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Josep Lluís Raymond
Dolors Cotrina
Àlex Costa
Enric Puig
Vittorio Galletto
Sandra Aguilera
Marc Fíguls

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Parc de Recerca, Mòdul A
Universitat Autònoma de Barcelona
08193 Cerdanyola del Vallès, Barcelona, Spain.

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GDP estimation for Barcelona and the Barcelona Metropolitan Area. Methodological improvement in the estimation of productivity dynamics with wage information

Josep Lluís Raymond
Departament d'Economia i d'Història Econòmica
Universitat Autònoma de Barcelona
08193 Cerdanyola del Vallès, Barcelona (Spain)

Dolors Cotrina
Àlex Costa
Enric Puig
Departament d'Anàlisi - Gabinet Tècnic de Programació
Oficina Municipal de Dades
Ajuntament de Barcelona
08002 Barcelona (Spain)

Vittorio Galletto
Sandra Aguilera
Marc Fíguls
Institut d'Estudis Regionals i Metropolitans de Barcelona
Universitat Autònoma de Barcelona
08193 Cerdanyola del Vallès, Barcelona (Spain)
Email: vittorio.galletto@uab.cat

Abstract: The Gross Domestic Product (GDP) is the most important macroeconomic magnitude of the economic accounting of a territory. In spite of its known limitations, it is a basic magnitude in knowing the sectoral structure of an economy; furthermore, its evolution is the indicator that best measures economic dynamics. The relevance of GDP is not limited to the knowledge of country or regional economies, but it is also key to the knowledge of local and metropolitan economies.

In the case of Barcelona, the estimates made by the Technical Planning Office (GTP) of the Barcelona City Council available up to now start from the calculation for the base year 2011, calculating the values of the following years assuming that the effect of the agglomeration economies (characteristics of urban areas) does not vary from year to year. The availability of wages data from Barcelona, the Barcelona Metropolitan Area (AMB) and Catalonia from the Continuous Sample of Labour Lives (MCVL) allows us to relax this assumption, opening up the possibility of a methodological improvement in which the effect of agglomeration is picked up by the wage differentials between sectors and territorial areas registered every year. The aim of this paper is, therefore, to methodologically improve the calculation of the GDP of Barcelona and the AMB with the introduction of information on wage levels as indicators of productivity.

The results achieved with this methodological improvement show a high correlation with the data so far prepared by the GTP, both for Barcelona and for the AMB, so that the methodology used here is validated. The implication of these results is quite significant: the wage differentials between territorial areas would be reflecting differences in the levels of productivity. To our understanding, these are very relevant results that may be of considerable interest for urban economic statistics, as they allow a more up-to-date estimate of municipal GDP (with an annual frequency) and with a significant degree of reliability.

Keywords: Metropolitan GDP, Wages and productivity, Regional economic accounts
JEL: R11, R12, C53

1. INTRODUCTION

In 2015, the Technical Planning Office (GTP) of Barcelona City Council initiated a project to estimate the Gross Domestic Product (GDP) of the city of Barcelona. Although estimates of municipal GDP can be found in the official statistics prepared by the Statistical Institute of Catalonia (Idescat), the GTP considered necessary to address their own estimate in order to obtain more updated data, with a higher level of sectoral disaggregation, with growth rates of GDP in real terms (and not only nominal) and, finally, that it incorporated the agglomeration effect of the Barcelona urban economy in its estimation. This effect is one of the most remarkable elements of the economy of large cities, as urban economic theory has shown, so that it was considered it had to be taken into account in the GDP estimates of Barcelona.

The first GDP report for Barcelona 2010-2014 was published at the beginning of 2016 and the series for the period 2010-2016 are now available. Shortly after the publication of the first report, the estimation of the GDP of the territorial aggregate that make up the municipalities that belong to the Metropolitan Area of Barcelona (which we will call AMB[1]) was also elaborated. The analysis of the GDP results of the AMB is currently carried out by the Institute of Regional and Metropolitan Studies of Barcelona (IERMB).

There is no need to insist on the relevance of having an estimate of GDP and its real evolution. As is established both in the Manual of National Accounts of the United Nations of 2008 and in the Regulation of the European System of National and Regional Accounts of the European Union of 2013, GDP is the most important macroeconomic magnitude of the economic accounting of a territory. The GDP on the supply side is basic in order to know the sectoral structure of an economy and its real evolution is the indicator that best measures the economic dynamics.

The relevance of GDP is not limited to the knowledge of the economy of countries or regions, but it is also key in the knowledge of the local and metropolitan economies. For this reason, GDP estimates for urban economies can be found in the most advanced statistical systems. An outstanding reference is the one from the Bureau of Economic Analysis (BEA) of the USA, with its statistics of "GDP by Metropolitan Area", but there are many other examples as much in a country-wide basis (Statistics Canada, Australian Bureau of Statistics, Office of National Statistics of the United Kingdom) as well as in the field of supranational organizations (UN-Habitat, OECD or Eurostat).

[1] The AMB is a supramunicipal institution formed by Barcelona and other 35 contiguous municipalities accounting for 3.2 million inhabitants.

Regarding the methodology used so far by the GTP, it can be said that a classic strategy in economic accounting has been applied. In the first place, the Gross Value Added (GVA) for the base year 2011 is estimated, this is the year for which the most disaggregated macroeconomic productivity data are available, thanks to the Input-Output tables of Catalonia in 2011, and secondly, an annual projection from this base year is carried out. The 2011 base year estimate reflects the agglomeration effect on sectoral productivity but, on the other hand, the annual projection applied until now supposed that this effect is fixed over time. The objective of this work is precisely to overcome the restriction of a fixed agglomeration effect over time, thereby contemplating dynamic changes in the economy of Barcelona and the AMB. In particular, this improvement is evaluated in the study based on wage information from Barcelona, the AMB and Catalonia. The hypothesis that is formulated is that the wage differential -sector to sector- of each one of the local economies under study includes -partially- a differential of sectoral productivity. This differential, which varies from year to year, is a consequence of the dynamics of the agglomeration effect of the economy of Barcelona and the AMB compared to Catalonia.

2. CURRENT METHODOLOGY AND PROPOSAL FOR IMPROVEMENT

The GVA estimate for Barcelona for the base year is based on an estimate of employment and productivity at the highest possible level of disaggregation. This approach is based on the idea that, in nearby territories, the productivity of labour depends more on the specific economic activity that develops and not on the specific location of the productive centre, as long as the data has a fairly detailed sectoral disaggregation.

The source of information on productivity are the latest Input-Output Tables for Catalonia for 2011 (TIOC 2011), which provide data for 82 economic activities. To calculate the apparent labour productivity (ALP), a slight simplification of this disaggregation has been made reducing it to 73 sectors of activity.

The hypothesis of equivalent sectoral productivity in Catalonia and Barcelona is corrected by means of two adjustments designed to capture the agglomeration economies, differentiating between economies of scale and those of urbanization, typical of the economy of the city.

In order to capture scale economies, an index of productivity correction has been applied by strata, taking into account the distribution of employment in

Barcelona and Catalonia by sector and according to these strata. This information has been obtained thanks to the Central Directory of Companies and Establishments (DIRCE) from the Spanish Institute of Statistics (INE). Quantification of urbanization economies has been possible thanks to the exploitation of data of unilocalised companies in Barcelona and Catalonia. This analysis shows that in most economic sectors (though not all) productivity in Barcelona is higher than in Catalonia. It should be noted that this increase in productivity is general in the metropolitan areas of the advanced economies, as reflected in the OECD reports (e.g. OECD 2014).

The relative simplicity when selecting the 2011 TIOC as a source of information on the sectoral GVA contrasts with the case of employment. For Barcelona and for 2011 the available data is from the Social Security system, the Population Census (with travel-to-work data) and, finally, the aforementioned Central Directory of Companies and Establishments (DIRCE).

The differences between these three sources are very noticeable. A priori, the best source is the DIRCE, since both the 2011 Census and the information derived from Social Security records have known biases. It must be remembered that in the 2011 Census, the travel-to-work data was obtained by sampling, a fact that generates representativeness problems when a tabulation needs to be made with a detailed sectoral breakdown. This a priori assessment is reinforced by the data on Barcelona provided by the INE for Barcelona (2011) to Eurostat in the framework of the Urban Audit project, where the results show a high degree of coherence with those of the DIRCE.

Once the DIRCE has been identified as a basic reference for employment, two important limitations of this source must be overcome. The first one is of a general nature, to have a lower level of disaggregation (37 branches of activity) than the TIOC. This problem has been addressed through the calibration of Social Security data, that is, adjusted to the totals for the 37 branches of the DIRCE. A second problem is the non-coverage of the DIRCE in the case of three sectors: the primary sector, the Public Administration and the household sector. In this case, different specific sources have been used.

To obtain the base year, it is necessary to go from GVA to GDP through the estimation of taxes. At this point the Eurostat criteria, followed both by the INE in Regional Accounting and by Idescat, are to apply to taxes the same percentage that the territory accounts for in terms of GVA.

The obtaining of the results for the rest of the years, based on the results corresponding to 2011, has been implemented with two levels of sector aggregation. The information on the variation of productivity was used for the 44 sectors of the Economic Accounts of Catalonia published by Idescat with a

2010 base, together with the variation of employment that is provided by the complete information of the Social Security system, assuming that its bias in terms of levels does not translate into variations. At the time of preparing this statistical study, this strategy has a limitation derived from the Economic Accounts of Catalonia, since the information of 44 sectors only reaches the reference year of t-3. Therefore, for the most recent period this system is limited to only 10 sectors of activity.

Regarding the annual projection of the results from the base year, a reasonable but simplistic hypothesis has been used. Logically, the agglomeration effect itself may have temporary variations and the equalization of the variation in sectoral productivity in Catalonia, Barcelona and the AMB does not contemplate this possibility. However, the application (year by year) of the system to capture the productivity differential between unilocalized companies has difficulties. The most important is that the necessary information is only available with a significant time lag.

The availability of reliable wage data from Barcelona, the AMB and Catalonia from the Continuous Sample of Labour Lives (MCVL) opened up the possibility of a methodological improvement in the process of annual projection from the base year. The GTP has developed different analyses of the labour market of the city using the MCVL. Therefore, once the generated information has been validated, the possibility of introducing the wage differential - sector by sector - of Barcelona and the AMB with regard to Catalonia was considered as an element to improve the estimation of the variation of sectoral productivity.

The theoretical foundation of this proposal will be presented in the following point. Even so, it is possible to advance that the link between wages and GDP, and the application of this information to make estimations of municipal GDPs is a sufficiently recognised strategy so that in the manual of the UN-Habitat Urban Indicators Guidelines (Better Information. Better cities) of 2009 this methodology is accepted as the most reliable of those that can be applied at the local level.

3. THEORETICAL FOUNDATION

In general, if we assume that the generation of Gross Value Added (GVA) by companies can be approximated by a production function of the type:

$$GVA = f(N, K, Z)$$

where N is employment, K the capital and Z the rest of the productive inputs. If companies maximize profits, the equality between wage and labour marginal productivity will be verified. That is to say:

$$\frac{\partial GVA}{\partial N} = \frac{\partial f(N,K,Z)}{\partial N} = W$$

where W is the wage. The approximation that is made is to suppose that this labour marginal productivity will have a certain correspondence with the apparent labour productivity.

In the case of a Cobb-Douglas production function it is verified:

$$GVA = AN^{\beta_1}K^{\beta_2}Z^{\beta_3}$$

Taking logarithms:

$$lnGVA = lnA + \beta_1 lnN + \beta_2 lnK + \beta_3 lnZ$$

Therefore:

$$\frac{\partial GVA}{\partial N} = \beta_1 \frac{GVA}{N} = W$$

It should be noted that the ratio between Value Added and employment is the apparent labour productivity (ALP) and, therefore:

$$ALP = \frac{1}{\beta_1}W$$

Finally, taking logarithms the following can be obtained:

$$lnALP = -ln\beta_1 + lnW = \alpha + lnW$$

That is to say, to assume a Cobb-Douglas production function and that a correspondence between wages and productivity exists, is equivalent to assume a unitary elasticity in the double logarithmic relation between ALP and wages.

However, a more general alternative is to not impose the restriction of unitary elasticity a priori and to estimate a model of the type:

$$lnALP = \alpha + \beta lnW \qquad \text{[Equation 1]}$$

To verify if this approach is confirmed by the available data at micro level, the "Survey on Business Strategies" of the SEPI Foundation for 1994, 1998, 2002 and 2006 has been used, with information on wages and productivity. With this data, three models have been estimated: with individual and temporary fixed effects, with individual stochastic and temporary fixed effects and a *pool* model (see Appendix 1). It should be noted that in all three cases the estimated elasticity between apparent labour productivity and wages is very close to unity. Although the information supporting these estimates is of a microeconomic type, the conclusion would be that it is reasonable to approximate the unobserved variations in productivity by the observed variations in wages. In any case, the purpose of these estimates is to verify that with micro data of individual companies the existence of a relationship between wages and productivity is confirmed.

4. ESTIMATION OF THE β COEFFICIENT FOR THE RELATIONSHIP BETWEEN WAGES AND ALP

As indicated above, the aim of this study is to obtain an estimate of the variation of the municipal (and metropolitan) GVA based on the β relationship established between average wages and the observed apparent labour productivity. Logically it would be optimal that these estimates of β could be derived from a panel data of GDP and wages at the city level, but the availability of this data is very limited.

For this reason, it has been chosen to use the official data at the regional level provided by the INE with the *Regional Accounting of Spain* (CRE). The data available contain a small number of observations for each region (Autonomous Community, 16 observations per sector for the period 2000-2015). Consequently, the combined set of regions has been chosen to estimate a fixed-effect model by region in which the dependent variable is the logarithm of the apparent labour productivity and the explanatory one, the logarithm of wages.

4.1. Alternative estimators to the β estimator by OLS

Under the standard assumptions of the fixed-effect model, the OLS estimator is unbiased. However, in this estimation the different regions receive the same weight, therefore, if due to the small number of observations for a given region there is an atypical observation, an undue weighting would be given to this atypical observation. For this reason, other alternative estimators have been considered in addition to the OLS estimator:

1. Weighted estimator, by population:

The selected weighting criterion is the value of the employed population (N) in each sector in the respective region. That is, the equation to estimate is of the type:

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it}$$

Where "i" is the region and "t" is time, the objective function to minimise is:

$$Min\left(\sum_{it} N_{it}\hat{u}_{it}\right)^2 = \left[\sum_{it} N_{it}\left(Y_{it} - \hat{\alpha}_i - \hat{\beta}X_{it}\right)\right]^2$$

When "N" is small it is possible that atypical observations have a higher distorting effect on small regions than in larger ones. In order to avoid that this weighting system distorts the sample size, the estimation of the standard errors of the β coefficients should be made by a heteroscedasticity robust procedure. Therefore, this weighting criterion can be understood as an indirect way to protect itself from the influence of atypical observations.

2. Weighted estimator, corrected for heteroscedasticity:

As previously indicated, for a given productive sector, the starting point is the regression model $Y_{it} = \alpha_i + \beta X_{it} + u_{it}$. By estimating this equation separately for each region, an estimate of σ_i is obtained. That is, the standard deviation of the random disturbance in the region "i". To correct this heteroscedasticity problem, we obtain the weighting $w_i = \frac{1}{\sigma_i}$. Defining:

$$Y_{it}^* = \frac{Y_{it}}{\sigma_i} \qquad \mathrm{X}_{\mathrm{it}}^* = \frac{\mathrm{X}_{\mathrm{it}}}{\sigma_i}$$

The new equation in which the problem of heteroscedasticity has been corrected is:

$$Y_{it}^* = \alpha_i + \beta X_{it}^* + u_{it}^*$$

3. **Double weighted estimator, by population and corrected for heteroscedasticity**:

   In the preceding equation, the random disturbance is homocedastic. However, the same weight is being given to large regions as it is to smaller ones. One possibility is to apply a new weighting to this homocedastic equation due to the size of the region (in terms of employed population). The equation to estimate would be given by:

$$N_{it}Y_{it}^{*} = \alpha_i N_{it} + \beta N_{it}X_{it}^{*} + N_{it}u_{it}^{*}$$

   To simplify, we can define the following composite weight obtained by means of the product of the preceding two: $cw_{i\,=}\,N_{it}/\sigma_i$

4. **Dynamic estimator**:

   There is not enough sample information to make this type of estimation. As an alternative, it is proposed first to estimate the sectoral elasticity with double weighting, then jointly estimate the equation for each year, and finally, apply to the sectoral β the time evolution of the joint estimate. In practice this implies:

   1) For the whole period, the ratio between the sectoral β and total β is calculated:

$$\tau_i = \frac{\hat{\beta}_i}{\hat{\beta}_{Total}}$$

   2) The total β is estimated for each year: $\hat{\beta}_{Total,t}$
   3) For each sector and year, it is estimated: $\hat{\beta}_{it} = \tau_i \hat{\beta}_{Total,t}$

   That is, it is assumed that the sectoral β follows the same temporal pattern as the total β.

4.2. Data sources used

As previously mentioned, to obtain the estimated β values, a panel data has been created which includes a period of 16 years between 2000 and 2015 and provides observations for 17 regions and 11 economic sectors. The data come from the Regional Accounting Office of Spain (INE) and reports on the value of the sectoral GVA, the number of total salaried employees for each sector and the value of wages of these workers. The data are disaggregated by economic sectors according to the NACE rev.2 classification (see Table 1):

Table 1. Aggregation of economic sectors according to the CRE

NACE rev.2		
01-03	A	Agriculture, livestock, forestry and fishing
05-39	B-E	Extractive industries; Manufacturing industry; Supply of electric power, gas, steam and air conditioning; Water supply, sanitation activities, waste management and decontamination
41-43	F	Construction
45-56	G-I	Wholesale and Retail; Repair of motor vehicles and motorcycles; Transport and storage, hospitality
58-63	J	Information and communication
64-66	K	Financial and insurance activities
68	L	Real estate activities
69-82	M-N	Professional, scientific and technical activities; Administrative activities and auxiliary services
84-88	O-Q	Public administration and defence; compulsory social security; Education; Health activities and social services
90-98	R-U	Artistic, recreational and entertainment activities; Repair of household items and other services

Source: Own elaboration from CRE, INE.

The ALP has been calculated as the ratio between the GVA and the number of total workers while wages are calculated as the ratio between the remuneration of employees and the number of salaried workers. Both magnitudes are expressed in logarithms.

4.3. Estimators of the β coefficient and interpretation of the results obtained

The estimations carried out have resulted in 4 estimators of static β and one dynamic β:

1. β -OLS
2. β -Weighted LS by the adjustment capacity (σ)
3. β -Weighted LS by the size of the sector in the region (N)
4. β -Double weighted LS (σ and N)
5. β -Dynamic

Starting from equation 1 ($\ln ALP = \alpha + \beta \ln W$), the interpretation of the possible values of β is derived. If β=1, changes in wages are proportionally transferred to the variations in productivity. If β>1 the changes in wages translate into a variation in productivity proportionally greater than the variation in wages. On the other hand, if β<1 the changes in wages translate into a productivity variation proportionally lower than that of wages.

Next, Table 2 summarizes the results of the four estimates of static β for all sectors. The goodness of fit (R^2) of the static models are considerably high, between 64% and 99%[2]. The values of the coefficients β are statistically significant in practically all the sectors for the four models and the average value for all the sectors approaches the unit, that is, on average the wage differentials are translated proportionally to the variations in productivity. Sectors A, J, MN, GI and RU (*Agriculture, livestock, forestry and fisheries; Information and communications; Professional, scientific and technical, administrative and auxiliary services; Wholesale and retail trade, vehicle repair, transport and storage and hospitality and artistic, recreational and entertainment activities, repair of household items and other services*) are those that show, in general, a lower value of β, in all cases less than 1. In these cases, changes in salaries correspond to proportionally lower variations in the level of productivity. On the other hand, the highest value of β corresponds to sector L (*Real estate activities*), which in two of the models is greater than 2. The sectors BE, F and OQ (*Industry and supplies, Construction and Public Administration and Defence, Social Security, education, health activities and social services*) also show values of β greater than 1. Therefore, wage changes in these sectors translate into proportionally higher variations in productivity levels.

As can be seen, the estimator that uses a double weighting (weighting by the adjustment capacity - σ - and by the size of the sector - N -) is the one that shows greater stability in all the sectors and, therefore, has been the chosen estimator for the next stage of the study along with the dynamic β coefficients, which are shown in Table 3.

[2] The estimation of the four static β and the values of their statistics for each economic sector are presented in Annex 2. In addition, the coefficients of the fixed effects by region are also shown.

Table 2. Estimation results of the static sectoral β coefficients

	Sectors	OLS	Weighted LS by σ	Weighted LS by N	Double weighted LS (σ, N)	Maxi mum	Mini mum
A	Agriculture, livestock, forestry and fishing	0.41	0.38	0.56	0.49	0.56	0.38
B-E	Extractive and manufacturing industry; supply of energy, gas, steam and air; supply of water, sanitation, waste management and decontamination	1.36	1.36	1.30	1.30	1.36	1.30
F	Construction	1.06	1.07	1.05	1.06	1.07	1.05
G-I	Wholesale and Retail; vehicle repair; transport and storage, hospitality	0.80	0.85	0.79	0.81	0.85	0.79
J	Information and communications	0.17	0.31	0.46	0.61	0.61	0.17
K	Financial and insurance activities	0.92	0.93	0.99	1.00	1.00	0.92
L	Real estate activities	2.29	2.27	1.68	1.70	2.29	1.68
M-N	Professional, scientific and technical activities; administrative activities and auxiliary services	-0.02	0.15	0.51	0.61	0.61	-.02
O-Q	Public administration and defence; Soc.Sec. compulsory education; health and social services activities	1.07	1.06	1.07	1.05	1.07	1.05
R-U	Artistic, recreational and entertainment activities; repair of household items and other services	0.74	0.75	0.80	0.80	0.80	0.74
	Total	1.10	1.11	1.10	1.10	1.11	1.10

Source: Own elaboration from CRE (INE).

Table 3. Estimation results of the dynamic sectoral β coefficients

Sector	2000	2001	2002	2003	2004	2005	2006	2007
A	0.334	0.344	0.354	0.352	0.368	0.386	0.413	0.415
B-E	0.891	0.917	0.944	0.939	0.981	1.028	1.101	1.107
C	0.808	0.831	0.855	0.851	0.889	0.932	0.998	1.003
F	0.725	0.746	0.768	0.763	0.798	0.836	0.896	0.901
G-I	0.556	0.572	0.588	0.585	0.611	0.641	0.686	0.690
J	0.417	0.430	0.442	0.439	0.459	0.481	0.516	0.518
K	0.688	0.708	0.729	0.724	0.757	0.793	0.850	0.855
L	1.165	1.199	1.234	1.227	1.282	1.344	1.439	1.447
M-N	0.419	0.432	0.444	0.442	0.462	0.484	0.518	0.521
O-Q	0.724	0.745	0.767	0.762	0.797	0.835	0.894	0.899
R-U	0.550	0.566	0.582	0.579	0.605	0.634	0.679	0.683
Total	0.756	0.778	0.801	0.796	0.832	0.872	0.934	0.939

Sector	2008	2009	2010	2011	2012	2013	2014	2015
A	0.438	0.440	0.437	0.449	0.464	0.462	0.334	0.344
B-E	1.168	1.172	1.165	1.198	1.238	1.232	0.891	0.917
C	1.058	1.062	1.056	1.086	1.122	1.116	0.808	0.831
F	0.950	0.953	0.948	0.974	1.007	1.002	0.725	0.746
G-I	0.728	0.730	0.726	0.747	0.772	0.768	0.556	0.572
J	0.547	0.549	0.545	0.561	0.580	0.577	0.417	0.430
K	0.901	0.904	0.899	0.925	0.955	0.951	0.688	0.708
L	1.526	1.531	1.523	1.566	1.618	1.610	1.165	1.199
M-N	0.549	0.551	0.548	0.564	0.582	0.579	0.419	0.432
O-Q	0.948	0.952	0.946	0.973	1.005	1.000	0.724	0.745
R-U	0.720	0.723	0.719	0.739	0.763	0.760	0.550	0.566
Total	0.991	0.994	0.988	1.016	1.050	1.045	1.051	1.039

Source: own elaboration.

5. MUNICIPAL AND METROPOLITAN GVA SIMULATIONS BASED ON β ESTIMATES

Starting from the estimations of β carried out and once the chosen elasticities have been decided, that is, (i) β=1 (which implies that the production function is a Cobb-Douglas function and that there is a correspondence between wages and productivity), (ii) the β estimator with double weighting and (iii) the dynamic β estimator, the next step is to apply these values to obtain the apparent labour productivity at the municipal and metropolitan levels, from which it is possible to derive the corresponding GVA.

We assume that at regional level is verified that:

$$lnALP_{it} = \alpha_i + \beta lnW_{it} + v_{it}$$

At the metropolitan (AMB) or municipal (Barcelona) scale, it is also verified that:

$$lnALP^*_{it} = \alpha_i + \beta lnW^*_{it} + v^*_{it}$$

where "lnALP" corresponds to the logarithm of the apparent labour productivity in the region, which in this case is Catalonia; "lnW" is the logarithm of wages in the same area. "v_{it}" is the corresponding residual that includes the rest of the effects that have not been taken into account. The sub-index "i" refers to the economic sector, the sub-index "t" corresponds to the year and the symbol * refers to the metropolitan or municipal area.

As will be seen later, the values of ALP are known through the data of the CRE and the values of the regional, metropolitan and municipal wages are known from the data of the MCVL. The values of ALP*, therefore, can be obtained simply by the difference (lnALP - lnALP*), so that:

$$lnALP^*_{it} = \ln ALP_{it} + \beta(lnW^*_{it} - lnW_{it}) + (v^*_{it} - v_{it})$$

If we apply the conditional expectation to the previous population expression, the following expression can be obtained:

$$E[lnALP^*_{it}|lnALP^*_{it}, lnW^*_{it}, lnW_{it}] = \ln ALP_{it} + \beta(lnW^*_{it} - lnW_{it}) + E[v^*_{it} - v_{it}]$$

Under the hypothesis that $E[v^*_{it} - v_{it}] = 0$, therefore:

$$lnALP^*_{it} = \ln ALP_{it} + \hat{\beta}(lnW^*_{it} - lnW_{it})$$

is the expression that allows us to obtain the values of the ALP*. Note that this expression implies that the fixed effect of Barcelona is equal to that of Catalonia. It must be said that insofar as the objective of the work is to estimate growth rates, this hypothesis is neutral, that is, the possible difference between the fixed effect of Barcelona and Catalonia is irrelevant, since this effect does not vary through time. In addition, it is implicitly assumed that the factor that "translates" wage changes into changes in the ALP (ie, the coefficient β) is the same at the regional scale as at the municipal and metropolitan scales, that is, the conversion factor does not depend on the territory. It seems a logical assumption, to the extent that the agglomeration factor (urbanisation economies) would be included in wages, and that β would only pick up the (technical) relations that do not depend on the territory.

The expected results are two series of data for the variable ALP and GVA, both for the municipality of Barcelona and for the AMB. These series will also be disaggregated by economic sector according to the NACE rev.2 classification (see Table 1).

5.1. Data sources used

To perform these simulations, three data sets are needed: GVA, employment and average wages.

With respect to the GVA data, two sources are available. On one side, the GVA of Catalonia published by Idescat and, on the other side, the GVA of the municipality of Barcelona and of the AMB calculated by the Technical Planning Office of the Barcelona City Council in accordance with the methodology exposed in section 2 of this document. The GVA of Catalonia (Idescat) is used to calculate $\ln ALP_{it}$ while the GVA of the municipality of Barcelona and the AMB is used as a reference value once $\ln ALP_{it}*$ has been calculated. In both cases, the time period is 2011-2016.

Regarding employment data, two sources of data were initially considered: employees registered at Social Security files, based on data from the National Institute of Social Security (INSS), and the registered employment in the DIRCE. Both data sources offer information at the municipal, metropolitan and regional levels. However, the main difference between these two sources is that the DIRCE data captures better the localised employment while the INSS data does not differentiate employees in companies' headquarters. For this reason, the employment data taken as a reference to calculate the value of $\ln ALP_{it}$ are those from the DIRCE.

The information regarding wages comes from the MCVL and the average annual and daily wages are available for the three territorial levels of analysis during the period 2011-2015. It must be born in mind that the MCVL is a representative extraction of 4% of the population that at any given moment in time maintains a relationship with the Social Security, either as an affiliate of one of the Social Security schemes or well as a beneficiary of an unemployment or retirement benefit. Another question to keep in mind is that the information is available for all municipalities with more than 40,000 inhabitants according to the census. For practical purposes, this means that the data corresponding to the AMB correspond to only 14 of the 36 municipalities that make up this area. However, these municipalities represent 88% of the population of the AMB, therefore, it can be considered a sufficiently representative sample. Finally, it should be noted that the disaggregation by sector includes all economic sectors, including the manufacturing sector, except the *Agriculture, livestock, forestry and fishing sector* (sector A). Thus, the total set of available data covers the period from 2011 to 2015, for all sectors except the *Agriculture, livestock, forestry and fishing sector* (sector A).

Table 4. Data sources used for the simulation variables

Variable	Source	Period available	Sectors included	Unit of measurement	Notes
GVA	Idescat	2011 – 2016	A, B-E, F, G-i, J, K, L M-N, O-Q, RU	Millions of euros	Data available for Catalonia.
	GTP	2011 – 2016	A, B-E, F, G-i, J, K, L M-N, O-Q, RU	Millions of euros	Data available for Barcelona and the AMB .
Employment	Social Security	1999 – 2017	A, B-E, C, F, G-i, J, K, L M-N, O-Q, RU	Workers	Aggregated data at the municipal level. Data available for the number of total workers, workers affiliated to the general regime of Social Security and self-employed.
	DIRCE, INSS	2011 – 2016	A, B-E, F, G-i, J, K, L M-N, O-Q, RU	Workers	Series calculated from the 2011 DIRCE data and projected based on the evolution of the number of Social Security affiliates (all regimes).
Wages	MCVL	2011 – 2015	B-E, C, F, G-i, J, K, L M-N, O-Q, RU	Euros	Data are available for Catalonia, AMB (municipalities with more than 40,000 inhabitants) and Barcelona. There are two series available: annual average wage and wage per day, both in euros.

Source: own elaboration.

Regarding the estimated value of β, two possibilities are proposed for each economic sector. In addition to the β=1 option, based on the results obtained in the estimates made in section 4, the estimates of the municipal and metropolitan GVA are calculated using the estimated β value with double weighting for each economic sector. In addition, the values of the municipal and metropolitan apparent labour productivity have been calculated according to the estimated values of the dynamic β coefficient.

5.2. Simulation results

This section presents the results obtained from the simulations of "lalp*" and GVA for the municipality of Barcelona and for the AMB. In view of the results obtained, we have finally opted to use the average wages per day instead of the annual averages since they better approximate the wages of the employees once all the different possible types of contracts of the workers included in the sample are taken into account.

With respect to GVA, the simulations were calculated using the GVA of Catalonia published by Idescat to obtain the ALP of Catalonia, and the values of GVA for Barcelona and the AMB published by the GTP as a reference value. The results of the simulations are graphically displayed below in interannual variation rates and numerically in relative terms (%) of the difference with respect to the published value of the GVA of the municipality of Barcelona and the AMB, for the different values of the coefficient $\hat{\beta}$, for all the years in the period 2012-2015 and for all sectors (except the Agriculture sector).

Estimates of total GVA growth[3] for the municipality of Barcelona differ between -0.7% and -0.1%, approximately, with respect to the published total GVA (see Table 5). This difference shows a downward trend throughout the analysed period, going from an average of -0.5% for 2012 to -0.3% in 2015. Another relevant point is that the differences between the published value and the resulting value of the different simulations are similar for the three possible estimators of β.

[3] The Tables corresponding to the disaggregation by sector can be found in Appendix 3; Appendix 4 presents the corresponding Tables of the disaggregation by sectors in levels.

Table 5. Growth rates of published GVA and differences with simulated GVA according to the different values of β, for the municipality of Barcelona, in % points; 2011-2015

	2012	2013	2014	2015
GVA published (growth rate)	-1.8	-0.5	1.8	3.0
Difference from published value, in % points				
β=1	-0.7	-0.3	-0.2	-0.1
Double weighted β	-0.6	-0.1	-0.1	-0.3
Dynamic β	-0.3	-0.2	-0.1	-0.4
Average	-0.5	-0.2	-0.1	-0.3

Source: Own elaboration and Technical Programming Office of the Barcelona City Council

Estimations of total GVA growth[4] for the AMB, however, differ between 0.4% and -0.1%, approximately, with respect to the published total GVA (see Table 6). This difference, contrary to what is observed for the municipality of Barcelona, shows an increasing trend throughout the analysed period, going from an average of 0.1% for 2012 to 0.4% in 2015. On the other hand, the differences between the published value and the resulting value of the different simulations are also similar for the three possible estimators of β.

Table 6. Growth rates of published GVA and differences with simulated GVA according to the different values of β, for the AMB, in % points; 2012-2015

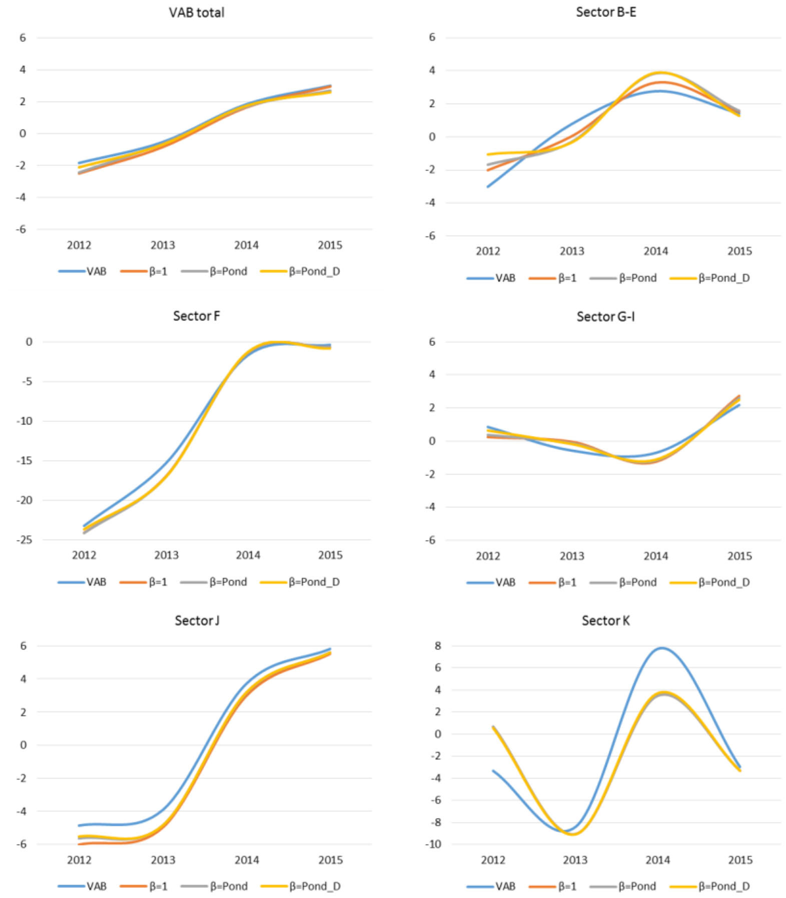
	2012	2013	2014	2015
GVA published (growth rate)	-2.4	-0.6	2.5	3.3
Difference from published values, in % points				
β=1	-0.1	0.1	0.0	0.4
Double weighted β	0.1	0.3	0.0	0.4
Dynamic β	0.4	0.2	0.0	0.3
Average	0.1	0.2	0.0	0.4

Source: Own elaboration and Technical Programming Office of the Barcelona City Council

[4] The Tables corresponding to the disaggregation by sector can be found in Appendix 3; Appendix 4 presents the corresponding Tables of the disaggregation by sectors in levels.

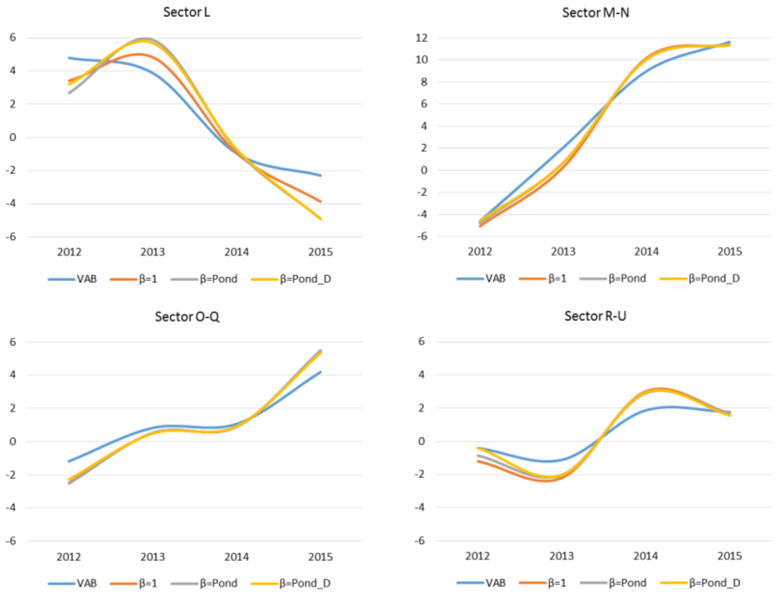
As can be seen, despite these differences with respect to the published GVA, the rates of variation of the GVA obtained in the different simulations corresponding to the possible values of the coefficient $\hat{\beta}$ not only overlap each other, but they also follow very faithfully the same trend and only some notable variation is seen in the *Information and communications sector* (sector K) in the case of the GVA of Barcelona. This overlap in the published and simulated GVA variation rates is clearly observable both in terms of the municipal GVA of Barcelona (see Figure 1) and the GVA of the AMB (see Figure 2).

Figure 1. Results of the GVA simulations for Barcelona, in interannual variation rates; 2012-2015



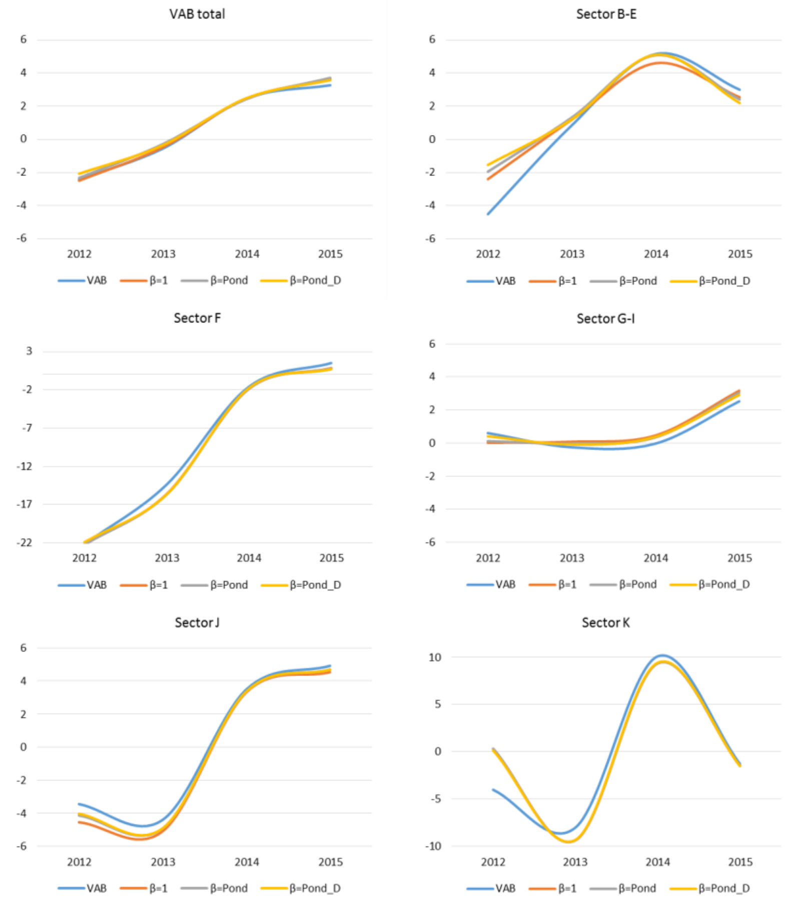
Source: own elaboration.

Figure 1. Results of the GVA simulations for Barcelona, in interannual variation rates; 2012-2015 (continued)



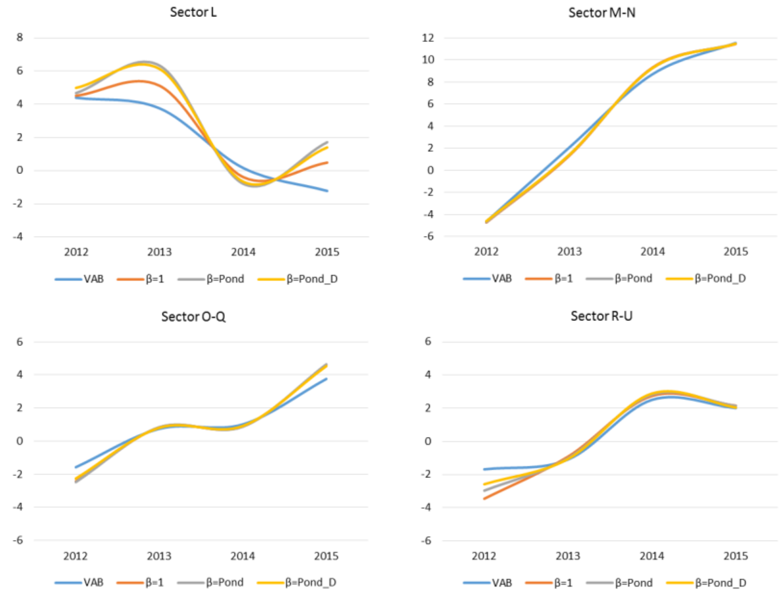
Source: own elaboration.

Figure 2. Results of the GVA simulations for the AMB, in interannual variation rates; 2012-2015



Source: own elaboration.

Figure 2. Results of the GVA simulations for the AMB, in interannual variation rates; 2012-2015 (continued)



Source: own elaboration.

6. HYPOTHESIS TEST ON β COEFFICIENTS

As detailed in section 3, under the hypothesis that there is a correspondence between wages and productivity and that the sectoral production function can be approximated by a Cobb-Douglas function, it will be verified that:

$$lnALP = -ln\beta_1 + lnW = \alpha + lnW$$

That is, under the simplest hypothesis, the elasticity of the GVA against wages should be unitary. It can be considered, however, that this hypothesis is unrealistic, so that an alternative approach is to use estimated βs as those obtained in this work.

In the estimation of the coefficient β, the five alternatives introduced in section 4.3 have been considered:

- Set an a priori unitary value of β.
- Estimating β econometrically by OLS.

- Estimating β econometrically taking into account population elevation factors.
- Estimating β econometrically correcting for heteroscedasticity and taking into account population elevation factors.
- Estimating β econometrically in a dynamic way, allowing a variation in the coefficient by economic sector and by time.

The objective of the following paragraphs is to determine to what extent different hypotheses about β involve dissimilarities or similarities in the estimated GVA. That is, the relevant question is not whether β is unitary or not, but rather to determine to what extent different options for β lead to similar results.

The simplest hypothesis is to set β=1. Therefore, this will be the starting hypothesis and it is a matter of checking if alternative values of estimated β modify the results or not. These analyses are carried out by applying econometric tests.

We have three estimates of the sectoral GVA. The one that derives from the use of the simplest model (β=1), the one that is derived from the estimation of β using population elevation factors, and the one using both corrections for heteroscedasticity and population elevation factors. The objective is to test whether the simple predictor, which can be called "X" (equivalent to β=1) can be considered an unbiased predictor of the more complex "Y" predictor that uses one of the estimated β[5].

Based on the respective GVA estimates, the following regression is formulated:

$$Y_{it} = \alpha + \beta X_{it} + u_{it}$$

The condition for "X_{it}" (GVA estimate in sector "i" for year "t" using β=1) to be an unbiased predictor of "Y_{it}" (GVA estimate in sector "i" the year "t" using one of the estimated β) is that the joint null hypothesis α=0 and β=1 not to be rejected. In this case, it will be verified:

$$E(Y_{it}) = E(X_{it})$$

[5] For operational reasons, the contrast with the dynamic β has not been applied. The objective of this section is to show that estimating β or setting β = 1 does not result in statistically different estimates of sectoral GVA.

A panel data has been formed using the values of 5 years and 10 sectors and then stochastic effects models have been estimated. The results are the following:

Table 7. Results of the hypothesis tests, estimates in levels

Hypothesis test	Dependent variable	Explanatory variable	Test result
I	GVA of the AMB obtained with β estimated using population elevation factors	GVA estimated with β=1	Chi^2=1.67 Prob>Chi^2=0.43 H_0 not rejected
II	GVA of the AMB obtained with β estimated using correction for heteroscedasticity and population elevation factors	GVA estimated with β=1	Chi^2=0.33 Prob>Chi^2=0.84 H_0 not rejected
III	GVA of Barcelona obtained with β estimated using population elevation factors	GVA estimated with β=1	Chi^2=0.27 Prob>Chi^2=0.87 H_0 not rejected
IV	GVA of Barcelona obtained with β estimated using correction for heteroscedasticity and population elevation factors	GVA estimated with β=1	Chi^2=1.73 Prob>Chi^2=0.42 H_0 not rejected

Source: Own elaboration.

Table 8. Results of the hypothesis tests, estimates in first differences of logarithms

Hypothesis test	Dependent variable	Explanatory variable	Test result
V	GVA of the AMB obtained with β estimated using population elevation factors	GVA estimated with β=1	Chi^2=4.14 Prob>Chi^2=0.12 H_0 not rejected
VI	GVA of the AMB obtained with β estimated using correction for heteroscedasticity and population elevation factors	GVA estimated with β=1	Chi^2=7.52 Prob>Chi^2=0.02 H_0 rejected at 5% H_0 not rejected at 1%
VII	GVA of Barcelona obtained with β estimated using population elevation factors	GVA estimated with β=1	Chi^2=0.27 Prob>Chi^2=0.62 H_0 not rejected
VIII	GVA of Barcelona obtained with β estimated using correction for heteroscedasticity and population elevation factors	GVA estimated with β=1	Chi^2=4.21 Prob>Chi^2=0.12 H_0 not rejected

Source: Own elaboration.

That is, briefly, either using levels (see Table 7) or first differences of logarithms (see Table 8), the null hypothesis that the simplified predictor is an unbiased predictor of the most elaborate predictor is only rejected in one case out of eight tests made, and with a "p" value of 2.3%. In the remaining cases the null hypothesis is not rejected, justifying the use of the simplified approach.

7. CONCLUSIONS

The objective of the work has been the methodological improvement in the calculation of the GVA of Barcelona and the AMB incorporating the wage information as proxy of the different levels of productivity in different territorial scales. The results achieved with this methodological improvement show a high correlation with the data so far elaborated by the GTP of the Barcelona City Council, both for Barcelona and for the AMB, obtained with a more complex methodology and which requires more information. That is, wage differentials between territorial areas would be reflecting differences in productivity levels (coefficient β is different from zero). No doubt this is a relevant element when evaluating the feasibility of applying this new methodology to the GDP estimates of Barcelona and the AMB in the coming years.

A second result is that the sensitivity of the different scenarios of the value of β is quite limited. The simplest hypothesis is to assume that $\beta=1$. This circumstance would occur if the sectoral production function could be approximated by a Cobb-Douglas and if there is correspondence between wages and marginal labour productivity. Alternatively, one can try to estimate β econometrically. In order to decide which of the two approaches is more convenient, the respective GVA values obtained can be compared. In this case, the result of this comparison is that the hypothesis of a $\beta=1$ has very similar implications to those derived from estimating specific β at the sectoral level. It should be noted that when sectoral βs are estimated econometrically, the null hypothesis of $\beta=1$ is rejected by the data. However, despite this rejection, imposing a unitary β does not have important implications in terms of the estimation of sectoral GVAs.

Although no decision has been made about what value of β to use in future estimates, the doctrine derived from the *Ockham Knife* would lead to the application of the option $\beta=1$, since it is the simplest. It is also an option that avoids having to estimate the values of β each year and opens the door to be able to apply the effect of the wage differential with a higher level of sectoral disaggregation.

We believe that the results obtained open a door that may be of considerable interest for urban economic statistics in our country, to the extent that it would allow the estimation of municipal GDP with a significant degree of reliability.

To achieve these results, it will be necessary to advance in two stages. In the first place, it is necessary to verify the validity of this method for other (Spanish) urban economies. This would be the case, for example, of other municipalities or metropolitan areas with a GDP estimation by their respective regional statistics offices (for example, those of the Basque Country, Andalusia or Galicia). Secondly, to the extent that the most important outcome from a point of view of economic dynamics is the variation in real terms, the next step should be to obtain productivity variations in real terms. This approximation could be done either by estimating the deflators from the wages, or by a replication of the estimates made here, although in this case, using the real productivity instead of the nominal productivity.

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Appendix 1: Micro analysis of the relationship between wages and productivity

This Appendix presents the results of the estimation of three models with micro data from the "Survey on Business Strategies" of the SEPI Foundation for the years 1994, 1998, 2002 and 2006, specifically 1,800 companies and a sectoral disaggregation of 20 sectors corresponding to the national classification of NACE CLIO activities.

a) Estimation of the model with individual and temporary fixed effects. The individual fixed effects correspond to the 20 sectors of the national classification of economic activities, and the temporary fixed effects capture the displacement of the ordinate in the origin as a by-product of inflation and economic growth.

b) Estimation of a model with individual stochastic effects and temporary fixed effects.

c) Estimation of a *pool* model. This estimation is made using a consistent estimator of the variance and covariance matrix with the "cluster" option. The results of the estimation are shown in Table 9.

Table 9. Results of the analysis of the relationship between wages and productivity with microdata from the Survey on Business Strategies

	(a) Individual and temporary fixed effects model (var. dependent: lalp)		(b) Individual stochastic effects and temporary fixed effects model (var. dependent: lalp)		(c) Pooling (var. dependent: lalp)	
lw	1.0538	***	1.0553	***	1.0834	***
	0.0148		*0.0147*		*0.0326*	
Constant	-0.2445		-0.2519	*	-0.5365	*
	0.1459	*	*0.1475*		*0.3085*	
Temporary fixed effects:						
1998	0.0738	***	0.0734	***	0.0678	***
	0.0168		*0.0168*		*0.0178*	
2002	0.0340	*	0.0336	*	0.0251	
	0.0174		*0.0174*		*0.0208*	
2006	-0.0072		-0.0076		-0.0153	
	0.0172		*0.0172*		*0.0244*	
N.obs.	7,285		7,285		7,285	
Groups	20		20			
R^2	0.5096		0.5096		0.5096	
Test F $u_{i}=0$	13.2	***				

In italics the standard error is shown. The asterisks represent statistical significance at 1% (***), 5% (**) y 10% (*).
Source: Own elaboration.

In all three cases, the estimated elasticity between apparent labour productivity and wages is very close to unity. Therefore, the conclusion would be that it is reasonable to approximate the unobserved variations in productivity through the observed variations in wages.

Appendix 2: Results of the estimations of β

Table 10. Unweighted OLS model estimation results. (The information that appears associated with the names of the region corresponds to the estimated fixed effects)

	A	BE	F	GI	J	K	L	MN	OQ	RU	Total
β	**0.406**	**1.358**	**1.064**	**0.803**	**0.174**	**0.920**	**2.285**	**-0.021**	**1.070**	**0.744**	**1.103**
Std Err.	*0.063*	*0.022*	*0.024*	*0.032*	*0.101*	*0.051*	*0.111*	*0.061*	*0.019*	*0.015*	*0.017*
pvalue	0.000	0.000	0.000	0.000	0.086	0.000	0.000	0.732	0.000	0.000	0.000
α	**6.609**	**-3.055**	**-0.136**	**2.300**	**9.575**	**1.498**	**-9.864**	**10.449**	**-0.536**	**2.752**	**-0.555**
Std Err.	*0.575*	*0.229*	*0.243*	*0.320*	*1.066*	*0.554*	*1.116*	*0.608*	*0.195*	*0.147*	*0.172*
pvalue	0.000	0.000	0.577	0.000	0.000	0.007	0.000	0.000	0.007	0.000	0.001
Aragon	0.113	-0.068	-0.036	0.053	-0.011	-0.002	-0.431	0.023	0.034	-0.042	-0.019
	0.047	*0.016*	*0.023*	*0.012*	*0.033*	*0.040*	*0.068*	*0.027*	*0.004*	*0.008*	*0.010*
Asturias	-0.486	-0.155	-0.106	-0.002	-0.080	0.003	0.123	0.102	0.006	-0.034	-0.065
	0.033	*0.021*	*0.021*	*0.007*	*0.025*	*0.041*	*0.060*	*0.027*	*0.004*	*0.007*	*0.007*
Balearic	-0.446	-0.051	-0.121	0.145	-0.033	0.016	-0.165	0.263	0.001	-0.052	0.022
Islands	*0.054*	*0.016*	*0.014*	*0.022*	*0.025*	*0.040*	*0.057*	*0.028*	*0.006*	*0.017*	*0.010*
Canary	-0.180	0.138	-0.040	0.100	0.293	-0.023	-0.069	0.125	0.001	0.034	0.019
Islands	*0.020*	*0.022*	*0.019*	*0.016*	*0.048*	*0.043*	*0.065*	*0.031*	*0.004*	*0.010*	*0.008*
Cantabria	-0.402	-0.154	-0.002	0.054	0.197	-0.013	0.406	0.060	0.017	-0.044	-0.021
	0.034	*0.019*	*0.015*	*0.008*	*0.051*	*0.039*	*0.067*	*0.039*	*0.005*	*0.010*	*0.007*
Castilla y	0.179	0.450	0.241	0.403	0.543	0.491	0.846	0.632	0.430	0.370	0.382
León	*0.034*	*0.024*	*0.033*	*0.012*	*0.024*	*0.043*	*0.056*	*0.037*	*0.018*	*0.008*	*0.014*
Castilla la	-0.064	-0.409	-0.274	-0.399	-0.422	-0.484	-0.167	-0.631	-0.367	-0.431	-0.402
Mancha	*0.036*	*0.021*	*0.023*	*0.023*	*0.043*	*0.044*	*0.078*	*0.037*	*0.021*	*0.005*	*0.016*
Catalonia	-0.005	-0.147	-0.100	0.068	-0.131	0.039	-0.774	0.154	0.010	-0.017	-0.036
	0.029	*0.017*	*0.014*	*0.010*	*0.030*	*0.042*	*0.076*	*0.034*	*0.005*	*0.005*	*0.008*
Valencian	0.040	-0.074	0.050	0.030	-0.019	0.019	-0.156	0.072	0.025	0.026	0.009
Country	*0.026*	*0.017*	*0.018*	*0.008*	*0.027*	*0.043*	*0.058*	*0.030*	*0.006*	*0.006*	*0.007*
Extremadura	-0.089	0.141	0.103	-0.078	0.170	-0.070	0.449	-0.085	0.021	-0.048	-0.034
	0.015	*0.023*	*0.013*	*0.009*	*0.048*	*0.041*	*0.111*	*0.031*	*0.004*	*0.007*	*0.006*
Galicia	-0.316	0.034	0.065	0.040	-0.037	-0.020	0.145	0.027	0.039	-0.091	-0.017
	0.061	*0.013*	*0.014*	*0.012*	*0.027*	*0.040*	*0.064*	*0.030*	*0.004*	*0.006*	*0.007*
Madrid	-0.402	-0.062	-0.068	0.099	-0.092	-0.048	-1.099	0.326	0.022	-0.033	-0.051
	0.042	*0.016*	*0.013*	*0.012*	*0.037*	*0.042*	*0.083*	*0.054*	*0.006*	*0.010*	*0.008*
Murcia	-0.355	-0.014	-0.007	0.065	0.103	0.039	0.109	-0.065	0.014	0.001	0.013
	0.052	*0.016*	*0.016*	*0.009*	*0.041*	*0.046*	*0.063*	*0.035*	*0.006*	*0.006*	*0.010*
Navarra	0.152	-0.146	-0.139	0.113	0.095	0.119	-0.226	0.173	0.018	-0.021	-0.042
	0.049	*0.017*	*0.025*	*0.010*	*0.034*	*0.040*	*0.076*	*0.032*	*0.005*	*0.006*	*0.009*
Basque	-0.171	-0.187	0.041	0.088	-0.089	0.021	-0.266	0.252	0.012	-0.036	-0.050
Country	*0.039*	*0.017*	*0.017*	*0.009*	*0.026*	*0.040*	*0.075*	*0.039*	*0.004*	*0.007*	*0.008*
La Rioja	0.288	0.026	-0.042	0.094	0.030	0.050	-0.089	0.096	0.034	-0.021	0.042
	0.033	*0.018*	*0.014*	*0.007*	*0.037*	*0.044*	*0.065*	*0.029*	*0.007*	*0.018*	*0.008*
R^2 Adjusted	0.720	0.958	0.935	0.960	0.742	0.736	0.781	0.888	0.978	0.966	0.981
rmse	0.132	0.055	0.064	0.041	0.113	0.117	0.200	0.086	0.031	0.034	0.028
N	272	272	272	272	272	272	272	272	272	272	272

Standard error is presented in italics.
Source: Own elaboration.

Table 11. LS weighted by the adjustment capacity (σ) model, estimation results. (The information that appears associated with the names of the region corresponds to the estimated fixed effects)

	A	BE	F	GI	J	K	L	MN	OQ	RU	Total
β	**0.379**	**1.362**	**1.066**	**0.846**	**0.311**	**0.926**	**2.275**	**0.149**	**1.055**	**0.751**	**1.107**
Std Err.	*0.046*	*0.022*	*0.020*	*0.022*	*0.086*	*0.051*	*0.109*	*0.056*	*0.011*	*0.013*	*0.014*
pvalue	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.000
α	**6.862**	**-3.091**	**-0.163**	**1.871**	**8.122**	**1.439**	**-9.761**	**8.758**	**-0.379**	**2.676**	**-0.601**
Std Err.	*0.418*	*0.230*	*0.199*	*0.221*	*0.911*	*0.551*	*1.097*	*0.557*	*0.113*	*0.125*	*0.138*
pvalue	0.000	0.000	0.415	0.000	0.000	0.010	0.000	0.000	0.001	0.000	0.000
Aragon	0.116	-0.069	-0.036	0.049	-0.025	-0.002	-0.430	0.010	0.034	-0.043	-0.019
	0.047	*0.016*	*0.023*	*0.011*	*0.032*	*0.040*	*0.068*	*0.028*	*0.003*	*0.008*	*0.010*
Asturias	-0.473	-0.155	-0.106	-0.002	-0.079	0.002	0.123	0.093	0.006	-0.034	-0.066
	0.026	*0.021*	*0.021*	*0.007*	*0.026*	*0.041*	*0.060*	*0.029*	*0.004*	*0.007*	*0.007*
Balearic Islands	-0.439	-0.051	-0.120	0.140	-0.040	0.015	-0.165	0.241	0.002	-0.052	0.022
	0.051	*0.016*	*0.014*	*0.023*	*0.026*	*0.040*	*0.057*	*0.030*	*0.006*	*0.017*	*0.010*
Canary Islands	-0.178	0.138	-0.040	0.097	0.288	-0.024	-0.070	0.127	0.001	0.033	0.019
	0.020	*0.021*	*0.019*	*0.017*	*0.050*	*0.043*	*0.065*	*0.032*	*0.004*	*0.010*	*0.008*
Cantabria	-0.388	-0.155	-0.002	0.053	0.197	-0.014	0.405	0.059	0.017	-0.044	-0.021
	0.026	*0.019*	*0.015*	*0.009*	*0.051*	*0.039*	*0.067*	*0.043*	*0.005*	*0.011*	*0.007*
Castilla y León	0.182	0.450	0.241	0.402	0.553	0.491	0.845	0.637	0.430	0.370	0.382
	0.034	*0.024*	*0.034*	*0.012*	*0.024*	*0.043*	*0.057*	*0.040*	*0.017*	*0.008*	*0.014*
Castilla la Mancha	-0.059	-0.409	-0.274	-0.398	-0.431	-0.485	-0.167	-0.632	-0.368	-0.431	-0.402
	0.036	*0.021*	*0.023*	*0.022*	*0.043*	*0.044*	*0.078*	*0.040*	*0.022*	*0.005*	*0.016*
Catalonia	-0.001	-0.148	-0.100	0.060	-0.154	0.039	-0.772	0.116	0.010	-0.017	-0.037
	0.029	*0.017*	*0.014*	*0.009*	*0.029*	*0.042*	*0.075*	*0.033*	*0.005*	*0.005*	*0.008*
Valencian Country	0.042	-0.074	0.050	0.027	-0.022	0.019	-0.156	0.063	0.025	0.026	0.009
	0.026	*0.017*	*0.018*	*0.008*	*0.028*	*0.043*	*0.058*	*0.032*	*0.007*	*0.006*	*0.007*
Extremadura	-0.089	0.142	0.103	-0.074	0.163	-0.070	0.449	-0.072	0.021	-0.048	-0.034
	0.015	*0.023*	*0.013*	*0.009*	*0.050*	*0.041*	*0.112*	*0.035*	*0.004*	*0.007*	*0.007*
Galicia	-0.301	0.034	0.065	0.042	-0.045	-0.021	0.145	0.023	0.039	-0.090	-0.017
	0.056	*0.013*	*0.014*	*0.011*	*0.027*	*0.040*	*0.065*	*0.032*	*0.004*	*0.006*	*0.007*
Madrid	-0.401	-0.063	-0.068	0.086	-0.129	-0.049	-1.096	0.264	0.021	-0.034	-0.052
	0.041	*0.016*	*0.012*	*0.011*	*0.035*	*0.041*	*0.082*	*0.051*	*0.005*	*0.010*	*0.007*
Murcia	-0.355	-0.014	-0.007	0.068	0.119	0.039	0.108	-0.059	0.014	0.002	0.013
	0.051	*0.016*	*0.016*	*0.009*	*0.042*	*0.046*	*0.063*	*0.039*	*0.005*	*0.007*	*0.011*
Navarra	0.154	-0.147	-0.140	0.107	0.076	0.119	-0.224	0.138	0.019	-0.022	-0.042
	0.050	*0.017*	*0.025*	*0.009*	*0.034*	*0.040*	*0.076*	*0.032*	*0.006*	*0.006*	*0.009*
Basque Country	-0.158	-0.188	0.040	0.080	-0.105	0.020	-0.264	0.202	0.013	-0.037	-0.051
	0.033	*0.017*	*0.016*	*0.008*	*0.025*	*0.040*	*0.075*	*0.038*	*0.004*	*0.007*	*0.008*
La Rioja	0.289	0.026	-0.043	0.091	0.026	0.049	-0.089	0.082	0.034	-0.021	0.042
	0.033	*0.018*	*0.014*	*0.007*	*0.036*	*0.044*	*0.065*	*0.032*	*0.007*	*0.018*	*0.008*
R^2 Adjusted	0.758	0.964	0.946	0.964	0.804	0.729	0.812	0.864	0.982	0.974	0.983
rmse	0.113	0.053	0.056	0.033	0.091	0.116	0.184	0.078	0.023	0.030	0.025
N	272	272	272	272	272	272	272	272	272	272	272

Standard error is presented in italics.
Source: Own elaboration.

Table 12. LS weighted by the size of the sector in the region model, estimation results. (The information that appears associated with the names of the region corresponds to the estimated fixed effects)

	A	BE	F	GI	J	K	L	MN	OQ	RU	Total
β	**0.557**	**1.296**	**1.045**	**0.791**	**0.463**	**0.988**	**1.683**	**0.511**	**1.066**	**0.797**	**1.097**
Std Err.	*0.060*	*0.023*	*0.025*	*0.026*	*0.122*	*0.082*	*0.138*	*0.098*	*0.020*	*0.016*	*0.016*
pvalue	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
α	**5.239**	**-2.410**	**0.048**	**2.424**	**6.513**	**0.768**	**-3.804**	**5.138**	**-0.489**	**2.234**	**-0.497**
Std Err.	*0.546*	*0.240*	*0.250*	*0.265*	*1.287*	*0.886*	*1.382*	*0.981*	*0.212*	*0.156*	*0.160*
pvalue	0.000	0.000	0.850	0.000	0.000	0.387	0.006	0.000	0.022	0.000	0.002
Aragon	0.083	-0.063	-0.045	0.056	-0.043	-0.009	-0.392	0.004	0.034	-0.046	-0.018
	0.043	*0.015*	*0.023*	*0.011*	*0.034*	*0.042*	*0.073*	*0.027*	*0.004*	*0.009*	*0.010*
Asturias	-0.545	-0.133	-0.104	0.000	-0.078	-0.004	0.123	0.087	0.006	-0.034	-0.064
	0.032	*0.020*	*0.024*	*0.008*	*0.026*	*0.043*	*0.069*	*0.030*	*0.004*	*0.008*	*0.007*
Balearic	-0.453	-0.053	-0.122	0.142	-0.049	0.005	-0.151	0.208	-0.001	-0.047	0.021
Islands	*0.062*	*0.017*	*0.016*	*0.020*	*0.028*	*0.044*	*0.059*	*0.031*	*0.006*	*0.015*	*0.010*
Canary Islands	-0.194	0.134	-0.056	0.097	0.251	-0.027	-0.131	0.142	0.002	0.034	0.019
	0.020	*0.022*	*0.019*	*0.015*	*0.056*	*0.046*	*0.066*	*0.030*	*0.004*	*0.010*	*0.008*
Cantabria	-0.466	-0.147	-0.011	0.055	0.171	-0.025	0.377	0.053	0.018	-0.048	-0.020
	0.031	*0.019*	*0.016*	*0.008*	*0.053*	*0.043*	*0.072*	*0.043*	*0.005*	*0.012*	*0.007*
Castilla y León	0.144	0.450	0.224	0.400	0.566	0.486	0.804	0.646	0.424	0.369	0.381
	0.036	*0.021*	*0.037*	*0.011*	*0.027*	*0.044*	*0.059*	*0.041*	*0.018*	*0.008*	*0.014*
Castilla la	-0.108	-0.408	-0.272	-0.393	-0.448	-0.495	-0.165	-0.633	-0.363	-0.430	-0.400
Mancha	*0.032*	*0.022*	*0.026*	*0.022*	*0.046*	*0.048*	*0.090*	*0.040*	*0.021*	*0.006*	*0.016*
Catalonia	-0.039	-0.134	-0.098	0.071	-0.176	0.034	-0.683	0.062	0.009	-0.021	-0.035
	0.027	*0.015*	*0.016*	*0.009*	*0.032*	*0.043*	*0.070*	*0.033*	*0.006*	*0.006*	*0.008*
Valencian	0.028	-0.080	0.040	0.030	-0.028	0.020	-0.164	0.056	0.027	0.025	0.010
Country	*0.024*	*0.016*	*0.018*	*0.008*	*0.029*	*0.045*	*0.065*	*0.031*	*0.007*	*0.008*	*0.007*
Extremadura	-0.084	0.131	0.103	-0.077	0.145	-0.072	0.458	-0.040	0.021	-0.047	-0.033
	0.018	*0.023*	*0.014*	*0.009*	*0.054*	*0.042*	*0.113*	*0.037*	*0.004*	*0.006*	*0.007*
Galicia	-0.424	0.031	0.065	0.044	-0.051	-0.023	0.133	0.023	0.040	-0.087	-0.017
	0.054	*0.013*	*0.016*	*0.011*	*0.028*	*0.042*	*0.070*	*0.032*	*0.004*	*0.006*	*0.007*
Madrid	-0.370	-0.052	-0.067	0.103	-0.160	-0.065	-0.943	0.179	0.022	-0.035	-0.049
	0.049	*0.016*	*0.014*	*0.011*	*0.043*	*0.043*	*0.080*	*0.053*	*0.006*	*0.009*	*0.008*
Murcia	-0.367	-0.020	-0.012	0.063	0.127	0.040	0.075	-0.045	0.012	0.003	0.011
	0.056	*0.015*	*0.018*	*0.009*	*0.047*	*0.047*	*0.070*	*0.040*	*0.006*	*0.008*	*0.010*
Navarra	0.123	-0.135	-0.161	0.116	0.043	0.114	-0.126	0.087	0.019	-0.027	-0.040
	0.047	*0.016*	*0.022*	*0.009*	*0.038*	*0.042*	*0.086*	*0.033*	*0.005*	*0.007*	*0.009*
Basque	-0.249	-0.173	0.036	0.092	-0.120	0.008	-0.166	0.125	0.013	-0.042	-0.047
Country	*0.035*	*0.017*	*0.017*	*0.009*	*0.028*	*0.044*	*0.087*	*0.039*	*0.005*	*0.008*	*0.008*
La Rioja	0.260	0.023	-0.040	0.096	0.009	0.043	-0.066	0.064	0.036	-0.031	0.043
	0.032	*0.018*	*0.016*	*0.007*	*0.035*	*0.045*	*0.065*	*0.035*	*0.007*	*0.018*	*0.008*
R^2 Adjusted	0.644	0.969	0.937	0.965	0.728	0.692	0.742	0.873	0.976	0.973	0.983
rmse	0.119	0.047	0.058	0.037	0.073	0.117	0.176	0.087	0.029	0.027	0.025
N	272	272	272	272	272	272	272	272	272	272	272

Standard error is presented in italics.
Source: Own elaboration.

Table 13. LS weighted by σ and by the size of the sector in the region model, estimation results. (The information that appears associated with the names of the region corresponds to the estimated fixed effects)

	A	BE	F	GI	J	K	L	MN	OQ	RU	Total
β	**0.487**	**1.298**	**1.055**	**0.809**	**0.608**	**1.001**	**1.696**	**0.611**	**1.054**	**0.800**	**1.101**
Std Err.	*0.049*	*0.025*	*0.023*	*0.021*	*0.121*	*0.084*	*0.140*	*0.070*	*0.012*	*0.017*	*0.014*
pvalue	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
α	**5.880**	**-2.431**	**-0.052**	**2.243**	**4.989**	**0.623**	**-3.932**	**4.151**	**-0.364**	**2.200**	**-0.533**
Std Err.	*0.445*	*0.253*	*0.235*	*0.215*	*1.279*	*0.909*	*1.402*	*0.695*	*0.126*	*0.168*	*0.138*
pvalue	0.000	0.000	0.826	0.000	0.000	0.494	0.005	0.000	0.004	0.000	0.000
Aragon	0.091	-0.063	-0.047	0.054	-0.058	-0.010	-0.393	-0.003	0.034	-0.046	-0.018
	0.044	*0.015*	*0.023*	*0.011*	*0.034*	*0.042*	*0.073*	*0.029*	*0.004*	*0.010*	*0.010*
Asturias	-0.514	-0.133	-0.106	0.000	-0.077	-0.005	0.123	0.081	0.007	-0.034	-0.064
	0.027	*0.020*	*0.024*	*0.007*	*0.027*	*0.043*	*0.069*	*0.032*	*0.004*	*0.008*	*0.007*
Balearic Islands	-0.436	-0.053	-0.122	0.140	-0.057	0.003	-0.151	0.194	0.000	-0.047	0.021
	0.059	*0.017*	*0.016*	*0.020*	*0.031*	*0.044*	*0.059*	*0.033*	*0.006*	*0.015*	*0.010*
Canary Islands	-0.187	0.134	-0.055	0.096	0.246	-0.028	-0.130	0.144	0.002	0.034	0.019
	0.019	*0.022*	*0.019*	*0.015*	*0.058*	*0.046*	*0.066*	*0.032*	*0.004*	*0.009*	*0.008*
Cantabria	-0.435	-0.147	-0.012	0.055	0.172	-0.026	0.378	0.052	0.018	-0.049	-0.021
	0.025	*0.019*	*0.016*	*0.008*	*0.053*	*0.043*	*0.073*	*0.045*	*0.005*	*0.012*	*0.007*
Castilla y León	0.152	0.451	0.225	0.399	0.576	0.486	0.805	0.648	0.424	0.369	0.381
	0.037	*0.021*	*0.038*	*0.011*	*0.028*	*0.044*	*0.059*	*0.043*	*0.017*	*0.008*	*0.014*
Castilla la Mancha	-0.095	-0.408	-0.272	-0.393	-0.457	-0.497	-0.165	-0.634	-0.363	-0.430	-0.400
	0.032	*0.022*	*0.025*	*0.021*	*0.046*	*0.048*	*0.090*	*0.042*	*0.021*	*0.006*	*0.016*
Catalonia	-0.029	-0.134	-0.099	0.068	-0.199	0.033	-0.686	0.039	0.009	-0.021	-0.036
	0.027	*0.015*	*0.016*	*0.009*	*0.031*	*0.042*	*0.070*	*0.031*	*0.005*	*0.006*	*0.008*
Valencian Country	0.032	-0.080	0.041	0.029	-0.031	0.020	-0.164	0.051	0.027	0.025	0.009
	0.024	*0.016*	*0.018*	*0.008*	*0.030*	*0.045*	*0.065*	*0.033*	*0.007*	*0.008*	*0.007*
Extremadura	-0.085	0.131	0.105	-0.075	0.138	-0.072	0.458	-0.033	0.021	-0.047	-0.033
	0.016	*0.023*	*0.015*	*0.009*	*0.056*	*0.042*	*0.113*	*0.039*	*0.004*	*0.006*	*0.007*
Galicia	-0.384	0.031	0.066	0.045	-0.059	-0.024	0.133	0.020	0.040	-0.087	-0.017
	0.051	*0.013*	*0.016*	*0.011*	*0.029*	*0.042*	*0.071*	*0.034*	*0.004*	*0.006*	*0.007*
Madrid	-0.370	-0.052	-0.069	0.098	-0.201	-0.068	-0.947	0.143	0.021	-0.035	-0.050
	0.046	*0.016*	*0.014*	*0.010*	*0.043*	*0.043*	*0.080*	*0.046*	*0.006*	*0.009*	*0.007*
Murcia	-0.366	-0.020	-0.012	0.064	0.144	0.040	0.076	-0.041	0.013	0.003	0.011
	0.054	*0.015*	*0.019*	*0.009*	*0.049*	*0.047*	*0.070*	*0.042*	*0.005*	*0.008*	*0.010*
Navarra	0.127	-0.135	-0.164	0.114	0.024	0.113	-0.128	0.067	0.019	-0.028	-0.041
	0.049	*0.016*	*0.022*	*0.009*	*0.039*	*0.042*	*0.085*	*0.031*	*0.006*	*0.007*	*0.009*
Basque Country	-0.218	-0.173	0.033	0.089	-0.136	0.006	-0.168	0.094	0.014	-0.043	-0.048
	0.031	*0.017*	*0.017*	*0.008*	*0.029*	*0.044*	*0.086*	*0.035*	*0.004*	*0.008*	*0.008*
La Rioja	0.262	0.023	-0.041	0.095	0.005	0.043	-0.066	0.055	0.036	-0.031	0.043
	0.033	*0.018*	*0.016*	*0.007*	*0.034*	*0.045*	*0.065*	*0.037*	*0.007*	*0.019*	*0.008*
R^2 Adjusted	0.694	0.971	0.947	0.966	0.750	0.684	0.756	0.867	0.980	0.976	0.985
rmse	0.100	0.046	0.051	0.032	0.055	0.116	0.172	0.073	0.023	0.026	0.023
N	272	272	272	272	272	272	272	272	272	272	272

Standard error is presented in italics.
Source: Own elaboration.

Appendix 3: GVA growth rates 2012-15

Table 14. GVA growth rate published for Barcelona, in %; 2012-2015

	2012	2013	2014	2015
B-E	-3.0	0.8	2.8	1.4
F	-23.2	-15.3	-1.7	-0.4
G-I	0.9	-0.6	-0.7	2.2
K	-4.9	-3.9	3.7	5.8
L	-3.3	-8.4	7.7	-3.0
J	4.8	3.9	-1.0	-2.3
M-N	-4.6	2.0	9.0	11.6
O-Q	-1.2	0.8	1.1	4.2
R-U	-0.4	-1.1	1.9	1.8
Total	-1.8	-0.5	1.8	3.0

Source: Technical Planning Office of the Barcelona City Council.

Table 15. GVA growth rate for Barcelona according to the econometric model with β = 1, in %; 2012-2015

	2012	2013	2014	2015
B-E	-2.0	0.0	3.3	1.5
F	-24.1	-16.9	-1.4	-0.7
G-I	0.2	0.0	-1.3	2.7
K	-6.0	-5.0	3.0	5.5
L	0.7	-9.1	3.5	-3.3
J	3.4	4.8	-1.0	-3.9
M-N	-5.1	0.3	10.2	11.3
O-Q	-2.5	0.5	0.9	5.4
R-U	-1.2	-2.2	3.0	1.7
Total	-2.5	-0.8	1.6	2.9

Source: Own elaboration.

Table 16. GVA growth rate for Barcelona according to the econometric model with β weighted, in %; 2012-2015

	2012	2013	2014	2015
B-E	-1.7	-0.3	3.8	1.6
F	-24.1	-17.0	-1.4	-0.7
G-I	0.4	-0.1	-1.2	2.6
K	-5.6	-4.9	3.2	5.6
L	0.7	-9.1	3.5	-3.3
J	2.7	5.9	-0.8	-4.9
M-N	-4.8	0.7	10.0	11.4
O-Q	-2.5	0.5	0.9	5.5
R-U	-0.9	-2.0	2.9	1.7
Total	-2.4	-0.6	1.7	2.7

Source: Own elaboration.

Table 17. GVA growth rate for Barcelona according to the econometric model with dynamic β, in %; 2012-2015

	2012	2013	2014	2015
B-E	-1.1	-0.3	3.9	1.3
F	-23.6	-17.0	-1.3	-0.9
G-I	0.6	-0.2	-1.1	2.5
K	-5.5	-4.9	3.2	5.6
L	0.6	-9.1	3.7	-3.3
J	3.2	5.7	-0.7	-4.9
M-N	-4.6	0.7	10.0	11.4
O-Q	-2.3	0.5	0.9	5.3
R-U	-0.4	-2.0	3.0	1.6
Total	-2.1	-0.7	1.7	2.6

Source: Own elaboration.

Table 18. GVA growth rate published for the AMB, in %; 2012-2015

	2012	2013	2014	2015
B-E	-4.5	0.8	5.2	3.0
F	-22.2	-14.4	-1.6	1.5
G-I	0.6	-0.3	0.0	2.5
K	-3.4	-4.4	3.5	4.9
L	-4.0	-8.0	10.1	-1.3
J	4.4	3.8	0.2	-1.2
M-N	-4.6	2.1	8.7	11.5
O-Q	-1.6	0.7	1.0	3.8
R-U	-1.7	-1.1	2.5	2.0
Total	-2.4	-0.6	2.5	3.3

Source: Technical Planning Office of the Barcelona City Council.

Table 19. GVA growth rate for the AMB according to the econometric model with β = 1, in %; 2012-2015

	2012	2013	2014	2015
B-E	-2.4	1.2	4.6	2.5
F	-22.2	-15.6	-1.8	0.8
G-I	0.0	0.1	0.5	3.2
K	-4.5	-5.1	3.3	4.5
L	0.3	-9.3	9.4	-1.5
J	4.5	5.1	-0.4	0.5
M-N	-4.7	1.3	9.3	11.4
O-Q	-2.4	0.8	0.9	4.6
R-U	-3.5	-0.9	2.7	2.2
Total	-2.5	-0.5	2.5	3.6

Source: Own elaboration.

Table 20. GVA growth rate for the AMB according to the econometric model with weighted β, in %; 2012-2015

	2012	2013	2014	2015
B-E	-1.9	1.3	5.1	2.4
F	-22.2	-15.7	-1.9	0.8
G-I	0.1	0.0	0.3	3.0
K	-4.1	-4.9	3.3	4.7
L	0.3	-9.3	9.4	-1.5
J	4.7	6.3	-0.8	1.7
M-N	-4.7	1.4	9.2	11.5
O-Q	-2.5	0.8	0.9	4.6
R-U	-3.0	-1.0	2.8	2.1
Total	-2.3	-0.3	2.4	3.7

Source: Own elaboration.

Table 21. GVA growth rate for the AMB according to the econometric model with dynamic β, in %; 2012-2015

	2012	2013	2014	2015
B-E	-1.5	1.2	5.1	2.2
F	-21.9	-15.7	-1.8	0.7
G-I	0.4	-0.1	0.4	2.9
K	-4.0	-4.9	3.4	4.7
L	0.1	-9.3	9.4	-1.5
J	5.0	6.1	-0.7	1.4
M-N	-4.6	1.4	9.3	11.5
O-Q	-2.3	0.8	0.9	4.5
R-U	-2.6	-1.1	2.9	2.0
Total	-2.1	-0.4	2.5	3.6

Source: Own elaboration.

Appendix 4: GVA in levels (millions €) 2012-15

Table 22. GVA published for Barcelona, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	4,841	4,879	5,014	5,085
F	2,460	2,084	2,049	2,041
G-I	17,870	17,768	17,641	18,026
K	4,913	4,720	4,895	5,179
L	3,323	3,043	3,278	3,181
J	9,100	9,453	9,362	9,147
M-N	7,820	7,980	8,695	9,706
O-Q	11,382	11,477	11,599	12,085
R-U	3,486	3,447	3,512	3,574
Total	65,237	64,889	66,081	68,061

Source: Technical Planning Office of the Barcelona City Council.

Table 23. GVA for Barcelona according to the econometric model with β=1, in mil. €; 2012-2015

	2012	2013	2014	2015
B-E	4,891	4,893	5,054	5,131
F	2,432	2,020	1,992	1,979
G-I	17,761	17,755	17,533	18,011
K	4,853	4,611	4,749	5,010
L	3,461	3,147	3,257	3,149
J	8,980	9,414	9,324	8,964
M-N	7,782	7,802	8,595	9,569
O-Q	11,234	11,292	11,393	12,011
R-U	3,458	3,382	3,484	3,543
Total	64,894	64,356	65,418	67,406

Source: Own elaboration.

Table 24. GVA for Barcelona according to the econometric model with weighted β, in mil. €; 2012-2015

	2012	2013	2014	2015
B-E	4,908	4,893	5,081	5,161
F	2,431	2,018	1,990	1,977
G-I	17,784	17,763	17,553	18,012
K	4,873	4,636	4,782	5,050
L	3,461	3,147	3,257	3,149
J	8,916	9,441	9,366	8,908
M-N	7,806	7,859	8,647	9,635
O-Q	11,228	11,287	11,389	12,015
R-U	3,470	3,400	3,499	3,558
Total	64,918	64,483	65,602	67,502

Source: Own elaboration.

Table 25. GVA for Barcelona according to the econometric model with dynamic β, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	4,939	4,922	5,113	5,178
F	2,447	2,030	2,004	1,987
G-I	17,831	17,801	17,601	18,041
K	4,879	4,642	4,789	5,057
L	3,456	3,142	3,259	3,150
J	8,962	9,472	9,404	8,941
M-N	7,822	7,876	8,667	9,653
O-Q	11,257	11,313	11,419	12,029
R-U	3,486	3,415	3,516	3,570
Total	65,120	64,651	65,808	67,644

Source: Own elaboration.

Table 26. GVA published for the AMB, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	11,104	11,199	11,775	12,128
F	4,544	3,891	3,829	3,887
G-I	27,879	27,809	27,801	28,503
K	6,134	5,864	6,069	6,367
L	4,926	4,532	4,990	4,926
J	12,237	12,696	12,716	12,561
M-N	10,760	10,982	11,938	13,314
O-Q	15,394	15,508	15,665	16,254
R-U	4,534	4,484	4,597	4,689
Total	97,639	97,094	99,499	102,749

Source: Technical Planning Office of the Barcelona City Council.

Table 27. GVA for the AMB according to the econometric model with β=1, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	11,350	11,486	12,014	12,320
F	4,540	3,831	3,761	3,792
G-I	27,715	27,739	27,867	28,751
K	6,065	5,756	5,946	6,216
L	5,149	4,668	5,105	5,030
J	12,251	12,877	12,827	12,890
M-N	10,749	10,892	11,905	13,267
O-Q	15,259	15,386	15,522	16,236
R-U	4,452	4,411	4,532	4,629
Total	97,657	97,174	99,599	103,251

Source: Own elaboration.

Table 28. GVA for the AMB according to the econometric model with weighted β, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	11,402	11,553	12,140	12,432
F	4,541	3,829	3,758	3,788
G-I	27,744	27,738	27,834	28,683
K	6,090	5,791	5,985	6,265
L	5,149	4,668	5,105	5,030
J	12,270	13,046	12,943	13,165
M-N	10,754	10,905	11,913	13,283
O-Q	15,253	15,382	15,516	16,237
R-U	4,474	4,429	4,554	4,652
Total	97,804	97,470	99,868	103,654

Source: Own elaboration.

Table 29. GVA for the AMB according to the econometric model with dynamic β, in millions €; 2012-2015

	2012	2013	2014	2015
B-E	11,450	11,588	12,180	12,447
F	4,560	3,845	3,777	3,803
G-I	27,824	27,801	27,907	28,719
K	6,097	5,797	5,992	6,272
L	5,139	4,661	5,100	5,024
J	12,306	13,060	12,972	13,155
M-N	10,763	10,914	11,925	13,292
O-Q	15,286	15,409	15,551	16,256
R-U	4,492	4,445	4,573	4,666
Total	98,045	97,649	100,096	103,754

Source: Own elaboration.