Heterogeneous firms and comparative advantage: evidence from Spain (1995-2007)*

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Abstract
The literature has shown that the effects of symmetric trade liberalization on a particular country are different for comparative advantage (CA) and comparative disadvantage (CD) industries. First, in CA industries, there should be a greater increase in the number of exporters and a greater fall in the number of non-exporters than in CD industries. Second, average firm size and average firm productivity should increase more in CA industries than in CD ones. Third, there should be net job creation in CA industries and net job destruction in CD ones. We analyze to what extent these predictions apply to Spanish 3-digit manufacturing industries in 1995-2007, looking at employment, number of exporters and non-exporters, average firm size and average firm labour productivity. The BRS predictions are only partly verified as these variables are fairly static over time and CA together with liberalization do not explain more than 12% of their variation. Depending on the mode of trade liberalization, there is some mixed evidence that the employment, size and productivity gap between the CA and the CD group has increased, together with a higher number of exporters and a lower number of non-exporters in both groups.

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1. Introduction

Traditional trade theory in its factor proportion version predicts that when countries open up to trade they specialize in industries that are relatively intensive in the factors that are relatively abundant in each country. The specialization process should thus imply the reallocation of production factors away from comparative disadvantage (CD) industries into comparative advantage (CA) ones. This theory could not explain trade between countries with similar factor endowments and so models of intra-industry trade came up that could explain that type of trade through economies of scale and the existence of product variety (Krugman, 1980). However, the rise of emerging markets brought the issue of inter-industry trade back into the spotlight because those countries are substantially better endowed with unskilled labour than the high-income countries to which they export. Krugman (2008), for example, has observed that over the last decade high-income countries have been importing unskilled labour-intensive products from emerging markets.

On the other hand, empirical work has found that not all firms export (see, among others, Bernard and Jensen (2004) for the United States; Roberts and Tybout (1997) for Colombia; Aitken *et al.* (1997) for Mexico; and Clerides *et al.* (1998) for Colombia, Mexico and Morocco).[1] As a consequence, the literature has searched for an explanation based on the existence of fixed entry costs into export markets and firm heterogeneity with respect to productivity. According to Melitz (2003), it is too costly for low-productivity firms to enter export markets and so only firms with sufficiently

[1] For two comprehensive surveys on the firm's exporting and investment decisions see Helpman (2006) for the theory and Greenaway and Kneller (2007) for the empirics.

high productivity levels will export. Moreover, trade impacts the economy through both an extensive and an intensive margin. From the point of view of consumers, there will be more varieties available and a higher quantity of each. This happens because, even though in each country the number of firms decreases when the least productive firms exit with trade, consumers will have access to all the varieties being produced under trade. Additionally, each surviving firm will be larger and thus supply a higher quantity of the variety it produces.

Due to the renewed importance of inter-industry trade, it is not sufficient to study firm heterogeneity without looking into the characteristics of the industry to which the firms belong. Bernard, Redding and Schott (2007, henceforth BRS) have shown that the effects of symmetric trade liberalization on a given country are different for CA and CD industries. First, in CA industries, there should be a greater increase in the number of exporters and a greater fall in the number of non-exporters than in CD industries. Second, average firm size and average firm productivity should increase more in CA industries than in CD ones. Third, although there is job creation and job destruction in all industries, the net effect should be job creation in CA industries and job destruction in CD industries. In summary, resource reallocation takes place across firms within the same industry, as well as between industries.

Spain has been participating in European integration and in worldwide trade liberalization, as well as in international value chains. As such, it is an interesting field to study to what extent the BRS predictions may be verified by the data. Existing work on Spanish data (Delgado *et al*, 2002; Antras *et al*, 2010) has studied the

heterogeneous (total factor) productivity of Spanish firms, distinguishing between exporters and non-exporters. Delgado *et al* (2002) have found that exporters were more productive than non-exporters over the period 1991-96. Antras *et al* (2010) have corroborated this finding over the period 2000-09. They also found that under the current crisis (since 2007) smaller firms have experienced higher productivity growth than larger firms. The work of these authors does not, however, consider the type of industry a firm belongs to as a determinant of firm performance.

As proposed by BRS, in this paper we identify, on the one hand, which manufacturing industries have been subject to significant trade liberalization as based on tariff data and, on the other hand, which manufacturing industries are of the CA or the CD type. Crossing this information, we analyze to what extent the BRS predictions apply to Spanish manufacturing in 1995-2007,[2] for the 3-digit CA or CD industries believed to have been through some process of trade liberalization.

We analyze five variables at the 3-digit industry level: employment, number of exporters and of non-exporters, average firm size and average firm labour productivity. The BRS predictions are only partly verified as these variables are fairly static over time and CA together with liberalization do not explain more than 12% of their variation. Depending on the mode of trade liberalization, there is some mixed evidence that the employment, size and productivity gap between the CA and the CD

[2] We collected data up to 2007 precisely because the current crisis period has special characteristics that distinguish it from the previous 15 years of data, as Antras *et al* (2010) have shown. Given that adjustment processes are slowed down by various rigidities, more time has to elapse from the start of the crisis in order to allow a better understanding of the impact of the end of the construction boom and its effects upon the construction-related sectors.

group has increased, together with a higher number of exporters and a lower number of non-exporters in both groups.

Section 2 presents some relevant industry-level features of Spanish manufacturing and foreign trade. Section 3 carries out an analysis of the applicability of the BRS predictions to Spanish data. Section 4 concludes and leaves some thoughts for future research.

2. Industry-level features of Spanish manufacturing and foreign trade

Before studying the extent of verification of the BRS predictions for Spanish data, it is important to highlight some relevant industry-level features of Spanish manufacturing and foreign trade.

2.1. Manufacturing

We collected data from *Encuesta Industrial de Empresas* (database from the Spanish National Institute of Statistics – INE) on employment, number of firms (from which the number of exporters and of domestic firms is calculated), turnover (deflated by industrial prices) and labour productivity (calculated as deflated turnover per worker) for 3-digit industries according to CNAE-93 (the Spanish analogue to NACE Rev 1.1)[3] in 1995-2007.

[3] Comprehensive information on these industries can be found at: http://epp.eurostat.ec.europa.eu/portal/page/portal/nace_rev2/introduction.

In the BRS model, the only trigger for change is symmetric trade liberalization, whereby trade costs decrease to the same extent in both directions of trade. However, our empirical analysis of the Spanish economy spans a decade during which there was trade liberalization as well as economic growth.[4] We have tried to deal with this issue by weighing industry data with respect to total changes in the manufacturing sector, which approximate overall growth in the economy. In this way, changes taking place in each industry are deviations from the manufacturing average and should depend on industry-specific factors rather than economy-wide factors. For this reason, employment and number of firms (exporters and non-exporters) are analyzed as the industry's share in total manufacturing. Average firm size and average firm productivity are calculated as respectively industry employment and industry productivity divided by the industry's total number of firms (exporters and non-exporters). This allows us to work with industry averages in the spirit of BRS and the study of the distribution of firms within the industry is left for future research.[5]

With respect to the key industry characteristics analyzed, most industries are located around a median value as represented in Figure 1. However, a few industries contain the highest values of each particular characteristic which are located off-bounds and in some cases show an evolution which is opposite to the rest. These industries are of particular interest due to their economic weight and are highlighted in Figure 2. Their observed evolution points towards some important characteristics of Spanish

[4] Spanish economic growth during this period was mainly extensive, with a large increase in the use of labour but little technological progress (Castiglionesi and Ornaghi, 2009).

[5] We consider that, as in Melitz (2003), the industry's size and productivity distributions can be fully characterized by its average size and average productivity. Size and productivity are, of course, very correlated.

manufacturing: on the one hand, the participation in international value chains in the automobile industry (341); on the other hand, the increment in construction that created internal spare capacity and allowed the associated industries (281) to become net exporters; finally, the impressive decline of the clothing industry (181+182) with respect to the number of firms (both exporters and non-exporters) and to employment.

Figures 1 and 2 about here

It is interesting to note that in the case of the clothing industry the exporters seem to be holding on better than the non-exporters. The clothing industry is a primary case of symmetric trade liberalization as presented by BRS, since it has been undergoing substantial worldwide trade liberalization at the WTO level, culminating in the dismantling of the Textiles and Clothing Agreement in 2005.[6] The fact that the exporters resist better than the non-exporters can be explained by a selection bias in favour of exporters, which are more productive than domestic firms and thus better able to withstand trade liberalization.[7]

BRS indicate that, when symmetric trade liberalization takes place, the number of exporters, as well as average firm size and average firm productivity, would increase in all industries, the number of non-exporters would decrease in all industries and workers would be reallocated from CD to CA industries. Some reallocation effect has been present in Spanish manufacturing, for example away from the meat (151) and

[6] For a detailed firm-level study of the textile-clothing industry in Spain see Puig and Marques (2010).
[7] For Spain, Delgado *et al* (2002) have found strong evidence of self-selection into exporting by the most productive firms.

clothing (181+182) industries into construction-related industries (281). However, it is not clear that this is a reallocation from CD to CA industries, as will be shown further ahead. Employment has varied with the number of firms (exporters and non-exporters), as job turnover in the largest industries has taken place more through the entry and exit of firms than by variations in average firm size, which apart from its decline in the automobile industry (341), was fairly static in 1995-2007. On the other hand, average firm productivity has seen increases at the top, but not at the bottom of the industry distribution. Before relating these changes to trade liberalization and comparative advantage, we summarize some relevant features of Spain's foreign trade.

2.2 Foreign trade

The EU15 is Spain's most important trade partner, taking up over 65% of Spain's exports and over 55% of Spain's imports (Table 1). Moreover, whilst the EU15 share in exports has been more or less stable during 1995-2007, its share in imports has decreased by about 10% over the period. This development corresponds to a faster increase in Spain's imports from outside the EU15, such that extra-EU15 trade registered an increased deficit, whilst Spain's deficit in intra-EU15 trade was lower and fairly stable throughout the period (Table 2).

Tables 1 and 2 about here

Spain's foreign trade is concentrated around a few industries, with five out of 83 industries taking up 47%-48% of intra-EU15 trade and of extra-EU15 exports, with that share reaching almost 67% of extra-EU15 imports (Table 3). In extra-EU15 trade the

top five industries are present in both exports and imports (three in intra-EU15 trade), which hints at some importance of intra-industry trade. Next we turn into identifying the patterns of trade liberalization and comparative advantage in Spanish industry.

Table 3 about here

3. Heterogeneous firms and comparative advantage in Spain

We will consider three fundamental BRS predictions on the outcome of symmetric trade liberalization for CA and CD industries. First, there should be higher creative destruction of firms in CA industries, resulting in higher net creation of exporters and higher net destruction of non-exporters in those industries. This result would be explained by the exit of more low productivity firms and the start of exporting by a higher number of more productive firms in CA industries. Second, average firm size and average firm productivity should increase in all industries, but more so in CA industries. The higher average productivity gains in CA industries would be a consequence of the higher entry and exit dynamics in those industries. On the other hand, exporters are simultaneously the most productive and the largest firms. The correlation between size and productivity of exporters is explained by the existence of fixed costs of exporting. Finally, there should be job creation and job destruction in all industries, resulting in net job creation in CA industries and net job destruction in CD industries.

The study of the verification of these hypotheses requires the knowledge of which industries can be classified as being of the CA or the CD type. This can be found using different criteria, the simplest of which is a revealed comparative advantage (RCA)

index, possibly corrected for the existence of intra-industry trade (Neven 1995). The second element required to test the above propositions is the definition of trade liberalization. We use tariff data from the TRAINS database provided by UNCTAD to define the industries where a significant liberalization of trade has occurred. We further distinguish between symmetric and asymmetric trade liberalization from the point of view of Spanish exports and imports. This is an important distinction, since the BRS predictions are derived from a model that considers cases of symmetric trade liberalization.

3.1. Patterns of comparative advantage

The revealed comparative advantage (RCA) of sector k in country i is measured by a simple index based on the difference between the export and import shares of sector k in country i's foreign trade normalized by their sum. Neven (1995) has interpreted this correction as allowing for the existence of intra-industry trade. The resulting index can be written as follows:

$$RCA_{ki} = \frac{\frac{X_{ki}}{X} - \frac{M_{ki}}{M}}{\frac{X_{ki}}{X} + \frac{M_{ki}}{M}}$$

where X_{ki} and M_{ki} are respectively exports and imports of sector k in country i and X_i and M_i are country i's total exports and imports. The index varies between 1 (maximum CA when sector k products are exported by country i but not imported) and –1 (maximum CD when sector k products are imported by country i but not exported). Values close to 0 are interpreted as a sign of predominance of intra-industry trade.

We have calculated this index for Spanish trade in 1995-2007 taken from Eurostat's *Comext* database and converted to NACE Rev 1.1 at 3 digits in order to make it compatible to manufacturing data from INE's *Encuesta Industrial de Empresas*.[8] Taking a 5-year moving window to avoid the effects of short term changes in foreign trade due to variations in nominal determinants (exchange rates, energy prices, etc), we found three groups of industries classified according to a 95% confidence interval with respect to world trade: (i) those with a positive RCA index (41 industries); (ii) those with a negative RCA index (33 industries); and (iii) those with a statistically null RCA, where intra-industry trade predominates (9 industries).

The distribution of Spain's RCA indexes for 3-digit industries in intra- and extra-EU15 trade is represented in Figure 3. The CA distribution of Spain's total trade follows that of intra-EU15 trade, as the latter represented around 65% of Spain's total trade in 1995-2007. As a consequence, in both cases there are RCA indexes with absolute value lower than 0.2 for 50% of the industries with a median very close to zero. However, the slight median CD in intra-EU15 trade is more than compensated by a median CA of around 0.25 in extra-EU15 trade and more extreme values in the latter.

Figure 3 about here

The higher importance of inter-industry trade in Spain's trade with non-EU15 countries is to be expected in an endowments-driven setup. Together with the fact that trade liberalization should have occurred in extra-EU15 trade, as Spain has been an EU

[8] This conversion has been done using Eurostat's SITC Rev 3 – ISIC Rev 3 conversion table and UN's ISIC Rev 3.1 – NACE Rev 1.1 conversion table. SITC Rev 3 5-digits categories were aggregated at NACE Rev 1.1 3-digit categories to match INE's 3-digit level data.

member during the sample period, we can conclude that the study of the BRS predictions for Spanish data should be carried out with respect to extra-EU15 trade.

3.2. Patterns of trade liberalization

The BRS predictions come out of a model with symmetric trade liberalization, although in reality there can be several modes of trade liberalization. We consider the possibility of symmetric or asymmetric trade liberalization, defining symmetry (asymmetry) as the existence of statistically equal (unequal) rates of trade liberalization on the export and the import sides. We define the rate of trade liberalization in sector k (LIB_k) as the change in the tariff rate faced by Spanish exports (XT_k) or imports (MT_k) in sector k:

$$XLIB_{k,t} = XT_{k,t} - XT_{k,t\text{-}1}$$
$$MLIB_{k,t} = MT_{k,t} - MT_{k,t\text{-}1}$$

After computing 95% confidence intervals for a 5-year moving window for LIB in order to remove short term fluctuations in tariff rates due to short-lived policy measures, we found 14 industries with statistically asymmetric liberalization strongly in favour of exports ($XLIB_{k,t} < MLIB_{k,t} < 0$), 27 industries with liberalization taking place only on the export side ($XLIB_{k,t} < 0 = MLIB_{k,t}$), 11 industries with liberalization taking place only on the import side ($MLIB_{k,t} < 0 = XLIB_{k,t}$), 12 industries with statistically null liberalization and the remaining 29 industries with statistically symmetric liberalization (Table 4).

Table 4 about here

Figure 4 crosses the information on trade liberalization with the existence of CA or CD and retains those industries showing significant changes in the trade regime and either CA or CD. As would be expected, the pattern of intra-EU15 CA is more stable than that of extra-EU15 trade. Given the relative stability of the pattern of intra-EU15 CA, it is credible to think of a link between the CA evolution and the changes in the international competitive environment, namely induced by processes of trade liberalization. However, CA changes are more abrupt outside the EU15 independently of the mode of liberalization considered, showing a correlation between the RCA index and trade liberalization that is important to take into account. Moreover, in most cases Spanish exports have benefitted from more liberalization than its imports. This has occurred both at the extensive margin (number of industries where the reduction of tariffs was greater on exports than on imports) and at the intensive margin (extent of tariff reduction on the export side compared to the import side).

Figure 4 about here

Among those sectors facing symmetric liberalization, an interesting case is provided by the favourable evolution of textile fibres (171), knitted fabrics (176) and man-made fibres (247) in extra-EU15 trade and their unfavourable evolution in intra-EU15 trade (particularly knitted fabrics) in a climate of worldwide liberalization of the textile-clothing industry following the removal of tariffs by the WTO up to 2005. Textile fibres, knitted fabrics and man-made fibres are intermediate inputs to the textiles-clothing industry, but whereas the production of the first two is intensive in unskilled labour, the production of man-made fibres is subsidiary to the chemical products industry and is R&D-intensive (see Puig and Marques 2010 for a detailed discussion in the context of

Spain). In this case, trade liberalization is revealing the underlying CA or CD in an endowment-driven context. Taking into account that the BRS model considers symmetric trade liberalization, a case like this is expected to follow the BRS predictions.

We are now interested in verifying how the patterns of comparative advantage and trade liberalization detected in Spanish data in 1995-2007 relate to the evolution of industry characteristics in that period.

3.3. Industry characteristics and comparative advantage

BRS point to the role of comparative advantage in differentiating the evolution of industries undergoing symmetric trade liberalization. We have identified those industries by crossing changes in tariff rates faced by Spanish exports and imports. For those industries, we distinguished a CA group from a CD group. Under these conditions, we expect that the progress of symmetric trade liberalization, seen as a statistically equal decrease in tariffs on the export and the import sides, has brought net destruction of firms, with more exporters but fewer non-exporters, and this effect has been more intense in CA industries. We also expect an increase in average firm size and average firm productivity, and more so in CA industries. Finally, we expect net job creation in CA industries and net job destruction in CD industries.

Table 4 also summarizes industry characteristics for the trade liberalization types previously identified. The symmetric liberalization group has the largest number of industries (29), as well as the largest share of employment (26.58%), exporters

(26.84%), and domestic firms (31.23%). This group also has the highest average firm productivity, together with the export-side liberalization group, which has the highest average firm size (1704 employees).

The relationship between the evolution of industry characteristics and comparative advantage for the 1995-2007 period average is represented in Figure 5 for the industries facing symmetric liberalization as defined above. Due to the importance of the EU15 in Spanish foreign trade, the relationship between the evolution of industry characteristics and comparative advantage in world trade is very much influenced by that found in EU15 trade. Thus, at the world level, we see a negative relationship between comparative advantage and changes in employment, number of exporters and non-exporters. The relationship between comparative advantage and changes in average firm size and productivity is positive.

Figure 5 about here

These observations must, however, be taken with a grain of salt, because the changes occurring in most industries are very close to zero and so the apparent direction of the relationship is driven by only a few industries that have been either winners or losers of liberalization processes. In this way, the production of various food products (158)[9] has lost an important share of employment and number of firms (both exporters and non-exporters), whereas made-up textiles (174) have gained share of exporters and the production of structural metal products (281) has been a winner with a rising share of employment and number of firms (both exporters and non-exporters). On the other

[9] This is a residual category that includes very diverse products such as bread, pastries, pastas, sugar, cocoa, chocolate, tea, coffee and seasonings.

hand, the production of TV-radio-sound-recording apparatus (323) registered the highest increase in average firm productivity.

According to BRS, one would expect CA industries to register employment gains, higher number of firms (both exporters and non-exporters), higher average firm size and higher average firm productivity. These theoretical predictions are only partly verified, but it must be taken into account that some of the highlighted industries have comparative advantage only inside or outside the EU15. This result shows the importance of distinguishing intra- and extra-EU15 trade when studying the validity of the BRS predictions for an EU member country such as Spain. In particular, if we want to study the kind of symmetric liberalization processes considered by BRS, we should focus on extra-EU15 trade, because that is where tariff reductions have taken place. So, it is in those flows that we should look for a general comparison of the CA and CD groups. We start by comparing the aggregate evolution of their characteristics in the sample period and then test those differences more formally.

We start with those industries with significant inter-industry trade vis-à-vis countries outside the EU15 and subject to significant symmetric trade liberalization (Figure 6), which represent around 25-30% of employment and number of firms in 1995-2007. Employment does show a slight tendency to increase in the CA group and to decrease in the CD group; however the number of firms (both exporters and non-exporters) has remained fairly constant. Average firm size has decreased very slightly in both groups, whereas average firm productivity has indeed increased, and to a greater extent, in the CA group.

Figure 6 about here

These patterns show that the adjustment process described by BRS in the presence of trade liberalization seems to have partly operated in CA industries as the sample period ends with more productive, although not larger, firms. Because employment has increased in these industries, probably there has been market entry. Moreover, the productivity gap between CA and CD industries has widened over time as probably new firms are more productive.

Given these mixed results, we widen the search to include inter-industry trade industries subject to any mode of trade liberalization. Table 5 lists those industries which present the evolution suggested by BRS with respect to extra-EU15 trade. The same industries behave according to the BRS predictions with respect to each variable (employment, number of firms, firm size and productivity): 46 industries in the CA group and 16 industries in the CD group.

Table 5 about here

Moreover, we find 15 CA industries and 7 CD industries undergoing symmetric liberalization and meeting the BRS predictions. These industries, some of which had already been highlighted in Figure 5, correspond to respectively 32.6% and 43.75% of the BRS industries found, implying that symmetric liberalization cannot be the only factor that is generating compliance with the BRS criteria. A possible additional, although complementary, explanation is that most of the industries following the BRS predictions have seen higher changes in their extra-EU15 RCA index than in their intra-

EU15 RCA index, as Spain increased imports from outside the EU15. This evolution could be due once again to trade liberalization of whatever type.

Taking the analysis into more formal testing, Table 6 presents the P-values of one-sample t-tests on the sign of the change in industry characteristics in each group and an independent samples t-test on equality of means for the two groups.[10] In each case, the alternative hypothesis is the one which verifies the BRS prediction for that variable-group pair.

Table 6 about here

In general, the t-tests provide further evidence of the static behaviour of industry characteristics, as 15 years of data is not enough to capture very slow adjustment processes in an economy with high levels of rigidity in-built into product and labour markets which shelter CD industries and delay the adjustment to processes of trade liberalization by slowing down the exit of less productive firms. Nevertheless, the BRS hypotheses on the behaviour of industry characteristics are validated for particular modes of trade liberalization: (i) increase in the number of exporters in CD industries and decrease in the number of non-exporters in CA industries under import-side liberalization; (ii) decrease in the number of non-exporters and employment in CD industries under export-side liberalization; (iii) increase in average firm productivity in the CA group under symmetric liberalization; (iv) higher growth of average firm size

[10] Other statistical tests available to test the difference in the statistical properties of the two groups are not adequate for continuous data. For example, the Wilcoxon-Mann-Whitney test on equality of statistical distributions is to be used with ordinal or interval data and the Pearson chi-squared test on equality of medians is constructed from contingency tables applied to categorical data.

(under export-side liberalization) and productivity (under import-side liberalization) in the CA group relative to the CD group.

Although we have already seen that industry behaviour differs in each group, the results seem to hint that, on the whole, trade liberalization has uncovered underlying comparative disadvantage in Spanish industry and so those industries and firms that are more exposed to international competition have been more affected. This is exactly what one would expect from trade liberalization, but the results from Spanish data do not quite follow the BRS predictions. The expansion of CA industries is not as high as would be expected, although more firms started exporting as average productivity levels went up in this group. Nevertheless, as has already been shown, these are small changes and in many cases we can hardly detect any statistically significant change.

Table 7 provides further evidence on the behaviour of industry characteristics across modes of liberalization and direction of comparative advantage.[11] This grouping explains around 7.6% of variation in employment, 10.7% of variation in the number of non-exporters, 11.7% of variation in the number of exporters, 4.5% of variation in average firm size and 6.5% of variation in average firm productivity. In CD industries, the introduction of liberalization has, in some cases, caused lower levels of

[11] The use of panel regression would provide additional information if we included time-varying independent variables in order to generate within variation in the model. A full model of industry behaviour would be required in order to correctly and fully identify the relevant variables. That, however, is outside the scope of this paper. In the absence of within variation in the model, all explained variation is generated by between variation. In these circumstances, only pooled regression was carried out. The coefficients match those of a between model (regression on industry means) but the standard errors provide an upper bound for significance. For the purposes of this paper, it is enough to identify this upper bound.

employment, a reduction in the number of both exporters and non-exporters and an increase in average firm size and productivity. In CA industries, the introduction of liberalization has, in some cases, caused higher levels of employment, an increase in the number of both exporters and non-exporters and an increase in average firm size and productivity.

Table 7 about here

For most modes of liberalization, there is a significant difference between the changes in industry characteristics attributable to trade liberalization in the CA and CD groups. There is a net loss of employment when trade liberalization is introduced as net gains in the CA group are not enough to compensate net losses in the CD group, except in the case of import-side liberalization. With respect to the number of firms (exporters and non-exporters), a net increase is observed under symmetric and import-side liberalization as the CA group gains more than compensate for CD group losses, whereas the opposite effect is observed under export-side liberalization. In the latter case, average firm size increases significantly more in the CA group, whereas this happens for average firm productivity under export-biased and import-side liberalization.

It should be mentioned that, out of the 81 industries identified as significantly subject to trade liberalization, five are among those with the highest external trade share (Table 3): textile fibres (171), basic chemicals (241), soaps and detergents (245), plastics (252) and tubes (272). Out of these, only basic chemicals (241), plastics (252) and tubes (272) meet the BRS predictions. Given the lower trade share of the

remaining industries affected by trade liberalization, it is not surprising to see that any important shift at the industry level is not very much reflected at the group level. The incomplete verification of the BRS predictions may very well be linked to the diverging behaviour of industries and hints at the need to search for results at a very disaggregated level, identifying for which industries those predictions are verified, as well as distinguishing between extra-EU15 and intra-EU15 trade.

4. Concluding remarks

In this paper we have found a mixed fit of the BRS predictions on the evolution of CA and CD industries to Spanish data in 1995-2007. We have used a very simple index of revealed comparative advantage, which nevertheless enables some industry-level analysis. A more disaggregated view using firm-level data is left for future research.

Moreover, we have not distinguished intermediate from final goods and how comparative advantage and disadvantage in intermediates feeds into final goods. In order to be able to make this distinction, more sophisticated measures of endowment-driven comparative advantage are required, such as direct measures of the factor content of trade considering trade in final goods as in, for example, Davis and Weinstein (2001), or also taking into account trade in intermediate goods as suggested by Trefler and Zhu (2010). Since the data requirements for this analysis are substantial, this issue is also left for future research.

All in all, the empirical verification of the BRS predictions in a particular country is influenced by the degree of rigidity in product and labour markets. Moreover, if that

country also participates in a regional free trade area, such as Spain in the EU, it is important to disentangle trade within and outside that area.

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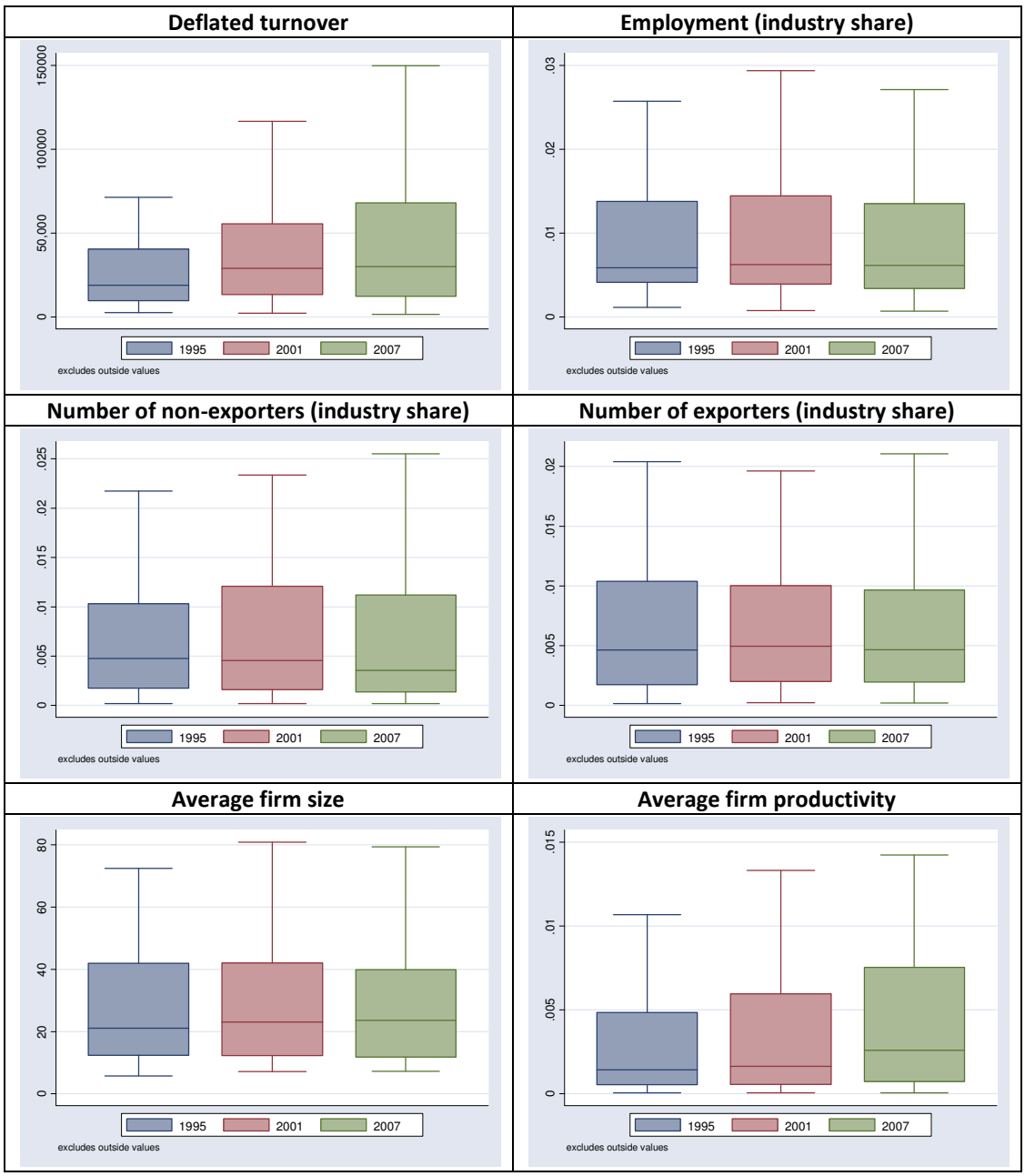
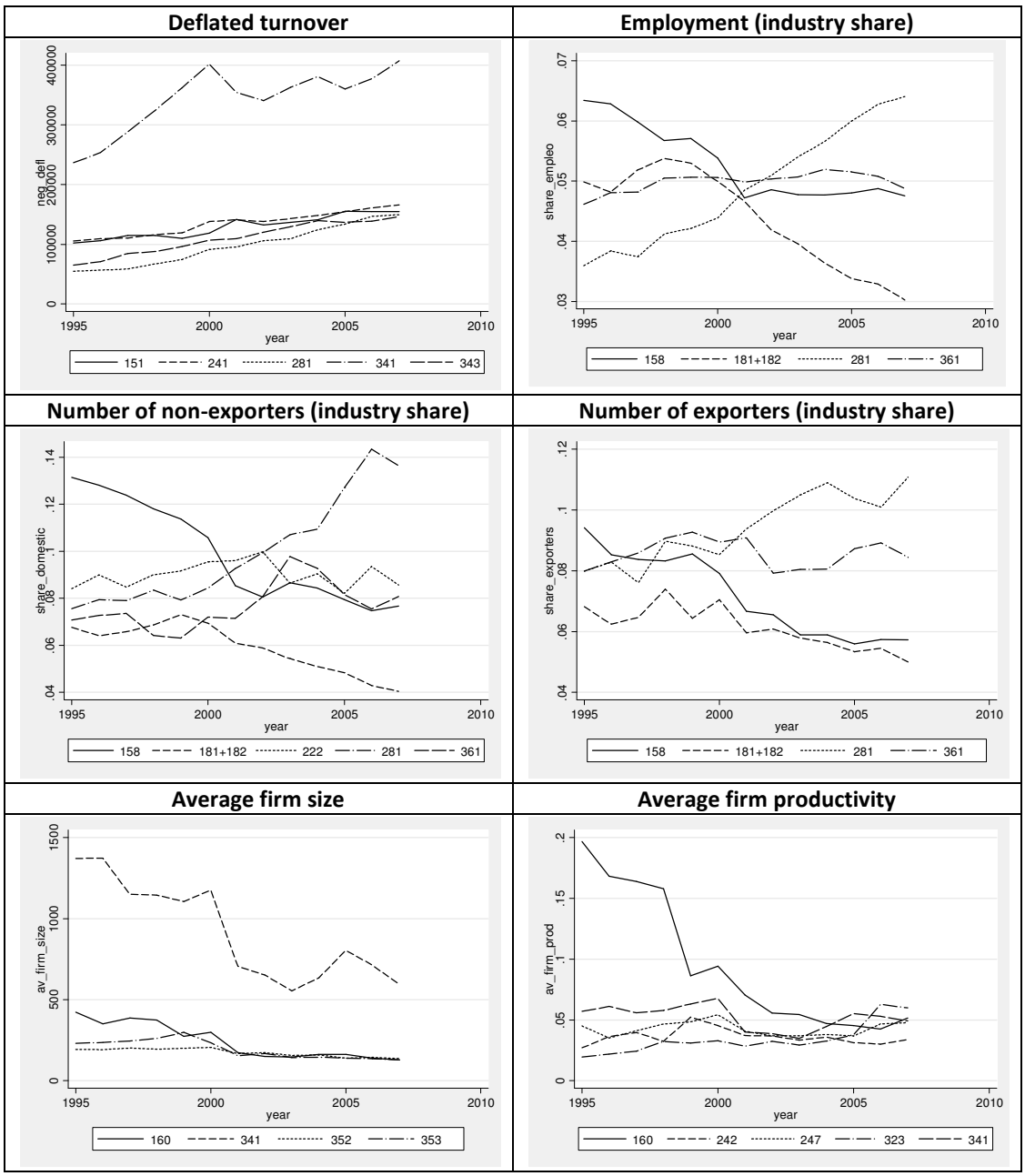
Figure 1: Distribution of manufacturing industry characteristics across industries in Spain excluding top quintile industries (1995-2007)



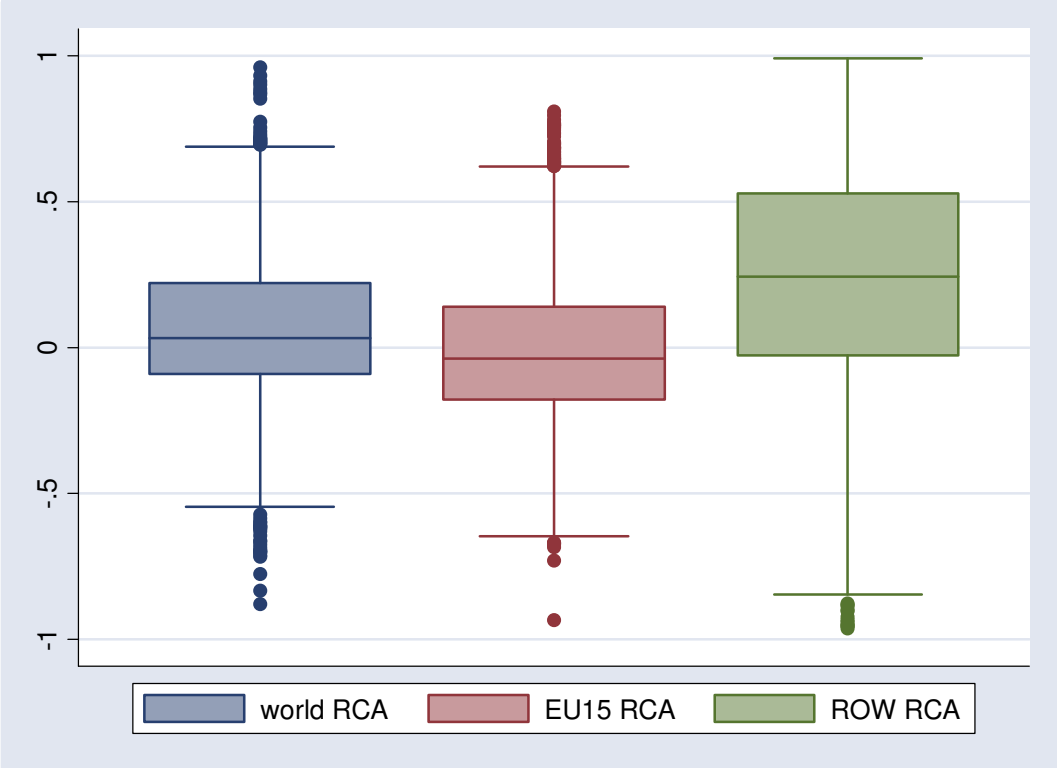
Source: INE's Encuesta Industrial de Empresas (industries classified using NACE Rev 1.1 at 3 digits)

Figure 2: Evolution of manufacturing industry characteristics in Spain for top quintile industries (1995-2007)



Source: INE's Encuesta Industrial de Empresas (industries classified using NACE Rev 1.1 at 3 digits)

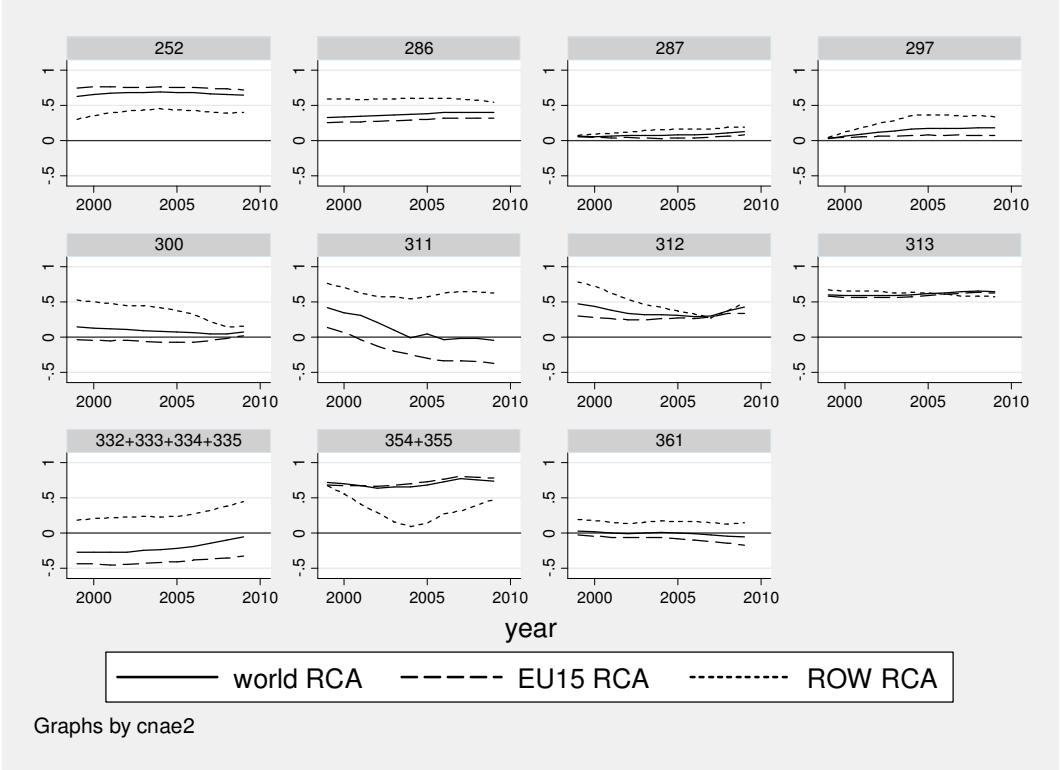
Figure 3: Distribution of comparative advantage in 3-digit industries in Spain (5-year moving window in 1995-2007)



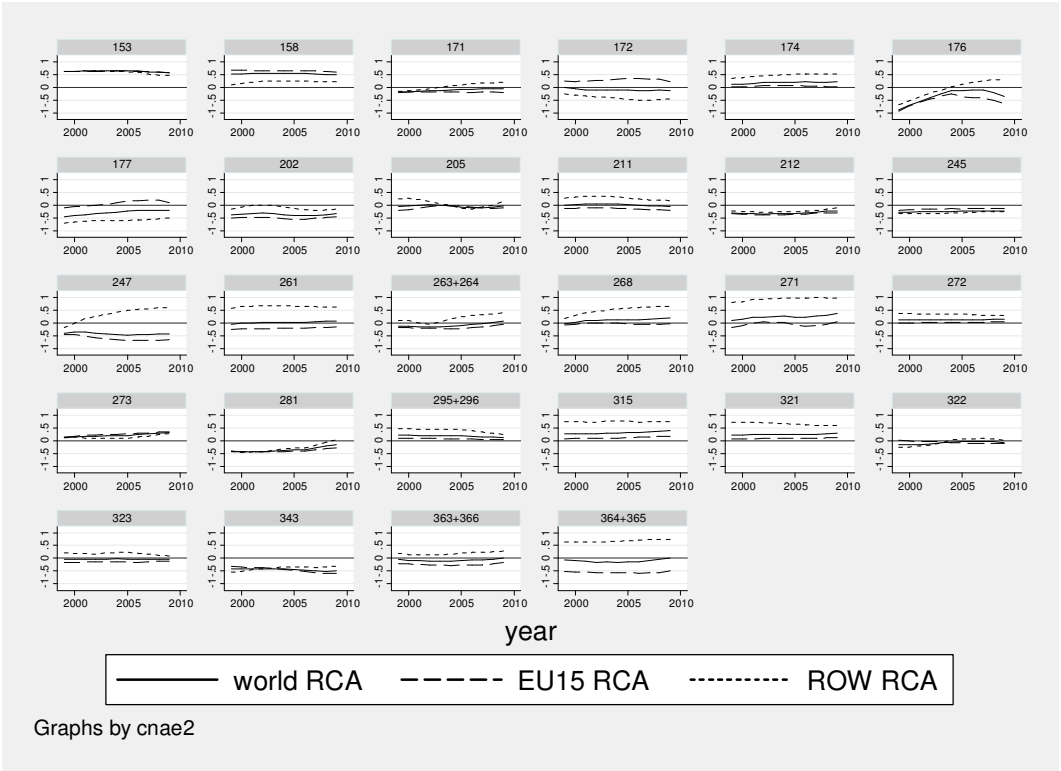
Source: Eurostat's Comext (industries classified using NACE Rev 1.1 at 3 digits)

Figure 4: Evolution of the pattern of comparative advantage in industries exhibiting significant inter-industry trade and trade liberalization in Spain (5-year moving average in 1995-2007)

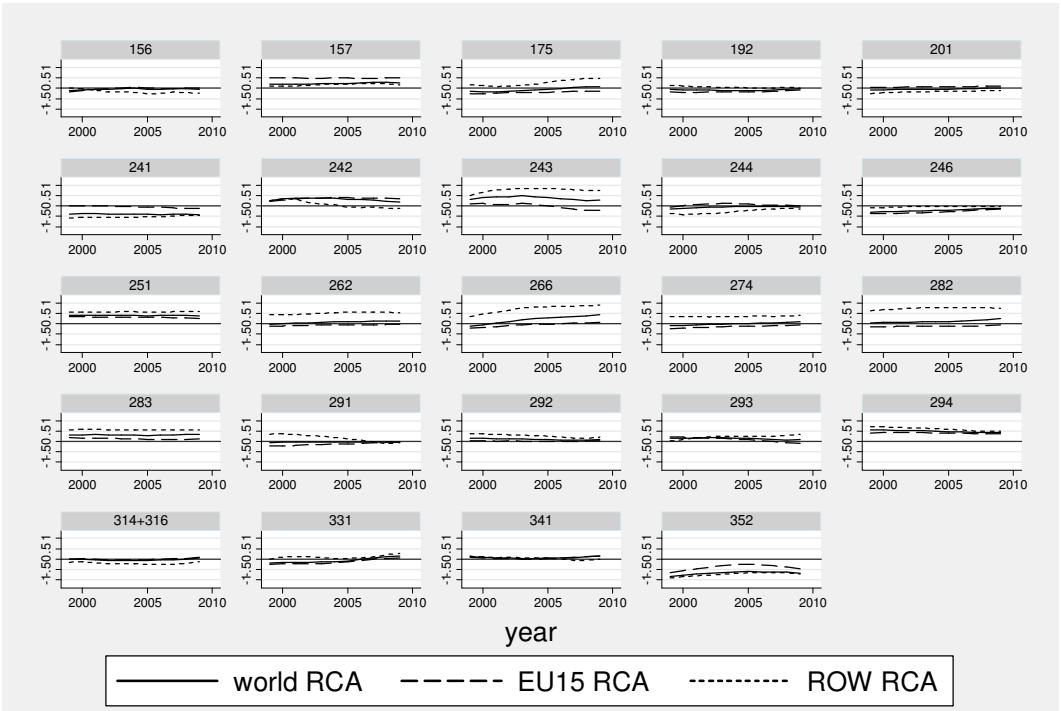
(i) Export-biased liberalization



(ii) Symmetric liberalization



(iii) Export-side liberalization



(iv) Import-side liberalization

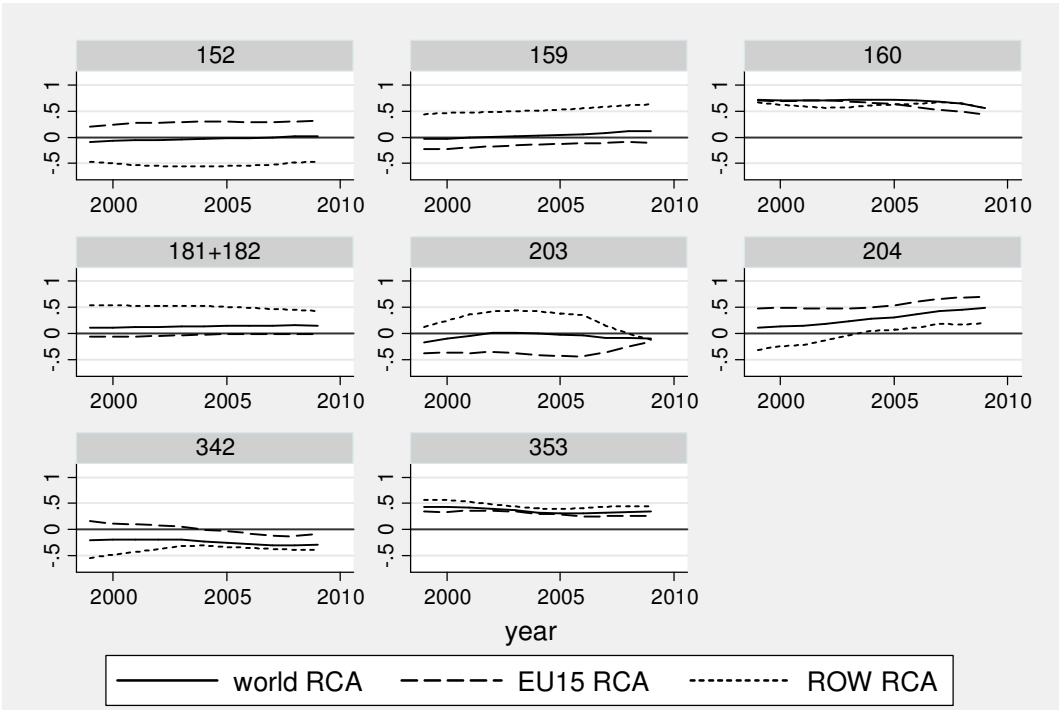
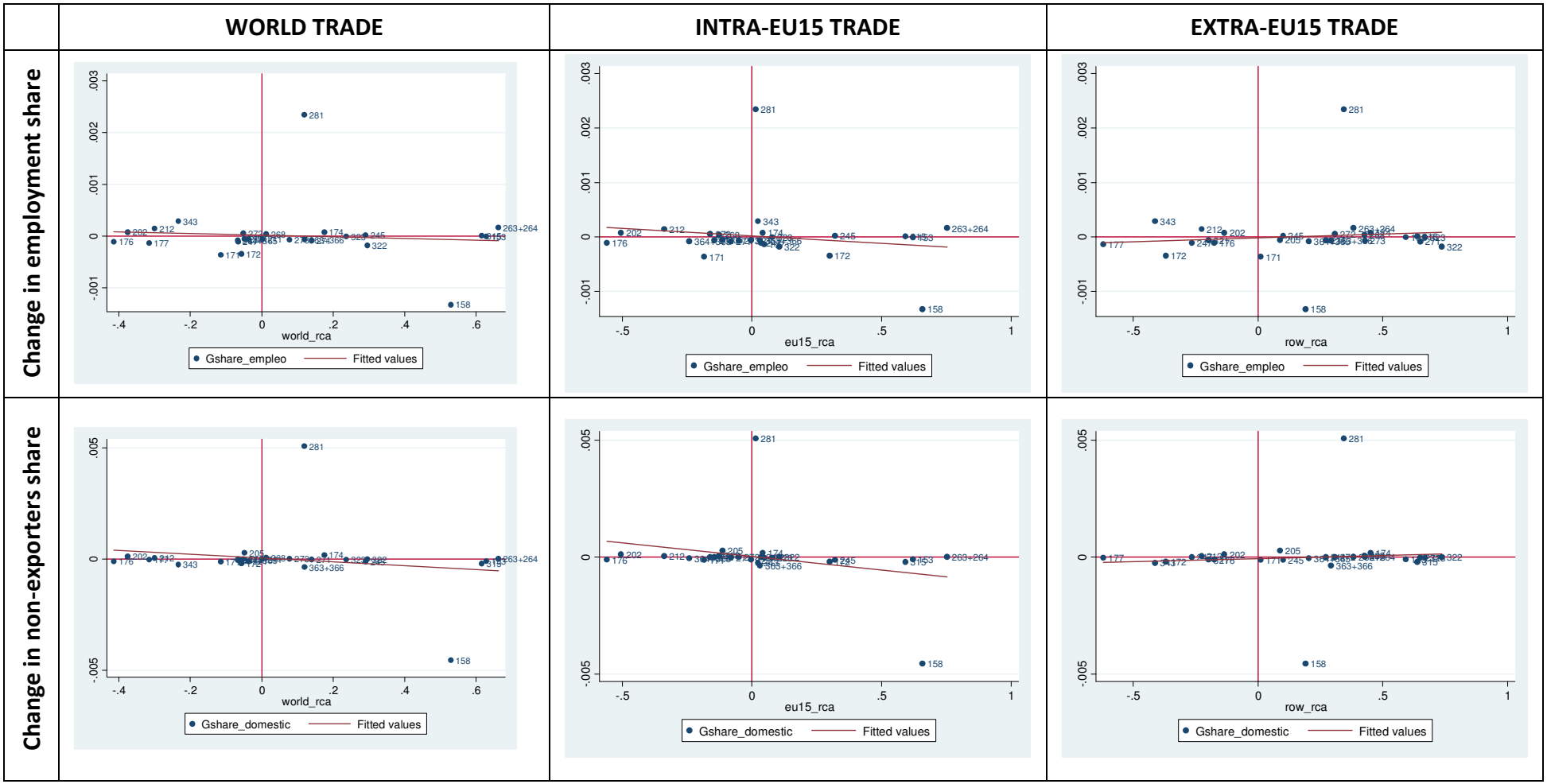


Figure 5: Comparative advantage and the evolution of industries exhibiting significant inter-industry trade and symmetric trade liberalization in Spain (1995-2007 average)



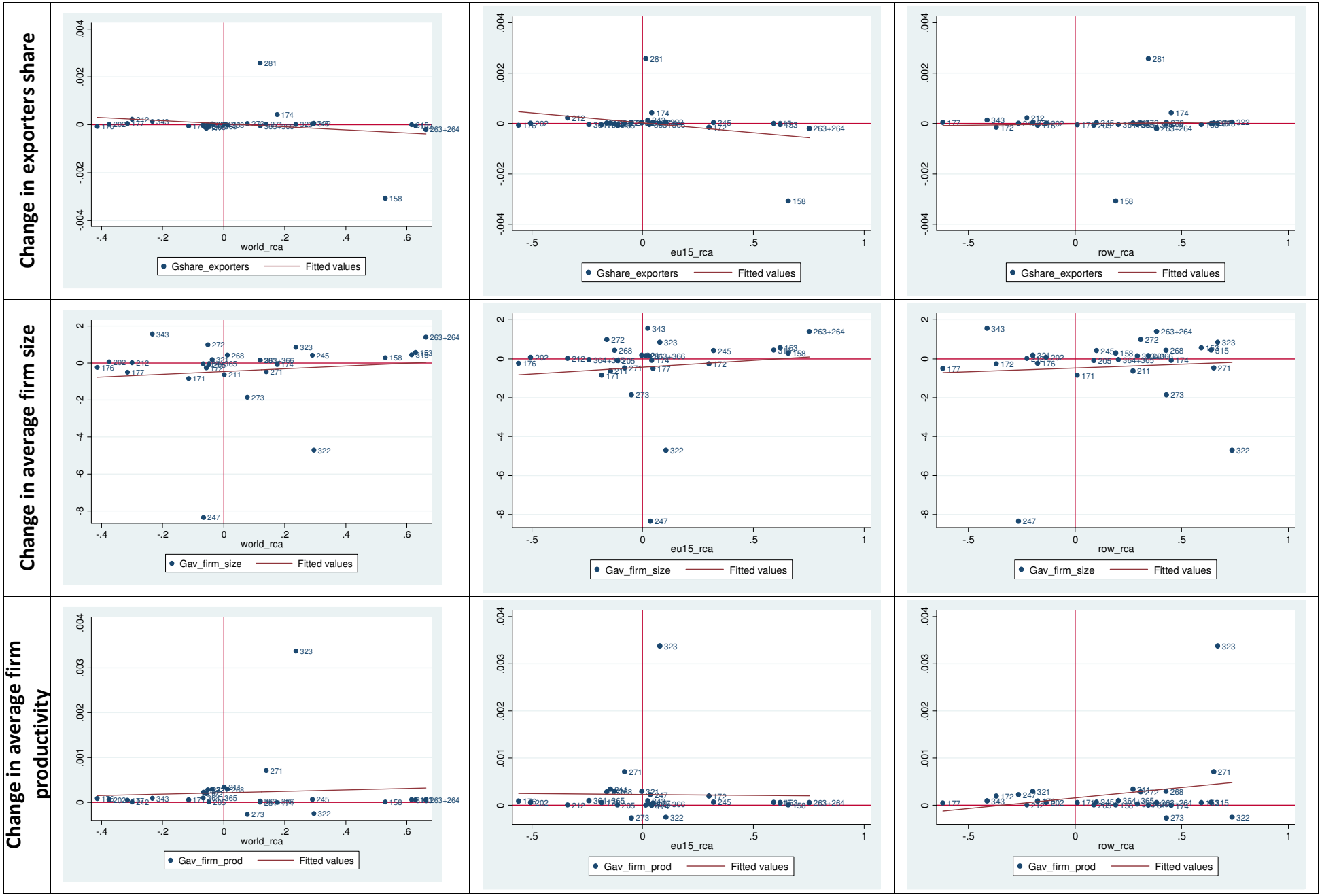

Change in exporters share
Change in average firm size
Change in average firm productivity
world_rca
eu15_rca
row_rca
Gshare_exporters
Gav_firm_size
Gav_firm_prod
Fitted values

Figure 6: Aggregate evolution of manufacturing industry characteristics for industries undergoing symmetric liberalization in the comparative advantage and comparative disadvantage groups in Spain's extra-EU15 trade (1995-2007)

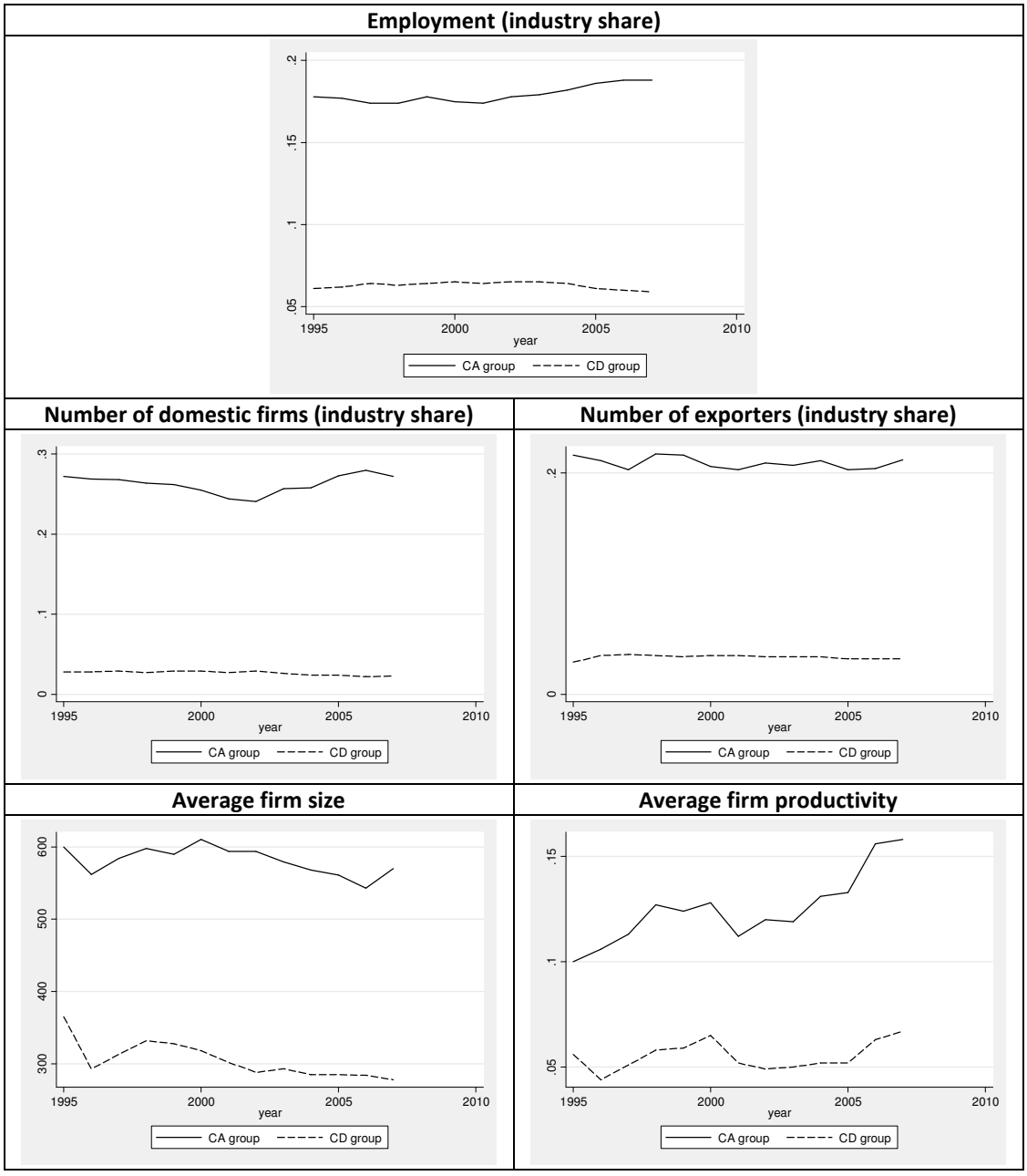


Table 1: Share of intra-EU15 trade in Spain's total foreign trade (1995-2007, %)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Exports	67	66	67	70	69	69	70	70	71	70	67	66	65
Imports	65	65	62	67	65	61	62	63	63	61	57	54	55

Source: Eurostat's Comext (industries classified using NACE Rev 1.1 at 3 digits)

Table 2: Export/import ratio in Spain's intra- and extra-EU15 trade (1995-2007, %)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Intra-EU15	80	82	87	79	79	80	81	80	80	78	77	77	76
Extra-EU15	74	77	68	69	64	56	57	58	57	53	50	48	52

Source: Eurostat's Comext (industries classified using NACE Rev 1.1 at 3 digits)

Table 3: Structure of Spain's intra- and extra-EU15 trade (1995-2007 average)

Intra-EU15				**Extra-EU15**			
Exports		**Imports**		**Exports**		**Imports**	
Industry	**Share (%)**	**Industry**	**Share (%)**	**Industry**	**Share (%)**	**Industry**	**Share (%)**
193 footwear	18.85	193 footwear	20.79	193 footwear	15.01	241 basic chemicals	34.23
272 tubes	10.23	272 tubes	9.85	241 basic chemicals	10.94	245 soaps & detergents	13.99
252 plastics	6.37	245 soaps & detergents	6.86	272 tubes	10.39	193 footwear	9.43
155 dairy	5.83	241 basic chemicals	6.56	245 soaps & detergents	7.61	272 tubes	5.17
241 basic chemicals	5.74	171 textile fibres	4.71	171 textile fibres	4.62	171 textile fibres	4.13
Sum	**47.02**	**Sum**	**48.76**	**Sum**	**48.57**	**Sum**	**66.95**

Source: Eurostat's Comext (industries classified using NACE Rev 1.1 at 3 digits)

Table 4: Descriptive statistics for industry characteristics by trade liberalization types in 3-digit industries (1995-2007 average)

	Export-biased liberalization (Lib X > Lib M)	**Symmetric liberalization** (Lib X = Lib M)	**Export-side liberalization**	**Import-side liberalization**	**No liberalization**
Exports	Liberalization (DT<0)	Liberalization (DT<0)	Liberalization (DT<0)	No liberalization (DT=0)	No liberalization (DT=0)
Imports	Liberalization (DT<0)	Liberalization (DT<0)	No liberalization (DT=0)	Liberalization (DT<0)	No liberalization (DT=0)
Number of industries	14	29	27	11	12
Employment (industry share)	16.58%	26.58%	20.43%	10.71%	15.98%
Number of exporters (industry share)	19.96%	26.84%	12.41%	13.88%	17.87%
Number of non-exporters (industry share)	16.84%	31.23%	14.09%	14.49%	22.95%
Average firm size	345	954	1704	539	245
Average firm productivity	0.07	0.19	0.19	0.12	0.03

Source: UNCTAD's TRAINS and INE's "Encuesta Industrial de Empresas" (industries classified using NACE Rev 1.1 at 3 digits)

Table 5: Industries presenting the evolution suggested by BRS (1995-2007)

	Positive extra-EU15 RCA				Negative extraEU-15 RCA			
	3-digit industries	**RCA**	**XLIB**	**MLIB**	**3-digit industries**	**RCA**	**XLIB**	**MLIB**
Export-biased liberalization	287. Manufacture of other fabricated metal products	0.08	-0.50	-0.10	252. Manufacture of plastic products	-0.22	-0.50	-0.14
	297. Manufacture of domestic appliances	0.50	-0.42	-0.09	286. Manufacture of cutlery, tools and general hardware	-0.39	-0.33	-0.11
	300. Manufacture of office machinery and computers	0.19	-0.40	-0.10				
	311. Manufacture of electric motors, generators and transformers	0.13	-0.48	-0.06				
	312. Manufacture of electricity distribution and control apparatus	0.09	-0.39	-0.08				
	313. Manufacture of insulated wire and cable	0.15	-0.47	-0.17				
	354, 355. Manufacture of motorcycles, bicycles and other transport equipment	0.37	-0.34	-0.11				
	361. Manufacture of furniture	0.69	-0.37	-0.08				
Symmetric liberalization	153. Processing and preserving of fruit and vegetables	0.64	-0.37	-0.69	172. Textile weaving	-0.09	-0.56	-0.26
	158. Manufacture of other food products	0.54	-0.43	-0.15	177. Manufacture of knitted and crocheted articles	-0.31	-0.57	-0.33
	174. Manufacture of made-up textile articles, except apparel	0.18	-0.38	-0.23	202. Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board, fibre board and other panels and boards	-0.36	-0.45	-0.17
	211. Manufacture of pulp, paper and paperboard	0.30	-0.46	-0.22	212. Manufacture of articles of paper and paperboard	-0.32	-0.45	-0.24
	263, 264. Manufacture of ceramic tiles and flags, bricks, tiles and construction products, in baked clay	0.67	-0.60	-0.16	247. Manufacture of man-made fibres	-0.06	-0.48	-0.28
	268. Manufacture of other non-metallic mineral products	0.42	-0.30	-0.06	321. Manufacture of electronic valves and tubes and other electronic components	-0.04	-0.42	-0.22
	271. Manufacture of basic iron and steel and of ferro-alloys	0.14	-0.43	-0.17	343. Manufacture of parts and accessories for motor vehicles and their engines	-0.22	-0.26	-0.17
	272. Manufacture of tubes	0.29	-0.43	-0.17				
	273. Other first processing of iron and steel	0.09	-0.43	-0.17				
	281. Manufacture of structural metal products	0.12	-0.42	-0.12				
	315. Manufacture of lighting equipment and electric lamps	0.60	-0.29	-0.09				
	322. Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	0.29	-0.35	-0.15				
	323. Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	0.24	-0.38	-0.15				
	363, 366. Manufacture of musical instruments and miscellaneous	0.11	-0.30	-0.09				
	364, 365. Manufacture of sports goods, games and toys	0.18	-0.32	-0.15				

Export-side liberalization	157. Manufacture of prepared animal feeds	0.23	-0.32	-2.91	156. Manufacture of grain mill products, starches and starch products	-0.04	-0.71	-1.25
	175. Manufacture of other textiles	0.21	-0.51	-0.23	201. Sawmilling and plaining of wood; impregnation of wood	-0.05	-0.31	-0.03
	192. Manufacture of luggage, handbags and the like, saddlery and harness	0.06	-0.26	-0.09	242. Manufacture of pesticides and other agro-chemical products	-0.65	-0.29	-0.08
	241. Manufacture of basic chemicals	0.47	-0.39	-0.15	244. Manufacture of pharmaceuticals, medicinal chemicals and botanical products	-0.39	-0.34	-0.08
	243. Manufacture of paints, varnishes and similar coatings	0.77	-0.43	-0.09	251. Manufacture of rubber products	-0.25	-0.48	-0.07
	246. Manufacture of other chemical products	0.40	-0.42	-0.07				
	262. Manufacture of non-refractory ceramic goods other than for construction purposes; manufacture of refractory ceramic products	0.39	-0.66	-0.17				
	266. Manufacture of articles of concrete, plaster and cement	0.06	-0.39	-0.06				
	274. Manufacture of basic precious and non-ferrous metals	0.21	-0.39	-0.08				
	282. Manufacture of tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers	0.18	-0.41	-0.08				
	283. Manufacture of steam generators, except central heating hot water boilers	0.34	-0.42	-0.09				
	291. Manufacture of machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	0.31	-0.23	-0.09				
	292. Manufacture of other general purpose machinery	0.37	-0.36	-0.07				
	293. Manufacture of agricultural and forestry machinery	0.08	-0.34	-0.09				
	294. Manufacture of machine tools	0.22	-0.40	-0.08				
	314, 316. Manufacture of electrical equipment	0.35	-0.30	-0.07				
	341. Manufacture of motor vehicles	0.24	-0.60	-0.15				
	352. Manufacture of railway and tramway locomotives and rolling stock	0.15	-0.40	-0.12				
Import-side liberalization	159. Manufacture of beverages	0.50	-1.24	-1.14	152. Processing and preserving of fish and fish products	-0.04	-0.16	-0.25
	160. Manufacture of tobacco products	0.70	-1.83	-2.84	353. Manufacture of aircraft and spacecraft	-0.68	-0.17	-0.04
	181, 182. Manufacture of wearing apparel	0.13	-0.36	-0.31				
	203. Manufacture of builders' carpentry and joinery	0.32	-0.16	-0.16				
	342. Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	0.06	-0.25	-0.13				

Note: The values presented are 5-year moving average means classified by 95% confidence intervals.

Table 6: Comparison of statistical properties of industry characteristics for modes of liberalization and comparative advantage and comparative disadvantage groups in extra-EU15 trade (1995-2007)

One-sample t-test						
H_0	H_A	All	Export-biased	Symmetric	Export-side	Import-side
$\Delta(\text{exporters share})_{CA} = 0$	$\Delta(\text{exporters share})_{CA} > 0$	0.7258	0.3327	0.5432	0.7951	0.8416
$\Delta(\text{exporters share})_{CD} = 0$	$\Delta(\text{exporters share})_{CD} > 0$	0.2733	0.2328	0.2713	0.9141	0.0610*
$\Delta(\text{non-exporters share})_{CA} = 0$	$\Delta(\text{non-exporters share})_{CA} < 0$	0.2958	0.6682	0.4990	0.1501	0.1072*
$\Delta(\text{non-exporters share})_{CD} = 0$	$\Delta(\text{non-exporters share})_{CD} < 0$	0.3512	0.6399	0.2094	0.0783*	0.8283
$\Delta(\text{average firm size})_{CA} = 0$	$\Delta(\text{average firm size})_{CA} > 0$	0.9585	0.8485	0.6345	0.8946	0.9405
$\Delta(\text{average firm size})_{CD} = 0$	$\Delta(\text{average firm size})_{CD} > 0$	0.8990	0.2106	0.9020	0.3026	0.8106
$\Delta(\text{average firm productivity})_{CA} = 0$	$\Delta(\text{average firm productivity})_{CA} > 0$	0.6711	0.3546	0.0474*	0.2878	0.9580
$\Delta(\text{average firm productivity})_{CD} = 0$	$\Delta(\text{average firm productivity})_{CD} > 0$	0.2559	0.2849	0.3128	0.2603	0.6312
$\Delta(\text{employment share})_{CA} = 0$	$\Delta(\text{employment share})_{CA} > 0$	0.6761	0.4052	0.2446	0.3549	0.9795
$\Delta(\text{employment share})_{CD} = 0$	$\Delta(\text{employment share})_{CD} < 0$	0.3239	0.9692	0.3482	0.0301*	0.9397
Two-sample t-test on equality of means						
H_0	H_A	All	Export-biased	Symmetric	Export-side	Import-side
$\Delta(\text{exporters share})_{CA} = \Delta(\text{exporters share})_{CD}$	$\Delta(\text{exporters share})_{CA} > \Delta(\text{exporters share})_{CD}$	0.7987	0.3368	0.3667	0.8021	0.1285
$\Delta(\text{non-exporters share})_{CA} = \Delta(\text{non-exporters share})_{CD}$	$-\Delta(\text{non-exporters share})_{CA} > -\Delta(\text{non-exporters share})_{CD}$	0.6000	0.5237	0.4037	0.4938	0.9091
$\Delta(\text{average firm size})_{CA} = \Delta(\text{average firm size})_{CD}$	$\Delta(\text{average firm size})_{CA} > \Delta(\text{average firm size})_{CD}$	0.2048	0.1041*	0.8242	0.0905*	0.4585
$\Delta(\text{average firm productivity})_{CA} = \Delta(\text{average firm productivity})_{CD}$	$\Delta(\text{average firm productivity})_{CA} > \Delta(\text{average firm productivity})_{CD}$	0.2176	0.6404	0.7136	0.3457	0.0859*

Note: P-values are shown. Those P-values lower than 0.10 are highlighted by an asterisk.

Table 7: Pooled regression results for industry characteristics by modes of liberalization and direction of comparative advantage in extra-EU15 trade (1995-2007)

	Employment (industry share)	Number of exporters (industry share)	Number of non-exporters (industry share)	Average firm size	Average firm productivity
Export-biased * CA	**-0.0051*†**	-0.004	0.007	**16.7*†**	**0.0067*†**
Symmetric * CA	**0.0045*†**	**0.010*†**	**0.022*†**	4.5†	**0.0023***
Export-side * CA	0.0029†	0.003†	0.006†	**46.6*†**	-0.0019†
Import-side * CA	**0.0130*†**	**0.024*†**	**0.032*†**	-21.0†	**0.0105***
Export-biased	**0.0050***	**0.005***	**-0.008***	-1.2	**-0.0018***
Symmetric	**-0.0047***	**-0.009***	**-0.018***	**15.3***	**0.0031***
Export-side	**-0.0059***	**-0.011***	**-0.015***	**17.2***	**0.0065***
Import-side	**-0.0070***	**-0.012***	**-0.019***	**61.6***	**0.0063***
CA	-0.0005	-0.001	**-0.009***	0.3	0.0004
Constant	**0.0126***	**0.014***	**0.023***	**18.6***	**0.0024***
# obs	1079	1079	1079	1079	1079
F-test	**22.35***	**36.01***	**58.75***	**24.91***	**40.54***
R^2	0.0761	0.1171	0.1073	0.0451	0.065
Root MSE	0.0111	0.0171	0.0201	108.53	0.0150

Note: Coefficients estimated using robust standard errors are shown. Those with P-values lower than 0.10 are highlighted by an asterisk. The rejection of equality between mode of liberalization coefficients for CA and CD industry types at 10% is highlighted by a dagger placed by the CA mode of liberalization parameter.