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AN ANALISYS OF REGIONAL PRODUCTIVITY DETERMINANTS IN SPAIN: 1987-2000

Evidence shows that Spanish regions differ significantly in their economic performance. Moreover, the process of regional convergence in labour productivity has practically stopped since 1985. If the drivers of productivity (investment, skills, innovation enterprise and competition) worked effectively, regional productivity would catch up. However, when regional market failures exist (in product, capital or labour markets), regional differences in performance regarding each of these drivers cannot fully explain regional productivity disparities. Because of the 1984 employment protection reform in Spain, there is evidence that the share of temporary contracts (with low severance pay) surged in the second half of the 1980s – staying above 30% since 1990 – in a clear regional divergence process, thus being far from EU standards (10% – 15%). In this context, the aim of this paper is to investigate the hypothesis that this surge in temporary contracts has a negative impact on regional productivity growth.. The estimations results of the empirical model in the NUTS 2 Spanish regions over the period 1987-2000 show that, in addition to under-investment in physical, human and technological capital, differences in regional economic performance would be explained by the negative effect on productivity of the conversion of permanent contracts into temporary contracts in very segmented regional markets.

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1. Introduction

As a result of the recent economic growth in Spain, since 1995 the GDP per inhabitant has been increasingly approaching the EU mean. At the same time, however, the differential in labour productivity has significantly increased. According to Estrada, Pons, and Vallés (2006), labour productivity in Spain was equivalent to 106% of the EU-25 mean in 1995, but in 2006 this was 96.8%. However, this aggregate result for the Spanish economy is the result of heterogeneous regional behaviour. According to the data provided by the Regional Accounts, in 2003 the level of labour productivity – calculated as the quotient between the regional GVA (at factor cost) and the number of filled jobs – in the region with the worse result (Extremadura) was 68% of the level of the region with best result (Navarra), whose productivity level was higher than the EU-15 mean for that year. Furthermore, the level of regional differences has not significantly decreased since 1985 (Villaverde, 2005). Thus, it seems evident that the economic performance of some regions in this period is clearly affecting the potential of the Spanish economy as a whole, and there would be significant benefits for the Spanish economy if each region reached its full productive capacity.

At an aggregate level, the available evidence highlights the following determinants of labour productivity growth (HM Treasury, 2004 and Trichet, 2006):

- Increases in physical capital stock per worker, including infrastructures.
- Increased quality in human capital.
- An intensified process of technological innovation from the perspective of its diffusion and integration into productive processes.
- The development of business initiatives and entrepreneurship.
- Increased market competitive process within a stable macroeconomic framework.

To the extent that economic processes tend to make regional differences in factors promoting productivity growth disappear, the less developed regions should converge with the most developed. However, for this process to occur there must be no market failures affecting the less developed regions. Such failures can affect product markets, leading to weakened competitive discipline thereby reducing incentives for innovation in firms. They can also affect market capital if, for example, existing credit constraints impede the development of business initiatives or the growth of physical, human or

technological capital. These market failures can also affect the labour market when its institutional framework generates market inflexibility, segmentation or spatial/educational mismatches.

The present work attempts to analyze the impact on productivity caused by a specific failure affecting the Spanish labour market: the use of temporary employment contracts to fill permanent positions. Since 1984, there has been increased labour market segmentation due to the surge in temporary contracts as a result of the reforms in employment protection legislation. The literature indicates that temporary contracts reduce productivity growth by weakening incentives for job training and work effort, worsen working conditions, and increasing the risk of work-related accidents in addition to generating greater instability in employment (Bentolila and Dolado, 1994; Dolado, García-Serrano and Jimeno, 2002; Albert, García-Serrano and Hernanz, 2005). Although the impact of investment in physical, technological and human capital on labour productivity has been widely analyzed in the literature (de la Fuente and Vives, 1995; Maudos, Pastor and Serrano, 2000; Pilat, 2005; de la Fuente and Domenech, 2006 and Mas and Quesada, 2007), no conclusive macroeconomic evidence is available on the relationships between productivity growth and the use of temporary contracts in Spain. Thus, this paper attempts to obtain evidence on the aggregate impact that increased labour market segmentation has had on regional labour productivity since the second half of the 1980s. The estimation of an augmented production function which includes variables reflecting the changes occurring in the composition of employment (according to the type of contract – temporary or permanent – and the share of self-employed workers) can contribute to achieving this. A descriptive analysis is presented of how regional productivity has evolved in Spain since 1987 and its main determinants followed by an econometric analysis.

2. The evolution of regional labour productivity in Spain: Explanatory factors

The following analysis attempts to point out the main determinants of the evolution in regional productivity levels (NUTS 2 level) since 1987, based on a database whose content is described in Appendix 1. Table 1 shows the levels of labour productivity in the regions compared to the Spanish average from 1987 to 2000, as well as their annual growth rates in the same period.

Productivity in Spain has grown at a mean rate of 1.16% p.a. during 1987-2000, although the rate was 0.60% p.a. during 1995-2000, indicating a clear trend toward a slow-down in growth (see Appendix 2).

Table 1. *Relative levels and annual growth rates in regional productivity and employment in the period 1987-2000*

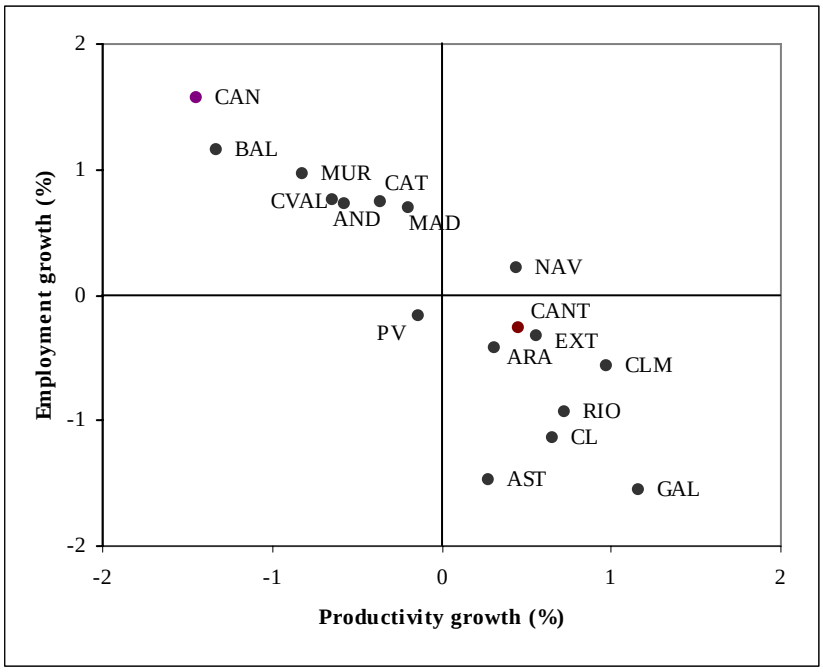
	Labour productivity (GVA fc/ No. of filled posts)			*No. of filled posts*
	Year 2000	*Year 1987*	*Δ % (mean annual)*	*Δ % (mean annual)*
Andalusia AND	90.29	97.26	0.59	2.46
Aragón ARA	103.22	95.78	1.47	1.30
Asturias AST	98.10	89.80	1.44	0.26
Balearic Islands BAL	101.12	124.29	-0.17	2.89
Canary Islands CAN	91.96	110.22	-0.29	3.30
Cantabria CANT	100.27	95.01	1.62	1.46
CAT *Catalonia*	105.73	109.20	0.80	2.47
C- León CL	101.71	90.20	1.81	0.59
C- La Mancha CLM	92.47	84.51	2.13	1.16
C. Valenciana CVAL	91.76	95.81	0.52	2.48
Extremadura EXT	79.55	71.05	1.72	1.40
Galicia GAL	81.71	68.36	2.32	0.17
C. of Madrid MAD	115.99	118.25	0.97	2.43
Murcia MUR	87.31	94.61	0.34	2.69
Navarra NAV	117.39	116.11	1.60	1.94
Basque Country PV	120.39	121.04	1.03	1.56
La Rioja RIO	109.73	95.71	1.88	0.79
Standard deviation	12.01	16.16	0.77	0.95
SPAIN	100.00	100.00	1.16	1.73

Source: Regional Accounts and BD.MORES

If, on the other hand, the regional index values for 1987 and 2000 are compared, the following regions change their position in relation to the average: Aragón, Cantabria, Castilla León and La Rioja. These communities have index values lower than 100 in 1987 but are above the average in 2000, whereas the opposite occurs in the case of the Canary Islands. In addition, if the levels in 1987 are compared with the mean growth rates for 1987-2000, in general, the regions with levels of productivity below the average in 1987 show higher growth rates in this variable than Spain as a whole and vice versa. The exceptions are Andalusia, the Valencian Community and Murcia, on the one hand, and Navarra, on the other.

It seems clear that the most productive regions (Catalonia, Madrid, Navarra and the Basque Country) maintained their relative advantage in this period. It is also important to take into account that regional productivity could be raised by a 'negative' route. This occurs when productivity increases due to little growth in employment, or employment is even destroyed in net terms as a result of adjustment processes (rationalization and downsizing) in firms (Gardiner, Martin and Tyler, 2006). Graph 1 shows that this could be the case of Asturias and Galicia, whose employment growth rate is clearly below the Spanish average. The data suggest that this is not the situation of Navarra and Madrid. These regions are competitive in the sense that they maintain their leadership in productivity despite having much higher employment growth rates than the mean. Neither is this the situation in the Canary and Balearic Islands; their employment growth rate has been significantly higher than the Spanish average but, as a result, have poor productivity performance.

Graph 1. *Annual growth rates in regional productivity and employment, 1987-2000*
(Deviations from the average growth rate)



Source: Regional Accounts and BD.MORES

Table 2 presents the ranking of the regions according to the core determinants of labour productivity growth. The capital deepening process has meant that the position of the different regions in terms of physical capital per employee is not very far from the

Spanish average, fluctuating around 90% in 2000. In addition, human capital in Spain has undergone sustained growth since 1987 (see Appendix 2), showing a clear process of regional convergence (Marchante and Ortega 2006). This fact is clearly reflected in Table 2: the regional differences for the mean years of schooling of the working-age population are relatively low, although some regions, such as Extremadura, still had a significantly low level in 2000.

Table 2. *Relative levels and annual average growth rates of the main determinants of productivity growth in 1987-2000*

	Physical capital per worker			*Mean years of schooling of working age population*			*Technological capital per worker*		
	Year 2000	*Year 1987*	*Δ% annual*	*Year 2000*	*Year 1987*	*Δ% annual*	*Year 2000*	*Year 1987*	*Δ% annual*
AND	88.87	89.03	1.86	90.54	83.12	2.42	61.62	54.92	4.12
ARA	124.99	120.11	2.06	99.34	103.63	1.34	77.98	71.53	3.90
AST	124.27	127.12	1.88	98.11	107.29	1.04	70.58	58.78	4.64
BAL	107.07	126.04	1.08	99.48	100.42	1.69	25.75	27.26	2.79
CAN	89.68	95.39	1.38	94.03	99.06	1.40	48.82	32.09	6.46
CANT	117.01	128.22	1.37	105.52	114.90	1.06	64.50	55.73	4.35
CAT	104.40	110.80	1.52	103.10	108.22	1.25	123.17	114.58	3.79
CL	119.20	112.23	2.12	93.62	92.70	1.82	66.35	40.91	6.95
CLM	121.25	119.56	2.27	89.70	88.21	1.81	41.49	14.26	11.45
CVAL	92.42	88.60	2.07	101.01	90.27	2.49	60.01	38.54	6.64
EXT	105.22	114.27	0.96	86.69	78.58	2.56	36.18	28.79	4.99
GAL	91.84	74.62	3.47	97.64	96.86	1.74	48.17	25.84	8.02
MAD	86.02	77.41	2.81	116.14	121.86	1.15	230.47	332.19	0.42
MUR	88.68	82.93	2.35	95.08	88.30	2.40	56.17	52.24	3.79
NAV	119.28	109.91	2.56	110.91	112.13	1.48	105.91	90.39	4.45
PV	116.52	138.18	0.86	110.94	122.43	0.96	153.83	152.76	3.28
RIO	113.42	110.88	2.28	97.77	98.94	1.65	50.12	9.11	16.34
Stan. dev.	14.16	19.26	0.69	7.99	12.90	0.53	50.98	76.82	3.67
SPAIN	100.00	100.00	1.94	100.00	100.00	1.66	100.00	100.00	5.67

Source: INE, BBVA foundation and BD.MORES.

However, in the technological capital stock per worker — measured as the cumulative sum of investments in R & D, in line with the methodology described in Appendix 1 — some regions display their main productive weakness and regional differences are more accentuated[1]. Thus, for example, by 2000, the technological capital stock in the Balearic Islands was equivalent to 26% of that in Spain, contrasting with Madrid, where it was 2.3 times higher than that in Spain.

[1] These differences are more striking in the context of EU-15. Puente and Pérez (2004) estimate that the stock of technological capital in Spain in relation to the GDP was 44% of the EU average in 2000.

In addition, according to the evidence available for Spain, labour productivity has been dragged down by other factors, in particular by the surge in temporary contracts (OECD, 2005). From the mid-1980s, after the 1984 reform in Employment Protection Legislation and the introduction of new fixed-term contracts (temporary)[2], the quotient between temporary employment and total salaried employment reached 34.6% in Spain and 47.2% in Andalusia in 2004; this was around 13% in the OECD as a whole. Despite the 1994, 1997 and 2001 reforms –aimed at both reducing the firing cost for permanent employees and restricting the use of fixed-term contracts–, severance pay seems to continue to have a deterrent effect on the creation of permanent contracts[3]. In line with Dolado, García-Serrano and Jimeno (2002), the share of temporary employees has only marginally declined from 35.4% in 1995 to 32.0% in 2001. Temporary contracts appear to continue to significantly reduce marginal labour costs and "labour hoarding". Thus, demand for temporary employment displays greater sensitivity to market wage conditions and the financial situation of the firms, increasing the volatility of employment during the business cycle and raising the hiring and lay-off rates (Güell and Petrolongo, 2006).

From a regional perspective, the information in Table 3 shows that the relative distribution of temporary contracts among the regions is not uniform. There are large differences in the total employment share of workers with a temporary contract. These differences can be explained, among other factors (García Perez and Rebollo, 2006), by the existence of dissimilarities in the regional productive structure, especially regarding the weight of services linked to tourism and construction sector. Moreover, the share of temporary contracts shows a strong direct correlation with the unemployment rate. However, Table 3 shows that those regions where the share of temporary contracts was lower in 1987 have experienced very rapid growth in this variable, much higher than the

[2] The new temporary contracts allow hiring employees to perform regular activities (whereas previous temporary contracts were mainly seasonal) and entail much lower dismissal costs than (regular) permanent contracts (see Dolado, García-Serrano and Jimeno, 2002).

[3] The 2001 labour market reform contains restrictions on the successive use of temporary contracts, increases in fiscal support for the creation of jobs with new permanent contracts and transitory incentives to convert temporary contracts into permanent ones (OECD, 2007, pp. 52).

average (Galicia, Madrid, the Basque Country and Asturias). Obviously, this evolution could not have been the result of a change in the regional productive structure.

Table 3. *Total employment share of permanent, temporary and non-salaried workers, 1987-2000*

	Share of permanent workers			*Share of temporary workers*			*Share of self employed workers*		
	Year 2000	*Year 1987*	*Δ% annual*	*Year 2000*	*Year 1987*	*Δ% annual*	*Year 2000*	*Year 1987*	*Δ% annual*
AND	78.31	96.51	-2.68	142.93	146.88	5.89	104.77	85.47	-0.86
ARA	104.33	93.41	-0.23	83.57	98.09	4.87	111.22	119.40	-2.75
AST	101.01	92.50	-0.40	81.03	57.21	8.78	126.10	143.09	-2.97
BAL	103.44	110.49	-1.58	90.15	90.37	6.08	103.95	75.69	-0.45
CAN	95.70	93.78	-0.92	112.66	170.83	2.90	94.53	80.70	-1.71
CANT	97.48	95.26	-0.90	88.71	72.72	7.63	125.77	127.36	-2.04
CAT	110.75	105.78	-0.72	85.31	115.52	3.77	87.44	75.82	-1.41
CL	97.17	82.82	0.15	82.89	80.68	6.31	135.80	157.95	-3.20
CLM	85.91	92.75	-1.67	113.32	90.13	7.86	125.66	125.36	-2.23
CVAL	95.45	95.73	-1.10	115.08	137.39	4.74	91.61	92.56	-2.07
EXT	83.20	73.31	-0.10	110.68	150.49	3.74	138.66	148.36	-2.02
GAL	82.76	75.25	-0.35	96.03	40.82	12.68	162.84	199.72	-3.92
MAD	127.70	130.80	-1.26	68.40	38.06	10.61	57.91	46.08	-0.67
MUR	87.22	84.78	-0.86	123.56	173.15	3.50	105.49	104.63	-0.98
AVN	107.22	105.45	-0.95	78.63	77.10	6.25	109.38	96.64	-1.61
PV	104.05	118.56	-2.08	104.88	70.88	9.11	79.12	63.27	-0.09
RIO	105.08	81.37	0.89	74.38	152.17	0.59	123.02	125.01	-2.58
St. dev.	12.27	15.02	0.86	20.09	44.09	3.03	25.04	39.01	1.04
SPAIN	100.00	100.00	-0.87	100.00	100.00	6.19	100.00	100.00	-1.86

Source: Regional Accounts and Active Population Survey (Spanish Institute of Statistics, INE).

This strong increase in the share of temporary contracts may have penalized productivity growth in Spain since 1987. In addition to generating greater instability in employment and worsening working conditions (Sánchez and Toharia, 2000; Herranz and Toharia, 2004), excessive temporary contracting negatively affects productivity growth in at least three ways (Dolado, García-Serrano and Jimeno, 2002):

- Workers with temporary contracts may increase their labour effort if they know that they have a chance of becoming part of the staff. The short mean duration of temporary contracts suggests that the prospects of remaining in the company are very limited. For the Spanish economy, Güell and Petrolongo (2006) estimated a conversion rate of temporary contracts into permanent ones of 18% in 1987 and 14% in 2001, having fallen to 5% in 1996. It is clear then that employers use those contracts more as a flexible device to adjust employment in the face of adverse shocks than as a "screening device".

- The increase in temporary contracts reduces the probability of investing in human capital or receiving specific training in the company. According to the estimations carried out by Dolado, Felgueroso and Jimeno (1999), the probability of receiving free or subsidized on-the-job training is 22% lower for temporary workers than for workers with open-ended contracts. Also, Albert, García-Serrano and Hernanz (2005) show that workers holding temporary contracts are less likely to be employed in firms providing training.
- High temporary contracting can stimulate sectorial shifts in activity. The activities that benefit most form temporary employment belong to low-productivity sectors (agriculture, construction, and the hospitality sector). For this reason, such that promoting temporary contracts can generates incentives for divert investment toward them, hindering the emergence of activities with higher value added (OECD, 2005).

Thus, given productive specialization and recent evolution in the economy, the increased share of temporary contracts has possibly had a heterogeneous effect on regional labour productivity growth in Spain. The econometric analysis of this hypothesis is the main aim of the following section.

3. Regional econometric analysis of the determinants of apparent labour productivity

With a view to studying to what extent the evolution of regional productivity can be affected by changes in the type of contracts employees have had since 1987, a model for labour productivity has been specified and estimated directly derived from an aggregate production function. This function is defined under the assumption that technology is common across regions in this period.

3.1. Theoretical model

It is assumed that technology can be represented through the following production function:

$$Y = A \cdot N^{\alpha} \cdot K^{\beta} \cdot HK^{\gamma} \cdot TK^{\varphi} \qquad [1]$$

where Y represents aggregated net output, N effective labour input, K the stock of physical capital, HK human capital, TK technological capital and A a factor that, among others, can represent disembodied technical progress.

To control the possible heterogeneity of the labour input, it is assumed that effective labour is a function of the number of jobs and their characteristics. Specifically, among the various factors that can help to explain the heterogeneity of the labour input, the type of contract and the condition of being self-employed are attributes that can shape effective labour input and thus the aggregate output. This selection of determinants of effective labour input is justified on two counts. First, as mentioned, because temporary contracts can affect labour productivity. Second, because there is little empirical literature on the aggregate impact of the increase in temporary contracts on Spanish productivity performance. Thus, following Haskel and Martin (1993), effective work N is defined as follows:

$$N = PL^{\theta p} \cdot TL^{\theta t} \cdot SEL^{\theta ns} \qquad [2]$$

where PL represents the number of jobs filled by workers with permanent contracts, TL those with temporary contracts and SEL the number of non-salaried (self-employed) workers. L is the number of total jobs (= PL + TL + SEL). It is assumed that:

$$\theta_{ns} = 1-\theta_p - \theta_t$$

Replacing [2] in [1] and using logarithms yields:

$$\ln Y - \ln L = \ln A + \beta \ln K + \gamma \ln HK + \varphi \ln TK + (\alpha-1) \ln L +$$
$$+ \alpha (1- \theta_p - \theta_t) \ln (1-PL/L - TL/L) + \alpha \theta_p \ln (PL/L) + \alpha \theta_t \ln (TL/L) \qquad [3]$$

In line with the previous discussion, it is expected that $\theta_p > \theta_t$, which would imply that an increase in the employment share of permanent contracts would lead to an increase in labour productivity whenever $\theta p > PL/L$ (Haskel and Martin, 1993; Cörvers, 1997).

3.2. Econometric model and results

To estimate equation [3], panel data have been used with observations of variables from 17 Spanish regions (at NUTS 2 level) in 1987-2000. Nevertheless, variables related to the intensity of inputs use have to be added to equation [3] for its estimation, in addition to the random disturbance term. These variables make it possible to control the cyclic component of labour productivity growth (OECD, 2001, p. 119). Following Basu and Kimball (1997), the variable *H* is considered to control the intensity in the use of the labour input, representing the average hours worked by employee (per week) in every region. To control intensity in the use of physical capital, either the level of intermediate consumption can be considered or the quotient between gross fixed capital formation (GFCF) and total capital stock. The latter variable, *GFCF/K* for each region and year, has thus been added to equation [3] in the estimations[4]. Table 4 shows the results of the estimation of equation [3], in line with the empirical variables previously defined.

Table 4 (col. 1) shows the results of the OLS estimation of the theoretical model [3] under the assumption of a common intercept for all regions. The variables have the correct sign and are significant, except for the coefficients for the variables related to technological capital stock, intensity in capital use and the variable measuring the share of self-employed workers in total employment. On the other hand, it is noteworthy in col. 1 that, despite not having taken into account in the estimation any possible spatial heterogeneity factor, the adjusted coefficient of determination is 0.89.

The results of the OLS estimation for fixed effects are shown in column (2). Testing the equality hypothesis of regional fixed effects shows that it is possible to reject the specification of the model with a common intercept; moreover, the statistic for joint significance of individual intercepts indicates that its non-significance can be rejected. On the other hand, the Hausman test (Hausman, 1978 and Arellano, 1993) has been used to confirm whether the estimation shows correlation between the regional fixed effects and the regressors remaining in the model.

[4] Residential capital is excluded from the range of assets that are included in this analysis.

Table 4. *Results of the estimations of the model [3]*

Variables	*Levels*		*First differences*				
	OLS (1)	Fixed effects (2)	OLS (3)	Aitken GLS (4)	OLS (5)	GMM (6)	GMM (7)
Constant	10.416 (0.000)	9.322 (0.000)	-	-	-	-	-
ln L (No. of filled jobs)	-0.179 (0.000)	-0.612 (0.000)	-0.547 (0.000)	-0.502 (0.000)	-0.517 (0.000)	-0.515 (0.000)	-0.524 (0.000)
ln K (Physical capital stock)	0.175 (0.000)	0.266 (0.000)	0.266 (0.000)	0.255 (0.000)	0.269 (0.000)	0.226 (0.004)	0.207 (0.041)
ln HK (Mean years of schooling of the working-age population)	0.416 (0.000)	0.139 (0.034)	0.166 (0.035)	0.103 (0.093)	0.159 (0.040)	0.185 (0.136)	0.132 (0.456)
ln TK (Technological capital stock)	-0.001 (0.876)	0.062 (0.000)	0.055 (0.000)	0.054 (0.000)	0.052 (0.001)	0.063 (0.030)	0.089 (0.001)
ln H (Average hours worked by employee weekly)	-0.697 (0.000)	-0.192 (0.126)	-0.080 (0.422)	-0.077 (0.362)	-	-	-
ln GFCF/K (GFCF / Physical capital stock)	0.030 (0.298)	0.040 (0.013)	0.019 (0.101)	0.013 (0.215)	-	-	-
ln PL/L (No. open-ended contracts/ No. of total jobs)	0.534 (0.000)	0.222 (0.000)	0.131 (0.016)	0.141 (0.001)	0.136 (0.010)	0.391 (0.005)	0.384 (0.000)
ln TL/L (No. temporary (fixed term) contracts/ No. of total jobs)	0.101 (0.000)	0.067 (0.000)	0.044 (0.010)	0.048 (0.000)	0.047 (0.005)	0.109 (0.004)	0.127 (0.000)
ln SEL/L (No. non-salaried workers/No. of total jobs)	-0.046 (0.144)	-0.020 (0.4521)	-0.013 (0.555)	-0.011 (0.582)	-0.014 (0.512)	0.008 (0.915)	0.065 (0.022)
Adjusted R^2	0.888	0.978	0.402	0.471	0.398	0.286	0.305
Akaike information criterion	-3.205	-4.782	-5.391	-5.554	-5.394	-	-
Durbin-Watson Statistic	0.264	0.666	1.972	1.960	1.962	-	-
Lagrange Multiplier Test for 1st-order autocorrelation	-	149.777 (0.000)	1.024 (0.312)	0.000 (0.991)	0.719 (0.398)	3.917 (0.049)	0.045 (0.833)
Lagrange Multiplier Test for 2nd-order autocorrelation	-	54.007 (0.000)	0.003 (0.955)	0.411 (0.522)	0.003 (0.954)	3.244 (0.073)	9.900 (0.002)
Equality test for fixed effects	-	1092.626 (0.000)	-	-	-	-	-
Joint significance test of fixed effects	-	407.312 (0.000)	-	-	-	-	-
Hausman test	-	86.404 (0.000)	-	-	-	-	-
Sargan test of over identifying restrictions	-	-	-	-	-	14.893 (0.603)	11.653 (0.270)
No. of available observations	238	238	221	221	221	221	221

Notes: The dependent variable is (ln Y - ln L) for the 17 regions and 1987-2000. The standard errors and covariances of the estimations are heteroscedasticity-consistent. The p-value of the statistics is indicated in parentheses. The Lagrange Multiplier tests for autocorrelation are based on a modification of the Breusch-Godfrey test (Greene, 1997, p. 597). The instruments used in the Generalised Method of Moments (GMM) estimations are: in the column 6 the specific constants for each region; the 2nd and 3rd lags of the mean annual growth rate of physical capital stock; the ln of the GFCF and of the average hours worked H; the mean annual growth rates of the unemployment rate, R &D spending and the population older than 16 years old with secondary studies (forming a total of 24 instruments). In the case of column 7, the 1st, 2nd and 3rd lags of the ln of the following variables: GFCF; share of workers with university studies in total employment; share of industrial GVA in total regional GVA; unemployment rate; average labour compensation per employee (in constant euros); and the 1st and 2nd lags of ln L (17 instruments). The estimations have been obtained using the module GMM/DPD of Eviews 5.1 software.

According to the results, the null hypothesis for absence of correlation can be rejected. In this case, the results compatible with the data structure are those obtained with the fixed effects model. It is worth noting that the value calculated for the adjusted coefficient of determination in this case is 97.8%. Furthermore, the values estimated for the output direct elasticities are similar to those obtained in the Spanish empirical literature (Argimón, González-Páramo, Martín and Roldán, 1994; de la Fuente, 1996; Serrano, 1996; Fernández and Polo, 2002 and Estrada, Pons and Vallés, 2006, among others).

However, the fixed effects estimation suffers from the presence of serial autocorrelation in the residuals. A possible way to avoid this problem is to assume that the residuals of the fixed effect model follow a random walk. In this case, estimating the model in first differences should provide uncorrelated residuals. Table 4 (col. 3) shows the results of estimating the model in first differences. It is noteworthy that the value of the estimations of the coefficients does not vary significantly when comparing this estimation's results with those from the fixed effects model. In addition, the statistics estimated to detect 1^{st} and 2^{nd} order autocorrelation in the residuals do not make it possible to reject the null hypothesis of absence of serial correlation.

Taking into account the large differences in the size of regional economies, the model has been estimated in first differences employing the Aitken generalized least squares (GLS) estimator where cross-section weights are used to obtain efficient estimations in the light of possible heteroscedasticity in the residuals. The similarity of the results obtained with OLS and GLS estimators are noteworthy. The only difference pertains to the elasticity of the product in relation to the human capital stock, whose estimated coefficient reduces both its value and the precision of its estimation. Furthermore, the estimated coefficients for the variables associated with intensity in the use of the factors ln GFCF/K and ln H are not significant in any of the cases. In this sense, Table 4 (col. 5) shows that excluding both variables does not alter the coefficients of the remaining explanatory variables estimated by OLS.

Finally, to mitigate the effects of possible endogeneity on the estimations and/or the existence of measurement errors in some regressors, an estimation procedure that

provides robust results is obtained by using instrumental variables estimators (IV) in models in first differences (Griliches and Hausman, 1986). Sometimes economic theory can suggest which explanatory variables in the model might be endogenous, but cannot indicate whether the correlation with the error term is sufficiently large as to invalidate the OLS estimation due to its inconsistency. This paper has analyzed the possible endogeneity of the regressors from an empirical perspective. To this end, a Wu-Hausman test was used which makes it possible to test the null hypothesis of exogeneity of the regressors. The results of this test applied to the regressors in first differences, as shown in Table 4 (col. 5), show that the hypothesis of exogeneity of the predetermined variables cannot be rejected in any of the cases. Thus, in principle, the predetermined variables themselves and their lags can be valid instruments for the estimation by IV. Table 4 (cols. 6 and 7) shows the results of the estimations by GMM of the specification in first differences of equation [3] using two different sets of instruments (Arellano and Bond, 1988). In both cases, the Sargan's test does not reject the validity of the set of instruments used, which is crucial in the IV estimations because, if the chosen instruments are not orthogonal to the error term, the inconsistency degree of the IV estimator can be greater than the OLS estimator (Nakamura and Nakamura, 1998). In the light of the results obtained, the most noteworthy discrepancies of these estimations regarding the OLS estimation in first differences refers to the variables this work focused on i.e. those measuring the total employment share of permanent and temporary workers. The GMM estimations show a significant increase in the value of the direct elasticity of labour productivity in relation to the share of permanent contracts as well as the difference between this coefficient and the one for the share of workers with a temporary contract.

3.3. Effects of the increase in temporary contracts on labour productivity

Table 4 (col. 6) shows that the estimated value for direct elasticity of productivity growth in relation to the growth in the share of permanent contracts ($\alpha \cdot \theta_p$) is 0.391 (0.384 in the case of col. 7). These results indicate a positive relationship between growth in labour productivity and the rate of growth in this share. However, the value of parameter θ_p should be relatively high, given that high elasticity of permanent workers in relation to effective labour input corresponds to a high mean product by these workers compared to the one obtained in the other two categories considered. Table 4

(col. 6) specifically shows that an increase by 1 percentage point in the annual growth rate of the employment share of permanent contracts — thereby implying a reduction by the same amount in the growth rate of temporary ones — would involve an increase by 0.28 percentage points in the mean annual growth rate in labour productivity (0.26 percentage points in the case of col. 7). This differential effect would be still greater (and equal to 0.39 percentage points) if the increase in the share of permanent contracts occurred exclusively as a consequence of reductions in the share of non-salaried workers (0.32 in accordance with results in col. 7).

Furthermore, it can be deduced from equation [3] that the necessary condition for the elasticity of labour productivity regarding the share of permanent workers in employment (and thus its marginal productivity) to be positive is that $\theta_p > PL/L$, which would mean that an increase in the share of permanent workers would lead to an increase in regional productivity. Given the results of the estimations (in the case of col.6, $\alpha\ \theta_p = 0.391$, $\alpha = 0.485$ and, as the mean in 1988-2000, $PL/L = 0.551$), it seems clear that the previous condition is also confirmed.

In addition to the estimations' results shown in Table 4, Table 5 shows a decomposition of the causes of productivity growth in 1988-2000.

Table 5. *Decomposition of labour productivity growth, 1988-2000*
(Percent growth per annum)

Variables	*Δ % observed (annual)*	*Estimated contribution to productivity growth*
ln L (No. of filled jobs)	1.57	-0.81
ln K (Physical capital stock)	3.71	0.84
ln HK (Mean years of schooling of the working-age population)	1.56	0.29
ln TK (Technological capital stock)	7.23	0.46
ln PL/L (No. permanent contracts/No. of total jobs)	-0.87	-0.34
ln TL/L (No. temporary contracts/No. of total jobs)	6.20	0.68
ln SEL./L (No. non-salaried workers/No. of total jobs)	-2.00	0.00

Note: Figures have been calculated taking into account the coefficients shown in Table 4 (col. 6). The independence of each variable's effects on productivity is assumed in order to carry out this decomposition.

Taking into account that the mean annual growth rate in labour productivity in Spain during 1988-2000 was 1.17%, the following scenarios can be postulated for the period, while taking into account the results in Table 5:

- If an increase in physical, human and technological capital stock had not occurred in the period, at the same time as the variations registered in employment and its composition according to type of contract, the mean annual growth rate in productivity would have been -0.47%.
- If, together with employment, only the physical capital stock had increased, the estimated productivity growth rate would have been 0.37% per year.
- In view of the fact that the estimated contribution to productivity growth of the increase in human capital is 0.29%, the annual productivity growth rate would have been 0.66%, not taking into account the contribution deriving from the increase in technological capital stock. Therefore, the contribution to productivity growth of the increase in technological capital (0.46%) amounts to 39% of the mean annual variation registered in the period for labour productivity.
- Finally, the estimations indicate, under *ceteris paribus* conditions, that if the annual real productivity growth rate in Spain in the period had been 1.17%, the growth would have been higher (1.45%) if the employment shares of the temporary and permanent workers had remained constant at its 1988 level.

Thus, it is clear that in order to explain the evolution of labour productivity in Spain during 1987-2000, in addition to growth in the three capital categories studied and in employment, it is also crucial to control the effect on productivity of the changes taking place in the composition of employment, regarding the share of permanent and temporary contracts and that of non-salaried workers.

4. Conclusions

This work attempts to obtain evidence on the impact of the increasing labour market segmentation on apparent labour productivity growth in the Spanish regions since the second half of the 1980s. This evidence was obtained by estimating an augmented production function. This function includes, together with the core determinants of productivity, other variables that reflect the changes occurring in the composition of employment, regarding the type of contract – temporary or permanent – and the share of non-salaried workers.

During 1987-2000, productivity grew in Spain at a mean rate of 1.16% per year, with a clear trend toward slowdown in growth since 1995. It is also clear that the most productive regions (Catalonia, Madrid, Navarra and the Basque Country) maintained their relative advantage throughout the whole period. Navarra and Madrid are noteworthy: both regions maintained their leadership in productivity even though they registered above average employment growth rates.

Because of the capital deepening process in Spain, the situation in the different regions regarding physical capital is very close to the Spanish average, fluctuating around 90% in 2000. In addition, human capital has undergone sustained growth since 1987, leading to a clear decrease in regional differences. However, some regions display their main productive weakness in the level of technological capital stock per worker. Regarding this factor, regional differences are very high.

The relative distribution of temporary contracts between the regions is not uniform either. There are large differences in the share of temporary contracts which show a strong direct correlation with the regional unemployment rate, such that the regional productive structure does not seem to fully explain the existing differences.

In order to study how far the evolution of regional productivity can be explained by changes in the relative proportion of workers with temporary contracts since 1987, a labour productivity function has been specified and estimated, based on an aggregate production model defined under the assumption that technology is common across regions during this period. Evidence indicates that a 1 percentage point increase in the annual growth rate of the share of permanent contracts — which implies a reduction by the same amount in the growth rate of the share of temporary contracts — would lead to an increase of 0.28 percentage points in the annual growth rate of labour productivity. This differential effect would be still greater (i.e. 0.39 percentage points) if the increase in the share of permanent workers occurs exclusively as a consequence of reductions in self-employed workers. Furthermore, taking into account that the mean annual growth of labour productivity observed in Spain during 1988-2000 was 1.17%, it can be postulated that this rate of growth would have been 1.45% if the share of temporary and permanent workers in employment had remained at the 1988 level.

Thus, the analysis means that there are two determinants of special regional relevance among those factors slowing progress in Spanish productivity: weakness of investment in technological capital and persistent labour market segmentation. These two factors are not independent of each other regarding their effects on productivity growth: labour market segmentation generates incentives for developing low-technology sectors, which are those that benefit most from temporary employment (OECD, 2005). In addition to designing and applying technological policies that take into account the problems of SMEs and the characteristics of productive specialization in the regions, the labour market reforms needed to effectively reduce the share of temporary contracts must be addressed as a matter of urgency to improve the technological level of Spanish firms. The efficacy of such technological policies would be seriously undermined if improvements in worker training — required to efficiently incorporate technical progress into productive activities — were penalized by the existence of precariousness in employment. Correcting these problems is particularly essential for the low performance regions, which place a burden on the productive potential of the Spanish economy as a whole.

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Appendix 1. Statistical information used

The statistical documents employed to construct the database used in this work are as follows:

- Contabilidad Regional de España. Base 1995 (INE). *Spanish Regional Accounts. 1995* database (Spanish Institute of Statistics, INE).
- Contabilidad Regional de España. Base 1986. Serie enlazada 1986-1996 (INE). *Spanish Regional Accounts.1986 database; Linked series 1986-1996*.
- Encuesta de Población Activa (INE). *Active Population Survey*.
- Censos de Población de los años 1980, 1990 y 2001 (INE). *Population Census for 1980, 1990 and 2001*.
- La estadística de I+D en España: 38 años de historia (1964-2001) (INE). *Statistics for R&D in Spain: 38 years of history (1964-2001).*
- Base de datos BD.MORES, Ministerio de Economía y Hacienda. *BD.MORES Database. Ministry of the Treasury*.
- El stock de capital en España y su distribución territorial (1964-2002). Fundación BBVA. *Capital stock in Spain and its regional distribution (1964-2002). BBVA Foundation.*

The GVAfc linked series and the deflators used are described in Marchante and Ortega (2006). This work also describes the series corresponding to the mean years of schooling of the working-age population. It is important to take into account that the *Regional Accounts* from the Spanish Institute of Statistics (INE) introduced a change into the concept of Total Employment. From 1995 onwards the data on employment refers to number of filled jobs and not to the number of workers employed, as was the case before. For this reason, from 1986 a linked series was obtained for the number of jobs in each region corresponding to salaried and non-salaried (self-employed) workers. Data from the *Active Population Survey* (APS) from the INE has also been used to estimate the share of workers with permanent and temporary contracts. Data related to the working age population (older than 16 years), the rate of regional unemployment in the second quarter of every year and average hours worked also comes from APS.

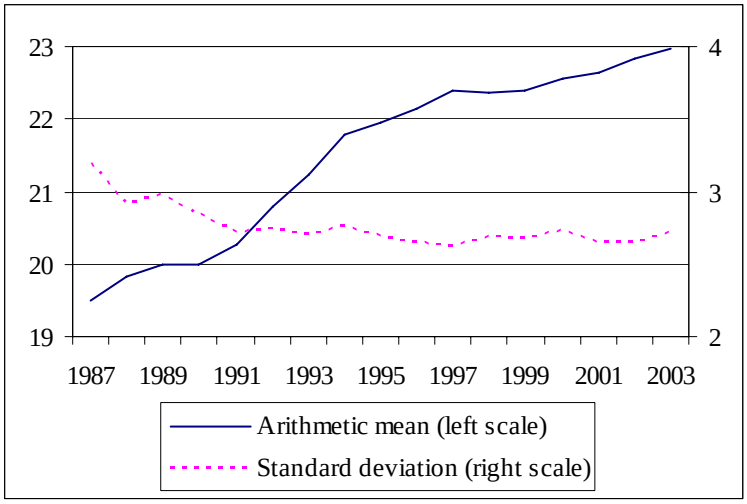
Data relating to public and private capital come from *Capital stock in Spain and its territorial distribution (1964-2002)* in 2005. Specifically, the physical capital stock is

the sum of private and public productive capital. The former has been calculated as the total capital stock of private sector activities minus the residential capital, and the latter as the sum of the territorialized capital in roads, water infrastructures, ports, airports, urban structures and railways, plus the non-territorialized capital, distributed between the regions according to geographical surface area. All the series are expressed in thousands of 1990 €. The Gross Fixed Capital Formation (GFCF), including private and public capital, comes from the same source.

In turn, the regional technological capital stock series were estimated in line with the methodology proposed by Griliches (1979) and adapted for Spain by Puente and Pérez (2004). These authors consider technological capital as being the cumulative fund of knowledge that is part of the intangible capital of the economy and is obtained from R&D activities. Taking this definition into account, they propose calculating technological capital stock by applying the permanent inventory method to cumulative spending on R&D. The initial capital stock for 1987 is established from the investment flow for that year divided by the depreciation rate, which is considered constant and equal to 15%. Data on spending on R&D in the regions come from INE, *The R&D statistics in Spain: 38 years of history (1964-2001)*. Expenditure is presented in thousands of current euros for each year, which means that the series has been deflated using the GFCF deflator series from the *Spanish National Accounts*.

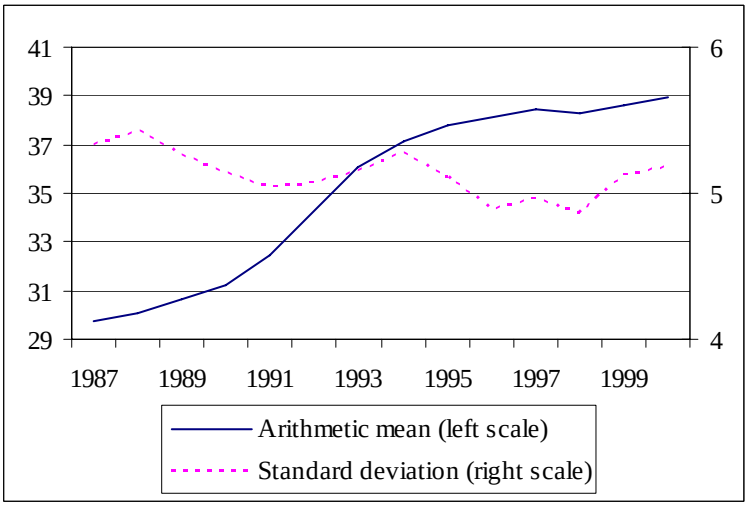
Appendix 2

Graph A.2.1. *Regional labour productivity*
(Thousands of 1990 euros)



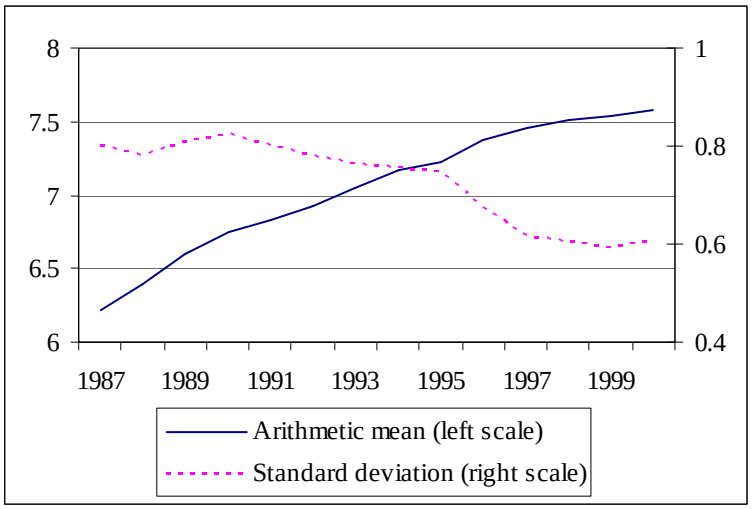
Source: Regional Accounts and BD.MORES

Graph A.2.2. *Productive physical capital stock per worker in the regions*
(Thousands of 1990 euros)



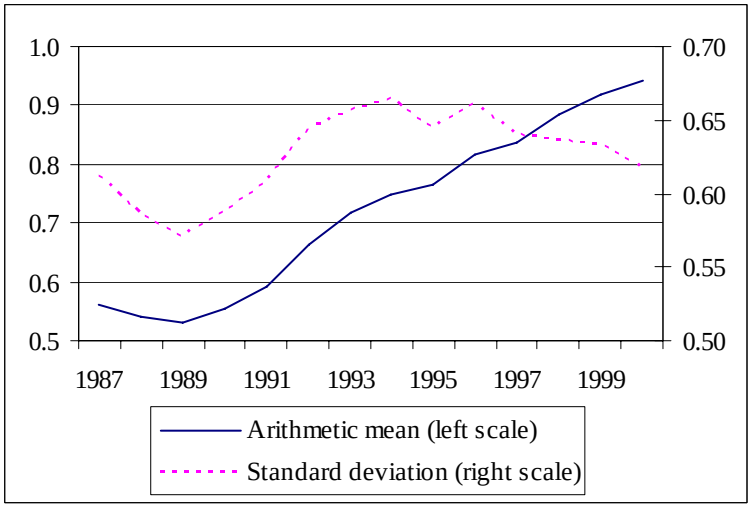
Source: Regional Accounts, BBVA Foundation and BD.MORES

Graph A.2.3. *Human capital stock in the regions*
(Mean years of schooling of the working age population)



Source: INE, BBVA Foundation and BD.MORES

Graph A.2.4. *Technological capital stock per worker in the regions*
(Thousands of 1990 euros)



Source: INE, BBVA Foundation and BD.MORES.