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Research Policy 33 (2004) 409–424
research policy
www.elsevier.com/locate/econbase

Does innovativeness matter for international competitiveness in developing countries? The case of Turkish manufacturing industries

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Received 4 February 2003; received in revised form 1 September 2003; accepted 4 September 2003

Abstract

We examine the determinants of export performance of firms in the Turkish manufacturing industry. Prominent differences show up between innovator and non-innovator firms in terms of the impacts of such variables as firm size, advertisement intensities, ownership structures, and composition of employees. Importance of innovations and R&D activities, conduciveness of capital intensity, and insignificance of the real wage are meaningful as far as a rational international competition policy is concerned. Results are suggestive of a technology-oriented and capital-formative development path, if Turkey is to come up with the international competitive standards.

Keywords: Innovation; R&D; International competitiveness; Exports

> [I]n capitalist reality as distinguished from its text-book picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization . . . (Schumpeter, 1942, p. 84)

1. Introduction

Accumulation of studies that have tried to link the export performance of economic units (be they countries, industries or firms) with their technological orientation has basically generated a wide-spread emphasis on the role of technology in developed countries. As a matter of course, being developed and technological superiority have for long been the two sides of the same coin. Thus, relative fewness of the studies which deal with the less-developed economies must not be surprising. Nevertheless, construction of a rationale for investigating the interactions between exports and technology in technologically-backward countries may also be fruitful in terms of a better determination of relevant strategies. A perspective directed towards the differences among the successful and unsuccessful country-specific strategies for improving international competitiveness may help one to distinguish between the correct and ill-advised policy options. The Turkish experience has demonstrated that mere recourse to ready-made policies (such as export subsidies or real devaluations) cannot be useful in escaping from

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0048-7333/$ – see front matter
doi:10.1016/j.respol.2003.09.011

underdevelopment or competitive disadvantages. Searching for alternative strategies seems inevitable. Innovativeness, as a genuine lever required to raise living standards, may well be the pertinent key to improving international competitiveness. Subject-matter of this study is, thus, an inquiry into the seemingly closed doors that could be opened by this key.

Following Section 2 not only elaborates on the course of the alternative treatments of the technology factor within the theoretical literature, but also sets forth industrial organizational bases for firm-level studies. It is in Section 3 where the empirical literature is surveyed. Section 4 begins with Turkey's initially successful yet eventually retrogressive export-led growth strategy during the 1980s, and draws attention to (i) substantially neglected formation of gross fixed capital and, (ii) lack of a political conscience as to the significance of a national technology policy. After describing the data set, the model and the method to be utilized for empirical analysis, descriptive statistics are summed up. In Section 5, we interpret the determinants of the export intensity of Turkish firms, and compare and contrast innovators and non-innovators. The paper runs its course with a set of concluding remarks in Section 6, which also embodies a few bits of policy recommendation.

2. "Innovative competitiveness" as rationale for firm-level studies

"As is frequently observed, it matters a great deal today whether a country specializes in the production of potato chips or micro chips. According to conventional trade theory, however, this choice does not really matter" (Haque, 1995, p. 22). Apart from its "conventional" textbook versions, the evolution of international trade theory has witnessed extensions. Neofactor and neotechnological trade theories are two cases as such.

Variants of the neofactor theory, which emerged as a reaction to the well-known Leontief paradox, have basically distinguished between qualified labor (human capital) and unskilled labor. Preserving the assumption of common production functions over the world, they have included "knowledge" as an additional factor of production. The fact that knowledge can be generated through R&D (the expected resultant of which is innovation) has served as a source of inspiration for several studies. For instance, Gruber et al. (1967), Keesing (1967), Baldwin (1971), Branson (1971), Lowinger (1975), Stern and Maskus (1981), and Sveikauskas (1983) revealed the significantly positive impact of R&D efforts on US commodity trade in general. Similar results were obtained by Hughes (1986) for the UK and Vestal (1989) for Japan.

At this point, inclusion of human capital and R&D as explanatory variables was necessary yet insufficient insofar as the framework of neofactor theories was concerned. Treatment of physical and human capital and technological factors as static endowments was inappropriate due to their pertinently dynamic nature. Trying to get rid of the static world, family of neotechnological theories of trade was, thus, a further attempt in this respect.

Neotechnological attitudes basically originate from Posner's (1961) technological-gap theory (TGT) and Vernon's (1966) product life-cycle theory (PLCT), both of which rely on varying production functions for the same commodities across countries. In the TGT, a product innovation provides the innovating domestic firm(s) with a temporary monopoly power at home and abroad. Profits earned by the innovator above "normal" levels lead to imitation on the part of foreign firms, which eventually develop comparative advantages in the new commodity. In this way, this imitation lag is suggestive of technological-gaps across countries on the basis of the differences in innovative capabilities. PLCT, on the other side, represents a step forward with respect to the TGT. In contrast to the strong factor intensity assumption of the factor-endowment theories, PLCT predicts that a new product will have varying relative input requirements over its life cycle. "Accordingly, as the product matures and becomes standardized, comparative advantage may shift from a country relatively abundant in skilled labor to a country abundant in unskilled labor" (Chacoliades, 1990, pp. 107–108). On the one (static) hand, "countries with a high technological capacity produce technology-intensive goods"; on the other (dynamic) hand, "technology intensity of goods decreases over time as they become standardized" (Wakelin, 1997, p. 17). Hence, the dynamic component of these neotechnological theories basically relies on the changing input requirements of products. Changing production technologies across countries are not a matter of import in this respect. The dynamism here refers merely to products, in which case a static implication is still dominant in terms of technical stability (Walker, 1979). Technologically capable and relatively innovative countries will continuously have a comparative advantage in new products, and a comparative disadvantage in standardized ones. Of course, this leaves no potential dynamics for "catching-up" through learning-by-innovating on the part of technologically-backward countries. Thus, "product dynamism", rather than truly technological dynamism, yields another case for insufficient treatment of the technology factor, which can yet be tempered by the inclusion of the essentials of the Schumpeterian analysis on competitiveness.

Schumpeter's seminal attitude, in this respect, may be regarded as a case of blending two crucial concepts: He underscores a dynamic competition for innovation in lieu of the static price-competitiveness. Basic unit of analysis in the Schumpeterian view is the capitalist business enterprise since the innovation activity as the single most important determinant of competitiveness is basically carried out at the firm-level. Innovation requires substantial R&D layouts, which, in turn, necessitate the existence of relatively large firms in a particularly innovative industry. In other words, Schumpeter draws attention to the importance of monopolistic and oligopolistic market structures in creating innovative capabilities that yield competitive edges. To be sure, this is in sharp contrast with the perfectly competitive and atomistic firms of the conventional theory. In conventional theory, there is no reason to delve into the determinants of international competitiveness at the firm-level since its very assumptions yield identical degrees of competitiveness abroad for the firms in the same industry.

In contrast, neoScumpeterian conception of competitiveness relies on the evolutionary aspects of innovation as a microeconomic process that takes place within the firm.[1] This process is identified by "search for knowledge and techniques, and the cumulative nature of technological change". Decisions to spend on the generation and development of innovative capacities are taken at the level of the firm (Wakelin, 1997, p. 20). It is also a level at which the returns to innovation are collected in terms of new products and markets, cost advantages, and rents. Finally, an imperfect world entails different degrees of international competitiveness for firms from the same industry.

At this point, it must be noted that firms are not independent or autonomous entities in terms of their innovation-related decision-making processes, which inevitably yield spillover effects at the inter-firm level. Indeed, "interactive learning and collective entrepreneurship are fundamental to the process of innovation" (Lundvall, 1995, p. 9) and "innovating firms are not islands of planned co-ordination in a sea of market relations" (Oerlemans et al., 1998, p. 307). Because innovation entails the processing of tacit knowledge, learning in this context may well necessitate "cooperation for innovation" in the form of "external linkages". Freel (2003) is a recent case study comprising a concise review of the literature on this issue. On the other side of the same coin, "intrafirm" technological efforts should also be taken into account. An original case study by Galende and Fuente (2003) examines and reveals such internal factors of innovation at intrafirm level.

Consequently, it is quite reasonable to conceive firms to be developing their capabilities in conformity with their firm-specific characteristics especially in terms of their technological efforts and skills (Atkinson and Stiglitz, 1969). In this regard, the idea that firms do not operate on a common production function is one of the major premises of evolutionary theories (Nelson, 1981, 1987; Nelson and Winter, 1982). Put differently, technological capabilities of firms differ from each other, and an evolutionary viewpoint is promising in explaining the "permanent existence of asymmetries among firms, in terms of their process technologies and quality of output" (Dosi, 1988, p. 1155). Generation of firm-level technological capabilities are influenced by such factors as firm size; organizational and managerial skills; adaptability to new methods and technologies; and access to skills from the market, external technical information and support, and embodied technology (Lall, 1992, p. 169). In this connection, three types of capabilities interact with each other to yield competitiveness:

[1] Relying largely on the Schumpeterian framework, Nelson and Winter (1982) developed a seminal theory that led to what may be called the "technological capability approach", which conceptualizes firms in the face of imperfect knowledge of technological possibilities (Lall, 2000). With a focus on technology generation in Latin America, the collection by Katz (1987) shows up as a leading work within the same domain of inquiry.

Capabilities in production, investment and innovation. In the case of developed countries, the feeding sequence generally runs from innovation to investment to production. However, developing countries mostly transfer technology, and thus "they usually reverse the sequence and use production capability as the foundation for developing capabilities in investment and innovation" (Dahlman et al., 1987). Therefore, once the conventional assumption that firms operate on a common production function is dropped, varying degrees of innovativeness among firms become self-evident especially in developing economies.

However, the set of arguments above does not imply that the priority of developing countries is production systems rather than knowledge systems. Technology transfer alone cannot be a long-term development strategy; technology creation must be learned as well. Transformation from under-development to a developed economy necessitates a due attention to national systems of innovation in the long-term. Bell and Albu (1999), for instance, convincingly elaborate on "the need to focus on systems of knowledge accumulation, rather than just production systems" in developing countries. Technological capability, thus, must be considered an end per se, rather than a simple by-product of production and investment activities.

3. Firm-level studies on the determinants of export performance

Linking the export performance of firms with their technological orientation, relevant studies have adopted a number of measures and proxies for the degree of success in foreign trade and the inclination to innovative behavior. A variety of export performance measures has been regressed, via several econometric techniques, on such technology-related variables as R&D-to-sales ratio, R&D dummies taking the value of one if the firm has proved to be an R&D performer, formal R&D expenditures, value of the royalty and licensing fees abroad, the percentage of equity held by foreign firms (as a measure of access to technology via direct foreign investment), dummies that distinguish between the producers of capital goods and of other goods, labor and capital productivities, skill and capital intensity of operations, imports of technology, number of innovations used or produced in the industries in which the firms-in-question are located, etc.

The causality postulated to run from technological factors to export performance has usually been verified. In general, studies have been successful in demonstrating that there exist major exporters who relate their R&D activity more to exporting over time (Lall and Kumar, 1981), that the propensity-to-export of firms engaged in R&D tends to be higher than that of the entire branch to which they belong (Hirsch and Bijaoui, 1985), and that the variation in export sales are well explained by the variations in R&D-to-sales ratio (Hirsch et al., 1988). Exporting firms were also found to have higher labor productivities (Abd-el-Rahman, 1991), technology showed up as a quite crucial factor in explaining the export behavior of firms in medium and low-technology industries (and not in high-tech ones) especially in the case of developing countries (Kumar and Siddarthan, 1994), and innovating and non-innovating firms turned out to behave differently both in terms of the probability of exporting and the level of exports implying that the capacity to innovate fundamentally affected the export performance of firms (Wakelin, 1998). Moreover, a recent study demonstrates that innovativeness is conducive to competitiveness in export markets in general, and that significant differences emerge between not only the firms of a country, but also the countries themselves: (i) Innovative UK firms (as compared with the non-innovative ones) benefit more from sectoral spill-over effects of innovation activities, while the reverse is true for non-innovative German firms, and (ii) scale of innovation activity and export propensity are positively related for UK firms, whereas a negative relation holds for German firms (Roper and Love, 2002). A study on some Indian engineering and chemical firms reveals the significance of firm-specific determinants of export performance with the conclusion that product-centered R&D in engineering has a negative impact on international competitiveness, and that process-centered R&D in chemicals, while not taking India to world standards of efficiency, does not constitute a handicap in terms of product quality and design characteristics (Lall, 1986). A study examining Italian manufacturing firms not only reveals the important impact of R&D activities on export performance, but also yields that product innovations are more contributive in the case of small firms, whereas process innovations enhance the exports of medium-sized and large firms (Sterlacchini, 1999, 2001). Similar results are obtained by Nassimbeni (2001) who finds that export propensity of "small" Italian firms is affected most by the ability to generate new products and to develop inter-organizational relations, while technological profiles matter much less. While providing evidence for the expected consequence that export intensity of innovative firms exceed that of the non-innovative ones, another study on Italian firms focuses on the negative impact of exchange rate devaluations on the conduciveness of technological capabilities to export performance (Basile, 2001).

The cruciality of technical collaborations and indigenous R&D efforts and yet the negative impact of capital intensity on the export performance of the firms (in the Indian automobile industry) have also been evidenced (Bhat and Sethuraman, 1995). Last but not the least, it has also been shown that not only the influence of R&D on both export propensity and growth is significantly positive, but also there exist reciprocal relationships between R&D and exports (Zhao and Li, 1997).

As a matter of fact, examination of a possible causality in the opposite direction (i.e. from exporting behavior towards technological improvement) is a desideratum for studies such as this. The so-called "learning-by-exporting" literature has been developed in that context. The idea that export-oriented policies may well expand technological frontiers (especially in the case of developing countries) provides a rationale for this domain of research. For instance, Dahlman and Westphal (1982) provide evidence that Korean firms were able to generate improvements in product quality and design as well as in productivity thanks to participating in exporting activity. Kırım (1990), in a case study of 659 largest Turkish manufacturing firms, argues that the attempt of export-led growth during the 1980s had significant impacts on the direction of in-house technological change, albeit not on the rate of R&D. All the same, while admitting the possibility of an opposite or a two-directional causality, we would still rather confine the scope of this study to a framework of exporting-by-learning. Examining, on the one hand, whether exporter firms are more efficient than their domestic non-exporter counterparts, Clerides et al. (1996), on the other, inquire into whether exporting generates efficiency gains. Relying on this firm-level panel-data study, which finds that more innovative firms become exporters and not vice versa, we are to be content with the present framework at least for the time being. Our cross-sectional data at hand comes from the only available innovation survey conducted for the first time at the end of 1998. In this regard, with the accumulation of new data through prospective surveys in the near future, a time-series dimension may also be available, in which case dealing with two-directional causalities becomes rigorously feasible.

Finally, inclusion of technology-related variables (as potent determinants of export performance) into any model of international competitiveness is inevitable. However, they alone cannot account for the entirety of inter-firm variations. Thus, any such model is to incorporate some other explanatory variables, whereby the wider comprehension can help improve the empirical results. This, in turn, necessitates an elaboration through industrial organization with an eye to international economics. At this point, one of the most inextricable tasks in front of an empirical researcher is to take into account such factors as firm size, technical manpower, industrial concentration, product differentiation, unit labor costs, wages, markups, profitability, expenditures on advertising, etc. as other possible determinants of export performance, which have usually shown up as significant regressors in empirical literature (Glejser et al., 1980; Lall and Kumar, 1981; Hirsch and Bijaoui, 1985; Lall, 1986; Hirsch et al., 1988; Abd-el-Rahman, 1991; Kumar and Siddarthan, 1994; Bhat and Sethuraman, 1995; Zhao and Li, 1997; Wakelin, 1998; Wignaraja, 2002).

4. Descriptive aspects of the Turkish manufacturing industry

In the 1960s and 1970s, Turkey adopted an import substitution industrialization strategy, which was able to generate a process of rapid yet unsustainable economic growth. Towards the end of 1970s, a balance-of-payments crisis led the Turkish government to implement a stabilization and structural adjustment program, the essence of which turned out to be an export-led growth strategy in the 1980s. In this context, ready-made tools were plentiful export subsidies cum incessant real devaluations. In 1983, export incentives came up to 36% of the export revenue (Uygur, 1991), and from 1979 to 1984 Turkish lira was devalued against USD by 100% in real terms. The consequence was an export boom in the period under consideration. The boom-in-question, however, was achieved at the expense real wages. Indeed, real wage rates (deflated by the consumer price index) could not catch up with their 1978 levels before the early 1990s (Taymaz, 1999).

Dramatic real wage deterioration created as such was accompanied by a non-increasing gross fixed capital formation (GFCF) in manufacturing during the 1980s. This was a seemingly controversial phenomenon since it was the manufacturing industry that led the others in the process of export boom. At this point, Dani Rodrik solves the paradox in a comparative study on the differences between the export-led growth strategies of South Korea and Taiwan on the one hand and Turkey and Chile on the other: "[M]odest export booms in Turkey and Chile in the 1980s have required cumulative exchange rate depreciations contemporaneously of the order of 100%, a change in relative prices vastly in excess of anything observed in East Asia" (Rodrik, 1995, p. 2). The two East Asian countries in question were able to blend export-orientation with successful investment and technology strategies, whereas Turkey and Chile solely relied on devaluations and export incentives without any significant efforts to feed up the productive infrastructure.

In this regard, it is a quite convincing contention that "one way of differentiating competitively strong and weak countries is by the methods they adopt to gain the competitive edge–productivity increases or reduced wages" (Haque, 1995, p. 23). While the former method, by and large, necessitates a search for technological development in the form of R&D activities (as implemented by South Korea and Taiwan, "Asian tigers" as of now); the latter may, for instance, be accomplished through a real devaluation of the currency (as a ready-made tool embraced by Turkey and Chile). It turns out that genuine international competitiveness is a matter of innovativeness, which has nothing to do with cost-reductions-via-devaluations (or by way of artificial incentives, like export subsidies, for that matter).

It is in the light of above-mentioned arguments that we intend to inquire into whether technological efforts of Turkish manufacturing firms are conducive to their export performance. With a weak "national system of innovation" and a negligibly small share of R&D expenditures in GNP, Turkey is an interesting case of analysis. Her manufacturing industry is relatively dynamic and productive implying that long-term growth and international competitiveness are most likely to arise therefrom.[2] If "individual" technological efforts of manufacturing firms are shown to play a role in enhancing export intensities, this may well imply much higher benefits to be reaped under a well-established system of innovation. Perhaps, it is in this way that the conventional ready-made attitudes towards international competition policy can be replaced by technology-centered priorities.

Our main data set comes from the Innovation Survey that was conducted the first time by the State Institute of Statistics (SIS) of the Republic of Turkey in 1998. The survey covers the innovation activities of firms in the period 1995–1997. The questionnaire is compatible with the Community Innovation Survey of the European Union, and defines "technological innovation", as "technologically new products and processes or significant technological improvements in products and processes".[3] An innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Innovation is explicitly defined at the firm-level, i.e. "innovation occurs when a firm implements a new or improved product or process which is technologically novel for the firm, not for the market". In order to check the quality of responses, firms who claim to be innovative are asked to describe their (at most three) product and process

[2] See Pamukçu (2003) for an analysis of the determinants of innovation-related decisions of plants in the Turkish manufacturing industry.

[3] The questionnaire includes 24 questions on product and process innovations, sales revenue and employment, internet access, R&D activities and expenditures, aims of innovative activities, sources of information for innovation, obstacles to innovation, research collaborations, R&D support, patenting behavior, and organizational innovations. For more information about the survey, see the web site of the SIS, http://www.die.gov.tr/konularr/teknollojikYenilik.htm (in Turkish). For definitions see OECD (1996).

innovations. Respondents' descriptions seem to suggest that their responses are quite reasonable.

A sample of about 4000 firms stratified by size and industry category was asked to complete the questionnaire. The response rate was about 55%. The SIS performed a non-response analysis and estimated sample weights for each respondent. Consistent with other science and technology indicators, the aggregate innovation rate in the manufacturing industry is found to be quite low compared to the EU countries (only 23.0%). This finding suggests that firms do not overstate their innovative performance. The size and sectoral distribution of innovators are consistent with a priori expectations: the proportion of innovators increases monotonically by size, and firms in chemicals, non-metallic minerals, metal, and engineering industries tend to be more innovative.

The innovation database was matched with the 1995–1997 data from the Annual Survey of Manufacturing Industries as part of a National System of Innovation Project (for details, see Taymaz, 2001), where a preliminary version of the econometric analysis reported in this paper was conducted as a background study.

Export intensity equations are estimated to find out the determinants of export performance. It is obvious that the whole sample consists of many firms that do not export at all. Hence, the dependent variable (share of exports in total sales, EXPINT) assumes the value of zero for non-exporter firms, and positive values for the exporters. Such being the case, the most appropriate way of obtaining unbiased and consistent estimators is the so-called Tobit estimation procedure, which is thus utilized to obtain the inferential results.[4]

Among the explanatory variables, our focus of attention is a number of technology-related variables, which we utilize in separate regressions due to the correlations among them. Two basic innovation dummies, PRODUCT and PROCESS, are equal to one if a firm reported to have introduced any product or process innovation, respectively, and zero otherwise. Another innovation dummy, INNOVATOR, is equal to one if a firm reported to have introduced any innovation (product or process). INNOVATOR is likely to serve as a better explanatory variable since PRODUCT and PROCESS are correlated. Share of R&D expenditures in total sales, or R&D intensity (RDINT), is another technology-related variable (which is correlated with PRODUCT and PROCESS). We determine the impact of technology transfers with the inclusion of a dummy (TECHTRAN), which is equal to one if the firm acquired technology through license or know-how agreements, and zero otherwise. Finally, regional spill-over effects are also taken into account by REGINN, which is the ratio of innovators to the total number of firms in the region (province) where the respective firm is located.

Size of firms has long been a conventional variable of interest in the empirical literature insofar as its impact upon (export) performance is concerned. Number of employees is a conventional measure of firm size. Our regressions also include firm size as an explanatory variable: SIZE $X+$ is equal to 1 if the firm employs X or more employees, zero otherwise, where X is set at 25, 50, 150, 250 and 500 to end up with five dummies for measuring the influence of firm size. The rationale behind utilizing size dummies (instead of individual sizes of firms) is to avoid problems that might arise from potential non-linearities between EXPINT and size (number of employees) of firms.

It is generally agreed that use of factors also plays an important role. Among our explanatory variables, thus, we have capital intensity (CAPINT) (or capital-to-labor ratio, which is proxied by the logarithm of the ratio of depreciation allowances to the number of employees). Logarithm of the real wages (WAGE) is also included in order to capture the probable influence of the quality of labor.

Export intensities may also be related to ownership structures in the firms. Three shares, sum of which is equal to unity, are to be considered in this respect: (i) public ownership, (ii) (domestic) private ownership,

[4] As mentioned by one of our referees, the Tobit estimation imposes a proportionality restriction on the effect of each regressor on the probability of exporting and export intensity. The validity of this restriction can be tested against an alternative unrestricted form comprising separate Probit and truncated regression models (Greene, 2003, p. 770). In such a case, the probit model tests the effects on the "capacity" to export (does the firm export or not), and the second model tests the effects on export intensity (how much does the firm export). Appendix A presents the maximum likelihood estimation results of the selection model. Since both methods generate qualitatively same results, we discuss here only the Tobit estimation results (the correlation coefficient between export intensities predicted by two models is 0.968). All other maximum likelihood estimation results of the sample selection models are available from the authors upon request.

and (iii) foreign ownership. In our regression analysis, two of these shares serve as non-omitted explanatory variables (PUBLIC and FOREIGN), which are expected to yield significant impacts with respect to domestic private ownership.

Along with advertisement intensity, ADVERINT (advertisement expenditures/sales), two variables are incorporated into regressions in order to determine whether the structure of production affects export performance: Share of inputs subcontracted to suppliers (SUBINPUT) and share of output subcontracted by customers (SUBOUT). Finally, composition of the labor force is also taken into account by including the shares of "administrative", "technical" and "female" personnel in all employees (ADMINSH, TECHSH and FEMALESH, respectively).

Since we are interested in inter-firm variations, descriptive statistics at the firm-level are rather informative before analyzing the inferential results. Means of the variables are separately provided in Table 1 for (i) the whole sample (all firms), (ii) the firms that reported to have introduced product and/or process innovations (innovators), and (iii) the firms without innovations (non-innovators). All statistics are weighted by sample factor weights.

Export intensity is higher for innovators (16.6%) than for non-innovators (11.8%). The difference between innovators and non-innovators is quite obvious so far as their size is concerned (198 versus 89 employees on the average, respectively). The well-known Schumpeterian hypothesis, in this regard, seems to be descriptively supported. Interpretation of the capital intensity variable is interesting: Innovators use capital-intensive production techniques, while non-innovators rely, by and large, on labor rather than capital. Technology transfer is practiced more commonly by the innovators than by non-innovators (7.6 versus 2.6%, respectively). This may indicate that technology transfer and innovativeness are complements. Logarithm of real wage is 2.5 in innovators and 1.76 in non-innovators indicating that innovators pay much higher wages. Ownership of the firms, advertisement intensity, subcontracted input and output shares, as well as the shares of administrative and technical personnel differ only slightly between innovators and non-innovators. Of course, these variables may still play significant roles in the determination of inter-firm variations in export intensity. Finally, it is noteworthy that the share of female personnel is seven percentage

Table 1
Variable definitions and descriptive statistics

Label	Definition	All firms	Innovators	Non-innovators
EXPINT	Export/sales ratio	0.129	0.166	0.118
PRODUCT	Product innovator	0.149	0.649	0.000
PROCESS	Process innovator	0.182	0.790	0.000
INNOVATOR	Innovator	0.230	1.000	0.000
RDINT	RD expenditures/sales ratio (10^2)	0.176	0.742	0.007
RDGINN	Regional innovation intensity	0.332	0.372	0.320
SIZE	Number of employees	114	198	89
CAPINT	(ln) depreciation allowances per employee	−0.254	0.462	−0.502
TECHTRAN	Technology transfer dummy	0.038	0.076	0.026
WAGE	(ln) Real wage rate	1.952	2.501	1.764
PUBLIC	Share of public ownership	0.054	0.036	0.060
PRIVATE	Share of private ownership	0.931	0.936	0.929
FOREIGN	Share of foreign ownership	0.015	0.028	0.011
ADVERINT	Advertisement expenditures/sales ratio	0.005	0.009	0.004
SUBINPUT	Subcontracted output/sales ratio	0.042	0.036	0.045
SUBOUT	Subcontracted input/inputs ratio	0.063	0.042	0.071
ADMINSH	Share of administrative personnel	0.202	0.212	0.199
TECHSH	Share of technical personnel	0.066	0.069	0.064
FEMALESH	Share of female personnel	0.216	0.164	0.234

Source: EXPINT, PRODUCT, PROCESS, INNOVATOR, RDINT, REGINN and SIZE from SIS, Innovation; Survey, 1995–1997. Other variables, SIS, Annual Survey of Manufacturers, 1995–1997.
Note: Weighted means.

Table 2
Sample characteristics by industry

	31 Food	32 Textile	33 Wood	34 Paper	35 Chemicals	36 Non-metallic	37 Metal	38 Engineering	39 Other
EXPINT	0.070	0.246	0.028	0.033	0.056	0.091	0.096	0.072	0.052
PRODUCT	0.088	0.092	0.195	0.191	0.357	0.171	0.146	0.215	0.145
PROCESS	0.149	0.124	0.090	0.205	0.254	0.293	0.311	0.244	0.203
INNOVATOR	0.167	0.154	0.195	0.236	0.390	0.332	0.369	0.319	0.203
RDINT	0.000	0.001	0.000	0.000	0.002	0.008	0.001	0.003	0.000
RDGINN	0.304	0.340	0.341	0.331	0.344	0.358	0.309	0.340	0.329
SIZE	99	132	75	114	126	109	212	84	119
CAPINT	−0.270	−0.376	−0.919	0.499	0.304	0.012	0.016	−0.435	0.010
TECHTRAN	0.016	0.017	0.117	0.013	0.093	0.031	0.030	0.084	0.110
WAGE	2.365	1.415	1.700	2.761	3.053	1.899	2.467	2.115	2.635
PUBLIC	0.149	0.015	0.070	0.097	0.059	0.050	0.037	0.048	0.196
PRIVATE	0.818	0.979	0.929	0.898	0.907	0.933	0.957	0.935	0.804
FOREIGN	0.033	0.006	0.001	0.005	0.034	0.017	0.006	0.018	0.000
ADVERINT	0.003	0.004	0.015	0.007	0.009	0.007	0.003	0.005	0.002
SUBINPUT	0.003	0.079	0.008	0.032	0.016	0.009	0.014	0.032	0.006
SUBOUT	0.003	0.117	0.006	0.047	0.040	0.000	0.043	0.049	0.000
ADMINSH	0.298	0.149	0.158	0.251	0.289	0.186	0.178	0.204	0.267
TECHSH	0.055	0.066	0.041	0.131	0.064	0.050	0.068	0.075	0.028
FEMALESH	0.120	0.381	0.081	0.080	0.122	0.066	0.027	0.098	0.083

Source: See Table 1.

points higher for non-innovators as compared to innovators.

Insofar as our sample is concerned, some descriptive characteristics of the nine sub-sectors are reported in Table 2. Unsurprisingly, one of the most discernible differences is the relatively much higher average export intensity of the textile sector, traditional export leader. The average export intensity of the eight sectors, excluding textile, equals 6.23%, whereas textile exports are about 25% of total textile sales. Interestingly however, the average of the percentage of firms that introduced product and process innovations is considerably low for textiles (15.4%); indeed, it is the lowest value among the nine sub-sectors. Average percentage of innovators is the highest in the case of the manufacture of chemicals (39%), which in turn has a modest export intensity (5.6%). In the light of these facts, it can be argued that, at the sectoral level, innovativeness per se does not seem to necessarily contribute to exports. Moreover, R&D intensities of all sectors are negligibly small. But it must be noted that the share of R&D in overall innovation expenditures is about 10–15% in Turkey (Taymaz, 2001).

The average size of firms in the sectors is seemingly uncorrelated with export intensity. The capital intensity variable indicates that food, textiles, wood and engineering sectors are labor-intensive. The average export intensity of these labor-intensive sectors equals 10.5%, whereas that comes up to only 6.6% for the remaining capital-intensive ones. This sectoral aspect, of course, is somewhat supportive of the factor-endowment theory since Turkey is most likely to be a labor-abundant country. Technology transfer and export intensity seem to be independent from each other. When it comes to investigate real wages in the sectors, it is markedly the manufacture of chemicals (the leader in innovativeness) that pays the highest wages. The lowest wages, on the other side, are paid by textiles, the traditional export leader. These two descriptive aspects as to real wages somewhat confirm conventional a priori expectations.

We discuss our econometric results in the following section. Before that, however, we had better attract the attention of the reader to an important aspect of the models we estimated by the Tobit procedure. All regressions, on which we elaborate next, include sectoral dummy variables at the ISIC two-digit level. Sectoral dummies not only capture some unobservable aspects of the sectors, but also reflect, at least partially, the impact of factor proportions. Our results suggest that such dummies are quite explanatory as far as the export performance is concerned at the sectoral level. Coefficients of the dummies tend to be relatively lower for capital-intensive sectors. In other words, export-intensity of labor-intensive sectors is relatively higher. Keeping this important sectoral aspect in mind, we should also draw attention to the intra-sectoral heterogeneity of the firms. Needless to say, a firm-level analysis is desirable in this regard. This is what we attempt in what follows in order to shed light on the micro-dynamics between competitiveness and innovativeness.

5. Determinants of international competitiveness: estimation results

It is in Table 3 where Tobit estimation results for firm-level determinants of export intensity are presented. The first three models involve "all firms"; that is, both innovators and non-innovators. Model 4 comprises innovators only, whereas Model 5 is for non-innovators only. The data for the dependent variable (export intensity) belongs to the year 1997, whereas the explanatory variables are measured in terms of averages in the period 1995–1997. Hence, it is reasonable to expect to capture the lagged effect of explanatory variables on export performance. In the models considered, basic innovation variables (PRODUCT and PROCESS) and R&D intensity variable (RDINT) have been cautiously incorporated. Since "innovation" is the expected resultant of R&D activities, they tend to exhibit high correlations with each other. Therefore, innovation and R&D variables have been separately utilized within the regressions. Of course, we did the same in the case of the INNOVATOR variable. Furthermore, Models 4 and 5, which have an identical set of explanatory variables, were utilized basically for comparing and contrasting innovators and non-innovators. In those models, we exclude RDINT since respective data are available only for innovators. In what follows, estimation results are discussed for "all firms" in the first place. Then, "innovators" and "non-innovators" are compared and contrasted.

So far as "all firms" in the sample are concerned (Models 1–3), one of the most outstanding results is that statistical significance of the explanatory variables remains intact irrespectively of the inclusion of basic innovation variables (PRODUCT, PROCESS, INNOVATOR) and R&D intensity (RDINT). In other words, explanatory variables are insensitive to changing technology variables.

It is up to 150 employees that a larger firm size implies a significantly higher export performance. Beyond that size, export intensity seems to be independent of the number of employees. Those firms which employ more than 500 employees also tend to have higher export intensities; however, such large firms are quite few in number, and they may be operating in relatively low-technology industries, while basically producing for export markets. Besides, capital intensity (CAPINT) and wage (WAGE) variables may be interpreted together: The former is significantly conducive to export performance, whereas the latter has no impact. This could be related to labor quality. In this regard, if Turkey is a labor-abundant country, then the positive influence of capital intensity on the export performance of Turkish firms turns out to be reminiscent of the well-known Leontief paradox, albeit on different grounds (that is, as contrasted with the capital-abundancy of the United States against the capital intensity of her import-competing sectors).

Lower public ownership along with higher foreign ownership (PUBLIC and FOREIGN) implies higher export intensity. In this regard, state-owned enterprises (establishment objective of which was import substituting industrialization) can be said to be naturally less export-oriented, whereas existence of foreign share-holders seems to be influential on exporting efforts. Negatively significant impact of advertisement intensity (ADVERINT) is an interesting result. A presumable interpretation is that advertising basically targets the home market mainly for consumer goods. Put differently, those firms with higher advertisement intensities are essentially preoccupied with meeting the domestic demand. On the other side, those firms which subcontract their inputs to "subcontractors" tend to have higher export intensities, whereas subcontractor firms have lower export intensity implying that international subcontracting is not well-developed. Composition of labor force is also important: Share of female personnel in all employees (FEMALESH) is conducive to export performance, whereas shares of administrative and technical personnel (ADMINSH and TECHSH)

Table 3
Determinants of export intensity, 1995–1997 (Tobit estimation)

	Model 1 (all firms)		Model 2 (all firms)		Model 3 (all firms)		Model 4 (innovators)		Model 5 (non-innovators)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
PRODUCT	0.028	0.900								
PROCESS	0.052	1.810*								
INNOVATOR			0.065	2.641**						
RDINT					2.575	3.519**				
REGINN	0.160	1.880*	0.161	1.899*	0.188	2.239**	−0.024	−0.308	0.219	1.444
CAPINT	0.031	3.780**	0.031	3.752**	0.033	4.086**	0.035	3.403**	0.031	2.459**
TECHTRAN	0.010	0.190	0.007	0.134	0.006	0.121	0.050	1.045	0.055	0.574
WAGE	0.005	0.590	0.005	0.630	0.006	0.717	0.009	1.164	0.005	0.318
ADVERINT	−2.003	−2.630**	−1.947	−2.565**	−1.877	−2.486**	−1.625	−2.528**	−1.996	−1.356
PUBLIC	−0.367	−6.180**	−0.367	−6.177**	−0.378	−6.379**	−0.171	−2.374**	−0.477	−5.127**
FOREIGN	0.448	4.570**	0.452	4.613**	0.449	4.586**	−0.042	−0.426	0.851	4.995**
SUBINPUT	1.117	9.120**	1.107	9.046**	1.111	9.084**	0.971	6.011**	1.110	5.995**
SUBOUT	−0.354	−4.380**	−0.358	−4.439**	−0.361	−4.426**	−0.426	−4.240**	−0.361	−2.978**
ADMINSH	−0.226	−2.500**	−0.230	−2.538**	−0.228	−2.522**	−0.273	−2.659**	−0.160	−1.123
TECHSH	−0.244	−2.190**	−0.246	−2.202**	−0.243	−2.188**	0.186	1.268	−0.361	−1.868*
FEMALESH	0.332	6.010**	0.333	6.036**	0.343	6.203**	0.496	6.453**	0.325	3.932**
SIZE 25+	0.165	3.330**	0.165	3.325**	0.166	3.356**	0.071	0.817	0.174	2.509**
SIZE 50+	0.102	4.040**	0.101	4.020**	0.111	4.420**	0.039	1.284	0.122	3.073**
SIZE 150+	0.022	0.620	0.023	0.624	0.026	0.721	0.042	1.105	0.031	0.536
SIZE 250+	−0.008	−0.160	−0.008	−0.167	−0.005	−0.099	0.023	0.486	−0.055	−0.675
SIZE 500+	0.090	1.860*	0.092	1.886*	0.095	1.956*	0.011	0.254	0.164	1.896*
Pseudo R^2	23.21		23.22		23.42		32.95		24.88	
log likelihood	−1057.5		−1057.4		−1054.7		−351.54		−554.47	
No. of observations	1529		1529		1529		683		846	
No. of exporters	968		968		968		515		453	

All models include sectoral dummy variables at the ISIC two-digit level.

* Means statistically significant at the 10% level, two-tailed test.

** Means statistically significant at the 5% level, two-tailed test.

have a negative influence. These findings suggest that Turkish manufacturing firms are more competitive in activities that require home-based skills, but less competitive in activities that require technical skills.

Since it is the principal aim of this study to deal with the possible impacts of technological capabilities on the export performance of firms, technology-related variables must be discussed in detail. With respect to Model 1, process innovations are conducive to exports, whereas product innovations do not have a significant influence. However, it is to be noted that PRODUCT turns out to be significant determinant, when PROCESS is dropped from Model 1. Positive significance of INNOVATOR and RDINT can be observed in Models 2 and 3, respectively.[5] Besides, one should also consider the facts that (i) regional innovation intensity (REGINN) somewhat contributes to the export performance, and (ii) technology transfers through license or know-how agreements (TECHTRAN) seem to have no significant impact.

One of the objectives of this study is to detect the similarities and differences between innovators (Model 4) and non-innovators (Model 5). Irrespectively of being an innovator or non-innovator, there are a number of explanatory variables that significantly affect export intensity in the same direction. Interestingly, those variables have significant impacts in the same direction for the whole sample, too. In this sense, these variables may be regarded as the most potent determinants of firm-level export performance in the Turkish manufacturing industry: Impacts of CAPINT, SUBINPUT and FEMALESH are positive, whereas those of PUBLIC and SUBOUT are negative.

Surprisingly, there are also two impotent variables: Neither WAGE nor TECHTRAN has to do with the export intensity of innovators or that of non-innovators (or that of the sample as a whole). Moreover, even though REGINN has a somewhat significant impact in the case of all firms (Models 1–3), it interestingly turns out to be an insignificant regressor when regressions are run separately for innovators and non-innovators. To be sure, REGINN is higher for innovators; and if innovators actually concentrate within certain regions, the significant impact in the case of all firms may be disappearing when the whole sample is grouped into innovators and non-innovators.

Despite such important similarities, differences are no less between innovators and non-innovators. The most prominent difference arises from size. Size matters only for non-innovators. Once non-innovators turn out to be innovators, number of employees does not influence exporting behavior. Up to 150 employees in non-innovators, a larger firm size yields a significantly higher export performance. Beyond that size, export intensity seems to be independent of size. In this connection, the average number of employees in innovator and non-innovator firms may be important: 198 and 89, respectively. An average innovator is already twice larger than an average non-innovator, which may imply that most innovators have already surpassed a size threshold beyond which export intensities have nothing to do with firm size. Moreover, like in the case of all firms, non-innovators that employ more than 500 employees also tend to have higher export intensities; however, there are only a few so large non-innovators, which may be operating in relatively low-technology export industries.

Advertisement intensity (ADVERINT) is an insignificant regressor for non-innovators, while it significantly yet negatively influences the export intensity of innovators. The interpretation we set forth for all firms may also be valid for innovators: Since they may basically produce to meet domestic demand, it is no surprise that advertising by innovators targets the home market. Exporter innovators establish different ways of connections with their foreign customers.

In contradiction, while the share of foreign ownership (FOREIGN) does not affect the export

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[5] Marginal effects of basic innovation variables as well as R&D intensity have also been calculated for their mean values. In this respect, for an exporter firm, introducing a product innovation raises export intensity by 1.2% point; and a process innovation does the same by 2.3% point (Model 1). For instance, an average firm with an export intensity of 13% would be able to raise it up to 16.5% (a 3.4% point increase), if it introduced a product innovation along with a process innovation. Similarly, a 1.0% increase in R&D intensity generates a 1.1% increase in export intensity (Model 3). On the other side, when a non-exporter firm introduces a product innovation, its probability of becoming an exporter increases by 3.1% point; whereas the respective contribution of a process innovation is 5.8% point (Model 1). These are quite substantial because the proportion of exporters is about 37% (weighted average). Consequently, a 1.0% increase in R&D intensity yields a 2.9% increase in the probability of becoming an exporter (Model 2). To be sure, implementation of a national technology policy is to seriously take into account such marginal effects as informational guidelines.

intensity of innovators, it is conducive to that of the non-innovators. Prior motive of foreign share-holders may be export-orientation rather than innovativeness. Moreover, innovators may have already attained a particular level of international competitiveness to which foreign ownership does not have much to contribute.

Finally, with negative impacts, share of administrative personnel (ADMINSH) is significant only for innovators, and share of technical personnel (TECHSH) is somewhat significant only for non-innovators. Non-innovators can have competitive disadvantages in those products which use relatively skilled labor.

6. Concluding remarks

One of our preliminary contentions was that firm-level analysis is required to understand important dynamics between innovativeness and competitiveness. By their very nature, technological processes are sequences of cumulative adaptation experienced within the firm. Accordingly, it is a good idea to conceive the generation of competitive advantages within a micro-dynamic context. The entire process, thus, should be perceived as a two-sided propagation rather than a unilateral feeding from innovativeness towards competitiveness. To be frank, we do not claim to have comprehensively examined the dynamics as such. The cross-sectional nature of the data set prevented us from doing so. As innovation surveys accumulate over time, it will be possible to add a time-series dimension to the analysis, in which case we will eagerly undertake the work of modeling simultaneous causations. This is, indeed, the genuine challenge in front of us.

It has been verified to a great extent that innovations and R&D activities are crucial for the international competitiveness of Turkish manufacturing firms. However, technology transfers (through license or know-how agreements) do not show up as significant determinants of export performance. Therefore, promotion of in-house innovativeness seems a good idea insofar as the priorities of a rational technology policy is concerned. All the same, technology transfers must not be easily overlooked since own innovation activities and technology transfers are likely to be "complementary" processes.

As a prominent difference between innovators and non-innovators, size does not matter for the former insofar as their export performance is concerned. Taking into account the pertinently large size of innovators, it may be argued that number of employees contributes to export performance only up to a certain size threshold (which is 150 for non-innovators). Once non-innovators turn out to be innovators, exports become independent of the firm size.

Export performance of non-innovators is positively influenced by the share of foreign ownership, while that of innovators remain intact with respect to the same variable. Foreign impulse to improving exports is an important factor for non-innovators, whereas innovators may have already developed their own peculiar motives irrespectively of foreign or domestic ownership. The structure of international marketing links, thus, can also be different between innovators and non-innovators.

With its negative impact, public ownership shows up as one of the most potent determinants of export intensity in the Turkish manufacturing firms. Put differently, exports basically arise from the private sector, and this is no surprise since state economic enterprises were established to produce for the domestic market with the objective of import substitution.

Two other important aspects of Turkish manufacturing firms are observed with respect to the "share of inputs subcontracted to suppliers" and "share of output subcontracted by customers"; the former with a positive and the latter with a negative impact upon export intensities. Exporting behavior seems to be characterized by two steps: First, purchase of unfinished products within local networks; second, their sale abroad after processing. In other words, subcontractor manufacturers basically sell at home, and what they sell is exported after being processed by non-subcontractors.

Last but not the least, persistent insignificance of real wage is also worthwhile considering. Turkey has conventionally implemented devaluations (basically to accommodate high inflation) with a hope to improve her international competitiveness via real cost reductions (e.g. the alleged advantage of "cheap labor"). Nevertheless, real wage was able to significantly affect export intensity in none of the five regressions we considered. In contradistinction, capital intensity turned out to be invariably significant and conducive in the very same regressions. Along with the important impact of technology-related factors, these two results regarding wages and capital intensity yield a quite crucial warning to be obeyed by the policy-makers at all costs: Turkey as well as similar developing countries must escape from the illusion of temporary export booms achieved by such ready-made tools as devaluations and export subsidies, and construct a coherent technology policy cum a national development strategy that will generate permanent increases in gross fixed capital formation, and thus in productivity and international competitiveness.

Acknowledgements

Earlier versions of this paper were presented at two international conferences (ERC/METU International Conference in Economics V, Ankara, September 10–13, 2001 and Economic Research Forum 8th Annual Conference, Cairo, January 15–17, 2002). Many thanks go to the participants in those sessions for their helpful comments. Cem Somel of METU deserves special thanks for his valuable suggestions at a later stage. Finally, we would like to thank two anonymous referees for their formative influence on producing the final version of this paper.

Appendix A

Maximum likelihood estimation of exporting and export intensity models

	Exporting (1 if exports, 0 otherwise)		Export intensity (export/sales ratio)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic
PRODUCT	0.143	1.540	0.049	1.340
PROCESS	0.208	2.460**	0.079	2.390**
REGINN	0.388	1.590	0.168	1.760*
CAPINT	0.110	4.590**	0.038	4.050**
TECHTRAN	0.063	0.410	0.005	0.090
WAGE	0.035	1.400	0.013	1.330
ADVERINT	−4.888	−2.190**	−1.998	−2.290**
PUBLIC	−0.716	−4.200**	−0.273	−4.090**
FOREIGN	1.037	3.710**	0.439	4.030**
SUBINPUT	3.384	9.350**	1.288	9.170**
SUBOUT	−1.306	−5.690**	−0.452	−5.010**
ADMINSH	−0.506	−1.910*	−0.194	−1.880*
TECHSH	−1.299	−3.600**	−0.463	−3.280**
FEMALESH	0.995	6.070**	0.362	5.650**
SIZE 25+	0.467	3.330**	0.177	3.250**
SIZE 50+	0.493	6.550**	0.181	6.140**
SIZE 150+	0.141	1.330	0.052	1.270
SIZE 250+	−0.068	−0.490	−0.025	−0.460
SIZE 500+	0.293	2.060**	0.080	1.440
log likelihood	−747.0			
LR test for independent equations	303.9**			
No. of observations	1529			
No. of exporters	968			

* Means statistically significant at the (10%) level, two-tailed test.

** Means statistically significant at the 5% level, two-tailed test.

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