

The adjustment capacity of the European economy examined with an input-output based key sector analysis: towards a Review of the European Single Market

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Abstract

The Single Market is a pillar of the European Union (EU) and has been essential in the last twenty-five years for the smooth functioning of Europe's economic and monetary policies. Besides, it is also the heart of a range of EU policies such as the Lisbon Strategy on growth and jobs. Despite these achievements, the Single Market still has untapped potential and needs to adapt to new realities. Subsequently, the European Commission set out its reviewed vision for the 21st century Single Market providing a response to the challenges of globalisation. As part of this report, the Commission's services developed a new approach for a more systematic monitoring of the functioning of key goods and services markets, which was presented at the informal European Council in October 2007. Within this context, this paper screens all the industries of the European economy to identify those key markets and sectors that are most important for growth and adjustment in the EU in terms of production, employment and income. It contributes to the literature by making a sensitivity analysis of the backward and forward impact indicators to identify the key sectors and eventually provides results for the EU as a whole and for individual countries for selected sectors: chemicals, fabrication of motor vehicles, food industry, construction work and pulp and paper industry.

Keywords: *Single Market, Input-output analysis, Key sector analysis, European Union.*

JEL Codes: C67; O52.

¹ The views expressed in this paper belong to the authors and should not be attributed to the European Commission or its services.

1. Background

The Single Market (EC, 2007a) is a pillar of the European Union (EU). It has turned the free movement of people, goods, services and capital into a tangible reality, delivering real benefits for Europeans. The single market has been essential for the smooth functioning of Europe's economic and monetary policies and served as a strong base for the launch of the Euro. The enlarged single market has made Europe more open, more diverse and more competitive -creating new opportunities, respecting social rights, and promoting high standards for health, safety and the environment. Besides, the single market is at the heart of a range of EU policies such as the Economic Monetary Union and the Lisbon Strategy on growth and jobs.

Despite these achievements, the single market still has untapped potential and needs to adapt to new realities. In February 2007, the Commission set out its vision for the 21st century single market: a strong, innovative and competitive market, which maximises the potential of services, directly benefits consumers and entrepreneurs and positions Europe to better respond to and shape globalisation. Also, now that the EU has become bigger and more diverse the single market needs to: (a) deliver more results for citizens, consumers and small and medium enterprises; (b) take better advantage of globalisation; (c) open new frontiers of knowledge and innovation; and (d) encompass a strong social and environmental dimension.

All of this calls for new working methods and the use of a diverse set of instruments. Efforts have focused on removing cross border barriers, mainly through legal measures. Efforts should now be made to develop a more varied set of tools and a more impact-driven approach: making markets deliver more effectively in areas which will bring the best return for consumers, growth and job creation. To that purpose, the Review sets out a new approach to the single market. It does not include a classic legislative action programme but rather fostering flexibility and adaptability while maintaining the legal and regulatory certainty necessary to preserve a well-functioning single market.

This new approach is described in the documents on market monitoring, single market instruments and trade instruments which accompany the Review (EC, 2007a). Along with other related documents including a summary of achievements of the single market, they represent an important part of the Commission's response to the challenges of globalisation "The European interest - succeeding in an era of globalisation" (EC, 2007b) which was presented at the informal European Council in October 2007.

As part of these documents, the Commission's services have developed a methodology for a more systematic monitoring of the functioning of key goods and services markets. The first stage of this methodology consisted in screening sectors offering the greatest potential benefits in terms of growth, job creation and consumer welfare. In the second stage, selected sectors will be examined in more detail in order to determine why markets are functioning poorly (lack of openness/integration, lack of choice and transparency for consumers, low degree of competition, poor regulatory environment and lack of innovation). This will give crucial insights to address the

specific challenges faced in the sector(s) concerned. The Commission intends to work closely with national authorities to develop this new approach.

A staff working paper (EC, 2007c) was presented alongside the Review (EC, 2007a) to present the first findings of the first stage, which are based on the recent methodology published in the "Guiding principles for product and market monitoring" (EC, 2007d). The screening and analysis carried out allowed to: (a) identify markets and sectors which are important for growth and adjustment in the EU; (b) identify the existence of market malfunctioning within the Internal Market; and (c) offer some insights into the causes of markets malfunctioning. The sector screening could contribute to improve efficiency and consistency in the future design of horizontal policy instruments and help address Single Market problems affecting the EU. In the staff working paper (EC, 2007c), all sectors of the economy were screened on the basis of their economic importance, their contribution to the adjustment capacity of the EU and signs of market malfunctioning.

Within this context, the JRC/IPTS and the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN) have cooperated closely in the screening of the most important sectors in each of the individual euro area and EU27 Member States by means of input-output analysis in order to assess the challenges for market based economic adjustment in the framework of the European Monetary Union and the European Union.

The Communication 'A Single Market for the 21st century Europe' (EC, 2007a) and to the accompanying Commission Staff working document "Implementation of the new methodology for product market and sector monitoring" have drawn extensively on the work carried out by JRC/IPTS on behalf of DG ECFIN on the identification of the sectors that most contribute to the adjustment capacity of the EU economy. The work of the JRC/IPTS on methodology development and the results obtained are explicitly reflected in many places of the latter document (cf. pages 12 to 18 in EC, 2007c) and in the Communication. Eventually, the complete analysis, initiated as a policy support study, was subsequently generalised and extended into this paper.

2. Layout, data and methods

This paper identifies the sectors that most contribute to the adjustment capacity of the EU economy, regarding the supply of essential inputs to the rest of the economy. The objective is to assess the extent to which the functioning of markets is sufficiently flexible to allow an endogenous and smooth adjustment to changing economic conditions (EC, 2007c). This is done on the basis of a key sector analysis by using interlinkages of sectors with the rest of the economy, since the stronger these linkages, the more important are the repercussions of the performance of the sector on the rest of the economy. Complementarily, the EC (2007c) also includes in the study an analysis of (a) the contribution of the sectors to the development, absorption and diffusion of new technologies, as this helps to promote greater economic efficiency and competitiveness; and (b) the contribution of the sectors to price adjustment, as price stickiness hampers the reallocation of resources across activities and reduces the pass through of cost

reductions to consumers. Nonetheless, the discussion of the latter two issues would go beyond this paper and therefore it is not included.

The identification of key sectors can be addressed from the demand side, the supply side or from both angles. From the demand side, we can identify those sectors for which a one-unit increase in the final demand of their primary outputs would drive other sectors either in terms of total output, employment or income, by increasing their corresponding intermediate inputs, i.e.: backward oriented sectors. The analysis from the supply side reveals those sectors providing the inputs supplied to other sectors as a result of one-unit increase in their gross value added or, generally speaking, gross domestic product, i.e.: forward oriented sectors.

The identification of key sectors is a well-known subject in the literature² and it can be addressed with input-output analysis using a single symmetric input-output table³ (SIOT). The JRC/IPTS has recently estimated a SIOT of the EU27 for the year 2000 (Rueda-Cantuche et al., 2007), which is adequate to apply standard input-output analysis with that purpose. By taking the two impact multipliers together, the key sectors can be identified as those with highest backward and forward multipliers. To this purpose, the analysis will be developed for output, employment and income multipliers. All primary data is from Eurostat (Eurostat, 2007); further estimations, where necessary, were developed by JRC/IPTS⁴. The analysis is made at a fairly aggregated level, at the two-digit level of the NACE industrial classification.

However, the key sector analysis is not a straightforward task. Firstly, the analysis shall account for domestic intermediate uses. Otherwise, policy-oriented impacts in final demand may lead to output growth in the exporting countries rather than in domestic industries. Secondly, forward and backward multipliers shall be weighted according to gross value added and final demand shares of sectors, respectively, in order to discriminate against sectors that are too small, in the EU, to ever have any relevance on macroeconomic observations. Finally, one should take into consideration that the total effects on the whole system as a result of variations in the final demand of a product might be spread throughout many sectors or just be concentrated on a single one.

In addition, it might be interesting to account for the shares of intermediate uses over both the total intermediate inputs and the total intermediate outputs. Their average would serve as a measure of the direct relationship between buying and supplying sectors. Accordingly, this report will map the production networks of the EU economy

² The key sector analysis has prompted out a huge literature. To mention some examples: Beyers (1976), Bon (1986), Cella (1984), Chenery and Watanabe (1958), Dietzenbacher (1997, 2002), Ghosh (1958), Hazari (1970), Hirschman (1958), Jones (1976), Laumas (1975, 1976), McGilvray (1977), Oosterhaven (1988, 1989), Oosterhaven and Stelder (2002), Rasmussen (1956) and Sonis, Hewings and Guo (2000).

³ For simplicity, we will use "sectors" throughout the document albeit the EU27 SIOT is on a product by product basis. Roughly speaking, results would not be significantly different as long as the amount of secondary outputs was not comparable to the primary outputs.

⁴ Since the main interest of this paper relies on the Single Market Review, the discussion hereafter will be focused on primarily market based sectors. That is, all industries except the primary sectors and mining (1 to 8); real estate (47); public administration and defence (52); education (53); and health and social work (54). This distinction is taken from the EUKLEMS consortium: www.euklems.net.

on the basis of the aggregate symmetric input-output table for 2000, and thus providing the main direct sectoral interlinkages within the EU.

In the next section, we present a brief description of the EU economy in terms of output, income and employment; section 4 maps the production networks on the basis of direct linkages while section 5 introduces the key sector analysis and identifies the sectors that most contribute to the adjustment capacity of the EU economy through total linkages. Subsequently (section 6), we compare the results taking into account their contribution to output, employment and income and made a sensitivity analysis (section 7) to check the robustness of the results. There, the threshold used to identify key sectors (average vs. median) together with the choice of either including or excluding from the analysis the corresponding main diagonals of each matrix of backward and forward linkages will be discussed. In section 8, we have selected five key sectors considered with the greatest environmental impact (JRC/IPTS and ESTO, 2006) and we explore where in Europe these sectors are so crucial in terms of growth, income and jobs. Finally, section 9 concludes. The formal aspects of the methodology used are reported in the Appendix.

3. Descriptive analysis

Figure 1 shows six of the top eight sectors in terms of output, gross value added and employment in the EU for the year 2000. *Public administration* and *health and social work* would complete the list but they are not considered here since they are not primarily market based sectors. Percentages stand for the shares of output, gross value added or employment over their totals in the whole economy.

As shown in Figure 1, construction work and other business services (i.e. accounting and law activity services, engineering and architecture technical services, marketing services, among others) represent each one nearly 7% of total output, followed by wholesale trade and the food manufacturing industry with 4.6% and 4.2%, respectively.

In terms of gross value added, other business services goes up to 8.5% while construction work and wholesale trade only reach 5.7% and 5.2%, respectively.

As for employment, construction work represents 7.6%, followed by wholesale and retail trade services with 6.1% and 5.6%, respectively.

HERE FIGURE 1

4. Mapping direct linkages

Figure 2 depicts the main links of the production structure network in the EU for the year 2000. By taking the average of the shares of intermediate uses over the total intermediate inputs and over the total intermediate outputs, a flow index was defined in order to measure the degree of direct relationship between sectors (see the Appendix for a formal definition).

For instance, on the one hand 71.32% of total intermediate outputs of agriculture are delivered to the food industry while 33.19% of total intermediate inputs of the food industry correspond to agricultural products. Then, this would yield a flow index given by the average of the two latter figures, i.e. 52.26% (0.5226). On the other hand, 18.78% of total intermediate outputs of food products (mainly animal feed) are conveyed to the agriculture sector whilst 10.21% of total intermediate inputs of agricultural activities correspond to products supplied by the food industry. Hence, the average would be 14.49% (0.1449) in this case.

The relationships depicted in Figure 2 cover around 45% of the total intermediate transactions. They represent average of the shares greater or equal to 0.1 in all cases. The following considerations might be drawn from Figure 2:

HERE FIGURE 2

- a) The whole production network is pivoting on the construction work activities, wholesale trade and other business services, which are three of the most important sectors in terms of total gross value added, output and employment (see Figure 1).
- b) Other business services is highly forward interrelated with computer services; sewage and refuse disposal, sanitation and similar activities; wholesale trade; the manufacture of tobacco products; insurance; and real estate activities.
- c) Supporting and auxiliary transport activities (including travel agencies) are also highly forward interrelated with land, water and air transport activities; and wholesale trade.
- d) Construction work is highly backward interrelated with the manufacture of wood, products of wood and cork; fabricated metal products; other non-metallic mineral products (quite strong); electrical machinery and apparatuses; and other mining and quarrying.
- e) Land transport activities are also highly backward interrelated with the manufacture of refined petroleum products⁵; the sale, maintenance and repair of motor vehicles and motorcycles, and retail sale services of automotive fuel; and auxiliary transport activities.
- f) The manufacture of food products and beverages presents a quite strong interrelationship with agriculture and fishing (backward oriented) and with agriculture and hotel and restaurant services (forward oriented).
- g) The manufacture of basic metals shows strong direct (backward) linkages with recycling and mining of metal ores as well as relevant direct (forward) effects on the manufacture of fabricated metal products.

⁵ Sector 17 actually includes also the manufacture of coke and nuclear fuels; the interpretation of the link is however evident.

h) The strongest linkages are found in:

h.1) Energy sectors, i.e. uranium and crude and natural gas providing inputs to the petroleum refining and nuclear fuels sector; and coal mining supplying inputs to the electricity, gas, steam and hot water sector.

h.2) Food industry and related services, i.e. agriculture and fishing providing inputs to the food industry; and food industry supplying inputs to hotels and restaurants.

h.3) Textiles and clothing, i.e. the manufacture of textiles providing inputs to the manufacture of wearing apparel; dressing and dyeing of fur.

h.4) Metallurgy, i.e. mining of metal ores and recycling providing inputs to the manufacture of basic metals; and metallurgy supplying inputs to the manufacture of fabricated metal products.

h.5) Construction work and related services, i.e. the manufacture of other non-metallic mineral products providing inputs to construction activities; and construction supplying inputs to real estate activities.

For ease of visualisation, in Figure 2 different colours have been assigned to different clusters of related sectors, which might be seen as crucial sector clusters in the economy. The denomination of the clusters will refer to each pivotal sector and does not imply any omission of other related activities within the cluster. These are the following⁶: a) Manufacture of basic metals and fabricated metal products; b) Construction work; c) Retail trade; d) Pulp, paper and paper products; editing; e) Other business services; f) Finance and insurance; g) Food industry; hotels and restaurants; h) Wholesale trade; i) Land transport; j) Energy; k) Chemicals; motor vehicles; l) Auxiliary transport activities; m) Textiles and clothing; n) Office machinery and computers. Figure 3 summarizes the interrelationships between the clusters.

HERE FIGURE 3

5. Key sector analysis

The activity of a particular sector has two kinds of economic effects on other sectors in the economy: the so-called demand and supply driven effects (see for instance: Miller and Blair, 1985). If the electricity sector increases its output, then there will be increased demand from electrical power stations (as purchasers) on the sectors whose products are used as inputs to produce electricity (e.g. coal, crude petroleum or natural gas). These demand driven effects are captured in standard input-output models or demand-side models by the *backward multipliers*, which indicate the interconnection of a particular sector to those sectors from which it purchases inputs.

On the other hand, increased output in the electricity sector also means additional amounts of electricity available to be used as input to other sectors for their own production. That is, there will be increased supplies from the electricity sector (as a seller) to the sectors which use electricity in their production. The impact of the increased supply is captured by the supply-side model, which relates gross value added to total output by means of the so-called *forward multipliers*. This term is used to indicate the interrelationship of a particular sector with those sectors to which it sells its

⁶ Notice that forestry and health and social work clusters are not included since they are not primarily market based sectors.

outputs and it is usually interpreted as a meaningful indicator of production only for those sectors where there is shortage of supply⁷.

Key sectors in an economy are identified by comparing the magnitude of their backward and forward multipliers, scaled by the overall prominence of the sector in the economy (see considerations on the weighting of sectors). If the backward multiplier of the manufacture of chemicals and chemical products is larger than that of the manufacture of rubber and plastics, one might conclude that an euro worth of expansion of the former sector output would be more beneficial to the economy than would an equal expansion in the latter sector's, in terms of generating more productive activity throughout the economy. Similarly, if the forward multiplier of wholesale trade is larger than that of insurance services, it could be said that a euro worth of expansion of the output of wholesalers has a higher impact on the overall productive activity than a similar expansion in the output of insurers. The rationale to identify key sectors is that the greater a sector's interlinkages of the EU economy, the greater the need to ensure that markets in that sector are functioning well and the greater returns of policy intervention to remedy possible problems in the Single Market. Nevertheless, policy decisions addressing specific sectors based on their impact on the whole economy cannot be taken on the basis of one single criterion and/or approach; other factors, such as for instance production capacities, may play a relevant role in total effects.

Table 1. *Identification of key sectors.*

		Forward oriented	Forward oriented	No relevant forward effects	No relevant forward effects
		Spread	Concentrated	Spread	Concentrated
Backward oriented	Spread	<i>Key sectors with widely spread effects</i>	<i>Key sectors but with forward effects concentrated</i>	<i>Backward oriented sectors with widely spread effects</i>	
Backward oriented	Concentrated	<i>Key sectors but with backward effects concentrated</i>	<i>Key sectors without widely spread effects</i>	<i>Backward oriented sectors without widely spread effects</i>	
No relevant backward effects	Spread	<i>Forward oriented sectors with widely spread effects</i>	<i>Forward oriented sectors without widely spread effects</i>	<i>Weakly linked sectors</i>	
No relevant backward effects	Concentrated				

The measures of backward and forward multipliers presented here include both direct and indirect connections between sectors, which differs from the last section

⁷ Forward multipliers can also be interpreted in terms of unitary price changes by means of input-output analysis.

where we addressed only direct relationships. By taking the two impact multipliers together, the key sectors shall be identified as those with highest backward and forward multipliers. To this purpose, the analysis will be developed for output, employment and income.

However, the key sector analysis is not a straightforward task. Firstly, the analysis shall account for domestic intermediate uses because otherwise total estimated effects might be found to be transferred outside the EU through intermediate imports. Secondly, forward and backward multipliers shall be weighted according to gross value added and final demand shares of sectors, respectively. The purpose is to avoid giving the same importance to every sector independently of their relevance in terms of gross value added (for forward effects) and final demand (for backward effects). Finally, one should take into consideration that the total effects on the whole system as a result of variations in the final demand of a product might be spread throughout many sectors or just be concentrated on a single one. In this sense, different implications may in fact arise if a sector channels its external effects to a wide variety of other producing industries or essentially to a single one. For instance, if the building industry crashes it will bring down all those services sectors that depend exclusively on building and real estate; an industry that serves more diverse customers is better able to come out relatively unaffected from a sectoral crisis. To recap, we will identify key sectors according to the typology shown in table 1.

Output multipliers

Table 2 shows the results regarding output multipliers. To simplify the visualisation, numbers have been assigned to each sector following the NACE scheme (see the Appendix for detail). From the multipliers analysis described above, the following sectors emerge by all parameters as *key sectors in the European economy* for the year 2000:

- a) Manufacture of chemicals and chemical products (18)
- b) Construction (34)
- c) Wholesale trade and commission trade, except of motor vehicles and motorcycles (36)
- d) Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (37)
- e) Real estate activities (47)
- f) Recreational, cultural and sporting activities (57)

In particular, the forward effects of key sectors are not spread throughout the economy whilst their backward impacts can be more or less spread.

Notice also that those sectors with relevant spread forward effects on output are mainly related to energy inputs, certain manufacturing industries, transport, telecommunications, and financial, renting, and computer services; and those with important spread backward impacts consists of the food industry, the manufacture of machinery and equipment, the manufacturing, sale, maintenance and repairing of motor vehicles, hotels and restaurants and insurance services.

Table 2. Key sectors in terms of outputs

		Forward oriented	Forward oriented	No relevant forward effects	No relevant forward effects
		Spread	Concentrated	Spread	Concentrated
Backward oriented	Spread		18, 34, 36	9, 23, 28, 35, 38, 45	
Backward oriented	Concentrated		37, 57		
No relevant backward effects	Spread	14, 15, 16, 19, 21, 22, 31, 32, 39, 42, 43, 44, 46, 48, 49	20, 51	10, 11, 12, 13, 17, 24, 25, 26, 27, 29, 30, 33, 40, 41, 50, 55, 56, 58, 59	
No relevant backward effects	Concentrated				

Source: own elaboration.

The manufacture of other non-metallic mineral products as well as other business activities do not have relevant backward effects while having a prominent role in terms of forward output effects, albeit not so spread.

Employment multipliers

Table 3 depicts results for employment multipliers, with sector numbering in accordance with the NACE classification (see Appendix). In this case, the following sectors emerge as key sectors (although the effects are not very spread) in terms of employment:

- a) Construction (34)
- b) Sale, maintenance and repair of motor vehicles and motorcycles; retail sale services of automotive fuel (35)
- c) Wholesale trade and commission trade, except of motor vehicles and motorcycles (36)
- d) Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (37)
- e) Hotels and restaurants (38)
- f) Recreation, cultural and sporting activities (57)

Generally speaking, construction activities, trade and hotel and restaurant services emerge as key sectors regarding employment impacts.

It emerges from this analysis that energy sectors have no significant effects on employment in contrast with certain manufacturing activities (pulp and paper (15), chemicals (18), fabricated metal products and publishing and editing (22)); telecommunications; land transport and related supporting and auxiliary transport services; and other business services such as renting, computer services and finance, which have relevant forward effects on employment.

Concerning backward impacts, the food industry; the manufacture of machinery and equipment and the manufacturing of motor vehicles emerged again with spread relevant employment impacts, in this case along with real estate activities.

Table 3. Key sectors in terms of employment

		Forward oriented	Forward oriented	No relevant forward effects	No relevant forward effects
		Spread	Concentrated	Spread	Concentrated
Backward oriented	Spread			9, 23, 28	
Backward oriented	Concentrated		34, 35, 36, 37, 38, 57		
No relevant backward effects	Spread	15, 16, 18, 22, 39, 42, 43, 44, 48, 49	14, 20, 51	10, 11, 12, 13, 17, 19, 21, 24, 25, 26, 27, 29, 30, 31, 32, 33, 40, 41, 45, 46, 50, 55, 56, 58, 59	
No relevant backward effects	Concentrated				

Source: own elaboration.

Income multipliers

Income multipliers provide the categorization represented in table 4. Again the numbering follows the NACE classification (see Appendix). In this case, the following sectors can be considered key sectors in terms of income effects:

- a) Construction (34)
- b) Wholesale trade and commission trade, except of motor vehicles and motorcycles (36)
- c) Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (37)
- d) Real estate activities (47)
- e) Other business activities (51)
- f) Recreational, cultural and sporting activities (57)

Additionally, the sectors with prominent forward effects more or less spread throughout the system refer to certain manufacturing industries (other non-metallic mineral products; pulp and paper; publishing and editing; and fabricated metal products), land transport and related supporting and auxiliary transport activities, energy inputs, telecommunications, finance, renting and computer services.

Concerning relevant spread backward effects, the food industry, the manufacturing of machinery and equipment and of motor vehicles show up again, in this case accompanied by the chemical industry.

Table 4. *Key sectors in terms of income*

		Forward oriented	Forward oriented	No relevant forward effects	No relevant forward effects
		Spread	Concentrated	Spread	Concentrated
Backward oriented	Spread		34	9, 18, 23, 28	
Backward oriented	Concentrated		36, 37, 51, 57	35, 38	
No relevant backward effects	Spread	15, 16, 22, 32, 42, 43, 44, 46, 48, 49	20, 39	10, 11, 12, 13, 14, 17, 19, 21, 24, 25, 26, 27, 29, 30, 31, 33, 40, 41, 45, 50, 55, 56, 58, 59	
No relevant backward effects	Concentrated				

Source: own elaboration.

Some further considerations on investment goods

In the analysis presented in the previous sections, forward and backward multipliers are weighted according to final demand shares of sectors in order to avoid giving the same importance to gas extraction and to the mining of uranium (which is a tiny sector in the EU economy), for instance. Backward multipliers can also be weighted by using shares of final demand for investment goods rather than for total final demand, which will produce a measure of *relevant investment goods producing sectors*. The following additional elements emerged from this complementary analysis:

- a) The manufactures of fabricated metal products; electrical machinery and apparatuses; radio, television and communication equipments; medical, precision and optical instruments, watches and clocks; other transport equipment; furniture and other

manufactured products; and computer and related activities, emerged with relevant backward multipliers both in terms of output, income and employment.

b) The manufacture of office machinery and computers emerged with output and income-only relevant backward effects whilst other business activities had only output and employment relevant backward multipliers.

It may seem odd that the ICT sectors are not identified as key sectors throughout the analysis reported in the preceding sections. However, we argue that this should be expected (and is actually the only possible outcome) if ICT expenditures are recorded as capital formation rather than intermediate inputs to production. Indeed, when backward multipliers are weighed by the investment column vector (instead of the total final demand vector), some ICT producing sectors turned out to have relevant backward effects. Particularly, ICT producing sectors (codes 24, 25, 26 and 27) are included within the top ten sectors with highest share of investment over their total commodity outputs. Furthermore, the high share of imported ICT products may yield a reduction of the measured volume of ICT products in the domestic input-output table, i.e.: ICT producing sectors (codes 24, 26 and 27) are included within the top ten sectors with highest volume of imported share of their total commodity outputs.

Then, the extent to which a one-unit-increase in ICT capital in industry i is embodied in a particular industry or in the overall industry (impact effects) may not be well captured by the (intermediate and domestic input based) key sector analysis and may be better quantified as in Myung-Hwan Rim et al (2005), where ICT purchases are treated as capital increase and from a dynamic perspective rather than as intermediate inputs. Verspagen (2002) also considers ICT purchases as a capital good increase and uses a known capital flow matrix (column vector of investment broken down by purchasing sectors) that is summed along with the intermediate matrix. Then, the standard key sector analysis would apply to the new modified "technical" and "delivery" coefficient matrices. Alas, the data that would be necessary for this analytical exercise is currently not available with sufficient coverage of the EU and with sufficient quality.

6. Comparative analysis of multipliers

Table 5 shows a comparative analysis of multipliers according to their relevance in terms of output, employment and income. In this sense, construction activities (34), wholesale (36) and retail (37) trade and recreational, cultural and sporting activities (57) emerged by all parameters as key sectors while real estate activities (47) do for output and income.

On the other hand, the manufacture of chemicals and chemical products (18) emerged as key sector in terms of output while other business activities (51) do in terms of income. With regards to employment, the sale, maintenance and repair of motor vehicles and motorcycles (35); and the hotel and restaurant services (38) emerged as key sectors in terms of employment.

In addition, there are sectors clearly forwardly oriented and with slightly relevant backward effects. The manufacture of pulp, paper and paper products (15);

publishing, printing and reproduction of recorded media (16); the manufacture of other non-metallic products (20); the manufacture of fabricated metal products (22); land transport services (39); supporting and auxiliary transport activities (42); post and telecommunications (43); financial intermediation (44); renting of machinery and equipment (48); and computer and related services (49), present highly relevant forward effects in all parameters (output, employment and income). The manufacture of wood and of products of wood and cork (14) and other business activities (51) played relevant roles in terms of output and employment while the electricity, gas, steam and hot water supply sector (32) and the activities auxiliary to financial intermediation (46) did it in terms of output and income. Relevant output forward effects are shown in the manufacture of rubber and plastic products (19), the manufacture of basic metals (21) and the recycling (31), among others. The manufacture of chemicals and chemical products (18) is also a forwardly oriented sector in terms of employment effects.

Table 5. Comparative analysis of multipliers

	O – E – I	O – E	O – I	O	E	I
Key Sectors	34, 36, 37, 57			18	35, 38	51
Forward oriented	15, 16, 20, 22, 39, 42, 43, 44, 48, 49	14, 51	32, 46	19, 21, 31	18	
Backward oriented	9, 23, 28		35, 38	45		18

Legend: O = Output; E = Employment; I = Income

Source: own elaboration

NOTE: No single sector emerged as relevant only in terms of employment and income.

With regard to backward oriented sectors, the food and beverages industry (9), the manufacture of machinery and other equipment (23) and the manufacture of motor vehicles, trailers and semi-trailers (28) have relevant backward effects in all parameters. The sale, maintenance and repair of motor vehicles and motorcycles (35); and the hotel and restaurant services (38) emerged as mainly backward oriented sectors in terms of output and income. Finally, insurance and pension funding (45), real estate activities (47) and the manufacture of chemicals and chemical products (18) have relevant backward effects in terms of output, employment and income, respectively.

7. Sensitivity analysis

On the one hand, the key sector analysis presented so far seems to overestimate the relevance of several sectors for which either their share of gross value added and/or their share of final demand over the total economy output is large; see, for instance: construction, wholesale and retail trade, public administration, health and social work, education, real estate and recreational, cultural and sporting activities.

Moreover, forward multipliers of certain sectors may well not generate additional output in other sectors but almost exclusively on their own outputs. This is the case when own intermediate consumption represents a large amount of all intermediate input requirements. This particularity can be addressed by removing the main diagonal from the backward and forward multipliers matrices in order to avoid giving extra relevance to own effects.

On the other hand, the identification of key sectors depends to a great extent on the threshold used for discrimination, i.e. the mean. The mean is the standard threshold throughout the literature although it is not robust in the presence of outlier values. The median is a different kind of average. It is the value that is greater than or equal to half of the values in the data set. It is the middle point of the data set and easy to determine if you first order the data from low to high⁸. Therefore, it can be interesting to address the key sector analysis by using the median as threshold instead of the mean.

Bearing these considerations in mind, the sensitivity analysis of key sectors was carried out with three different variants: a) by removing the main diagonals from each matrix of backward and forward multipliers; b) by using the median as threshold instead of the mean; c) by using unweighted backward and forward multipliers.

Removing main diagonals of each matrix of multipliers

The removal of the main diagonal from each matrix of backward and forward multipliers affected mainly those sectors with large amounts of own intermediate consumption, in relative terms. These sectors are: public administration, wholesale trade, retail trade, construction, health and social work services, real estate, education and recreational, cultural and sporting services. These sectors came out now mainly as backward oriented sectors rather than as key sectors, which indicates that the formerly larger forward multipliers were related to additional amounts of their own primary output rather than of other different sectors. This makes a difference when addressing interlinkages.

The median as threshold

Using the median as threshold produced additional key sectors. Either including or excluding the main diagonals of each matrix of backward and forward multipliers, mostly the same sectors turned out to be key sectors by all parameters: output, employment and income (see table 6). These sectors were the following:

- a) Publishing, printing and reproduction of recorded media (16);
- b) Manufacture of chemicals and chemical products (18);
- c) Manufacture of fabricated metal products (22);
- d) Electricity, gas, steam and hot water supply sector (32);
- e) Land transport services (39);
- f) Post and telecommunications (43);
- g) Financial intermediation (44);

⁸ See a numerical example in <http://en.wikipedia.org/wiki/Median>

h) Other business services (51);

Particularly, the manufacture of electrical machinery and other apparatuses (25) became a key sector only when the main diagonal was excluded from each matrix of multipliers. Conversely, computer and related services (49) turned out to be a key sector only when including the main diagonals (see Table 6).

Table 6. Additional key sectors

	Including main diagonal	Excluding main diagonal
Output	1, 16, 22, 32, 39, 42, 43, 44, 49	16, 22, 25, 32, 39, 43, 44, 51
Employment	16, 18, 22, 39, 43, 44, 49, 51	16, 18, 22, 25, 32, 39, 43, 44, 51
Income	16, 18, 22, 32, 35, 38, 39, 43, 44, 49, 51	16, 18, 22, 25, 32, 39, 43, 44, 51

Source: own elaboration

Nevertheless, there is no way to determine the best threshold for the purpose of identifying key sectors in an economy. At least, by using the median we don't let outlier values affect the outcome, which is desirable. In this way the list of key sectors can be refined as shown in Figures 4 to 9 (see Appendix).

ICT producing sectors such as post and telecommunications (43) and the manufacture of electrical machinery and other apparatuses (25) emerged with relevant backward and forward effects. The manufacture of radio, television and communication equipment and other apparatuses (26) and the manufacture of medical, precision and optical instruments, watches and clocks (27) only emerged as backward oriented sectors.

Similarly, ICT user sectors such as publishing, printing and reproduction of recorded media (16), financial intermediation (44), other business services (51) and computer related services (49) became visible as additional key sectors. In addition, activities auxiliary to financial intermediation (46), renting of machinery and equipment (48) and research and development (50) presented relevant forward multipliers whilst other ICT users emerged as backward oriented sectors, i.e.: manufacture of wearing apparel; dressing and dyeing of fur (12); the manufacture of machinery and other equipment (23); the manufacture of other transport equipment (29); the manufacture of furniture; and other manufacturing products (30); wholesale trade (36); retail trade (37); and insurance and pension funding except compulsory social security (45).

However, the emergence of some ICT sectors as crucial for growth, jobs and income by using the median instead of the mean should not lead us to think of this method as an alternative to that of Myung-Hwan Rim (2005) and/or Verspagen (2002).

Unweighted backward and forward multipliers

As expected, the results obtained by identifying key sectors without applying any kind of weighting scheme resulted in a plethora of tiny sectors having relevant backward and forward multipliers (key sectors) mostly by all parameters, e.g.: the mining of coal and lignite; extraction of peat (4), the mining of uranium and thorium ores (6), other mining and quarrying (8) and secondary raw materials (31). Hence, unweighted multipliers were disregarded for the same reasons already given in the introductory section.

8. Analysis of selected sectors by Member State

The JRC/IPTS and the European Science and Technology Observatory (JRC/IPTS and ESTO, 2006) singled out the products that have the greatest environmental impact from a life cycle perspective in the EU25 (2000). Consumption categories such as "food and beverages; tobacco", "housing, furniture, equipment and utility use" and "transport" emerged in most of the parameters (global warming, eutrophication, photochemical oxidation and acidification) as main contributors to the total environmental impacts.

Not surprisingly, some product groups under the above mentioned consumption categories have been identified in this paper with relevant backward and/or forward impacts. For instance, the food industry (9) and the manufacturing of motor vehicles, trailers and semi-trailers (28) emerged as backward oriented sectors by all parameters (output, employment and income) and construction work (34) activities are identified as a key sector also by all parameters. In addition, we have selected the chemical industry (18), a key sector in terms of output while a forward oriented sector in terms of employment and a backward oriented sector concerning income; and the pulp and paper industry (15), which has relevant forward effects by all parameters.

In this section, we explore which are the best performing Member States in the selected sectors in terms of output, employment and income. To that purpose, we replicated the key sector analysis for each one of the 27 Member States. The main conclusions derived from this follow-up study on some selected sectors have been summarized here and illustrated with maps (see the Appendix) in order to help the reader to grasp the various outcomes.

Food industry

By taking into consideration the European Union as a whole, the food industry has strong backward linkages. In other words, an increase in the final demand of food products may lead to growth of output, jobs and income throughout the European economy. Particularly, Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Portugal, Slovakia, Sweden and the UK have predominantly backward relevant impacts in output. As regard the growth of jobs, the former list of countries extends to Cyprus, the Czech Republic, Hungary, Ireland, Latvia, Lithuania and Spain, too. In terms of growth of income, all Member States have relevant backward effects except Malta, Romania and Slovenia, in which the food industry is considered key sector (with both backward and forward relevant effects).

Motor vehicles, trailers and semi-trailers

As for the food industry, variations in final demand of motor vehicles, trailers and semi-trailers may cause relevant backward effects in the growth of output, jobs and income throughout the European economy. Precisely, Belgium, the Czech Republic, France, Germany, Hungary, Italy, Slovenia, Spain, Sweden and UK are responsible for the remarkable employment impacts while Poland and Romania would complete the list when accounting for income effects. If still we add Austria, Portugal and Slovakia then we would have the full list of Member States with high relevant backward impacts on output growth.

Construction work

Construction activities are particularly interesting since they emerge as key sector almost in all the Member States of the EU. Except for Luxembourg, all the countries have backward and forward relevant impacts on their whole national economies in terms of output and income. Regarding employment, Romania is the only exception.

Chemicals

The chemical industry performs in a peculiar way. Indeed, it has a different type of relevance impact (backward, forward or both) depending on the parameter (output, employment and income) at the aggregate EU level. Concerning the growth of output, the chemical industry in Belgium, Bulgaria, Hungary, Ireland and Romania emerged as key sector; while in the case of employment effects, the Greek, Romanian and British chemical sectors have strong forward impacts. Finally, this sector in Belgium, Bulgaria, Denmark, France, Germany, Hungary, Ireland, the Netherlands, Romania, Slovakia, Slovenia, Sweden and the UK has important backward income effects.

Pulp and paper

The pulp and paper industry emerged as a forward oriented sector at the aggregate EU level with relevant multiplier effects on output, employment and income. At the national level, it is remarkable that Cyprus, Denmark, France, Greece, Italy, Lithuania, Romania, Spain and UK emerged with relevant forward effect as regard the growth of output. However, we must drop Denmark, Greece, Italy, Lithuania and Romania from that list to keep the right countries with important employment impacts. In terms of income, Denmark, France, Romania, Spain and UK present the highest effects at the national levels.

9. Concluding remarks

Bearing in mind the results of the descriptive analysis developed in the third section, the mapping of the production network of the economy as a whole given in the fourth section and the key sector analysis carried out both for the EU27 and the Member States in terms of output, employment and income, the following conclusions might be drawn for manufacturing industries and for construction, trade and services.

Manufacturing industries

The manufacturing industries (covering sectors 9 to 33) are mainly forwardly oriented sectors (see table 5). In particular, further detailed considerations can be drawn on the following sectors:

a) The **manufacture of chemicals and chemical products** is a key activity in terms of output, a forward oriented sector in terms of employment and a backward oriented sector in terms of income, with both relevant spread backward and forward effects. This sector amounts to 3% of total output, and nearly 2% of total gross value added and of total employment.

b) The manufacture of **pulp, paper and paper products**, the **publishing, printing and reproduction of recorded media** industry and the manufacture of **fabricated metal products**, are mainly forward oriented sectors by all parameters, with spread effects across industries. These industries represent 4.4% of total output and around 3.5% of total gross value added and of total employment.

c) The **manufacture of other non-metallic mineral products** has relevant (only) forward impacts on income, output and employment. However, these products are supplied mainly to construction activities, thus having strong concentrated effects. This sector amounts to around 1% of total output, total employment and of total gross value added.

d) The **manufacture of wood and of products of wood and cork** is a mainly forward oriented sector by all parameters except for income, having spread effects only in the case of output. This sector stands for 0.7% of total output and around 0.5% of total employment and of total gross value added.

e) The **electricity, gas, steam and hot water supply industry** is a mainly forward oriented sector with spread effects by all parameters except for employment. This sector represents 2% of total output, 1.7% of total gross value added and 0.8% of total employment. It also has a strong dependence on coal mining as a relevant supplying input.

f) The manufacture of **rubber and plastic products**, **metallurgy** and **recycling** are mainly forward oriented sectors only in terms of output (with spread effects). They altogether amount to nearly 3% of total output and around 1.7% of total employment and of total gross value added. Particularly, the two latter sectors present strong interconnections, particularly recycling providing inputs to metallurgy.

g) The **manufacture of food products and beverages**, the manufacture of **machinery and other equipments** and the manufacture of **motor vehicles, trailers and semi-trailers** are mainly backward oriented sectors by all parameters, with spread effects across industries. These industries reach up to 10% of total output and around 6% of total gross value added and of total employment. In particular, the food products and

beverages industry presents quite strong backward direct linkages with agriculture and fishing.

h) The **manufactures of textiles and of wearing apparel**; dressing and dyeing of fur, have a quite strong direct interrelationship, albeit the two sectors are weakly interconnected to the rest of the economy. They seem to function as an isolated cluster.

Construction, trade and services

a) **Construction** is a key sector with regards to output, employment and income, with more or less spread effects. It is one of the sectors on which the production network pivots in terms of direct relationships. In addition, construction activities and their related services present strong linkages with other inputs-supplying industries. This sector represents nearly 7% of total output, 5.7% of total gross value added and 7.6% of total employment.

b) **Wholesale trade** and commission trade, excluding motor vehicles and motorcycles, similarly is a key sector regarding output, employment and income, with variably spread impacts. It is mainly backward oriented while being in a central position within the production network. It reaches 4.6% of total output, slightly more than 5% of total gross value added and 6.1% of total employment.

c) **Retail trade**, excluding motor vehicles and motorcycles, also emerged as key sector in terms of output, income and employment, with more or less spread effects, albeit direct interrelations within the production network is weak. It stands for 3.7% of total output, nearly 5% of total gross value added and 5.6% of total employment.

d) **Recreational, cultural and sporting activities** can be considered as well key sector by all parameters. However, the resulting forward and backward effects are quite concentrated on a few sectors. This sector amounts to 1.7% of total output, nearly 2% of total gross value added and 2.2% of total employment.

e) The **sale, maintenance and repair of motor vehicles and motorcycles; retail sale services of automotive fuel** and the **hotel and restaurant** services emerged as key sectors only in terms of employment. However, they are mainly backward oriented sectors when considering output and gross value added, with more or less spread effects. Notice the strong direct backward linkage of hotel and restaurant services with respect to the food industry as main supplier. Finally, these two sectors amount to nearly 5% of total output, slightly more than 5% of total gross value added and 6.4% of total employment.

f) **Other business activities** emerged as key sector only in terms of gross value added, with concentrated effects on industries. In turn, they are mainly forward oriented sectors regarding output and employment, with concentrated effects too. They play a central role in supplying inputs to other sectors (e.g. wholesale and retail trade, food industry, etc.), representing 6.9% of total output, 8.5% of total gross value added and 4.5% of total employment.

g) **Land transport and supporting and auxiliary transport activities** have generally widely spread relevant (only) forward effects in terms of gross value added, output and employment. They represent around 4% of total output and of total gross value added and 3.8% of total employment.

h) **Post and telecommunications, financial intermediation services, renting services of machinery and equipment and computer related services**, are mainly forward oriented sectors by all parameters. They amount to 7.7% of total output, 6% of total gross value added and 5.3% of total employment.

i) **Activities auxiliary to financial intermediation** are mainly forward oriented services by all parameters except for employment. It has a strong direct forward interconnection with insurance and pension funding. This activities stand for around 0.75% of total output and of total gross value added and 0.4% of total employment.

j) **Insurance and pension funding** is a mainly a backward oriented sector only in terms of output. It is strongly direct backward linked to those activities auxiliary to financial intermediation. This sector represents 1.2% of total output, nearly 1% of total gross value added and 0.6% of total employment.

Besides, the sensitivity analysis showed that sectors with large shares of own consumption have also large forward impacts on themselves rather than on other different sectors. Also, backward multipliers are heavily affected by outlier values and results may differ once we take as threshold the median instead of the mean to identify key sectors. In this sense, most ICT producing and ICT user sectors now would emerge with relevant backward and forward multipliers. However, in order to analyse the effects of ICT producing sectors in the economy explicitly as forward links we should refer to either Myung-Hwan Rim et al (2005) and/or Verspagen (2002).

Finally, this paper also shed light on the distribution of the backward and forward effects within the Member States, which have been illustrated with maps. It is also particularly interesting to find that some of the sectors identified by the JRC/IPTS and the ESTO as those having the largest environmental impacts emerged in this analysis with relevant impact effects in economic terms. Indeed, the necessity to de-link the growth of output, jobs and income from the environmental impact has been a topic of importance in the political arena and in the civil society for the last years.

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Appendix

Methodological approach

To start with, we shall use the following notation:

- Z** = domestic intermediate input-output matrix (order 59x59)
- I** = identity matrix (order 59x59)
- x** = output column vector (59)
- e** = column vector of ones (59)
- m** = column vector of employment (59)
- w** = column vector of compensation of employees (59)
- y** = final demand column vector (59)
- g** = gross value added row vector (59)
- n* = number of sectors and commodities (59)

Next, we will define the following coefficients:

Input-coefficients

$$A = \mathbf{Z} * \text{diag}(\mathbf{x})^{-1}$$

Delivery-coefficients

$$A^* = \text{diag}(\mathbf{x})^{-1} * \mathbf{Z}$$

Labour coefficients

$$l^t = \mathbf{m}^t * \text{diag}(\mathbf{x})^{-1}$$

Employees' compensation coefficients

$$w^t = \mathbf{w}^t * \text{diag}(\mathbf{x})^{-1}$$

Leontief inverse of input-coefficients

$$L = (\mathbf{I} - A)^{-1}$$

Ghosh inverse of delivery-coefficients

$$L^* = (\mathbf{I} - A^*)^{-1}$$

According to the literature, backward multipliers are recommended to be computed using L while forward multipliers using L^* . These multipliers are defined as follows:

Table A.1 Input-Output Multipliers

	Backward	Forward
Output effects	$\mathbf{e}^t L$	$L^* \mathbf{e}$
Employment effects	$l^t L$	$L^* l$
Income effects	$w^t L$	$L^* w$

As said in the text, backward and forward multipliers shall be modified to account for the different shares of each sector's final demand or gross value added, respectively. To that purpose, these multipliers will be redefined and weighted using the following *final demand* (f) and *gross value added* (v) coefficients:

$$f = \mathbf{y} * [\mathbf{e}^t \mathbf{y} / n]^{-1}$$

$$v = [\mathbf{g} \mathbf{e} / n]^{-1} \mathbf{g}$$

being f a column vector and v a row vector, both of order 59.

Then, we define new modified Leontief and Ghosh inverses. That is:

Weighted Leontief inverse of input-coefficients

$$L_w = (\mathbf{I} - A)^{-1} * \text{diag}(f)$$

Weighted Ghosh inverse of delivery-coefficients

$$L_w^* = (\mathbf{I} - A^*)^{-1} * \text{diag}(v)$$

As a result, we construct another table with the corresponding weighted formulas:

Table A.2 Weighted Input-Output Multipliers

	Backward	Forward
Output effects	$\mathbf{e}^t L_w$	$L_w^* \mathbf{e}$
Employment effects	$l^t L_w$	$L_w^* l$
Income effects	$w^t L_w$	$L_w^* w$

Notice that in Table A.2, e.g. backward effects would represent variations in the total e.g. output of the system produced as a result of one-unit increase in the final demand of a product. However, these effects do not make any distinction about their origin, i.e. can all the effects be ascribed to one single sector or are they spread all throughout the economy? Thus, it would be also interesting to account for individual effects on sectors as well as with a relative dispersion measure, i.e. the Pearson coefficient of variation (given by the ratio between the standard deviation of the corresponding effects and their average). It would be clear now that lower coefficients of variation would represent highly spread effects.

Finally, Table A.3 shows accordingly the three different kinds of multipliers to be estimated for the EU27 in the year 2000.

Table A.3 Input-Output Multipliers Matrices

	Backward	Forward
Output effects	L_w	L_w^*
Employment effects	$diag(l) L_w$	$L_w^* diag(l)$
Income effects	$diag(w) L_w$	$L_w^* diag(w)$

Identification of key sectors

Let b_{ij} be the (i,j) -th element of any of the backward multipliers matrices (output, employment or income) presented in Table A.3. Hence, backward multipliers will be defined as:

$$\mathbf{b}_j = \sum_i b_{ij}$$

and the so-called **normalized backward multiplier** as:

$$\mathbf{b}_j^N = \frac{\sum_i b_{ij}}{\sum_j b_j} n$$

where those sectors with $\mathbf{b}_j^N > 1$ will be said *backward oriented sectors*.

Additionally, let c_j be the j -th coefficient of variation, calculated by:

$$\mathbf{c}_j = \frac{\sqrt{\frac{1}{n} \sum_i (b_{ij} - \bar{b}_j)^2}}{\frac{1}{n} \sum_i b_{ij}}$$

and analogously, we derive the **normalized backward coefficient of variation** as:

$$\mathbf{c}_j^N = \frac{c_j}{\sum_j c_j} n$$

where those sectors with $\mathbf{c}_j^N < 1$ will be said to have *backward effects widely spread* throughout the whole system.

The analysis follows the same structure for forward multipliers.

Calculation of direct forward and backward linkages; and the flow index

Let us define **S** as a matrix (59x59) of shares of intermediate uses over the total intermediate outputs for each product (row). This matrix depicts the so-called *forward linkages* and can be expressed as:

$$\mathbf{S} = [\text{diag}(\mathbf{Z}\mathbf{e})]^{-1} * \mathbf{Z}$$

On the other hand, let us define **D** as another matrix (59x59) of shares of intermediate uses over the total intermediate inputs for each sector (column). This matrix includes the so-called *backward linkages* and can be written as follows:

$$\mathbf{D} = \mathbf{Z} * [\text{diag}(\mathbf{e}'\mathbf{Z})]^{-1}$$

Eventually, let us define the *flow index* as the average of forward and backward linkages for each element of matrices **S** and **D**. That is:

$$\mathbf{FI} = \frac{(\mathbf{S} + \mathbf{D})}{2}$$

NACE A60 Classification

Nr	Sector
1	Agriculture, hunting and related service activities
2	Forestry, logging and related service activities
3	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing
4	Mining of coal and lignite; extraction of peat Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding
5	surveying
6	Mining of uranium and thorium ores
7	Mining of metal ores
8	Other mining and quarrying
9	Manufacture of food products and beverages
10	Manufacture of tobacco products
11	Manufacture of textiles
12	Manufacture of wearing apparel; dressing and dyeing of fur
13	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
14	Manuf. of wood & of products of wood and cork, exc. furniture; manuf. of articles of straw & plaiting materials
15	Manufacture of pulp, paper and paper products
16	Publishing, printing and reproduction of recorded media
17	Manufacture of coke, refined petroleum products and nuclear fuels
18	Manufacture of chemicals and chemical products
19	Manufacture of rubber and plastic products
20	Manufacture of other non-metallic mineral products
21	Manufacture of basic metals
22	Manufacture of fabricated metal products, except machinery and equipment
23	Manufacture of machinery and equipment n.e.c.
24	Manufacture of office machinery and computers
25	Manufacture of electrical machinery and apparatus n.e.c.
26	Manufacture of radio, television and communication equipment and apparatus
27	Manufacture of medical, precision and optical instruments, watches and clocks
28	Manufacture of motor vehicles, trailers and semi-trailers
29	Manufacture of other transport equipment
30	Manufacture of furniture; manufacturing n.e.c.
31	Recycling
32	Electricity, gas, steam and hot water supply
33	Collection, purification and distribution of water
34	Construction
35	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale services of automotive fuel
36	Wholesale trade and commission trade, except of motor vehicles and motorcycles
37	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
38	Hotels and restaurants
39	Land transport; transport via pipelines
40	Water transport
41	Air transport
42	Supporting and auxiliary transport activities; activities of travel agencies
43	Post and telecommunications
44	Financial intermediation, except insurance and pension funding
45	Insurance and pension funding, except compulsory social security
46	Activities auxiliary to financial intermediation

- 47 Real estate activities
 - 48 Renting of machinery and equipment without operator and of personal and household goods
 - 49 Computer and related activities
 - 50 Research and development
 - 51 Other business activities
 - 52 Public administration and defence; compulsory social security
 - 53 Education
 - 54 Health and social work
 - 55 Sewage and refuse disposal, sanitation and similar activities
 - 56 Activities of membership organisation n.e.c.
 - 57 Recreational, cultural and sporting activities
 - 58 Other service activities
 - 59 Private households with employed persons
-

Figure 1.- Sectoral structure of the EU 2000

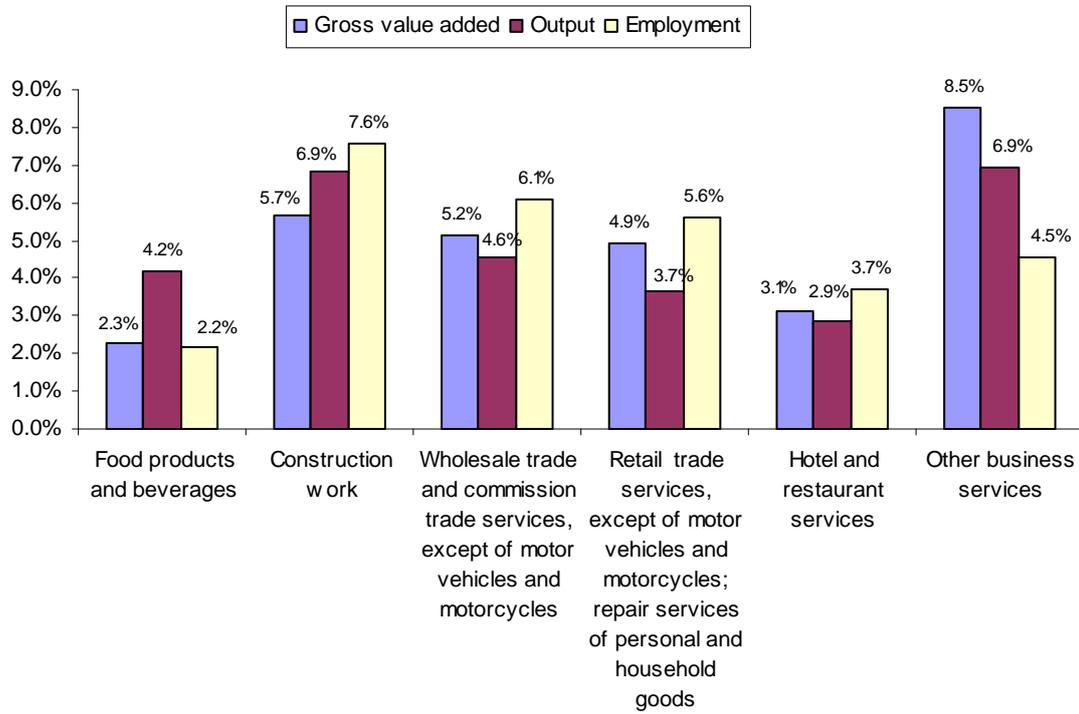


Figure 3.- Mapping direct relationships in the EU (2000) – Summary

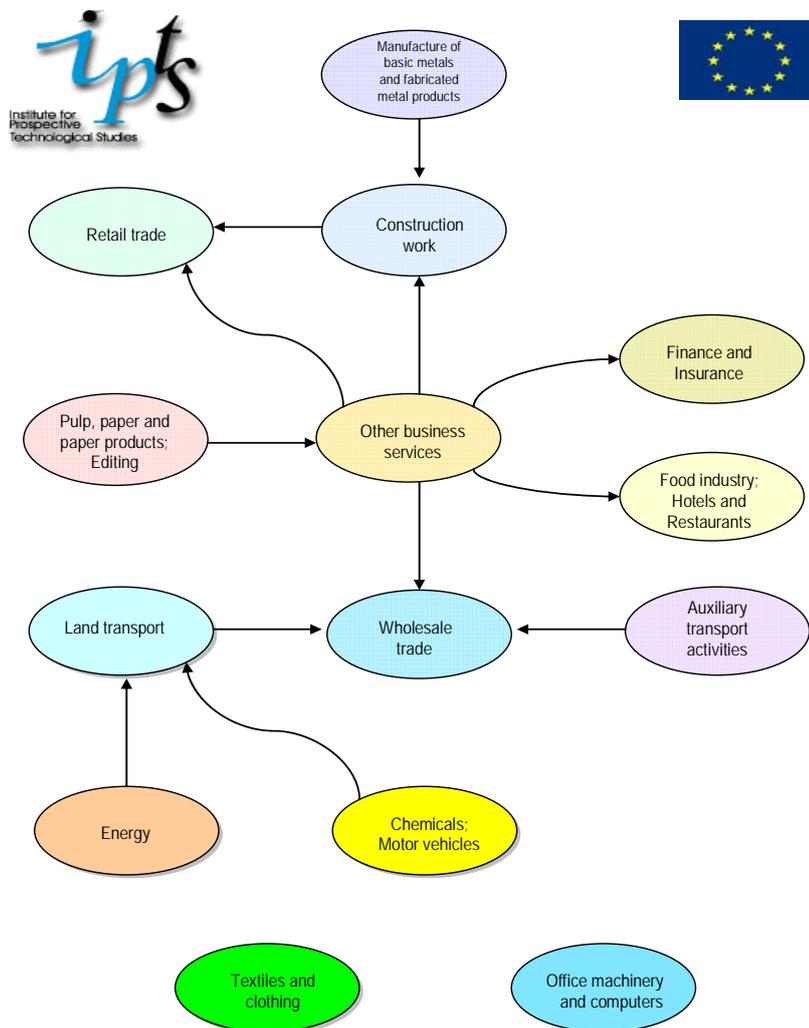


Figure 4.- Identification of key sectors by using different thresholds and weighted (scaled) OUTPUT multipliers (I)

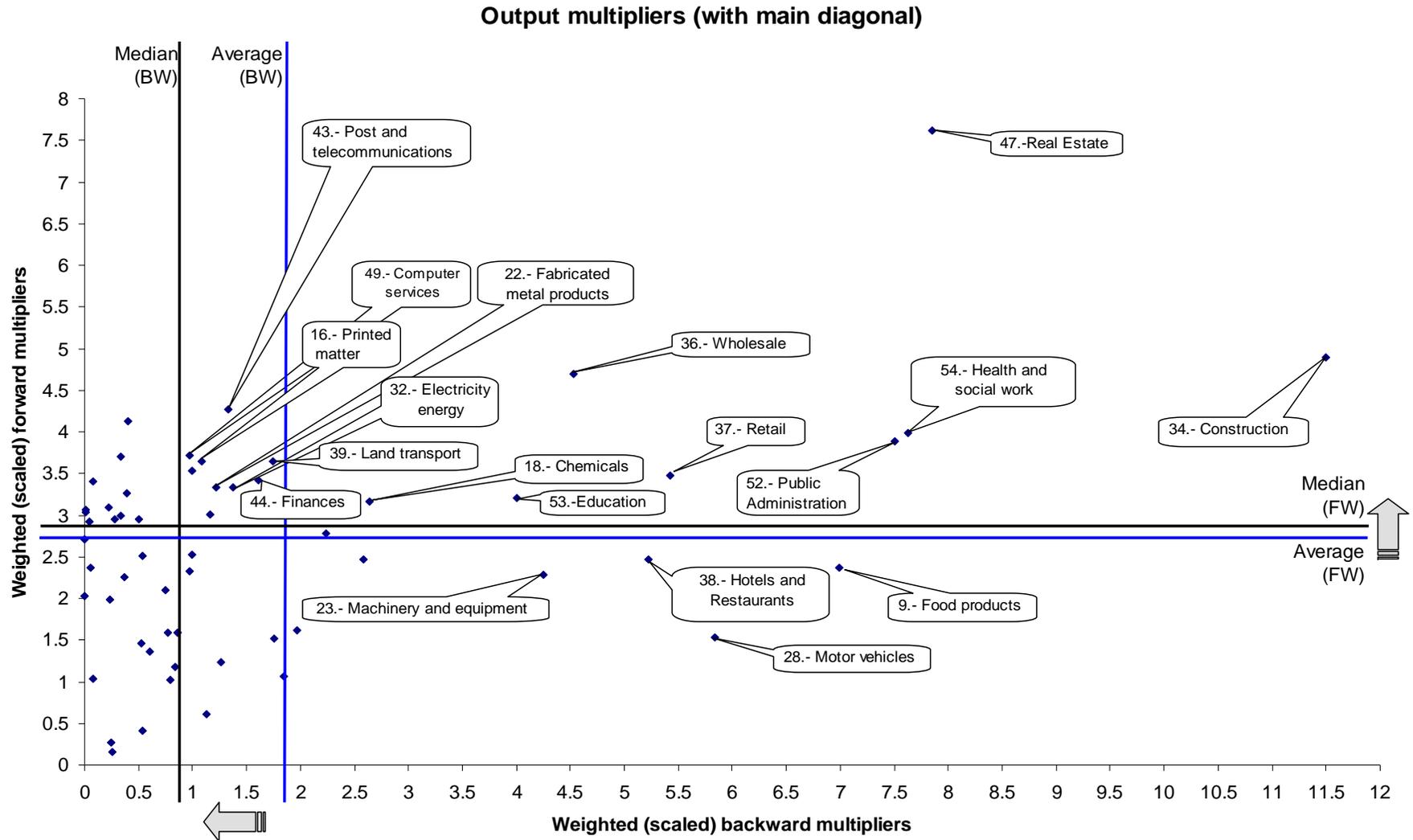


Figure 5.- Identification of key sectors by using different thresholds and weighted (scaled) OUTPUT multipliers (II)

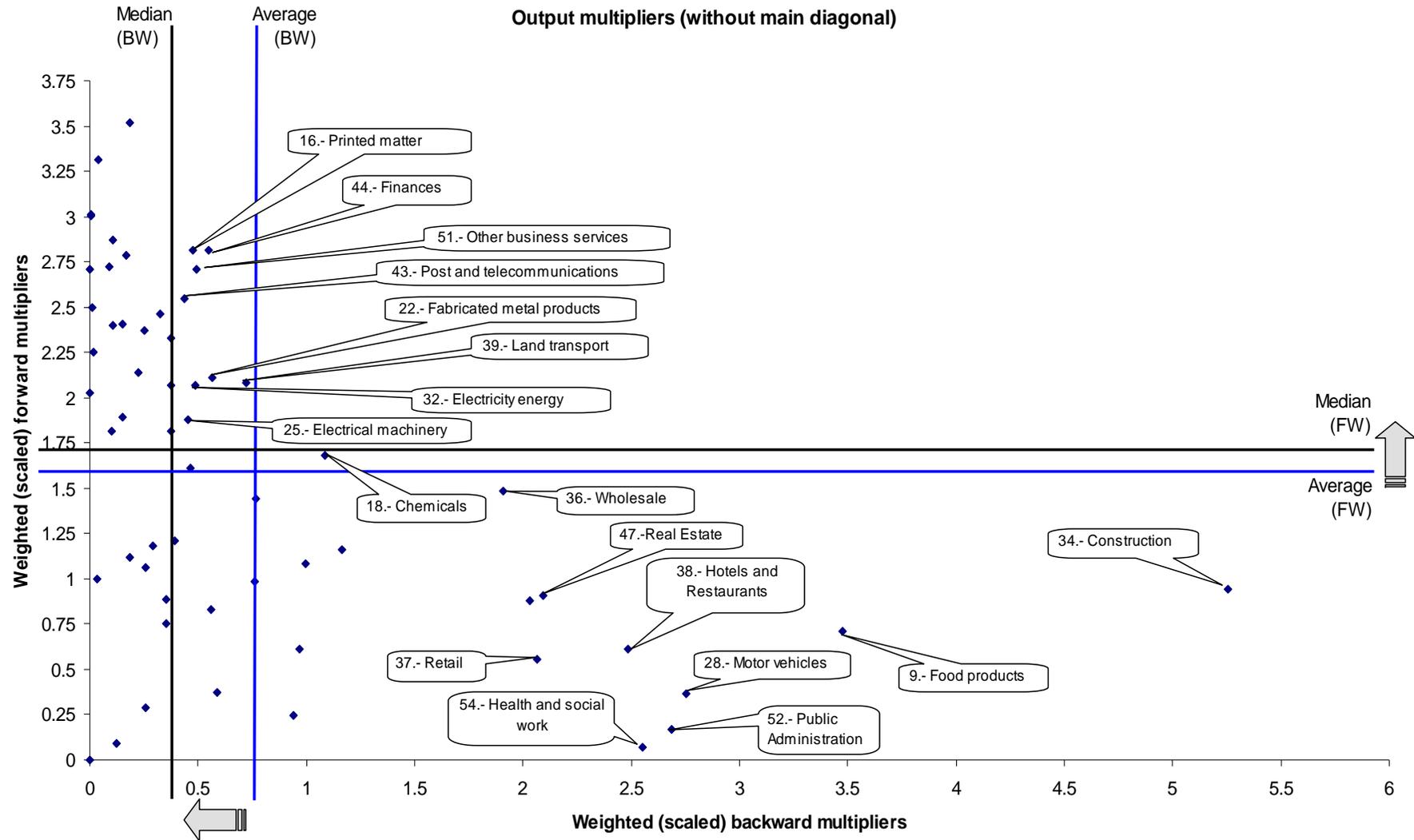


Figure 6.- Identification of key sectors by using different thresholds and weighted (scaled) EMPLOYMENT multipliers (I)

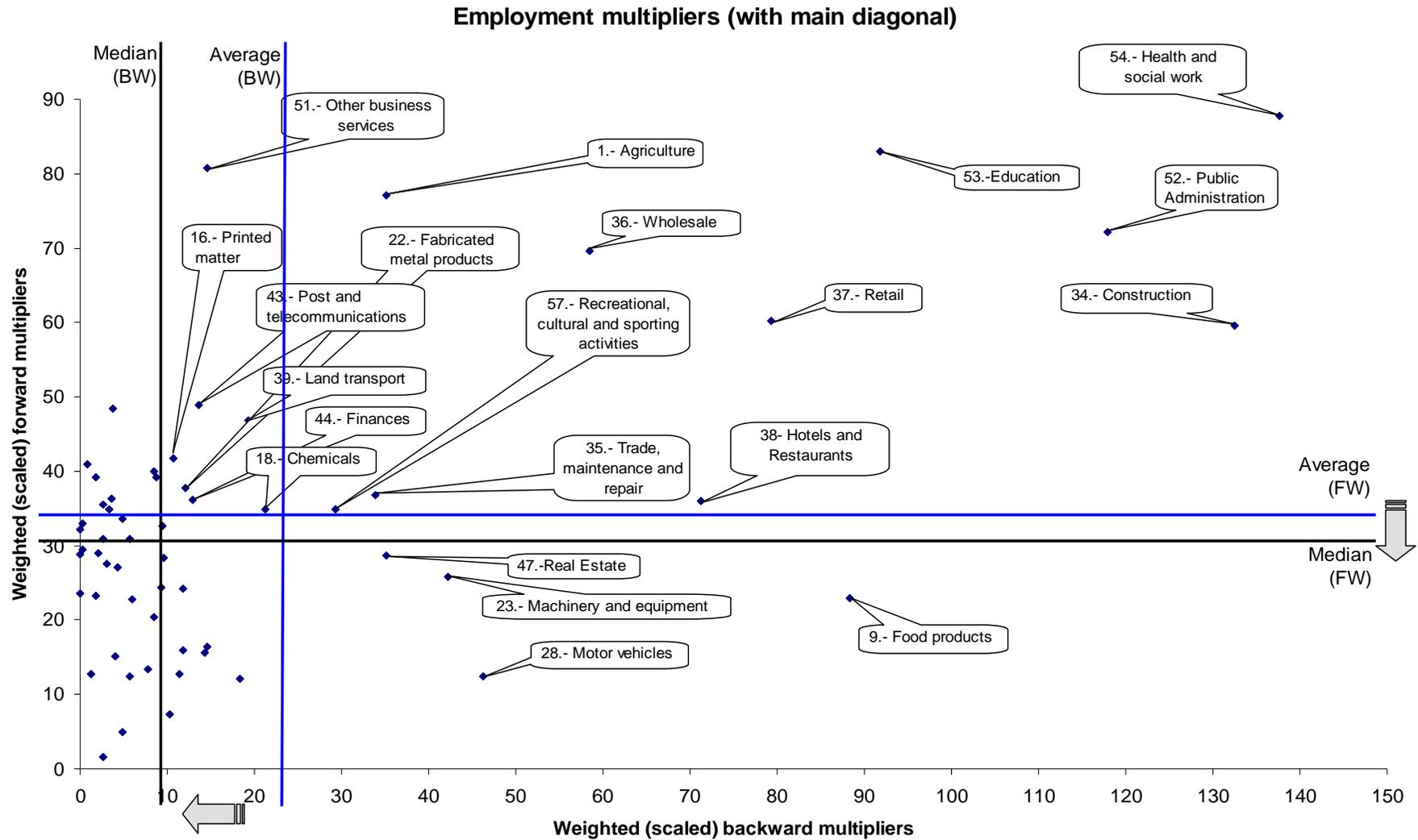


Figure 7.- Identification of key sectors by using different thresholds and weighted (scaled) EMPLOYMENT multipliers (II)

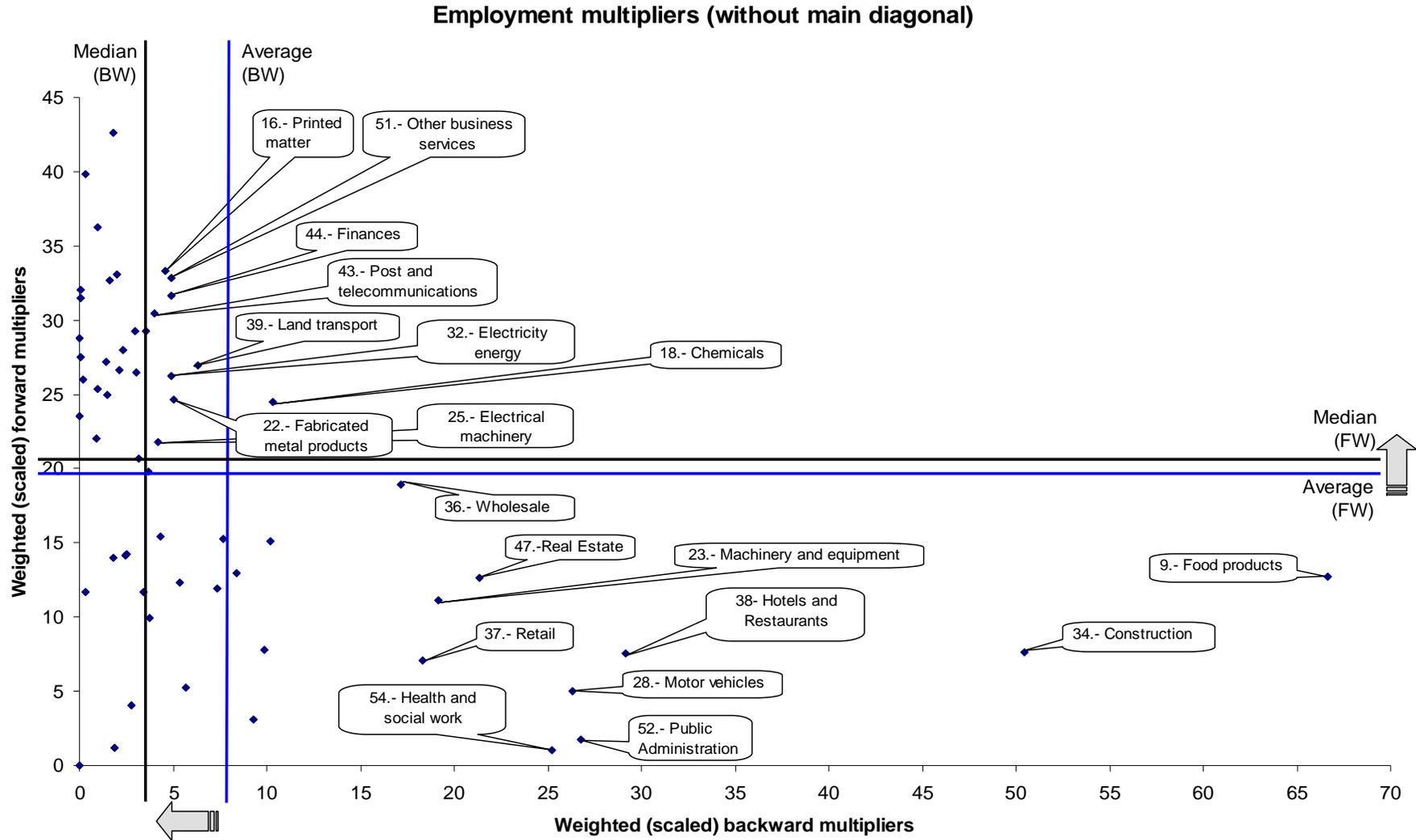


Figure 8.- Identification of key sectors by using different thresholds and weighted (scaled) INCOME multipliers (I)

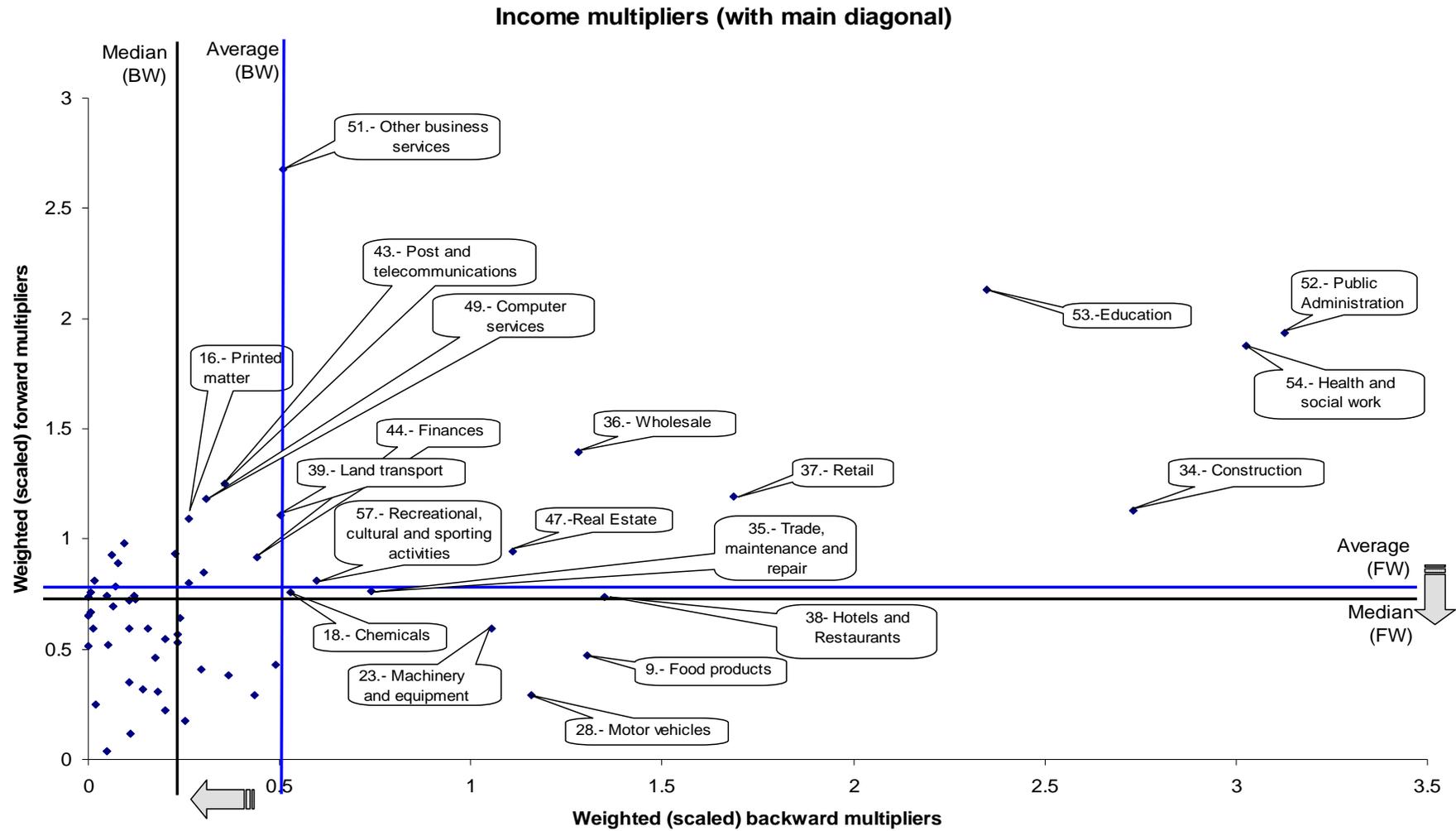
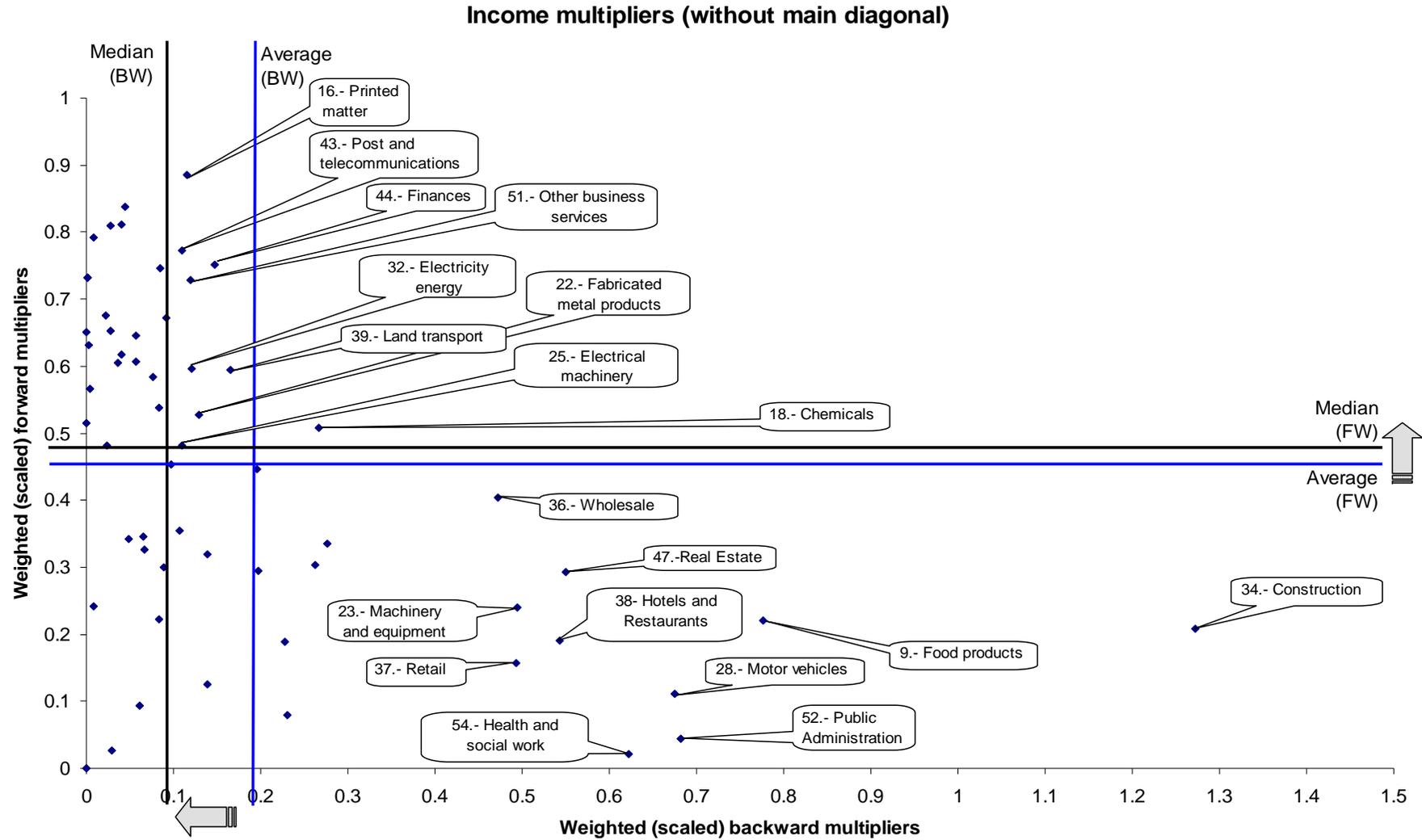


Figure 9.- Identification of key sectors by using different thresholds and weighted (scaled) INCOME multipliers (II)



Food products and beverages :
Output multipliers in EU27 (2000)



Food products and beverages :
Employment multipliers in EU27 (2000)



Food products and beverages :
Income multipliers in EU27 (2000)



- Key sector
- Backward sector
- Forward sector
- Non relevant



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 Coordinate Reference System: ETRS89 Lambert Azimuthal Equal Area
 Cartography : IPTS-GIS team, 09/2008
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Construction work : Output multipliers
in EU27 (2000)



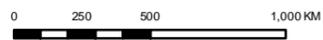
Construction work : Employment
multipliers in EU27 (2000)



Construction work : Income multipliers
in EU27 (2000)



- Key sector
- Backward sector
- Forward sector
- Non relevant



Source data : EUROSTAT and own calculations (v2)
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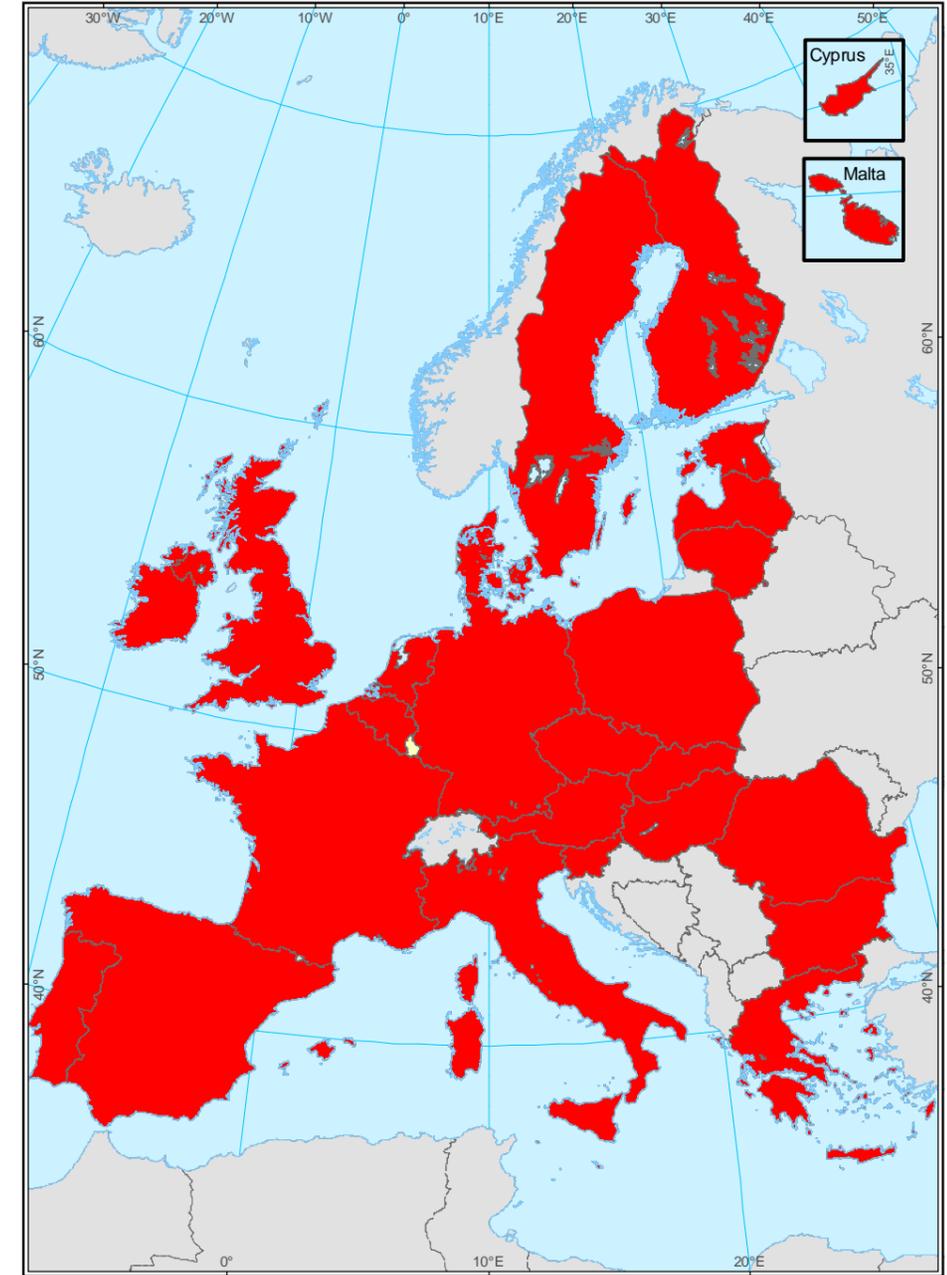
Construction work : Output multipliers in EU27 (2000)



Construction work : Employment multipliers in EU27 (2000)



Construction work : Income multipliers in EU27 (2000)



- Key sector
- Backward sector
- Forward sector
- Non relevant



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Chemicals : Output multipliers
in EU27 (2000)



Chemicals : Employment multipliers
in EU27 (2000)



Chemicals : Income multipliers
in EU27 (2000)



- Key sector
- Backward sector
- Forward sector
- Non relevant



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Pulp and paper : Output multipliers in EU27 (2000)



Pulp and paper : Employment multipliers in EU27 (2000)



Pulp and paper : Income multipliers in EU27 (2000)



- Key sector
- Backward sector
- Forward sector
- Non relevant



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