_{t-1}w_{t-1}}}{\frac{(1-\tau_{w,t-1})}{B_{t-1}} + \frac{1-N_{t-1}}{N_{t-1}w_{t-1}}}.$$

In Section 2, we have argued that $N_{t-1}w_{t-1} = \bar{Y}_{t-1}$ and that $B_{t-1} = vY_{t-1}$. Taking into account these equations, we can further rewrite the growth rate of capital as follows

$$\frac{K_{t+1}}{K_t} = \frac{\bar{}(1 - \tau_{w,t})\gamma_t n_t + v\beta_t(1 - N_t)}{\bar{}(1 - \tau_{w,t-1}) + v(1 - N_{t-1})}. \tag{4.2}$$

Thus, the growth rate of capital positively depends on the growth rate of wages, the growth rate of labour, and the growth rate of Social Security benefits, and it negatively depends on the level of direct taxes.

Back again to the empirical implementation of the model, we will use (4.2) and (2.1) to estimate the growth rate of private capital and the growth rate of GDP. In particular, taking equation (4.2) as a reference, we estimate the following expression:

$$\textcent k_t^{pr} = \gamma_0 + \gamma_1 \textcent n_t^{pr} + \gamma_2 \textcent w_t^{pr} + \gamma_3 \textcent b_t^{ss} + \gamma_4 \iota_t^d + \gamma_5 c_{t_i 1} + u_{4t}; \qquad (4.3)$$

where the operator $\textcent$ means the increase in the variable and c_t is competitiveness.[15] De...ned as in Table 1, competitiveness helps to capture the consequences of external shocks, such as the oil price ones in the seventies.

The production function depends on private capital, employment and TFP. Therefore, the growth rate of GDP will positively depend on the growth rate of capital, employment and TFP. The variables $\textcent w_t^{pr}$; $\textcent b_{t_i 1}^{ss}$; ι_t^d capture the growth rate of capital and a_t is the growth rate of TFP. Accordingly, we estimate the following economic growth equation:

$$\textcent y_t^{pr} = \beta_0 + \beta_1 \textcent y_{t_i 1}^{pr} + \beta_2 a_t + \beta_3 \textcent n_t^{pr} + \beta_4 \textcent n_{t_i 1}^{pr} + \beta_5 \textcent w_t^{pr} + \beta_6 \textcent b_{t_i 1}^{ss} + \beta_7 \iota_t^d + u_{5t}:$$
$$(4.4)$$

Estimation of a_t is obtained from equation (3.3). More precisely, TFP is obtained as the fraction of GDP not explained by private production factors i.e., $\circ_6 g_t + \circ_7 t + \circ_8 t^{1:5}$.[16] Finally, a_t is the gross growth rate of TFP, i.e.

$$a_t = \frac{TFP_{t+1}}{TFP_t} = \frac{\tilde{A} \circ_6 g_{t+1} + \circ_7 (t+1) + \circ_8 (t+1)^{1:5} !}{\circ_6 g_t + \circ_7 t + \circ_8 t^{1:5}} : \qquad (4.5)$$

Table 5 shows the results obtained in the estimation of (4.3) and (4.4). Note that the growth rate of capital rises with the growth rates of employment, wages and Social Security bene...ts, and it decreases as the direct tax rate increases. Thus, as (4.2) predicts, capital accumulation is accelerated when workers' income increases. The growth rate of GDP positively depends on the growth rates of employment, TFP, wages and Social Security bene...ts and negatively depends on direct taxes.

[Insert Table 5]

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[15] Note that $\textcent y_t^{pr}$; $\textcent k_t^{pr}$; $\textcent n_t^{pr}$; $\textcent w_t^{pr}$, and $\textcent b_t^{pr}$ are the growth rates of Y_t^{pr}; K_t^{pr}; N_t^{pr}; W_t^{pr}, and B_t^{pr}; respectively.

[16] In the theoretical model we introduce the simplifying assumption that TFP only depends on the ratio of public to private capital. However, there are externalities that also a¤ect TFP and that must be taken into account in the empirical model. This externalities are summarized by the two trends.

Summing up, we have an empirical model that captures our main theoretical ...ndings. This system includes expressions (3.1), (3.2), (4.3) and (4.4), and allows us to attempt an evaluation of the economic consequences of increasing public capital. In what follows, we undertake a ...scal policy exercise which simulates the e¤ects on private employment and on economic growth of increasing the ratio of public to private capital when public capital is ...nanced by means of taxes on the interest rate. Because the utility function is homothetic, taxes on the interest rate do not distort agents' decisions on savings.[17]

To simulate the impact of a rise in g_t, we solve the empirical model forward under di¤erent assumptions that a¤ect the long-run behavior of the variables. First, the endogenous variables time path is explained by the base-run equations of the model (3.1), (3.2), (4.3) and (4.4). For the long run value of TFP we have the auxiliar equation (4.5). Thus, given the value of g_t, we know the time path of a_t. With respect to the exogenous variables, apart from the trends and dummies, we must introduce assumptions on the time path of g_t, b_t^{ss}, λ_t^d, i_t, c_t.

Note that g_t, λ_t^d, i_t and c_t are all I(0) variables, whereas b_t^{ss} is a trended variable. In the long-run, we expect all the I(0) variables to stabilize in such a way that they can be considered as constants. As a consequence, we could assume that the long-run value of these variables coincides with the last one available. Nevertheless, we do not need to make such an assumption. The reason is that we will evaluate the response of the endogenous variables in the presence and in the absence of a particular ...scal shock. In this case, the assumption made on the value of the I(0) variables will not a¤ect the results of the simulation exercise.

With respect to b_t^{ss}, as a growing variable, we need to simulate its long-run behavior. We follow Section 2 and we assume that B_t^{ss} is a constant fraction of GDP, which is set equal to the last available value of this fraction.[18]

Once the model can be solved forward, we simulate it. To this end, we ...rst keep the ratio of public to private capital at the same value as in 1998; then, we introduce a 1% permanent increase in the 1999 value with respect to that of 1998. This is done under two scenarios, a ...rst one with the model in which b_t^{ss} a¤ects the wage setting mechanism, and a second one where, instead, the relevant regressor in the wage equation is λ_t^d. Figures 1 and 2 show, under these two scenarios, the long-run consequences of this expansionary ...scal policy on both the labour market and economic growth.

Note that in the ...gures we always refer to the growth rate of a particular variable. The reason is that we evaluate the e¤ects of the permanent shock in terms of how would a particular variable change in the long run in response to the new situation. This change is stated in growth rates resulting from comparing the

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[17] The budget constraint is $X_t = \lambda_k r_t K_t$. It can be rewritten as follows $G_t = \lambda_k r_t$.
[18] Note that this assumption implies that $\updownarrow b_t^{ss} = \updownarrow y_t^{pr}$.

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time path of the variable in the presence and the absence of the shock. Given that the variables are expressed in logarithms, this difference is equivalent to a growth rate. We consider that a particular series has converged once its value completely stabilises. This is the long run value of that particular series in response to the shock. When stating that a 90% of convergence is achieved we indicate that the variable has attained, at least, 90% of its long run value.

[Insert Figure 1 and Insert Figure 2]

Our simulation exercise shows that a 1% permanent increase in g_t has a positive effect on private employment. This effect seems to be robust across the two different specifications of the wage equation, and attains a long run value of 0.47% under the first scenario and of 0.43% under the second one. This is the total consequence of the shock operating through several channels in the system. Further on, we can decompose this impact on its various sources and isolate the effect due to the influence of g_t on the wage setting mechanism. When only this channel is active, employment in the long-run would rise 0.20% in the first case, and 0.23% in the second one. Despite this should be taken just as a simulation exercise on the basis of a concrete model, this finding gives additional evidence on the positive link between employment and public capital through the wage effect derived in section 2.

The main difference between the two scenarios is in the speed of convergence. In the first scenario it takes 24 years for employment to converge to a 90% of the new steady state value (that is, the one after the expansionary fiscal policy), whereas in the second one it just takes 9 years. The reason for this difference, that is common to two other endogenous variables (real wages and capital stock) lies in the presence of a trended exogenous variable such as b_t^{ss}. In the other scenario, ξ_t^d acts as a constant in the long-run, therefore the system does not need to accommodate an extra variable to its new steady state. Thus, the transition to the new equilibrium in this case is rapidly completed. Note also that, under the second scenario, the new steady state is achieved, for all the endogenous variables, within a decade.

Despite the long-run response of wages to the fiscal shock is positive in both cases, it differs substantially among scenarios. In the first case, increases by 0.29%, whereas under the second scenario attains 0.69%. This result is in accordance with the better economic growth effects that Figure 2b displays with respect to Figure 1b. Indeed, we expect labour to have a higher compensation rate in an economy with higher levels of productivity, capital stock and, summing up, higher production. Again, note that, despite these differences across scenarios, the long-run effect of a change in g_t on employment does not show much of variation. This confers an extra degree of robustness to our results.

Concerning the long run e¤ects on GDP, note that they are positive and similar in the two scenarios: in the ...rst one GDP growth is 1.34%, whereas it attains 1.45% in the second one. Although this response to the shock may seem relatively large, we need to point out various aspects on this respect. First, along the same lines as in Section 3, remark that we are evaluating a change in the ratio of public to private capital stock whose magnitude is much higher than a shock on the sole level of public capital stock. Second, we examine the long-run e¤ects in the context of a dynamic model with a net of lagged adjustment processes in each of the equations. As it can be seen in both Figures, the impact of g_t on GDP is the outcome of three e¤ects. The direct one on TFP and two indirect e¤ects which are summarized by the increases in both production factors, capital and employment. The interaction of these three e¤ects through which the impact of the shock hits the model with the dynamic structure of the system contribute to prolong and enhance the e¤ects of the shock.

Another important remark on the results refers to the short-run behavior of wages. Interpreting the initial impact of this permanent ...scal policy change as the short-run e¤ect, we can argue that the immediate reaction of real wages is to decrease due to the negative direct in‡uence that g_t has in the wage equation. This negative e¤ect drives the dynamics of the other variables. In particular, the initial reduction in wages explains the initial large e¤ect on employment that ...rst overshoots, and decreases in the medium run as wages increase. This initial over reaction explains why the impulse-response functions of GDP and the stock of private capital overshoot[19].

Summing up, the main ...nding is that an increase in g_t has a long run positive e¤ect on GDP growth and also on employment even though wages increase. This occurs because public capital positively a¤ects the labour demand and because the increase in wages is small when compared with the rise in GDP. Previously, we have justi...ed the small impact on wage growth by an increase in the elasticity of the labour demand. Precisely, this e¤ect is shown up by the initial reduction in wages.

5. Concluding Remarks

We have developed a theoretical model that provides a rationale for the existence of a positive in‡uence of public capital on employment. Based on this theoretical model, we have estimated a structural model for the Spanish economy and obtained empirical results in accordance with our theoretical setup. Besides, this

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[19]For a detailed analysis on shock responses within a structural framework see Karanassou and Snower (2000).

estimation has allowed to simulate the effects of a fiscal shock: that is, the long-run impact of a permanent increase in public capital on the labour market and economic growth .

The main result of the paper is that increasing public capital enhances the growth rates of GDP and private capital stock, rising also wages and employment. The later effect is explained as a technological effect associated to an increased level of public capital, and is reflected in a higher elasticity of labour demand with respect to wages that prevents wage growth. This effect is shown up by the negative relationship between wages and public capital along the wage equation.

The results on the fiscal policy exercise illustrate this argument and show a long run growth rate for wages far below the GDP one. With regard to employment, the simulation offers what we interpret as a robust result. Indeed, no matter the scenario we consider, there is a similar response of private employment, which would increase from 0.43% to 0.47% in response to a 1% increase in the ratio of public to private capital stock.

In this paper, we have assumed that the way investment in public capital is financed by the government does not distort agents' decisions. This holds because we assume that public capital is financed by means of taxes on the interest rate that, due to the assumptions on the consumers' preferences, do not distort savings. An alternative would be to assume that the increase in public capital is financed by means of taxes on the labour income, this time distorting agents' decisions. Another extension in the same direction is to take into account that social security benefits are financed by direct taxes on the labour income. To consider these alternative assumptions is the aim of future research.

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Appendix

Discussion on the production function

Let us consider the following production function

$$Y_t = AK_t\left(aG_t^{½} + N_t^{½}\right)^{\frac{1}{½}}; \quad ½ < 1; \; a > 0; \; A > 0:$$

The elasticity of the labour demand with respect to wages is

$$"_t = \frac{\frac{@Y_t}{@N_t}}{N_t\frac{@^2Y_t}{@N_t^2}} = \frac{AK_t\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}i\,1}N_t^{½i\,1}}{N_tAK_t\;\left(\frac{1}{½}i\,1\right)\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}i\,2}N_t^{(½i\,1)2}+(½i\,1)\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}i\,1}N_t^{½i\,2}}$$

which simpli...es to

$$"_t = \frac{1}{\left(\frac{1}{½}i\,1\right)\frac{N_t^{½}}{\left(aG_t^{½}+N_t^{½}\right)}+(½i\,1)}:$$

Note that $\frac{@"_t}{@G_t} > 0$ and, however, $\frac{@Y_t}{@N_t} \boldsymbol{6} {}^{-}\frac{Y_t}{N_t}:$ In order to simultaneously obtain that $\frac{@"_t}{@G_t} > 0$ and $\frac{@Y_t}{@N_t} = {}^{-}\frac{Y_t}{N_t}$ externalities must be introduced. As an example consider the following production function:

$$Y_t = AK_t^{1i\,{}^{-}}\overline{K}_t^{\,{}^{-}}N_t^{\,{}^{-}}\left(aG_t^{½} + \overline{N}_t^{½}\right)^{\frac{1}{½}}; \quad 0 < {}^{-} < 1$$

where $\overline{K}_t$ and $\overline{N}_t$ are externalities accruing from the average levels of capital and employment, respectively.

Remark that at the ...rm level $\frac{@Y_t}{@N_t} = {}^{-}\frac{Y_t}{N_t}:$ Note also that, at the aggregate level $K_t = \overline{K}_t$ and $N_t = \overline{N}_t:$ Hence, the production function simpli...es to

$$Y_t = AK_tN_t^{\,{}^{-}}\left(aG_t^{½} + N_t^{½}\right)^{\frac{1}{½}}:$$

Thus, the production function is lineal in capital, which means that sustained growth is possible. Moreover, the elasticity of the labour demand with respect to wages is

$$"_t = \frac{\frac{@Y_t}{@N_t}}{N_t\frac{@^2Y_t}{@N_t^2}} = \frac{{}^{-}AK_tN_t^{\,{}^{-}i\,1}\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}}}{N_t{}^{-}AK_t\;({}^{-}i\,1)N_t^{\,{}^{-}i\,2}\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}}+N_t^{\,{}^{-}i\,1}\left(aG_t^{½}+N_t^{½}\right)^{\frac{1}{½}i\,1}N_t^{½i\,1}};$$

which simpli...es to

$$"_t = \frac{1}{{}^{-}i\,1+\frac{N_t^{½}}{aG_t^{½}+N_t^{½}}}:$$

Again, note that $\frac{@"_t}{@G_t} > 0:$

Discussion on the wage setting process

The wage setting process considered in the paper is a very particular one. This implies that the result summarized in (2.5) may not hold when a more general wage setting is considered. In what follows we analyze two generalizations of the wage setting process in order to discuss the robustness of (2.5).

The ...rst generalization consists in introducing a wage bargaining between unions an ...rms. We assume the following Nash product:

$$\left[((1 - \tau_{w;t})w_t - B_t)\, N^d(w_t; G_t; K_t)\right]^\circ \left[Y_t - w_t N^d(w_t; G_t; K_t)\right]^{1-\circ}$$

where $\circ$, $0 < \circ < 1$, is a parameter representing union's bargaining power.

The unions' aim is to maximize the workers income and the ...rms' aim is to maximize the ...rms pro...ts. Under the assumption that the labour's share in the aggregate income is constant in the long run, i.e. $w_t = \bar{\ } \frac{Y_t}{N_t}$; this function becomes

$$\left[((1 - \tau_{w;t})w_t - B_t)\, N^d(w_t; G_t; K_t)\right]^\circ \left[\left(\frac{\bar{A}}{1 - \bar{\ }} - 1\right) w_t N^d(w_t; G_t; K_t)\right]^{1-\circ}:$$

We further assume that unions and ...rms bargain on the wage taking into account that the labour demand is set by ...rms as the marginal product of labour and, hence, it decreases with the wage.

From the ...rst order conditions we derive the following wage equation:

$$w_t = w(B_t; \tau_{w;t}; \eta_t; \circ) = \frac{B_t}{(1 - \tau_{w;t})\,\frac{\eta_t - 1}{\eta_t + \circ - 1}}:$$

Note that, when $\circ = 1$, this equation coincides with (2.4) in the main text. Assuming that $w_t = \bar{\ }\frac{Y_t}{N_t}$ and that $B_t = vY_t$; we obtain

$$N_t = \left(\frac{\bar{A}}{v}\right)(1 - \tau_{w;t})\left(\frac{\eta_t - 1}{\eta_t + \circ - 1}\right):$$

Again, when $\circ = 1$, this gives rise to equation (2.5) in the main text. Furthermore, our central argument is still valid as employment increases with η_t and public capital may only increase employment by rising η_t: Thus, the result derived from the monopoly union model holds in a more general wage bargaining model.

The second generalization consists in modifying the unions' utility function by giving di¤erent weights to wage and employment. This implies to consider a utility function having the following form:

$$\left[(1 - \xi_{w;t})w - B_t\right]^\circ {}^{\mathbf{h}} N^d(w_t; G_t; K_t)^{\mathbf{i}}{}^{1-\circ} :$$

From the ...rst order condition the wage set by unions is

$$w_t = \frac{B_t}{(1 - \xi_{w;t})\left[1 - \frac{\circ}{1-\circ}\frac{1}{"_t}\right]} :$$

Again, assuming that $w_t = \bar{}\frac{Y_t}{N_t}$ and that $B_t = vY_t;$ we derive

$$N_t = \left(\frac{\bar{}}{v}\right)\left[(1 - \xi_{w;t})\left(1 - \frac{\circ}{1-\circ}\frac{1}{"_t}\right)\right]^{\mu\frac{1}{-1}\P} :$$

Equation (2.5) in the main text follows when the same weight is given to both employment and wages, i.e. $\circ = \frac{1}{2}$: Again, employment increases with $"_t$ and public capital may only increase employment by rising $"_t$: Therefore, the result derived in the main text holds when the unions' utility function is generalized.

We have shown that the main result in the paper holds under two generalizations of the wage setting process. However, both generalizations are based on the assumption of intertemporal independence. In other words, the equilibrium amount of current employment does not a¤ect the future amount of employment. Other models consider intertemporal dependence. Among them, the insider-outsider model. We believe that these models may yield a di¤erent result. In particular, public capital may also a¤ect employment by means of increasing the marginal productivity of labour. This would explain our empirical ...nding in section 4 showing that the rise in the elasticity of the labour demand with respect to wages only accounts for half of the increase in employment.

Table 1: De...nitions of the variables.

n_t^{pr}	:	log of private employment
w_t^{pr}	:	log of real wage in the private sector
y_t^{pr}	:	log of GDP in the private sector
μ_t^{pr}	:	average productivity in the private sector de...ned as $y_t^{pr} - n_t^{pr}$
k_t	:	log of private capital stock
k_t^{ps}	:	log of public capital stock
g_t	:	log of the ratio of public to private capital stock de...ned as $k_t^{ps} - k_t$
i_t	:	real long-term interest rates
b_t^{ss}	:	log of real Social Security Bene...ts per person
τ_t^d	:	total direct taxes as a % of total GDP
c_t	:	competitiveness de...ned as $\log \frac{\text{Import prices}}{\text{Domestic prices}}$
t	:	linear trend
$t^{1:5}$	:	non-linear trend
d^i	:	dummy variable taking value $\left(\begin{array}{l}\text{0 from 1967 to } i-1 \\ \text{i onwards}\end{array}\right)$
		for i=1978, 1984, 1987
b_t^{ss-78}	:	$b_t^{ss} \times d^{78}$

Source: Fundación BBVA and OECD, Economic Outlook.

Table 2: labour demand equation. Spain, 1967-1998.

Dependent variable: n_t^{pr}

	OLS		Restricted 3SLS¤ (b^{ss} in wages)		Restricted 3SLS¤ (τ^d in wages)	
	coe¤.	t-stat.	coe¤.	t-stat.	coe¤.	t-stat.
Cnt	1:10	(1:17)	2:36	(6:33)	2:25	(6:00)
n_{t-1}^{pr}	0:92	(5:41)	1:04	(8:48)	1:05	(8:54)
n_{t-2}^{pr}	-0:49	(-3:38)	-0:58	(-5:37)	-0:59	(-5:42)
k_t^{pr}	0:70	(4:41)	0:54	(¤¤)	0:54	(¤¤)
g_t	0:12	(1:57)	0:12	(1:64)	0:13	(1:90)
w_t^{pr}	-0:36	(-3:72)	-0:26	(-5:72)	-0:24	(-5:33)
i_t	-0:05	(-4:26)	-0:05	(-4:95)	-0:05	(-4:88)
t	-0:02	(-3:61)	-0:02	(-3:69)	-0:02	(-3:85)
R^2	0:98		0:98		0:98	
S:E:	0:010		0:011		0:011	

(*): Instruments for the 3SLS estimation: c, t; n_{t-1}^{pr}; n_{t-2}^{pr}; w_{t-1}^{pr}; w_{t-2}^{pr}; y_{t-1}^{pr}; y_{t-2}^{pr}; k_t; k_{t-1}^{pr}; k_t^{ps}; k_{t-1}^{ps}; i_t; τ_t^d or b_t^{ss}; d^{84}; d^{87}; t; $t^{1:5}$.
(**): Restricted coe¢ cient

Table 3: Wage equation. Spain, 1967-1998.

Dependent variable: w^{pr}_t

	OLS (b^{ss} in wages)		OLS (τ^d in wages)		Restricted 3SLS[a] (b^{ss} in wages)		Restricted 3SLS[a] (τ^d in wages)	
	coef.	t-stat.	coef.	t-stat.	coef.	t-stat.	coef.	t-stat.
Cnt	2.57	(1.39)	0.71	(0.30)	2.03	(1.23)	1.25	(0.55)
w^{pr}_{t-1}	0.60	(4.24)	0.80	(4.58)	0.62	(5.24)	0.80	(5.22)
w^{pr}_{t-2}	-0.21	(-1.54)	-0.28	(-1.61)	-0.18	(-1.48)	-0.31	(-2.02)
g_t	-0.15	(-2.35)	-0.15	(-1.87)	-0.12	(-2.01)	-0.17	(-2.09)
b^{ss}_t	0.21	(4.53)	-		0.21	(5.43)	-	
b^{ss}_{t-78}	0.005	(1.76)	-		0.005	(1.16)	-	
τ^d_t	-		0.01	(2.10)	-		0.01	(2.42)
μ^{pr}_t	0.26	(1.67)	0.49	(2.61)	0.19	(3.99)	0.53	(2.75)
n^{pr}_{t-1}	0.26	(3.22)	0.20	(1.96)	0.27	(-1.84)	0.18	(2.03)
d^{84}	-0.02	(-1.71)	-0.03	(-2.07)	-0.02	(-3.96)	-0.04	(-2.67)
d^{87}	-0.05	(-3.57)	-0.07	(-2.90)	-0.05	(1.97)	-0.07	(-3.32)
R^2	0.99		0.99		0.99		0.99	
S.E:	0.012		0.016		0.012		0.016	

(*): Instruments for the 3SLS estimation: ctt; n^{pr}_{t-1}; n^{pr}_{t-2}; w^{pr}_{t-1}; w^{pr}_{t-2}; y^{pr}_{t-1}; y^{pr}_{t-2}; k_t; k^{pr}_{t-1}; k^{ps}_t; k^{ps}_{t-1}; i_t; d^{84}; d^{87}; t; $t^{1.5}$; τ^d_t or b^{ss}_t and b^{ss}_{t-78}

Table 4: Production function. Spain, 1967-1998.

Dependent variable: y_t^{pr}

	OLS		Restricted 3SLS[*] (b^{ss} in wages)		Restricted 3SLS[*] (τ^d in wages)	
	coef.	t-stat.	coef.	t-stat.	coef.	t-stat.
Cnt	−1.73	(−0.93)	0.51	(3.55)	0.58	(3.98)
y_{t-1}^{pr}	0.43	(2.13)	0.56	(3.32)	0.52	(3.06)
y_{t-2}^{pr}	−0.35	(−1.84)	−0.20	(−1.41)	−0.21	(−1.41)
n_t^{pr}	0.86	(5.60)	0.83	(5.86)	0.86	(5.87)
n_{t-1}^{pr}	−0.47	(−2.57)	−0.56	(**)	−0.59	(**)
k_t	0.66	(2.60)	0.37	(2.70)	0.42	(3.02)
g_{t-1}	0.43	(3.77)	0.34	(3.34)	0.39	(3.79)
t	0.04	(2.30)	0.04	(2.61)	0.04	(2.76)
$t^{1.5}$	−0.006	(−3.18)	−0.005	(−3.19)	−0.006	(−3.48)
R^2	0.99		0.99		0.99	
S.E.:	0.012		0.013		0.013	

(*): Instruments for the 3SLS estimation: ctt; n_{t-1}^{pr}; n_{t-2}^{pr}; w_{t-1}^{pr}; w_{t-2}^{pr}; y_{t-1}^{pr}; y_{t-2}^{pr}; k_t; k_{t-1}^{pr}; k_t^{ps}; k_{t-1}^{ps}; i_t; d^{84}; d^{87}; t; $t^{1.5}$; τ_t^d or b_t^{ss} and b^{ss} [78]

(**): Restricted coefficient

Table 5: Growth equations. OLS. Spain, 1967-1998.

Dependent variable: Δk_t^{pr}

	coef.	t-stat.
Cnt	0.07	(7.01)
Δn_t^{pr}	0.42	(6.07)
Δw_t^{pr}	0.17	(2.38)
Δb_t^{ss}	0.07	(1.66)
τ_t^d	−0.005	(−5.29)
c_{t-1}	−0.03	(−3.09)
R^2	0.89	
S.E.:	0.007	

Dependent variable: Δy_t^{pr}

	b^{ss} in wages		τ^d in wages	
	coef.	t-stat.	coef.	t-stat.
Cnt	0.02	(5.04)	0.02	(5.06)
Δy_{t-1}^{pr}	0.12	(2.48)	0.12	(2.48)
Δa_t	1.00	(20.8)	1.00	(19.5)
Δn_t^{pr}	1.39	(23.5)	1.35	(21.8)
Δn_{t-1}^{pr}	−0.76	(−10.4)	−0.74	(−9.56)
Δw_t^{pr}	0.09	(2.29)	0.10	(2.30)
Δb_{t-1}^{ss}	0.04	(1.59)	0.04	(1.58)
τ_t^d	−0.001	(−3.49)	−0.001	(−3.50)
R^2	0.98		0.98	
S.E.:	0.004		0.004	