Outsourcing and Structural Change. What can input-output analysis say about it?

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Abstract

The paper aims at investigating the capacity of input-output analysis to identify the structural change implications of outsourcing. In particular, it develops the idea that outsourcing leaves "traces" in the intersectoral structure of one economy that can be caught empirically, to a different extent by different indicators. The pros and cons of these indicators are discussed from a methodological point of view and their actual interpretative power shown through an application to the OECD area for the '80s and the early '90s. The main result of the paper is that an accurate mapping of the relationship between outsourcing and structural change requires us to use different indicators jointly, rather than alternatively. In particular, a purely sectoral kind of perspective needs to be combined with a subsystem one, which detects the effects of outsourcing on the vertical integration degree of one economy's sectors.

Keywords: Outsourcing; Input-output analysis; Vertically integrated sectors; Manufacturing.
JEL: D230, D570, L160, L220, L240, L600, O140

Outsourcing and structural change: What can input-output analysis say about it?*

Sandro Montresor Giuseppe Vittucci Marzetti

1 Introduction

Outsourcing has recently become a core topic of several economic disciplines dealing with the firm, such as industrial organization, labour microeconomics, industrial relations and operation management, just to mention a few.[1]

This increasing interest for outsourcing at the firm level has also had an important cross-disciplinary fertilization. For example, a new strand of trade theories has developed on the basis of its "fragmentation" effects (e.g. Kohler, 2004; Jones - Kierzkowski, 2001), and the topic has recently entered the "unfamiliar" domains of regional and local development (e.g. Taymaz - Kilicaslan, 2005). Quite surprisingly, instead, the new wave of outsourcing studies has not been accompanied by an enthusiastic revival of one of the economic fields which for first recognized its relevance (e.g. Momigliano - Siniscalco, 1982b; Stanback, 1979; Ginzberg - Vojta, 1981; Gershuny - Miles, 1983): that is, applied *structural change analysis*.

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[1] For a critical survey of the different approaches to national and international outsourcing see, for example, Spencer (2005).

This fact can be explained by two reasons. On the one hand, the increasing availability of firm micro-data and the extraordinary development of direct-survey techniques have made the analysis of the outsourcing impact on the firm boundaries dominant with respect to the analysis of its effects on the sectoral boundaries of one economy. On the other hand, the scanty availability of input-output tables and the strong micro-hypotheses on which input-output analysis relies have marginalized its interpretative role of a phenomenon which is claimed to occur at a different level of analysis.

This is unfortunate, as the role of outsourcing, and of service outsourcing above all, in explaining the structural change of economic systems is quite apparent. The externalization of business services undertaken by manufacturing firms, while (or rather than) decreasing the industrialization degree of one economy, in fact determines a reshaping of the sectoral boundaries between manufacturing and services.

In order to contribute to fill this gap, the paper aims at exploring the "tools-box" of input-output analysis. In particular, we look for in it proper procedures and instruments to detect and examine those traces outsourcing leaves in the intersectoral structure of one economy, that is, its structural change implications.

The paper is organized as follows. Section 2 recapitulates the strand of applied studies which have addressed the outsourcing - structural change relationship, in which the present one is placeable. The methodological problems which emerge in dealing with the same issue are then spelled out in Section 3. Section 4 examines a set of indicators which could be used to distinguish outsourcing from "simple" tertiarization in applied structural change analysis. Their functioning and interpretative power is then shown in Section 5 through an illustrative empirical application to a set of OECD countries. Section 6 concludes.

2 Outsourcing and structural change: background literature

The structural change analysis of outsourcing has a long history. Indeed, more than 20 years ago, Momigliano - Siniscalco (1982b), among others at that time (e.g. Stanback, 1979; Ginzberg - Vojta, 1981; Gershuny - Miles, 1983), recognized that the externalization of production activities by manufacturing firms to specialized producers of business services determines, also and above all, a change in the relationships among the sectors of an economic system, in terms of both production output and employment. More precisely, rather than a pure "tertiarization" effect, outsourcing would entail a change in the integration of services in manufacturing or, possibly, of some manufacturing activities in other manufacturing activities. In general, through the glasses of input-output analysis real effects can be distinguished from illusion effects in investigating structural change.

Consider, for example, a textile firm that outsources its machinery maintenance to a specialized service firm. Does this imply that the economic weight of textiles on manufacturing and, in turn, that of manufacturing on the whole economic system will decrease in favor of that of services? Can we really talk of tertiarization in this case? The volume of the activities of the textile firm will not necessarily decrease. To be sure, it will possibly increase if outsourcing augments its efficiency by exploiting the specialization advantages of the provider (Abraham - Taylor, 1996). What we face here is thus something different. The boundaries of the textile firm somehow come to extend up to its provider, although through a non-authority coordination mechanism, as the latter enters in the former's network-firm (e.g. Antonelli, 1988). And this has an important structural change implication: the service sector becomes more vertically integrated in the manufacturing one (Momigliano - Siniscalco, 1982b).

As we already said, although quite important, these early insights about the relationship between outsourcing and structural change have remained unexplored for a certain (long) time. Quite recently, however, the increasing pervasiveness of outsourcing has spurred some researchers to reconsider the role that, along with technological change and changes in demand, the organi-

zational change entailed by outsourcing has on the economic restructuring of developed economies (Dietrich, 1999; McCarthy - Anagnostou, 2004). More precisely, these studies have tried to "decompose" the changes occurred over time in input-output tables data, with the aim of disentangling the relative weight of demand-side and supply-side factors in driving economic restructuring. In fact, these studies generally conclude that the "de-industrialization" arguments that have been used, for example, in accounting for the economic restructuring of Europe from the '70s to the '90s, have largely overlooked the extent of outsourcing processes. In so doing, they add, conventional economic views would have underestimated the actual importance and contribution of manufacturing to GDP.[2]

In order to restore a correct interpretation of the issue, these studies attempt to bridge the industrial analysis of outsourcing with the intersectoral one of structural change. More precisely, they put forward some input-output proxies of outsourcing to be used along with sectoral proxies of other demand and supply factors of structural change, and they suggest different ways to combine them.

The present paper intends to move along this research line by investigating its main methodological and empirical issues. To start with, let us consider the main problems which arise in dealing with outsourcing through input-output analysis.

3 Outsourcing and sectoral input-output relations: some critical issues

In industrial organization, outsourcing is usually defined a process through which a certain firm switches from *making* a certain activity in-house to *buying* its outcome from an external provider (e.g. Grossman - Helpman, 2002). In some cases, this switch concerns activities which are ancillary to the production

[2]Although extremely relevant, these studies about the actual extent of de-industrialization processes use decomposition techniques which rely on a non fully satisfactory set of hypotheses. For a more sophisticated decomposition exercise of aggregated growth patterns which tries to distinguish "pure" from "spurious" outsourcing effects, see Montresor - Vittucci Marzetti (2006a).

ones, and are thus externalized to specialized suppliers of other industries (e.g. janitorial services and ICT). In these cases of "interindustry outsourcing" one would thus expect that the phenomenon gets reflected by a correspondent change in the relevant input-output table. On the contrary, when firms outsource parts of their production process itself (e.g. by contracting out the transformation of a certain intermediate input), the evidence of a change at the input-output level will be less visible, as it amounts to an "intraindustry outsourcing" relation. Still, as we will argue, a certain correspondence between the two levels of analysis could be looked for.

Although plausible, the matching between the firm-level and the sectoral-level of analysis of outsourcing is however not perfect, as it is affected by at least two critical issues.

The first and most important issue has to do with the procedures through which data are collected, along with the conventions (namely systems of national and international accounts) adopted to turn these data in a well organized sectoral series of interflow input output tables. As is well known, input-output tables are built up by measuring and adding, sector by sector, deliveries of goods and services among different "establishments", rather than among different firms. Accordingly, inter-establishments deliveries within the same enterprise are also accounted as total output of the production unit and as either intermediate consumption or gross fixed capital formation of the receiving one. This problem, termed "establishment-enterprise problem" (Postner, 1990), seems to represent a serious obstacle in detecting both vertical integration (Woodrow Eckard, 1979) and disintegration starting from input-output tables. However, we claim, their sensitivity to outsourcing depends on the specific case. At the outset, it is high when a certain establishment substitutes services and/or intermediate inputs provided by an establishment of a different firm, for those previously produced within the establishment itself. For instance, when a firm decides to outsource the janitorial services previously performed *within* its establishments to an external specialized provider. The sensitivity is instead definitively lower when, before being outsourced by a certain firm, services and intermediate inputs were provided to a certain establishment by another establishment of the same firm. Indeed, outsourcing in this case could virtually leave the correspondent input-output

deliveries unchanged, but just in quantitative terms. In terms of value, instead, outsourcing would certainly find an input-output manifestation because of the substitution of market prices for "internal prices" in evaluating the outsourced transaction.[3]

In conclusion, although it is certainly true that the difference in the unit of analysis poses some problems in dealing with outsourcing with input-output tables, nevertheless, such a difference is not always crucial. This is particularly true when the reference is to service outsourcing and the externalizing firm is not significantly diversified in its constituent establishments. As far as services are concerned, given the particular nature of their output (i.e. neither storable, nor transportable), firms rarely set up separate establishments for the "in-house" provision of services such as janitorial or ICT: the lower sensitivity case (see above) is thus unfrequent. Moreover, even when services provision entails deliveries between different establishments of a certain firm, it is not always possible to identify and register them separately.[4]

Finally, as recently showed by Pilat - Wölfl (2005), the breakdowns of both production and employment data according to the establishment and the enterprise level do not differ substantially; accordingly, manufacturing firms do not seem to have many establishments primarily engaged in service production and input-output data can thus effectively be used in measuring

[3]For instance, own-account constructions, own-account research & development and own-account software development, although counted as products, according to SNA93 are included in non-market output and therefore measured at production costs. When they are contracted-out they are instead valued at market or equivalent market-prices (United Nations, 2003, pp.23-24), and the latter are usually greater than the former. Finally, let us note that input-output tables could be even "over-sensitive", rather than insensitive, to outsourcing. When a certain firm creates, *ex-novo*, a new establishment for the provision of certain services and/or intermediate inputs to another existing establishment of its own, the correspondent changes in input-output relationships could actually assimilate it to outsourcing although, strictly speaking, it is not.

[4]"In practice, the recording of the production of services for own consumption is less common than for goods. Most of the services produced for own consumption by an enterprise (e.g., transportation, storage, maintenance, etc.) are produced by ancillary activities and are thus not separately identified or recorded either under the output or the intermediate consumption of the establishment or the enterprise to which it belongs" (United Nations, 2006, par.6.87).

service outsourcing.

The second critical issue of an input-output analysis of outsourcing refers to the international "fragmentation" of production (e.g. Jones - Kierzkowski, 2001). Indeed, in the recent years, international outsourcing has become a dominant strategy adopted by both large and small firms in searching for lower labour costs and missing internal competences (the case of US with respect to India is a notable example), affecting both the internal and the external relations of one economy. In this last respect the problem is that, although some of its effects can be detected by referring to input-output tables and relating imported to domestic intermediate sectoral inputs (e.g. Campa - Goldberg, 1997; Feenstra, 1998; Feenstra - Hanson, 1999), it is not possible to distinguish to which extent they are due to "international delocalization" rather than "international outsourcing" as such. Although they are often used interchangeably (e.g. Feenstra - Hanson, 1999; Glass, 2004; Jones *et al.*, 2005; Van Long, 2005; Abbagnano, 1961), the distinction between these two channels is in general quite important. While the former refers to the set-up of a plant in a foreign country by a domestic firm, the latter instead usually refers to a firm which contracts out parts of its production process to foreign firms. In general, as they rather mix the two phenomena, input-output tables are deemed inappropriate in capturing the impact of outsourcing on the so called "international division of labour". Nevertheless, as we will show in the following, an accurate use of domestic and imported intersectoral flows can at least allow us to capture the influence of outsourcing on the sectoral boundaries of an economy.

Finally, a remark should be made about the quality of input-output data. In general such quality is rather poor: intersectoral flows are estimations with a lot of guess work and what we have is just a rough approximation of reality. Furthermore, the service sectors pose deep analytical problems to statisticians, since there is no physical output they can measure. This unavoidably raises the margin of error of statistical estimations, above all for sectoral data.[5]

With these caveats in mind, in the following we discuss a set of input-

[5]On the problems posed by the increasing role of services in modern economies for the standard measures of output and productivity see, for instance, Griliches (1992) and, more recently, Triplett - Bosworth (2001).

output indicators of outsourcing, at different levels of analysis (e.g. sectoral and subsystem) and with different interpretative power (e.g. direct and indirect).

4 Input-output measurements for relating outsourcing and structural change

If outsourcing is considered a structural change determinant, substitutive or complementary with respect to others (such as industrialization and de-industrialization), the identification of a consistent sectoral measurement for it will become necessary.

Looking for this measurement, in the following we will concentrate on the effects outsourcing determines in the intersectoral structure of one economy — that is, in the input-output relationships which map it — by changing the identity of the economic unit which was supplying a certain service (or intermediate input) before it got outsourced. As the micro analysis of outsourcing shows, this change often entails also specialization economies and efficiency gains which can translate, at the sectoral level, in factor productivity increases. However, the former kind of change does not depend on the latter, the latter does not alter the former, and the final result is rather obtained by summing up the two. Accordingly, in the following we will try to map the intersectoral changes induced by outsourcing under a general *ceteris paribus* hypothesis, that is, by assuming that outsourcing is not (yet) able to determine efficiency gains and other indirect effects (e.g. changes in demand, market-prices variations, and the like) in addition to the direct ones of a production re-organization.

4.1 *Sectoral indicators of service outsourcing*

The most straightforward way to capture the amount of service outsourcing made by the firms of a certain manufacturing sector, i, is looking at the correspondent intersectoral flows. For instance, we could analyze, at constant prices, the changes occurred over time in the market transactions of intermediate services ($SERV_i$) made by its firms per unit of production (Q_i), that is:

$\Delta(SERV_i/Q_i)$.

Apparently, this is the most direct indicator to be used, as a positive variation of $SERV_i/Q_i$ could be taken as a signal of outsourcing. However, in using it we have to implicitly assume two hypotheses. First of all, returns to scale should be held constant, referring to a common but quite problematic assumption in input-output analysis of structural change. Second, we have to assume that technological progress does not significantly affect service input-output coefficients in manufacturing sectors. In particular, if we are interested in cross-sectional comparisons, we should retain that this effect is the same across the countries compared. Moreover, given that the present indicator is based on nothing but an input-output coefficient, we should also discount the fact that a change of it might be even provoked by cases of "intraindustry outsourcing". Indeed, as we will clarify in the next section, this kind of outsourcing might decrease $SERV_i/Q_i$ *via* an increase of the gross production of sector i itself.

In order to overcome these problems, it could be possible to use an alternative indicator of service outsourcing for sector i, suggested by McFetridge - Smith (1988), and analyze the changes occurred over time in the ratio between its market transactions of intermediate services ($SERV_i$) and the value of its wages and salaries ($LABR_i$), that is: $\Delta(SERV_i/LABR_i)$. Indeed, as we will argue in the following, outsourcing usually implies a substitution of primary inputs, mainly labour, for intermediate inputs, so that a positive variation of $SERV_i/LABR_i$ could also be a signal of service outsourcing.

However, in order to use this measure as an indicator of outsourcing we still have to make an important implicit assumption: the price of business sector services in wage-units has to be considered stable over time. In making cross-section comparisons, for example, we have to assume a constant relative cost of labour across countries, an assumption which hardly holds true for economic systems with different levels of development. Moreover, the same indicator tends to vary, and thus becomes less reliable, whenever a change in the labour productivity of a certain sector is not properly reflected in the correspondent monetary wages.

In conclusion, also the present indicator, as the previous one, is just an imperfect indicator of service outsourcing at the sectoral level. Both of them

are affected by different phenomena, not all related to outsourcing. However, the "noise" by which they are affected can be deemed less problematic when, and if, they both signal traces of outsourcing, while contrasting signals would recommend caution.

4.2 *Input-output coefficients*

The effects outsourcing brings about at the sectoral level are not just limited to the ones associated to an increase of $SERV_i/Q_i$. Through any kind of outsourcing, intra-firm transactions, or better to say, "intra-establishment deliveries", which cannot be caught by national accounts and input-output data, actually shift outside the firm (the establishment) and thus become measurable by them. In other words, outsourcing brings about an increase in the intermediate consumptions of that sector i in which it occurs, which comes from organizational changes and not from technological ones. More precisely, through this mechanism outsourcing affects the intermediate consumption, the total production and the value added of sector i. Accordingly, it determines a change in the relevant input-output coefficients, that is in the correspondent elements a_{ij} of matrix $\mathbf{A}$ defined as:

$$\mathbf{A} = \mathbf{W}\ \hat{\mathbf{q}}^{-1} \tag{1}$$

where $\hat{\mathbf{q}}$ and $\mathbf{W}$ stand for, respectively, the diagonalized vector of sectoral gross production and the matrix of production flows.

At the outset, these effects are different depending on the sectoral classification of the establishments themselves. Should a certain sector i be interested by "intraindustry outsourcing", its gross output (Q_i) is expected to increase, because the correspondent intrasectoral inflows (w_{ii}) increase for accounting reasons. On the other hand, the inflows out of the main diagonal (w_{ij} with $i \neq j$) do not change. For this reason, outsourcing determines, first of all, a reduction in the extra-diagonal coefficients for sector i, that is, a_{ij} (with $i \neq j$). In addition, as the sectoral value added, which is not affected by duplication, remains unchanged, the increase of w_{ii} turns out to be greater than that of Q_i.[6] Accordingly, outsourcing also makes the autocoefficients a_{ii}

[6] Q_i is in fact the sum of all the intermediate inflows plus the value added of the same

increase. Summing up, "intraindustry outsourcing" in a certain sector i might be expected to determine a reduction in the input-output coefficients a_{ij} (with $i \neq j$) and an increase in the autocoefficient a_{ii}. Let us stress once more that this occurs only for accounting reasons, not related to the production side (for a formal treatment of the implications of "intraindustry outsourcing" see Appendix A).

The effects described above do not occur, instead, in the case of "interindustry outsourcing", such as in the case of producer services analyzed in the previous section: *ceteris paribus*, in the "outsourcee" sector, gross production can be expected to remain unchanged and its value added to diminish because of outsourcing. Therefore, disentangling organizational changes from technological ones becomes in this case nearly impossible. Additional information could however be obtained by looking at an important related indicator, that is the ratio between sectoral value added and gross production, to which we will now turn.

4.3 *The ratio between sectoral value added and gross production*

In addition to a change in the relevant input-output coefficients, outsourcing could also be expected to bring about a lower value added-gross production ratio in the sector i of the outsourcee firm. This is a common idea in measuring both vertical integration and disintegration of both firms and sectors in industrial organization (Stigler, 1951; Adelman, 1955; Laffer, 1969; Tucker - Wilder, 1977).

Although quite common, however, in using this indicator one should be aware of the fact that the value added-gross production ratio is affected by cyclical effects as well as sectoral crises. Indeed, given that $Q_i \equiv VA_i + M_i$, where Q_i, VA_i and M_i stand for, respectively, the gross production, the value added and the intermediate consumptions of a certain sector i, the derivative of VA_i/Q_i with respect to VA_i is:

$$\frac{\partial}{\partial VA_i}\frac{VA_i}{Q_i} = \frac{M_i}{Q_i^2} \ (> 0).$$

sector.

It follows that, whenever there is a cyclical reduction of VA_i, with a constant M_i, VA_i/Q_i will diminish. And the same ratio will decrease also when the rate of decrease of VA_i is greater than the rate of decrease of M_i, as it usually happens in sectoral crises, due to demand slowdowns. Indeed, whenever $g_{Mi} > g_{VAi}$, where g_x stands for the rate of change of x, we have that:

$$g_{VAi/Qi} = g_{VAi} - g_{Qi} = g_{VAi} - \left(\frac{M_i}{Q_i}g_{Mi} + \frac{VA_i}{Q_i}g_{VAi}\right) = \frac{M_i}{Q_i}(g_{VAi} - g_{Mi}) < 0.$$

In order to solve, at least to a certain extent, these problems one could of course use average values of the same sectoral ratio over a sufficiently long period of time (an alternative index is instead proposed by Tucker - Wilder (1977)). Although with some arbitrariness, due to the identification of the length of this period, average VA/Q sectoral ratios can be considered as indicators of sectoral vertical integration/disintegration, with important elements of complementarity with respect to other indicators. As we will see, this complementarity is quite strong with respect to those indicators which can be built up by referring to a subsystem, rather than to a purely sectoral level of analysis.

Before moving to this last point, it is worthwhile emphasizing that, in spite of the bias attributed to VA_i/Q_i by the sectoral proximity of i to raw materials (Tucker - Wilder, 1977),[7] the use of this indicator in cross-sectoral analysis of outsourcing can be motivated by recognizing the complex nature of the integration relationships among the sectors of one economy. Indeed, if horizontal linkages among sectors are recognized along with vertical ones (Baranzini - Scazzieri, 1990), intersectoral cycles among sectors have to be

[7] In brief, the problem is that VA/Q "will be higher the closer the firm in question is to the raw materials source of the production chain" (Tucker - Wilder, 1977, p.83), *regardless from* other organizational elements such as outsourcing. For example, let us suppose there are only three sectors in the economy, each adding a value of 100. If sector a produces its own output using just labour and non produced means of production, sector b utilizes sector a's output as an input and the same does sector c with sector b's output to eventually deliver its products to its final demand. In this case, the value added-sales ratios of the three sectors will be the following:

$$\frac{VA_a}{Q_a} = \frac{100}{100} = 1;\ \frac{VA_b}{Q_b} = \frac{100}{200} = 0.5;\ \frac{VA_c}{Q_c} = \frac{100}{300} = 0.\overline{3}.$$

considered and prevent us from ranking sectors in terms of proximity to raw materials, so that the bias of VA/Q gets attenuated (for a graph theory analysis of this issue see Montresor - Vittucci Marzetti (2006c)). The same bias could remain consistent for those sectors in which vertical linkages are prominent with respect to horizontal ones, such as when a manufacturing sector is compared with an agricultural one. However, when the comparison is between two manufacturing sectors horizontal linkages are usually far more important than vertical ones and processes which can be deemed "closer" to raw materials than others hardly distinguishable.

In conclusion, the value added-gross production ratio can be retained a rather consistent indicator of vertical integration and disintegration also in comparisons across sectors. What is more, the coexistence of vertical and horizontal linkages spurs the researcher to look for outsourcing measurements which are able to catch the whole complexity of the input-output relations of an economic system and the concept of subsystem is an important reference point in this last respect.

4.4 *The weight of sectors in the relative subsystems*

The genesis of vertical integration, defined as the "logical device" of "excluding the consideration of interdependence among productive processes that are supplying essential inputs to one another, and of stressing the transformation of primary resources into finished goods" (Scazzieri, 1990, p.20), can be traced back to William Petty (1662) and Adam Smith (1776). However, starting from the seminal notion of "subsystem" put forward by Sraffa (1960), it was only in the late '60s that such "logical device" was analytically studied by, among the others, Zaghini (1967) and Pasinetti (1973), who developed the concept of "vertically integrated sector", a compact representation of the productive system suitable for dynamic analyses.

Since then on, these concepts have been mainly utilized in empirical studies on productivity.[8] However, in the early 1980s, in a series of studies on the Italian economy, Momigliano - Siniscalco (1982b) utilized a particular

[8]See, for instance, the studies by Gossling (1972) and Gupta - Steedman (1971) and, more recently, by Milberg (1991), Panethimitakis (1993) and De Juan - Febrero (2000).

analytical version of subsystem for the analysis of the tertiarization process.[9]

The concept of subsystem as operationalized by Momigliano - Siniscalco (1982b) is extremely useful when one wants to retain both direct and indirect relations in analyzing the structural change implications of outsourcing.

Following these studies, outsourcing indicators at the subsystem level can be obtained by referring to a matrix $\mathbf{C}$ defined as:

$$\mathbf{C} = \hat{\mathbf{l}}\mathbf{B}(\widehat{\mathbf{l}'\mathbf{B}})^{-1} \tag{2}$$

where $\mathbf{l}'$ is the row vector of labour inputs, the hat symbol is used to denote diagonalization and $\mathbf{B}$ is defined as:

$$\mathbf{B} = \hat{\mathbf{q}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}}. \tag{3}$$

In Equation (3) $\hat{\mathbf{q}}$ is the diagonalized vector of gross production, $\mathbf{A}$ is the matrix of input-output coefficients and $\hat{\mathbf{y}}$ is the diagonalized vector of total final demand.[10]

Each row of $\mathbf{B}$ adds up to 1 and shows "the shares of output of each branch which contribute to the different subsystems" (Momigliano - Siniscalco, 1982b, p.156). Accordingly, two outsourcing measures can be obtained from it. First

[9]Although there are differences between Sraffa's (1960) notion of subsystem and Siniscalco's (1982) version, the most important one being the relevance given in the latter to the actual final demand vector, we think that such differences should not be overemphasized. In this regard, it is interesting to note that the authors themselves decided not to translate the Italian term "blocco" (literally "block") and to substitute it with the more common word "subsystem" in a subsequent english version of their paper (Momigliano - Siniscalco, 1982a).

[10]It has to be noted that the elements of $\mathbf{C}$ turn out to be invariant with respect to changes in the relative prices as well as in the final demand. The former property follows directly from the invariance of the $\mathbf{B}$ operator to changes in the relative prices, as demonstrated by Rampa (1982). The latter property, noted by us, results from the fact that each element of $\mathbf{C}$ amounts to sectoral *shares* in subsystems which, in the presence of constant returns to scale, are not affected by scale effects. Indeed, the generic element c_{ij} of $\mathbf{C}$ can be expressed as follows:

$$c_{ij} = \frac{h_i \alpha_{ij} y_j}{\sum_{i=1}^{n} h_i \alpha_{ij} y_j} = \frac{h_i \alpha_{ij}}{\sum_{i=1}^{n} h_i \alpha_{ij}}$$

where h_i, y_j and α_{ij} stand for, respectively, the labour input coefficient of sector i, the final demand of j and the generic element of the Leontief inverse matrix.

of all, each cell c_{jj} of the main diagonal of $\mathbf{C}$, which tells us the proportion of total labour, directly and indirectly needed to produce the output of a certain sector j, accounted by the sector j itself. If this sector were fully vertically integrated, i.e. if the production process turning non produced inputs into final goods took place entirely within the sector itself, this value would be equal to 1. Conversely, the closer the value of the main diagonal cell is to 0, the more the correspondent sector will be vertically disintegrated, the more outsourcing processes can be retained relevant for it.

A second indicator can be obtained by adding up for each column j the rows (let us say, from n to m) of the $\mathbf{C}$ matrix which refer to business sector services (i.e. considering, for the subsystem j, $\sum_{i=n}^{m} c_{ij}$). Also this indicator can provide us with important information in terms of outsourcing: the lower this sum, the less market services are integrated into the relevant manufacturing subsystem, the more service outsourcing has been presumably at work.

In evaluating the outsourcing signaling power of the $\mathbf{C}$ matrix based indicators, three aspects should be remarked. First of all, these indicators can be taken as indicators of what should be called "system" integration, i.e. the integration that arises from the whole set of input-output relations occurring in the economic system. As it is determined by both technological and organizational factors, and not only specific to the sector under consideration, this system integration is different from that integration which is usually contrasted with outsourcing.

Second, while the temporal analysis of these indicators sheds light on phenomena of "interindustry outsourcing", on the contrary, it does not point out organizational changes that occur entirely inside the sector itself, i.e. "intraindustry outsourcing" (for a formal proof of the invariance of $\mathbf{C}$ to "intraindustry outsourcing" see Appendix A).

Third, in spite of the methodological problems that this entails,[11] the

[11] In brief, when total input coefficient matrices are utilized in computing subsystem values, the theoretical meaning of the operation through which labour input coefficients are multiplied by the Leontief inverse becomes less clear. However, they can still be used by resorting to a more articulated interpretation of the deflation of the imported input coefficient matrix ($\mathbf{M}$), such as for example that proposed by Rampa - Rampa (1982). As

international scope of outsourcing processes makes it opportune to build up the subsystem indicators described above by referring, rather than to domestic flows only (as in Momigliano - Siniscalco (1982b)), to total flows (domestic plus imported). Thus, instead of working out **C** as in Equation (2), it is possible to calculate it as follows:

$$\mathbf{C} = \hat{\mathbf{l}}\,\mathbf{N}(\widehat{\mathbf{l}'\,\mathbf{N}})^{-1} \tag{4}$$

where:

$$\mathbf{N} = \hat{\mathbf{q}}^{-1}\left(\mathbf{I} - (\mathbf{A} + \mathbf{M})\right)^{-1}$$

and where **A** and **M** are the matrices of domestic inputs coefficients and imported inputs coefficients, respectively.[12]

As we will see in the next section, in spite of these caveats, the subsystem level of analysis allows us to better qualify the structural change implications of outsourcing. Before turning to the empirical application, it is convenient to recapitulate the meaning of the indicators we have presented so far.

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they argued:

> "If m_{ij} is an imported inputs *technical* coefficient and $\bar{m}^0_{ij} = (p^0_{mi})\ m_{ij}(p^0_j)^{-1}$ is the associated *expenditure* coefficient at constant prices, the latter can be written as $(p^0_{mi}/p^0_i)\ p^0_i\ m_{ij}(p^0_j)^{-1}$. Thus $\bar{m}^0_{ij}$ can be seen as the quantity of domestic input i needed to obtain the amount of imported input i necessary to produce a unit of j at the terms of trade which prevail in the base year (p^0_{mi}/p^0_i)" (Rampa - Rampa, 1982, p.318, our translation).

Thus, by using the deflated **M** matrix in working out **B**, and by pre-multiplying it by $\hat{\mathbf{l}}$, we obtain a matrix whose generic element can be seen, with respect to the imported part, as the labour needed for a "special" kind of international exchange, that is: the labour necessary to produce the domestic commodities necessary to obtain — through an international exchange carried out at the import-export relative prices of the base year — the foreign ones used in producing the relative (subsystem) final good.

[12]Let us observe that when the total flows transaction matrix is used, instead of the domestic one, the invariance of **C** to changes in the relative prices does not hold any more given that **C** turns out to be affected by changes in terms of trade, so that matrices at constant prices should be used. Furthermore, unlike Equation (2), Equation (4) does not refer to the final demand, but this is not important given the proved invariance of **C** to changes in the final demand.

4.5 *Summing up*

In order to measure the structural kinds of change induced by outsourcing, a number of indicators based on sectoral and intersectoral data can be put forward. Although in the presence of some *coeteris paribus* assumptions and of some distortions, positive or negative variations can be expected for them in the aftermaths of outsourcing as from Table 1.

Let us observe that these indicators, or better to say proxies, are inherently diverse among them. As we will show in the empirical application which follows, this fact can be exploited to overcome the specific limitations of each of them. For example, a complementary use of the value-added/gross production ratio of Section 4.3 and of the vertical integration degree of Section 4.4 could be useful in disentangling the extension of "interindustry" vs. "intraindustry outsourcing". Indeed, while the vertical integration indicator is not affected by the latter, the same does not hold true with respect to the sectoral VA/Q ratio, which instead tends to decrease in the presence of it. Furthermore, the vertical integration indicator is less influenced than the VA/Q ratio by those "market power" factors which affect the translation of the different sectoral labour costs into prices. If a sector is far from a perfectly competitive model, firms might in fact impose a mark-up relatively high, and the sectoral VA/Q ratio will tend to rise.

Similar complementary arguments can be developed with respect to the other indicators, thus increasing their interpretative power. Indeed, the complementarity we emphasize here can be framed into the more general claim for complementarity in the use of the concepts of industries and vertically integrated sectors that, following the seminal contribution of Pasinetti (Pasinetti, 1981, 1993), some scholars of structural change have recently emphasized (e.g. Hagemann *et al.*, 2003; Schilirò, 2006).

5 An illustrative application to the OECD area

In order to illustrate the actual functioning of the outsourcing measurements discussed above, we apply them in both a cross-sectional and an inter-temporal

Table 1: Expected variations of the sector/subsystem indicators in the manufacturing sector i

Event	Level	Indicators	Expected variation
Interindustry disintegration	Sector	VA_i/Q_i	$-\Delta$
		a_{ii}	$=/-\Delta$
		$SERV_i/Q_i$ (service outsourcing)	$+\Delta$
		$SERV_i/LABR_i$ (service outsourcing)	$+\Delta$
	Subsystem	Vertical integration degree	$-\Delta$
		Service integration (service outsourcing)	$+\Delta$
Intraindustry disintegration	Sector	VA_i/Q_i	$-\Delta$
		a_{ii}	$+\Delta$
		$SERV_i/Q_i$	$-\Delta$
		$SERV_i/LABR_i$	$=$
	Subsystem	Vertical integration degree	$=$
		Service integration	$=$

analysis of the economic structure of some OECD countries over the '80s and the middle '90s. More precisely, because of data availability (detailed in Appendix B), we will refer to two different country sets: the OECD6, made up of Canada, Denmark, France, Japan, UK and US, over the '80s; the OECD18, that includes Australia, Canada, Check Republic, Denmark, Spain, Finland, France, Germany, Greece, Hungary, Italy, Japan, Korea, Netherlands, Norway, Poland, UK and US, with respect to the middle '90s (Appendix C). Data availability allows us to retain a sectoral disaggregation for manufacturing (including construction) of 14 sectors for the OECD6 over the '80s, and of 17 sectors for the OECD18 in the middle '90s (Appendix D), while business sector services are identified according to standard OECD conventions (50–74 ISIC Rev.3).[13]

In the methodological vein of the paper, the application is just intended to be illustrative of the pros and cons of the various indicators, rather

[13]In order to reduce the distortions introduced by sectoral aggregation, calculations have been carried out at the maximum level of disaggregation and the results have been then reaggregated as required.

than explorative of the economic structure and structural change of the investigated OECD countries (a more extended empirical analysis can be found in Montresor - Vittucci Marzetti (2006b)). We will start the analysis by looking for the most general traces of outsourcing, at the subsystem level, for then moving to more specific insights at the sectoral level.

5.1 *Searching for "system" traces of service outsourcing*

To start with, it could be interesting to identify those sectors of the investigated OECD area which are "structurally" more disintegrated than others, and for which outsourcing could thus be more relevant. Although a rough measurement, the cross-country average of sectoral vertical integration indicators (Section 4.4) provides us with interesting insights in this last respect. Across the 18 countries considered in the middle '90s, five are the subsystems in which, on average, extra-sectoral labour contributions (direct and indirect) are particularly relevant (Table 2).[14] For two of them — that is, food, beverages and tobacco, and coke, petroleum, and nuclear fuel — this is due to their high intensity of natural resources, which makes the contribution of the correspondent sectors (e.g. agriculture) quite important. The remaining three are those in which outsourcing traces are the most evident, that is: basic metals, chemical and transport equipment.

Quite interestingly, these are also among the manufacturing sectors in which production services have the greatest average weight (in terms of labour) in the middle '90s. More in general, the two rankings are quite similar (their Spearman correlation, with and without the two "resource intensive" sectors is, respectively, 0.684 and 0.798), supporting our tentative interpretation of a relationship between vertical disintegration and service integration. Our structural analysis seems thus aligned with the results of other case-studies at the firm level, in particular for transport equipments and chemicals (Domberger, 1998). As far as basic metals is concerned, instead, the result is apparently inconsistent with its "closeness" to raw

[14]The ranking remains substantially unchanged when the reference is to domestic production flows (the Spearman correlation index is as high as 0.941).

Table 2: Vertical disintegration and market services integration per industrial subsystems - middle '90s – cross-country average values

Industrial subsystems	Avg % values			
	Vertical disintegration	Rank	Service integration	Rank
Low vertical integration				
Coke, refined petroleum products and nuclear fuel	9.9	1	35.8	1
Food products, beverages and tobacco	26.3	2	20.6	14
Motor vehicles, trailers and semitrailers	35.1	3	28.4	4
Chemicals	35.4	4	35.3	2
Basic metals	37.4	5	30.2	3
Middle vertical integration				
Rubber and plastics products	44.2	6	25.7	7
Electrical machinery & apparatus, nec	45.4	7	24.9	8
Office and computing machinery - Communication equipment - Medical, precision and optical instruments	46.9	8	27.6	5
Other non-metallic mineral products	48.5	9	26.3	6
Machinery and equipment, nec	49.4	10	23.4	10
Other transport equipment	49.6	11	21.2	13
Wood, products of wood and cork	50.2	12	18.2	16
High vertical integration				
Manufacturing, nec; Recycling	52.2	13	19.4	15
Construction	52.4	14	21.4	11
Pulp, paper, paper products, printing and publishing	53.2	15	24.9	9
Fabricated metal products	54.2	16	21.3	12
Textiles, textile products, leather and footwear	64.6	17	17.8	17

Source: OECD I-O Database (2005) and 60-Industries GGDC Database (2005).

materials. However, the relevant input-output data also show a prominent role of horizontal linkages over the vertical ones for manufacturing, along with a high integration of services in the basic metal subsystem, revealing a process of intense restructuring.

Interesting results emerge also in terms of cross-country structural comparisons and of structural change. As far as the former is concerned (Table 3), the country ranking we got by looking at subsystem integration/disintegration is substantially different from that obtained working with value added and employment shares of business sector services in the total economy: "simple" sectoral indicators of tertiarization could thus be misleading in interpreting more complex cases of structural change (Montresor - Vittucci Marzetti, 2006b). On the one hand, market services are relatively less integrated in manufacturing in all the transition economies considered, namely Czech Republic, Poland and Hungary. Hungary, in particular, in spite of the large increase of the service sector occurred in the early '90s (both in terms of value added and labour), and of the fast grow of labour productivity in manufacturing (see, for instance, Landesmann, 2000), reveals the smallest degree of service integration in manufacturing: the tertiarization of the country seems thus mainly due to final services, whereas producer services still lag behind. On the other hand, at the opposite extreme, the highest integration of services in manufacturing is shown by the UK, for which the actual nature of the tertiarization process has also been largely documented (see, for instance, Matthews - Gardiner, 2000).

As far as the structural change analysis is concerned, a first set of insights emerge from the average degrees of both vertical integration and service integration of the manufacturing subsystems which can be compared over time. First of all, vertical disintegration at the subsystem level appears a quite recent phenomenon in OECD manufacturing, of the middle '80s at most, and indeed a switch with respect to the early '80s. Apart from transport equipment, all the manufacturing sectors of our disaggregation increased, rather than decreased, their average vertical integration at the beginning of the '80s (Figure 1). At that stage, only motor vehicles and other transport equipment in the OECD6 seemed to have started undergoing a process of vertical reorganization of labour, being it due to technological change or other

Table 3: Service integration in the manufacturing subsystem - middle '90s – Weight of business sector services on the manufacturing subsystem in terms of hours worked

Country	Service integration			
	Total flows	Rank	Domestic flows	Rank
United Kingdom	29.1	1	26.6	2
Netherlands	29.0	2	25.9	4
France	28.9	3	26.4	3
Australia	26.9	4	24.2	6
United States	25.7	5	27.2	1
Canada	25.4	6	24.9	5
Norway	25.1	7	21.4	8
Spain	24.9	8	21.0	11
Korea	24.2	9	21.1	10
Finland	23.5	10	19.0	14
Italy	23.3	11	18.6	15
Japan	22.9	12	21.4	9
Germany	22.5	13	19.7	12
Czech Republic	21.8	14	19.4	13
Poland	21.4	15	17.4	16
Denmark	20.3	16	22.1	7
Greece	19.1	17	14.9	18
Hungary	15.2	18	16.1	17

Source: OECD I-O Database (2005) and 60-Industries GGDC Database (2005).

causes, such as outsourcing. Moreover, unlike vertical disintegration, the increase of the labour weight of services on manufacturing subsystems was already occurring in the early '80s (Figure 2).[15] Combining the two results, it seems that, although increasingly more important for manufacturing, in the early '80s market services did not enter in it in a substitute way yet. This has possibly occurred instead in the middle '80s, as the vertical integration of services in manufacturing further increased on average and was accompanied, as we saw, by the vertical disintegration of the latter.

Further results can be drawn at the individual country level. By referring to manufacturing as a whole (Figure 3), for example, one can contrast UK with the US: while the former reveals a remarkable increase of the service integration in manufacturing, the latter is the only country in which the weight of services in manufacturing during the '80s, rather than increasing, decreased to an appreciable extent (at a negative growth rate of -5.3%).

Idiosyncratic patterns of change can be finally observed also at the level of individual subsystem. The transport equipment subsystem (Figure 4), for example, reveals in Japan an integration level (0.34) nearly half that of the US (0.65). Moreover, during the '80s, in Japan its vertical integration degree decreased at a dramatic rate of change (-29.4%), while in the US it grew at an appreciable pace (5.5%). Once more, the outcomes of other studies at the firm level on the restructuring of the Japanese sector (see, for instance, Womack *et al.*, 1990) get thus confirmed.

5.2 *Sectoral value added-gross production ratios: are they reliable?*

Following standard industrial analysis, the vertical integration/disintegration degree of a certain sector should be simply reflected by its value added-gross production ratio. In the OECD18, for example, the cross-country average

[15]It should be noted that, by keeping both the technical coefficients and the organization of production constant, the weight of services on manufacturing subsystems tends to grow over time when, as it is generally assumed, the rate of growth of labour productivity in manufacturing is greater than in services. Accordingly, service outsourcing only accelerates the pace of this "natural" tendency.

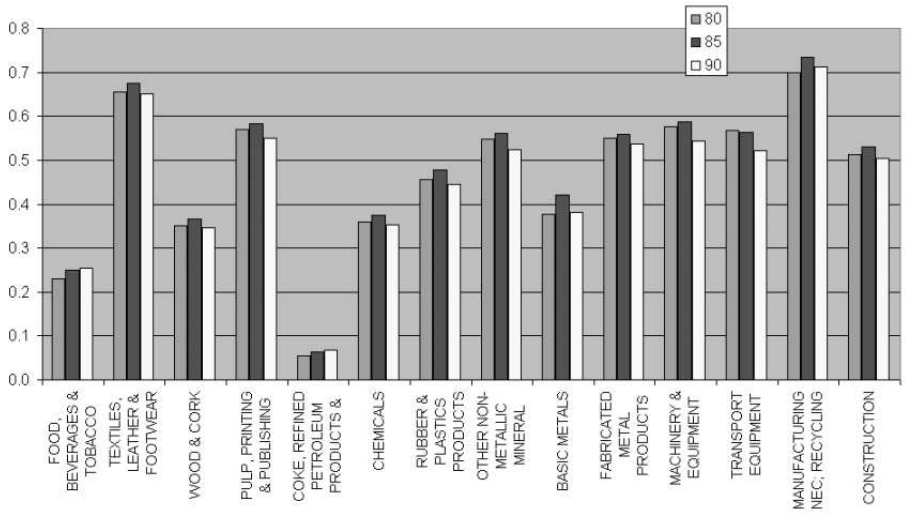


Figure 1: Vertical integration degree of OECD6 manufacturing – cross-country average values: 1980-1990 – Weight of sectors on the relative subsystems (hours worked) – total flows at constant prices

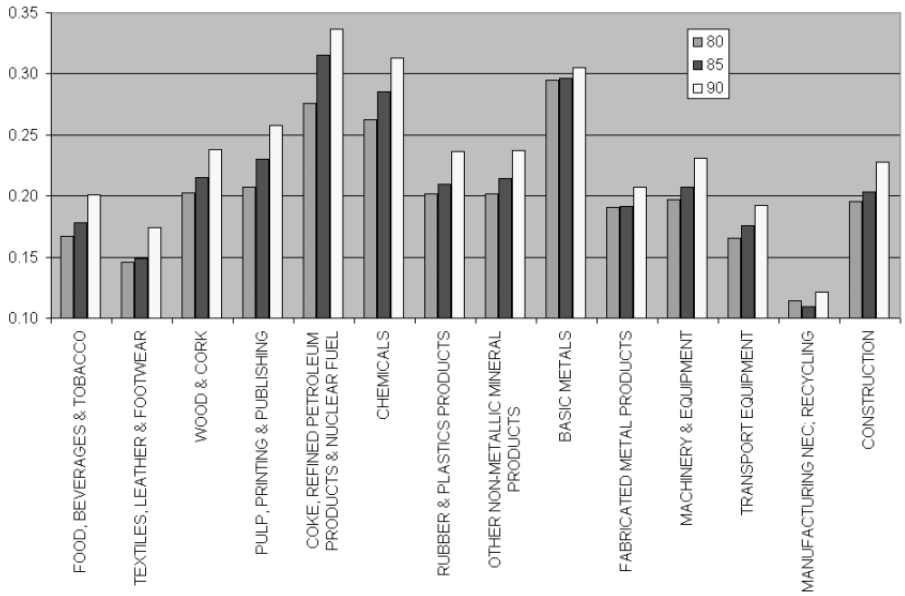
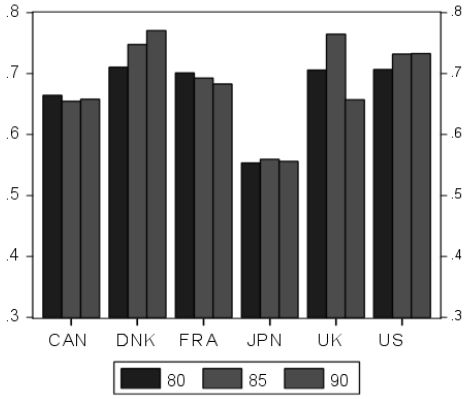
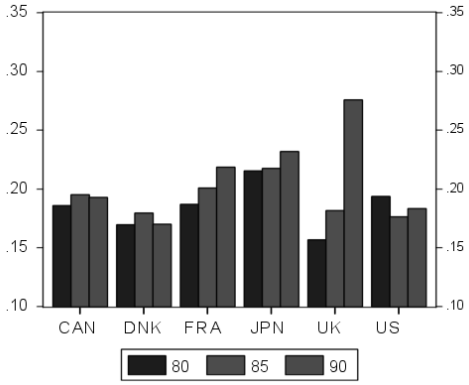


Figure 2: Service integration in manufacturing subsystems in the OECD6 – cross-country average values: 1980-1990 – Weight of business sector services in manufacturing subsystems (hours worked) – total flows at constant prices

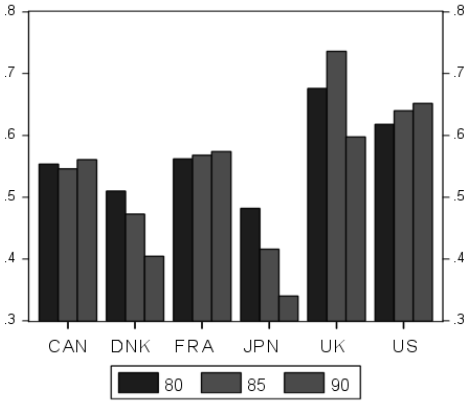


(a) Vertical integration degree

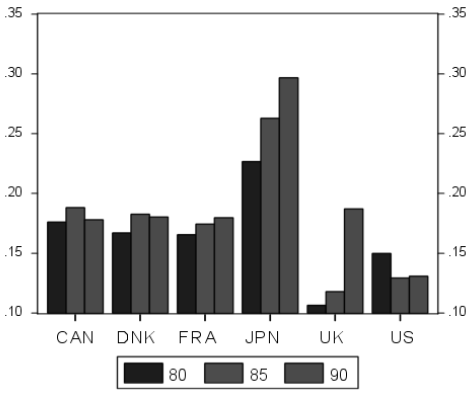


(b) Weight of business sector services

Figure 3: Total manufacturing: 1980-1990



(a) Vertical integration degree



(b) Weight of business sector services

Figure 4: Transport equipment: 1980-1990

of these sectoral ratios for the '90s would suggest that, in addition to the usual natural-resource-intensive sectors (that is, coke, petroleum and nuclear fuel; basic metals; food, beverages and tobacco), outsourcing might have been relatively more pervasive in motor vehicles, chemicals and, consistently with other evidence at the firm level, wood products, electrical products and textile ones (Table 4, left-column).[16]

As we have argued in Section 4.3, although built up by using simple sectoral data, the value added-gross production ratio should be regarded as an outsourcing measurement which refers to the subsystem level. Accordingly, we should expect a certain correlation between such a measurement and that applied in the previous section. Indeed, once calculated with our dataset (that is for the sectors and the countries of Appendix B), this correlation turns out to be as high as 0.862 (Figure 5). Furthermore, the sectoral rankings of our dataset according to, respectively, average sectoral VA/Q ratios and percentage sectoral labour shares in the relative subsystems, are quite similar (Table 4), except for some sectors.

Deviations in ranking are particularly large for textiles, leather and footwear, other non-metallic mineral products and construction. These and other outliers deserve a special attention, as they actually reveal the different "disintegration" rationale the two measurements are able to capture. First of all, as we said in Section 4.5, while the vertical integration degree does not change because of phenomena of intraindustry disintegration, the same does not hold true with respect to the sectoral VA/Q ratio, which tends to decrease when establishments belonging to a certain sector outsource to establishments classified in the same sector. Apparently, this is what happened during the 1990s in the textile sector, where phenomena of "intraindustry outsourcing" were quite frequent in the form of subcontracting intermediated

[16]Following the methodological instructions of Section 4.3, mean values of VA/Q sectoral ratios have been worked out over the '90s. Eventual biases due to the sectoral proximity to raw materials have also been checked for and did not turn out evident. For example, basic metals has got a ratio equal to 0.261, while the ratios of fabricated metals product and electrical & optical instruments sectors are equal to, respectively, 0.401 and 0.353. The coke, refined petroleum products and nuclear fuel sector has the lowest VA/Q ratio (0.202), though it is certainly one of the most structurally "closer" to raw materials among the manufacturing sectors.

Table 4: Average sectoral VA/Q ratios of OECD18 manufacturing sectors 1990-2000 – cross-country average values

Industrial sectors	VA/Q (Avg 1990-2000)	Subsystem integration
Coke, refined petroleum products and nuclear fuel	0.202	9.9
Basic metals	0.261	37.4
Food products, beverages and tobacco	0.264	26.3
Motor vehicles, trailers and semitrailers	0.268	35.1
Chemicals	0.332	35.4
Wood and products of wood and cork	0.349	50.2
Electrical and optical instruments	0.353	46.4
Textiles, textile products, leather and footwear	0.361	64.6
Other transport equipment	0.363	49.6
Rubber and plastics products	0.368	44.2
Machinery and equipment, nec	0.376	49.4
Pulp, paper, paper products, printing and publishing	0.380	53.2
Manufacturing, nec; Recycling	0.400	52.2
Fabricated metal products	0.401	54.2
Other non-metallic mineral products	0.405	48.5
Construction	0.421	52.4

Source: OECD I-O Database (2005) and 60-Industries GGDC Database (2005).

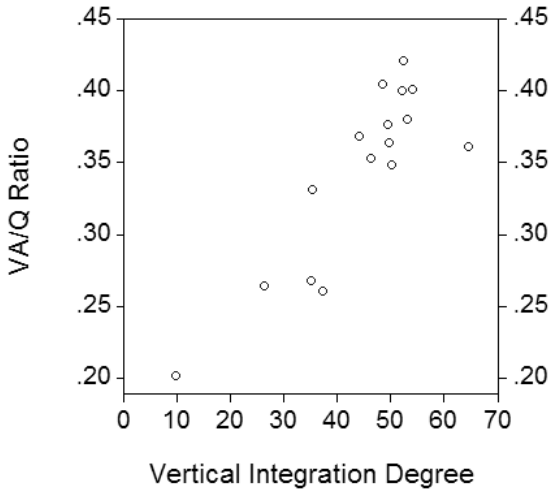


Figure 5: Sectoral VA/Q ratios vs vertical integration degrees

stages of the textile production process itself. Although to a lesser extent, the same holds true also for wood products, basic metals and paper products. Once more, what emerge from the data can be related to important re-organizations recently occurred in these sectors, involving a reduction in their minimum efficient scale: the emergence of mini-mills in the steel production (e.g. Audretsch - Feldman, 1996) and the massive computerization occurred in printing and publishing in the last years (e.g. Domberger, 1998) are two remarkable examples. A different argument instead holds true with respect to construction, other non metallic mineral products and rubber and plastics products, which appear less disintegrated in terms of VA/Q than what the relative sector-subsystem ratio would suggest. As we also pointed out in Section 4.5, this could be due to the peculiar market structure of these sectors, of the construction one in particular, in which monopolistic rents are quite diffuse and hinder the outsourcing revealing power of the VA/Q ratio.

In conclusion, although the present application has nothing but an illustrative character, and a wider dataset is needed to confirm a significant correlation, we argue that the two indicators of disintegration/integration should be used in a complementary way to have a better understanding of the investigated phenomenon.

5.3 *Service outsourcing: what input-output coefficients have to say?*

The final point to address is how consistent the previous "system" indicators of outsourcing are with the more direct "sectoral" ones we have presented in Section 4, that is $SERV/Q$ and $SERV/LABR$.

At the outset, let us observe that, once calculated for the OECD18 in the middle '90s, the rank correlation between $SERV/Q$ and $SERV/LABR$ is very low (0.31). As we have noticed before, this could be due to the fact that $SERV/LABR$ does not turn out very reliable in cross-country comparisons, because it is affected by national differences in the relative costs of labour (Table 5).

The sectoral ranking according to $SERV/Q$ is not consistent with the results we have obtained at the subsystem level either (see Table 3),[17] thus confirming what we have argued above from a methodological point of view. Variations in the incidence of services on an economy's activity volume just signal eventual changes in the resort to service outsourcing at the sectoral level. Conversely, they are unable to capture the integration relationships among sectors that service outsourcing determines at the subsystem level. The replication of the analysis carried out in Section 5.1 for manufacturing as a whole and for transport equipment can be of some help in illustrating this last point (Figures 6 and 7).

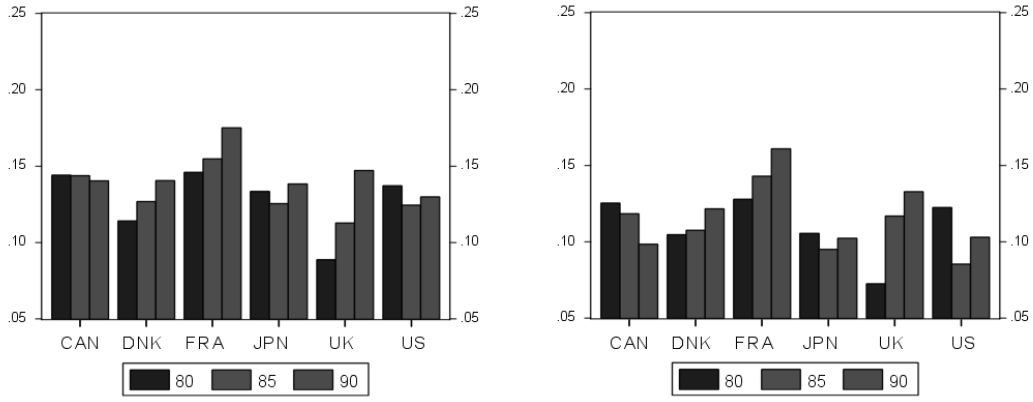
At the outset, let us observe that, if we limit our attention to the European countries, $SERV/Q$ and $SERV/LABR$ become quite consistent between them and supportive of the outsourcing hypothesis. Indeed, these countries show significant increases in both the variables over the whole period. In particular, the data provide further evidence of the economic restructuring of the UK manufacturing sector during the '80s, especially in the last five years, for which $SERV/Q$ increased of more than 66% and $SERV/LABR$ of 60.6%. On the other hand, we should also emphasize that the actual integration of services in UK manufacturing is largely underestimated by the two indicators

[17] The linear correlation between $SERV/Q$ in manufacturing and the business services integration in the manufacturing subsystem is not more than 0.42, while the rank one is even lower (0.325).

Table 5: Business sector services expenditure per production unit ($SERV/Q$) and on labour compensation ($SERV/LABR$) in manufacturing in the mid-'90s

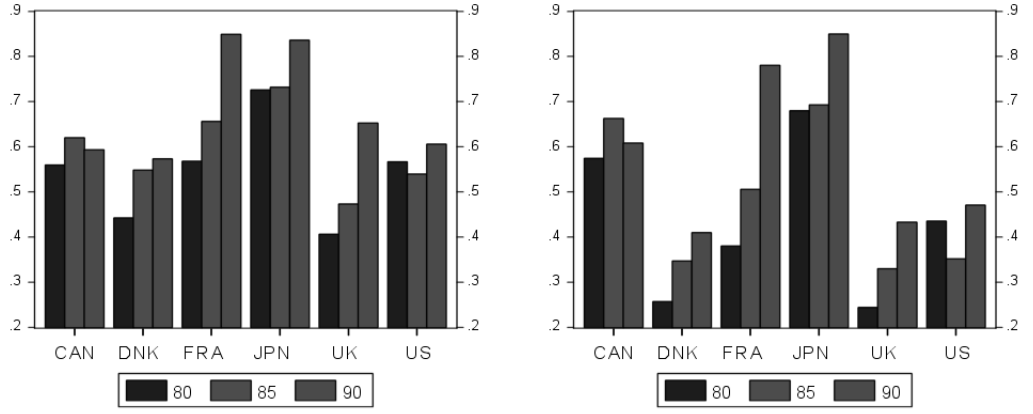
Country	$SERV/Q$	Rank	$SERV/LABR$	Rank
United Kingdom	0.186	1	0.752	9
France	0.183	2	0.855	4
Denmark	0.183	3	0.721	15
Norway	0.178	4	0.829	6
Germany	0.177	5	0.624	17
Japan	0.177	6	0.775	8
Australia	0.176	7	0.986	2
Poland	0.171	8	1.128	1
United States	0.168	9	0.752	10
Italy	0.158	10	0.840	5
Netherlands	0.152	11	0.751	11
Spain	0.152	12	0.750	12
Czech Republic	0.139	13	0.986	3
Finland	0.128	14	0.667	16
Greece	0.127	15	0.788	7
Canada	0.121	16	0.593	18
Hungary	0.115	17	0.737	13
Korea	0.111	18	0.728	14

Source: OECD I-O Database (2005) and 60-Industries GGDC Database (2005).



(a) Total Manufacturing (b) Transport Equipment

Figure 6: Intermediate market services expenditure per production unit (constant prices): 1980-1990



(a) Total Manufacturing (b) Transport Equipment

Figure 7: Intermediate market services expenditure on labour compensation (current prices): 1980-1990

of the present section, both in terms of levels and of rates of changes, as it clearly emerges by comparing Figures 3-4 with Figures 6-7. This suggests how considering both direct and indirect intersectoral relationships matters in dealing with outsourcing as much as with other processes of economic restructuring.

Different results emerge with respect to Canada and the US, where data do not show significant tendencies toward service outsourcing, apart from the US transport equipment sector in the late '80s.[18]

Finally, a special attention should be paid to the case of Japan, and of the Japanese transport equipment sector in particular, for which our indicators seem to be somehow inconsistent. On the one hand, as we saw in Section 5.1, during the '80s the service integration in the transport equipment subsystem grew at a substantial rate (that is of 30.8%) and was accompanied by a related process of sectoral disintegration (its vertical intregration grew at a negative rate of -29.4%), thus clearly signalling an intense process of economic restructuring.[19] On the other hand, however, the same outsourcing pattern is not revealed by the data on $SERV/Q$. Unlike the other countries, in the Japanese sector there was no significant increase in service expenditure per production unit during the 1980s (see Figure 6(b)), and the same does hold true also for its traditional supplier sectors, that is, machinery & equipment, basic metals, rubber and plastics products and other fabricated metal products.[20]

[18]In the US, during the '80s the overall rate of change of $SERV/Q$ for the whole manufacturing is negative and equal to -5.2%, whereas the rate of change of $SERV/LABR$, though positive, is relatively small (6.9%).

[19]This fact gets somehow confirmed by the data on $SERV/LABR$: for transport equipments, its overall rate of growth for the '80s was nearly 25%, although this increase mainly occurred in the last five years. At the same time, the indicator increased a lot also for machinery & equipment (+35.4%), the main supplier sector of transport equipments. As far as basic metals and fabricated metals products are concerned, the other two manufacturing sectors with relevant labour shares in the transport equipment subsystem, the rates of change of $SERV/LABR$ were, respectively, 24.1% and -2.9%. Furthermore, looking at the average levels of the indicators in the two sectors, Japan shows the highest values.

[20]Although sectoral input flows at constant prices from business sector services increased more than 89.8%, the overall increase in the sectoral gross production was 95.6%, thus determining a reduction in the coefficients of -2.94%. Furthermore, both the levels and the rates of change of $SERV/Q$ in the sectors related to motor-vehicles were in Japan

In synthesis, it seems that the restructuring of Japanese manufacturing, and of its transport equipment sector above all, while reflected in the changes occurred in the employment structure, does not come out from the data on intermediate service consumptions per production unit.

A tentative explanation of this apparent inconsistency can be found by recalling the relationship between "intraindustry outsourcing" and sectoral input-output coefficients we have pointed out in Section 4.2. Indeed, this is a case in which the resort to input-output tables can help in distinguishing real from illusion effects. As we said, in the presence of "intraindustry outsourcing", $SERV/Q$ would tend to decrease in the outsourcing sector i, whereas, *ceteris paribus*, neither $SERV/LABR$ nor the indicators at the subsystem level would be affected by it. What is more, all the input-output coefficients of the same sector (that is, the a_{ij}s) would tend to decrease, with the exception of the autocoefficient (a_{ii}), which would instead increase.

In order to ascertain whether this was the case of the Japanese transport equipment sector too, we have compared both the levels and the rates of changes of its input-output coefficients with those experienced by the same sector in the other countries of our smaller dataset (the OECD6). The results seem to support our interpretation. First of all, over the '80s the *autocoefficients* of the transport equipment sector in Japan increased by 70.9%, while the largest increase of the remaining five countries (that of UK) was of just 32.9% (Figure 8): an increase, it should be stressed, which is neither due to changes in the composition of the sector nor to the reorganization of production across the national boundaries.[21] Second, in the same Japanese sector all the *extra-diagonal coefficients* decreased over the '80s, in particular those related to the most important and complementary inputs in the production of transport equipments: basic metals (-31.4%), machinery & equipment (-37.3%) and fabricated metal products (-22.7%). In the other five countries, instead, the reduction in the coefficients related to basic metals was always

substantially smaller than in the other OECD countries, UK in particular.

[21] On the one hand, by increasing the level of disaggregation the basic insights get in fact confirmed. Indeed, the rate of growth of motor vehicles, trailers and semitrailer in Japan was of 52.7%, whereas in the UK it was of just 12.9%. On the other hand, domestic flows-based autocoefficients in the Japanese transport equipment sector over the '80s increased by 71%, almost the same as total flows-based ones.

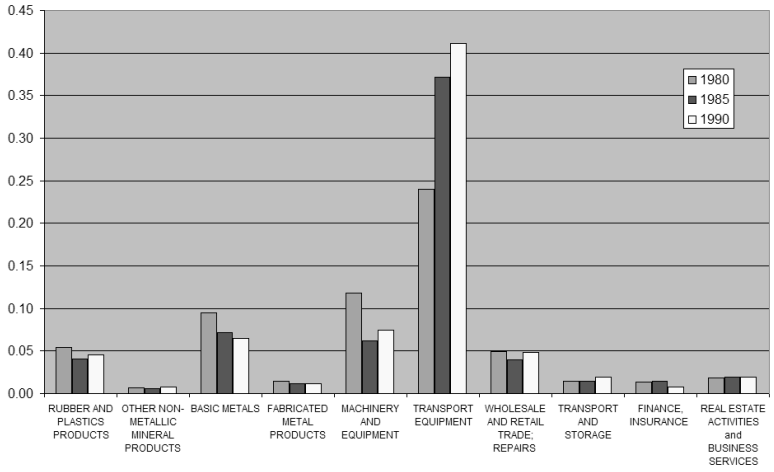
accompanied by an increase for machinery & equipment and fabricated metal products. Once more, let us stress that would these changes be just due to technical progress, a concurrent marked increase in the correspondent autocoefficient such as the one we observed would not be consistent.

In conclusion, our input-output analysis seems to reveal evidences of a certain process of intraindustry disintegration of the Japanese transport equipment sector, a process which could explain the inconsistency between subsystem and sectoral indicators we have detected. This interpretation is supported by the data on employees *per establishment* in the automobile industry of the same country. Indeed, in the late 1980s Japan had the lowest number of employees per establishment among the top five economies in the World at that time (Williams *et al.*, 1998, p.25). However, we cannot exclude that other factors might have played a role in explaining the same inconsistency. First of all, the actual contribution of service inputs to manufacturing might result underestimated because of the typical features of the Japanese industrial organizations (of which "keiretsu" are the most notable example), in which input prices are more similar to intra-firm "transfer prices" rather than to normally negotiated "market prices" (see, for instance, Jarillo, 1993). Second, an increase in the service labour share of the transport equipment subsystem might have been caused by the large labour productivity gains obtained by the transport equipment sector during the '80s, not accompanied by an equal increase of labour productivity in the service sectors.

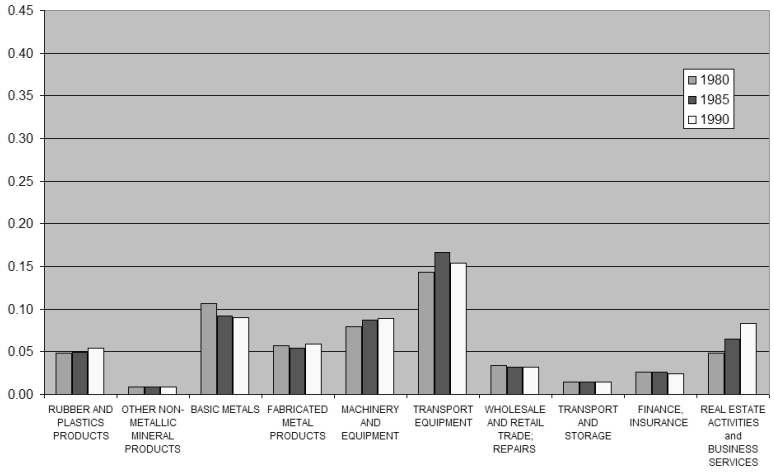
In spite of these caveats, however, the complementary use of different indicators — in this case, of standard service outsourcing indicators and input-output technical coefficients and autocoefficients — appears once more a suitable methodological way to proceed. A result that we will further emphasize among the conclusions.

6 Conclusive remarks

Although mainly investigated as a process of organizational change, in particular of the firm's boundaries, outsourcing has important implications also for the structure of the economic system in which the "outsourcer" and the "outsourcee" firms operate. The organizational and the structural kinds of



(a) Japan



(b) United Kingdom

Figure 8: Input-output coefficients in transport equipment (constant prices)

changes that outsourcing determines are thus nothing but two coins of the same medal.

In the attempt at bridging the micro and the macro-analysis of outsourcing - an effort so far successful only in international trade studies (for a survey see Spencer, 2005) - this paper illustrates, compares and applies a set of input-output outsourcing indicators, that is, indicators which help us disentangling to which extent and in which way the different externalization decisions of the firms turn into changes of the intersectoral and intrasectoral relationships of the economic system in which they operate. In other words, a set of indicators through which outsourcing, especially of producer services, can be accounted for in explaining structural change along with other more "popular" determinants (e.g. technical, production and demand-led changes).

Given that the different structural change determinants of one economy are at work simultaneously, an accurate analysis and interpretation of the indicators we have presented should be accompanied by a suitable decomposition of their relative weight. Indeed, some decomposition techniques have been recently put forward for this scope (e.g. Dietrich, 1999; McCarthy - Anagnostou, 2004). However, their construction and interpretation appears to us still problematic and requires further research efforts. Accordingly, we decided to place this issue on our future research agenda and rather pursued two intermediate objectives with respect to it. First of all, we have discussed the rationale of an input-output kind of outsourcing indicators. Second, we have applied them in an illustrative empirical exercise and simply alerted the reader about the need of controlling for extra-outsourcing determinants when necessary.

The methodological discussion of the outsourcing indicators we have presented leads us to a first important result. Although they are all affected by the externalisation decisions of the correspondent firms, their interpretative power differs for several factors. Some indicators capture the effects of outsourcing at the subsystem level, while some others at the sectoral level; some are able to distinguish "interindustry" from "intraindustry outsourcing", while some others are unable to; some are affected by market structures, while some others are unaffected by them. Accordingly, the same indicators should be considered as complementary rather than substitute among them, while

looking for the "best" or the "most revealing" indicator could be misleading.

The illustrative empirical application we carried out with respect to a set of OECD countries over the '80s and the middle '90s corroborates this suggestion. Some results confirm, on a comparable and systematic basis, what previous work had already suggested on the basis of case-studies and/or nation specific analyses, such as, for example, the idiosyncratic resort to service outsourcing of the UK manufacturing sectors. Some of the results we got are instead quite original, as they have been obtained by working on a new OECD dataset, covering updated input-output tables for a larger set of countries than the "old" one, and by crossing it with other newly available sources of sectoral data (e.g., the *60-Industry Groningen Growth and Development Centre Database*). The evidence we obtained for the former socialist European countries, usually retained to have been invested by a massive tertiarization process over the 1990s, but here characterized by the lowest degree of service integration in manufacturing subsystems, is one of the most relevant of these results. Finally, some of the results turn out to be inconsistent among them or mixed-up, as different indicators point to, at least apparently, different predictions in terms of outsourcing: the case of the Japanese transport equipment sector is for sure the most representative of them. However, an accurate complementary use of the different indicators we discussed turns out to be helpful in solving these apparent contradictions and in eliminating the inherent biases by which some of them are affected. In the Japanese case, for example, a closer look at the input-output coefficients of the transport equipment sector sheds some light on the hypothesis of an intraindustry disintegration process over the '80s and the middle '90s.

In closing the paper, it seems to us that, in spite of the need of controlling for other factors, the indicators we have presented could be used as complementary (although possibly rough) proxies of a structural change determinant which should be extrapolated from the "black-box" of other important economic processes.

A Intraindustry outsourcing and input-output indicators. A formal treatment

As argued in Section 4.2, "intraindustry outsourcing" in a certain sector j entails a change of the intrasectoral flows (w_{jj}) by a certain amount (d_j) and a correspondent change in the sectoral gross production (Q_j) by the same amount.

Denoting with $\hat{\mathbf{d}}$ the diagonalized vector of the sectoral changes d_j, the matrix of input-output coefficients ($\mathbf{A}$) defined in Equation (1) takes on the following expression:

$$\mathbf{A}_d = (\mathbf{W} + \hat{\mathbf{d}})(\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1} = \begin{pmatrix} \frac{w_{11}+d_1}{Q_1+d_1} & \cdots & \frac{w_{1n}}{Q_n+d_n} \\ \vdots & \ddots & \vdots \\ \frac{w_{n1}}{Q_1+d_1} & \cdots & \frac{w_{nn}+d_n}{Q_n+d_n} \end{pmatrix}$$

Given that $0 \leq w_{ij} < Q_j$, it follows that:

$$\frac{w_{jj}+d_j}{Q_j+d_j} \begin{cases} > \frac{w_{jj}}{Q_j} & \text{if } d_j > 0 \\ < \frac{w_{jj}}{Q_j} & \text{if } d_j < 0 \end{cases}$$

and

$$\frac{w_{ij}}{Q_j+d_j} \begin{cases} < \frac{w_{ij}}{Q_j} & \text{if } d_j > 0 \\ > \frac{w_{ij}}{Q_j} & \text{if } d_j < 0 \end{cases}$$

Thus, an increase (decrease) in the value of the duplication in sector j, because of an increased (decreased) intraindustry disintegration within the sector, $d_j > 0$ ($d_j < 0$), will cause, *ceteris paribus*, an increase (decrease) of the relevant autocoefficient (a_{jj}) and a decrease (increase) in all the remaining coefficients (a_{ij} with $i \neq j$).

Moreover, given that the value added is not affected by duplication and "intraindustry outsourcing" does not entail any reorganization of production among sectors, the sectoral value added remains unchanged. Thus, we have that:

$$\frac{VA_j}{Q_j+d_j} \begin{cases} < \frac{VA_j}{Q_j} & \text{if } d_j > 0 \\ > \frac{VA_j}{Q_j} & \text{if } d_j < 0 \end{cases}$$

Hence, *ceteris paribus*, the sectoral value added/gross production ratio tends to decrease for phenomena of "intraindustry outsourcing".

Let us also note that, given a non-service sector i, if its intraindustry disintegration increases, this will cause, *ceteris paribus*, a reduction in $SERV_i/Q_i$, while $SERV_i/LABR_i$, defined in Section 4.1, will not change.

Finally, it remains to prove that "intraindustry outsourcing" cannot alter any of the indicators at the subsystem level discussed in Section 4.4, namely those of vertical integration degree and service integration. In order to do so, let us prove the following equality:

$$(5) \qquad \hat{\mathbf{q}}^{-1}(\mathbf{I} - \mathbf{W}\ \hat{\mathbf{q}}^{-1})^{-1} = (\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\left(\mathbf{I} - (\mathbf{W} + \hat{\mathbf{d}})(\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\right)^{-1}$$

Inverting both sides of the equality and recalling that $(\mathbf{M}_1\mathbf{M}_2)^{-1} = \mathbf{M}_2^{-1}\ \mathbf{M}_1^{-1}$, where $\mathbf{M}_1$ and $\mathbf{M}_2$ are two generic conformable square matrices, we obtain:

$$\begin{aligned}
\left(\hat{\mathbf{q}}^{-1}(\mathbf{I} - \mathbf{W}\ \hat{\mathbf{q}}^{-1})^{-1}\right)^{-1} &= \left((\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\left(\mathbf{I} - (\mathbf{W} + \hat{\mathbf{d}})(\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\right)^{-1}\right)^{-1} \\
(\mathbf{I} - \mathbf{W}\ \hat{\mathbf{q}}^{-1})\ \hat{\mathbf{q}} &= \left(\mathbf{I} - (\mathbf{W} + \hat{\mathbf{d}})(\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\right)(\hat{\mathbf{q}} + \hat{\mathbf{d}}) \\
\hat{\mathbf{q}} - \mathbf{W} &= (\hat{\mathbf{q}} + \hat{\mathbf{d}}) - (\mathbf{W} + \hat{\mathbf{d}}) \\
0 &= 0
\end{aligned}$$

that demonstrates the previous equality.

From Equation (5) it follows that:

$$(6) \qquad \mathbf{B} = \hat{\mathbf{q}}^{-1}(\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{y}} = (\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\left(\mathbf{I} - (\mathbf{W} + \hat{\mathbf{d}})(\hat{\mathbf{q}} + \hat{\mathbf{d}})^{-1}\right)^{-1}\hat{\mathbf{y}}$$

Thus, intraindustry disintegration phenomena do not alter the operator $\mathbf{B}$ and the other matrix defined at the subsystem level, $\mathbf{C}$. Accordingly, the indicators based on this matrix are not affected by "intraindustry outsourcing".

B Dataset description

Data have been obtained from different datasets. Input-output tables come from both the "new" *OECD Input-Output Database* (2005), recently released, and the "old" OECD I-O Database for the '80s (1995).

Sectoral data on total hours worked have been obtained from the *60-Industry Groningen Growth and Development Centre Database* (2005).

The data on sectoral gross production and value added over the '90s used for calculating the average sectoral ratios in the analyses carried out in Section 4.3 come from the *OECD STAN Database* (2004). Because of missing data, in this specific application we have excluded Australia from the average ratio of the construction sector. Furthermore, when for some country some of the needed disaggregated data were missing, we used the least aggregated data available assuming that, for that country, the proportion between the disaggregated data and the more aggregated ones is the same as that between the correspondent average values. This procedure has been applied to the following missing values: Chemicals and chemical products (Cod. 24) and Rubber and plastics products (Cod. 25) for Norway, using the data of Chemical, rubber, plastics and fuel products (Cod. 23-25); Basic Metals (27) and Fabricated metal products (28) for Australia and Czech Republic, using the data of Basic metals and fabricated metal products (27-28); Motor vehicles, trailers and semi-trailers (34) and Other transport equipment (35) for Czech Republic, using the data on Transport equipment (34-35). The ensuing results are quite robust and do not change significantly if some other method is adopted, such as, for instance, simply calculating the sectoral averages without the sectors of the countries for which the data are missing.

C Country coverage

Country	Input-Output Tables			
	early '80s*	mid-'80s*	early '90s*	mid-'90s
Australia				1995
Canada	1981	1986	1990	1997
Czech Republic				1995
Denmark	1980	1985	1990	1997
Finland				1995
France	1980	1985	1990	1995
Germany				1995
Greece				1994
Hungary				1998
Italy				1992
Japan	1980	1985	1990	1995
Korea				1995
Netherlands				1995
Norway				1997
Poland				1995
Spain				1995
United Kingdom	1979	1984	1990	1998
United States	1982	1985	1990	1997

*Input-output tables at constant prices

D Manufacturing sectors

Sector	ISIC Rev.3 Codes
Food products, beverages and tobacco	15-16
Textiles, textile products, leather and footwear	17-19
Wood and products of wood and cork	20
Pulp, paper, paper products, printing and publishing	21-22
Coke, refined petroleum products and nuclear fuel	23
Chemicals (including pharmaceuticals)	24
Rubber and plastics products	25
Other non-metallic mineral products	26
Basic metals	27
Fabricated metal products (except machinery and equipment)	28
Machinery & equipment	
...Machinery and equipment, nec	29
...Office and computing machinery - Communication equipment - Medical, precision and optical instruments	30,32-33
...Electrical machinery and apparatus, nec	31
Transport equipment	
...Motor vehicles, trailers and semitrailers	34
...Other transport equipment	35
Manufacturing, nec; Recycling	36-37
Construction	45

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Summary: Outsourcing and Structural Change: What Can Input-Output Analysis Say About It? (J.E.L. D230, D570, L160, L220, L240, L600, O140)

The paper aims at investigating the capacity of input-output analysis to identify the structural change implications of outsourcing. In particular, it develops the idea that outsourcing leaves "traces" in the intersectoral structure of one economy that can be caught empirically, to a different extent by different indicators. The pros and cons of these indicators are discussed from a methodological point of view and their actual interpretative power shown through an application to the OECD area for the '80s and the early '90s. The main result of the paper is that an accurate mapping of the relationship between outsourcing and structural change requires us to use different indicators jointly, rather than alternatively. In particular, a purely sectoral kind of perspective needs to be combined with a subsystem one, which detects the effects of outsourcing on the vertical integration degree of one economy's sectors.