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April 2011

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MPRA Paper No. 32034, posted 05 Jul 2011 17:59 UTC

The role of product variety and quality and of domestic supply in foreign trade

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ABSTRACT

The study examines the behaviour of imports of goods in the Greek economy during the last five decades and their determinants, with an emphasis on consumer's preferences for "variety and quality" of the imported goods as well as on the demand and supply conditions of these goods in the domestic market. The estimated equations provide strong evidence for the importance of these two factors for import demand, and also explain significantly the stylized facts as well as long- and short-term movements in trade.

JEL classification: F14, F41, E21, C22

Keywords: effective demand for imports, New Trade Theory, product variety and quality.

Acknowledgements: The author would like to thank Ioannis Papadakis and George Oikonomou for their useful comments, as well as George Karadimas and Paris Mavrogenis for their contribution in the equation system estimation process. Thanks are also due to participants in the Bank of Greece Workshop for their helpful suggestions, and to Maria Toulia and Irene Gougoulia for the collection and processing of the statistical data.

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1. Introduction

Large imbalances in the external balance of Greece are anything but rare. In fact, at times high external balance deficits have been a factor restricting the country's economic growth and the pursuit of a stabilisation and growth policy. Almost permanently, Greek balance of payments deficits stem mainly from the high deficit of the trade balance, given that this reflects not only cyclical factors but also structural weaknesses of the production base.

These chronic trade deficits are due to a series of factors that affect the imports and exports of goods. On the imports side, the major factors are the following:

- Domestic investment in machinery and equipment relies almost exclusively on imports of such products, which account for a considerable share of total imports. Additionally, domestic production of ready-made goods depends largely on imports of intermediate goods and raw materials.
- The high import content of exported goods, which entails the interdependence of imports and exports and the persistence of the trade deficit. This is because the value added of exports does not suffice to cover a substantial part of the trade deficit.
- The dependence of the technological upgrading of domestic production on the transfer of technology through imports.
- The high competitiveness of imported goods in the Greek market.
- The inelasticity of supply with respect to changes in demand, due to the negative effect of cost factors and structural rigidities.

Thus, strengthening demand and the rate of economic growth, and technologically modernising domestic production, lead to increased imports and widen the trade deficit.

This study aims at analysing the behaviour of imports of goods and estimating the effect of their main determinants. The empirical analysis relies on quarterly statistical data for the period 1962-2007, i.e. covers a long period (45 years) of economic developments. The study introduces some major innovations, most prominent of which are the following: **First**, it expands the traditional model of imports, so as to include product diversification in line with the New Trade Theory; **Second**, it enhances the theoretical analysis of the imports function, so as to incorporate the inadequacy of domestic supply, as well as to express the relationship that links actual imports with the demand for imports at the equilibrium level, and also with the effective demand for imports; **Third**, it specifies the density function for actual imports.

The analysis suggests a number of solutions: **First**, two thirds of Greek imports originate from the EU-15; **Second**, imports of high-tech goods, despite having increased, fall short of those of the other countries of Southern Europe; **Third**, import penetration into the domestic market for manufactured goods has been rising fast in the last decade, crowding out domestic industrial products; **Fourth**, the competitiveness of domestic production displays a permanent deterioration from 1988 onwards and worsens after the country's entry into the euro area.

The most important findings of the econometric analysis are the following: **First**, in the long run, Greek imports are affected by competitiveness (relative prices), disposable income and particularly the "variety and quality" of the imported goods, as well as the demand for the domestic good to the extent this is not satisfied. The elasticities of these factors are equal to, or slightly higher than one, save for the relative price elasticity. **Second**, in the short run, imports are affected by "variety and quality", capacity utilisation and, to a lesser extent, competitiveness, while they seem to be unaffected by income. **Third**, although in the long run domestic and imported goods are substitutes, in the short run their relationship appears to be complementary.

The study continues as follows: Section 2 presents in detail the structure of Greek imports. Section 3 discusses import penetration, domestic competitiveness and import control policies. The theoretical model is analysed in Section 4, while Section 5 specifies the econometric estimation of the models. The results of the estimations are presented in Section 6 and, finally, Section 7 summarises the study's conclusions.

2. The structure of Greek imports and the exposure of the Greek economy to international trade

2.1 The structure of Greek imports by area of origin, product category, technological content, and final destination

The evolution of imports¹ broken down by geographical area shows that between 2001 and 2008 the share of imports originating from the EU-15 countries fell slightly to 67% from 70% in the period 1977-2000 (Chart 1). In the same period (2001-2008), the share for each of the countries / areas of origin – i.e. the US, China, SE Europe, and Middle East and the Mediterranean – ranges between 4% and 5%. However, it can be seen that between the periods 1997-2000 and

¹ The source of data is the National Statistical Service of Greece.

2001-2008 the share of China has doubled, while that of the Middle Eastern and Mediterranean countries has also increased considerably.

Chart 1: Structure of imports by geographical area
(percentages)

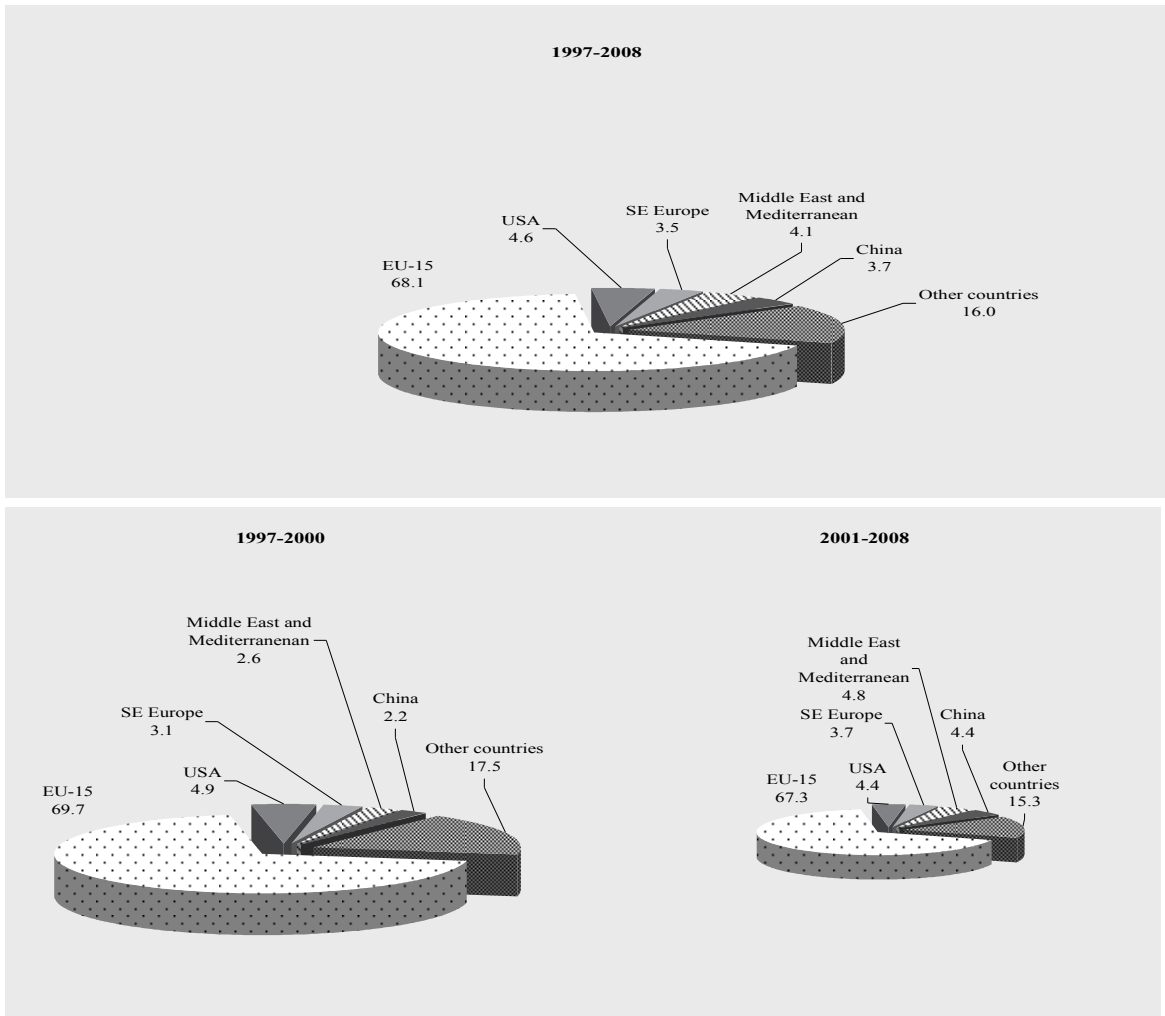


Chart 2 displays the structure of Greek imports in the period 1997-2008 broken down by single-digit category of the Standard International Trade Classification (SITC). More specifically, the category of "Food" includes the single-digit categories 1, 0 and 4, and the category of "Other manufacturing products" the single-digit categories 6 and 8.

It can be seen that, in the period under study, approximately one third of all imports relates to products of the "Machinery and transport equipment" category,² and one third to "Other manufacturing products". The share of "Food" and of "Chemicals" stands at roughly 15% for each category, while that of "Raw materials" amounts to 3%. In the period 2001-2008 the share of "Machinery" shows a slight decline compared with the period 1997-2000, while that of "Chemicals"

² Henceforth this category will be referred to simply as "Machinery".

a small increase. It should be recalled that throughout the period 1997-2008 Greek exports of this category recorded a considerable growth.

Chart 2: Structure of imports by product category
(percentages)

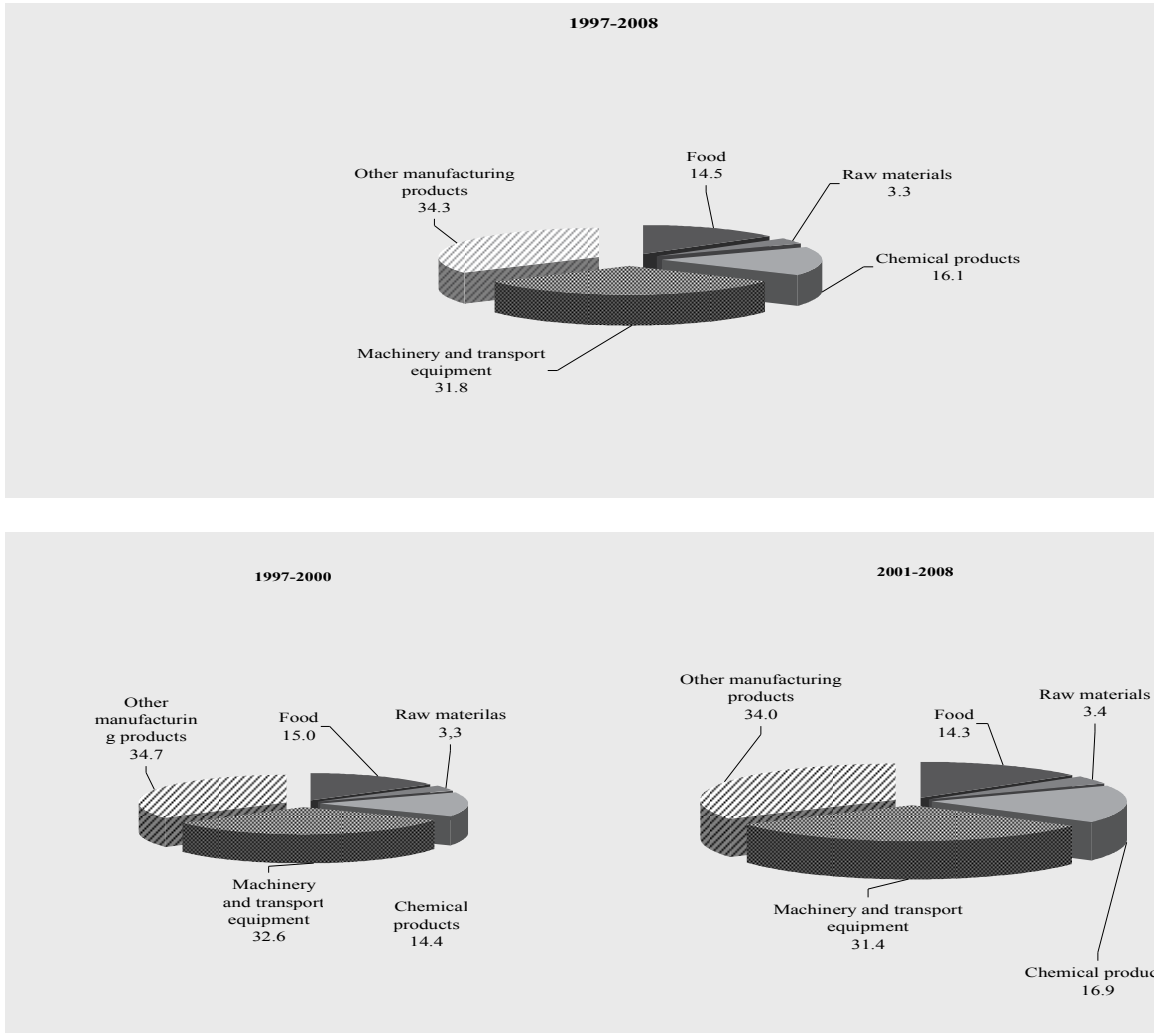
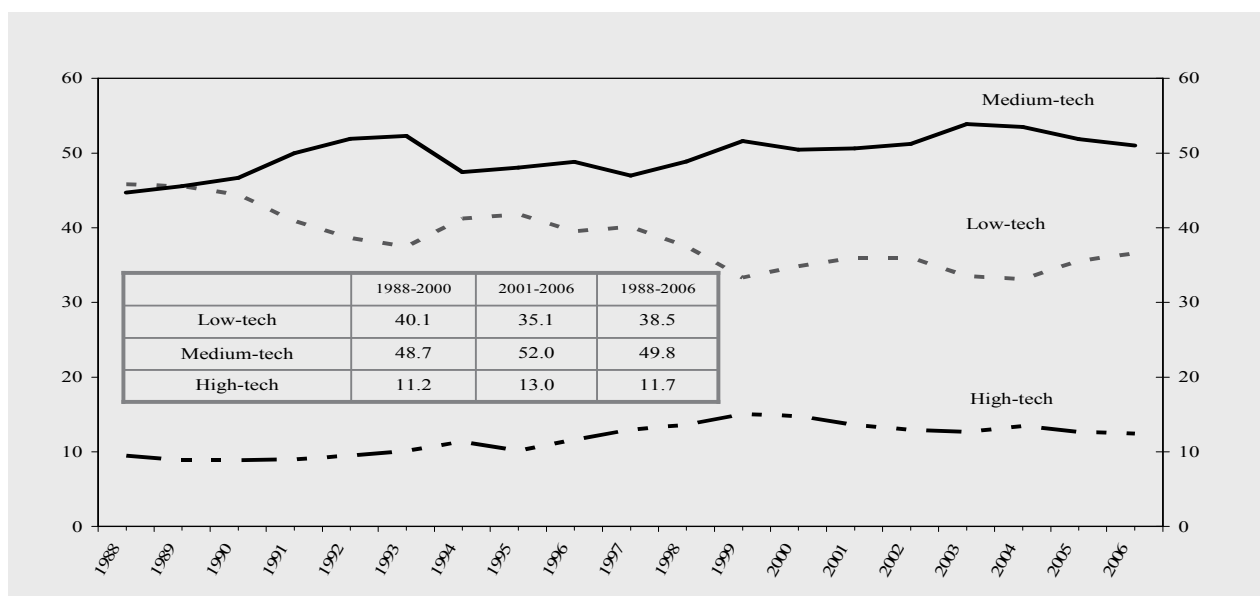


Chart 3 presents the structure of imported goods, grouped under the categories of "low-tech", "medium-tech" and "high-tech" products based on their technological content. This structure exhibited remarkable changes during the period under study. The share of low-tech products fell to 38% in 2006, from 46% in 1996, whereas a rise was observed in the shares of mainly medium-tech products (to 51% from 44%) and, to a lesser extent, high-tech products (to 12% from 10%).

Chart 3: Structure of Greek imports of manufactured products based on their technological content
(percentages)



However, despite the observed gradual substitution of low-tech products by mostly medium- and, to a lesser extent, high-tech products, the structure of Greek imports remains weaker than that of the countries of Southern Europe, since the share of imports of high-tech products for Greece averages 13% in the period 2001-2006, compared with 17% for Portugal and roughly 16% for Italy and Spain, respectively (Table 1).

Table 1: Imports of manufactured high-tech products
(percentage shares in the total of manufactured products)

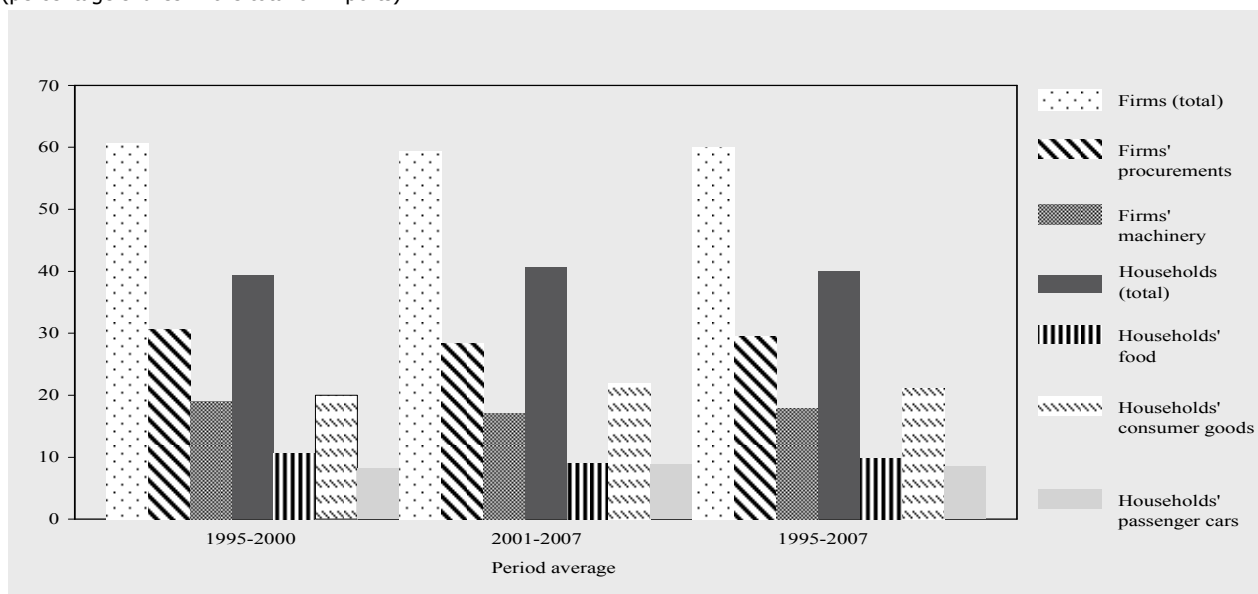
Countries	Period average 2001-2006
Greece	12.86
Italy	16.07
Spain	15.70
Portugal	16.88

Source: Bennett et al. (2008).

This fact, in combination with the limited levels of domestically produced high technology, weighs heavily on domestic production, productivity and exports, particularly when considering the dynamics of strong demand for high-tech products manifest at global level.

Finally, the structure of imports broken down by final domestic destination (i.e. intended for either firms or households), appears in Chart 4. It can be seen that 60% of imports are destined for firms and the remaining 40% for households. Imports for firms relate mainly to procurements, i.e. raw materials and intermediate goods (30% of total imports for firms), and machinery (18%). Imports of consumer goods (22%), food (10%) and passenger cars (8%) make up almost the total of imports for households. Although the distribution of imports between firms and households remains unchanged in the sub-periods 1995-2000 and 2001-2007, the structure of imports of these two categories nevertheless changes. Specifically, the shares of procurements and machinery for firms decrease, and the shares of consumer goods and cars for households increase.

Chart 4: Structure of imported goods by final destination (firms or households)
(percentage shares in the total of imports)



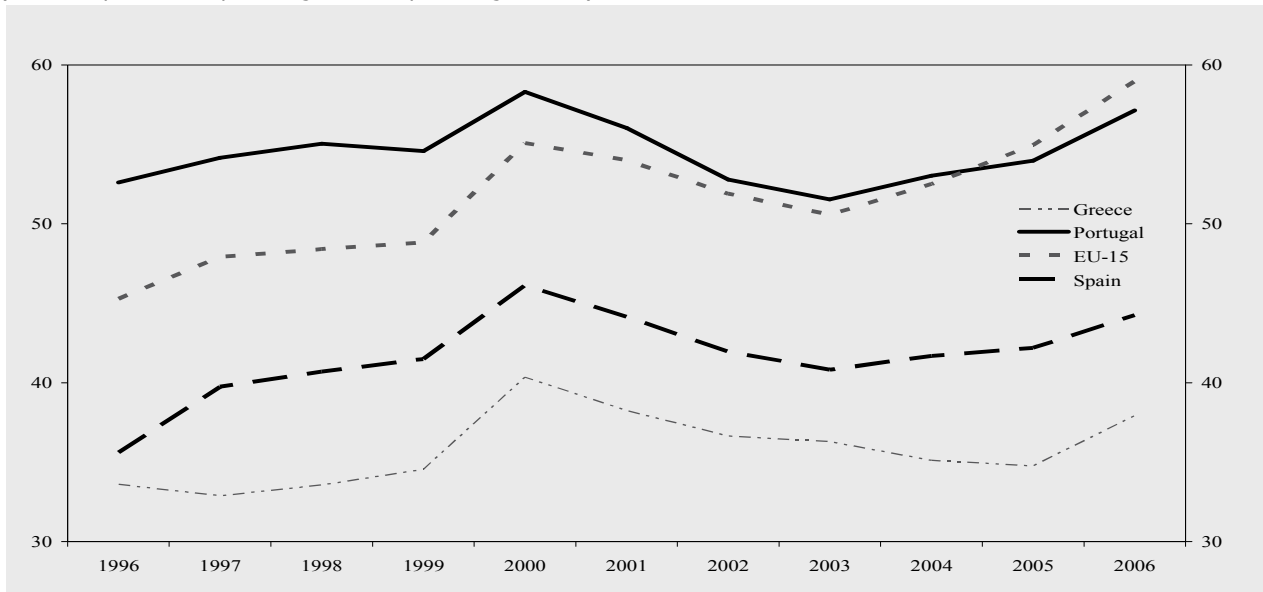
Source: UN.

2.2 The Greek economy's exposure to international trade

As mentioned earlier, a series of factors – such as the gradual deregulation of international trade, particularly the establishment of the Single Market within the EU, reduced transport costs, and increased consumer demand for more varieties of products – has contributed in the last three

decades to a considerable “opening” of many European countries to international trade. As can be seen in Chart 5 (and Table B1 in Annex B), although the openness of the Greek economy to foreign trade increased appreciably in the period 1996-2006, it still remains the most closed economy among the EU-15 countries.

Chart 5: Openness to foreign trade
(total of imports and exports of goods as a percentage of GDP)



3. Imports, trade policy and the domestic market

3.1 Import penetration

Import penetration³ (at current prices) in Greece in the period 1996-2006 is slightly lower than the respective EU-15 average (Table 2). However, import penetration (at constant prices) into Greek manufacturing in the period 2000-2008 recorded a rise, and by 2008 exceeded 80% of the domestic apparent consumption⁴ of manufactured goods (Chart 6). The rise in import penetration was more pronounced in the industries of chemicals, base metals, transport equipments, textiles, clothing-footwear and leather (Bank of Greece, 2006).

³ For the definition see note of Table 2.

⁴ Apparent consumption is defined as the sum of the gross value of domestic output plus imports minus exports.

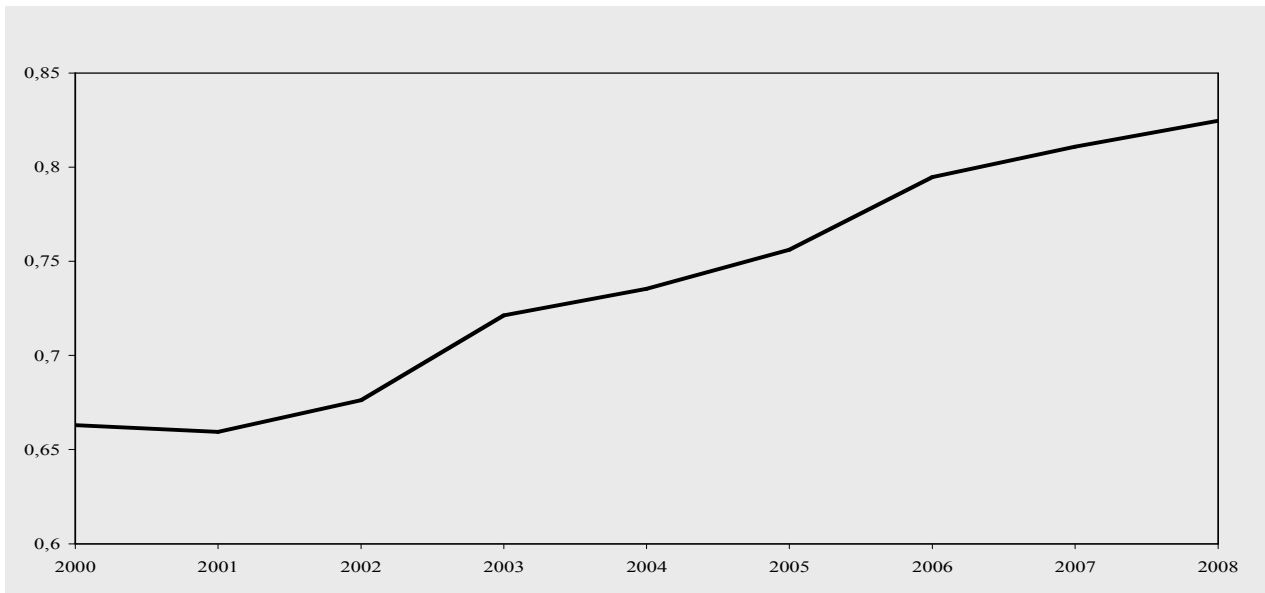
Table 2: Import penetration (total of goods)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	27.5	30.3	31.2	32.1	35.2	36.2	35.3	35.3	38.2	39.6	41.4
Belgium	56.7	60.2	60.5	60.5	68.6	68.1	65.7	64.8	67.6	70.4	71.4
Denmark	25.2	26.6	26.8	26.5	29.1	28.9	29.3	27.7	28.5	30.5	32.7
Finland	24.9	26.4	26.0	25.2	29.7	26.9	26.1	26.2	27.4	30.1	33.3
France	17.5	18.8	19.6	20.0	22.9	22.2	21.0	20.2	20.9	21.7	22.7
Germany	19.1	21.0	22.0	22.8	26.7	26.6	25.7	26.3	28.2	30.5	34.5
Greece	20.8	20.6	21.2	21.8	25.0	23.9	23.4	23.2	22.5	22.1	23.4
Ireland	58.6	59.7	62.4	62.4	68.3	65.4	57.5	43.0	42.1	40.7	38.2
Italy	16.4	17.4	17.7	18.1	21.2	20.8	19.9	19.3	20.0	20.9	22.9
Luxemburg	43.6	47.5	49.4	45.6	47.6	48.6	45.7	43.3	46.4	45.5	44.5
Netherlands	44.1	47.0	46.4	46.5	52.9	49.9	46.3	45.4	48.4	51.0	55.2
Portugal	27.9	28.9	29.5	29.6	31.4	30.2	28.5	27.6	28.6	29.1	30.5
Spain	18.6	20.6	21.3	22.1	24.7	23.6	22.4	21.9	22.6	23.1	24.3
Sweden	26.0	28.1	29.1	28.8	31.8	30.4	28.9	28.6	29.9	32.0	34.1
UK	22.7	21.9	20.6	20.4	21.9	21.7	20.9	19.9	20.0	21.2	22.9
EU-15	22.3	23.5	23.9	24.3	27.5	26.9	25.7	25.1	26.1	27.5	29.6
USA	10.2	10.5	10.4	10.9	12.2	11.1	10.9	11.2	12.2	13.0	13.5
Japan	7.0	7.4	6.8	6.6	7.6	7.8	7.9	8.4	9.2	10.6	12.5

Note: Import penetration = M/DD , where $DD (=Y+ M-X)$ is domestic demand, while X , M and Y are the exports and imports of goods and GDP respectively, in US dollars, at current prices.

Source: OECD.

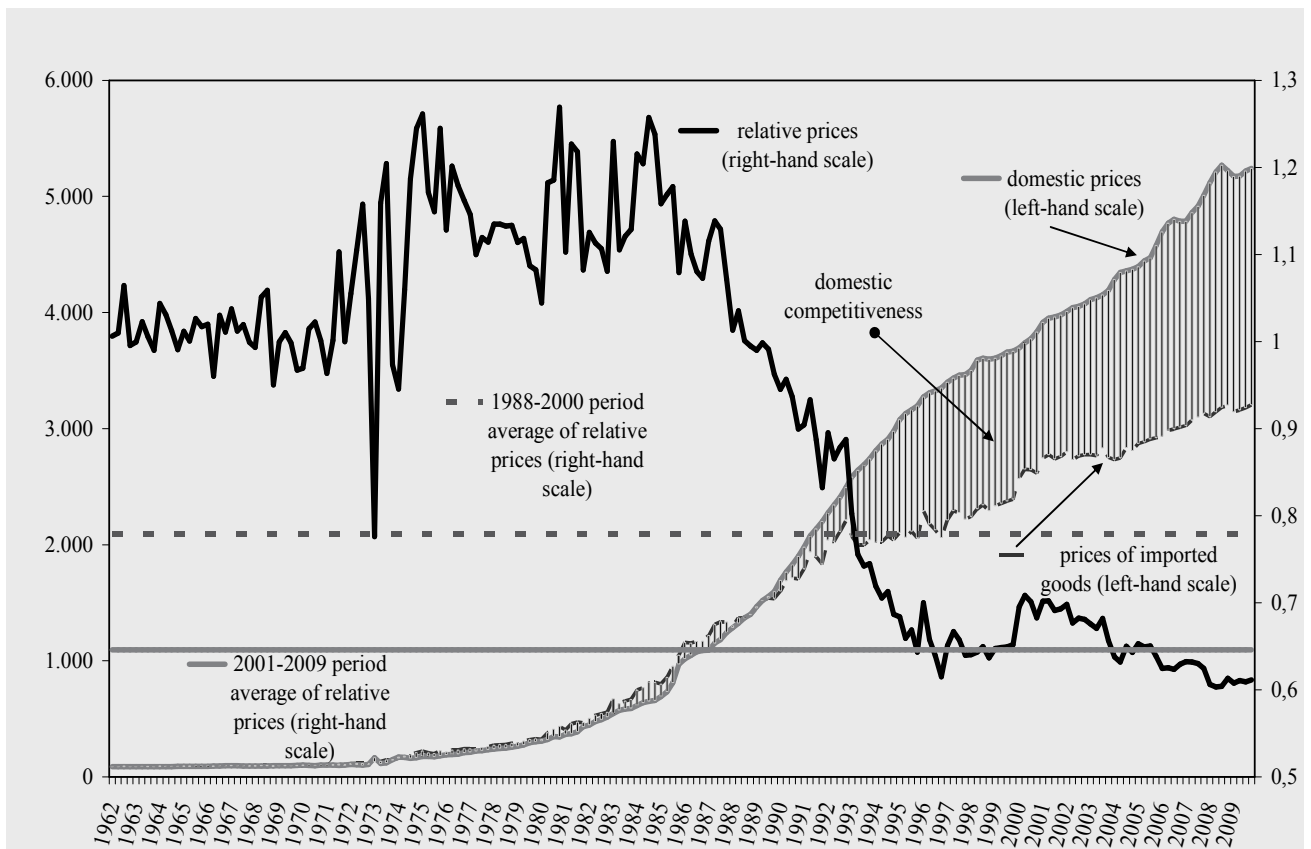
Chart 6: Import penetration in manufacturing
(constant prices 2000)



3.2 Prices of imports, domestic prices and relative prices

In Chart 7 it can be seen that from 1988 onwards domestic product prices rose faster than the prices of imported goods. This rate accelerated from 2001 onwards, causing domestic prices to exceed cumulatively those of imported goods by approximately 40%. The loss in domestic competitiveness in the period 2001-2007 compared with the previous decade amounts to roughly 11 percentage points.

Chart 7: Domestic prices, prices of imported goods and relative prices (excluding fuel)
(1970=100)



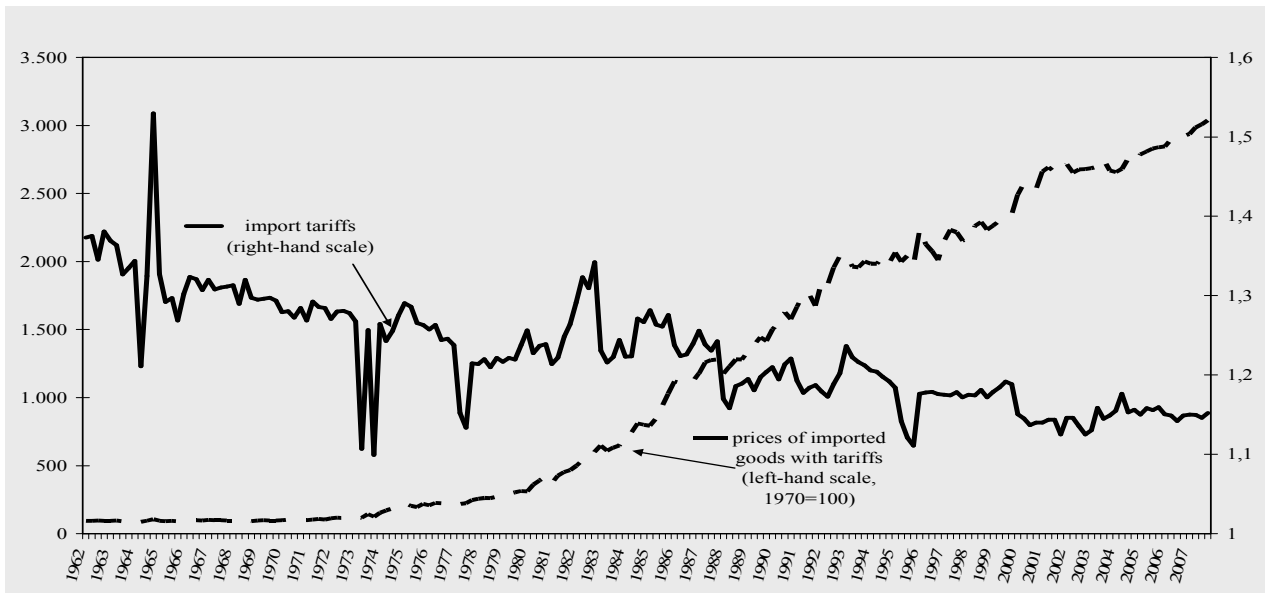
3.3 Import control policies

The trade policy pursued by Greece until its entry in the EU aimed, among other things, at moderating imports, and was based on the following three types of measures:

- tariffs and tariff-equivalent taxes;
- importers' mandatory advance deposits with the Bank of Greece; and
- administrative measures.

The accession of Greece to the EU in 1981 led to the lifting of these restrictions to its trade policy, resulting in a considerable growth of economic activity in industries where the country had or acquired a comparative advantages, as well as in increased imports. Specifically, in the first decade after Greece's accession, the trade deficit with the EU almost tripled (1980: 2.6 billion US dollars, 1991: 7.4 billion US dollars), while also the share of the trade deficit with the EU in the total deficit

Chart 8: Prices of imported goods (excluding fuel) and import tariffs



almost doubled. It should be noted that in 1980 the average nominal tariff and non-tariff protection⁵ amounted to around 28%, while effective protection was considerably higher (roughly 60%, Chart 8).

4. The theoretical model

4.1 Imports in equilibrium

4.1.1 Domestic households

It is assumed that domestic households own firms. Consequently, the representative household has two sources of income: wage income and income from profits. The assumption that profits are distributed in the next period entails that they are exogenous. Additionally, the present

⁵ For all imports, nominal protection borders on 33%.

study adopts the following two assumptions: that the supply of imports is infinitely elastic, and that consumer demand in the domestic market is satisfied either by domestic or imported goods, or both. The first assumption appears reasonable for a small economy such as Greece. The share of Greek imports in world imports is less than 1%, therefore demand for the imported goods can always be satisfied by supply without affecting prices. The second assumption, which relies on the first, entails that domestic households can increase imports whenever they are constrained in the domestic goods market.

Domestic households have a utility function that depends on the domestic and the imported product. The two goods are imperfect substitutes in the domestic market:

$$U = U(D, M), \quad (1)$$

Households maximise equation (1) subject to the following budget constraint:

$$P_q D + P_m M = y, \quad (2)$$

where D = the quantity of the domestic good; M = the quantity of the imported good; P_q = the price of the domestic good; P_m = the price of the imported good; and y = total expenditure (at nominal prices), with $y = P_q Y$.

Solving this maximisation programme produces the following demand functions⁶ for the domestic and the imported good, respectively:

$$D^d = f(P_q, P_m, Y), \quad (3)$$

- + +

$$M_n^d = g(P_q, P_m, Y), \quad (4)$$

+ - +

The signs that appear under the variables in equations (3) and (4) are acceptable based on both theory and empirical analysis. The theoretical elaboration of equation (4) was undertaken in the study by Leamer and Stern (1970), while Goldstein and Khan (1985), as well as Hooper, Johnson and Marquez (2000), among others, present empirical estimates.

⁶ Also called Walras (or Marshall) demand functions, or even 'notional' according to Clower (1965).

4.1.2 The Walrasian equilibrium

The equilibrium conditions in the goods market and the economy's external sector are expressed through the following equations:

$$C^d = D(P_q, P_m, Y) + M(P_q, P_m, Y) - \text{exog} , \quad (5)$$

$$Q^d = C^d + X^d - M^d + \text{exog} , \quad (6)$$

$$Q^d = Q^s , \quad (7)$$

$$TB = P_q X - P_m M , \quad (8)$$

Consumer demand (5) is the sum of domestic demand for the domestic good plus demand for imports minus the exogenous demand (exog), which is equal to the sum of investment and public expenditure. The identity in (6) specifies total demand for the domestic good in the domestic and the foreign markets. Equation (7) represents the equilibrium condition in the product market. Equation (8) shows the trade balance which is denominated in the domestic currency, while X and M denote the actual (equilibrium) quantities of exports and imports, respectively.

It should be noted that the effect of relative prices P_m / P_q (terms of trade) on domestic demand (for the domestic good) depends on whether the relative price elasticity of imports is greater, equal to, or less than unity (1.0). Relationship (2) entails that:

$$e_m^n = [- \partial M_n^d / \partial (P_m / P_q)] \cdot [(P_m / P_q) / M_n^d] = 1 + [\partial D / \partial (P_m / P_q)] \cdot (1 / M_n^d)$$

where e_m^n = the relative price elasticity of demand for imports.

From the above relationship, it becomes obvious that:

$$\partial M^d / \partial (P_m / P_q) \geq < 0, \text{ as } e_m^n \geq < 1 \quad (9)$$

Equation (9) implies that:

- if $e_m^n < 1 \Rightarrow$ the two goods are complementary, and
- if $e_m^n \geq 1 \Rightarrow$ the two goods are substitutes.

4.1.3 Imports and the New Trade Theory

The New Trade Theory, based on the works of Helpman and Krugman (1985), Krugman (1989), and Grossman and Helpman (1991) entails that the traditional equations for imports (such as equation (4)) are imperfectly specified since they fail to include the effect of product (horizontal and vertical) differentiation. This differentiation is expressed as the households' preference for the "variety and quality" of goods. Therefore, equation (4) can be expanded to:

$$M_n^d = g(P_q, P_m, Y, VQ, AD, D), \quad (10)$$

where VQ = the variable that denotes the variety and quality of the imported goods and is proxied by expenditure on machinery and equipment as a percentage of the GDP⁷ of the major countries of origin of Greek imports;⁸ AD = the importers' "opportunity cost",⁹ i.e. the real cost of the importers' mandatory advance deposits¹⁰ in the period 1962-1992; and D = a dummy variable that takes the value of 0 for the period 1962-1980 and the value of 1 for the period 1981-2007.

Specifications of import functions based on equation (10) are rare in the international literature. Product variety in the study by Gagnon (2004) is represented by the rate of increase of the exporting country's potential output, while in that by Barrell and Vede (1999) by the importing country's level of foreign direct investment (FDI). It should be noted that the potential output variable, as it incorporates a strong trend over time, is trend stationary and thus may generate problems during the estimation of the long-run vector of imports, if the other variables are difference stationary. Moreover, the available statistical data on FDI in Greece fall considerably short of the sample of this study.

Finally, it should be noted that the variable of expenditure for machinery and equipment as a percentage of GDP, used in the present study, also incorporates technological advances and

⁷ We think that this variable, in addition to data availability, is a good proxy since it shows the level of innovation and the technological advancement of these countries that can affect trade through the variety and quality of traded products. For the definition of this variable see Annex A: The statistical data.

⁸ See Annex B: Chart B3.

⁹ For the definition of this variable see Annex A: The statistical data.

¹⁰ The real costs of the importers' mandatory advance deposits with the Bank of Greece were used as an important discouragement mechanism imposed by the government on imports (see Brissimis, 1986). This measure was abolished when Greece joined the EU, although a period of exemption followed due to the implementation of the 1985 stabilisation programme, as can also be seen in Chart B2 of Annex B.

innovations in the production process, i.e. factors that contribute substantially to product diversification.

4.2 The effective demand for imports

In the event that the domestic market is characterised by excess demand for the domestic good, households recalculate their demand for imports taking into account, besides income, the existing constraint on the domestic product. In other words, the households' maximisation programme can be written as follows:

$$\max U = U(D, M)$$

$$\text{s.t.: } \quad \text{i) } P_q D + P_m M = y, \text{ and}$$

$$\text{ii) } D^d \leq \bar{D}, \text{ with } \bar{D} = D$$

where \bar{D} represents the constrained demand for the domestic good, which is assumed to be equal to the actual quantity.

Consequently, the demand for imports, which is now called **effective** (M_e^d), can be expressed as:

$$M_e^d = M_n^d + (P_q / P_m) (D^d - \bar{D}), \quad (11)$$

where import demand (M_n^d) is denoted equation (10), while the term $(P_q / P_m) (D^d - \bar{D})$ on the right-hand side of equation (11) denotes the **spill-over effect** (in nominal terms) from the non-satisfaction of demand for the domestic good. Therefore, based on equation (11), whenever domestic demand for the domestic good exceeds domestic supply, households increase their demand for imports by $(P_q / P_m) (D^d - \bar{D})$, providing that the constraint ($D^d \leq \bar{D}$) really holds.

The effective demand for imports (11) poses considerable econometric problems. First, its linear expression in logarithms is quite complex, and second, the term expressing the spill-over effect is not measurable. To solve the first problem we use Taylor's first order expansions of $\ln M_e^d$

around $\ln M_n^d$, and of $\ln D^d$ around $\ln \bar{D}$. Replacing these proxies in equation (11), we obtain equation (12):

$$\ln M_e^d = \ln M_n^d + \{ (P_q / P_m) (D^d / M_n^d) \} \ln (D^d / \bar{D}) , \quad (12)$$

In any case, obviously equation (12) cannot be estimated econometrically, due to the presence of the ratio (in nominal terms) of domestic demand to demand for imports (spill-over coefficient), as well as of the term $\ln (D^d / \bar{D})$ that represents the disequilibrium in the domestic market for the domestic good. The latter term is unobservable and can only be measured by a proxy.

The present study makes the assumption that the households' utility function is exponential, whereby, in such a function the spill-over coefficient has been proven to be equal to a constant (see Ito, 1980). Consequently, it could be written that:

$$(P_q / P_m) (D^d / M_n^d) = m_{e,6} , \quad (13)$$

The term $\ln (D^d / \bar{D})$ can be expanded as follows:

$$\ln (D^d / \bar{D}) = \ln (Q^d / Q^s) + [\ln (D^d / Q^d) - \ln (\bar{D} / Q^s)] , \quad (14)$$

The first term on the right-hand side of equation (14) expresses the pressure of demand in the domestic goods market and can be replaced by a proxy for which statistical data are available. Examples of using the capacity utilisation rate¹¹ (CU) in such cases abound in the empirical literature. The second right-hand-side term of equation (14) is omitted, given that it can be neither observed nor proxied by the statistical data and, in addition, the error due to the omission of this term is estimated to be small and assumed to be random. Therefore, equation (14) can be written as follows:

$$\ln (D^d / \bar{D}) = \ln CU + v , \quad (15)$$

Replacing equations (13) and (15) in equation (12), we obtain:

¹¹ See Annex B: Chart B4.

$$\ln M_e^d = \ln M_n^d + m_{e,6} \ln CU + u_e, \quad (16)$$

±

where $u_e = m_{e,6} v + u_n$; and u_n = the random error of the M_n^d equation.

The sign of the coefficient of the CU variable in equation (16) depends on the relationship between the two goods. It will be positive in the case that the goods are complementary and negative when they are substitutes. Consequently, if we denote by e_m^e the relative price elasticity of M_e^d , it will hold that:

– if $e_m^e (e_m^n) < 1$ and $m_{e,6} > 0 \Rightarrow$ the two goods will be complementary, and

– if $e_m^e (e_m^n) \geq 1$ and $m_{e,6} < 0 \Rightarrow$ the two goods will be substitutes.

Three major issues arise when comparing equations (10) and (11):

First, an increase in the constraint \bar{D} reduces effective demand M_e^d :

$$\partial M^d / \partial \bar{D} = - P_q / P_m < 0.$$

Second, the effective marginal propensity to import is higher than the respective Walrasian one:

$$(\partial M_e^d / \partial Y) > (\partial M_n^d / \partial Y), \text{ and}$$

Third, the slope of the effective demand for imports curve is less steep than the respective Walrasian one:

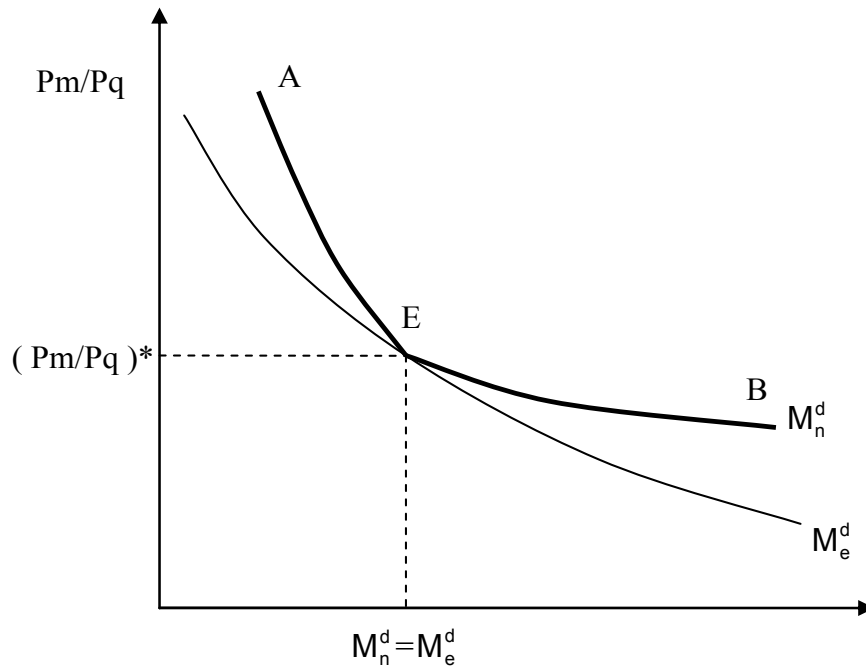
$$\begin{aligned} \partial M_e^d / \partial (P_m / P_q) &= \partial M_n^d / \partial (P_m / P_q) + \partial [P_q / P_m (D^d - \bar{D})] / \partial (P_m / P_q) \\ &= \partial M_n^d / \partial (P_m / P_q) + (P_m / P_q) [\partial D^d / \partial (P_m / P_q) - (P_m / P_q) (D^d - \bar{D})] \end{aligned}$$

Whatever the sign of the partial derivative of D^d with respect to (P_m / P_q) , it will always hold that:

$$[\partial M_e^d / \partial (P_m / P_q)] < [\partial M_n^d / \partial (P_m / P_q)]$$

The above relationship entails that: $e_m^e < e_m^n$.

Chart 9: Actual imports and demand curves for imports



Based on all the above, the graphs of M_n^d and M_e^d are depicted in Chart 9. In this chart, when relative prices are higher than $(P_m / P_q)^*$, the demand for imports lies in section AE of the effective demand schedule M_e^d . In case relative prices are lower than $(P_m / P_q)^*$, demand is given by section EB of the demand M_n^d . Therefore, in light of the above in combination with the assumption that **actual imports** are always equal to demand, we find that **actual imports** M will be:

$$M = \max (M_e^d , M_n^d) , \tag{17}$$

In Chart 9, the bold line AEB represents relationship (17).

Finally, **the system of equations** to be estimated includes the following:

$$\ln M = \max (\ln M_n^d, \ln M_e^d), \quad (18)$$

$$\ln M_n^d = m_{n,0} + m_{n,1} \ln(P_m / P_q) + m_{n,2} \ln Y + m_{n,3} \ln VQ + m_{n,4} \ln AD + m_{n,5} D + u_n, \quad (19)$$

$$\ln M_e^d = m_{e,0} + m_{e,1} \ln(P_m / P_q) + m_{e,2} \ln Y + m_{e,3} \ln VQ + m_{e,4} \ln AD + m_{e,5} D + m_{e,6} \ln CU + u_e, \quad (20)$$

5. Econometric specification

5.1 Estimation of individual equations of the demand for imports by the cointegration method

The analysis of time series variables in a multivariate context is carried out in three steps (Enders, 1995). First, one has to determine the integration order of the time series, which is a prerequisite for cointegration analysis. Second, if the variables are integrated of the same order $I(1)$, the next step is to estimate the long-run equilibrium relationship, using cointegration analysis. Third, provided that the variables are cointegrated, one estimates the model's dynamic behaviour by incorporating in it the "residuals" from the long-run estimation lagged one period, as an error correction term (Vector Error Correction Model, VECM). The correspondence between cointegration and the VECM is specified by Granger's "representation theorem" (Engle and Granger, 1987). The variables' descriptive statistical series are included in Table 3.

Table 3: Descriptive statistical series of the variables (1962-2007)

Statistical series	Domestic prices (1970=100)	Imported goods' prices (1970=100)	Relative prices (1970=1)	Imports (billions of euro)	Capacity utilisation rate	Income (billions of euro)	Expenditure in machinery and equipment (% of GDP)
Minimum	86.89	87.54	0.61	3,774.31	0.66	31.56	7.27
Maximum	5,215.31	3,044.75	1.20	121,746.10	0.95	327.25	10.61
Average	1,626.06	1,159.24	0.88	39,203.78	0.79	144.86	8.64
Median	890.02	804.52	0.91	21,810.75	0.78	119.03	8.67
Standard deviation	1,633.08	1,032.41	0.16	34,852.96	0.58	83.22	0.76
Variability coefficient	1.00	0.89	0.18	0.89	0.73	0.57	0.88
Skewness	0.62	0.39	-0.16	0.86	0.67	0.82	0.20
Kurtosis	1.85	1.57	1.74	2.31	3.06	2.63	2.64

First, we check for the existence of stochastic trends among the model's variables, using the Dickey-Fuller (ADF), Phillips-Perron, and Bierens (1993) tests of the hypothesis of a unit root, $I(1)$, against the linear trend stationarity $I(0)$, as well as the Bierens (1997) unit root test against the non-linear stationarity. In addition, we apply the Bierens-Guo (1993) test of the hypothesis of stationarity against the alternative of a unit root. Finally, all the aforementioned tests are also used on the variables' first differences. The estimation of the cointegration vector (VECM) relies on the maximum likelihood (ML) approach elaborated by Johansen and Juselius (1990) and Johansen (1991).

As mentioned earlier, we initially estimate the long-run relationship. The number of cointegrating vectors that is determined applying two tests: the λ -trace and the λ -max (maximum eigenvalue). At the final step, we estimate the short-run dynamic model, which is expressed by equation (21):

$$\Delta M_t = \alpha_0 + \alpha_1 EC_{t-1} + \sum_{i=1}^n \beta_i \Delta M_{t-1} + \sum_{i=1}^n \gamma_i \Delta (P_m / P_q)_t + \sum_{i=1}^n \delta_i \Delta Y_t + \sum_{i=1}^n \varepsilon_i \Delta AD_t + \sum_{i=1}^n \zeta_i \Delta VQ_t + \sum_{i=1}^n \theta_i \Delta CU_t \quad (21)$$

where Δ = the operator of the first differences of the variables' logarithms.

Consequently, this framework recognises that the short-run import demand is not immediately adjusted to its long-run equilibrium, due to lags between the initially agreed for the goods and their final prices, expectations, and adjustment costs (e.g. transport costs, market research costs, etc.).

5.2 Estimation of actual imports

To estimate the system of equations (18) to (20), we first need to calculate the density function of actual imports. The relevant density function for relationship (18) is expressed by the following proposition:

Proposition:

If the following assumptions hold:

i) $u_n \sim N(0, \sigma_{u_n})$ and $u_e \sim N(0, \sigma_{u_e})$;

ii) $\text{cov}(u_{n,t}, u_{n,t-1}) = 0$;

iii) $\text{cov}(u_{e,t}, u_{e,t-1}) = 0$; and

iv) $\text{cov}(u_{n,t}, u_{e,t}) = 0$,

then the density function of equation (18) is given by the following relationship:

$$f(M) = f_n(M) F_e(M) + f_e(M) F_n(M), \tag{22}$$

where $f_n(M)$ = the density function of M in case $M = M_n^d$

$F_e(M)$ = the probability density function of $M = M_e^d$

$f_e(M)$ = the density function of M in case $M = M_e^d$

$F_n(M)$ = the probability density function of $M = M_n^d$ and

$$f_n(M) = 1 / \sigma_{u_n} \sqrt{2^n} \exp(-u_n^2 / 2\sigma_{u_n}^2)$$

$$f_e(M) = 1 / \sigma_{u_e} \sqrt{2^n} \exp(-u_e^2 / 2\sigma_{u_e}^2)$$

$$F_e(M) = \int_{-\infty}^M f_e(M) dM_e^d$$

$$F_n(M) = \int_{-\infty}^M f_n(M) dM_n^d$$

Proof:

In Chart 10, the region of the plane $M_n^d M_e^d$ where $\max (M_n^d , M_e^d) \leq M$ is the set of points such that $M_n^d \leq M$ and $M_e^d \leq M$.

Therefore, the probability masses in this region are given by the relationship:

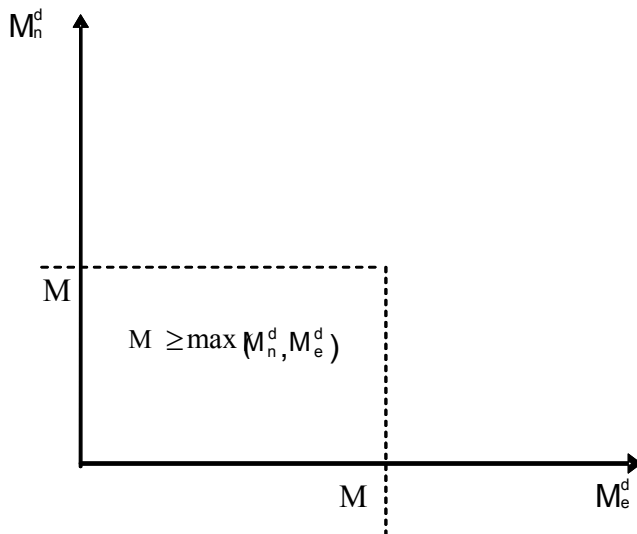
$$F(M) = F(M , M) , \tag{23}$$

But since the events $(M_n^d = M)$ and $(M_e^d = M)$ are independent based on assumption (iv), equation (23) is written as follows:

$$F(M) = F(M , M) = F_n(M) F_e(M) , \tag{24}$$

Taking the total differential of equation (24), we arrive at relationship (22) – q.e.d.

Chart 10: Probability distribution in the imports market



For the maximum likelihood estimation, we need to specify the common density function or the probability function for the vector of the independent variables. For independent observations, this function is given by the following equation:

$$L(M) = \prod_{t=1}^T f(M) , \tag{25}$$

In logarithms, equation (25) is written as:

$$\ln L(M) = \sum_{t=1}^T \ln f(M) , \quad (26)$$

Finally, the maximisation of equation (26) yields the estimates of the relevant parameters of the imports functions.

6. Results of the estimations

6.1 Results by the cointegration method

6.1.1 *Preliminary estimates*

The imports functions are estimated for the period 1962:1-2007:4 using seasonally adjusted quarterly data. The results of the unit root tests imply that all the variables in logarithms follow the I(1) process and that their first differences are I(0) stationary. The AIC (Akaike Information Criterion), HQ (Hannan-Quinn) and F statistics were used in order to choose the lag-length of 2 as appropriate in the vectors 1.1-1.4 of Table 4. Table 4 (part A) presents the λ -trace and λ -max statistics, which specify the number of the cointegration vectors. These statistics prove the presence of only one cointegration vector for each of the equations (1.1-1.4) estimated on the basis of critical values equal to 1% and 5%, respectively. In all these estimates the vector is very stable, since it satisfies both stability conditions, i.e. its characteristic root is equal to one (1.0), while its second root is considerably less than one (1.0).

Table 4: Cointegration analysis of demand for imports (1962:1-2007:4)

Equations	1.1		1.2		1.3		1.4	
Variables								
A. Cointegration tests								
H ₀ : Number of vectors (r)	λ trace	λ max	λ trace	λ max	λ trace	λ max	λ trace	λ max
critical value: 1% or 5%	54.5	32.2	76.1	38.8	76.1	38.8	103.2	45.1
r ≤ 1	39.3	20.8	61.4	24.1	68.5	24.1	102.7	40.2
B. Coefficients of the cointegration vector variables								
Constant	5.006		2.358		5.665		0.496	
p _m /p _q	-0.486 (-3.14)		-0.430 (-3.30)		-0.430 (-3.30)		-0.327 (-2.71)	
y	0.959 (13.27)		1.103 (16.72)		0.171 (0.81)		1.312 (17.99)	
ad	0.018 (1.32)		0.007 (0.59)				0.003 (0.28)	
vq			0.954 (3.33)		2.030 (4.24)		1.260 (4.72)	
cu							-1.327 (-4.29)	
D	0.826 (6.40)		0.586 (5.35)		0.445 (3.76)		0.449 (4.46)	
a ₁	-0.192 (-3.44)		-0.256 (-4.07)		-0.178 (-2.51)		-0.242 (-3.98)	
Log L	942		1561		629		1907	
Stability condition	1st ch.r.: 1 2nd ch.r.: 0.687		1st ch.r.: 1 2nd ch.r.: 0.684		1st ch.r.: 1 2nd ch.r.: 0.821		1st ch.r.: 1 2nd ch.r.: 0.670	
Period	1962-2007		1962-2007		1993-2007		1962-2007	

Note: Low case fonts denote logarithms of the initial variables.
 Vectors are estimated lagged two periods.
 The λ trace and λ max statistics have been adjusted with the degrees of freedom.
 The t statistics are presented in parentheses.
 For the dummy variable D, see Section 4.1.3.

6.1.2 Estimation of long-run relationships

Closer examination of Table 4 (part B) reveals the following: *First*, the coefficients on the variables have the expected signs, and in almost all cases are statistically significant. *Second*, imports are inelastic with respect to relative prices (0.49 in equation 1.1, 0.43 in equation 1.2 and 0.33 in equation 1.4). Moreover, taking into account that the relative price elasticity of Greek exports (price competitiveness) is marginally higher than one (1.0) (see Athanasoglou and Bardaka, 2010), it can be seen that the “usual” form of the Marschall-Lerner condition is satisfied. *Third*, the income elasticity ranges from 0.96 in the traditional model to 1.31 in equation 1.4, which also includes, in addition to the “variety and quality” variable (VQ), domestic demand relative to supply (CU). As has been observed in previous studies (see Athanasoglou, 1992), the fact that the income elasticity of Greek imports is higher than that of domestically produced-goods,¹² implies that in periods of economic growth (recession), the demand for imports rises

¹² The income elasticity of private consumption has been found to be appreciably less than one (1.0) (see Zonzilos, 1990, and Bank of Greece, 1989).

(falls) faster than that for domestic goods. The above estimates of (both relative price and income) elasticities of the Greek economy¹³ lie rather at the lower end of the spectrum compared with those for other countries (see Hooper et al., 1998, and Anderson, 1993). *Fourth*, with respect to the "variety and quality" variable imports have an elasticity close to one (0.95) in equation 1.2 and greater than one (1.26) in equation 1.4. As already mentioned, the omission of this variable from the imports equations entails a bias error due to incorrect model specification. Indeed, as can be seen by comparing equations 1.1 and 1.2, the constant in the latter equation has fallen to half the value in the former, while the value of Log L has also increased considerably. Moreover, as expected from the theory, the relevant elasticity is particularly high in the period 1993-2007 (equation 1.3: elasticity equal to 2), a time when economic activity in Greece recorded high rates of growth (around 4%), resulting in a stronger consumer preference for buying imported goods of wider variety and high quality. *Fifth*, imports are elastic with respect to domestic demand relative to supply (CU). This elasticity takes a value (-1.33) slightly higher than income elasticity, and has a negative sign, a fact which implies that the two goods, the imported and the domestic one, are in the long run substitutes, and therefore, the relative increase of the supply of the domestic product can reduce imports of goods, to an extent that may neutralise the effect of income.

Therefore, the estimates of Table 4 (part B) show that "variety and quality" (VQ), denoted by expenditure on machinery and equipment as a percentage of GDP, as well as the demand and supply conditions of the domestic good in the domestic market, denoted by the capacity utilisation rate (CU), have a considerable effect on Greek imports of goods. Excluding these two variables from the imports equation causes a significant specification error to the model.

Finally, Table 4 (part B) presents the coefficients α_1 , which denote the speed of adjustment to long-run equilibrium of the imports equations. It can be observed that adjustment takes place in four quarters in equations 1.2 and 1.4, while it appears slightly slower (five quarters) in equation 1.1.

6.1.3 Estimation of short-run single equations

¹³ Similar estimations of long-run income elasticity have also been carried out in other studies (see Zonzilos, 1991).

The short-run equation (21) was estimated by the maximum likelihood (ML) method using lags up to the 2nd degree. Specifically, the results of the estimations of equations 1.1, 1.2 and 1.4 of Table 4 (part B) are presented in Table 5.

Table 5: Estimates of the short-run imports equation (1962:1-2007:4)

Method: ML	Estimation of single equations			Estimation of equation systems	
	Equations				
Explanatory variables	1.1	1.2	1.4	1.2	1.4
Constant	0.023 (3.50)	0.026 (4.39)	0.022 (3.70)	0.025 (3.68)	0.019 (2.97)
Δm^d_{t-1}	-0.271 (-2.98)	-0.224 (-3.20)	-0.240 (-3.22)	-0.232 (-3.77)	-0.262 (-3.56)
$\Delta(p_m/p_q)_t$		-0.314 (-1.89)	-0.245 (-1.58)	-0.353 (-2.89)	-0.138 (-1.16)
$\Delta(p_m/p_q)_{t-1}$	-0.130 (-0.73)				
Δy_{t-1}	0.337 (1.80)	0.032 (0.21)	0.108 (0.70)	0.173 (0.89)	0.122 (0.53)
Δad_t	-0.021 (-1.46)	-0.026 (-2.01)	-0.015 (-1.19)	-0.009 (-0.90)	-0.005 (-0.38)
Δvq_{t-1}		1.125 (3.15)	1.357 (3.44)	0.654 (1.35)	0.990 (1.94)
Δcu_t			0.295 (1.99)		0.440 (3.12)
EC_{t-1}	-0.199 (-3.17)	-0.300 (-4.18)	-0.199 (-3.83)	-0.274 (-5.05)	-0.243 (4.33)
D	0.055 (0.92)	0.038 (1.69)	0.025 (1.13)	0.040 (0.457)	0.037 (0.55)
Log L	207	214	214	705	705
Wald	47	861	67		
$\rho_1(A)$	0.254 (2.64)	0.292 (2.63)	0.297 (3.11)		
$\rho_1(G)$	0.617 (3.55)	0.672 (6.29)	0.607 (4.99)		

Note: Δ denotes the first differences of the variables in logarithms.
The t statistics are presented in parentheses.
For the dummy variable D, see Section 4.1.3.
The equations were estimated by the ML method with lags of two periods.
The second autocorrelation coefficients of the residuals and the fluctuation, i.e. $\rho_2(A)$ and $\rho_2(G)$, are statistically insignificant in all cases.

The estimated coefficients, which represent short-run (impact) elasticities, have the expected signs. The coefficient of EC_{t-1} is negative and statistically significant, in support of the cointegration hypothesis.

Relative prices have only a minor effect on imports and are significant only in equation 1.4. Disposable income has a statistically insignificant effect on imports in all cases except in equation 1.1, where its effect is still minor (0.34).

The “variety and quality” variable seems to have the strongest effect on imports. The short-run elasticity takes a value of 1.13 in equation 1.1, and of 1.36 in equation 1.4 (see Table 5). These results entail that, when the short-run imports equation is imperfectly specified, the effect of relative prices on imports is underestimated, whereas the effect of income is overestimated. Finally, the effect of the CU variable appears to be statistically significant with a coefficient of roughly 0.30, i.e. takes a positive sign. This estimate leads to the conclusion that, contrary to what was estimated for the long-run period, in the short run domestic and imported goods are complementary. Consequently, a 10% higher capacity utilisation rate can lead to a reduction of imports of around 3%. This result is unsurprising, given that a share of about 60% of total imports relates to machinery, equipment and intermediate goods.

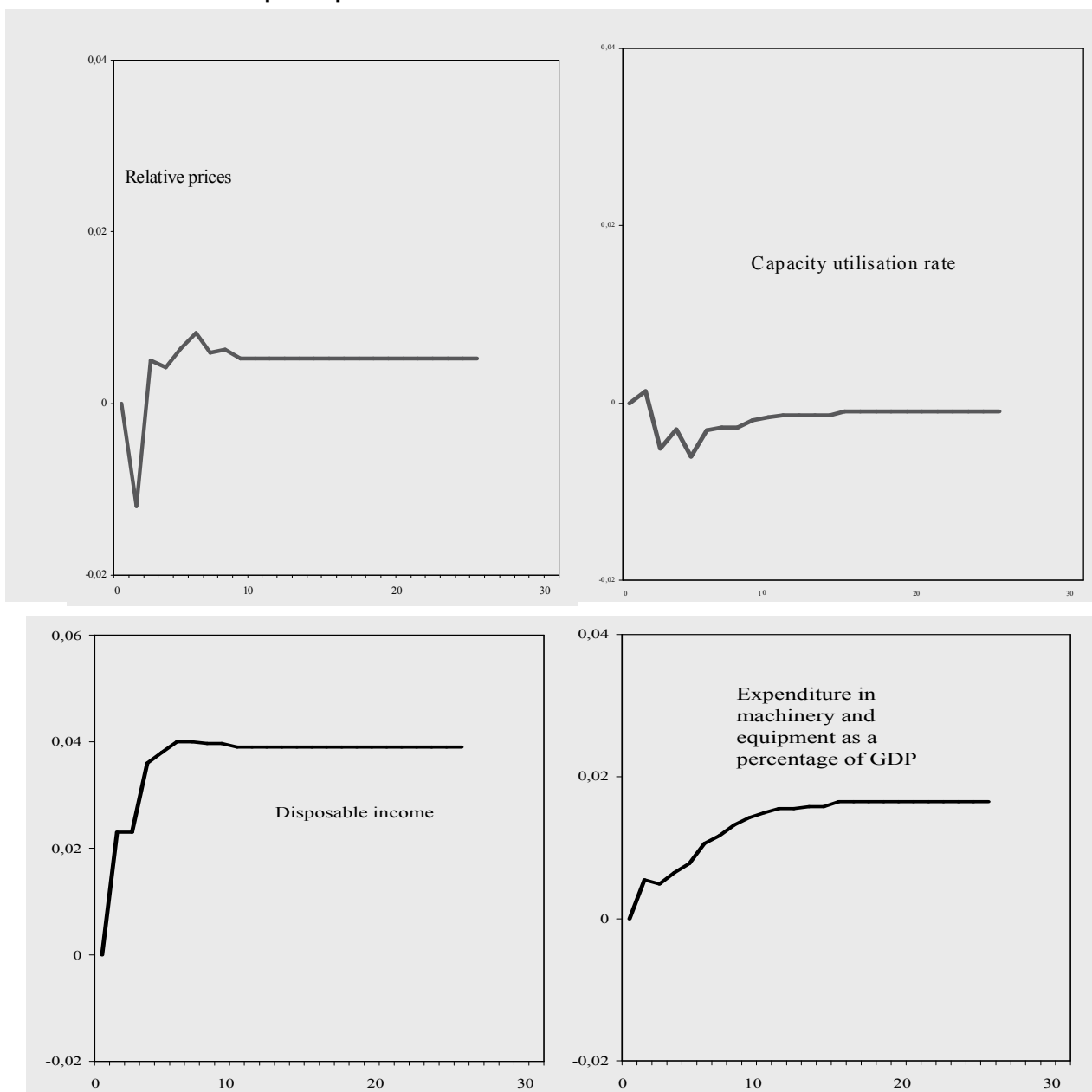
6.2 Results from the estimation of actual imports

In the maximisation of the probability function (22) we use the GRADX (Quadratic Hill Climbing) algorithm with analytic derivatives. This method is deemed sufficiently reliable and effective, as it uses first and second derivatives. However, the computational burden involved was immense.

The estimates derived by this method, presented in Table 5 (last two columns), are consistent with economic theory. Based on the probabilities associated with each of the two imports functions, it can be seen that approximately 95% of the sample’s observations are accounted for by the effective demand for imports. This observation leads to the safe conclusion that Greek imports are accounted for by that function which, in addition to consumer preference for variety and quality, also incorporates the demand and supply conditions of the domestic market.

The results of the estimates derived by this method with respect to relative prices and income confirm in both equations those derived by the cointegration method. In contrast, the effect of the “variety and quality” variable in both functions (1.2 and 1.4) appears to be smaller than that derived by the cointegration method. However, this variable is significant in equation 1.4 and takes an elasticity equal to one (1.0). In the same equation, the elasticity with respect to the CU variable is positive, statistically very significant, and stands at 0.44, that is quite higher than by the previous method. However, this method confirms the previous estimates, i.e. that in the short run the two goods are complementary.

Chart 11: Simulation of imports equation 1.4



In light of the foregoing analyses we arrive at the conclusion that Greek imports of goods are better explained by effective demand, where the spill-over effect from the domestic product's market is also taken into account. Therefore, not including a variable proxying this effect in the Greek imports function, as was the case in the relevant literature, causes a considerable specification error.

Chart 11 shows the path of imports after an one unit increase in their major determinants. Specifically, higher relative prices, although they initially reduce imports, later lead to a marginal increase. Indeed, not only relative prices but the other variables as well – i.e. disposable income, "variety and quality" (expenditure for machinery and equipment), and the capacity utilisation rate – generate **permanent effects** on imports (see Chart 11).

7. Conclusions

This study examined the behaviour of imports of goods in the Greek economy in the last five decades and their determinants, with an emphasis on the "variety and quality" of the imported goods, as well as on the demand and supply conditions of the domestic market.

Greek imports display a high geographical concentration, as roughly two thirds of total imports originate from the EU-15. However, the last decade has seen a considerable increase of imports from China and the countries of the Middle East and the Mediterranean area. The commodity structure of Greek imports reveals a high share of investment goods and intermediate goods for further processing. As regards the final use of imports, a share of approximately 60% is destined for firms and the remaining 40% for households. It is indicative that in the last two decades Greek imports recorded a slight shift from low-tech goods to mainly medium- and, to a lesser extent, high-tech goods. However, Greece lacks in its imports of high-tech goods compared with the other EU Southern European countries. Therefore, the transfer and overall supply of high technology is relatively low in Greece, a fact that has a negative impact on productivity growth, domestic supply and exports.

Import penetration in manufacturing has followed an upward trend. The abolition of trade policy restrictions, as a result of the country's entry into the EU, led to higher imports, but also to a considerable growth in economic activity in industries where the country had or developed a comparative advantage.

Empirical investigation of the factors that affect imports involved the estimation of functions for the period 1962-2007. The analysis showed that domestic competitiveness, as measured by the ratio of the prices of imported products (excluding fuel) to the prices of domestically produced goods (excluding fuel) from 1988 onwards, displays a permanent deterioration, which indeed intensifies in the period after the country's accession to the euro area.

The econometric analysis of the time series reveals that the imports function in its traditional form (i.e. imports as a function of income and relative prices) cannot adequately explain the evolution of imports. For that purpose, it was expanded to include consumer preferences satisfied by "variety and quality" of imported products (New Trade Theory), as well as the pressure exerted by the relationship between domestic demand and supply of the domestic good. It is worth noting that Greek imports are affected not only by relative prices and income but also, particularly, by qualitative characteristics, such as the "variety and quality" of the imported goods. The effect of

this factor is considerably high in the last two decades. Finally, the inability of supply to meet demand for the domestic good, also exerts a considerable effect on imports.

In the long run, the elasticity with respect to the above factors is equal to or slightly higher than one (1.0), save for the relative price elasticity, which is estimated to be relatively low. In the short run however, only "variety and quality" and the part of demand for the domestic good not satisfied by domestic production, as well as, to a lesser extent, relative prices shape the change in imports. In contrast, the contribution of income is statistically insignificant. Finally, although in the short run the relationship between the domestic and the imported goods appears to be complementary, in the long run the two goods are characterised as substitutes.

These findings are highly relevant for policy. Specifically, prices as policy tools, e.g. through the incomes policy or measures to limit the domestic market's oligopolistic structure, have a limited effect on imports, and consequently on the trade balance as well, both in the short and the long run. In the short run, although domestic price restraint can contribute to a reduction of imports, the effectiveness of their change is limited. In general, imports are affected in the short run by the phase of the economic cycle and the level of economic activity. In the long run, policies that strengthen domestic production and supply are those that can contribute to a substitution of imports and the narrowing of the trade deficit. Therefore, enhancing the factors that increase productivity and the potential growth rate of production contributes effectively to the substitution of imports and the reduction of the current account deficits.

References

- Anderson, P.S. (1993), "The 45° – rule", *Applied Economics*, 25, 1279-84.
- Athanasoglou, P. (1992), "Economic policy and the balance of payments", Bank of Greece, *Studies and Speeches Archive*, 72 [in Greek].
- Athanasoglou, P. and I. Bardaka (2010) "New trade theory, non-price competitiveness and export performance", *Economic Modelling*, 27, 217-28.
- Bank of Greece (1989), *Annual Report*, Athens.
- Bank of Greece (2006), *Annual Report*, Athens.
- Barrell, R. and D.W. te Velde (1999), "Evolving patterns in manufacturing demand in the European Union: an empirical investigation of 10 European countries", National Institute of Economic and Social Research.
- Bennett, H., J. Escolano, S. Fabrizio, E. Gutierrez, I. Ivaschenko, B. Lissovolik, M. Moreno-Badia, W. Schule, S. Tokarick, Y. Xiao and Z. Zarnic (2008), "Competitiveness in the southern euro area: France, Greece, Italy, Portugal and Spain", IMF, Working Paper, 1120.
- Bierens, H.J. (1993), "Higher order autocorrelation and the unit root hypothesis", *Journal of Econometrics*, 57, 137-60.
- Bierens, H.J. (1997), "Testing the unit root with drift hypothesis against non-linear trend stationarity, with an application to the US price level and interest rate", *Journal of Econometrics*, 81, 29-64.
- Bierens, H.J. and S. Guo (1993), "Testing stationarity and trend stationarity against the unit root hypothesis", *Econometric Reviews*, 12, 1-32.
- Brissimis, S. (1986), "Import discouraging mechanisms and their effectiveness in Greece in the period 1975-1983", Bank of Greece, *mimeo*, [in Greek].
- Clower, R. (1965), "The keynesian counterrevolution: a theoretical appraisal", in Hahn and Brechling (eds.), *The Theory of Interest Rates*, London, Macmillan.
- Enders, W. (2005), *Applied Econometric Time Series*, 2nd ed., John Wiley & Sons.
- Engle, R.F. and C.W.J. Granger (1987), "Co-integration and error correction: representation, estimation and testing", *Econometrica*, 55, 2, 251-76.
- Gagnon, E.J. (2004), "Productive capacity, product varieties, and the elasticities approach to the trade balance", *International Finance Discussion Papers*, 781, Board of Governors of the Federal Reserve System.
- Goldstein, M. and M. Khan (1985), "Income and price elasticities in trade", in Jones and Kenen (eds.), *Handbook of International Economics*, II, North-Holland, Amsterdam.
- Grossman, G. and E. Helpman (1991), *Innovation and growth in the global economy*, MIT Press, Cambridge, MA.

- Helpman, E. and P.R. Krugman (1985), *Market structure and foreign trade: Increasing returns, imperfect competition and the international economy*, MIT Press, Cambridge, MA.
- Hooper, P., K. Johnson and J. Marquez (2000), "Trade elasticities for the G-7 countries", *Princeton Studies in International Economics*, 87, August.
- Ito, T. (1980), "Methods of estimation for multimarkets disequilibrium models", *Econometrica*, 48, 97-126.
- Johansen, S. (1991), "Estimation and hypothesis testing of co-integration vectors in Gaussian Vector Autoregressive Models", *Econometrica*, 59, 6, 1551-80.
- Johansen, S. and K. Juselius (1990), "Maximum likelihood estimation and inference on co-integration – with application on the demand for money", *Oxford Bulletin of Economics and Statistics*, 52, 169-210.
- Krugman, P. (1989), "Differences in income elasticities and trends in real exchange rates", *European Economic Review*, 33, 1031-54.
- Leamer, E.E. and R.M. Stern (1970), *Quantitative international economics*, Allyn and Bacon, Boston.
- Zonzilos, N. (1990), "Consumption: empirical investigation of the rational expectations permanent income hypothesis in Greece", *Spoudai*, 40, 60-80, [in Greek].
- Zonzilos, N. (1991), "Modelling imports when variables are stochastically trending", *Greek Economic Review*, 2, 269-86.

Annex A

The statistical data

M = the value (at 1970 constant prices, in millions of euro) of imports, excluding imports of fuel and ships. Source: National Statistical Service of Greece (NSSG), Foreign Trade Statistics.

y = the domestic disposable income at 1970 constant prices. Given that no quarterly statistical data were available for the period under study, these were calculated based on the annual data on disposable income, applying the quarterly seasonal pattern of the employees' earnings in Greece during a calendar year.

P_m = the imports unit value index, excluding fuel (1970=100).

$P_{m,d}$ = the adjusted P_m index by the "tariffs and taxes",¹⁴ which is written as follows:

$$P_{m,d} = P_m \left(\frac{1 + d_t}{1 + A_t d_o} \right) , \quad (27)$$

where d_t = the tariffs (and taxes) rate at time t ; d_o = the tariffs rate in the base year; and A_t = the adjustment parameter.

It can be seen from the above that in this study the adjustment of import prices, based on tariffs and taxes, is different from that usually carried out in other studies, based simply on the $(1+d_t) / (1+d_o)$ ratio. To demonstrate that this latter approach is incorrect, we can assume that imported product prices include tariffs and taxes. Therefore, the Paasche price index is written as:

$$P_{m,d} = \frac{\sum (P_{ij} + D_{ij})Q_{ij}}{\sum (P_{oj} + D_{oj})Q_{ij}} , \quad (28)$$

where P_{ij} and D_{ij} = the unit price and the unit tariff (and tax) of product j at time i ; Q_{ij} = the quantity of the product, and i, j = the time (in quarters) and the products, respectively.

¹⁴ The term "tariffs and taxes" comprises: (1) import tariffs; (2) stamp duties; (3) the special tax under article 17 of Law 3092/54; (4) consumption tax; and (5) luxury tax.

Equation (28) can be written as follows:

$$P_{m,d} = \frac{\sum P_{ij}Q_{ij} + \sum D_{ij}Q_{ij}}{\sum P_{oj}Q_{ij} + \sum D_{ij}Q_{ij}}$$

or, dividing the numerator and the denominator by $\sum P_{oj}Q_{ij}$, as:

$$P_{m,d} = \frac{\frac{\sum P_{ij}Q_{ij}}{\sum P_{oj}Q_{ij}} + \frac{\sum D_{ij}Q_{ij}}{\sum P_{oj}Q_{ij}}}{1 + \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{ij}}} = \frac{\frac{\sum P_{ij}Q_{ij}}{\sum P_{oj}Q_{ij}} \left(1 + \frac{\sum D_{ij}Q_{ij}}{\sum P_{oj}Q_{ij}}\right)}{1 + \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{ij}}}, \quad (29)$$

In this relationship the ratio in the denominator does not represent the share of tariffs in the base year, unless we adopt the assumption that in the base year all imported goods were subject to the same tariff rate. However, this last hypothesis is rejected by the data. Thus, this ratio is expanded as follows:

$$\begin{aligned} \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{ij}} &= \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{ij}} \cdot \frac{\sum D_{ij}Q_{ij}}{\sum D_{oj}Q_{oj}} \cdot \frac{\sum P_{oj}Q_{oj}}{\sum P_{oj}Q_{ij}} \\ &= \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{ij}} \cdot \frac{\sum \left(\frac{D_{oj}Q_{oj} \left(\frac{Q_{ij}}{Q_{oj}} \right)}{\sum D_{oj}Q_{oj}} \right)}{\sum \left(\frac{P_{oj}Q_{oj} \left(\frac{Q_{ij}}{Q_{oj}} \right)}{\sum P_{oj}Q_{oj}} \right)} = \frac{\sum D_{oj}Q_{ij}}{\sum P_{oj}Q_{oj}} \cdot A_t \end{aligned}$$

In the above expression it can be seen that coefficient A_t is derived as a weighted sum of the volume indexes of the individual goods, where the weights in the numerator are the share of tariffs of each product in total, in the base year, and in the denominator the share of imports of each product in total, in the base year. To calculate the weights we used the breakdown of imports and of tariffs and taxes by single-digit code level of the SITC. The time series of the adjustment parameter A_t justifies this effort, as it takes values ranging between 0.95 and 1.25, rather than always being equal to one (1.0).

P_q = the NSSG wholesale index of domestic goods (excluding fuel) for domestic consumption.

AD = the real cost of the importers' mandatory advance deposits, calculated based on the relationship $AD = D \cdot r \cdot d / P_q$, where D = the importers' mandatory advance deposits with the Bank of Greece; r = the interest rate on 3-month time deposits; and d = the advance deposits' duration.

VQ = the expenditure for machinery and equipment as a percentage of the GDP of ten countries (eight European ones, the US and Australia) from which roughly 70% of total Greek imports originate. This expenditure was weighted based on the shares of Greece's annual imports from these countries to total Greek imports.

CU = the capacity utilisation rate. Estimates based on the production method for the period 1962-1980, and IOBE data for the period 1981-2007.

Annex B

Chart B1: Imports, exports and trade balance
(billions of euro)

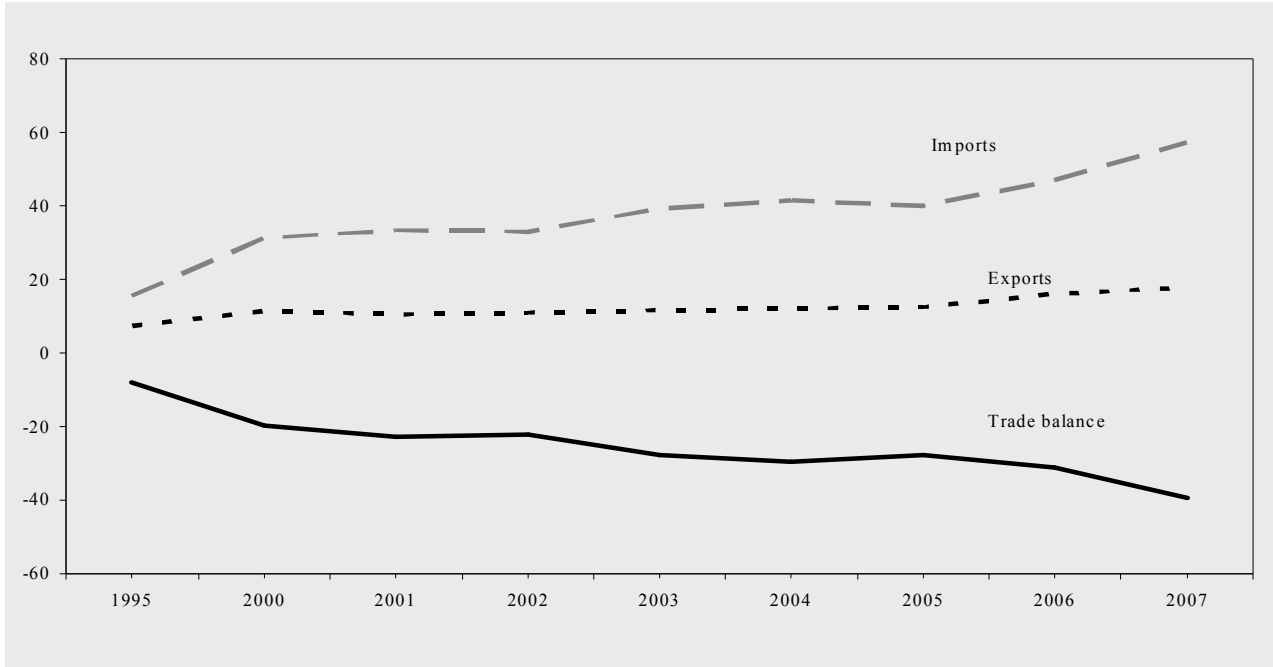


Chart B2: Interests on the importers' mandatory advance deposits
(millions of euro)

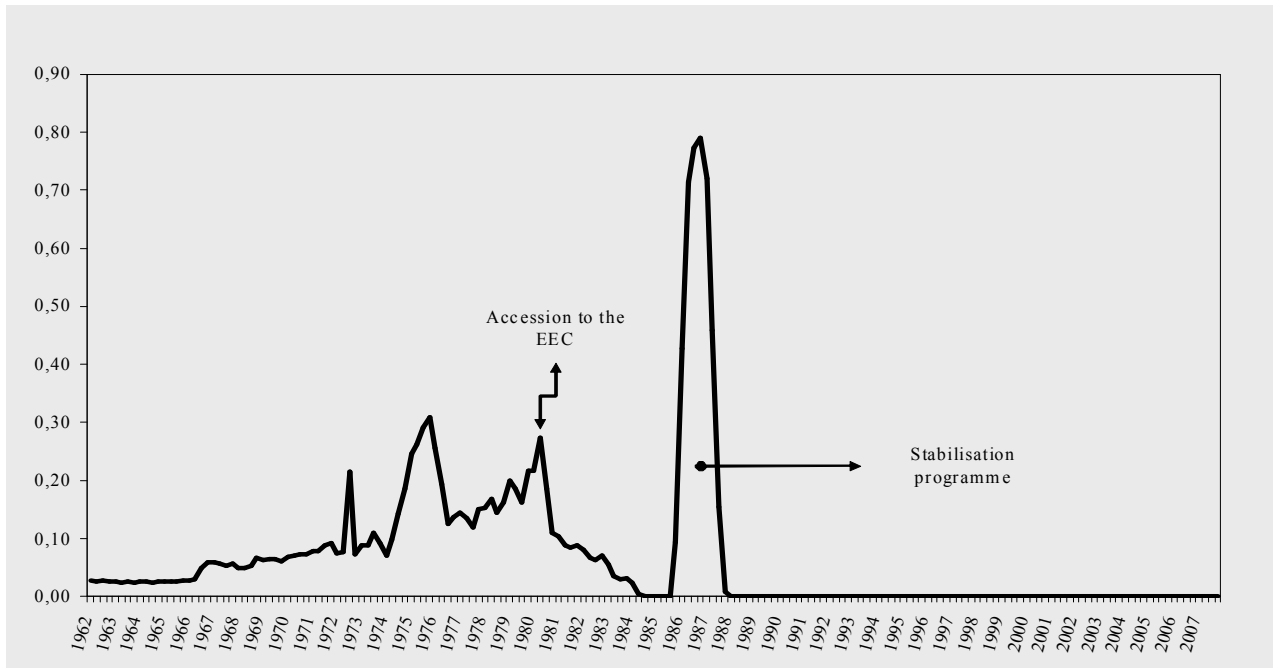


Chart B3: Expenditure in machinery and equipment of the ten major countries of origin of the Greek imports (percentages of GDP)

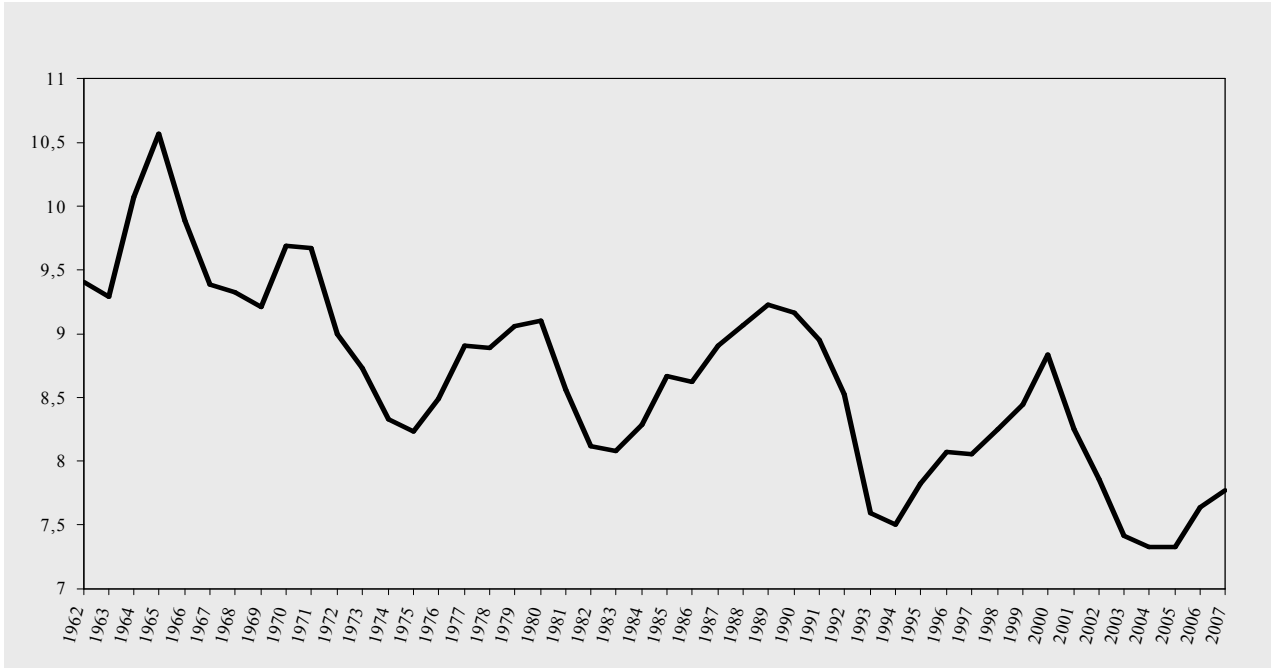


Chart B4: Gross disposable income (at constant prices) and capacity utilisation rate in manufacturing (1962-2007)

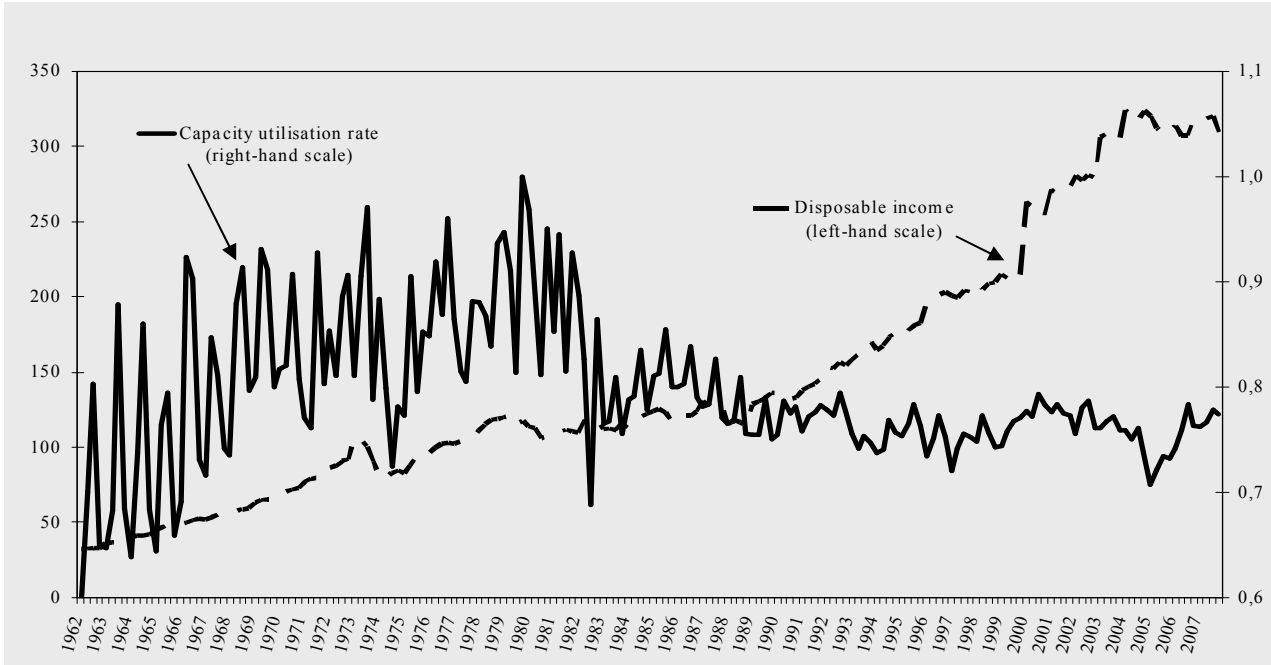


Table B1: Openness to foreign trade

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	53.3	59.5	61.5	63.4	69.7	72.0	70.7	70.5	76.4	79.1	82.7
Belgium	112.9	119.5	120.1	120.2	136.5	135.2	130.2	128.5	134.1	140.0	142.3
Denmark	51.9	54.4	54.2	54.3	59.5	59.3	60.1	57.0	58.1	61.8	65.6
Finland	54.4	57.3	56.8	55.0	63.9	58.6	56.6	56.1	57.8	62.2	68.4
France	35.7	38.9	40.1	40.6	45.6	44.5	42.4	40.5	41.5	42.7	44.5
Germany	40.0	43.9	46.0	47.3	54.8	55.5	54.5	55.4	59.5	63.8	71.2
Greece	33.6	32.9	33.6	34.5	40.3	38.3	36.6	36.3	35.1	34.8	37.9
Ireland	113.9	115.4	119.8	119.2	127.0	122.6	110.8	89.4	87.5	84.6	79.8
Italy	35.8	37.0	37.4	37.4	42.9	42.4	40.5	39.0	40.3	41.8	45.5
Luxemburg	86.0	94.5	98.6	90.0	94.6	96.8	90.6	85.1	92.1	89.9	87.9
Netherlands	88.9	94.3	93.1	93.2	105.5	99.7	93.1	91.3	97.1	101.9	109.6
Portugal	52.6	54.2	55.0	54.6	58.3	56.0	52.8	51.6	53.0	54.0	57.1
Spain	35.6	39.7	40.7	41.5	46.1	44.2	42.0	40.8	41.7	42.2	44.2
Sweden	55.4	59.6	61.2	60.5	66.0	63.5	60.6	59.8	62.5	66.1	70.0
UK	44.5	42.9	39.8	38.9	41.9	41.0	39.1	37.3	36.9	39.3	42.6
EU-15	45.3	47.9	48.4	48.8	55.1	54.0	51.9	50.6	52.5	55.0	59.0
USA	18.4	19.1	18.5	18.9	20.8	18.8	18.1	18.4	19.9	21.1	22.2
Japan	15.5	16.9	16.2	15.6	17.2	17.0	17.8	18.7	20.6	22.9	26.4

Note: Openness = $(X + M)/Y$, where X, M and Y are the exports and imports of goods and the GDP respectively, in US dollars, at current prices.

Source: OECD.

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