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Immigration, factor endowments and the productive structure of Spanish regions, 1996-2005.

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7 *Abstract.* Participation of immigrants in Spanish labour market increased from less
8 than 3 percent in 1996 to more than 13 percent in 2005. We use the factor proportion
9 model of production to examine the impact of such a large labour supply shock on the
10 industrial structure of Spanish regions. The results confirm that, first, labour
11 endowment differences across regions help to explain the regional patterns of industry
12 specialisation. Second, immigrants and natives act as complementary factors in most
13 industries. Third, the importance of immigration is relatively small compared to
14 production technique changes and idiosyncratic industry changes in explaining the
15 overall changes in industrial structure.
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25 **Key Words:** Rybczynski Effect, immigration, production specialisation, technological
26 change.
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28 **JEL:** F22, R11, R13
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7 **Inmigración, dotaciones factoriales y estructura productiva de las**
8 **regiones españolas, 1996-2005.**
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11 Guadalupe Serrano+, Francisco Requena**, Joan Martin-Montaner *
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15 *Resumen. La participación de los inmigrantes en el mercado de trabajo español*
16 *aumentó desde menos de un 3% en 1996 hasta más de un 13% en 2005. En el marco del*
17 *modelo de producción de proporciones factoriales, analizamos el impacto de este shock*
18 *de oferta de trabajo en la estructura productiva de las regiones españolas. Los*
19 *resultados apuntan que: las diferencias en las dotaciones factoriales regionales*
20 *determinan los patrones regionales de especialización industrial; los inmigrantes y los*
21 *nativos actúan como factores complementarios en muchos sectores; y en la explicación*
22 *de los cambios en la estructura productiva, la importancia de la inmigración es*
23 *relativamente pequeña comparada con la de los cambios tecnológicos y de las*
24 *características idiosincrásicas sectoriales.*
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1. INTRODUCTION

Large migration flows can be viewed as labour supply shocks which affect the relative factor endowments in both the source and the host economy. If the skill endowments of migrant workers strongly differ from those of native workers in the host countries, then it is likely that the factor intensities in different sectors may be affected. This could be one explanation for the observed differences in wages of more-skilled relative to less-skilled workers in the developed countries over the nineties (Davis and Reeve, 2004). This migratory phenomenon may also induce (or prevent) technological adjustments, as the adoption of new capital-intensive technologies could be delayed when low-skilled labour is a relative abundant factor (Lewis, 2004; Gandal et al., 2004).

In this paper we analyse the impact of immigration on Spanish regions' industrial compositions by quantifying the extent to which the rise of the immigrant labour force has caused a shift in the industrial specialisation pattern of the regional economies. To do so, we adopt a general equilibrium approach –the factor proportions model of production– to explain up to which point changes in industrial structure of economies are driven by shifts in factor endowments, with independence of those specific changes happening in each industry.¹ This approach was popularised by Harrigan (1995) as an empirical tool for investigating the shifts in production composition in an economy over time. Harrigan found that relative factor endowments had a large influence on industrial specialisation across OECD countries over the period 1970-1985.² Bernstein and Weinstein (2002) evaluate the prediction capacity of the standard factor proportions theory using both regional and international data. They observed that prediction errors using intra-national data were much larger than using international data and concluded that the standard factor proportions model of

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7 production does a poor job of explaining production patterns at regional level. Redding
8 and Vera-Martin (2006) analyse the regional pattern of output specialisation in Europe
9 and find that it is necessary to account for technological differences and price
10 differences across countries in the standard factor proportion model to predict
11 accurately the pattern of industrial specialisation of the European regions. Based on
12 previous research we adopt the standard factor proportion model of production in our
13 analysis of the pattern of specialization of Spanish regions and check for technological
14 and price differences across regions.
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26 A novelty of the paper is the incorporation of immigrants as an additional
27 production factor. The underlying assumption is that immigrants and native workers are
28 imperfect substitutes. Recent papers by Carrasco et al. (2008), Izquierdo et al. (2009)
29 and De la Rica and Dorantes (2009) provide empirical support in the case of Spain. First,
30 there is evidence of important occupational segregation, in line with the popular idea
31 that immigrants are employed in jobs that native workers do not want. Second, there are
32 important institutional barriers (such as the existence of regional languages and the need
33 for public recognition of the educational degree) that limit the access of foreign workers
34 to be employed in certain jobs (professional services with a university degree, jobs in
35 the public sector). Third, the arrival of immigrants is recent and has occurred very
36 quickly so there has been insufficient time for complete assimilation. The foreign labour
37 force in Spain increased from 2.7% of the total labour force in 1996 to an astonishing
38 13.3% in 2005. The existence of important institutional barriers, the lack of sufficient
39 time for cultural assimilation and the fact that there are vacancies which require skills
40 that foreign workers have, are three reasons that explain why immigrant workers with
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7 the same level of education as their native colleagues are not being employed in the
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9 same occupations.
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11 Finally, and despite the strong efforts made by both private and public agents to
12 increase the level of R&D expenditures, the adoption of new technologies in certain
13 manufacturing and services activities in Spain has been slow compared to other
14 European countries (OECD, 2005). A plausible reason is the type of technologies
15 required to accommodate the new inflows of workers in sectors that use the new
16 production factor more intensively. Therefore, knowing whether production in each
17 sector varies because of changes in endowments or because of the adoption of new
18 technologies becomes a key point in the analysis.
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31 The rest of the paper is structured as follows. First, we formalise the production
32 side of the factor proportions model and its extensions to accommodate differences in
33 prices and technology across regions. Second, we present the data and describe the
34 evolution of the foreign and native labour force in the period 1996-2005. Third, we
35 estimate the model using different levels of regional and sectoral aggregation and
36 interpret the Rybczynski coefficients. Fourth, we allow the Rybczynski coefficients to
37 change over time and assess the relative importance of changes in factor endowments
38 and changes in production techniques in explaining changes in industrial specialisation.
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49 Finally, we summarize our results in the conclusions section.
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54 2. THE PRODUCTION SIDE OF THE FACTOR PROPORTIONS MODEL

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57 In this section we describe the factor endowment production function, originally
58 proposed by Harrigan (1995) and extended recently by Harrigan and Zakrajšek (2000),
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7 Reeve (2006) and Redding and Vera-Martín (2006) to accommodate differences in
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10 technology and factor prices across countries and regions.

11 12 13 14 2.1. Theoretical foundations

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16 The core insight of the factor proportions model is that regions tend to produce
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18 relatively more of those goods that intensively use the factors of production that the
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20 region has in abundance. Thus, relative factor endowments become the determinant of
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22 industrial structure and the source of comparative advantage.
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26 Under constant-returns-to-scale technology and perfect competition in goods and
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28 factor markets, a country's national product is given by its revenue function
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30 $\Pi(P, V) = \max_Y \{PY | Y \in \mathbf{Y}(V)\}$ where P is an $(N \times 1)$ vector of goods prices, V is an $(M$
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32 $\times 1)$ vector of inelastic factor supplies, Y is an $(N \times 1)$ vector of net outputs, and
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34 $\mathbf{Y}(V)$ is a compact production set. Assuming $\Pi(P, V)$ is twice continuously
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36 differentiable, the gradient with respect to P gives the net supply vector, $Y = \Pi_p(P, V)$.
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40 Differentiating again with respect to factor supplies gives the matrix of Rybczynski
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42 derivatives, $R = \Pi_{pV}(P, V)$. Since the supply function is homogeneous of degree one in
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44 V ,

$$45 \quad Y = RV \quad (1)$$

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47 and net output is a linear function of factor endowments.³
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51 The underlying condition that allows the R matrix to be identical across regions
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53 and thus equation (1) to be used as a model of interregional location of production is
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55 that regions must be able to produce the same set of goods with the same techniques.
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60 Producing the same set of goods requires relative factor endowments not to be "too"

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7 dissimilar across regions.⁴ The fact that regions use the same techniques of production
8 depends on common technologies and factor prices. Good prices will be equalized
9 across regions with free trade and zero transport costs. A crucial condition for factor
10 price equalization is that the number of goods exceeds the number of factors, $N \geq M$.
11 However, in order for the supply function to be singly-valued, there must be at least as
12 many factors as goods, $M \geq N$. Thus, what is left is the “square” model in which there
13 are equal numbers of goods and factors, $N = M$. In this case, equation (1) holds for each
14 region and forms the basis for the empirical work to follow. Obviously there are more
15 goods than factors and therefore there does not exist a unique mapping between factor
16 endowments and production. Nevertheless, the existence of a structural relationship
17 between factor endowments and production is all that really matters for the present
18 analysis.⁵

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36 A final point is that the use of a general equilibrium relationship between
37 production structure, relative prices, technology and factor endowments holds
38 irrespective of the degree of factor mobility.⁶

42 43 44 45 *2.2 Empirical model.*

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Equation (1) can be rewritten for each industry in each year with an additive
error term as

$$Y_{ct}^i = v_{ct} R_t^i + \varepsilon_{ct}^i \quad (2)$$

Here, Y_{ct}^i is region c 's value added in industry i in year t and v_{ct} is region c 's $(1 \times M)$
vector of factor endowments in year t . The $(M \times 1)$ vector R_t^i represents the factor

proportions mapping from endowments to outputs for industry i . Collecting observations across regions and years, we get:

$$Y^i = V R^i + \varepsilon^i \quad (3)$$

for industry i . Now, Y_i and ε_i are $(C \times T \times 1)$ vectors and V is the $(C \times T \times M)$ endowment matrix.

Rather than estimating each equation individually, a multivariate regression model is built in such a way that each equation represents equation (3) for a particular industry i .

$$\begin{bmatrix} Y^1 \\ \vdots \\ Y^i \end{bmatrix} = \begin{bmatrix} V R^1 \\ \vdots \\ V R^i \end{bmatrix} + \begin{bmatrix} \varepsilon^1 \\ \vdots \\ \varepsilon^i \end{bmatrix} \quad (4)$$

The main advantage of this approach is the ability to test homogeneity hypotheses across equations, i.e. across industrial branches belonging to the same sector. Moreover, since it is likely that the disturbances across equations are correlated, the multivariate approach may lead to efficiency gains and account for inter-industry externalities, an issue that has not been addressed in previous studies.

Next we allow for a more flexible specification that relaxes the assumptions on identical prices and technology among regions. In order to do so the model becomes (4a).

$$\begin{bmatrix} Y^1 \\ \vdots \\ Y^i \end{bmatrix} = \begin{bmatrix} V R^1 \\ \vdots \\ V R^i \end{bmatrix} + \begin{bmatrix} D_\tau \phi_\tau^1 \\ \vdots \\ D_\tau \phi_\tau^i \end{bmatrix} + \begin{bmatrix} \varepsilon^1 \\ \vdots \\ \varepsilon^i \end{bmatrix} \quad (4a)$$

Where τ refers to “periods of time”: the 1996-2000 period of low immigration in Spanish regions and the 2001-2005 period of high immigration in Spain. Here, D_τ

captures any industry-specific impact of changes in prices and technology over the period τ .

The model can also be extended to accommodate time-invariant regional differences in relative prices and technology, by adding a time-invariant regional fixed effect, D_Z , with dimension $[(C \times T) \times Z]$, and its correspondent vector of $[Z \times 1]$ parameters, ϕ_Z , where C denotes the spatial dimension of the data that we are using – NUTS-2 Spanish Autonomous Communities or NUTS-3 Spanish provinces – while Z always is referred to NUTS-II Spanish Autonomous Communities.⁷ This is illustrated in model (4b).

$$\begin{bmatrix} Y^1 \\ \vdots \\ Y^i \end{bmatrix} = \begin{bmatrix} V & R^1 \\ \vdots \\ V & R^i \end{bmatrix} + \begin{bmatrix} D_\tau \phi_\tau^1 \\ \vdots \\ D_\tau \phi_\tau^i \end{bmatrix} + \begin{bmatrix} D_Z \phi_Z^1 \\ \vdots \\ D_Z \phi_Z^i \end{bmatrix} + \begin{bmatrix} \varepsilon^1 \\ \vdots \\ \varepsilon^i \end{bmatrix} \quad (4b)$$

A final extension consists on allowing region-specific differences in prices and technology to vary over time, by including a set of region-time dummy variables, $D_{Z\tau}$, with dimension $[(C \times T) \times (Z \times 2)]$, and its correspondent vector of $[(Z \times 2) \times 1]$ parameters, $\phi_{Z\tau}$, as shown in model (4c).

$$\begin{bmatrix} Y^1 \\ \vdots \\ Y^i \end{bmatrix} = \begin{bmatrix} V & R^1 \\ \vdots \\ V & R^i \end{bmatrix} + \begin{bmatrix} D_\tau \phi_\tau^1 \\ \vdots \\ D_\tau \phi_\tau^i \end{bmatrix} + \begin{bmatrix} D_{Z\tau} \phi_{Z\tau}^1 \\ \vdots \\ D_{Z\tau} \phi_{Z\tau}^i \end{bmatrix} + \begin{bmatrix} \varepsilon^1 \\ \vdots \\ \varepsilon^i \end{bmatrix} \quad (4c)$$

We estimate equations (4a), 4(b) and (4c) and test for the best specification using different geographic units and levels of industry aggregation.

3. DATA.

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7 The dependent variable in our study is annual production by geographical unit
8 and industry. Industry's output is measured by means of sector GVA (gross value
9 added) at current basic prices from the homogeneous series of INE's *Regional Accounts*
10 *base year 2000*. The database provides regional value added at two different
11 geographical levels: 17 regions (NUTS-2)⁸ which can be disaggregated into 52
12 provinces (NUTS-3). The number of industries varies depending on the level of
13 geographical aggregation. There are 21 sectors (S-21) for NUTS-2, which are grouped
14 into 5 sectors (S-5) for NUTS-3: Agriculture, Energy, Manufacturing, Building and
15 Services. Table A-1 in the Appendix displays the correspondence between S-21 and S-5.
16 The period of analysis is 1996-2005.

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31 Endowment data includes three primary factors: arable land, capital stock and
32 labour. Labour is split into native and foreign workers and into three educational
33 categories: low, medium, and high-educated workers, to account for differences in
34 human capital in the labour force. Data on arable land is provided by INE's *Statistical*
35 *Yearbook of Spain* and data on capital stock is provided by the BBVA Foundation and
36 IVIE (<http://www.ivie.es/banco/stock2.php>). Labour endowments come from INE's
37 Economically Active Population Survey (EPA, 2005 methodology). Low-educated
38 workers include illiterates and workers with only primary education. Medium-educated
39 workers have completed secondary school. High-educated workers have at least
40 enrolled in a high education degree. The Appendix provides a detailed explanation of
41 the construction of the variables.

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57 (Insert Table 1 approximately here)

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59 Immigrants increased their participation in the Spanish labour market from less
60 than 3 percent in 1996 to more than 13 percent in 2005. Table 1 shows that the newly

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7 arrived foreign population possesses a different composition of education levels
8 compared to natives. Over the period 1996-2005, the percentage of natives decreased
9 among low-educated actives and increased among high-educated actives; meanwhile the
10 percentage of immigrants among low-educated actives stayed the same and decreased
11 among high educated actives. Skill-upgrading within the immigrant group occurred only
12 at the medium-educated level in which the share of immigrants increased by 4 percent
13 from 1996 to 2005. Table 1 also shows that the foreign labour force is more
14 heterogeneously distributed across Spanish provinces than across regions. Moreover, by
15 education level, high-educated foreign actives are the most heterogeneously distributed
16 across regions.
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33 Figure 1 shows the map of Spain where NUTS-3 provinces (left map) and NUTS
34 2 regions (right map) are coloured according to their share of foreign-born workers
35 within the total labour force in year 2005. While all but three provinces in 1996 have a
36 share of foreign-born workers below 6 percent, in 2005 there were 15 provinces with
37 shares above 13 percent. At NUTS-2 level (regions), Madrid, Baleares, Murcia,
38 Comunidad Valenciana and Canarias contain a share of foreign actives higher than 18
39 percent. The highest concentration can be found, at NUTS 3 level (province), in
40 Alicante, Almeria, Baleares, Castellon, Gerona and Madrid, which exhibit shares of
41 foreign activity that range between 20 and 30 percent. As shown in Figure 2, medium-
42 educated workers are the dominant education category among both native and foreign
43 actives in all the regional units. Finally Figure 3 shows that the sectors that employ
44 more foreign workers are *Agriculture, Building and Services* (mostly *Trade and Hotels*
45 and *Household Services*). Additionally, the distribution of natives and immigrants is
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7 slightly different across sectors. The share of native workers in *Industry* is larger than in
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9 *Building*, while the opposite holds for immigrant workers. Only in *Agriculture* both
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11 types of workers are almost equally distributed.
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14 (Insert Figure 2 approximately here)
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17 (Insert Figure 3 approximately here)
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19 20 21 4. MODEL SPECIFICATION AND ESTIMATION 22

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24 We conduct the analysis from the two different data-sets referring to different
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26 geographic units in the Spanish economy. As we can also aggregate Spanish provinces
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28 from NUTS-3 to NUTS-2, we can perform our analysis both for S-5 and S-21
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30 classifications. This latter possibility allows us to explore differences in the estimates
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32 due to different levels of spatial and industrial aggregation.⁹
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35 Models (4a)-(4c) are estimated considering the eight productive factors
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37 described in the previous section. When data correspond to S-5 disaggregation, we
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39 estimate two five-equation SUR models both for provincial and regional data.¹⁰
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41 Nevertheless, computational capabilities do not allow the estimation of a 21-equation
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43 SUR model. Because of this, we estimate a single equation model for *Agriculture* and
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45 *Building* whereas SUR specifications are estimated for *Energy* (two equations), *Industry*
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47 (ten equations) and *Services* (seven equations).
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53 Through the analysis, sector Gross Value Added (GVA) for each region and the
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55 regional gross capital stock are measured in current prices. To control scale effects due
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57 to differences in the size of region, sectoral outputs and regional inputs are expressed in
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59 relative terms with respect to regional GDP, which is measured in current prices.
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Moreover, to avoid heteroskedasticity problems in each equation, we specify a SUR

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7 model with weighted equations, in which each weight is obtained from the equation's
8 robust estimation. Then, the estimates of the cross-equation covariance matrix are based
9 upon GLS parameter estimates of the weighted system.
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14 We start selecting the best model specification. Table 2 reports the mean
15 absolute percent errors (MAPE) by industry and regional units for the models (4a), (4b)
16 and (4c) in columns (ii), (iv) and (v) respectively.¹¹ As a crude benchmark for
17 comparison, these percent errors are contrasted with those based on the estimation of
18 relative production using the cross-sectional mean. This naïve estimator in the
19 estimation without dummy variables, column (i), has an overall mean absolute percent
20 error of 66.5 and 66.4 percent for provinces and for regions, respectively; that is 30
21 percentage points larger than the average error based on the factor proportions model. In
22 addition, the naïve estimator percent error is larger than the overall mean absolute
23 percent error in all sectors.¹²
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38 As was expected, the factor proportion model of production performs better at a
39 regional level (NUTS-2) than at a province level (NUTS-3). Thus, in the estimation
40 without regional dummies, column (i), the MAPE is 35.3 percent for provinces higher
41 than the one in the specification for regions (27.2 percent). Following the same trend,
42 the MAPE is smaller across regions than across provinces in those models including
43 time and regional dummies. Our results contrast with those of Bernstein and Weinstein
44 (2002), which report a MAPE of 310 percent using data on Japanese regions. More
45 striking is the fact that our largest MAPE, 35.3 percent in the provincial model without
46 dummies, is smaller than any other percent error reported by papers using international
47 data.¹³
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(Insert Table 2 approximately here)

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7 Table 2 also reports an LR test for the global significance of estimates and the
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9 AIC criterion for model selection. According to this last criterion, the better
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11 specification is (4c) in both S-5 and S-21 cases. This specification, which corresponds
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13 to an augmented factor proportion model of production, is such that regional dummies
14
15 capture differences in technology and prices that are not permanent but change over
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17 time. This conclusion is confirmed by three additional tests. First, we always reject the
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19 null hypothesis that the coefficients of the regional dummies are zero. Second, we reject
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21 the homogeneity of regional effects obtaining evidence supporting the fixed effects
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23 model specification. Finally, we test whether the coefficients for the regional dummy
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25 variables are constant over time (model 4b vs 4c), being that the hypothesis is always
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27 rejected.
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33 Finally, we analyse the validity of the SUR specification by testing the null
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35 hypothesis of no correlation of the residuals between equations independently
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37 estimated. The results of the Breusch-Pagan test do reject the null hypothesis,
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39 confirming the adequacy of the SUR estimation of the model (being the exception
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41 *Energy* in the specifications (i) and (ii) with 21 sectors).
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45 The analysis of the MAPE obtained in the S-5 model and in the S-21 model
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47 shows negligible differences, which does not support the idea that production
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49 indeterminacy is mainly due to the fact that the number of goods is larger than the
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51 number of factors. We perform a last test to choose between S-5 (Table A-2 in the
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53 Appendix) and S-21 (Table A-3 in the Appendix) using regional level data. Using the S-
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55 5 and S-21 sectoral correspondence in Table A-1 in the Appendix, we test the equality
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57 of Rybczynski parameters across those S-21 branches belonging to the same S-5 sector.
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59 The test results displayed in the last row of Table A-2 for model (4c), which includes
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7 time-varying regional dummy variables, show that the equality of Rybczynski
8 coefficients is rejected for branches belonging to *Energy*, *Industry* and *Services*.
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10 Because of that, we selected model (4c) using regional data (NUTS 2) and 21 sectors as
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12 our best specification. Estimates are displayed in Table A-3 and the findings are
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14 explained in the next section.
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22 5. IMMIGRATION IN THE FACTOR PROPORTION MODEL OF PRODUCTION.

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24 In this section we use the Rybczynski coefficients to investigate the impact of
25 immigration on the production structure of Spanish regions. The sign and significance
26 of the coefficients can be interpreted in terms of comparative advantage (Leamer, 1984).
27
28 Profit-maximizing firms adapt to changes in relative endowments, according to the
29 differences in benefits that can be drawn from an increase in the endowment of each
30 factor. Thus, productive factors are reallocated across sectors and that reallocation
31 might imply increases and reductions of production depending on the sector. Therefore,
32 a positive sign for the corresponding Rybczynski coefficient means that the increase in
33 one region's endowment of a certain factor translates into an increase in production in
34 that sector (or, in other words, represents a source of comparative advantage), whereas a
35 negative sign means that the accumulation of that factor leads to a reduction of the
36 production of the sector (representing, therefore, a comparative disadvantage).¹⁴ Table 3
37 reports the beta coefficient estimates. Beta coefficients indicate the relevance of the
38 explanatory variable in the regression, since they measure the expected change in the
39 standardised dependent variable induced by a unitary change in the standardised
40 independent variable, which is conditional on the other standardised regressors.¹⁵
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The coefficient on capital is significant in most sectors, although only displays a positive sign in branches 3 (*Electricity, gas and water*), 4 (*Food, drink and tobacco*), 14 (*Building*), 19 (*Renting and business services*) and 20 (*Education, health and other services*). The coefficient on land is also significant in most branches, playing a positive impact in branch 1 (*Agriculture*), 6 (*Wood Products*), 14 (*Building*), 18 (*Financial Services*), 19 (*Renting and business services*) and 20 (*Education, health and other services*). With regard to the native labour force, the coefficient on medium-educated workers appears to be positive and significant in most sectors (17 branches out of 21). For high-educated workers the coefficient is positive and significant in *Energy* and *Services* branches, whereas for low-educated workers the coefficient exhibits mixed signs across sectors.

With regard to immigrants, our results display a high degree of heterogeneity in terms of significance. The coefficient on medium-skilled immigrants is significant in 14 branches (in most cases negative), whereas for high-skilled immigrants it shows a statistically significant coefficient only in 6 branches. Low-skilled immigrants are in an intermediate position, with a statistically significant coefficient in 9 branches, most of them in the *Industry* sector. The significant, unexpected absence of less-skilled immigrants in *Agriculture* and *Building* can be explained by the fact that our data do not include undocumented workers which would likely enlarge the amount of foreign workers in that sector. Another striking result comes from the *Industry* sectors, where the impact of low and medium-educated foreign workers is negative in all its branches. This negative impact can be interpreted as foreign workers constituting a source of comparative disadvantage. This could explain both the small number of overall

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7 immigrants in *Industry* and the fact that they tend to be medium-level educated (some
8 qualifications are required, but not as many as to require high-qualified workers).
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11 We analyse next the kind of relationship, if any, that exists between foreign and
12 native workers. Table 4 shows the results of testing the equality of the parameters for
13 native and immigrant workers at different skill levels. The results are mixed. The
14 hypothesis of equal parameters for high-qualified workers is only rejected in two cases:
15 sectors 7 (*Paper and printing*) and 13 (*Miscellaneous*). This is not surprising as the
16 coefficients of both native and foreign high-qualified workers are the only significant
17 ones in these two sectors. The equality of the parameters for medium-qualified workers
18 is rejected in all the cases in which both native and foreign workers exhibit statistically
19 significant coefficients (sectors 1, 2, 4, 5, 6, 7, 10, 13, 15 and 17) and it is not rejected in
20 two cases: 3 (*Electricity, gas and water*) and 20 (*Education, health and other services*).
21 In these two cases the coefficient of both types of workers is positive. Finally, in the
22 case of low-qualified workers, equality is only rejected in three sectors: branches 4
23 (*Food, drink and tobacco*), 9 (*Plastic and Rubber*) and 10 (*Metal industries and non-*
24 *metallic products*).
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48 In general, it can be observed that the coefficient on immigrant workers is not
49 significant unless the coefficient on native workers is also significant. We observe that
50 only in 9 out of 63 cases the coefficient for a type of immigrant worker is statistically
51 significant when the coefficient of the native counterpart is not statistically significant.
52 This outcome is partly explained by the high standard errors in the estimated
53 coefficients associated with the immigrant worker variables (see Tables A-2 and A-3).
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60 Given the asymmetry of estimated effects for native and foreign workers in most sectors,

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7 it is not possible to point to any accumulation or compensation effect of foreign workers
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9 relative to native ones, but there is a sort of interrelation between both types of labour,
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11 especially for medium-qualified workers.
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14 15 16 6. FACTOR ACCUMULATION AND INDUSTRIAL STRUCTURE CHANGES 17 18 FROM 1996 TO 2005 19

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21 Although factor endowments have been proved to be significant in determining
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23 the value added for the different sectors, changes in the productive structure can also be
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25 caused by both changes in the level of those endowments or in the way they are
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27 combined to produce. In order to incorporate the possibility of changes in production
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29 techniques, we need to test the stability of the Rybczynski parameters over the period
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31 analysed. Table 3 reports the Wald test statistics for the null hypothesis of equality of
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33 coefficient estimates for the periods of 1996-2000 and 2001-2005. The null hypothesis
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35 of constant coefficients can be rejected at standard levels of significance in all the cases.
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37 Therefore changes in the techniques of production over the entire period 1996-2005
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39 could be an important source of change in industrial structure.
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45 In order to identify the relative importance of the forces acting on production
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47 structures, the estimation results from Equation (4) can be used to decompose the
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49 change in output from $t-n$ to t as:
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$$52 \quad Y_i^t - Y_i^{t-n} = (V^t - V^{t-n})\hat{R}_i + \bar{V}(\hat{R}_i^t - \hat{R}_i^{t-n}) + (\hat{\varepsilon}_i^t - \hat{\varepsilon}_i^{t-n}) \quad (5)$$

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54
55 where \bar{V} is the average value of factor endowments in years t and $t-n$, and \hat{R}_i is the
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57 average estimated coefficient matrix in periods t and $t-n$ for industry i . The first term,
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59 $\Delta_n V \hat{R}_i$ captures the contribution of changes in factor endowments, holding fixed \hat{R}_i ,
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7 the estimated techniques of production. The Rybczynski theorem characterises how
8 output responds to changes in endowments at fixed prices and technology, i.e. at fixed
9 techniques of production. Hence, the term $\Delta_n V \hat{R}_i$ can also be interpreted as the
10 Rybczynski effect. The second term in Equation (5), $\bar{V} \Delta_n \hat{R}_i$, is the effect that changes
11 in production techniques have on shifts in production, holding fixed endowments. Here,
12 “technique” refers to factor usage which depends on technology (i.e. the production
13 function) as well as relative factor prices.¹⁶ The final term, $\Delta_n \hat{\varepsilon}_i$, is the difference in the
14 residuals.
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28 Table 5 shows the decomposition analysis in equation (5) used to determine the
29 percentage contribution of changes in factor endowments and technology to variations
30 in value added between 1996-2000 and 2001-2005. The values reported are the
31 percentage contributions of the terms in equation (5), expressed as cross-country
32 averages.¹⁷ The overall contribution of factor accumulation, across all industries and
33 years, is about 7.2 percent. Changes in the techniques of production contribute about
34 47.5 percent. The residual term comprises the remaining 45.4 percent. In general terms,
35 these results give little room for changes in factor endowments to play a relevant role. In
36 fact, they factor endowments are the dominant source of change only in the case of
37 branch 14 (*Building*), and represent more than 10 percent in branches 20 (*Education,*
38 *health and other services*) and 21 (*Household services*). Nevertheless, changes in
39 techniques appear to have contributed more in most cases, followed by the region-
40 specific changes of each sector which are included in the residual term.
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The residual term in Table 5 represents a high share of the change in sector output in most cases. This term includes all regional issues beyond technology and endowments which may affect the regional value added per sector. In order to reduce this residual term and put on the front some of these regional issues, an alternative decomposition has been attempted.

In our estimates, we controlled scale effects due to differences in the size of the region by expressing sectoral output and regional inputs in relative terms with respect to regional GDP. Therefore model (2) can be rewritten for each industry in each year

as $\frac{Y_{ct}^i}{Q_{ct}} = v_{ct} \frac{R_t^i}{Q_{ct}} + \varepsilon_{ct}^i$, where Q_{ct} is the aggregate region c output. Following the same

methodology as in (5), we decompose the change in output from $t-n$ to t as:

$$Y_i^t - Y_i^{t-n} = (V^t - V^{t-n}) \hat{R}_i + \bar{V} (\hat{R}_i^t - \hat{R}_i^{t-n}) + (Q^t - Q^{t-n}) \hat{\varepsilon}_i + (\hat{\varepsilon}_i^t - \hat{\varepsilon}_i^{t-n}) \quad (6)$$

The new term, $\Delta_n Q \hat{\varepsilon}_i$, stands for a regional effect that captures the contribution of changes in regions' relative relevance (in regions' scale) on shifts in sector production.

As shown in Table 6, the scale effect is relevant. All three initial effects are smaller than in Table 5, although the mean for the technological effect and the residual are those which decrease more. Once the scale effect is taken into account, the factor endowment effects in *Building* becomes smaller (accounting for just a 10.4% of total VAB variation), whereas it becomes more important in the case of *Mechanical Machinery and Electric and Electronic Equipment* and *Transport Equipment* and, even more so, in *Wood Products*. Finally, the "regional scale effect" represents a high share in the total variation in value added in the case of *Chemical Products, Reparation and*

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7 *Commerce, Hotels and Transport and Communication Services*, whereas it is negligible
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9 for other service activities such as *Financial Services, Renting and Business Services,*
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11 *Education and Health* and *Household Services*.
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14 (Insert Table 6 approximately here)
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18 19 7. FINAL REMARKS. 20

21 This paper provides the first evidence of the impact of immigration in the pattern
22 of production specialisation across Spanish regions in the period 1996-2005. The extent
23 to which an increase in the immigrant labour force could induce shifts in the industrial
24 structure of regional economies is also quantified. Based on the factor proportions
25 model of international trade, foreign and native labour force are introduced as two
26 separate inputs in an augmented supply production function to estimate how much
27 sectoral output varies with changes in factor endowments (the so-called Rybczynski
28 coefficients).
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40 The results show that both the effects of factor endowments and specific time-
41 varying regional characteristics in each industry appear to be important in understanding
42 industrial structure. While a higher spatial disaggregation reveals a production
43 indeterminacy problem and a poor performance of the model, the higher sector
44 disaggregation does not seem to generate this indeterminacy problem.
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52 Our first finding is that the data reject the hypothesis of equality in the impact of
53 native and foreign labour by educational type on industrial shares across Spanish
54 regions. This result holds even when we examine those sectors in which the Rybczynski
55 coefficients for natives and immigrants have the same sign. This can be interpreted that
56 natives and immigrants are not perfect substitutes in the production function.
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7 In terms of the impact of factor endowments and its role as a source of
8 comparative advantage across industries within Spain, the results point to a small effect
9 caused by the presence of foreign workers. Only medium-educated foreign workers
10 present a statistically significant impact in most of the sectors, whereas the impact of
11 low and high-educated foreign workers appears to differ from zero in less than half of
12 the branches considered.
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21 If we connect these results to those showing complementarities between native
22 and foreign labour, we can conclude that the presence of immigrants never implies the
23 leaving of native workers from a sector, as shown by the fact that immigrant work is
24 never statistically significant without native work also being so. In general, results
25 suggest a sort of complementarity between natives and immigrants at the different
26 levels of qualification, especially among the medium-educated workers.
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35 To conclude, factor accumulation has tended to be the least important gross
36 force acting on production. In contrast, shifts in the national techniques of production
37 have been the more relevant source of changes in relative outputs in Spanish regions.
38 That immigration has been one of the most important sources of change in factor
39 endowments in Spain in recent years, a strong conclusion stems from our results:
40 although immigration has changed the factor endowment mix across Spanish regions, it
41 has had little impact on the changes observed in the industrial structure in Spain
42 between 1996 and 2005.
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9 2008/04059/ECON) is acknowledged. Francisco Requena is member of PROMETEO
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11 (program Generalitat Valenciana PROMETEO/2009/098). A previous version of this
12
13 research is in the IVIE's EC series Working Papers (WP-EC 2009-01)
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18 APPENDIX.

19 *Data sources and variable computations.*

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22 Data on Gross Value Added (GVA) have been obtained from INE's Spanish
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24 Regional Accounts Base-year 2000 information (www.ine.es). We use 1996-2005
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26 homogenous information on current GVA, both for Spanish provinces (NUTS-3) and
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28 regions (NUTS-2), for 5 aggregated production sectors (S-5). Data on current GVA for
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30 25 production branches is only available from the year 2000 onwards. Because of this,
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32 the need for estimating homogeneous information on current GVA for activity branches
33
34 implied the reduction of activity branches considered to 21 (S-21). See Table A1.

35
36 We obtain the current GVA of the 21 branches (S-21) from the period 1996-
37
38 1999, splitting the S-5 current GVA data, by using sector shares from information from
39
40 INE's Spanish Regional Accounts Base-year 1995 data, once those shares have been
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42 corrected according to Base 2000 database revision. The main problem with sector
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44 branch classification in current Euros is found in the services sector. While the Base-
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46 year 1995 database distinguishes between market and non-market service branches, the
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48 Base-year 2000 database does not distinguish the non-market services. Then, in order to
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50 reduce branch share differentials among both databases, we considered an aggregated
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52 "Education health, public administration and other services" branch which is obtained
53
54 as a rest.

(Insert Table A-1 approximately here)

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56 We use data from INE's Economically Active Population Survey (EPA, 2005
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58 methodology) to measure native and foreign labour endowments. We use data on the
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60 second quarter of each year from 1996 to 2005, given its possibility of actualization
using the new 2005 methodology, which is adopted explicitly to account for the large

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7 wave of immigrants that arrived in Spain from the second half of the nineties. In order
8 to extrapolate population data from sample data, the EPA compute an “elevation factor”
9 variable (so-called ‘facele’) from the 2001 population census data. The elevation factor
10 captures the representativeness of each individual in the EPA sample in the total
11 population. The use of the 2005 EPA methodology over the period 1996-2005 is
12 especially relevant for our immigrants’ population database because the INE considers
13 that, due to the unexpected fast increase of such population in Spain, the elevation
14 factor, computed using the previous population census (1991), severely underestimates
15 the immigrant population within the total Spanish population.
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18 Data on arable land is provided by INE’s *Statistical yearbook of Spain* and
19 interpolated when a specific year is missing. Finally data on the gross capital stock in
20 current Euros is obtained from estimations provided by the BBVA Foundation and IVIE.
21 Concretely, we use the gross capital stock in current Euros for the period 1995-2005,
22 which is valued at restoration prices.
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34 *Additional Tables.*

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36 (Insert Table A-2 approximately here)

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38 (Insert Table A-3 approximately here)
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46 NOTES

47 ¹ The key assumption for the present analysis is the existence of a structural relationship
48 between factor endowments and outputs, but for our purposes, we do not need to go
49 further into testing the factor proportion model’s assumptions against alternatives or
50 address any of its critics. Thus, the factor proportion model is a good theoretical
51 framework to base our analysis on.
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² Harrigan's conclusions are shown to be robust to alternative model specifications and estimation techniques by Harrigan (1999), Harrigan and Zakrajšek (2000) and Reeve (2006).

³ Equation (1) can also be derived in a monopolistic competition model with increasing returns to scale (see Harrigan, 1995). The assumption of constant returns to scale is supported by the work by Goerlich and Orts (1994) in the case of Spain.

⁴ Regions will produce a different set of goods in the case of "lumpiness" (i.e. an excessive uneven distribution of factors across Spanish provinces). Artal et al. (2008) applied the "lens condition" test and rejects the existence of lumpiness in the case of Spain.

⁵ The structural relationship goes in one direction since factor endowments are exogenous in the model. However, as far as accumulation depends primarily on broad forces that are largely external to a given sector, this assumption should not be a serious problem. For example, educational attainment seems to be driven largely by demographic characteristics and domestic educational policy and capital accumulation depends on aggregate forces such as life-cycle behaviour, macroeconomic conditions, and tax policy. From a more pragmatic point of view, there are no good instruments available for factor supplies. Indeed many empirical papers use factor endowments as "good" instruments of production output, when this variable is included in the regression as an explanatory variable, under the assumption that they are exogenous.

⁶ Redding and Vera-Martín (2006) show that the production-factor endowment relationship holds without factor price equalisation given that both differences in relative prices and technology are controlled in the model, and hold under factor

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8 mobility. However, the interpretation of this general equilibrium relationship changes
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10 depending on the mobility of factors. When factor immobility holds, the model can be
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12 interpreted in supply-side terms (external changes in factor endowments cause
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14 production structure changes). When factors are perfectly mobile across regions, there is
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16 also a demand-side interpretation (external changes in demand and production cause
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18 endogenous changes in factor endowments).
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23 ⁷ As we explain in more detail later, we use both EUROSTAT NUTS-2 (17 Spanish
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25 Autonomous Communities) and NUTS-3 (52 Spanish provinces) in our analysis. Then,
26
27 for NUTS-2, $C=Z$, and for NUTS-3, $C>Z$.
28

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30 ⁸ The Spanish *Autonomous Communities* (EUROSTAT NUTS-2 classification)
31
32 represent the most important administrative units at the regional level and 11 out of 17
33
34 include more than one province.
35

36
37 ⁹ In their study of regional production specialisation across European regions, Redding
38
39 and Vera-Martin (2006) find larger, within-sample-average absolute-percent errors in
40
41 disaggregated manufacturing industries, and relate it to the production indeterminacy
42
43 problem given the larger number of industries relative to production factors. They also
44
45 refer to the Bernstein and Weinstein (2002) explanation of production indeterminacy,
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47 “which is likely to be larger for the lower values of trade costs observed across regions
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49 within a country” (page 4).
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54 ¹⁰ See Table A-2 for estimated coefficients using regional data. Estimated coefficients
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56 using provincial data are available on request from the authors.
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59 ¹¹ $MAPE = \text{mean} \left(\frac{\text{abs}(\text{Observed value} - \text{Fitted Value})}{\text{Observed Value}} \right) \cdot 100$
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¹² The exceptions are *Wood Products* in all the specifications and *Financial Services* in the estimation without regional dummies.

¹³ Using OECD country-level data, Harrigan (1995), Bernstein and Weinstein (2002) and Reeve (2006) report absolute percent errors of 40 percent, 67 percent, and 52 percent, respectively.

¹⁴ Notice that the values of Rybczynski coefficients do not indicate differences in marginal value productivity. Rather the value of the coefficients indicates differences in the benefit that can be drawn from an increase in the endowment of each factor, after optimal reallocation of all factors, given the endowments of other factors.

¹⁵ Standardised or beta coefficients, discussed in Leamer (1984), are formed by multiplying the regression slope by the standard deviation of the explanatory variable and dividing by the standard deviation of the dependent variable. The actual coefficient estimates are reported in Table A-3 in Appendix.

¹⁶ Techniques can change for a wide variety of reasons. These include changes in technology and preferences. Other sources of change include trade liberalization with the rest of the world, the emergence of new industrialized trading partners, overall factor accumulation within the sample, and even industry-specific shocks. Whatever the reasons for change in techniques, they cannot be distinguished in the present framework. However, explaining the changes in the techniques is not our goal, but merely distinguishing them from the factor endowment effect.

¹⁷ Since the terms in Equation (5) can be of either sign, a simple average obscures their true contributions. Therefore, the averages are reported in terms of absolute values. Moreover, these components have been normalized to sum to 100 percent.

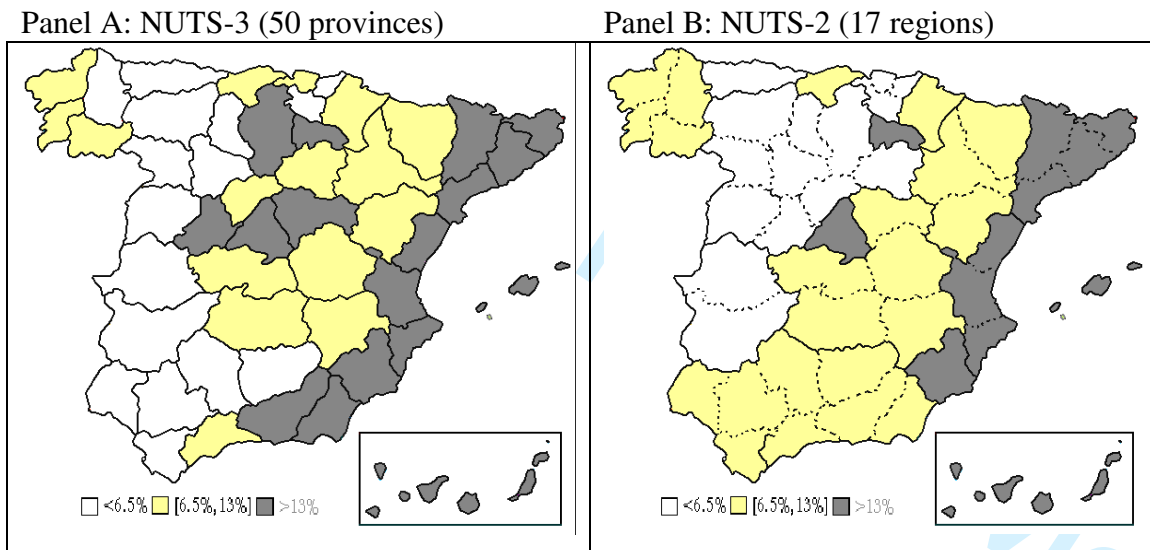
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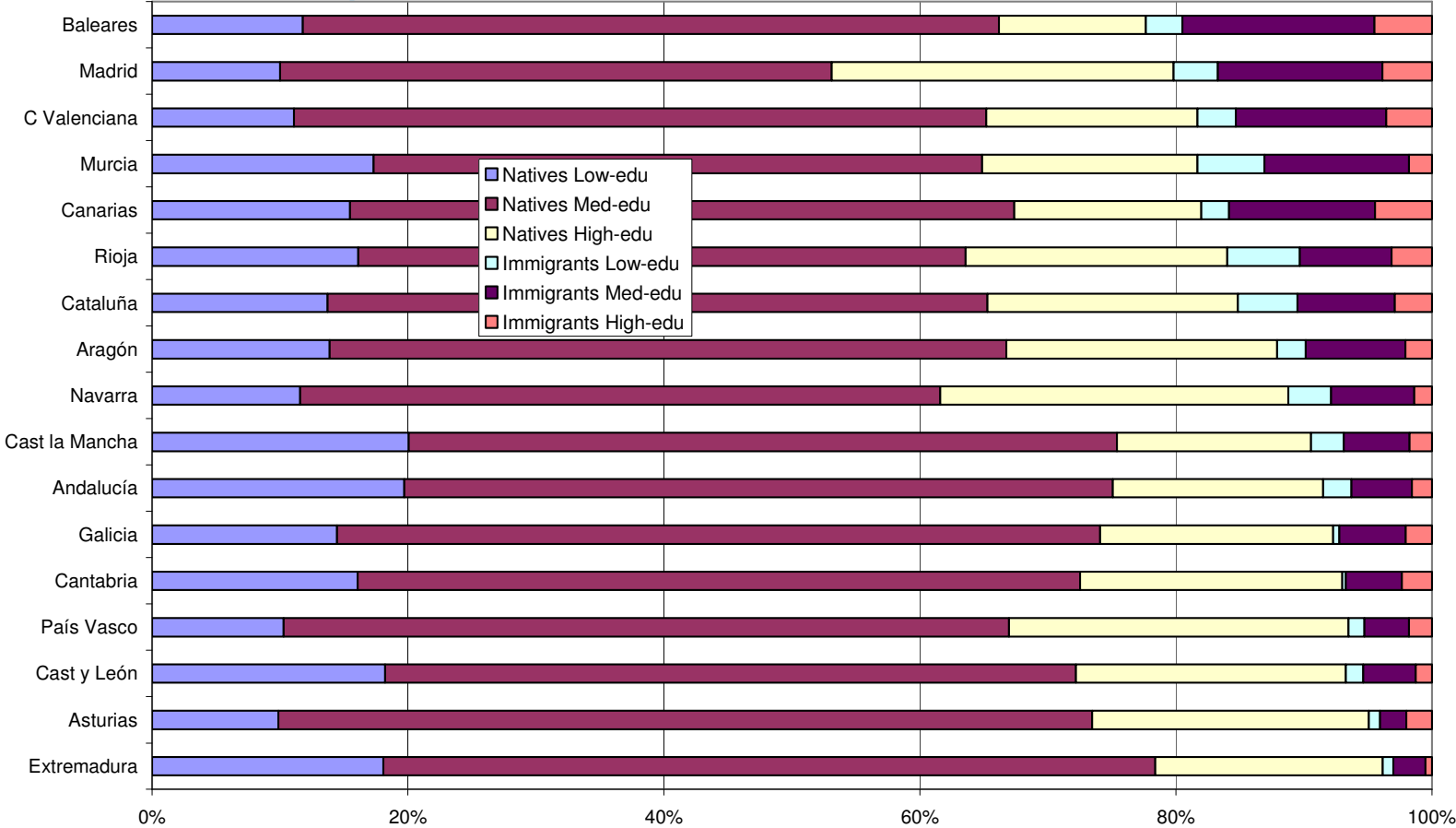
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Figure 1. Participation of foreign labour (% total labour force). Year 2005



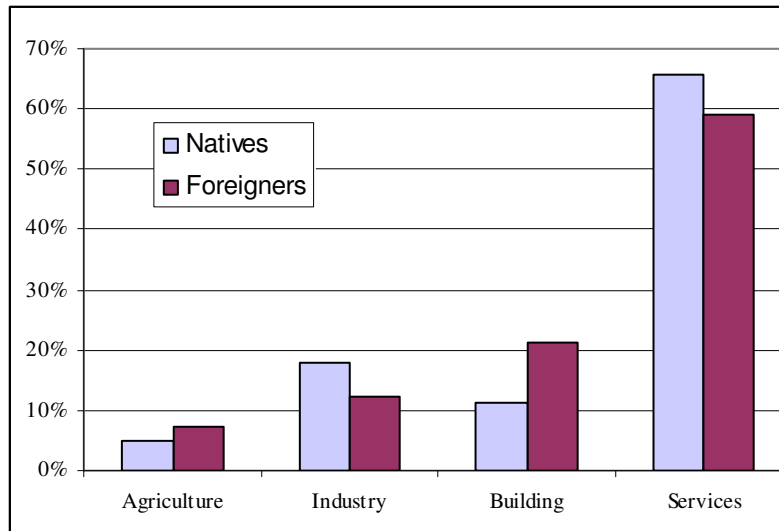
Source: Own elaboration using INE's Economically Active Population Survey.

Figure 2. Distribution of Spanish labour force by nationality, education level and territory (NUTS-2) in year 2005. (Regions are ordered - from high to low - according to the percentage of immigrants in the total labour force)



Source: INE's Economically Active Population Survey.

Figure 3. Share of Workers by Sector and Nationality. 2005.



Source: INE's Economically Active Population Survey.

Table 1. Composition of Labour Supply by Education Levels and Nationality.

| | Total | Low-edu | Medium-edu | High-edu | |
|--|-------|---------|------------|----------|------|
| Total | 1996 | 100 | 34,1 | 50,2 | 15,7 |
| | 2005 | 100 | 17,2 | 60,6 | 22,2 |
| Immigrants | 1996 | 2,7 | 20,9 | 55,7 | 23,5 |
| | 2005 | 13,3 | 20,9 | 59,5 | 19,6 |
| Rest of labour force | 1996 | 97,3 | 34,5 | 50,0 | 15,5 |
| | 2005 | 86,7 | 16,6 | 60,8 | 22,6 |
| Dispersion* of labour shares by education level and nationality across Spanish provinces in 2005 | | | | | |
| Immigrants | | 1,70 | 1,02 | 1,68 | 1,75 |
| Rest of Labour force | | 14,03 | 2,77 | 8,65 | 4,20 |
| Total | | | 0,86 | 0,78 | 0,59 |
| Dispersion* of labour shares by education level and nationality across Spanish regions in 2005 | | | | | |
| Immigrants | | 2,04 | 1,55 | 1,86 | 2,10 |
| Rest of Labour force | | 14,79 | 4,26 | 10,58 | 4,43 |
| Total | | | 4,53 | 15,71 | 5,20 |

Notes: Own elaboration using Spanish Economically Active Population Survey. Education levels: Low=primary education or less; Medium=high school or equivalent; High=university degree or equivalent. * Coefficient of variation of shares of actives by education level

Table 2. Model Specification and evaluation.

| | GLS & SUR ESTIM. 5 SECTORS. PROV. DATA | | | | | GLS & SUR ESTIM. 5 SECTORS. CCAA DATA | | | | | GLS & SUR ESTIM. 21 SECTORS. CCAA DATA | | | | |
|---------------------------------------|--|---------|----------|----------|-----------|---------------------------------------|--------|----------|----------|----------|--|---------|----------|----------|----------|
| | (i) | (ii) | (iii) | (iv) | (v) | (i) | (ii) | (iii) | (iv) | (v) | (i) | (ii) | (iii) | (iv) | (v) |
| MAPE Naïve model | | | | | | | | | | | | | | | |
| Agriculture | 158,93 | 158,93 | 158,93 | 158,93 | 158,93 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 | 201,60 |
| Energy | 91,49 | 91,49 | 91,49 | 91,49 | 91,49 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 | 37,27 |
| Manufacturing | 56,25 | 56,25 | 56,25 | 56,25 | 56,25 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 | 52,23 |
| Construction | 16,81 | 16,81 | 16,81 | 16,81 | 16,81 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 | 11,79 |
| Services | 9,25 | 9,25 | 9,25 | 9,25 | 9,25 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 | 9,09 |
| MEAN | 66,55 | 66,55 | 66,55 | 66,55 | 66,55 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 | 62,39 |
| MAPE | | | | | | | | | | | | | | | |
| Agriculture | 55,28 | 47,01 | 25,85 | 26,00 | 23,96 | 53,47 | 42,33 | 13,03 | 12,99 | 6,89 | 48,08 | 33,04 | 13,58 | 14,58 | 7,61 |
| Energy | 52,99 | 53,05 | 42,09 | 41,57 | 41,20 | 27,32 | 27,31 | 7,92 | 7,88 | 4,97 | 26,42 | 26,65 | 7,13 | 7,02 | 4,34 |
| Manufacturing | 45,41 | 44,04 | 23,27 | 23,41 | 22,50 | 34,98 | 33,20 | 2,99 | 2,98 | 1,81 | 43,98 | 42,66 | 5,52 | 5,51 | 3,94 |
| Construction | 16,10 | 14,10 | 10,78 | 10,77 | 10,11 | 12,64 | 9,67 | 3,14 | 3,11 | 1,94 | 12,43 | 9,92 | 3,58 | 3,48 | 2,50 |
| Services | 6,62 | 6,66 | 3,61 | 3,52 | 3,40 | 5,95 | 5,95 | 0,70 | 0,66 | 0,47 | 5,31 | 5,41 | 0,77 | 0,70 | 0,51 |
| MEAN | 35,28 | 32,97 | 21,12 | 21,06 | 20,23 | 26,87 | 23,69 | 5,56 | 5,52 | 3,21 | 27,24 | 23,53 | 6,12 | 6,26 | 3,78 |
| Global significance LR test | 1625,46 | 1816,83 | 3752,60 | 3812,66 | 4096,05 | 838,95 | 930,12 | 3675,21 | 3731,41 | 4651,93 | | | | | |
| Agriculture | | | | | | | | | | | 376,12 | 459,76 | 809,76 | 805,96 | 1012,30 |
| Energy | | | | | | | | | | | 102,55 | 104,55 | 852,45 | 856,42 | 1615,32 |
| Manufacturing | | | | | | | | | | | 801,90 | 868,45 | 7607,89 | 7646,55 | 10396,11 |
| Construction | | | | | | | | | | | 104,12 | 193,81 | 625,84 | 620,92 | 751,69 |
| Services | | | | | | | | | | | 949,05 | 1031,94 | 4432,22 | 4527,02 | 5428,73 |
| Akaike info. Criterion | | | | | | | | | | | | | | | |
| Agriculture | | | | | | | | | | | -5,77 | -6,25 | -8,13 | -8,10 | -9,12 |
| Energy | | | | | | | | | | | -14,88 | -14,88 | -19,10 | -19,11 | -23,39 |
| Manufacturing | | | | | | | | | | | -78,30 | -78,68 | -118,15 | -118,36 | -134,35 |
| Construction | | | | | | | | | | | -5,64 | -6,16 | -8,52 | -8,48 | -9,06 |
| Services | | | | | | | | | | | -50,82 | -51,29 | -71,12 | -71,67 | -76,78 |
| AIC Total model | -25,68 | -26,09 | -30,22 | -30,35 | -30,90 | -28,54 | -29,06 | -45,03 | -45,35 | -50,58 | | | | | |
| Breusch-Pagan test | 443,65 | 433,16 | 268,00 | 267,14 | 278,32 | 213,08 | 202,20 | 124,51 | 138,78 | 38,63 | | | | | |
| (P-value) | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | (0,00) | (0,00) | (0,00) | (0,00) | (0,00) | | | | | |
| Energy SURE | | | | | | | | | | | 1,12 | 1,23 | 39,78 | 41,42 | 2,71 |
| (P-value) | | | | | | | | | | | (0,29) | (0,27) | (0,00) | (0,00) | (0,10) |
| Manufacturing SURE | | | | | | | | | | | 1076,27 | 972,63 | 637,48 | 639,80 | 410,55 |
| (P-value) | | | | | | | | | | | (0,00) | (0,00) | (0,00) | (0,00) | (0,00) |
| Services SURE | | | | | | | | | | | 374,30 | 370,31 | 130,88 | 129,53 | 101,75 |
| (P-value) | | | | | | | | | | | (0,00) | (0,00) | (0,00) | (0,00) | (0,00) |
| Time dummies | No | Yes | No | Yes | Yes | No | Yes | No | Yes | Yes | No | Yes | No | Yes | Yes |
| Regional dummies | No | No | Yes | Yes | No | No | No | Yes | Yes | No | No | No | Yes | Yes | No |
| Time-varying Reg. dum. | No | No | No | No | Yes | No | No | No | No | Yes | No | No | No | No | Yes |
| Observations by eq | 461 | 461 | 461 | 461 | 461 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 170 |
| Parameters by eq | 9 | 10 | 25 | 26 | 42 | 9 | 10 | 25 | 26 | 42 | 9 | 10 | 25 | 26 | 42 |
| 1 Wald test. Non sigf. Reg.Dum | - | - | Rejected | Rejected | Rejected | - | - | Rejected | Rejected | Rejected | - | - | Rejected | Rejected | Rejected |
| 2 Wald test. Pooled data | - | - | Rejected | Rejected | Rejected | - | - | Rejected | Rejected | Rejected | - | - | Rejected | Rejected | Rejected |
| 3 Wald test. Constant Reg.Dum | - | - | - | - | Rejected* | - | - | - | - | Rejected | - | - | - | - | Rejected |

Notes: 1 Wald test for the Null of non significance of regional effects. 2 Wald test for the Null of pool vs. the alternative of panel data model. 3 Wald test for the Null of temporal stability of regional effects.

* Rejected at 8% of significance level. $MAPE = \text{mean absolute percent error} = \text{mean} \left(\frac{\text{abs}(\text{Observed value} - \text{Fitted Value})}{\text{Observed Value}} \right) \cdot 100$

Table 3. Standardised Coefficient Estimates (1996-2005). Beta Coefficients.

| Sectors ¹ | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|-------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------|------------|------------|------------|
| Absolute Prediction error | | 7,608 | 13,147 | 4,519 | 1,848 | 12,134 | 129,865 | 3,444 | 6,437 | 7,114 | 1,493 | 3,577 |
| Beta-coefficients | | | | | | | | | | | | |
| Native work | High-edu | -0,004 | 0,158 *** | 0,192 *** | 0,015 | -0,005 | -0,051 | 0,047 ** | -0,014 | -0,008 | -0,018 | -0,014 |
| | Medium-edu | 0,086 *** | 0,261 *** | 0,512 *** | 0,062 *** | 0,097 *** | 0,185 *** | 0,108 *** | 0,121 *** | 0,015 | 0,035 ** | 0,061 *** |
| | Low-edu | 0,147 *** | 0,049 | 0,610 *** | 0,107 *** | 0,009 | 0,004 | 0,019 | -0,006 | -0,034 ** | -0,028 *** | 0,005 |
| Immigrant work | High-edu | -0,011 | -0,004 | -0,002 | -0,001 | 0,008 | -0,040 * | 0,033 *** | -0,008 | -0,011 | -0,004 | -0,012 |
| | Medium-edu | 0,063 *** | 0,105 *** | 0,100 *** | -0,037 *** | -0,090 *** | -0,074 ** | -0,035 ** | -0,010 | -0,031 ** | -0,037 *** | -0,010 |
| | Low-edu | 0,015 | 0,059 *** | -0,008 | -0,040 *** | -0,025 *** | -0,053 ** | -0,020 ** | -0,016 | -0,054 *** | -0,029 *** | -0,007 |
| Capital | | -0,090 *** | 0,000 | 1,071 *** | 0,240 *** | -0,183 *** | -0,297 ** | -0,211 *** | -0,206 ** | -0,228 *** | -0,077 ** | -0,249 *** |
| Land | | 0,107 ** | -0,019 | -0,503 *** | -0,165 *** | -0,046 | 0,016 | -0,177 *** | -0,007 | -0,096 *** | -0,160 *** | -0,080 *** |
| Wald test | | | | | | | | | | | | |
| Temporal stability of Rybcz. Coeffs | | 12,62 | 27,63 | 465,03 | 77,71 | 319,66 | 21,11 | 178,44 | 66,97 | 159,53 | 331,50 | 54,56 |
| p-value | | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) |
| Sectors ¹ | | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| Absolute Prediction error | | 5,525 | 3,357 | 2,503 | 1,800 | 2,629 | 1,659 | 2,414 | 1,260 | 0,822 | 2,694 | |
| Beta-coefficients | | | | | | | | | | | | |
| Native work | High-edu | 0,034 * | 0,043 * | -0,052 | 0,020 | -0,058 * | 0,058 *** | 0,220 *** | 0,069 *** | 0,007 | 0,064 | |
| | Medium-edu | 0,057 ** | -0,082 ** | -0,523 *** | 0,075 ** | -0,087 ** | 0,084 *** | 0,056 | -0,046 | 0,084 *** | 0,000 | |
| | Low-edu | -0,001 | -0,038 ** | -0,489 *** | 0,081 *** | -0,016 | 0,049 *** | 0,043 | 0,010 | 0,101 *** | 0,145 *** | |
| Immigrant work | High-edu | 0,010 | 0,045 *** | -0,073 ** | -0,009 | -0,010 | 0,035 ** | -0,011 | 0,005 | 0,017 * | 0,049 ** | |
| | Medium-edu | -0,008 | -0,058 *** | 0,021 | -0,038 * | -0,041 ** | -0,082 *** | -0,003 | 0,050 ** | 0,020 * | -0,074 *** | |
| | Low-edu | 0,001 | -0,004 | 0,022 | 0,019 | 0,010 | -0,004 | 0,071 *** | 0,024 * | -0,002 | 0,032 | |
| Capital | | -0,236 *** | -0,309 *** | 0,328 ** | -0,206 *** | -0,046 | -0,287 *** | -0,314 *** | 0,303 *** | 0,308 *** | -0,517 *** | |
| Land | | -0,063 ** | -0,022 | 0,432 ** | -0,139 *** | -0,036 | -0,095 ** | 0,224 *** | 0,117 *** | 0,103 *** | -0,062 | |
| Wald test | | | | | | | | | | | | |
| Temporal stability of Rybcz. Coeffs | | 16,98 | 76,55 | 9,42 | 69,19 | 85,90 | 44,32 | 81,38 | 125,68 | 35,94 | 201,09 | |
| p-value | | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | (0,000) | |

Notes: ¹ Sector classification according to TableA-1. The model specification includes period-varying dummy variables. ***, **, * significant at 1%, 5% and 10% respectively. Wald test for the null of temporal stability of coefficients.

Table 4. Hypotheses Tests for Equality in the Marginal Effects of Native and Foreign Actives by Education Categories.

| Sector | Hig-edu. | Medium-edu. | Low-edu |
|---|------------------|-------------------|------------------|
| 1 Agriculture | 0,33 (0,5672) | 4,5 (0,0358) | 0,04 (0,8427) |
| 2 Extractive energy | 1,1 (0,2945) | 5,94 (0,0148) | 9,04 (0,0026) |
| 3 Electricity, gas and water | 1,43 (0,2323) | 0,57 (0,4496) | 8,24 (0,0041) |
| 4 Food, beverages and tobacco | 0,14 (0,7093) | 24,32 (0,000) | 55,69 (0,000) |
| 5 Textiles, clothing, leather, fur | 0,72 (0,3966) | 75,13 (0,000) | 9,71 (0,0018) |
| 6 Wood products, excl. Furniture | 1,59 (0,2072) | 11,34 (0,0008) | 6,62 (0,0101) |
| 7 Paper, printing & publishing | 4,15 (0,0417) | 10,83 (0,001) | 5,03 (0,0249) |
| 8 Chemical products | 0,25 (0,6145) | 3,43 (0,0638) | 2,44 (0,1179) |
| 9 Plastic & rubber | 0,82 (0,3648) | 6,84 (0,0089) | 35,68 (0,000) |
| 10 Metal basic and other non-metallic mineral prod. | 0,15 (0,6988) | 38,64 (0,000) | 28,35 (0,000) |
| 11 Mechanical & Electric and electronic equip. | 1,53 (0,2162) | 3,88 (0,0489) | 1,52 (0,2179) |
| 12 Transport equipment | 0,25 (0,6194) | 1,53 (0,2161) | 0,01 (0,9206) |
| 13 Miscellaneous | 6,88 (0,0087) | 8,9 (0,0029) | 0,01 (0,9249) |
| 14 Building | 2,62 (0,1082) | 11,46 (0,0009) | 4,66 (0,0327) |
| 15 Reparation and commerce | 0,5 (0,4789) | 6,27 (0,0123) | 0,7 (0,4016) |
| 16 Hotels | 0,05 (0,8274) | 3,72 (0,0537) | 0,95 (0,329) |
| 18 Transport & communi.serv. | 2,26 (0,1326) | 24,65 (0,000) | 0,37 (0,5448) |
| 18 Financial services | 3,21 (0,073) | 0,12 (0,7254) | 7,83 (0,0051) |
| 19 Renting and business services | 0,2 (0,6566) | 8,7 (0,0032) | 3,22 (0,0727) |
| 20 Education, health and other services | 2,48 (0,1153) | 0,26 (0,6123) | 1,65 (0,1996) |
| 21 Household services | 2,74 (0,0978) | 6,8 (0,0091) | 0,95 (0,3286) |

Note: Wald tests. P-values in parentheses.

Table 5. Decomposition of Output Change between 1996 and 2005

| Sector | Techniques $\bar{V}(\hat{R}_i^t - \hat{R}_i^{t-n})$ | Factor Endowments $(V^t - V^{t-n})\hat{R}_i$ | Residual $(\hat{\varepsilon}_i^t - \hat{\varepsilon}_i^{t-n})$ |
|--------|--|---|---|
| 1 | 47,5 | 6,7 | 45,8 |
| 2 | 50,4 | 0,9 | 48,7 |
| 3 | 44,5 | 8,9 | 46,5 |
| 4 | 40,8 | 14,7 | 44,5 |
| 5 | 49,9 | 9,8 | 40,3 |
| 6 | 46,2 | 29,8 | 24,0 |
| 7 | 50,8 | 2,0 | 47,2 |
| 8 | 52,1 | 3,8 | 44,1 |
| 9 | 51,1 | 1,9 | 47,0 |
| 10 | 41,2 | 8,5 | 50,3 |
| 11 | 53,8 | 1,8 | 44,4 |
| 12 | 42,8 | 8,9 | 48,3 |
| 13 | 47,3 | 20,5 | 32,2 |
| 14 | 31,9 | 57,4 | 10,8 |
| 15 | 37,6 | 5,0 | 57,4 |
| 16 | 26,9 | 18,9 | 54,1 |
| 17 | 36,1 | 11,4 | 52,4 |
| 18 | 47,7 | 2,3 | 50,0 |
| 19 | 47,8 | 2,2 | 50,0 |
| 20 | 46,8 | 3,1 | 50,1 |
| 21 | 47,0 | 3,2 | 49,8 |
| Mean | 44,8 | 10,6 | 44,7 |

Note: Values indicate the cross-region average percentage contributions of the three effects in terms of relative magnitudes, normalised to sum to 100 percent (aside from rounding).

Table 6. Alternative Decomposition of Output Change between 1996 and 2005

| Sector | Techniques $\overline{V}(\hat{R}_i^t - \hat{R}_i^{t-n})$ | Factor Endowments $(V^t - V^{t-n})\hat{R}_i$ | Regional Scale $(Q^t - Q^{t-n})\hat{\varepsilon}_i$ | Residual $(\hat{\varepsilon}_i^t - \hat{\varepsilon}_i^{t-n})$ |
|--------|---|---|--|---|
| 1 | 42,9 | 3,2 | 8,2 | 45,7 |
| 2 | 40,7 | 1,2 | 4,9 | 53,1 |
| 3 | 55,6 | 11,1 | 14,4 | 18,8 |
| 4 | 19,8 | 0,9 | 22,0 | 57,4 |
| 5 | 32,2 | 8,5 | 11,0 | 48,4 |
| 6 | 29,8 | 55,0 | 7,7 | 7,5 |
| 7 | 49,4 | 0,5 | 35,6 | 14,4 |
| 8 | 36,6 | 3,8 | 38,1 | 21,5 |
| 9 | 44,4 | 7,5 | 8,0 | 40,1 |
| 10 | 10,9 | 5,7 | 32,0 | 51,4 |
| 11 | 35,8 | 12,4 | 19,7 | 32,2 |
| 12 | 29,0 | 13,0 | 17,4 | 40,5 |
| 13 | 11,7 | 17,6 | 28,8 | 41,9 |
| 14 | 13,2 | 10,4 | 26,3 | 50,1 |
| 15 | 15,1 | 6,8 | 54,3 | 23,7 |
| 16 | 17,6 | 3,0 | 40,6 | 38,8 |
| 17 | 25,6 | 9,2 | 35,2 | 30,0 |
| 18 | 40,8 | 9,3 | 0,1 | 49,9 |
| 19 | 40,8 | 9,2 | 0,1 | 49,9 |
| 20 | 40,8 | 8,8 | 1,9 | 48,5 |
| 21 | 39,1 | 9,3 | 0,3 | 51,4 |
| Mean | 32,0 | 9,8 | 19,4 | 38,8 |

Note: Values indicate the cross-region average percentage contributions of the three effects normalised to sum to 100 percent (aside from rounding).

Table A-1. Geographic units and Sector classification.

| Geographic unit | |
|------------------------|---|
| Provinces (NUTS 3) | Autonomous Communities (NUTS 2) |
| Period | |
| 1996-2005 | 1996-2005 |
| Sectors | |
| S-5 | S-21 |
| 1. Agriculture | 1 Agriculture |
| 2. Energy | 2 Extractive energy and other energetic minerals, oil and nuclear 3 Electricity, gas and water |
| 3. Manufactures | 4 Food, drink and tobacco 5 Textiles, clothing, leather, fur 6 Wood products, excl. furniture 7 Paper, printing and publishing 8 Chemical products 9 Plastic, rubber 10 Metal basic industries and other non-metallic mineral products 11 Mechanical mach. & electric and electronic equipment 12 Transport equipment 13 Miscellaneous |
| 4. Building | 14 Building |
| 5. Services | 15 Reparation and commerce 16 Hotels 17 Transport and communication services 18 Financial services 19 Renting and business services 20 Education, health and other services 21 Household services |

Table A-2. Coefficient Estimates. GLS-SUR estimates. (1996-2005).

| Time dummies. Model (4a) | | AGRI | ENER | INDUS | CONST | SERV |
|--|------------|------------------------|----------------------|------------------------|----------------------|------------------------|
| Native work | High-edu | 0'777 (1'655) | 4'663*** (1'002) | -2'865 (4'287) | 3'498*** (1'137) | -8'858* (4'691) |
| | Medium-edu | 1'990*** (0'645) | 0'081 (0'365) | -12'899*** (1'597) | 1'535*** (0'422) | 8'777*** (1'710) |
| | Low-edu | 2'971*** (0'583) | 1'363*** (0'333) | -0'653 (1'312) | 0'183 (0'393) | -2'030 (1'383) |
| Immigrant work | High-edu | -32'109*** (10'304) | -9'530 (6'478) | -87'806*** (28'439) | -4'469 (6'771) | 137'969*** (29'602) |
| | Medium-edu | -2'737 (3'796) | 0'950 (2'389) | -46'177*** (9'997) | 6'091** (2'490) | 37'106*** (10'464) |
| | Low-edu | 25'773*** (4'638) | -2'514 (2'693) | 18'624 (12'536) | -7'553** (2'975) | -31'364** (12'919) |
| Capital | | 0'004 (0'003) | 0'007*** (0'002) | 0'027*** (0'009) | 0'011*** (0'002) | -0'051*** (0'010) |
| Land | | 0'420*** (0'029) | -0'015 (0'017) | -0'326*** (0'073) | 0'012 (0'018) | -0'102 (0'076) |
| Time & Regional dummies. Model (4b) | | AGRI | ENER | INDUS | CONST | SERV |
| Native work | High-edu | -1'504* (0'847) | 2'509*** (0'697) | 1'161 (1'208) | -1'051 (0'881) | 0'383 (1'286) |
| | Medium-edu | 0'522* (0'268) | 1'111*** (0'234) | 1'825*** (0'399) | -2'931*** (0'270) | 1'617*** (0'417) |
| | Low-edu | 1'552*** (0'152) | 1'337*** (0'132) | 0'187 (0'207) | -2'207*** (0'161) | 1'053*** (0'207) |
| Immigrant work | High-edu | 2'404 (2'865) | -2'370 (2'483) | -3'902 (4'118) | -2'789 (2'865) | 1'975 (4'352) |
| | Medium-edu | 1'510 (1'013) | 1'606* (0'902) | -2'636* (1'424) | 0'641 (0'990) | -0'373 (1'468) |
| | Low-edu | -3'484** (1'391) | 2'212** (1'103) | -2'134 (1'977) | 0'283 (1'533) | 9'526*** (2'003) |
| Capital | | -0'007*** (0'002) | 0'005*** (0'001) | -0'019*** (0'002) | 0'011*** (0'002) | 0'007*** (0'002) |
| Land | | 0'031 (0'026) | -0'105*** (0'021) | -0'235*** (0'034) | 0'144*** (0'025) | 0'192*** (0'034) |
| Time-varying Reg. dum. Model (4c) | | AGRI | ENER | INDUS | CONST | SERV |
| Native work | High-edu | -0'218 (0'474) | 2'004*** (0'433) | 0'264 (0'661) | -1'092** (0'489) | 1'455 (0'914) |
| | Medium-edu | 1'134*** (0'187) | 0'788*** (0'187) | 1'572*** (0'267) | -3'095*** (0'177) | 0'037 (0'380) |
| | Low-edu | 1'326*** (0'111) | 1'926*** (0'125) | 0'709*** (0'157) | -2'212*** (0'114) | 1'298*** (0'220) |
| Immigrant work | High-edu | -1'434 (1'619) | -1'100 (1'580) | 4'322* (2'383) | -6'516*** (1'655) | 1'803 (3'286) |
| | Medium-edu | 3'069*** (0'700) | 2'426*** (0'689) | -1'956* (1'026) | 0'591 (0'694) | -0'011 (1'297) |
| | Low-edu | 1'988* (1'053) | 0'877 (0'964) | -2'494* (1'443) | 0'562 (1'042) | 6'419*** (1'849) |
| Capital | | -0'007*** (0'001) | 0'007*** (0'001) | -0'019*** (0'002) | 0'013*** (0'001) | 0'002 (0'002) |
| Land | | 0'061** (0'026) | -0'034 (0'024) | -0'276*** (0'030) | 0'157*** (0'021) | 0'259*** (0'040) |
| Homogeneity of Rybzc coeffs across activity branches belonging to the same sector. Model (4c) | | | | | | |
| Wald test (df) | | - | 454'3 (8) | 1026,7 (72) | - | 1128,7 (48) |
| P-value | | - | (0,000) | (0,000) | - | (0,000) |

***, **, * significant at 1%, 5% and 10% respectively Standard errors are in parentheses.

Wald test: P-values in parenthesis

Table A-3. Coefficient Estimates. GLS and SUR estimates. (1996-2005). [Continues]

| Regional dummies | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|-------------------------|------------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|------------------------|----------------------|----------------------|----------------------|----------------------|---------------------|---------------------|----------------------|
| Native work | High-edu | -0'7424 (1'2178) | 1'468** (0'671) | 0'612 (0'732) | -0'425 (0'398) | -0'001 (0'300) | -0'628 (0'425) | -0'055 (0'200) | -0'200 (0'202) | 0'033 (0'109) | -0'244 (0'363) | 0'036 (0'314) | 0'655 (0'461) | 0'014 (0'125) | -0'136 (0'904) | 0'997 (1'001) | -0'791 (0'904) | 0'667 (0'465) | 1'522*** (0'492) | 1'028 (0'899) | 0'198 (0'872) | 0'026 (0'094) |
| | Medium-edu | 0'4004 (0'3711) | 0'718*** (0'206) | 0'402* (0'227) | 0'554*** (0'120) | -0'069 (0'094) | 0'026 (0'132) | 0'210*** (0'059) | 0'341*** (0'062) | 0'080** (0'034) | 0'249** (0'113) | 0'398*** (0'091) | 0'307** (0'140) | -0'044 (0'037) | -2'843*** (0'305) | -0'011 (0'268) | -0'220 (0'319) | 0'041 (0'142) | -0'256* (0'149) | -0'474* (0'261) | 1'934*** (0'269) | 0'087*** (0'030) |
| | Low-edu | 1'5489*** (0'1890) | 0'119 (0'108) | 1'414*** (0'114) | 0'426*** (0'059) | 0'055 (0'048) | 0'051 (0'065) | -0'027 (0'029) | -0'090*** (0'030) | -0'037** (0'018) | 0'007 (0'055) | -0'053 (0'046) | 0'015 (0'076) | -0'018 (0'019) | -2'164*** (0'155) | 0'367*** (0'133) | -0'532*** (0'148) | 0'254*** (0'073) | -0'013 (0'075) | 0'037 (0'133) | 0'904*** (0'139) | 0'140*** (0'017) |
| Immigrant work | High-edu | 5'6081 (4'0659) | -1'797 (2'265) | 0'553 (2'463) | 1'326 (1'296) | -1'891* (1'040) | -3'450** (1'355) | 1'381** (0'653) | -0'179 (0'647) | -0'138 (0'352) | -2'566** (1'186) | -0'166 (1'057) | 1'888 (1'507) | 0'262 (0'415) | -1'579 (3'342) | -1'547 (2'914) | 0'023 (3'245) | 2'576 (1'598) | 1'650 (1'619) | -0'280 (2'907) | 1'480 (2'800) | 1'158*** (0'325) |
| | Medium-edu | 0'8007 (1'4010) | 3'781*** (0'833) | -2'113** (0'832) | -0'248 (0'460) | -1'817*** (0'357) | -1'861*** (0'487) | -0'503** (0'226) | 0'015 (0'231) | 0'035 (0'121) | -0'445 (0'412) | -0'004 (0'354) | -0'168 (0'515) | -0'563*** (0'140) | 1'711 (1'152) | 0'871 (0'997) | -3'906*** (1'168) | -1'380*** (0'541) | 0'903 (0'561) | 1'907* (0'996) | 1'384 (0'971) | -0'159 (0'112) |
| | Low-edu | -2'8116 (1'9315) | 1'849 (1'167) | 0'791 (1'097) | -3'846*** (0'697) | -1'051** (0'496) | -1'327* (0'680) | -0'268 (0'294) | 1'297*** (0'312) | -0'515*** (0'175) | 0'875 (0'539) | 0'611 (0'484) | -0'244 (0'696) | 0'064 (0'203) | 2'202 (1'588) | -3'707*** (1'416) | 7'112*** (1'449) | 1'014 (0'724) | 2'361*** (0'777) | 2'052 (1'325) | -2'071 (1'367) | 0'427*** (0'150) |
| Capital | w1kap | -0'0059** (0'0024) | -0'004*** (0'001) | 0'009*** (0'001) | -0'002** (0'001) | -0'001 (0'001) | -0'001 (0'000) | -0'001** (0'000) | -0'001*** (0'000) | -0'001*** (0'001) | -0'000 (0'001) | -0'002*** (0'001) | -0'004*** (0'001) | -0'001*** (0'000) | 0'0103*** (0'00193) | -0'007*** (0'002) | 0'002 (0'002) | -0'003*** (0'001) | -0'003*** (0'001) | 0'010*** (0'002) | 0'015*** (0'002) | -0'001*** (0'000) |
| Land | w1land | 0'0524 (0'0335) | -0'052** (0'022) | -0'081*** (0'020) | -0'075*** (0'010) | 0'014 (0'009) | 0'015 (0'012) | -0'021*** (0'005) | 0'010* (0'005) | -0'012*** (0'003) | -0'078*** (0'010) | -0'020** (0'008) | -0'031** (0'013) | -0'002 (0'003) | 0'113*** (0'0276) | -0'002 (0'023) | 0'042 (0'027) | -0'007 (0'013) | 0'051*** (0'014) | 0'027 (0'024) | 0'052** (0'026) | -0'005* (0'003) |
| Akaike IC. | | -8,12 | -9,37 | -9,37 | -10,53 | -10,67 | -10,03 | -11,76 | -11,64 | -12,88 | -10,66 | -10,75 | -10,17 | -12,63 | -8,52 | -8,79 | -8,64 | -10,08 | -9,99 | -8,88 | -8,85 | -13,23 |
| Time & Regional dummies | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Native work | High-edu | -0'2189 (1'2395) | 1'442** (0'673) | 0'543 (0'730) | -0'564 (0'381) | -0'028 (0'300) | -0'642 (0'427) | -0'034 (0'202) | -0'225 (0'201) | 0'029 (0'109) | -0'237 (0'364) | 0'049 (0'314) | 0'566 (0'449) | -0'013 (0'124) | 0'418 (1'023) | 1'072 (0'907) | -0'859 (0'993) | 0'838* (0'432) | 1'767*** (0'421) | 1'157 (0'891) | 0'365 (0'870) | 0'012 (0'093) |
| | Medium-edu | 0'8671** (0'3932) | 0'684*** (0'215) | 0'272 (0'240) | 0'361*** (0'121) | -0'098 (0'097) | 0'054 (0'137) | 0'214*** (0'061) | 0'337*** (0'064) | 0'081** (0'035) | 0'249** (0'119) | 0'395*** (0'095) | 0'196 (0'141) | -0'069* (0'038) | -2'676*** (0'324) | -0'033 (0'282) | -0'055 (0'333) | 0'298** (0'138) | 0'074 (0'133) | -0'299 (0'274) | 1'979*** (0'281) | 0'073** (0'031) |
| | Low-edu | 1'7640*** (0'2077) | 0'090 (0'118) | 1'339*** (0'123) | 0'310*** (0'062) | 0'032 (0'052) | 0'061 (0'070) | -0'024 (0'032) | -0'097*** (0'033) | -0'037* (0'019) | 0'011 (0'060) | -0'064 (0'051) | -0'082 (0'081) | -0'035* (0'020) | -1'961*** (0'171) | 0'362** (0'146) | -0'433*** (0'162) | 0'406*** (0'073) | 0'196*** (0'069) | 0'149 (0'147) | 0'954*** (0'149) | 0'123*** (0'018) |
| Immigrant work | High-edu | 7'3363* (4'1258) | -1'621 (2'266) | 0'359 (2'450) | 0'809 (1'241) | -1'933* (1'038) | -3'663*** (1'356) | 1'337** (0'653) | -0'243 (0'645) | -0'161 (0'352) | -2'520** (1'192) | -0'367 (1'058) | 1'856 (1'466) | 0'271 (0'411) | -2'835 (3'404) | -1'561 (2'919) | 0'237 (3'215) | 2'532* (1'483) | 1'499 (1'387) | -0'259 (2'879) | 1'418 (2'787) | 1'156*** (0'319) |
| | Medium-edu | -0'5532 (1'4213) | 3'748*** (0'832) | -2'084** (0'827) | -0'108 (0'439) | -1'782*** (0'355) | -1'799*** (0'486) | -0'491** (0'226) | 0'047 (0'230) | 0'043 (0'121) | -0'465 (0'413) | 0'048 (0'355) | -0'157 (0'501) | -0'554*** (0'138) | 1'949* (1'172) | 0'882 (1'000) | -3'978*** (1'156) | -1'420*** (0'500) | 0'911* (0'479) | 1'879* (0'986) | 1'390 (0'966) | -0'167 (0'110) |
| | Low-edu | -1'5562 (1'9604) | 1'881 (1'165) | 0'816 (1'091) | -3'676*** (0'667) | -1'032** (0'493) | -1'339** (0'680) | -0'273 (0'294) | 1'310*** (0'311) | -0'513*** (0'175) | 0'873 (0'539) | 0'606 (0'485) | -0'227 (0'676) | 0'068 (0'201) | -0'601 (1'617) | -3'699*** (1'423) | 7'139*** (1'438) | 0'916 (0'668) | 2'213*** (0'664) | 1'972 (1'312) | -2'345* (1'364) | 0'438*** (0'148) |
| Capital | w1kap | -0'0057** (0'0024) | -0'004*** (0'001) | 0'009*** (0'001) | -0'001 (0'001) | -0'000 (0'001) | -0'001 (0'000) | -0'001** (0'000) | -0'001*** (0'000) | -0'001*** (0'001) | -0'000 (0'001) | -0'002*** (0'001) | -0'003*** (0'001) | -0'001*** (0'000) | 0'0114*** (0'00200) | -0'007*** (0'002) | 0'002 (0'002) | -0'004*** (0'001) | -0'004*** (0'001) | 0'009*** (0'002) | 0'015*** (0'002) | -0'001*** (0'000) |
| Land | w1land | 0'0806** (0'0341) | -0'052** (0'022) | -0'079*** (0'020) | -0'073*** (0'010) | 0'015 (0'009) | 0'015 (0'012) | -0'021*** (0'005) | 0'011* (0'005) | -0'012*** (0'003) | -0'078*** (0'010) | -0'019** (0'008) | -0'027** (0'012) | -0'002 (0'003) | 0'113*** (0'0281) | -0'003 (0'023) | 0'043 (0'026) | -0'009 (0'012) | 0'047*** (0'012) | 0'024 (0'012) | 0'048* (0'026) | -0'004 (0'003) |
| Akaike IC. | | -8,09 | -9,36 | -9,36 | -10,60 | -10,67 | -10,02 | -11,75 | -11,62 | -12,87 | -10,65 | -10,74 | -10,21 | -12,64 | -8,48 | -8,77 | -8,64 | -10,24 | -10,29 | -8,88 | -8,84 | -13,24 |

***, **, * significant at 1%, 5% and 10% respectively Standard errors are in parentheses

Table A-3 [continues]. Coefficient Estimates. GLS and SUR estimates. (1996-2005)

| Time-varying Reg. dum. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|------------------------|------------|------------------------|---------------------|----------------------|----------------------|----------------------|---------------------|----------------------|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------------------|----------------------|----------------------|---------------------|---------------------|----------------------|
| Native work | High-edu | -0'1699 (0'7565) | 0'623*** (0'194) | 1'199*** (0'277) | 0'116 (0'130) | -0'027 (0'100) | -0'311 (0'262) | 0'210** (0'100) | -0'064 (0'098) | -0'029 (0'073) | -0'219 (0'154) | -0'112 (0'128) | 0'285* (0'168) | 0'124* (0'073) | -1'194 (0'779) | 0'401 (0'558) | -1'243* (0'664) | 0'892*** (0'345) | 1'826*** (0'347) | 1'905*** (0'699) | 0'255 (0'575) | 0'115 (0'071) |
| | Medium-edu | 1'0502*** (0'2949) | 0'306*** (0'078) | 0'954*** (0'120) | 0'148*** (0'047) | 0'145*** (0'040) | 0'331*** (0'102) | 0'137*** (0'037) | 0'164*** (0'040) | 0'016 (0'027) | 0'132** (0'062) | 0'138*** (0'047) | 0'136** (0'063) | -0'069** (0'027) | -3'133*** (0'304) | 0'440** (0'211) | -0'576** (0'263) | 0'368*** (0'137) | 0'134 (0'135) | -0'366 (0'265) | 0'940*** (0'240) | -0'000 (0'029) |
| | Low-edu | 1'3711*** (0'1717) | 0'075 (0'049) | 1'387*** (0'077) | 0'338*** (0'027) | 0'016 (0'024) | 0'008 (0'060) | 0'028 (0'021) | -0'010 (0'022) | -0'041** (0'016) | -0'136*** (0'037) | 0'015 (0'027) | -0'004 (0'039) | -0'037** (0'016) | -2'237*** (0'177) | 0'539*** (0'124) | -0'143 (0'139) | 0'210*** (0'077) | 0'099 (0'079) | 0'086 (0'152) | 1'227*** (0'143) | 0'087** (0'018) |
| Immigrant work | High-edu | -1'8056 (2'6278) | -0'136 (0'677) | -0'061 (0'971) | -0'057 (0'417) | 0'310 (0'370) | -1'487* (0'866) | 0'935*** (0'327) | -0'248 (0'340) | -0'269 (0'242) | -0'434 (0'522) | -0'722 (0'450) | 0'602 (0'578) | 0'858*** (2'707) | -5'947** (1'829) | -1'030 (2'124) | -1'751 (1'211) | 2'840** (1'172) | -0'435 (2'292) | 0'806 (1'892) | 3'514* (0'253) | 0'566** (0'253) |
| | Medium-edu | 3'2888*** (1'0806) | 1'051*** (0'311) | 1'269*** (0'426) | -0'730*** (0'178) | -1'108*** (0'147) | -0'876** (0'370) | -0'321** (0'144) | -0'101 (0'147) | -0'237** (0'099) | -1'182*** (0'220) | -0'200 (0'177) | -0'147 (0'237) | -0'358*** (0'101) | 0'549 (1'113) | -1'364* (0'741) | -2'298** (0'908) | -2'081*** (0'502) | -0'035 (0'488) | 2'541** (1'006) | 1'347* (0'806) | -0'271*** (0'105) |
| | Low-edu | 1'6821 (1'5596) | 1'454*** (0'460) | -0'220 (0'561) | -1'910*** (0'301) | -0'676*** (0'222) | -1'435** (0'560) | -0'407** (0'194) | -0'364 (0'226) | -0'924*** (0'147) | -1'990*** (0'349) | -0'288 (0'246) | 0'028 (0'319) | -0'051 (0'150) | 1'243 (1'607) | 1'500 (1'136) | 1'125 (1'292) | -0'235 (0'732) | 2'083*** (0'707) | 2'676* (1'437) | -0'247 (1'141) | 0'230 (0'145) |
| Capital | w1kap | -0'0067*** (0'0020) | -0'000 (0'001) | 0'007*** (0'001) | 0'002*** (0'000) | -0'001*** (0'000) | -0'002** (0'001) | -0'001*** (0'000) | -0'001** (0'000) | -0'001*** (0'000) | -0'001*** (0'000) | -0'001*** (0'000) | -0'002*** (0'000) | -0'001*** (0'000) | 0'012*** (0'002) | -0'004*** (0'001) | -0'001 (0'002) | -0'005*** (0'001) | -0'003*** (0'001) | 0'009*** (0'002) | 0'012*** (0'002) | -0'001*** (0'000) |
| Land | w1land | 0'0775** (0'0339) | -0'003 (0'010) | -0'101*** (0'013) | -0'046*** (0'005) | -0'008 (0'005) | 0'003 (0'012) | -0'023*** (0'004) | -0'001 (0'005) | -0'010*** (0'003) | -0'077*** (0'007) | -0'021*** (0'005) | -0'017** (0'007) | -0'002 (0'003) | 0'154*** (0'035) | -0'077*** (0'026) | -0'028 (0'027) | -0'033** (0'015) | 0'043*** (0'016) | 0'087*** (0'030) | 0'105*** (0'028) | -0'003 (0'003) |
| Akaike IC. | | -9,12 | -11,82 | -11,05 | -12,83 | -12,91 | -11,13 | -13,14 | -13,10 | -13,66 | -12,39 | -12,62 | -12,13 | -13,81 | -9,06 | -9,76 | -9,59 | -10,57 | -10,62 | -9,32 | -9,64 | -13,72 |

Note: ***, **, * significant at 1%, 5% and 10% respectively. Standard errors are in parentheses.