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Intra and Extra-EU Intra-Industry Trade in Greece: Trends, Determinants, and Structural Adjustment

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Abstract. This paper examines the effects of the European integration process on Greece's intra-EU vis-à-vis extra-EU intra-industry trade (IIT) patterns over the 1981-2002 period and assesses the associated trade-induced structural adjustment costs. Furthermore, the trade developments between Greece and the Central and Eastern European Countries (CEECs) during the last decade are also examined. Our results indicate that intra-EU and extra-EU IIT in Greece exhibit diverging trends. IIT outside the EU is higher and displays a significant upward trend, whereas the extent of intra-EU IIT of Greece is generally lower and shows a decreasing trend. Comparative advantage considerations seem to determine Greece's intra-EU and extra-EU IIT. Greece's IIT with the CEECs is particularly low and to some extent declining. Our analysis suggests increasing inter-industry specialization and trade-induced adjustment costs for Greece's trade with the EU-15 and the new members.

JEL Classification Codes: F14; F15.
Keywords: Intra-industry trade; Trade-induced adjustment costs; European economic integration; Greece; EU.

1. Introduction

Trade liberalization and increasing economic integration within the European economic space induced a huge intra-European trade expansion over the last 45 years. Interestingly, one of the main features of European economic integration is that this trade expansion took the form of intra-industry trade (IIT) – the two-way exchange of commodities that belong in the same industry classification and exhibit similar production requirements – rather than inter-industry trade, especially in the early stages of integration,

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where European Union (EU) members displayed many similarities in their economic structures.

Since the 1960s analyses of IIT have been a major focus of trade economists. Because IIT reveals intra-industry specialization it implies lower trade-induced (labour) adjustment costs to member states. "Intra-industry trade poses fewer adjustment problems than inter-industry trade" (Krugman, 1981; p. 970), and thus economic integration is less problematic for members if it entails a large extent intra-industry specialization. In the literature, this reasoning has become known as the "smooth adjustment hypothesis". In addition, growing intra-regional IIT indicates to some extent a process of convergence in trade patterns and economic structures, and by extension a convergence in the level of economic development.

Since European economic integration is one of the most advanced processes of regional integration and is moving towards a deeper form of integration, a large number of studies on IIT are devoted to the EU (Brulhart, 1998; Brulhart and Elliott, 1998; Greenaway, 1987; Greenaway and Hine, 1991). However, most studies take a broad view of the European Union, without taking into account the special characteristics of individual EU member economies, and examine exclusively the development of intra-EU IIT patterns. Since European integration has a strong effect on member countries intra-regional trade and overall trade patterns, a question that arises is how the integration process has affected intra-EU and extra-EU IIT patterns.

In this paper, we investigate Greece's experience of IIT development and adjustment cost implications during her process of European economic integration. In particular, the main focus is on the intra-EU and extra-EU dimension of Greece's IIT over the 1981-2002 period, which should shed some light on the specific features and industry characteristics of these two dimensions. Though we do not examine industrial similarities and economic growth issues, our results may provide an indication of Greece's convergence efforts in her overall trade and economic structure vis-à-vis the European Union. Additionally, a country-specific analysis of IIT with the Central and Eastern European Countries (CEECs) is also conducted, as these countries constitute the new member states of the enlarged European Union, which obviously has important implications for the intra-EU versus extra-EU IIT development in Greece in the future.

The paper is organized as follows. In the next section, the theoretical background of international trade theory and the structural adjustment cost implications of IIT are briefly reviewed. Section 3, analyzes the intra-EU and extra-EU IIT patterns in Greece over the 1981-2002 period and discusses Greece's experience with regard to trade-induced adjustment costs. Section 4 examines the industry-specific determinants of Greece's IIT within and outside the EU. Section 5 examines the trends and the country-specific determinants of bilateral IIT between Greece and the CEECs during the 1992-2002 period, as well as the structural adjustment cost implications of bilateral trade expansion. Finally, section 6 points out the main findings and concludes.

2. Theoretical Background

2.1. International trade theory and IIT

In general, the expansion of trade flows between countries can be of the inter-industry type as well as of the intra-industry type. Inter-industry trade is the "traditional" one-way trade, where different products that belong in different industries are exchanged, while intra-industry trade can be defined as the two-way exchange of similar products that belong in the same industry. The former trade type prevails between countries with different relative factor endowments (and usually with different levels of income and economic development), whereas the latter takes place between developed and industrialized countries with similar factor endowments.

Since traditional comparative advantage models of international trade and specialization[1] are incompatible with IIT, they have long been criticized as an insufficient theoretical framework, which does not capture a considerable part of forces that are crucial in shaping and explaining trade patterns (Grubel, 1967 and 1970; Hufbauer and Chilas, 1974). The empirical observation that since the post-war period IIT shares are consistently growing, manifested the need for the development of alternative trade theories and stimulated the research on various theoretical and empirical issues of IIT.

As a response to that fact, in the 1980s and 1990s we saw developments in trade and location theory, which have been labelled as the

[1] Ricardo (1817); Heckscher (1919); Ohlin (1933); Vanek (1968).

"new" theories of trade and economic geography. The models by Krugman (1979; 1980; 1981) and Helpman and Krugman (1985), known as the "new trade theory", showed formally for the first time that scale economies and product differentiation (greater variety of products) could be a basis and source of international trade and aggregate welfare gains.

Theoretical advances in economic geography models occurred in the 1990s (Krugman, 1991a,b; Krugman and Venables, 1995a,b; Venables, 1996). These models, known as the "new economic geography" focus on externalities, technological spillovers, and input-output linkages among industries as the determinants of agglomeration and industrial concentration. These linkages create a circular process of causation and thus the economic geography and interregional trade is endogenously determined.

In the traditional neo-classical trade theory, international trade and specialization is driven by national differences in technologies and relative factor endowments. In this setting, economic integration leads to inter-industry trade and thus inter-industry specialization. On the other hand, the "new trade theory" incorporates industry-specific characteristics such as economies of scale, differentiated goods, imperfect competition, trade costs, and draws attention to domestic market size. In this case, economic integration can induce inter-industry or intra-industry specialization, depending on the importance of scale economies and trade costs. As trade costs fall towards zero, IIT diminishes and the increasing returns industry tends to concentrate in the large market (the core country).

2.2. IIT and the smooth adjustment hypothesis

Though trade economists emphasize the gains from international trade and specialization, changes in specialization patterns, as a result of trade liberalization and economic integration, are associated with trade-induced adjustment costs, at least in the short-run. Trade-induced adjustment can be thought of as any change in the domestic economy that is caused by trade liberalization (with everything else being constant); or as any change due to any exogenous (to the domestic economy) adjustment in the international economy (e.g. change in world market prices, relative demand, etc.). All these changes affect trade flows and trade patterns and thus also affect domestic conditions (production, distribution of wealth, production factors, etc.).

Although in principle trade-induced adjustment affects all production factors, special attention has been given to labour, as the adjustment issue is particularly salient in the labour-market context. Neary's (1985) specific-factors model considers the issue of labour adjustment in the context of trade liberalization. In this model a small open economy produces and consumes an exportable and an importable product, where labour is the only production factor that is mobile between the two sectors, but not between countries (all other factors are "specific" and thus fixed).

In the theoretical case of perfectly smooth adjustment, a change in the relative demand for either product leads the economy to a new equilibrium instantaneously, where the necessary labour adjustment has taken place without any cost or delay. In this case, the switching of labour between the export and import sector has occurred instantaneously and according to the change in the relative demand (e.g. a rise in the relative demand for the exportable product causes the switching of labour from the contracting sector, that produces the importable good, to the expanding sector that produces the exportable good). However, this adjustment process (the switching of labour between the export and import sector) may well be costly. As Neary (1985) has shown, trade-induced adjustment costs can arise from the imperfect substitutability of labour (which reduces the extent of labour mobility between the two sectors) and wage rigidities, which will both lead to incomplete adjustment. Here adjustment costs emerge when markets fail to clear quickly in response to changes in prices and relative demand conditions.

Thus, adjustment costs represent phenomena, such as the unemployment caused by trade liberalization and the cost of switching workers from the contracting import sector to the expanding export sector of the economy. This cost of switching labour from one sector to the other includes the cost of the re-training and relocation of the workforce. In (neo-classical) theory, adjustment costs are temporary because the necessary adjustment takes place in the short-run. In practice however, the adjustment process may be long-run orientated because of the inflexibilities and rigidities mentioned previously, which cause unemployment to be present also in the longer-run.

International economic integration may have serious implications for structural adjustment if it leads to substantial inter-industry specialization. As already mentioned, the "smooth adjustment hypothesis" postulates that IIT is associated with lower trade-induced adjustment costs than inter-industry trade is. This reasoning suggests that adjustment is smoother if the contracting and expanding activities are contained within the same industry and thus assumes that either labour mobility or wage flexibility (or both) is higher within industries than between industries.

The latter assumption seems to be less realistic and plausible, as generally the degree of wage flexibility within the same industry is about the same and is primarily determined by minimum-wage legislation and labour market regulations that apply either to the whole industry or to the entire economy. On the other hand, the former assumption appears to be more reasonable. Since IIT involves the exchange of similar goods with similar production requirements, labour requirements are expected to be more similar within industries. This in turn implies that labour substitutability and mobility is higher within than between industries. Hence, intra-industry adjustment appears to be smoother and less "costly" than adjustment that takes place between industries.

3. Intra and Extra-EU IIT Patterns in Greece

3.1. Methodology and measurement of IIT

Since the purpose of our analysis is the examination of trends and patterns of intra-EU and extra-EU IIT in Greece, the focus is on these two dimensions and thus the analysis is an industry-specific examination of Greece's IIT, where bilateral IIT relations are not investigated. Here EU refers to the EU-15 for the whole period under investigation. The study uses trade data that are disaggregated at the three-digit level of the Standard International Trade Classification (SITC) and are obtained from the United Nations COMTRADE database for the years 1981, 1986, 1991, 1996 and 2002. Intra-EU and extra-EU IIT in Greece is estimated for those years using the Grubel-Lloyd (1975) index, which is the most widely used measure of IIT in the empirical literature. The Grubel-Lloyd (GL) index is defined as:

$$IIT = GL_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \qquad (1)$$

where X_i and M_i are exports and imports of industry *i*, respectively. The GL index ranges between zero and one, where an index value of zero indicates trade in industry *i* to be completely of the inter-industry type, and a value of one indicates complete intra-industry trade. Furthermore, our analysis of IIT is not only concerned with one time point (year), but is rather a dynamic analysis, in the sense that it examines the development of IIT patterns. The recent literature argues that information on the pattern of the change in trade (IIT) flows cannot be revealed by the “static” GL index (Hamilton and Kniest, 1991; Greenaway et al., 1994; Brulhart, 1994). Therefore, this paper employs complementarily Brulhart’s (1994) A index of MIIT, which is given by:

$$MIIT = A_i = 1 - \frac{\left|\left(X_{i(t)} - X_{i(t-n)}\right) - \left(M_{i(t)} - M_{i(t-n)}\right)\right|}{\left|X_{i(t)} - X_{i(t-n)}\right| + \left|M_{i(t)} - M_{i(t-n)}\right|} \qquad (2)$$

where $X_{i(t)}$ and $M_{i(t)}$ denote exports and imports of industry i in year t, respectively, and n represents the number of years of the adjustment period. This index takes values between zero and one, where a low values of the A index reflects that a country’s exports and imports in a particular industry change (increase or decrease) disproportionately, and thus marginal (or new) trade in that industry is more of the inter-industry type. On the other hand, a high value of the A index implies that marginal trade is more of the intra-industry type.

3.2. IIT patterns and trends

Our analytical results for Greece’s IIT patterns by industry (aggregated to one-digit SITC sections) are reported in Tables 1 and 2. It is evident that the extent of Greece’s IIT *outside* the EU is higher than the respective extent *within* the EU and that intra-EU and extra-EU IIT move in different directions. Notably, intra-EU IIT follows a similar development with intra-EU trade in Greece in general.

Although extra-EU IIT declined in the first sub-period (1981-86), it increased dramatically afterwards. These broad trends reveal that during the first years of integration, where Greece experienced the highest intra-EU trade expansion, intra-EU IIT has increased at the expense of extra-EU IIT. In this case, Greece’s IIT with non-EU countries, which was relatively more important just before and at the first year of integration, fell below the intra-EU IIT level of the year 1986. Manufacturing IIT appears to be lower than overall IIT for the whole period under investigation. Non-manufacturing sectors exhibit consistently higher GL indices than manufacturing, especially Mineral Fuels, Crude materials, and Food and live animals. This result runs counter to the stylized fact that manufactured goods exhibit the highest levels of IIT and illustrates clearly the great importance of non-manufactures in Greece’s production and trade patterns, and the dissimilarity of Greece’s economic structure when compared to the EU structure.

The finding of high intra-EU IIT in primary and agricultural products could also point to the especially favourable treatment and protection that agricultural production enjoys within the European Union (e.g. due to the EU’s Common Agricultural Policy). As in the case of overall IIT, intra-EU manufacturing IIT in Greece exhibits a significant downward trend in recent years. However, between 1981 and 2002 there have been significant increases in IIT levels of some specific manufacturing industries, especially those industries that are classified under SITC sections 5 (Chemicals) and 7 (Machinery and transport equipment).

Interestingly, there are some important differences between intra-EU and extra-EU IIT patterns. In contrast with the case of intra-EU IIT, the level of extra-EU manufacturing IIT is higher than the level of non-manufacturing extra-EU IIT in certain years (1981, 1986 and 2002). In this case, some of the manufacturing industries display the highest IIT indices, especially those industries that are within SITC sections 5 (Chemicals) and 6 (Manufactured goods classified by material), whereas non-manufactures exhibit relatively low and moderate IIT levels. There are strong opposing trends between intra-EU and extra-EU IIT. Most industries exhibit higher extra-EU IIT levels as well as higher extra-EU IIT growth rates.

Another aspect of our analysis is marginal intra-industry trade, which is examined for intra-EU and extra-EU trade and for the time intervals 1981-86, 1986-91, 1991-96, and 1996-2002 (Tables 3 and 4). Overall intra-EU MIIT in Greece displays a downward trend (the proportion of IIT in new trade created during the time intervals decreases in the subsequent sub-periods), whereas in the case of manufactures there is an initial increasing trend that afterwards stagnates (Table 3). In the first sub-period (1981-86) about 25% of marginal trade was IIT, while in the last sub-period (1996-2002) about 20% of new trade created during this interval was IIT. As we would expect, in the first sub-periods MIIT levels were higher, as in these time intervals IIT levels increased. However, this has not always been the case, as an increase in the IIT level between two time points is compatible with an increase in inter-industry trade flows.

Extra-EU MIIT is also relatively more important in non-manufactures, except in the last time interval. However, in extra-EU MIIT there is an upward trend in both manufacturing and non-manufacturing MIIT, except in the last time period. The highest level of extra-EU MIIT is found in the time interval 1991-96, where about 40% of new trade created was IIT. Hence, it is evident that the increases in the IIT levels in Greece – for both intra-EU and extra-EU – are associated with a large amount of inter-industry trade flows, suggesting that significant inter-industry adjustments have taken place.

3.3. Intra-EU and extra-EU IIT in Greece by industry category

Having examined the observed IIT levels in Greece, we now conduct a more analytical examination by considering certain descriptive industry characteristics. These characteristics should reflect some basic features of IIT in Greece as well as important factors that shape the observed IIT patterns. For the purpose of our analysis, a good categorization of industries (commodity groups), which contains relevant information on some industry characteristics, has been compiled by UNCTAD (2002), which "classifies each product group into different categories according to the mix of different skill, technology and capital intensities and scale characteristics" (p. 87).

The categories distinguished are the following:[2] (1) Primary commodities, (2) Labour-intensive and resource based manufactures, (3) Manufactures with low skill and technology intensity, (4) Manufactures with medium skill and technology intensity, (5) Manufactures with high skill and technology intensity. In order to uncover the features and factors of Greece's IIT, we classify each commodity group of our sample into one of these categories and calculate the average IIT levels for each category over the whole sample period, as done, for instance, in Brulhart (1998). The results for intra-EU IIT and extra-EU IIT by industry category are plotted in Figures 1 and 2, respectively. From Figure 1 it is evident that Greece's intra-EU IIT is highest in primary goods. However, this industry category exhibits a significant downward trend. Labour and resource-intensive industries have the second highest IIT levels and exhibit a declining trend in recent years. Industries characterized as low skill and technology-intensive exhibit an upward trend until 1991 and then IIT levels decline slightly. In recent years, average IIT in this industry category amounts to about 25% of total trade of this industry group (GL index has a value close to 0,25). The industry categories that show the lowest IIT levels are the medium and the high skill

[2] In the UNCTAD (2002) report one more category is distinguished, "Unclassified products", which is not considered in our analysis.

and technology industries, which show an increasing trend over the 1981-2002 period. However, IIT in those industries is still very low.

On the other hand, a different picture emerges in the case of Greece's extra-EU IIT, as evidenced in Figure 2. Here, the primary goods category shows one of the lowest average IIT indices, but with a significant increasing trend. Extra-EU IIT in Greece is found to be important in labour and resource-intensive industries, as witnessed by the high average GL value for that industry category. Interestingly, the medium and the high skill and technology-intensive industries show a significant upward trend during our sample period (especially the medium skill and technology-intensive industry category). The results of our analysis illustrate that non-manufactures as well as labour and resource-intensive manufactures account for a large part of observed intra-EU IIT levels in Greece, whereas manufactures with high skill (medium skill) and technology intensity are less important in shaping Greece's IIT within the EU. In the case of extra-EU IIT it is also found that labour and resource-intensive industries shape Greece's IIT outside the EU, with the difference however that high and especially medium skill and technology-intensive manufactures play an increasingly important role in extra-EU IIT in Greece with relatively high IIT levels in recent years.

4. Determinants of Intra-EU and Extra-EU IIT in Greece

4.1. Explanatory variables and econometric specification

The previous section examined IIT trends as well as some descriptive industry characteristics associated with intra and extra-EU IIT in Greece. However, the analysis of descriptive industry characteristics neither constitutes nor gives adequate information on the determinants of IIT. Therefore, in this section we examine the industry-specific determinants of Greece's IIT by estimating two econometric models (one for intra-EU IIT and one for extra-EU IIT).

Since information on industry-specific variables are obtained from industrial statistics, where the data are provided according to an industrial classification which is different than the SITC classification of trade data, we have to classify-aggregate our calculated 3-digit SITC IIT indices into ISIC industries for which information on industrial data for Greece is available.[3] Our source for industrial statistics is the OECD's Structural Statistics for Industry and Services (SSIS) database,[4] which provides various relevant industrial data for Greece for 28 manufacturing industries at the 3-digit ISIC (rev. 2) level from 1970 until 1992, as well as the OECD STAN for Structural Analysis database, which provides data for Greece for 23 2-digit ISIC (rev. 3) industries from 1995 and onwards.[5] We use these two databases to perform two distinct econometric estimations. We do not combine the data into one dataset because in the STAN database some variables are not available compared to the SSIS database for Greece, and thus the combination would reduce the available data and variables examined in our econometric analysis. However, the SSIS dataset has data for Greece until the year 1992 and since our calculated IIT indices refer only to five time points (1981, 1986, 1991, 1996, and 2002) in our econometric model we can include and examine only the years 1981, 1986, and 1991. In order to examine also the more recent time points (1996 and 2002), we estimate an econometric model, which has less explanatory variables due to the lack of data, for those more recent years.

The relevant theoretical literature (new trade theory, IIT models) is the guideline for our econometric specification of industry-specific determinants. As (horizontal) product differentiation plays an important role in the emergence of IIT in (H)IIT models with monopolistic competition (e.g. Krugman, 1980) or oligopoly (e.g. Brander, 1981), the first explanatory variable to be included and examined in the model is product differentiation (*PD*). Following Greenaway et al. (1995, 1999), we use information on the number of 5-digit SITC products to proxy *PD*. Here, the *PD* variable is proxied by the number of 5-digit SITC products in each 3-digit ISIC (rev. 2) industry included in our sample for the econometric model considering the years 1981, 1981, and 1991, and in each 2-digit ISIC (rev. 3) industry in the model examining the years 1996 and 2002.

Another crucial factor for the emergence and explanation of IIT, as emphasized by the new trade theory, are economies of scale. Given the data

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[3] This conversion is based on a SITC-ISIC industry concordance by Maskus (1991).
[4] SSIS – Industrial Surveys ISIC (rev. 2), Vol. 2003, release 01.
[5] The conversion from 3-digit SITC to 3-digit ISIC (rev. 2) is based on a SITC-ISIC concordance by Maskus (1991). For the conversion into 2-digit ISIC (rev. 3) industries the concordance tables of the United Nations' statistics division have been used. In the Appendix, the 2 and 3-digit ISIC industries used in our analysis are presented.

availability, for the first model we use two alternative proxies for the scale economies (*SE*) variable, as the sign of the estimated coefficient and statistical significance of this variable often depends on the measure used. Since in many studies average plant size is used as a proxy for the importance of scale economies in an industry, we also make use of this measure, which is defined as follows:

$$SE = \frac{E_i}{n_i}$$

where E_i is total industry employment of industry i and n_i is the number of firms in industry i. The second proxy for the *SE* variable is based on Pratten's (1988) industry ranking of scale economies, where internal increasing returns to scale are measured by engineering firm-level cost functions on the basis of estimates given by engineers, managers and economists. Based on Pratten's (1988) ranking, we distinguish three categories of scale economies (high, intermediate and low) and allocate our industries into one of these three categories in a similar way as in Brulhart (1998). Thus, the *SE* variable is constructed as follows. Industries characterized by low scale economies take a value of 1, intermediate scale economies industries a value of 2, and industries with high scale economies a value of 3.

Market structure (*MS*) is also regarded as an important industry-specific determinant of IIT. Following Greenaway et al. (1995, 1999) and other studies in the field, we proxy *MS* by the number of firms within an industry. Since IIT can arise in a monopolistically competitive industry structure (large firm number case) as well as in an oligopolistic market structure (small firm number case), it is mainly an empirical issue to determine the relationship between IIT and industry structure, although the dominant theoretical framework is represented by the monopolistic competition case.

In addition to the above deterministic factors as postulated by the new trade theory, it is interesting to investigate additional industry-specific determinants. The first additional factor to be included is the degree of openness of an industry (*OP*), defined as follows:

$$OP = \frac{X_i + M_i}{Q_i}$$

where X_i, M_i and Q_i are exports, imports and output of industry *i*, respectively. This index measures the importance of an industry's international trade to the industry's production. The sign of this explanatory variable may in general be positive or negative, but we would expect more open industries to exhibit higher IIT levels. We also include and test whether the export sector of Greece engages in more IIT; that is whether industries with high export shares in total Greek manufacturing exports (thus export sectors) exhibit high IIT levels. The *XS* variable is defined as follows:

$$XS = \frac{X_i}{\sum_i^n X_i}$$

where *Xi* denotes exports of industry *i*, and $\Sigma_i X_i$ represents total manufacturing exports. Finally, we test whether industries with a high proportion of intermediate inputs in final production exhibit higher IIT levels. This reasoning follows from the fact that a large part of IIT takes place in the form of intra-firm trade or intermediate goods within the same industry for further processing and production of final consumer goods (known as vertical specialization or vertical IIT which is not based on quality product differentiation but on trade of goods in different stages of production). Following Amiti (1999) we proxy intermediate goods intensity in an industry (*IN*) by the following measure:

$$IN = \frac{Q_i - VA_i}{Q_i}$$

Where Q_i and VA_i denote production (output) and value added in industry *i*, respectively. This measure, however, does not distinguish between domestic and international intermediate inputs, and thus does not fully reflect international input use or vertical specialization of an industry.

Thus, the testable industry-specific determinants of Greece's intra-EU and extra-EU IIT are given by the following equations:

$$IIT_{it} = \beta_0 + \beta_1 PD_{it} + \beta_2 SE_{it} + \beta_3 MS_{it} + \beta_4 OP_{it} + \beta_5 XS_{it} + \beta_6 IN_{it} + \mu_i + \nu_t + u_{it} \qquad (3)$$

(for i = 28 and t = 3; 28 3-digit ISIC (rev. 2) industries for the years 1981, 1986, 1991)

$$IIT_{it} = \beta_0 + \beta_1 PD_{it} + \beta_2 SE_{it} + \beta_3 OP_{it} + \beta_4 XS_{it} + \mu_i + \nu_t + u_{it} \qquad (4)$$

(for i = 23 and t = 2; 23 2-digit ISIC (rev. 3) industries for the years 1996, 2002)

where IIT_{it} is intra-EU IIT or extra-EU-IIT of industry i in year t (depending on the model for estimation), β_1, β_2, β_3, β_4, β_5, β_6 are the parameters to be estimated, μ_i are unobserved industry-specific fixed effects, ν_t are time-specific fixed effects, and u_{it} is the error term. All explanatory variables enter the regression in natural logs. Furthermore, because the dependent variable (GL index) of both models is bound between 0 and 1, the estimated regression models (with Ordinary Least Squares) could have predicted values that lie outside the theoretically feasible interval [0, 1]. Therefore following Hummels and Levinsohn (1995), we apply the logistic transformation of the logit function to the GL index as follows:

$$\text{Transformed GL index} = \log\left(\frac{GL_{it}}{1 - GL_{it}}\right) \qquad (5)$$

Both models (1981-1991 and 1996-2002) for both IIT (intra-EU and extra-EU) are fixed-effects panel data models. A fixed-effects estimator is used in order to take account of unobserved industry and time-specific effects. Additionally, since the panel that makes up the sample has not been randomly selected but includes all ISIC manufacturing industries, the fixed-effects estimator is the appropriate estimation method.

4.2. Econometric results

Our econometric results are reported in Table 5. In the first two rows the results for the intra-EU IIT for the period 1981-1991 with the two alternative measures of scale economies are shown (specification (1) and (2) respectively). Similarly, the results in rows 3 and 4 refer to extra-EU IIT for each alternative specification (again for the years 1981, 1986, and 1991). In the last two rows, the results for the industry-specific determinants for intra-EU and extra-EU IIT for the period 1996-2002 are presented.

As it is evident from Table 5, our empirical results indicate that for both intra-EU and extra-EU IIT for the period 1981-1991 product differentiation, market structure, openness to the international economy, and export sectors are important industry-specific determinants of Greece's IIT within and outside the EU. The MS variable exhibits a positive sign, indicating that in the Greek case industries with a large number of firms exhibit higher IIT levels. Thus, our results support the large number case of IIT (monopolistic competition).

The intermediate inputs intensity variable is found to exhibit a negative coefficient and is not statistically significant, indicating that industries with a high proportion of intermediate goods in production do not exhibit higher IIT levels. Similarly, the scale economies variable with both measures (specification 1 and 2) for both intra-EU and extra-EU IIT exhibits an unexpected negative effect on IIT levels. However, the estimated coefficient is not statistically significant. Thus, having employed two alternative measures of scale economies, our results indicate that for Greece's IIT scale economies are not an important industry-specific determinant. According to our econometric models, the export sector (*XS*) variable and the product differentiation variable exert the strongest effect on Greece's IIT, and thus are found to be the relatively most important industry-specific determinants.

Turning to the econometric results for the period 1996-2002, it is evident that in general a similar picture emerges. Again the *XS*, *PD* and *OP* variables are found to exhibit a statistically significant and positive effect on (intra and extra-EU) IIT and are the most important determinants (in order of appearance). However, in contrast to the models for the 1981-1991 period the SE variable exhibits a positive coefficient, which is in accordance with theoretical expectations. Though scale economies are found to exert a positive effect on Greece's intra-EU and extra-EU IIT, our econometric analysis indicates that this effect is not statistically significant (as evident by the p-values).

5. Greece's Intra-Industry Trade with the CEECs

5.1. Bilateral IIT patterns

In this section we examine Greece's IIT and MIIT trends with the CEECs, which since 1st of May 2004 constitute the new members of the EU. The insights of this analysis should allow us to gain an appreciation regarding the likely trends and patterns of trade and specialization between Greece and the CEECs in the future. As it can be seen from Figure 3, the international trade relations of Greece with eastern European countries have become more important over time. More specifically, bilateral trade is highest with Poland, the Czech Republic and Hungary, and lowest with the three Baltic countries, Estonia, Latvia and Lithuania.

Regarding our IIT analysis, we have calculated IIT indices annually for each 3-digit SITC industry for the whole period 1992-2002.[6] The results for overall IIT and manufacturing IIT are presented in Figures 4 and 5, respectively.

From Figure 4 it becomes apparent that Greece's bilateral overall IIT levels with the CEECs are particularly low, especially with Estonia, Latvia and Lithuania. The highest bilateral IIT indices are found for the relatively larger countries (Poland and Hungary) as well as for the more advanced and developed transition economies (Slovenia and the Czech Republic). Notably between 1992 and 2002, Greece's IIT either decreased or stagnated with most countries, whereas bilateral IIT increased significantly only with Hungary.

As regards manufacturing IIT (Figure 5), IIT in manufactures appears to be slightly higher than overall IIT (and thus higher than IIT in non-manufactures), but can be characterized as very low, especially if one considers that in general, IIT prevails and is much higher in manufactured products. Manufacturing IIT in Greece exhibits a decreasing trend with all countries (especially with Slovenia), with the exception of Hungary, where a significant growth in IIT levels has been achieved (there is also a slight IIT increase with Lithuania). Comparing the results of the two figures we conclude that the observed downward trend or stagnation of total IIT is a result of the declining IIT levels in manufacturing products. This implies that there is an increasing trend of inter-industry specialization in manufactures between Greece and the CEECs, suggesting additionally increased trade-induced structural adjustment pressures. However, in order to have a clearer picture on the adjustment implications of the bilateral trade expansion between Greece and the new EU members we calculate bilateral MIIT indices for the adjustment period 1992-2002. The results of the MIIT analysis, which are depicted in Figure 6, indicate that in general countries

[6] For the Czech Republic and Slovakia the analysis refers to the time period 1993-2002.

with high values of bilateral GL indices tend to have high values of A indices (e.g. Hungary and Poland). Bilateral trade expansion with these countries has been associated mainly with increased IIT flows and thus intra-industry adjustment as well as to some extent with inter-industry trade flows. On the other hand, bilateral trade expansion between Greece and the other eastern European countries has been mainly inter-industry in nature. Thus, our results indicate that there is an increasing trend of inter-industry specialization between Greece and most CEECs, implying increasing structural adjustment costs.

5.2. Determinants of bilateral IIT patterns

In this section, we investigate some standard country-specific determinants of bilateral IIT patterns between Greece and the CEECs, as emphasized in the theoretical and empirical literature. In general, country-specific factors of IIT (or trade in general) are found to be more significant (compared to industry-specific) and provide valuable information for economic policy, as they focus on cross-country differences. Thus, based on the available theoretical and empirical literature, we include and test the following country-specific explanatory variables (hypotheses) in our econometric model.

Hypothesis 1: The smaller the difference in per capita income, the greater the extent of intra-industry trade. According to the Linder (1961) hypothesis, countries with similar per capita income are likely to have similar demand structures, and thus produce and export similar products, which translates into higher IIT shares. The independent variable is the natural log of the absolute difference of per capita GDP between Greece (i) and the CEECs (j) in year t: $ln\ (PCGDPDIF_{ijt})$. Data Source: Author's calculations based on the United Nations National Accounts Main Aggregates Database.

Hypothesis 2: The smaller the difference in country (economic) size, the greater the extent of intra-industry trade. Both, theoretical models and empirical evidence suggest that IIT prevails among countries of similar economic size. The explanatory variable tested is the natural log of the absolute difference of GDP between Greece (*i*) and the CEECs (*j*) in year *t*: $ln\ (GDPDIF_{ijt})$. Data Source: Author's calculations based on the United Nations National Accounts Main Aggregates Database.

Hypothesis 3: The greater the average market-size of two trading economies, the greater the extent of intra-industry trade. Originally, this point has been made by Loertscher and Wolter (1980), who argued that IIT between two countries is expected to be high if the average size of their outputs is high. Thus, the independent variable included is the natural log of the average of *i*'s and *j*'s GDP in year *t*: $ln\ (AVGDP_{ijt})$. Data Source: Author's calculations based on the United Nations National Accounts Main Aggregates Database.

Hypothesis 4: The greater the bilateral trade intensity, the greater the extent of intra-industry trade. Although increased bilateral trade flows must not be associated with increased intra-industry trade flows, countries with initial high levels of IIT are likely to increase the absolute volume as well as the share of IIT. The variable tested is the natural log of the absolute bilateral trade volume between Greece (*i*) and the CEECs (*j*) in year *t*: $ln\ (TINT_{ijt})$. Data Source: Author's calculations based on the United Nations COMTRADE Database.

Hypothesis 5: The higher the transportation costs, the lower the extent of IIT. A basic result of the theoretical and empirical literature (e.g. gravity models of trade) is that IIT is negatively correlated with transportation costs. We use the geographical distance as a proxy for transportation costs. Thus, the natural log of the distance between the capital city of Greece (*i*) and the capital cities of the CEECs (*j*) is included as an additional explanatory variable: $ln\ (DIST_{ijt})$. Data Source: Author's calculations based on CEPII's Geographical and Distance Database.

Thus, our econometric model to be estimated (with the expected signs of the explanatory variables) has the following specification:

$$IIT_{ijt} = f\,(\underset{(-)}{PCGDPDIF_{ijt}},\ \underset{(-)}{GDPDIF_{ijt}},\ \underset{(+)}{AVGDP_{ijt}},\ \underset{(+)}{TINT_{itj}},\ \underset{(-)}{DIST_{ijt}})$$

The dependent variable is the overall (total) bilateral GL index between Greece and the CEECs in year *t*. The logistic transformation of the logit function has been applied to the IIT index, as specified in equation (5), in order to avoid the problem of the limited range of the GL index (values taken only between 0 and 1). We estimate a balanced fixed-effects panel data model (controlling for and taking into account country-specific and time-specific fixed effects) for the period 1993-2002.[7]

[7] Since there are no data for the Czech Republic and Slovakia prior to 1993, we estimate a balanced panel data model including the years 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, and 2002.

Our econometric results of the country-specific determinants of bilateral IIT between Greece and the CEECs are reported in Table 6. All explanatory variables exhibit the expected sign and are statistically significant. More specifically, bilateral differences in country-economic size (*GDPDIF*) and in the development level (*PCGDPDIF*), as well as the bilateral geographical distance (*DIST*) affect negatively the extent of bilateral IIT, whilst the size of the combined market (*AVGDP*) and the extent of bilateral trade flows (*TINT*) exert a positive effect on bilateral IIT levels.

As regards the relative importance of the country-specific deterministic factors of IIT in our model, bilateral differences in economic size between Greece and the CEECs seem to be the most important determinant of bilateral IIT, followed by bilateral trade intensity. The third most important factor of IIT is the combined market of the two trading partners. Furthermore, geographical distance between Greece and the eastern European countries, which proxies also for transport and trade costs, has also a strong influence on the level of bilateral IIT, as witnessed by the value of the standardized regression coefficient which is close to one.

6. Conclusions

This paper analyzed Greece's IIT patterns for intra-EU trade, extra-EU trade, and bilateral trade with the CEECs, discussed the trade-induced adjustment cost implications for Greece, and examined the industry and country-specific determinants of observed IIT patterns. Our empirical analysis revealed that intra-EU and extra-EU IIT in Greece exhibit diverging trends. Greece's IIT outside the EU is higher and displays a significant upward trend (though a certain stagnation in recent years is present), whereas the extent of intra-EU IIT in Greece is generally lower and shows a decreasing trend. In addition, Greece's manufacturing IIT within the EU is lower than IIT in non-manufactures and much lower than extra-EU manufacturing IIT, which is relatively more important in Greece's extra-EU IIT. These findings suggest a particularly high degree of inter-industry specialization of Greece within the EU, and thus a large dissimilarity in the economic structure of Greece compared to the EU's structure.

Greece's intra-EU IIT is mainly found in primary commodities (agricultural products and raw materials) and labour- and resource-intensive manufactures, which indicates that relative factor endowments play a crucial role for Greece's IIT within the EU. Extra-EU IIT in Greece seems to be shaped mainly by manufactures with high labour- and resource-intensities and low skill intensity, while primary goods represent the least important factor. Thus, comparative advantage considerations seem to be important for Greece's intra-EU and extra-EU trade patterns. With regard to structural adjustment, our results suggest that trade-induced adjustment costs in Greece may have become more severe over time, especially in recent years.

Our analysis for bilateral trade with the new EU members from eastern Europe revealed that Greece's IIT with the CEECs is particularly low, especially with the Baltic countries and that there have been no significant increases in bilateral IIT levels during the 1992-2002 period, but instead IIT has either decreased or remained unchanged. Furthermore, our analysis indicated that there is an increasing trend of inter-industry specialization between Greece and most CEECs, implying increasing structural adjustment costs. Hence, it seems that inter-industry trade and specialization between Greece and the CEECs is relatively more important, which is likely to increase in the future.

APPENDIX:
ISIC industries included in econometric analysis of industry-specific determinants of intra-EU and extra-EU IIT (equations 3 and 4)

3-digit ISIC rev. 2 Industries	2-digit ISIC rev. 3 Industries
311.2 Food	15 Food products and beverages
313 Beverages	16 Tobacco products
314 Tobacco	17 Textiles
321 Textiles	18 Wearing apparel; dressing
322 Wearing Apparel	and dyeing of fur
323 Leather & Products	19 Leather, leather products and footwear
324 Footwear	20 Wood and of products of wood
331 Wood Products	and cork, except furniture
332 Furnitures & Fixtures	21 Paper and paper products
341 Paper & Products	22 Publishing, printing and reproduction
342 Printing & Publishing	of recorded media
351 Industrial Chemicals	23 Coke, refined petroleum
352 Other Chemicals	products and nuclear fuel
353 Petroleum Refineries	24 Chemicals and chemical products
354 Petroleum & Coal Products	25 Rubber and plastics products
355 Rubber Products	26 Other non-metallic mineral products
356 Plastic Products, n.e.c	27 basic metals
361 Pottery, China etc	28 Fabricated metal products,
362 Glass & Products	except machinery and equipment
369 Non-Metallic Products, n.e.c	29 Machinery and equipment n.e.c.
371 Iron & Steel	30 Office, accounting and computing machinery
372 Non-Ferrous Metals	31 Electrical machinery and apparatus n.e.c.
381 Metal Products	32 Radio, television and communication
382 Non-Electrical Machinery	equipment and apparatus
383 Electrical Machinery	33 Medical, precision and optical instruments,
384 Transport Equipment	watches and clocks
385 Professional Goods	34 Motor vehicles, trailers and semi-trailers
39 Other Manufacturing, n.e.s	35 Other transport equipment
	36 Manufacture of furniture, manufacturing n.e.c.
	37 Recycling

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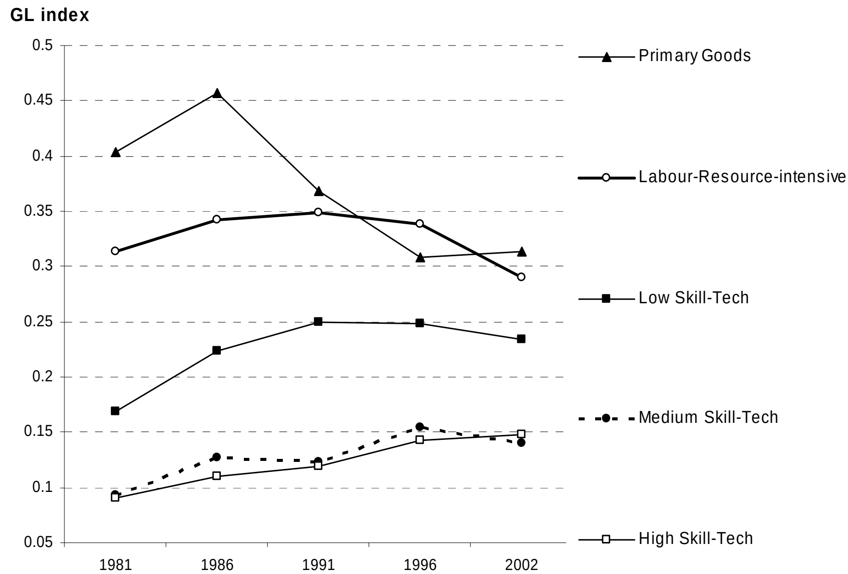


Figure 1. Greece's intra-EU IIT by industry category, 1981-2002

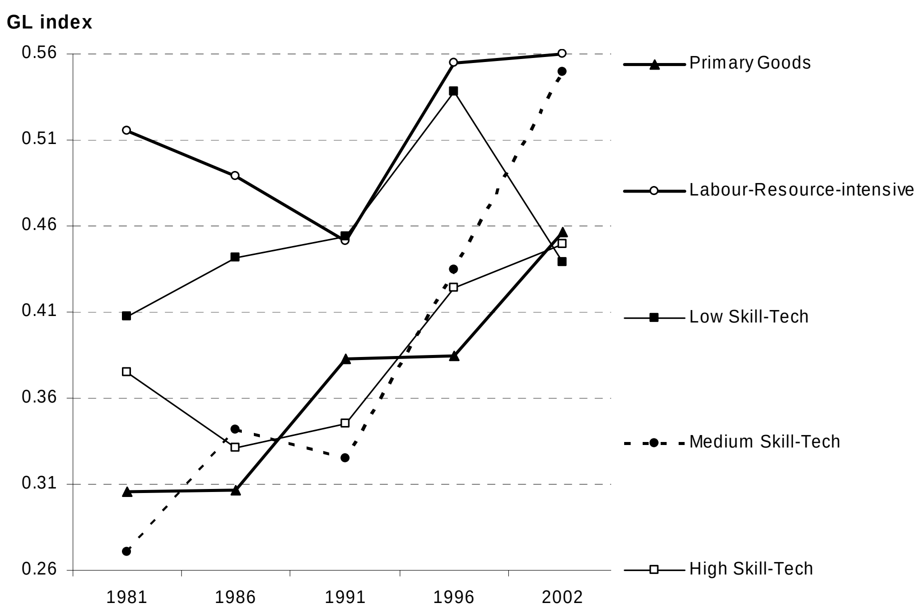
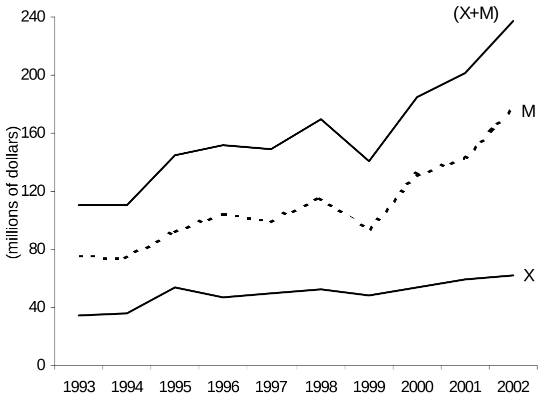
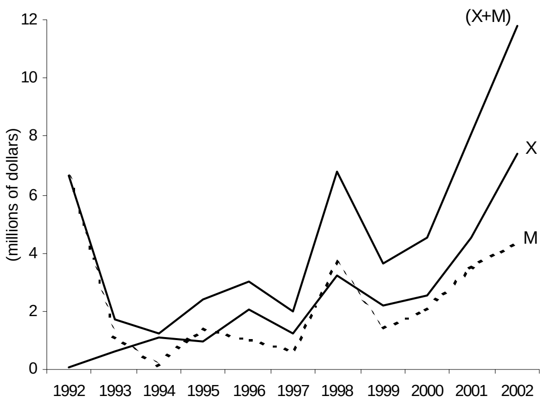


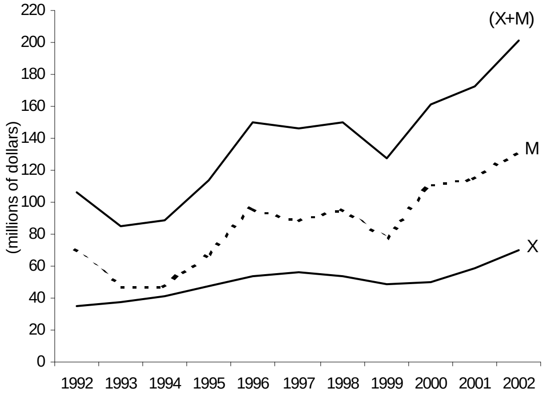
Figure 2. Greece's extra-EU IIT by industry category, 1981-2002



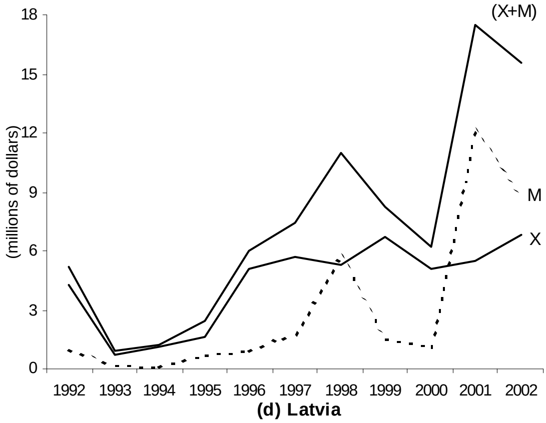
(a) Czech Republic



(b) Estonia

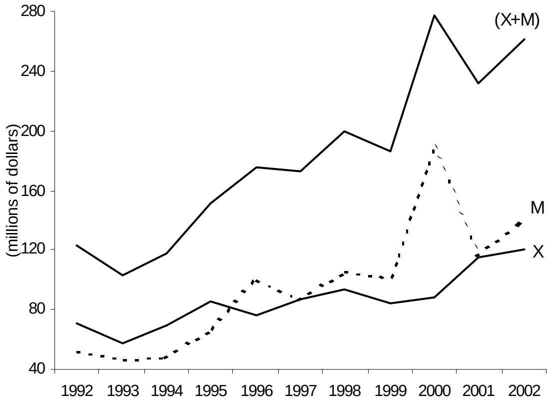


(c) Hungary



(d) Latvia

(e) Lithuania



(f) Poland

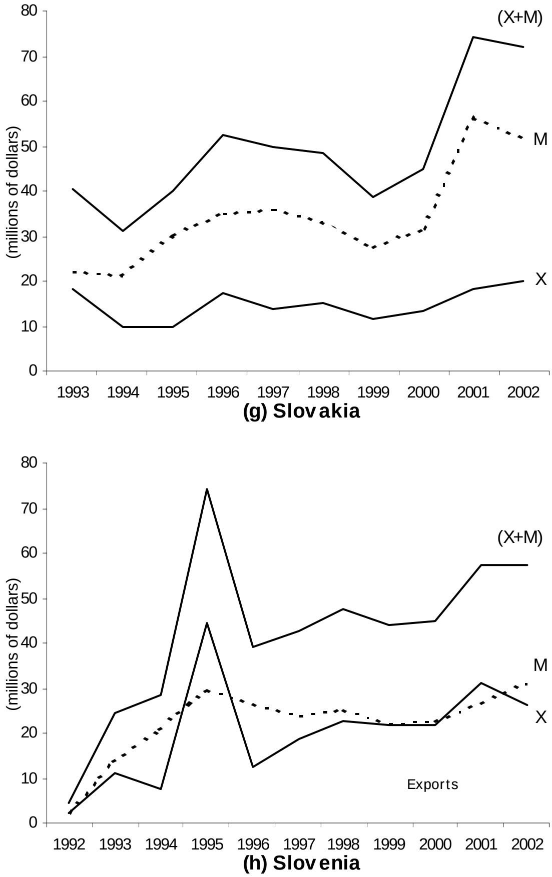


Figure 3. Greece's trade by individual Eastern European country, 1992-2002

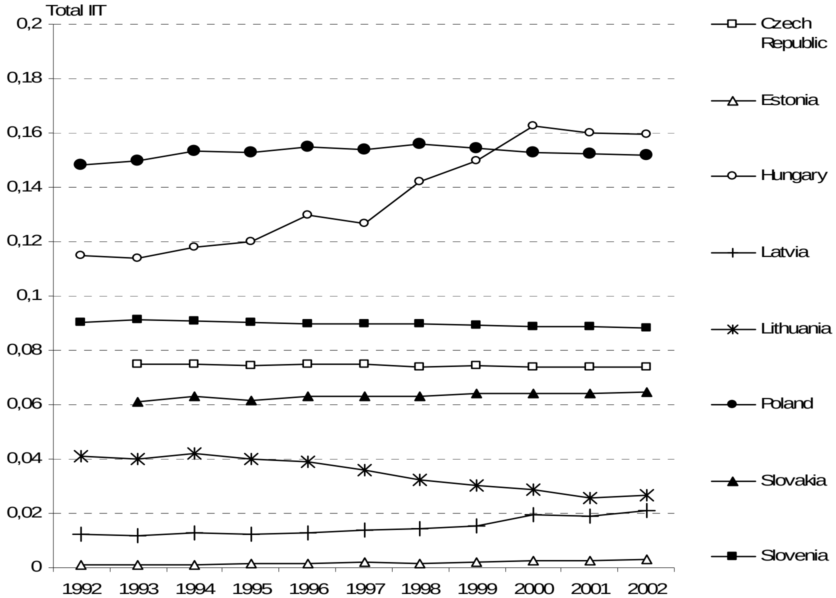


Figure 4. Greece's overall IIT with the CEECs, 1992-2002

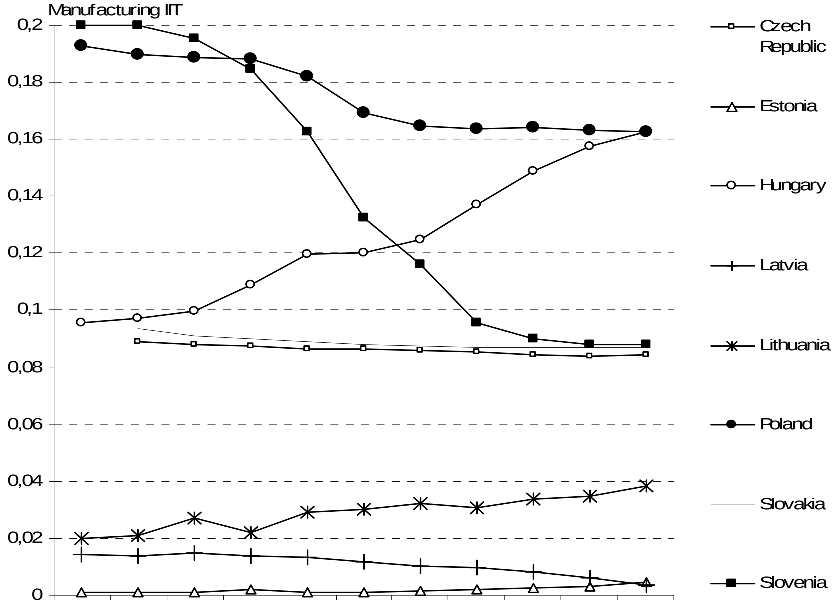


Figure 5. Greece's manufacturing IIT with the CEECs, 1992-2002

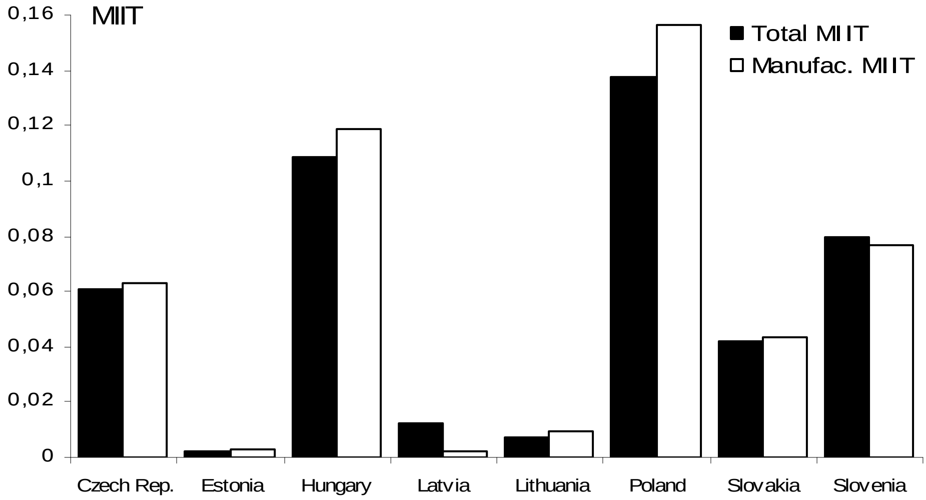


Figure 6. MIIT between Greece and the CEECs for 1992-2002 adjustment period

Table 1. Intra-EU IIT in Greece by industry, 1981-2002

SITC section	1981	1986	1991	1996	2002
0 - Food and live animals	0,120	0,307	0,323	0,329	0,382
1 - Beverages and tobacco	0,739	0,752	0,636	0,648	0,340
2 - Crude materials, inedible, except fuels	0,392	0,503	0,547	0,397	0,426
3 - Mineral fuels, lubricants and related mat.	0,920	0,736	0,681	0,830	0,781
4 - Animal and vegetable oils, fats and waxes	0,116	0,113	0,912	0,157	0,357
5 - Chemicals and related products	0,110	0,129	0,145	0,147	0,242
6 - Manufactured goods classified by material	0,284	0,406	0,397	0,341	0,285
7 - Machinery and transport equipment	0,059	0,084	0,080	0,129	0,121
8 - Miscellaneous manufactured articles	0,200	0,163	0,316	0,356	0,270
9 - Commodities and transactions n.e.s.	0,182	0,657	0,233	0,156	0,002
(5-8 – Manufactures)	0,174	0,226	0,238	0,239	0,213
(0-9 – All product groups)	0,206	0,278	0,294	0,275	0,254

Note: Unadjusted GL indices calculated from three-digit SITC trade data, weighted across industries.

Table 2. Extra-EU IIT in Greece by industry, 1981-2002

SITC section	1981	1986	1991	1996	2002
0 - Food and live animals	0,237	0,213	0,505	0,459	0,537
1 - Beverages and tobacco	0,023	0,202	0,360	0,253	0,301
2 - Crude materials, inedible, except fuels	0,456	0,507	0,433	0,345	0,426
3 - Mineral fuels, lubricants and related mat.	0,283	0,196	0,439	0,541	0,330
4 - Animal and vegetable oils, fats and waxes	0,129	0,081	0,499	0,772	0,860
5 - Chemicals and related products	0,676	0,605	0,454	0,501	0,449
6 - Manufactured goods classified by material	0,371	0,432	0,455	0,487	0,623
7 - Machinery and transport equipment	0,138	0,079	0,125	0,280	0,288
8 - Miscellaneous manufactured articles	0,330	0,238	0,367	0,556	0,468
9 - Commodities and transactions n.e.s.	0,245	0,036	0,025	0,002	0,825
(5-8 – Manufactures)	0,311	0,295	0,288	0,424	0,419
(0-9 – All product groups)	0,297	0,265	0,356	0,440	0,408

Note: Unadjusted GL indices calculated from three-digit SITC trade data, weighted across industries.

Table 3. Intra-EU MIIT in Greece by industry, 1981-2002

SITC section	1981-86	1986-91	1991-96	1996-2002
0 - Food and live animals	0,4138	0,3321	0,1720	0,1603
1 - Beverages and tobacco	0,6831	0,5287	0,2763	0,0000
2 - Crude materials, inedible, except fuels	0,3310	0,2740	0,2902	0,3070
3 - Mineral fuels, lubricants and related mat.	0,4279	0,0683	0,0159	0,8701
4 - Animal and vegetable oils, fats and waxes	0,1121	0,1350	0,0003	0,0839
5 - Chemicals and related products	0,1972	0,1723	0,1258	0,1277
6 - Manufactured goods classified by material	0,2555	0,3431	0,2663	0,3226
7 - Machinery and transport equipment	0,0545	0,0683	0,1639	0,1360
8 - Miscellaneous manufactured articles	0,1181	0,2488	0,2288	0,1824
9 - Commodities and transactions n.e.s.	0,0409	0,2791	0,4403	0,3569
(5-8 – Manufactures)	0,1460	0,2117	0,1978	0,2021
(0-9 – All product groups)	0,2514	0,2355	0,1855	0,2047

Note: A indices of MIIT calculated from three-digit SITC trade data, weighted across industries.

Table 4. Extra-EU MIIT in Greece by industry, 1981-2002

SITC section	1981-86	1986-91	1991-96	1996-2002
0 - Food and live animals	0,3143	0,4665	0,2591	0,4182
1 - Beverages and tobacco	0,2820	0,4799	0,1078	0,0613
2 - Crude materials, inedible, except fuels	0,0235	0,1457	0,0892	0,2654
3 - Mineral fuels, lubricants and related mat.	0,9330	0,5175	0,9393	0,0167
4 - Animal and vegetable oils, fats and waxes	0,0306	0,5123	0,6069	0,5128
5 - Chemicals and related products	0,1627	0,3938	0,4098	0,2922
6 - Manufactured goods classified by material	0,1049	0,2689	0,3502	0,3456
7 - Machinery and transport equipment	0,1807	0,1020	0,2845	0,2371
8 - Miscellaneous manufactured articles	0,0673	0,2116	0,5772	0,1916
9 - Commodities and transactions n.e.s.	0,0003	0,0294	0,0002	0,0009
(5-8 – Manufactures)	0,1293	0,1911	0,3839	0,2593
(0-9 – All product groups)	0,2341	0,2529	0,3955	0,2109

Note: A indices of MIIT calculated from three-digit SITC trade data, weighted across industries.

Table 5. Industry-specific determinants of Greece's intra-EU and extra-EU IIT

Model	PD	SE[1]	SE[2]	MS	OP	XS	IN	*N* (obs)	*Adj.R²*
Intra-EU 1981-91 (1)	0,321 (0,004)	-0,122 (0,405)		0,253 (0,096)	0,299 (0,088)	0,457 (0,031)	-0,094 (0,212)	84	0,576
Intra-EU 1981-91 (2)	0,034 (0,000)		-0,098 (0,541)	0,244 (0,099)	0,313 (0,080)	0,462 (0,022)	-0,082 (0,265)	84	0,579
Extra-EU 1981-91 (1)	0,440 (0,000)	-0,167 (0,323)		0,327 (0,079)	0,401 (0,051)	0,598 (0,002)	-0,124 (0,242)	84	0,652
Extra-EU 1981-91 (2)	0,447 (0,000)		-0,128 (0,389)	0,354 (0,067)	0,431 (0,044)	0,611 (0,000)	-0,120 (0,233)	84	0,661
Intra-EU '96-2002	0,363 (0,000)		0,034 (0,674)		0,320 (0,093)	0,342 (0,048)		46	0,530
Extra-EU '96-2002	0,592 (0,000)		0,065 (0,218)		0,378 (0,057)	0,550 (0,000)		46	0,641

Notes: Fixed effects panel data estimates (industry-specific and time-specific fixed effects included and significant) with White-robust standard errors. Results for the constant are not shown. P-values in parentheses. Standardized regression coefficients are reported. The standardized coefficients (also known as Beta coefficients) indicate the magnitude of the impact of an independent variable on the dependent variable, and thus show the relative importance of various explanatory variables of the model. More specifically, the standardized regression coefficients show how many standard deviations the dependent variable moves on average when the independent variable moves one standard deviation.

Table 6. Country-specific determinants of Greece's IIT with the CEECs

Explanatory Variables	Coefficient	P-value	*Adj.* R^2	*N* (obs.)
$ln\ (PCGDPDIF_{ijt})$	-0,584	0,084	0,768	80
$ln\ (GDPDIF_{ijt})$	-1,703	0,000		
$ln\ (AVGDP_{ijt})$	1,081	0,010		
$ln\ (TINT_{ijt})$	1,124	0,022		
$ln\ (DIST_{ijt})$	-0,986	0,043		

Notes: Fixed effects panel data estimates (country-specific and time-specific fixed effects included and significant) with White-robust standard errors. Results for the constant are not shown. P-values in parentheses. Standardized regression coefficients are reported. The standardized coefficients (also known as Beta coefficients) indicate the magnitude of the impact of an independent variable on the dependent variable, and thus show the relative importance of various explanatory variables of the model. More specifically, the standardized regression coefficients show how many standard deviations the dependent variable moves on average when the independent variable moves one standard deviation.