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Subcontracting dynamics and economic development:
A study on textile and engineering industries

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Abstract

Recent studies on small and medium sized establishments emphasize the importance of networking and regional clusters for industrial development. This study is focused on an important form of cooperation between firms: subcontracting relationship. Our aim is to estimate the determinants of subcontracting in Turkish textile and engineering industries, and to derive policy implications of our estimates. We estimate subcontract offering and subcontract receiving models for both industries by using panel data on all establishments employing 25 or more workers in the period 1988-97. Our findings show that short-term/unequal relationship exists between parent firms and subcontractors in the textile industry whereas subcontracting relationships in the engineering industry are established between "similar", relatively advanced firms that have complementary assets and technologies.

Keyword(s): Subcontracting, firm cooperation, vertical integration.

JEL Classification: L14, L22, L61, L67.

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1. Introduction

In most of the twentieth century, small and medium-sized establishments (SMEs) were considered to be an archetypical and declining sector in which "informal" and "pre-modern" labor relations and technologies hindered the process of economic development. In this context, “subcontracting” was considered as a form of domination of large firms over small ones where large firms benefited from low wages and flexible work arrangements in small firms. Therefore, the SME sector was thought to be eliminated by more efficient and advanced large firms. The tendency towards gigantism was dominant among public policy makers both in the developed and the less developed countries (LDCs) who were trying to imitate the industrial development experience of the former group since the early 20th century. The apparent failure of the industrialization attempt in most of the LDCs and the prolonged economic crisis in the developed countries in the 1970s and 1980s, as well as the striking resistance and vitality of SMEs in developing as well as in developed countries, forced policy makers to re-evaluate the role of SMEs in the economy.

The small firm has increasingly become the focus for public policy designed to decrease unemployment in the developed and less developed countries. In the 1970s, international organizations started to advocate the promotion of SMEs in LDCs to alleviate the problems of unemployment. It was argued that the capital-intensive "modern" sector in LDCs is unable to generate sufficient employment opportunities for a rapidly growing population. Subcontracting was supposed to play an important role in policies designed to promote SMEs. International organizations, like the World Bank and the United Nations Industrial Development Organization (UNIDO) called for the promotion of industrial subcontracting in the 1970s and 1980s. The Turkish governments also adopted SME-promotion policies under the influence of international organizations in the same period.

Almost all policy documents in Turkey emphasize the importance of SMEs for industrialization and economic development, and call for various support programs for those establishments. In spite of this rhetoric, there are not many comprehensive empirical studies on SMEs and the extend and characteristics of subcontracting relations. There are a few very good survey studies that analyze in detail the relationships between small and large firms and

subcontracting relations (see, for example, Bademli, 1977; Ayata, 1991; Aktar, 1990; Evcimen, Kaytaz and Cinar, 1991; Kaytaz, 1994; and Ozcan, 1995). Although these studies present very rich observations and offer alternative models and theories, their coverage is limited to certain sectors and regions because they usually rely on (small sample) survey data or field studies. To the best of our knowledge, this is the first study that analyzes the determinants of subcontracting at a comprehensive level. The study is restricted to Turkish textile and engineering (metalworking) industries because subcontracting relations are developed mainly in these two sectors. We suggest that firms engage in subcontracting because of a set of firm-specific factors (product characteristics, market characteristics, technology, ownership, so forth). We estimate two models for both sectors, one for the share of subcontracted inputs (subcontract offering firms), and the other for the share of subcontracted output (subcontract receiving firms) by using data for all establishments employing 25 or more workers in the period of 1988-97. The estimated model is the random-effects Tobit model.

The paper is organized as follows. Section 2 summarizes theories on the new role of SMEs and the importance of subcontracting in enhancing efficiency and flexibility. Section 3 presents a descriptive analysis of the changes in the share of subcontracting in Turkish manufacturing industries. Section 4 develops the model and presents the estimation results. Section 5 summarizes policy implications.

2. Economic development and subcontracting

Subcontracting is usually defined as a form of relationship between firms mostly depending upon complete or partial production of goods and services. A more formal definition of subcontracting would be “a situation where the firm offering the subcontract requests another independent enterprise to undertake the production or carry out the processing of a material, component, part or subassembly for it according to specifications or plans provided by the firm offering the subcontract” (Holmes, 1986: 84).

Holmes (1986), following Watanabe (1971) and Chaillou (1977) and others, identifies three major types of production subcontracting: capacity subcontracting, specialization subcontracting, and supplier subcontracting.

In the case of *capacity subcontracting*, only the fabrication of the subcontracted part is carried out by the subcontractor with respect to a detailed set of plans and specifications set

down by the contractor (the parent firm), and usually the parent firm will also be manufacturing the same part. The reason the parent firm subcontracts a proportion of its requirements is the capacity limit. In this sense, capacity subcontracting can be thought as a temporary relationship between the parent firm and the subcontractor that arises as a result of excess demand for the products produced by the parent firm. Since capacity subcontracting represents a horizontal disintegration of production, it is sometimes also referred as "horizontal subcontracting". However, the concept of horizontal subcontracting may indeed cover a broader range of contracts between firms. For example, as Spiegel (1993) shows, firms with asymmetric convex costs can use horizontal subcontracting to allocate production more efficiently even if the capacity limit is not binding. Therefore, we prefer to use the concept of "horizontal subcontracting" instead of the concept of "capacity subcontracting".

Specialization (complementary) subcontracting is the second form of production subcontracting in which the decision about the method of production is usually taken by the subcontractor. This case represents vertical disintegration of production and arises when two firms have (vertically related) complementary assets or technologies.

Finally, the last form of subcontracting is *supplier subcontracting*. This is similar to specialization subcontracting, but the subcontractor is an independent supplier with full control over the development, design and the method of production, but is willing to enter a subcontracting arrangement to supply a dedicated or licensed part to the parent firm.

What are the factors that lead firms to subcontract a part of their components/production activities to other firms? (For an excellent discussion on various theories, see Arena, Ravix and Romani, 1992.) First of all, the subcontracting relationships between firms may be due to the *structure and temporal stability of product markets* (Clarke, 1994). As Holmes (1986: 89) explains

> [t]hese include [firstly,] the situation where the parent firm is engaged in manufacturing a product for which demand is uncertain or irregular because of cyclical or seasonal variations in demand; secondly, the case where sufficient demand to permit the continuous mass production of a particular product line simply never exists; and, thirdly, the market conditions that exist at the beginning and end of a particular product.

Second, *production technology and labor-process organization* may favor resort to production subcontracting. These factors include the specific technical characteristics and fixed capital costs of the production technology used in the production process. A well-known case that leads to specialization subcontracting is the case where different stages of the production process may have different levels of optimum efficient scale.

Finally, the third set of reasons for the development of subcontracting relations would be the *structure and nature of labor markets*. The parent firm may seek to subcontract a portion of its (unskilled labor-intensive) production operations to take advantage of lower wages in smaller firms. This case arises when there is a kind of “dual labor market” and the subcontractor firm does not have the capability to distribute and to market its products, or cannot raise sufficient capital to establish its own distribution channels. If the parent firm (usually supposed to be a large firm) subcontracts a part of its production to a subcontractor (a small firm), this type of subcontracting can be considered as a form of domination of the large firm over the small firm.

In the 1970s and early 1980s, subcontracting was considered by many researchers and international organizations as a tool for modernization and employment generation. For example, Watanabe (1971: 51), in one of the leading articles on subcontracting, claimed that "... subcontracting can smooth the path of small enterprises and make them a suitable instrument for mass employment creation in developing countries that are committed to industrialisation." In a similar manner, UNIDO also called for the promotion of industrial subcontracting (for example, see UNIDO, 1974). The main idea behind advocating the development of subcontracting was based on the “benefits” a small subcontractor derives from a large parent firm in the form of guaranteed markets, secured raw materials, and technical assistance. Large firms that adopt modern technology would diffuse modern production techniques (the control of production processes, quality control, so forth) to subcontractors. Watanabe (1971: 73) even suggested that if “the small size of local markets and the scarcity or non-existence of potential parent firms with adequate marketing capacity and technological know-how” creates a problem, it can be solved by “casting established foreign companies in the role of parent firm” (for a critical analysis on the role of international subcontracting, see Bose, 1990 and Kumar, 1996). This argument on the role of large parent firms is based on the old dichotomy between modern/large firms and traditional/small firms. Based on this argument, one can claim that export oriented international subcontracting may favor economic

development by expanding manufactured exports for developing countries. In addition to this direct affect, international subcontracting of production may result in transfer of knowledge, designs, specifications and quality controls to the LDCs. Although these effects could vary across countries, international subcontracting of production has played a vital role in the export expansion of most East Asian countries (Kumar, 1996: 4).

An Expert Committee Report prepared for the Sixth 5 Year Development Plan in Turkey echoes the same argument (State Planning Organization, 1989: 148-149). It is claimed in the report that modern industry integrates firms in such a way that large industrial enterprises form the governing and leading main sector whereas small enterprises form the secondary/auxiliary sector. In this context, subcontracting is expected to lead to efficiency gains for large enterprises. The policy measures for encouraging subcontracting are similar to those suggested by the World Bank in 1980: "reduced import duties on machinery for subcontractors, accelerated depreciation allowance on equipment to facilitate subcontractors' acquisition of capital assets, provision of industrial extension services, materials testing equipment and industrial estate facilities" (World Bank, 1980, v.3: 46-47, cited in Kaytaz, 1994: 152).

There has been a shift in the locus of studies and policy proposals in recent years, especially after the publication of the influential book by Piore and Sabel (1984) on flexible specialization. The emphasis is now on networking and clusters, usually formed by SMEs themselves. International organizations like UNIDO (Ceglie and Dini, 1999), ILO (Pyke, 1992) and UNCTAD (UNCTAD, 1994) now support networking initiatives and the development of industrial districts. It is suggested that "on the account of the common problems they all share, small enterprises are in the best position to help each other" (Ceglie and Dini, 1999). They can do so through horizontal cooperation (they can collectively achieve scale economies), vertical cooperation (they can specialize in their core activities and develop the external division of labor), and networking among enterprises, providers of business development services, and local policy makers. These studies show that the dichotomy between large/parent firm and small/subcontractor firm is not valid, and non-market mediated interactions between firms should also be taken into account in designing and implementing economic policies.

As our brief presentation indicates, there are significant differences between traditional and new approaches to subcontracting. Traditional approaches consider subcontracting as a

relationship between two firms, the parent and the subcontractor. The unit of analysis is a specific subcontracting relationship between two particular firms. New approaches like the network and cluster approaches, as their names imply, look at a group of firms cooperating (and competing) within a complex web of supportive institutions. Externalities generated by this form of cooperation and competition are internalized by the network so that the collective efficiency and flexibility is enhanced. Moreover, the subcontractor in the traditional approach is a passive, dependent firm: it will benefit from subcontracting (in the form of guaranteed markets, technical assistance, so forth) to the extent the parent firm allows. However, the distinction between the parent firm and the subcontractors is not so sharp in the network analysis because the network can be established even by only small firms. Indeed, one of the main requirements for a well-functioning network is the fact that all firms in the network should have a certain level of technological capability to interact with each other. We consider these two conceptualizations not as alternatives, but formalizations of different types of inter-firm relationships corresponding to different models of development.

3. Subcontracting in Turkish manufacturing industries

Although there are some survey and field studies that analyzed subcontracting relationships in Turkish manufacturing industries (for a small sample, see Bademli, 1977; Ayata, 1991; Aktar, 1990; Evcimen, Kaytaz and Cinar, 1991; Kaytaz, 1994; and Ozcan, 1995), there is almost no comprehensive study in this field. Altin's study (1995) is one of the first studies that analyze firm characteristics and subcontracting for all sectors of the manufacturing industry.

The data used in our study come from the Census of Manufacturing Industry (1992) and Annual Surveys of Manufacturing Industry (all other years in the period 1987-97). These Surveys cover all establishments[1] in the manufacturing industry employing at least 25 workers. The Surveys for the size group 10-24 cover questions about subcontracting since 1992, but we do not include those firms into our analysis in order to have a consistent long panel.[2]

Subcontracting in the SIS survey is defined such that it does not cover all forms of subcontracting. The survey uses the Turkish word "fason", and defines "income from subcontract" as "income generated from the processing of materials provided by the firm

[1] Since most of the firms in the Turkish manufacturing industry are single-plant firms, we use the concepts of "firm", "establishment" and "enterprise" interchangeably.
[2] We estimated our model (equation 1) by including this group but results were almost the same.

offering the subcontract". This definition certainly excludes supplier subcontracting and may lead to an underestimation of the extent of subcontracting especially in the engineering industry.

Table 1 presents the data on subcontracting industry in Turkish manufacturing industries at the 2-digit ISIC[3] level for the periods 1988-92 and 1993-97. Subcontracting intensity (as measured by the share of subcontracted output in total output, and the share of subcontracted inputs in all inputs) is rather low in the Turkish manufacturing industry (about

Table 1. Subcontracting in Turkish manufacturing industries

		Subcontracted input share (%)		Subcontracted output share (%)	
		1988-92	1993-97	1988-92	1993-97
31	Food	0,31	0,51	0,28	0,35
32	Textile	6,20	6,31	5,63	5,63
33	Wood products	1,28	0,93	0,69	0,48
34	Paper	2,14	1,84	1,32	1,27
35	Chemicals	0,65	0,92	0,67	0,58
36	Pottery, glass, cement	1,88	1,79	0,18	0,29
37	Basic metal	1,04	1,26	1,36	1,36
38	Engineering	2,17	1,62	0,77	0,87
39	Other manufacturing	3,36	3,65	0,97	2,89
3	*Manufacturing*	*1,99*	*2,16*	*1,50*	*1,63*
Subcontracting intensive sub-sectors in the textile and engineering industries					
3211	Spinning, weaning and finishing	3,12	3,03	6,75	6,83
3212	Textile products exc. wearing apparel	6,67	12,37	3,37	4,24
3213	Knitting mills	11,22	10,80	3,03	4,08
3222	Wearing apparel, exc. fur and leather	16,17	15,56	6,31	6,79
3231	Tanneries and leather finishing	1,00	1,00	3,95	3,70
3813	Structural metal products	6,87	8,41	4,35	5,49
3823	Metal and wood working machinery	5,96	10,99	5,28	12,90
3841	Ship building and repairing	20,12	13,62	4,25	6,53
3851	Professional and scientific equipment	6,00	6,35	2,12	1,88

The data cover only those establishments with 25 or more employees.

"Subcontracted input share" refers to the proportion of subcontracted input in total inputs.

"Subcontracted output share" refers to the proportion of subcontracted output in total output.

1.5-2 percent). There is a slight increase over time but it may be due to temporary fluctuations. There are significant inter-industry variations in subcontracting intensity. The textile industry has the highest subcontracted input and output shares, followed by the paper and engineering industries. In this study, we analyze the determinants of subcontracting only in the textile and engineering industries because of their subcontracting intensity and dominant positions within

[3] ISIC refers to International Standard Industrial Classification, Revision 2.

the manufacturing industry (these two industries alone accounted for more than 70% of manufacturing employment in 1997).

The second part of the table shows subcontracting intensity for a selected sub-group of textile and engineering industries. Ship building and repairing had a very high share of subcontracted input intensity, followed by wearing apparel, knitting mills, textile products, metal and wood working machinery, structural metal products, and professional and scientific equipment. Those industries that are densely populated by subcontractors are metal and wood working industries, spinning, weaning and finishing, wearing apparel, ship building and repairing, structural metal products, tanneries and leather finishing and knitting mills. It is interesting to observe that subcontracted input-intensive sectors tend to be also subcontracted output-intensive. Moreover, on average, subcontracted input shares are usually higher than subcontracted output shares, partly because of the fact that our database does not cover micro and small establishments (those employing less than 25 workers).

Table 2. Empirical transition probabilities for parents and subcontractors

	Proportion at time t	Probability of being a	
		subcontractor at time t +1	parent at time t +1
Textile industry			
Non-subcontractor at time t	0.775	0.060	0.286
Subcontractor at time t	0.225	0.769	0.240
Non-parent at time t	0.733	0.227	0.097
Parent at time t	0.267	0.182	0.760
Engineering industry			
Non-subcontractor at time t	0.861	0.026	0.112
Subcontractor at time t	0.139	0.870	0.748
Non-parent at time t	0.811	0.052	0.051
Parent at time t	0.189	0.556	0.820

Note: A firm is classified as "subcontractor" ("parent") if the share of subcontracted output (input) is at least 10%.

Table 2 presents the data on empirical transition probabilities for parent and subcontractors firms. In calculating the transition probabilities, a firm is defined as “parent” if it subcontracts at least 10 percent of its inputs to subcontractors, and a firm is classified as “subcontractor” if the proportion of subcontracted output is at least 10 percent. As may be expected, the proportions of subcontractors and parent firms are much higher in the textile industry than the engineering industry (see the first column in Table 2). There are two significant differences between empirical transition probabilities of the textile and engineering

industries. First, subcontractors and parents are less likely to continue with the same form of subcontracting. For example, a subcontractor in the textile industry will be a subcontractor with 76.9 percent probability in the next year, whereas the same probability is 87.0 percent for an engineering firm. A similar difference is observed for parents firms as well (76.0 percent in the textile, and 82.0 percent in the engineering industries). Moreover, it is easier for a non-subcontractor (a non-parent) to be a subcontractor (a parent) in the textile industry than in the engineering industry. In other words, the rate of "turnover" in subcontracting status is much higher in the textile industry. Second, a larger proportion of those firms that are involved in any subcontracting relationship in the engineering industry are "primary subcontractors", i.e., those firms that simultaneously receive and offer subcontracts. Therefore, a subcontractor is very likely to be classified as a "parent" in the engineering industry (74.8 percent probability), but this type of behavior is less likely to be observed in the textile industry (24.0 percent). Empirical transition probabilities show that subcontracting relationships are less stable in the textile industry than in the engineering industry although there are more firms in the textile industry that are involved in any form of subcontracting.

Table 3 shows the variables used in our analysis and the data about the characteristics of firms according to their subcontracting behavior for two sub-periods. Firms in the first column are not involved in any subcontracting relationship. Parent firms are in the second column, and subcontractors in the third. Firms in the fourth column both receive subcontract orders and offer subcontracts to other subcontractors (for convenience, we call these firms "primary subcontractors"). The data show that there is a substantial number of firms that simultaneously receive and offer subcontracts, especially in the textile industry. This shows that secondary subcontracting is a widespread phenomenon.

Subcontracted input share is about 12-15 percent for parent firms and primary subcontractors in the textile industry and 7-9 percent in the engineering industry. Although subcontracted input shares are relatively low, in other words, parent firms are not heavily dependent on subcontractors, subcontracted output share for subcontractors is quite high in the textile industry (almost 50 percent), and modest in the engineering industry (about 20 percent).

Table 3a shows that average wage rates do not differ very much across subcontracting categories in the textile industry. Parent firms and primary subcontractors pay wages 10-15 percent higher than other firms. The wage differential seems to be wider in the engineering

Table 3a. Descriptive statistics, the textile industry
Average values for all establishments employing 25 or more workers

Label	Description	1988-92				1993-97			
		No sub.	Parent	Subcont.	Primary subcont.	No sub.	Parent	Subcont.	Primary subcont.
# obs	Number of observations	1477	1971	951	1656	2082	2528	1346	2567
SUB-INPUT	Subcontracted input share	0.000	0.124	0.000	0.142	0.000	0.129	0.000	0.150
SUB-OUTPUT	Subcontracted output share	0.000	0.000	0.489	0.238	0.000	0.000	0.475	0.223
OVER23	Share of 2nd and 3rd shift in production hours	0.204	0.113	0.234	0.181	0.203	0.097	0.213	0.176
ADVER	Advertisement expenditures/sales ratio	0.002	0.004	0.002	0.005	0.004	0.005	0.003	0.004
PTT	PTT expenditures/sales ratio	0.004	0.003	0.008	0.004	0.004	0.003	0.008	0.004
PRIVATE	Private ownership	0.966	0.961	0.965	0.947	0.973	0.972	0.978	0.963
FOREIGN	Foreign ownership	0.007	0.012	0.004	0.011	0.011	0.013	0.011	0.014
TECHNOTR	Technology transfer dummy	0.001	0.008	0.000	0.010	0.010	0.014	0.004	0.014
WAGE*	Average wage rate	1.404	1.524	1.403	1.549	1.250	1.324	1.197	1.371
WOMEN	Share of women employees	0.331	0.392	0.346	0.396	0.302	0.373	0.351	0.389
ADMIN	Share of administrative personnel	0.158	0.170	0.123	0.146	0.147	0.176	0.121	0.155
TECHNICIAN	Share of technicians	0.044	0.043	0.048	0.046	0.046	0.045	0.042	0.041
CAPINT*	Depreciation allowances/employees ratio	0.253	0.396	0.293	0.488	0.370	0.538	0.327	0.713
ENERINT*	Energy expenditures/employees ratio	0.328	0.213	0.530	0.342	0.511	0.378	0.641	0.551
NFIRM*	Number of firms in the same sector and province	33.3	100.8	55.4	96.8	34.7	126.2	67.2	104.8
GRFIRM	Annual growth rate of output (log form)	0.006	0.074	0.086	0.101	0.066	0.086	0.051	0.103
GRIND	Annual growth rate of sectoral output (log form)	0.070	0.104	0.075	0.094	0.098	0.070	0.078	0.080
EMPLOY*	Number of employees	76.2	93.8	86.4	116.0	72.2	78.7	73.9	106.2

* geometric average

Parent firms produce no output subcontracted by another firm. **Subcontractor** firms use no input from subcontractors. **Primary subcontractors** produce output subcontracted by parent firms and buy inputs from subcontractors. **No sub**contracting firms are not involved in any subcontracting relationship.

Wage, Capint, Enerint, GrFirm and GrInd variables are measured at constant 1987 prices.

Table 3b. Descriptive statistics, the engineering industry
Average values for all establishments employing 25 or more workers

Variable	Description	1988-92				1993-97			
		No sub.	Parent	Subcont.	Primary subcont.	No sub.	Parent	Subcont.	Primary subcont.
# obs	Number of observations	1853	1832	400	686	2695	2087	382	644
SUB-INPUT	Subcontracted input share	0.000	0.072	0.000	0.079	0.000	0.067	0.000	0.086
SUB-OUTPUT	Subcontracted output share	0.000	0.000	0.196	0.094	0.000	0.000	0.180	0.108
OVER23	Share of 2nd and 3rd shift in production hours	0.074	0.063	0.080	0.104	0.070	0.061	0.084	0.102
ADVER	Advertisement expenditures/sales ratio	0.007	0.008	0.007	0.006	0.007	0.008	0.007	0.008
PTT	PTT expenditures/sales ratio	0.006	0.006	0.007	0.006	0.006	0.004	0.005	0.005
PRIVATE	Private ownership	0.918	0.939	0.952	0.941	0.924	0.933	0.970	0.934
FOREIGN	Foreign ownership	0.037	0.023	0.020	0.018	0.048	0.038	0.013	0.032
TECHNOTR	Technology transfer dummy	0.099	0.106	0.080	0.118	0.089	0.113	0.079	0.112
WAGE*	Average wage rate	2.010	2.317	2.107	2.532	1.682	2.028	1.934	2.213
WOMEN	Share of women employees	0.097	0.095	0.104	0.077	0.096	0.093	0.097	0.087
ADMIN	Share of administrative personnel	0.192	0.219	0.203	0.225	0.197	0.230	0.208	0.251
TECHNICIAN	Share of technicians	0.070	0.080	0.074	0.074	0.079	0.090	0.074	0.081
CAPINT*	Depreciation allowances/employees ratio	0.474	0.565	0.578	0.776	0.557	0.746	0.653	0.944
ENERINT*	Energy expenditures/employees ratio	0.312	0.302	0.380	0.428	0.449	0.467	0.605	0.655
NFIRM*	Number of firms in the same sector and province	13.0	17.8	13.0	18.7	11.7	19.5	14.6	19.2
GRFIRM	Annual growth rate of output (log form)	0.064	0.083	0.058	0.079	0.105	0.147	0.111	0.085
GRIND	Annual growth rate of sectoral output (log form)	0.131	0.117	0.098	0.113	0.146	0.130	0.120	0.128
EMPLOY*	Number of employees	78.7	85.2	73.9	91.1	72.1	76.6	71.7	83.6

* geometric average

Parent firms produce no output subcontracted by another firm. **Subcontractor** firms use no input from subcontractors. **Primary subcontractors** produce output subcontracted by parent firms and buy inputs from subcontractors. **No sub**contracting firms are not involved in any subcontracting relationship.
Wage, Capint, Enerint, GrFirm and GrInd variables are measured at constant 1987 prices.

industry where parent firms pay 35% higher than those that are not involved in any subcontracting relationship. It is interesting to observe that primary subcontractors pay on average the highest wage in the engineering industry.

The share of women workers is higher in subcontract offering firms in the textile industry and almost the same for all categories in the engineering industry. Moreover, primary subcontractors and parent firms seem to be larger than others, especially in the textile industry.

There are also important inter-industry differences. First of all, more firms are involved in subcontracting in the textile industry (about 75 percent) than in the engineering industry (about 55 percent). The average wage rate is much higher in the engineering industry that employ proportionately less women. Engineering firms are more active in transferring technology from abroad (about 10 percent vs 1 percent in the textile industry), and employ more technical personnel (about 8 percent vs 4 percent).

4. Determinants of subcontracting in Turkish textile and engineering industries

Following the literature on subcontracting, we assume that the decision to offer and to receive a subcontract depends on a number of variables that reflect conditions in the product and labor markets, and characteristics of product and process technologies. We estimate two models, one for the share of subcontracted inputs (subcontract offering firms), and the other for subcontracted output (subcontract receiving firms) by using plant level data for the period 1988-97. The estimated model is the random-effects Tobit model which can be written as

$$\begin{aligned} y_{it} &= 1 && \text{if } y_{it} \geq 1 \\ y_{it} &= \beta_{0i} + \Sigma_{k \in K} \beta_{kit} x_{kit} + \varepsilon_{it} && \text{if } 1 > y_{it} > 0 \\ y_{it} &= 0 && \text{if } y_{it} \leq 0 \end{aligned} \qquad (1)$$

where y_{it} is the share of subcontracted input (output) for the i'th plant at time t, x_{kit} the k'th explanatory variable, and ε_{it} the error term. Moreover, β_{oi} are assumed to be i.i.d. with zero mean and σ_u. This term is used to control for unobservable firm-specific factors. The share of subcontracted inputs for subcontract offering firms is denoted by *Sub-Input,* and the share of subcontracted output for subcontract receiving firms by *Sub-Output*.

The following variables are used as explanatory variables in equation 1.

Over23: This variable is defined as the share of number of hours worked in the second and third shifts to total number of hours worked. The Over23 may have a temporary and a permanent impact on subcontracting behaviour. If a firm experiences a rapid growth in the demand for its products, firstly, it may increase the number of hours worked by employing workers for the second and even for the third shift. If it cannot satisfy the demand by increasing the number of hours, then it may decide to subcontract a part of its production to others (the case of capacity subcontracting). Therefore, we may expect a positive impact of the Over23 variable on the share of subcontracted inputs (those firms that have a higher Over23 value would be likely to have a higher share of subcontracted inputs, Sub-Input). This is a temporary effect because the parent firm may expand its capacity in investing in fixed capital in the long run. If the subcontractor firm receives contracts for processes that require high fixed costs (for example, the case of specialization subcontracting) the subcontractor firm may economize on capital costs by using the machinery and equipment more intensely, that is by employing workers for the second and third shifts. This is the permanent impact on subcontractors: in this case, we expect a positive effect of the Over23 variable on the share of subcontracted output intensity (Sub-Output).

Adver: This variable shows the advertising intensity of the firm, and is defined as the share of advertisement expenditure in total sales revenue. Firms that produce final products may have a higher advertisement intensity because they would try to inform a large group of customers. If this hypothesis is correct, then we expect a positive impact of the Adver variable on Sub-Input (final producers can subcontract a broad range of activities), but no impact on Sub-Output because there is no clear link between advertisement behaviour and subcontracts.

PTT: This variable measures the communications intensity of production and is defined by the proportion of expenditure on communications services (PTT) to total sales revenue. Firms that produce differentiated products may have a higher communications intensity because they need to exchange information intensively with suppliers and customers (for a similar argument on the effects of product diversity on outsourcing, see Kelley and Harrison, 1990). Thus we expect a positive coefficient for the PTT variable in both models explaining subcontract receiving and offering.

Private and *Foreign:* These variables are defined by the proportion of shares held by private national and foreign agents, respectively. Private=1 if all shares of the company are held by (national) private agents. The Private and Foreign variables measure the

subcontracting intensity of the private and foreign firms relative to the public firms. These two variables are included into the model to check the effects of the type of ownership on subcontracting. (For a study on local backward vertical linkages established by Japanese multinationals, see Belderbos *et al*., 2001).

Technotr: This is a dummy variable which takes the value 1 if the firm acquired any international technology through licensing, know how agreements, and so forth. The Technotr variable is used to examine the effect of the source of technology.

Wage: Wage is defined by the (log) average annual wage rate per employee. As explained in Section 2, the parent firm may subcontract a part of production to small firms that pay lower wages. If this hypothesis is correct, we expect a positive coefficient of the Wage variable in the subcontract offering model, and a negative coefficient in the subcontract receiving model.

Women, *Admin*, and *Technician:* These variables are defined by the shares of women, administrative, and technical (engineers and technicians) personnel in all employees, respectively. They are used in the models to check the effects of the composition of the workforce on subcontracting behavior. For example, Ypeij (1998) suggests that subcontracting is not a gender-neutral process: "feminine" production tasks are frequently subcontracted to the small-scale producers because i) female workers are paid lower wages, ii) "feminine" tasks are labor-intensive, and iii) women already possess knowledge that can be transferred into skills for labor-intensive, "feminine" tasks. As a result, we expect women in large-scale enterprises to lose their jobs (a negative coefficient for the Women variable in the subcontract offering model), and that jobs for women are more likely to be generated in small-scale subcontractors (a positive coefficient for the Women variable in the subcontract receiving model).

The share of administrative personnel may also have an impact on subcontracting behavior: Those firms that employ proportionately more administrative personnel can specialize in non-production activities (design, distribution, marketing) subcontracting out a large part of the production process. Therefore, we expect a positive coefficient for the Admin variable in the subcontract offering model. A subcontractor, however, is specialized in production activities, and will employ more production workers. Thus, a negative coefficient for the Admin variable is expected for the subcontract receiving model.

The share of technical personnel may have a similar effect. If subcontractors receive orders for their specialized activities that require skilled labor, the Technician variables will have a positive coefficient in the subcontract receiving model. On the other hand, if the subcontractors have a competitive advantage thanks to their low skilled-low wage labor, than we expect a negative coefficient.

Capint and *Enerint:* These variables measure capital and energy intensity, respectively. The Capint variable is defined by (log) annual depreciation allowances per employee, and the Enerint variable by (log) annual energy (electricity and fuel) expenditures per employee. These two variables will reveal the relationship between production technology and subcontracting behavior.

Nfirm: This variable is used to test the effects of regional clusters on subcontracting behavior. The Nfirm variable is defined by the (log) number of firms in the same sector (at the 4-digit ISIC level) in the same province. A higher value for the Nfirm variable will indicate regional concentration of establishments. If there is only one firm in the province in the sector where the firm operates, the value of Nfirm will be equal to zero. The literature emphasizes the importance of geographical proximity in establishing subcontracting relations. Therefore, we expect a positive coefficient for the Nfirm variable in both models.

GrFirm: This variable is defined by the annual growth rate of output and is used to capture the effects of capacity limits on subcontracting behavior. It is expected to have a positive impact on subcontracting inputs.

GrInd: The GrInd variable measures the annual growth rate of sectoral output where the sector is defined at the ISIC 4-digit level. If the parent and subcontractor firms operate in the same industry, the GrInd variable is expected to have a positive coefficient for the subcontract receiving model.

Employ: This variable is used to test the effects of establishment size on subcontracting behavior. Employ is defined by the (log) level of employment in the establishment. The literature suggests, and there is some econometric support (Kelley and Harrison, 1993; Christerson and Appelbaum, 1995) that large firms are more likely to offer subcontracting to small firms. If this hypothesis is correct, then the coefficient of the Employ variable is expected to be positive (negative) in the subcontract offering (receiving) model.

Time: Finally, the Time variable is used in the models to check if there is an exogenous shift in subcontracting intensity that cannot be explained by other factors.

Estimation results are presented in Table 4.[4] There is a striking pattern of similarities and differences between the textile and engineering industries. First of all, geographical concentration, that is, the existence of local clusters, seems to be very important in establishing subcontracting relations. The Nfirm variable has a positive coefficient for both subcontract receiving and offering models in the textile and engineering industries.[5] This is one of the strongest results of our analysis, and it has significant policy implications.

The growth rate of the firm (GrFirm) has a positive impact on subcontract offering in both sectors. This finding indicates that a rapidly growing firm is likely to subcontract a part of the production process out, i.e., capacity subcontracting is observed in both sectors. The growth rate of the industry (GrInd) does not reveal any clear pattern.

The capital intensity variable (Capint) has positive coefficients in the subcontract offering models, and negative coefficients in the subcontract receiving models (but not significant in the engineering industry). This shows that capital intensive firms are more likely to offer subcontracts, and labor intensive firms, especially in the textile industry, tend to operate as subcontractors, as a result of risk-sharing behavior of capital intensive firms. On the other hand, subcontractors use more energy-intensive technologies, whereas parents firms' energy intensity is lower (although the coefficient of the Enerint variable is negative but not significant at the 10 percent level for the engineering industry). This result may indicate that subcontractors are specialized in energy-intensive activities, possibly process-type production activities in the textile industry. The estimation results for the Over23 variable provide complementary evidence on the characteristics of subcontract offering and receiving firms. The Oevr23 variable has a positive effect on subcontract output intensity in both sectors, and a negative impact on subcontracted input intensity in the textile industry. The positive effect on subcontracted output indicates that subcontractors tend to economize especially on capital

[4] Estimated coefficients in the Tobit model can be used to determine both changes in the probability of establishing a subcontracting relationship and changes in the share of subcontracted input/output if the firm is already involved in subcontracting. In our interpretations, we consider effects at the sectoral level and do not quantify this decomposition.

[5] Unless otherwise stated, all effects are statistically significant at the 10 percent level, two-tailed test.

Table 4. Determinants of subcontracting in Turkish textile and engineering industries

Explanatory variables	Textile industry						Engineering industry					
	Subcontract receiving			Subcontract offering			Subcontract receiving			Subcontract offering		
	Coeff	Std.Err.	Prob.	Coeff	Std.Err.	Prob.	Coeff	Std.Err.	Prob.	Coeff	Std.Err.	Prob.
OVER23	**0.053**	**0.022**	**0.01**	**-0.040**	**0.010**	**0.00**	**0.044**	**0.026**	**0.09**	-0.001	0.011	0.93
ADVER	0.061	0.302	0.84	**0.326**	**0.113**	**0.00**	0.003	0.285	0.99	**0.175**	**0.082**	**0.03**
PTT	**7.292**	**0.436**	**0.00**	0.083	0.161	0.61	**1.988**	**0.395**	**0.00**	**-0.262**	**0.145**	**0.07**
PRIVATE	**-0.093**	**0.028**	**0.00**	**-0.090**	**0.017**	**0.00**	**0.128**	**0.037**	**0.00**	-0.014	0.040	0.72
FOREIGN	**-0.155**	**0.054**	**0.00**	-0.027	0.028	0.34	**-0.095**	**0.051**	**0.06**	-0.045	0.044	0.31
TECHNOTR	-0.022	0.049	0.65	0.005	0.017	0.77	-0.026	0.019	0.17	0.003	0.007	0.64
WAGE	**-0.044**	**0.010**	**0.00**	**0.008**	**0.004**	**0.04**	**0.051**	**0.010**	**0.00**	**0.017**	**0.003**	**0.00**
WOMEN	**0.102**	**0.024**	**0.00**	**0.060**	**0.009**	**0.00**	0.056	0.043	0.19	-0.009	0.015	0.55
ADMIN	**-0.338**	**0.043**	**0.00**	**0.062**	**0.015**	**0.00**	**0.071**	**0.034**	**0.04**	**0.077**	**0.012**	**0.00**
TECHNICIAN	-0.035	0.050	0.49	**-0.062**	**0.020**	**0.00**	-0.047	0.061	0.45	**0.064**	**0.020**	**0.00**
CAPINT	**-0.014**	**0.003**	**0.00**	**0.010**	**0.001**	**0.00**	-0.002	0.004	0.64	**0.003**	**0.001**	**0.07**
ENERINT	**0.039**	**0.004**	**0.00**	**-0.007**	**0.002**	**0.00**	**0.009**	**0.005**	**0.07**	-0.001	0.002	0.68
NFIRM	**0.023**	**0.004**	**0.00**	**0.038**	**0.002**	**0.00**	0.008	0.005	0.13	**0.008**	**0.002**	**0.00**
GRFIRM	-0.004	0.005	0.43	**0.005**	**0.002**	**0.01**	0.001	0.005	0.91	**0.007**	**0.002**	**0.00**
GRIND	-0.023	0.018	0.20	0.002	0.007	0.82	**-0.022**	**0.013**	**0.08**	-0.006	0.004	0.11
EMPLOY	**-0.029**	**0.006**	**0.00**	**0.010**	**0.003**	**0.00**	0.002	0.008	0.81	-0.005	0.004	0.18
TIME	-0.002	0.001	0.12	0.000	0.001	0.90	**-0.006**	**0.001**	**0.00**	**-0.001**	**0.000**	**0.00**
Constant	4.166	2.711	0.12	-0.263	1.075	0.81	**12.385**	**2.853**	**0.00**	**2.635**	**0.913**	**0.00**
σ_u	0.474	0.008	0.00	0.153	0.002	0.00	0.303	0.008	0.00	0.107	0.002	0.00
σ_e	0.274	0.003	0.00	0.123	0.001	0.00	0.202	0.004	0.00	0.089	0.001	0.00
$\rho \quad (\sigma_u^2/(\sigma_u^2+\sigma_e^2))$	0.749	0.007		0.609	0.008		0.691	0.012		0.592	0.011	
Wald test, $\chi^2(17)$	563.8		0.00	788.3		0.00	141.7		0.00	180.6		0.00
Log likelihood	-6931.9			817.4			-2612.4			1642.7		
# firms	3310			3310			2161			2161		
# observations	14578			14578			10579			10579		
# obs, subcontracting	6520			8722			2112			5249		
# obs, no subcontracting	8058			5856			8467			5330		

Probability values refer to the statistical signicance level, two-tailed test.

costs by working longer. This may also be related to the result obtained for the Enerint variable, because shift-work could easily (and, in many cases, necessarily) be adopted in process-type activities.

The advertisement intensity has a positive effect on subcontracted input intensity, and no effect on subcontracted output intensity in both sectors. It seems that those firms that produce final products tend to subcontract a larger part of their production activities. As expected, the PTT variable has a positive coefficient in subcontract receiving models. It has an unexpected negative coefficient in subcontract receiving model for the engineering industry. It seems that communication-intensity tend to be higher in subcontractors.

Ownership variables reveal an interesting pattern. The Foreign variable has a negative coefficient in all models (but not statistically significant in subcontract offering models). In other words, foreign firms tend to avoid subcontracting relationships. Private ownership has a similar effect in the textile industry, but private firms tend to receive more subcontract offers that public firms in the engineering industry.

In spite of the similarities on the effects of technology-related variables in the textile and engineering industries, labor-related variables reveal sharp differences between these two industries. First of all, establishment size indicates a major difference between the textile and engineering industries. It has the expected effects in the textile industry: positive effect on subcontract offering and negative effect on subcontract receiving. Large firms tend to subcontract a larger part of their production, and small firms to receive more subcontract orders in the textile industry. However, the size variable does not have any effect on subcontracting behaviour in the engineering industry.

The wage rate has also a similar effect on subcontracting in the textile industry. High wage textile firms tend to subcontract a bigger part of their production, and low wage textile firms have an advantage over others in receiving subcontract orders in the textile industry, i.e., the subcontracting relationship is established between large/high wage parent firms, and small/low wage subcontractors. However, the Wage variable has a positive effect on subcontracting, both in the subcontract receiving and offering models for the engineering industry. High wage engineering firms have a higher subcontracted input and output shares. In other words, subcontracting relations are established among high wage firms in the engineering industry (for a similar finding, see Kaytaz, 1994). If the wage level reflects skill level of the labor force, then it can be claimed that subcontracting relations in

the engineering industry are established between firms employing skilled workers. This finding supports Kaytaz's (1994) and Watanabe's (1971) observation that subcontracts are more specialization oriented in the engineering industry.

The estimates for the Women variable partly reinforce the findings on the Wage variable. Contrary to what Ypeij (1998) observed in Peru, the share of women workers has a positive impact on subcontract offering firms in the textile industry. In other words, those firms that employ proportionately more women workers tend to subcontract a larger part of their production activities. However, the Women variable has also a positive effect on subcontract output intensity. It seems that subcontracting relationship is established between firms that perform "feminine" activities in the textile industry. In the case of engineering industries, the Women variable has a significant effect neither on subcontract receiving nor subcontract offering firms, partly because of the fact that the share of women workers is very low in the engineering industry (about 10 percent).

The Technician variable has also opposite effects on subcontract offering behaviour in the textile and engineering industries. Those textile firms that have a higher proportion of technicians tend to subcontract a small part of their production whereas the share of technicians increases the share of subcontracted inputs in the engineering industry.

In the textile industry (as in the engineering industry), those firms that employ proportionately more administrative personnel tend to have a higher rate of subcontracted input. On the other hand, subcontractors tend to have a lower share of administrative personnel in the textile industry. In the engineering industry, subcontractors as well as parent firms have a higher share of administrative personnel than those firms that have no subcontracting relationship at all.

Finally, the Time variable has a negative impact both in the subcontract receiving and offering models for the engineering industry. In other words, after controlling the effects of all other variables in these models, subcontracted input and output intensities tend to decline in the engineering industry in the period under investigation (1988-97). There is no time-trend in the textile industry.

Unobservable firm-specific factors are also important in explaining the subcontracting behaviour. The Wald test for the hypothesis $\sigma_u=0$ is strongly rejected in all models (see Table 4).

We can summarize our findings as follows:

1) Traditional subcontracting relation that is simplified as a relationship between high wage/large firms employing male workers and low wage/small firms employing female workers is not dominant in Turkish textile and engineering industries. In the case of the textile industry, large, high wage firms tend to play the role of the parent firm, and small, low wage firms the role of subcontractor, but gender differences do not seem to be important in explaining subcontracting behaviour. In the engineering industry, neither size nor gender is an important factor.

2) Our findings indicate that short term capacity subcontracting exists in Turkish manufacturing industries. However, the subcontracting relations in the textile industry seem to be short-term relationships. Long-term, specialization (and supplier) subcontracting seems to be quite important in the engineering industry.

3) Subcontract offering firms tend to produce final products and spend more on advertisement activities than other firms.

4) Type of ownership is not an important determinant of subcontracting behaviour. Foreign firms do not help in establishing a network of small subcontractors.

5) Location is very important in establishing subcontracting relations. Subcontracting flourishes where many firms are located in the same region.

5. Conclusions

Our analysis supports, at least partially, recent theories on networks and clusters. Subcontracting, as a specific form of cooperation between firms, should not be conceived as an unequal relationship between small and large firms in all sectors. Although we did not analyze the impact of subcontracting on performance, the network and cluster approaches suggest that subcontracting may enhance efficiency and productivity through refined division of labor, and innovativeness through cooperation and non-market mediated information exchange between firms. As our findings indicate, there are significant differences between sectors (see also Gonzalez *et al*., 2000 for the construction sector), but networking aimed at higher product quality and innovativeness would be a good policy option for developing countries.

Large (and foreign) firms are not necessarily the carriers of modern technology, and

may not be used as nodes to diffuse modern technologies and production methods like quality control. Policy formulations that consider large firms as the "main industry" and small firms as the "secondary industry" (see, for example, SPO, 1989), or specific policy measures that require "larger firms receiving public contracts must subcontract specified portions of the work to SMEs" (World Bank, 1980, v.3: 44, cited in Kaytaz, 1994: 153) could not be useful in helping SMEs and in encouraging subcontracting, because there are significant inter-industry differences. For example, our analysis indicates that subcontractors in the textile and engineering industries are rather different. Subcontracting relationships in the engineering industry seem to be established between "similar" and relatively advanced firms that have complementary assets and technologies, and their cooperation improves collective efficiency and flexibility.

Subcontracting relationships can be established between large parent firms and small subcontractor firms, as in the case of Turkish textile industry. However, this type of subcontracting does not necessarily have a developmental nature because parent firms tend to transfer the burden of risks and costs on their subcontractors. There are some field studies that document quite primitive work conditions in subcontractors in the textile industry (for example, see Aktar, 1990). However, work conditions may not be better in parent firms as well, partly because of the existence of a large pool of subcontractors and the flexible labor market. Therefore, for such an industry, the problem is not the development of subcontracting relationship per se, but the development of the industry as a whole, that is, the development of the industry towards generating high wage employment of skilled workers who produce high quality/high value added products. This is the only strategy that will improve the standard of living of the population in the long run. Subcontracting, as a specific form of networking, could be effectively used for this purpose if due attention is paid to specific forms of subcontracting.

Subcontracting can be effectively developed if there is a sufficient concentration of firms in a certain region. Therefore, there may be a contradiction between regional development and industrial development objectives, at least in the short run. If the geographical dispersion of small firms is encouraged for regional development, they will not benefit from the externalities generated by networks and clusters. Therefore, the regional development policy should give a special emphasis on the factors that make firms enter into subcontracting relationships.

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