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**TRENDS AND PATTERNS OF OUTSOURCING IN SPANISH INDUSTRY:
A Comparative Sectoral Perspective.**

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Abstract:

The present paper analyzes the incidence of the outsourcing in the Spanish Industry from a sectoral (NACE Rev. 1, at 3-digit level) perspective. We find that around half of manufacturing industries have increased outsourcing intensity of material inputs from 1993 to 2002. Furthermore, we consider different types of fragmentation of production: outsourcing of intermediate inputs, subcontracting some production works and outsourcing the whole production process. The next step is investigate the international dimension of outsourcing. Our results show fragmentation of production has an international nature in recent years. International fragmentation is basically orientated to European countries or to Third countries depending of type of industries. Finally, we examine the determinants of outsourcing intensity at industry level. The results show that previous outsourcing level and unit labour costs are important drivers of outsourcing.

Key words: Fragmentation of Production, International Outsourcing, Manufacturing Industry, Subcontracting, Unit Labour Costs.

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1. INTRODUCTION

According to international empirical evidence, a new and complex production organization strategy is currently developing. This strategy favours the fragmentation of the production chain into more specialized and discernible phases in order to obtain the most efficient producer and location for each product or component. The main aim of fragmentation is to take advantage of specialization in component or phases of the value chain as well as to profit from a cheaper final product due to scale economies in the production of these components. By this way, firms seek to improve production efficiency, and consequently, their competitiveness. This innovative form of production organization, devised mainly by enterprises based in developed countries, try to face a very competitive market where, on the one hand, domestic customers demand highly differentiated products and, on the other, products coming from developing countries are highly competitive due to lower labour costs.

We may identify two dimensions in the fragmentation phenomenon: a geographical and an ownership dimension (Curzon Price, 2001). The geographical dimension needs to be taken into account because the segmentation of production may take place inside one country or go beyond international borders being thus called international fragmentation. The ownership dimension refers to the different managerial strategies for controlling those production phases that have been fragmented. These parts of chain of production may be taken place within a corporation, under its ownership and control (intra-firm fragmentation). Fragmentation can also go beyond company limits involving other independent enterprises (inter-firm fragmentation). In this case, fragmentation is not based on equity linkages and it is thus called “outsourcing”¹ (Figure 1). The fragmented value chain is linked through a variety of non-equity relationship such as franchising, subcontracting, marketing contracts and other strategic alliances. It is important to note that even though there is no managerial supervision over those production phases, this does not mean that there is not control over production at all. In outsourcing definition, transactions cannot be considered completely arm’s length transactions for two reasons: firstly, because the long-term nature of the relationship between the firms, and secondly, because of the great amount of information the independent firm receives; to be more precise, detailed instructions and specifications on the part of the

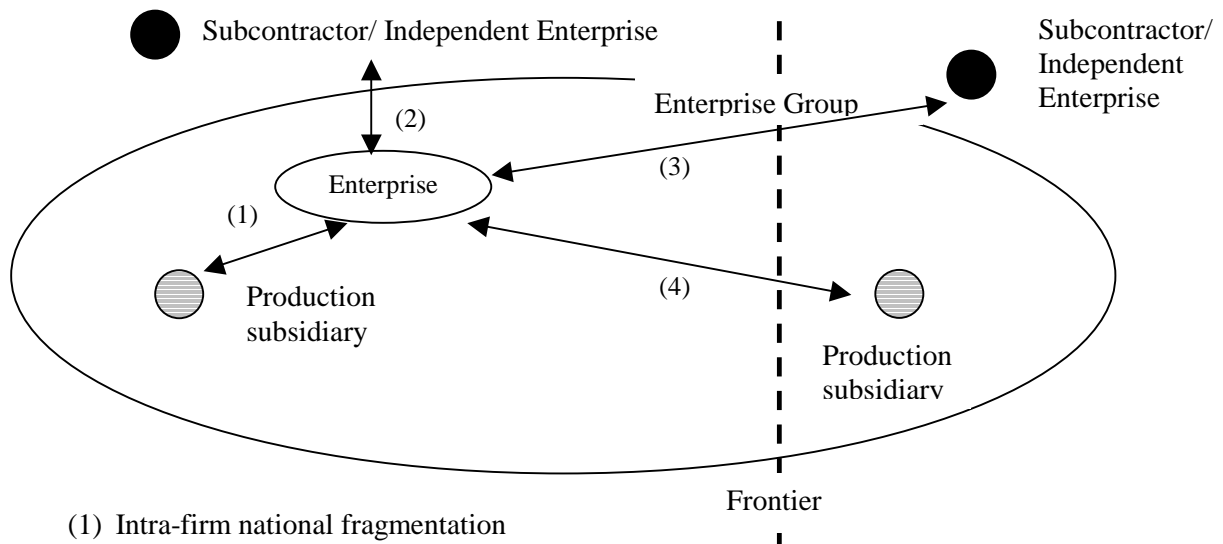
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¹ The term “outsourcing” comes from the compound expression, “outside resource using”.

consumer. Companies will opt for “outsourcing” when externalizing certain value chain phases allows to reduce costs, i.e., when externalising has more advantages than internalising.

The most important novelty in the “outsourcing” process is that the fragmentation of the value chain is becoming more international and segmentation is done more and more often with independent enterprises. The technological revolution that has taken place in the last decades has allowed for a significant drop in the costs of transport, communication and business coordination. This has made easier to segment production and to locate it in different places.

Figure 1: Dimensions of Fragmentation of Production.



- (1) Intra-firm national fragmentation
- (2) Inter-firm national fragmentation (national outsourcing)
- (3) Inter-firm international fragmentation (international outsourcing)
- (4) Intra-firm international fragmentation (FDI is required).

Source: Adapted from Kimura (2001).

The main aim of this paper is to study whether Spanish manufacturing industries are using fragmentation of production and to investigate the determinants of this strategy at industry-level. The paper is organized as follows. This brief introduction is followed by a detailed description of the statistical sources and the methodology used in the measurement of outsourcing. The third section describes the sectoral pattern of fragmentation in Spanish manufacturing industries. It also centres upon the analysis of the different types of outsourcing and its geographical dimension, in order to determine whether international outsourcing is increasing as it happens in other countries according to empirical evidence. In



the fourth section, the focus will lie on the analysis of a more narrow definition of fragmentation, i.e., the works that forming part of the production process are carried out by other companies. We investigate the determinants of outsourcing trying to check the “cost-saving” motive for outsourcing. Lastly, in the fifth section, some final considerations will be made.

2. DATA AND METHODOLOGY DESCRIPTION.

Studies centring upon outsourcing have so far been few and they all have encountered similar difficulties when dealing with the problem of measuring fragmentation. Two types of works on outsourcing can be distinguished:

1. The first group of studies concentrates on the analysis of fragmentation without considering its geographical dimension. In order to check if firms are externalising phases of the value chain, changes in the ratio intermediate goods over gross production or over labour costs are analyzed. Fragmentation is thus understood as a process of vertical disintegration of the company. An increasing use of intermediate inputs per unit of output is consequently interpreted as a sign that the firm is externalising production chain phases. Analysing what kind of intermediate goods is rising, we will determine which phases or functions are being externalized. Examples of these studies are Görg and Hanley (2003) who disaggregate outsourcing of material from outsourcing of service inputs using plant level data for the electronics sector in Ireland and Görzig and Stephan (2002) who distinguish external contract work from material inputs for German firms.
2. The second group of studies focuses on the international dimension of fragmentation. Most of these works analyse the evolution of the share of imported intermediate inputs embodied in production with data from the input-output tables. This is the only source which provides for each manufacturing industry the values of intermediate inputs by geographical origin. Examples of these works are Feenstra and Hanson (1999), Diehl (1999), Dell’mour *et al.* (2000), Görg, Hijzen and Hine (2001) and, for Spanish economy, Minondo and Rubert (2001)².

² International fragmentation has also been estimated empirically focussing on its consequences on international trade; particularly on the level of trade in parts and component (Yeats, 2001; Kaminski and Ng, 2001), the intra-firm trade (Barba, Haaland and Venables, 2002), the intra-industry trade (OECD, 2002) and the outward/inward processing trade (Ruane and Görg, 2001; Helg and Tajoli, 2002). Another way to study fragmentation is from the perspective of foreign direct investment since it can be considered as a vehicle for international intra-firm



This research intends to incorporate both perspectives. The paper draws on the Industrial Companies Survey provided by the Spanish National Statistical Institute. We use data of gross production and intermediate goods in Spanish manufacturing industries at a 3 digit-level of NACE (which includes 93 manufacturing sectors³) for the period 1993-2002. Opting for this Survey has two main advantages over the input-output tables:

- Information is presented with a high level of statistical disaggregation, which allows to detect the specific behaviours of some industries. In fact, this paper is intended to be the first attempt to study outsourcing at a high level of sectoral disaggregation and to deal with such a recent period although based only in Spanish economy.
- The Survey provides information not only about purchases of intermediate inputs, but also about the purchases of finished goods which, without transformation, will then be marketed by the buying enterprise (consumption of merchandise), as well as data about the different phases of the production process taken over by other companies (works done by other companies, normally using subcontracts). Consequently, information presented by the Survey provides data about the fragmentation of the intermediate or final phases of production or even the whole production process.

The methodology we intend to use has two parts (Figure 2). As a first step, the degree of fragmentation will be determined by the ratio of material intermediate goods to gross production. External services as well as other supplies such as package purchases, office material, fuels⁴, etc., are thus excluded from the intermediate goods. Consequently, our narrow outsourcing indicator⁵ is limited to material intermediate inputs related to the manufacturing process in itself, which allows for a better measurement of the degree of fragmentation of production.

fragmentation. For a more thorough revision of the advantages and disadvantages of these and other indicators of international fragmentation, see Díaz Mora and Gandoy (2004).

³ See statistical appendix.

⁴ Taking into account the fluctuation of energy prices, this item has been excluded from intermediate inputs since all variables are in nominal terms.

⁵ Feenstra and Hanson (1999) introduce an even more narrow measure of outsourcing, i.e. intermediate goods from the same industry. This indicator is more convenient when sectoral disaggregation is low (NACE at 2 digit-level). But if it is higher (NACE at 3 digit-level) this indicator may be too strict to measure outsourcing adequately. The Survey does not make a difference between the sectoral origin of intermediate goods, which invalidates the construction of this indicator of outsourcing.



In this part, the analysis will focus not on levels but on evolution since a raise in material intermediate inputs per unit of output will be interpreted as a sign of increasing fragmentation of production in Spanish manufacturing industries.

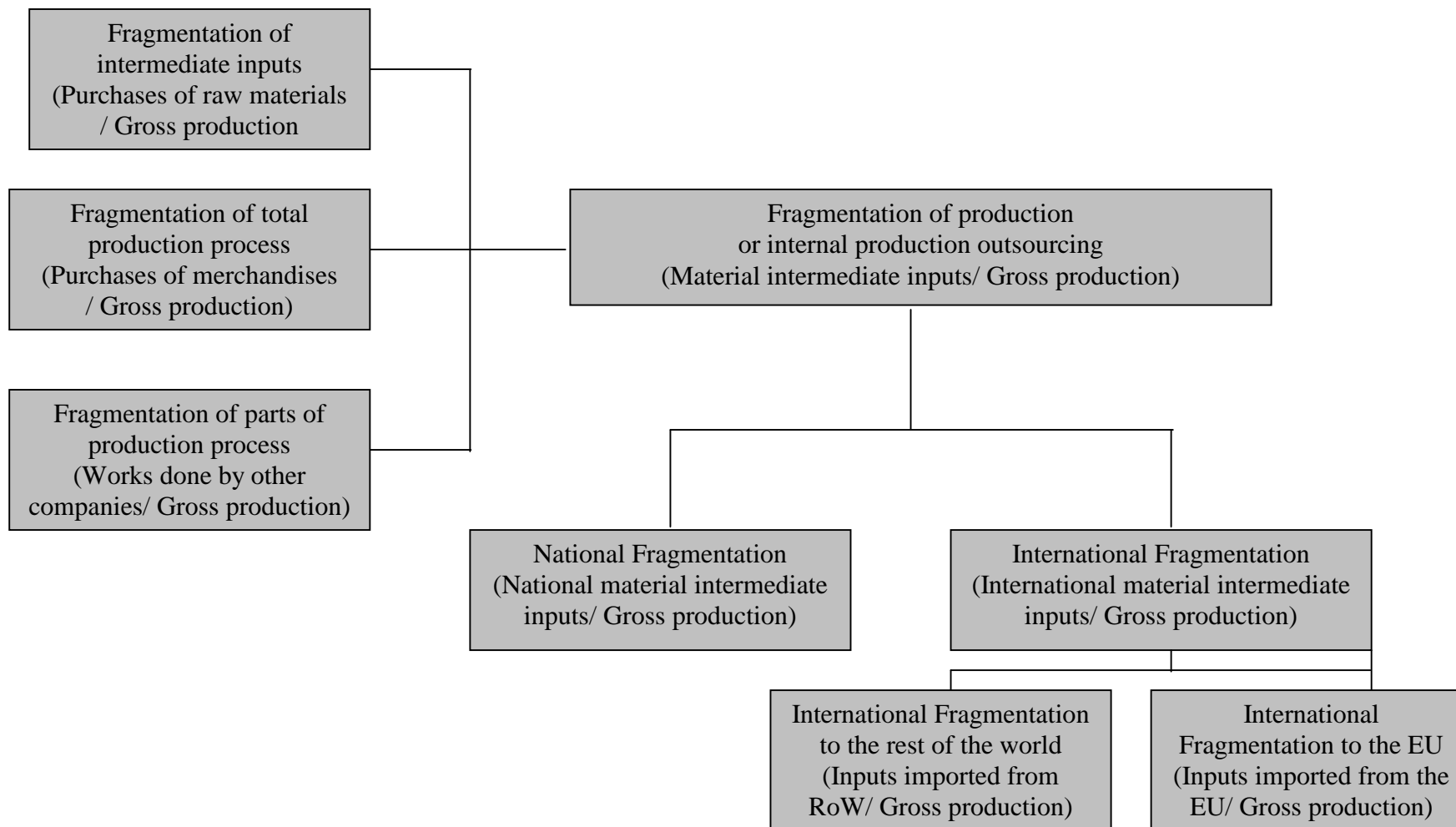
Nevertheless, the chosen indicator has some limitations when used to analyse the historical evolution of fragmentation in a sector. On the one hand, technological changes may alter the intermediate goods needed for each unit; this will surely have an influence on the indicator value. For instance, if some technological improvement is able to reduce the intermediate inputs requirements (or to raise inputs quality), it could cause intermediate inputs per unit to drop, thus hiding some fragmentation strategy. On the other hand, product differentiation processes, which could imply a rise in value added per unit, may also cover up a fragmentation strategy. Finally, fluctuations in the prices of both intermediate and finished goods may distort the results and lead to wrong conclusions if variables are in nominal terms, as it is the case here. Intermediate consumption should not be deflated because they are not sectorally disaggregated. However, data show that the industrial price index of intermediate goods has grown at the same rate as the industrial price index of finished products from 1993 to 2002.

As a second step in the methodology, this paper will investigate the geographical origin of intermediate inputs, in order to be able to discern the national or international scope of segmentation. However, data provided by the Survey has some limitations. On the first hand, the geographical origin on intermediate inputs is only available for total material intermediate inputs (including other supplies). So, the international dimension of fragmentation can be investigated for total material inputs and not for each type of inputs. The discrimination criteria are also very limited: goods domestically produced, goods coming from the European Union or goods coming from the rest of the world. On the second hand, the information deals only with enterprises employing 20 or more workers (these are surveyed more thoroughly). Finally, data are available only since 1999. To sum up, the research on geographical fragmentation in Spanish industry necessarily has to be limited to the period 1999-2002 and to medium-sized and large companies (20% of the number of companies and about 85% of gross production).

In the last part of the paper we study the determinants of outsourcing using the works carry out by other firms as a measure of fragmentation.



Figure 2: Measuring Fragmentation of Production.





3. EVOLUTION, SECTORAL PATTERNS AND INTERNATIONAL SCOPE OF OUTSOURCING

Using the methodology above described, our results show a relatively general process of fragmentation for Spanish industry between 1993 and 2002. The tendency to increase outsourcing has been more evident (rate increases of more than 5%)⁶ in 36 sectors. This means that 40% of manufacturing industries have opted for augmenting the level of fragmentation. Some sectors stand out in this growth, such as manufactures of wood and cork, ceramic goods, office machinery, electrical and electronic equipment and transport equipment⁷ (Figure 3).

Moreover, the ways in which this production fragmentation strategy is winning territory can be clearly defined: externalisation of intermediate inputs, of particular phases of production process or of the whole production process (Figure 4 and table 1). The most manufacturing industries show an increasing use of intermediate inputs relative to gross production. This raise has been more steady in the following industrial sectors: processing and preserving of fish products, articles of cork, office machinery and computers, valves and other electronic components, television and radio transmitters, precision equipment, motor vehicles, bodies and parts and accessories for motor vehicles.

Other sectors, such as wearing apparel industry, shipbuilding and aerospace industry have unambiguously opted for increasing fragmentation based on a greater dependence on works done by other enterprises.

The fragmentation of whole production process has been very important in two sectors: manufactures of man-made fibres and ceramic products. Tile imports from China have increased greatly in recent years; ceramic industry management data confirm that these

⁶ Due to the fact that the comparison between industries displays their different capabilities to carry out fragmentation processes (which is a consequence of their technical characteristics and determines the importance of intermediate goods per unit of output), we use percentage points variation instead of variation rates (the last would take into account the differences in fragmentation possibilities).

⁷ International empirical evidence verifies that it is precisely these industries the more prone to outsourcing. In fact, thanks to a wider indicator (the material and services intermediate inputs per unit of output) results for Spain can be compared to those belonging to EU industry. The data are taken from Structural Business Statistics (SBS) provided by Eurostat, which comprises data about companies with 20 or more workers at a 3 digit-level of NACE over the period 1993-2000. Spain, together with Germany and France, belongs to the group of countries where the growth of fragmentation has had a medium intensity. Finland, Denmark and Sweden lead the group where the fragmentation has been more intensive (most industrial sectors have displayed and increase of more than 5% in the indicator). Italy, Netherlander, Austria and the United Kingdom are in the third place, where the phenomenon of vertical disintegration has been less important. Moreover, we have calculated a similarity index which show a similar sectoral fragmentation pattern for France, Spain, Germany and even Italy.



purchases are made by Spanish enterprises in order to market them with their own trademarks. This would explain the rise in consumption of merchandises in this sector (see Cinco Días, 24 February 2004).

Empirical works about international fragmentation have been relatively abundant because the international dimension is one of its newest features. Our results reveal that the majority of the sectors that are increasing fragmentation strategies choose international fragmentation (Figure 5 and table 2). It has been more intensive in manufacture of knitted and crocheted fabrics, articles of fur, man-made fibres, steam generators, office machinery and computers, electric motors, valves and other electronic components, television and radio receivers, motor vehicles and parts and accessories for them. These are the same sectors that empirical evidence points out as more active in international fragmentation in other countries.

National fragmentation has been less frequent and less intensive. It is only remarkable in manufactures of prepared animal feeds, mineral water, insulated wire and cable and mainly in aerospace industry.

Data also helps to establish the main direction taken by international fragmentation: towards the EU countries or towards the rest of the world. The rise in the intermediate inputs from the rest of the world has been sharper in general. Increasing fragmentation towards the EU has been less significant; it has only been important in the manufacture of electric motors, generators and transformers.

4. DETERMINANTS OF FRAGMENTATION.

The variable “work done by other enterprises” refers to the expense corresponding to the work that, being a part of the production process, is taken over and carried out by other companies. Subcontracts are included within this concept. Subcontracts correspond to the relationship between two companies (the subcontractor and the main contractor). According to this subcontractual relationship, the subcontractor company participates in the design and production process of a particular product which belongs to the other company. The subcontract conditions may include the main contractor providing a diagram and precise technical specifications for the manufacture of the product, as well as the supply of its main raw materials. We think that this variable is the best measure of outsourcing for the following three reasons. On the first hand, because it comprises not only the externalisation of product manufacture using intermediate inputs, but also because any stage of the production process



such as product design or specific tasks (for instance, in the textile industry, sewing or ironing) or even the final assembly. On the second hand, because arms-length purchases of standardised components in the market are not included in this concept. One specific mark of fragmentation is that relationships are not done between completely independent companies. It is a long-term relationship and it usually implies sharing information about the product, in way of detailed instructions and specifications given to the subcontractor. The concept “work done by other enterprises” may well fulfil these required conditions. Finally, thanks to this indicator, it is possible to compare the levels of fragmentation among different industries, and not only the variation, because the technical characteristics of industries have not to influence at those levels.

Nevertheless, the lack of data has lead previous research to select wider indicators such as material intermediate inputs to gross production. One exception is the work of Görzig and Stephan (2002), already mentioned. These authors distinguish two types of internal production outsourcing: the share of material inputs and the share of external contract work in gross production. They describe only evolutions of those ratios, not levels. Another problem posed by this indicator is that it usually does not provide data about geographical dimension, which makes the distinction between national and international outsourcing impossible. As far as the author knows, only Tomiura (2004) does it. He investigates outsourcing, measured as subcontracts of the manufacturing or processing works to other companies, at a firm level for Japanese manufacturing industry. Tomiura analyses the relationship between a company’s preference for outsourcing and its characteristics, distinguishing foreign from domestic outsourcing.

According to the indicator based on works carried out by other firms, Spanish industry keeps a medium level of fragmentation: around 5% of its gross production are works done by other companies, after a period where fragmentation has increased steadily (average rise of 40% from 1993 to 2002)⁸. Nevertheless, some manufacturing industries stand out, such as textile industries, wearing apparel, footwear, publishing and printing, fabricated metal

⁸ This increase is higher than the average scored by German manufacturing enterprises, which has placed in 27% for the period 1992-2000 in Görzig and Stephan (2002). However, it should be noted that the fragmentation processes in German industry had most probably taken place before the 1990s. Fragmentation levels are lower than those displayed by Tomiura (2004), who distinguishes four groups in Japanese enterprises, depending on their involvement in national outsourcing, foreign outsourcing, both of them or not outsourcing at all. He offers the average level for each group. If these average levels are weighted by the numbers of firms included in each group, fragmentation in Japanese industry would be about 8 per cent.



products and shipbuilding and aerospace industry. All of them show fragmentation levels well above 10% of gross production, and 20% for the last two sectors (Figure 7).

Subcontracting, particularly international subcontracting, has been much more important in two kinds of sectors (Curzon Price, 2001). Firstly, those sectors producing highly technological, differentiated goods. In this case, most of or even all their physical production process has been externalized. Secondly, sectors producing standardized goods, where labour-intensive segments of production process are subcontracted to other firms. The link between fragmentation and type of good can be obtained clustered industries by their typical input combinations (Figure 8). Five groups are distinguished: labour-intensive, technological-driven, capital intensive, marketing-driven and mainstream manufacturing industries (Peneder, 1999). The fragmentation of production phases is common to all group of industries. Nevertheless, it is more relevant for labour-intensive industries where most of these sectors shows outsourcing levels above average, many of them even above 10% of the gross production (this can be interpreted as a high level of outsourcing). There is still a pending question: is fragmentation more important in less skilled, labour-intensive industries? In order to analyse the link between fragmentation and labour skills, manufacturing sectors are separated in four groups according to their different requirements for skilled labour: high-skills, medium/white collar skills, medium/blue collar skills and low skills (Peneder, 1999). It can be seen that sectors requiring a low skilled labour are those where the productive process has been more segmented (Figure 8). So, we can argue that industries producing goods intensive in labour relative to capital and technology and with low-skill requirements give stronger support to fragmentation based on contract out physical production to specialized producers than the rest of the industries.

From a theoretical perspective, it has been suggested that companies based on developed countries using outsourcing in order to reduce costs, mainly labour costs⁹. Externalizing production process segments to specialize providers would reduce labour costs; but it generates transaction costs on its turn. Only when the cost of purchase the input or industrial service from outside is lower than the cost of undertaking the activity within the boundaries of the firm will the company opt for outsourcing¹⁰.

⁹ Abraham and Taylor (1996).

¹⁰ Grossman and Helpman (2002) examine theoretically the decision between outsourcing or vertical integration of intermediate inputs (*make or buy decision*) taken into account its costs and benefits.



In this sense, it is relevant to determine whether fragmentation is higher in sectors with greater labour costs, in order to verify the hypothesis that outsourcing is a cost-saving strategy¹¹. However, when a simple regression of one variable on the other is made, a positive relation appears between them but it is not highly significant. In our opinion, this is due to the fact that the significance lies not in labour costs per worker, but on unit labour costs, because higher labour costs may be compensated with a higher productivity. Thus, we compute a competitiveness index (the ratio of labour costs to labour productivity¹²) for the different manufacturing industries that it is compared with fragmentation data. Figure 9 shows how the less competitive manufacturing sectors (higher labour costs per unit of output) tend to contract out more works than the rest. This result seems to confirm the initial hypothesis that fragmentation is an strategy created by developed-country enterprises in order to improve their efficiency in a context of strong competitiveness coming from regions with lower labour costs. It thus becomes necessary to externalise those parts of the production process which require an intensive use of unskilled labour, subcontracting them to more efficient enterprises.

For an adequate verification of the relationship between outsourcing and unit labour costs an econometric analysis is required. We estimate empirically the following equation to explain the paper of unit labour cost in outsourcing intensity:

$$\text{Out}_{it} = \alpha + \beta_1 \text{ULC}_{it} + \beta_2 \text{SIZE}_{it} + u_{it} \quad u_{it} = \alpha_i + v_{it} \quad (1)$$

Where i represent the 92 manufacturing sector¹³, t is the time period 1993-2002, Out is the outsourcing level measured as works carried out by other firms per unit of output, UCL are the unit labour costs measured as defined above and SIZE variable is the average firm size in a sector measured in terms of employment in each sector divided by the numbers of firms

¹¹ To test the importance of the “cost saving” motive for outsourcing, Girma & Görg (2002) include the wage rates for skilled and unskilled workers and they find out that high wages are related to outsourcing with larger effects from the former.

¹² Unit labour costs are defined as labour costs relative to output, where output can be represented by gross production or by value added. The choice of one variable or the other does not alter the correlation between fragmentation and unit labour costs. Due to the fact that labour costs only include the cost of paid persons employed (wages, social security contributions and employer contributions), the comparison takes place between these paid employees and total production. For this reason, it is more precise to calculate unit labour costs using this formula: ((labour cost / paid persons employed) * Employees) / Gross Production = labour cost per paid person employed / labour productivity). In this case, we assumed that unpaid worker earns the same wage as paid workers. This is the unit labour cost indicator used in the paper. The advantage of this measure is that it is free from any monetary measurement and can be therefore be interpreted in real terms.

¹³ The sector “Manufacture of office machiney and computers” has been removed from the econometric analysis. The data in 2002 show a sharp decrease of output that is not present in employment or number of enterprise. We think a measure error could be exit in this year. As the indicator of outsourcing used is works done by other firms per unit of output, this decrease affects the level of fragmentation which is overestimated.



in the same sector. The size variable is included to control for the economies of scale effect. There may be economies of scale in the production of specific components or phases of production process. So, we would expect bigger firms to be less intensive users of outsourcing whereas smaller firms tended to sourcing them from external specialized providers¹⁴. All variables are expressed in logarithmic forms.

We utilize a one-way error component model for the disturbance term, $u_{it} = \alpha_i + v_{it}$, where α_i denotes the unobservable individual specific effects that are independent and identically distributed (iid) over the sectors with variance σ_α^2 and v_{it} denotes the remainder disturbance that are iid over the whole sample with variance σ_v^2 . There may be variables that are time invariant that affect outsourcing. This kind of variables is often difficult to measure or hard to obtain¹⁵. For example, the specific production technology in a sector may allow the dispersion of phases of production process better than in another sector. This production technology varies across sectors but one does not expect that to change much across a short period of time.

The OLS estimation of the empirical model (1) ignores the existence of unobserved sector specific effects, that is, an identical intercept for all sectors is estimated ($\alpha_i = \alpha$). The results are presented in the first column of Table 4. Both ULC and SIZE variables are statistically significant. The sign of unit labour costs variable is positive suggesting that low competitiveness sectors are more prone to outsource in order to reduce cost. The sign of SIZE variable is negative. In line with our prior expectations, sectors with lower average size firms outsource more than those with bigger size firms.

If we think there are time-invariant sector specific effects and we want to account for them, OLS regression is problematic. A panel data technique is required to control for this unobserved sectoral heterogeneity. We test the significance of the individual effects with an F-test. In our model, the hypothesis that the specific effects are the same for all sectors is rejected. Next, a Hausman (1978) test is performed and it rejected the null hypothesis of no correlation between these individual effects α_i and the regressors. Based on this result, the Within estimator or fixed effects estimator is preferable because it is the only consistent. The

¹⁴ This reason for the use of outsourcing has been put forward by Abraham and Taylor (1996), although they argue that there may be economies scale for specialized services.

¹⁵ There could be sector invariant variables that affect outsourcing too. For example, a technological improvement that were nation wide, like new information technologies, could impulse the use of outsourcing. Nevertheless, in our model we consider these variables are not important because the period of time is short.



time-invariant sector specific effects α_i are wiped out by the deviation from means transformation used by this estimator. Moreover, the fixed effects model is the appropriate specification for our model because we are focusing on a specific set of sectors and our inference is restricted to the behaviour of these sectors. So, the sector-specific effects are assumed to be fixed parameters to be estimated. If explanatory variables were independent of the individual effects, it would not be necessary to purge the last ones. In this case, the random effects or variance component model is the most appropriate specification because it uses more information data: variation within sectors plus variation between sectors). The variance components estimator is computed by estimating the relative importance of between and within variation of the disturbance term u_{it} and using this estimated ratio to combine both estimator optimally. This estimator is asymptotically efficient, since it is a generalized least square estimator (GLS).

According to the within estimation (included in the third column of table 4) there is an unexpected negative effect of unit labour cost on outsourcing. Within sectors, an increase of unit labour cost is associated with a decrease of outsourcing intensity. The sector size variable maintains the negative sign of its coefficient but turns out to be statistically insignificant.

The between estimator (second column of table 4), which explains by taking the means of each manufacturing industry only the variation between individuals, indicates that those sectors which have higher unit labour cost are more prone to outsource, as the dispersion chart have already shown.

We have also observed that outsourcing seems to be more important in labour intensive industries. In order to test if there are group effects that influence outsourcing intensity, the model (1) is augmented with five dummies. These dummies are included to collect the type of industries according to their inputs combinations: labour intensive industries, research intensive industries, capital intensive industries, advertising intensive industries and mainstream manufacturing. The estimation results are presented in the last column of table 4. The F-test suggests that there are important individual effects. The Hausman test value does not rejected the null hypothesis and GLS estimator is consistent and the most efficient¹⁶. As we expected, the labour intensive industries outsource more than the

¹⁶ Since the Within estimation utilizes deviation from means, individual and group time-invariant effects are eliminated. So, the Within estimation of the augmented model offers the same results than Within estimation of the previous model.



rest of manufacturing industries. Inclusion of these group effects leads ULC variable being negative and statistically significant.

A potential econometric problem is the non-normality of the error terms. Then, OLS may be less efficient than other estimates. As a check, we used the Jarque-Bera test, which is a joint test for skewness and kurtosis. The hypothesis of normality can be accepted at the 1 per cent level.

Two additional questions need to be considered. The first is try to confirm the exogeneity of all the explanatory variables by a Hausman test. If there are endogenous variables (variables correlated with the disturbance term), Within estimator is biased and inconsistent and instrumental variables are required. All variables except UCL are exogenous. An interdependence relationship between outsourcing and unit labour costs may be the explication of this endogeneity. That is, the level of UCL determines a sector's outsourcing intensity but the causality probably goes the other way around: the level of outsourcing determines sector's unit labour cost. Enterprises tend to outsource the production phases more intensive in less skilled labour and the increasing outsourcing will affect internal labour costs. But UCL in period t-1 will not be affected by outsourcing decision in t. Sectors decide the level outsourcing subject to the relative unit labour costs that was prevalent in previous periods. Therefore the lagged value of ULC could be a valid instrument. We assume ULC is a predetermined or weakly exogenous variable. This means it can be affected by current and past realizations of the outsourcing intensity but not for future realizations of the error term. Nevertheless, weak exogeneity does not mean that manufacturing firms do not take into account expected future unit labour costs in their decision to outsourcing; it just means that unanticipated shocks to future unit labour costs do not influence current outsourcing. As a result the potential endogeneity bias is avoided¹⁷.

But it is necessary to take account another question. It seems reasonable that the decision of outsource in period t is related to the level of outsourcing in the previous period. Thus, there would be persistence in the outsourcing decision (Girma and Görg, 2002). We estimate a new specification:

$$\text{Out}_{it} = \beta_1 \text{Out}_{i,t-1} + \beta_2 \text{ULC}_{it} + \beta_3 \text{SIZE}_{it} + u_{it} \quad u_{it} = \alpha_i + v_{it} \quad (2)$$

¹⁷ Variables that are predetermined in a model can be treated, at least asymptotically, as if they were exogenous in the sense that consistent estimates can be obtained when they appear as regressors (Greene, 1997, page 714).



Again the first step is try to verify if it is necessary to control for unobserved sectoral heterogeneity. The F-test used allows us to accept the hypothesis that there are not time-invariant sector specific effects that may affect outsourcing intensity¹⁸. The pooled OLS estimations are preferred to a panel data model. Table 5 reports the results of estimating model (2) using OLS, Between and Within estimators¹⁹. According to OLS estimations, the lagged dependant variable has a positive and significant sign. The level of outsourcing in period t-1 is important to the outsourcing intensity in period t. Unit labour costs are significant and positive: higher ULC, higher outsourcing intensity. We can argue that sectors tend to use fragmentation of production like a defensive strategy augmented outsourcing intensity when their unit labour costs are higher.

As long as explanatory variables are strictly exogenous, the pooled OLS estimator will produce unbiased estimates. But unit labour costs variable is weakly exogenous and the use of instruments is required to deal with the potential endogeneity problem. We instruments for unit labour costs with the level of ULC lagged two periods and levels of strictly exogenous explanatory variables. It is important to assess the strength of the relationship between the instruments and the non-strictly exogenous regressors. Instrumental weakness can induce biased coefficients. For this reason, we include the F-statistics from the first stage regressions that test the relevance of the instruments. The high value of F-test rejects the hypothesis that the instruments should be excluded from the first-stage regression. Moreover, only if the disturbance term is not first-order serially correlated, lagged dependant variables will not be correlated with it. We test for first-order serial correlation in the disturbance by the Durbin-Watson test and the hypothesis is accepted. We therefore estimate the equation (2) using two stage least squares (2SLS). The last column of table 5 presents the instrumental variable estimates. A Hausman test does only allow us to reject the hypothesis of no systematic differences between simple OLS and the 2SLS estimates at a 37 per cent level of confidence. The results are, therefore, very similar. We find that higher the previous level of outsourcing,

¹⁸ In the case of relevant unobserved sector specific effects in our model, the equation (2) would represent a standard dynamic panel, where lagged dependant variables is included among the regressors. Since Out_{it} would be a function of time invariant individual specific effects, $Out_{i,t-1}$ would be also a function of them. Therefore, OLS, Within and Random effects estimators would be inconsistent. An appropriate estimator would be the Generalized Method of Moments (GMM) for dynamic panel data models developed by Arellano y Bond (1991). They suggest first differencing the model to get rid of the individual specific effects and then using instruments to deal with the problem that by construction the new error term is correlated with the lagged dependant variable. The GMM dynamic panel estimator utilizes the levels of dependant variables lagged two or more period as valid instruments (it uses all valid instruments available for each period t), since they are highly correlated with the instrumented variable but not correlated with new error term as long as v_{it} are not serially correlated.



higher is current outsourcing intensity as indicated the positive and statistically significant coefficient of lagged dependant variable. Respect to unit labour costs, we again find strong evidence that there are a positive relationship between this competitiveness measure and outsourcing. Manufacturing industries are more prone to use outsourcing when unit labour costs are higher. The size variable remains negative and statistically insignificant.

5. CONCLUSIONS.

In this paper we have investigated the outsourcing of material inputs using industry level data for Spanish economy. Our sample demonstrates that around 40 per cent of the manufacturing industries are involved in increasing outsourcing. We distinguish outsourcing of material intermediate inputs from outsourcing of the whole production process and from outsourcing of specific phases o works of the production process. Depending of the type of manufacturing industries, one or another type of fragmentation is increasing. The international dimension of fragmentation has been the most dynamic, mainly towards the rest of the world.

Attending to the outsourcing measured by the ratio of works carried out by other firms per unit of output, this paper examines the determinants of outsourcing. Using 2SLS estimation we find that previous level of outsourcing has a positive effect on current outsourcing intensity. Furthermore, we find that the unit labour costs positively affect the ratio of works that are contract out to external provider to output. Thus, we can argue that manufacturing sectors tend to use fragmentation of production as a defensive strategy opting for increase outsourcing intensity when unit labour costs are higher. Less competitiveness sectors, interpreted as higher unit labour costs, are the principal users of outsourcing strategy. In this sense, those industries producing goods intensive in labour relative to capital and technology and with low-skill requirements where the pressure of low-cost competitors is more intensive are the most encouraged to use fragmentation strategies.

¹⁹ Since the null that all $\alpha_i = \alpha$ has been accepted, Random-effects estimates has degenerated to pooled OLS.



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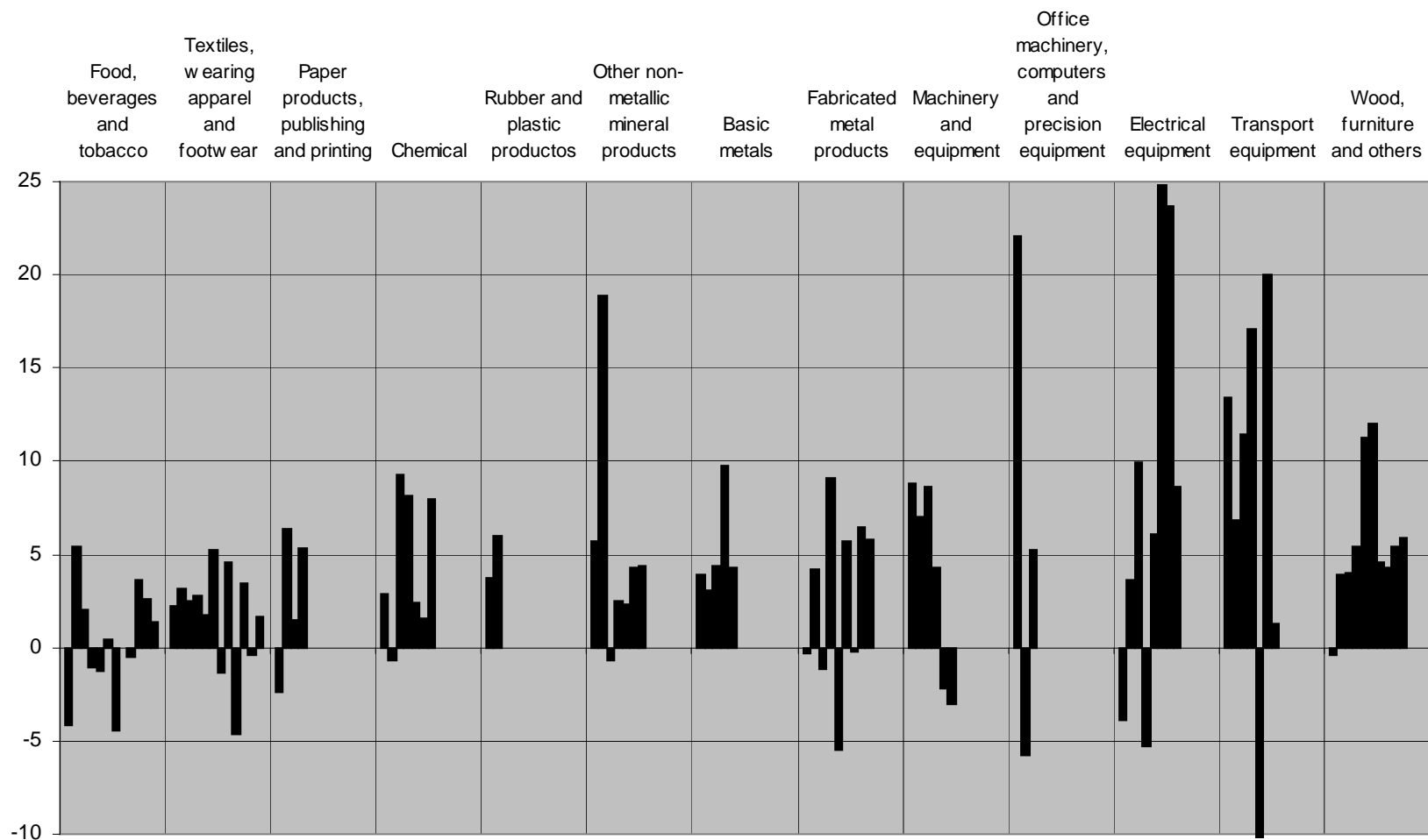
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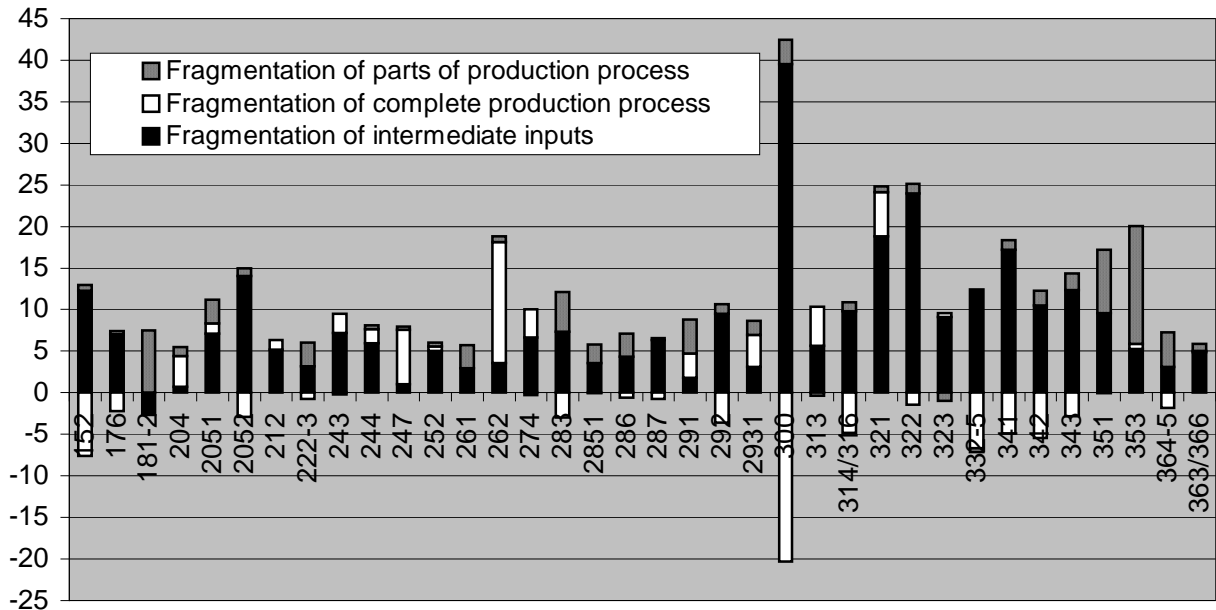
FIGURE 3: TRENDS OF FRAGMENTATION OF PRODUCTION IN SPANISH INDUSTRIES
(Percentage points variation of material intermediate inputs/ Gross Production, 1993-2002)



Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)



FIGURE 4: MODES OF INCREASING FRAGMENTATION IN SPANISH INDUSTRIES
(Classified according to types of material inputs, % points variation, 1993-2002)



Note: Only those branches where fragmentation has risen five or more percentage points are included.

TABLE 1: KEY BRANCHES ACCORDING TO MAIN MODE OF INCREASING FRAGMENTATION

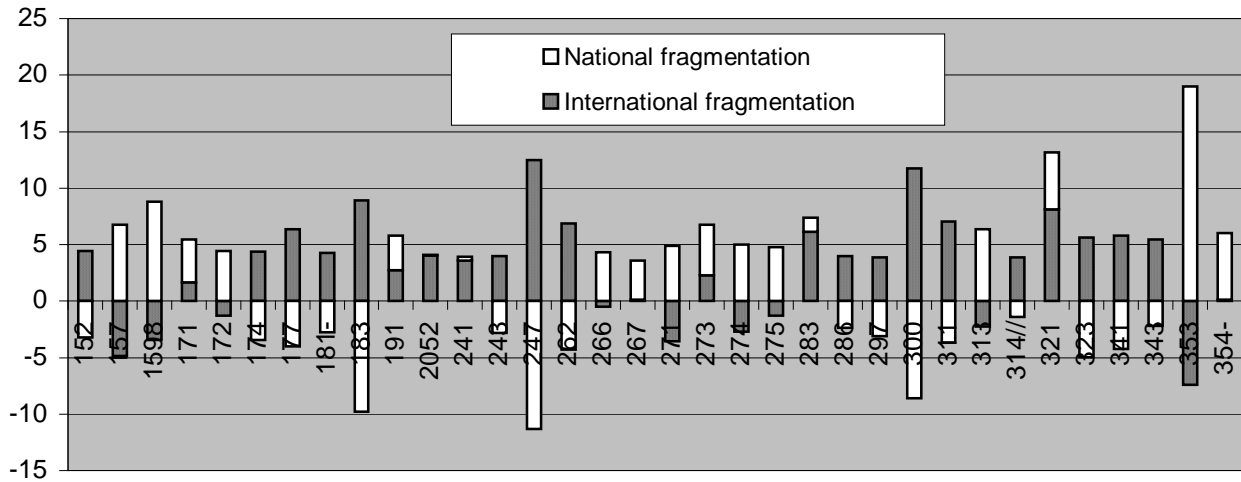
Fragmentation of intermediate inputs	
152 Processing and preserving of fish and fish products	292 Manufacture of other general purpose machinery
176 Manufacture of knitted and crocheted fabrics	300 Manufacture of office machinery and computers
2051 Manufacture of other products of wood	313 Manufacture of insulated wire and cable
2052 Manufacture of articles of cork, straw and plaiting materials	314/316 Manufacture of accumulators and electrical equipment n.e.c.
212 Manufacture of articles of paper and paperboard	321 Manufacture of electronic valves and other electronic components
222-3 Printing and service activities related to printing	322 Manufacture of television, radio transmitters, apparatus for line telephony
243 Manufacture of paints, varnishes and similar coatings	323 Manufacture of television and radio receivers, sound or video recording
244 Manufacture of pharmaceuticals, medicinal and botanical products	332-5 Manufacture of instruments for measuring and optical instruments
252 Manufacture of plastic products	341 Manufacture of motor vehicles
261 Manufacture of glass and glass products	342 Manufacture of bodies for motor vehicles, trailers and semi-trailers
274 Manufacture of basic precious and non-ferrous metals	343 Manufacture of parts, accessories for motor vehicles
283 Manufacture of steam generators	351 Building and repairing of ships and boats
2851 Treatment and coating of metals	363/366 Miscellaneous manufacturing n.e.c.
286 Manufacture of cutlery, tools and general hardware	
287 Manufacture of other fabricated metal products	
Fragmentation of complete production process	Fragmentation of parts of production process
204 Manufacture of wooden containers	181-2 Manufacture of leather clothes and other wearing apparel
247 Manufacture of man-made fibres	291 Manufacture of machinery for the production of mechanical power
262 Manufacture of ceramic goods	353 Manufacture of aircraft and spacecraft
293 Manufacture of agricultural and forestry machinery	364-5 Manufacture of sports goods and games and toys

Note: Only those branches where fragmentation has risen five or more percentage points are included.

Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)



FIGURE 5: GEOGRAPHICAL DIMENSION OF INCREASING FRAGMENTATION IN THE SPANISH INDUSTRIES (Enterprises with more than 20 workers, 1999-2002)



Note: Only those sectors which fragmentation (national o international) has risen more than 3 percentage points are included.

TABLE 2: KEY BRANCHES ACCORDING TO GEOGRAPHICAL DIMENSION OF INCREASING FRAGMENTATION

INTERNATIONAL FRAGMENTATION	NATIONAL FRAGMENTATION
152 Processing and preserving of fish and fish products	157 Manufacture of prepared animal feeds
174 Manufacture of made-up textile articles, except apparel	1598 Production of mineral waters and soft drinks
177 Manufacture of knitted and crocheted articles	171 Preparation and spinning of textile fibres
181-2 Manufacture of leather clothes and other wearing apparel	172 Textile weaving
183 Dressing and dyeing of fur; manufacture of articles of fur	191 Tanning and dressing of leather
191 Tanning and dressing of leather	266 Manufacture of articles of concrete, plaster, cement
2052 Manufacture of articles of cork, straw and plaiting materials	267 Cutting, shaping and finishing of stone
241 Manufacture of basic chemicals	271 Manufacture of basic iron and steel and of ferro-alloys (ECSC)
243 Manufacture of paints, varnishes and similar coatings	273 Other first processing of iron and steel
247 Manufacture of man-made fibres	274 Manufacture of basic precious and non-ferrous metals
262 Manufacture of ceramic goods	275 Casting of metals
283 Manufacture of steam generators	313 Manufacture of insulated wire and cable
286 Manufacture of cutlery, tools and general hardware	321 Manufacture of electronic valves and other electronic components
297 Manufacture of domestic appliances n.e.c.	353 Manufacture of aircraft and spacecraft
300 Manufacture of office machinery and computers	354-5 Manufacture of motorcycles and other transport equipment n.e.c.
311 Manufacture of electric motors, generators and transformers	
314/316 Manufacture of accumulators and electrical equipment n.e.c.	
321 Manufacture of electronic valves and other electronic components	
323 Manufacture of television and radio receivers, sound or video recording	
341 Manufacture of motor vehicles	
343 Manufacture of parts, accessories for motor vehicles	

Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)

FIGURE 6: DIRECTION OF INCREASING INTERNATIONAL FRAGMENTATION IN THE SPANISH INDUSTRIES
(Percentage points variation 1999-2002, firms with more than 20 workers)

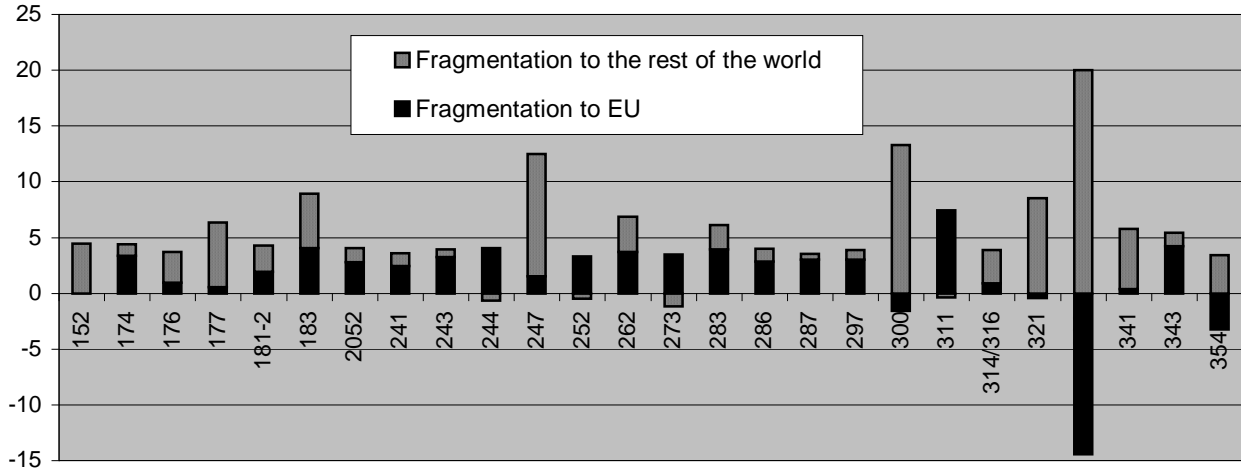


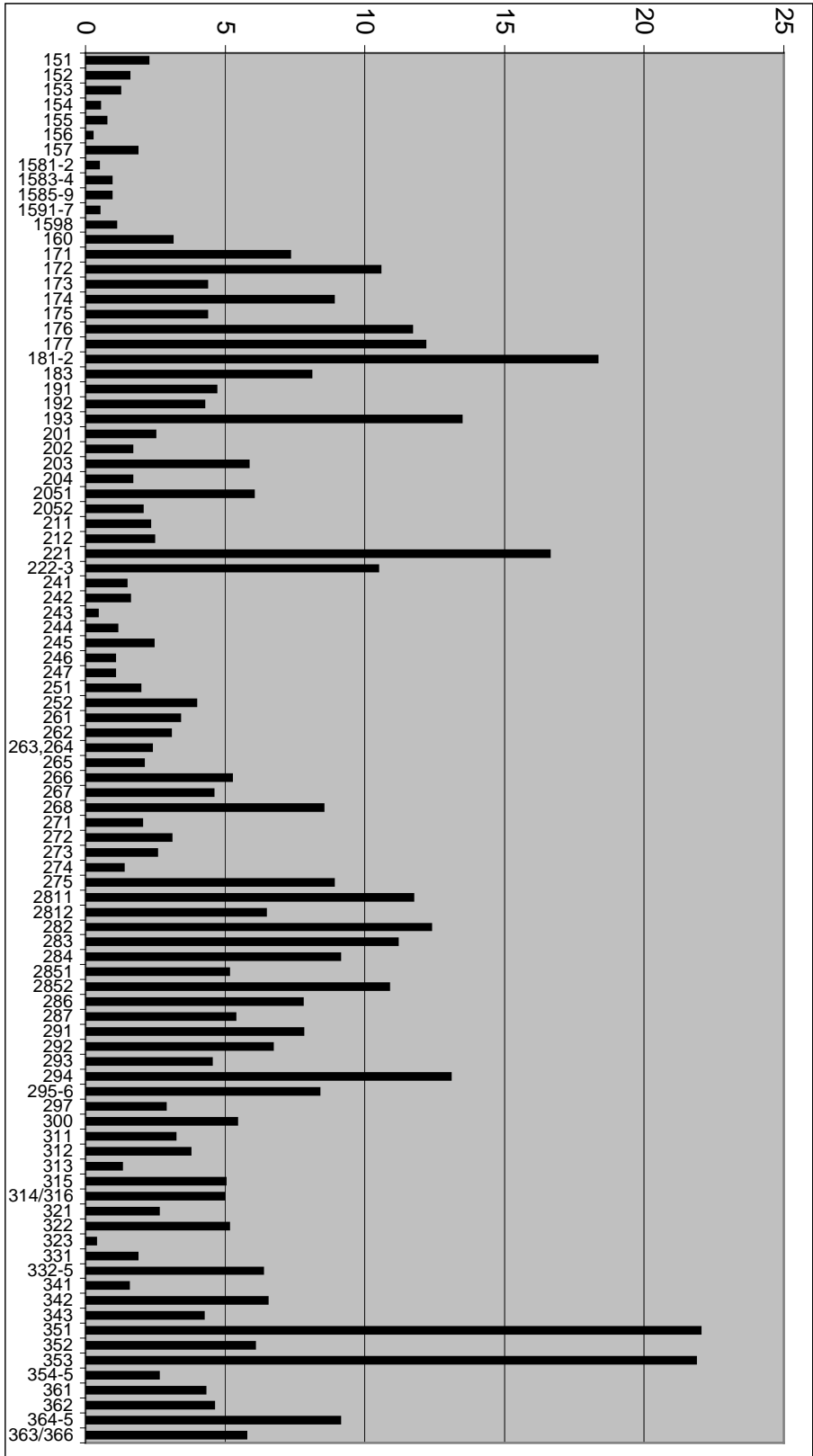
TABLE 3: KEY BRANCHES ACCORDING TO DIRECTION OF INCREASING INTERNATIONAL FRAGMENTATION

Fragmentation to EU	Fragmentation to ROW
174 Manufacture of made-up textile articles, except apparel	152 Processing and preserving of fish and fish products
181-2 Manufacture of leather clothes and other wearing apparel	176 Manufacture of knitted and crocheted fabrics
2052 Manufacture of articles of cork, straw and plaiting materials	177 Manufacture of knitted and crocheted articles
241 Manufacture of basic chemicals	181-2 Manufacture of leather clothes and other wearing apparel
243 Manufacture of paints, varnishes and similar coatings	183 Dressing and dyeing of fur; manufacture of articles of fur
244 Manufacture of pharmaceuticals, medicinal and botanical products	247 Manufacture of man-made fibres
252 Manufacture of plastic products	262 Manufacture of ceramic goods
262 Manufacture of ceramic goods	300 Manufacture of office machinery and computers
273 Other first processing of iron and steel	314/316 Manufacture of accumulators and electrical equipment n.e.c.
283 Manufacture of steam generators	321 Manufacture of electronic valves and other electronic components
286 Manufacture of cutlery, tools and general hardware	323 Manufacture of television and radio receivers, sound or video recording
287 Manufacture of other fabricated metal products	341 Manufacture of motor vehicles
297 Manufacture of domestic appliances n.e.c.	354-5 Manufacture of motorcycles and other transport equipment n.e.c.
311 Manufacture of electric motors, generators and transformers	
343 Manufacture of parts, accessories for motor vehicles	

Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)



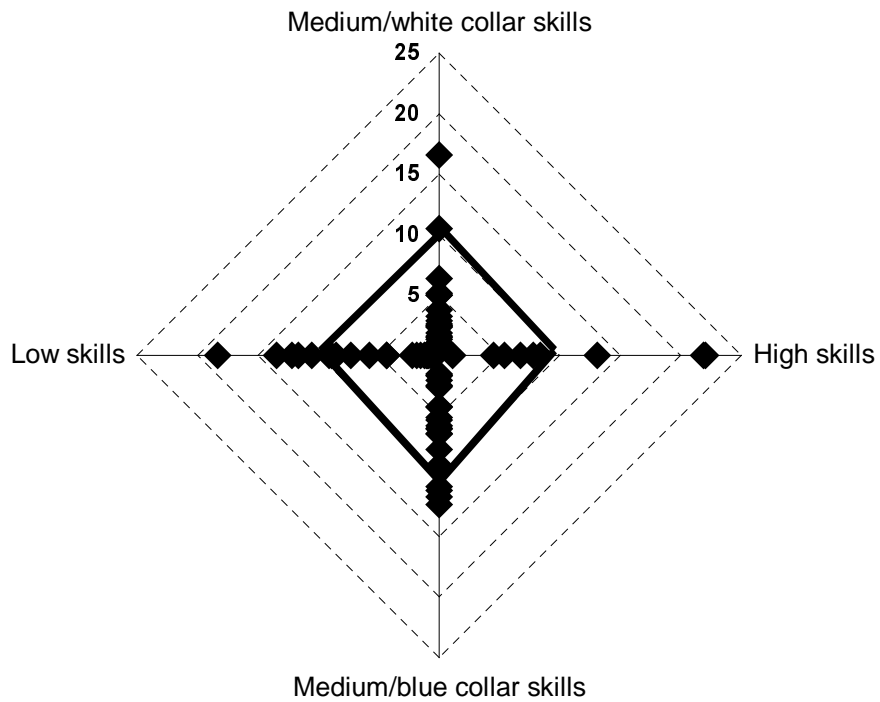
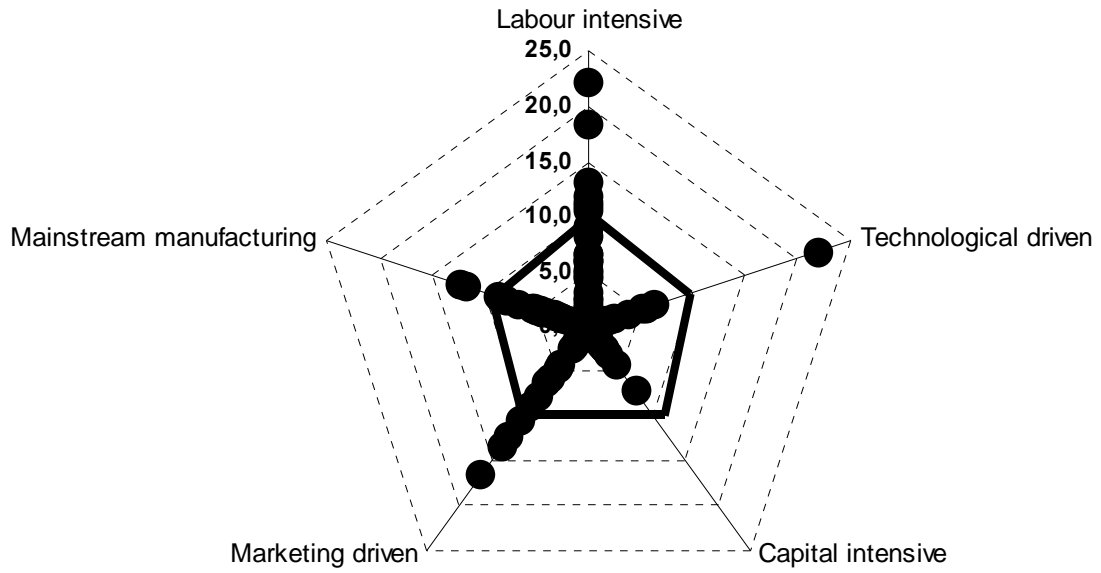
FIGURE 7: LEVEL OF FRAGMENTATION OF PRODUCTION, 2002
 (Works done for other companies / Gross production, in percentage)



Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)



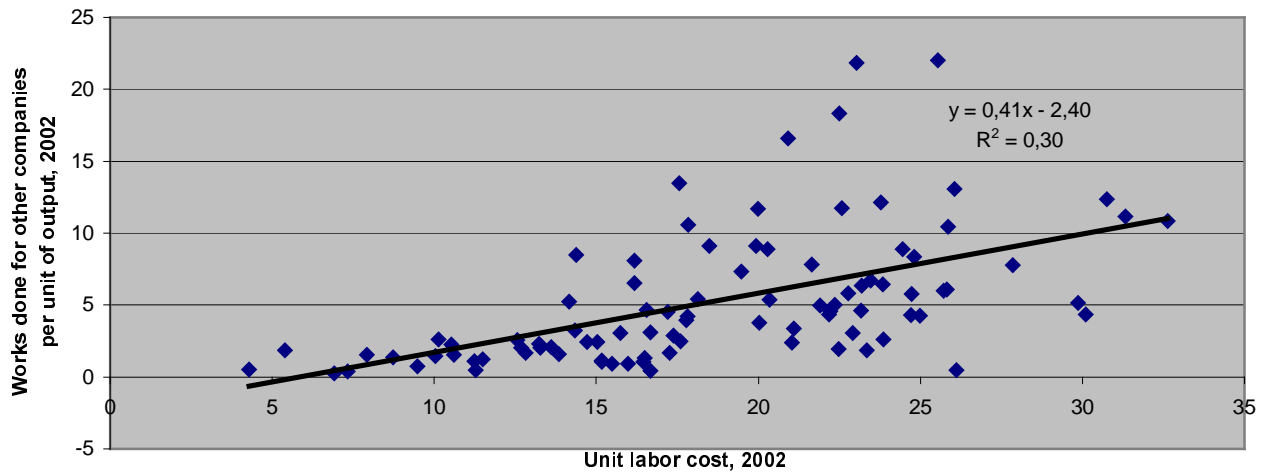
FIGURE 8: FRAGMENTATION OF PRODUCTION IN SPANISH INDUSTRIES ACCORDING TO COMBINATIONS OF FACTOR INPUTS AND REQUIREMENTS FOR SKILLED LABOUR



Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain) and Peneder (1999).



FIGURE 9: RELATIONSHIP BETWEEN FRAGMENTATION AND UNIT LABOR COSTS



Source: Industrial Companies Survey 2002 (National Statistical Institute of Spain)

TABLE 5: DETERMINANTS OF OUTSOURCING (REGRESSION RESULTS).
 Dependant variable is log of Works carried out by other firms per unit of output

Parameters	Model (1)				Model (1) augmented
	OLS	Between	Fixed effects	Random effects	Random effects
In ULC	1.267 (19.95)***	1.481 (6.93)***	-0.691 (-7.90)***	-0.517 (-8.14)***	-0.547 (-8.54)***
In SIZE	-0.163 (-5.15)***	-0,150 (-1.65)	-0.031 (-0.35)	-0.121 (-2.23)**	-0,071 (-1.23)
C	-2.092 (-8.84)***	-2.763 (-3.69)**		2.996 (10.65)***	2.367 (5.03)***
Labour-intensive					1.148 (2.99)***
Technology-driven					0.142 (0.36)
Capital-intensive					0.001 (0.01)
Marketing-driven					0.062 (0.16)
Mainstream					0.734 (1.91)*
Observations	920	920	920	920	920
F ($\beta=0$)	208.79	29.32	54.74		
Wald ($\beta=0$)				58.61	
R-squared	0.31	0.39	0.84	0.15	0.10
F test of $\alpha=\alpha_i$:	F(91,826) = 103.98; P-value (0.0000)				F(91,821) = 96.79; P-value (0.0000)
Hausman test (RE vs. FE)	CHISQ(2) =12.21; P-value (0.0022)				CHISQ(2)=1.49; P-value (0.4756)

Notes: t-statistics in parenthesis; * significant at 10%, ** significant at 5%, *** significant at 1%.

Standard errors are heteroskedastic-consistent.

F test and Wald test for joint significance of explanatory variables.



TABLE 6: DETERMINANTS OF OUTSOURCING INCLUDING LAGGED DEPENDANT VARIABLE (REGRESSION RESULTS).

Dependant variable is log of Works carried out by other firms per unit of output

Parameters	Model (2)			
	OLS	Between	Fixed effects	Pooled 2SLS
In Out _{t-1}	0.931 (82.88) ^{***}	0.984 (148.05) ^{***}	0.327 (9.69) ^{***}	0.929 (76.34) ^{***}
In ULC	0.099 (3.53) ^{***}	0.033 (2.01) ^{**}	-0.491 (-5.72) ^{***}	0.138 (4.34) ^{***}
In SIZE	-0.011 (-0.99)	0.001 (0.23)	-0.112 (-1.70) [*]	-0.025 (-0.23)
C	-0.143 (-1.64)	0.046 (-0.92)		-0.271 (-2.80) ^{***}
Observations	828	828	828	736
F (β=0)	3640.93	12324.94	55.44	
F (first-step)				3640.93
R-squared	0.93	0.99	0.18	0.93
F test of α=α _i :	F(91,733) = 4.30; P-value (0.0000)			
Hausman (p-value)				0.369

Notes: t-statistics in parenthesis; * significant at 10%, ** significant at 5%, *** significant at 1%.

Standard errors are heteroskedastic-consistent.

F test and Wald test for joint significance of explanatory variables.

Hausman test for systematic difference between OLS and 2SLS.



UCLM

STATISTICAL APPENDIX

Sectoral disaggregation of Industrial Companies Survey 2002

Manufactures of food products, beverages and tobacco	Manufacture of fabricated metal products
151 Production, processing, preserving of meat, meat products	2811 Manufacture of metal structures and parts of structures
152 Processing and preserving of fish and fish products	2812 Manufacture of builders' carpentry and joinery of metal
153 Processing and preserving of fruit and vegetables	282 Manufacture of tanks, central heating radiators and boilers
154 Manufacture of vegetable and animal oils and fats	283 Manufacture of steam generators
155 Manufacture of dairy products	284 Forging, pressing, stamping and roll forming of metal
156 Manufacture of grain mill products, starches and starch products	2851 Treatment and coating of metals
157 Manufacture of prepared animal feeds	2852 General mechanical engineering
1581-2 Manufacture of bread, biscuits and bakery products	286 Manufacture of cutlery, tools and general hardware
1583-4 Manufacture of sugar, cocoa and chocolate	287 Manufacture of other fabricated metal products
1585-9 Manufacture of other food products	Manufacture of machinery and equipment
1591-7 Manufacture of alcoholic beverages	291 Manufacture of machinery for the production of mechanical power
1598 Production of mineral waters and soft drinks	292 Manufacture of other general purpose machinery
160 Tobacco products	293 Manufacture of agricultural and forestry machinery
Manufacture of textiles, wearing apparel, leather and footwear	294 Manufacture of machine-tools
171 Preparation and spinning of textile fibres	295-6 Manufacture of other special purpose machinery and weapons
172 Textile weaving	297 Manufacture of domestic appliances n.e.c.
173 Finishing of textiles	Manufacture of office machinery, computers and precision equipment
174 Manufacture of made-up textile articles, except apparel	300 Manufacture of office machinery and computers
175 Manufacture of other textiles	331 Manufacture of medical and surgical equipment
176 Manufacture of knitted and crocheted fabrics	332-5 Manufacture of instruments for measuring and optical instruments
177 Manufacture of knitted and crocheted articles	Manufacture of electrical equipment
181-2 Manufacture of leather clothes and other wearing apparel	311 Manufacture of electric motors, generators and transformers
183 Dressing and dyeing of fur; manufacture of articles of fur	312 Manufacture of electricity distribution and control apparatus
191 Tanning and dressing of leather	313 Manufacture of insulated wire and cable
192 Manufacture of luggage, handbags and the like, saddler	315 Manufacture of lighting equipment and electric lamps
193 Manufacture of footwear	314/316 Manufacture of accumulators and electrical equipment n.e.c.
Manufactures of paper, paper products, publishing and printing	321 Manufacture of electronic valves and other electronic components
211 Manufacture of pulp, paper and paperboard	322 Manufacture of television, radio transmitters, apparatus for line telephony
212 Manufacture of articles of paper and paperboard	323 Manufacture of television and radio receivers, sound or video recording
221 Publishing	Manufacture of transport equipment
222-3 Printing and service activities related to printing	341 Manufacture of motor vehicles
Manufacture of chemical	342 Manufacture of bodies for motor vehicles, trailers and semi-trailers
241 Manufacture of basic chemicals	343 Manufacture of parts, accessories for motor vehicles
242 Manufacture of pesticides and other agro-chemical products	351 Building and repairing of ships and boats
243 Manufacture of paints, varnishes and similar coatings	352 Manufacture of railway, tramway locomotives, rolling stock
244 Manufacture of pharmaceuticals, medicinal and botanical products	353 Manufacture of aircraft and spacecraft
245 Manufacture of soap, detergents, cleaning, polishing	354-5 Manufacture of motorcycles and other transport equipment n.e.c.
246 Manufacture of other chemical products	Manufacture of wood, furniture; manufacturing n.e.c.
247 Manufacture of man-made fibres	201 Sawmilling and planning of wood, impregnation of wood
Manufacture of rubber and plastic products	202 Manufacture of veneer sheets and other panels and boards
251 Manufacture of rubber products	203 Manufacture of builders' carpentry and joinery
252 Manufacture of plastic products	204 Manufacture of wooden containers
Manufacture of other non-metallic mineral products	2051 Manufacture of other products of wood
261 Manufacture of glass and glass products	2052 Manufacture of articles of cork, straw and plaiting materials
262 Manufacture of ceramic goods	361 Manufacture of furniture
263-4 Manufacture of construction products	362 Manufacture of jewellery and related articles
265 Manufacture of cement, lime and plaster	364-5 Manufacture of sports goods and games and toys
266 Manufacture of articles of concrete, plaster, cement	363/366 Miscellaneous manufacturing n.e.c.
267 Cutting, shaping and finishing of stone	
268 Manufacture of other non-metallic mineral products	
Manufacture of basic metals	
271 Manufacture of basic iron and steel and of ferro-alloys (ECSC)	
272 Manufacture of tubes	
273 Other first processing of iron and steel	
274 Manufacture of basic precious and non-ferrous metals	
275 Casting of metals	