World Bank Reprint Series: Number 284

REP284
December 1982

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# An Empirical Test of the Infant Industry Argument

*By* ANNE O. KRUEGER AND BARAN TUNCER*

Since World War II, many developing countries have provided high levels of protection for newly established industries. These policies have generally been followed on the grounds that new industries are "infants," and that dynamic factors will come into play to insure later economic efficiency.[1]

At a theoretical level, the infant industry exception to the proposition that free trade is optimal has always been noted.[2] Skeptics have centered their misgivings on two grounds: 1) they have questioned whether protection through the trade regime would achieve the goals of infant industry protection;[3] and 2) they have pinpointed the combination of "dynamic factors" and "externalities" that would have to arise to justify infant industry intervention and questioned the empirical likelihood of such circumstances.

*University of Minnesota and the World Bank, respectively. We wish to thank the National Science Foundation for research support, grant no. SOC77-25776. We are also grateful to the Turkish Industrial Development Bank for its assistance in the project. We have benefited greatly from the comments and suggestions of W. M. Corden and James M. Henderson. Ebbe Yndgaard, Claus Vastrup, Martin Paldam, and other members of the faculty at Aarhus University provided helpful comments and suggestions at an early stage of the research, as did colleagues at Bogazici University, including especially Maxwell Fry. Members of the Trade and Development Workshops at the University of Chicago made many useful comments on an earlier draft of this paper. Zafar Ahmed, Roger Johnson, Inci Mubarek, Lale Tezel, and Paitoon Wiboonchutikula provided research assistance at various stages of the project.

[1]The "infant industry argument" is also the basis on which developing countries are excepted from some provisions of the GATT.

[2]See Paul Samuelson, (1958, ch. 8), for a discussion of the history of thought with regard to the optimality of free trade. The optimum tariff argument is irrelevant to the concerns of this paper and therefore not considered here.

[3]See Robert Baldwin (1969) for an excellent statement of the reasons why, even in the presence of infant industry considerations, tariff protection might fail to correct the assumed market imperfection.

Interestingly, the debate has been entirely theoretical. There has been virtually no systematic examination of the empirical relevance of the infant industry argument. This is remarkable in light of the importance of the question, and the fact that thirty years' evidence or more has accumulated in a number of countries. Even if there are conditions under which dynamic factors and externalities in an infant industry might warrant intervention, that does not prove that those conditions are in fact met. In the last analysis, defense of infant industry protection must rest on empirical grounds: do the long-run benefits justify the short-run costs of starting up an initially high-cost infant?

It is the purpose of this paper to develop a test of whether infant industry criteria are satisfied, and then to apply the test to one developing country, Turkey. Section I sets forth the infant industry argument and necessary conditions for there to be a valid case for intervention. Section II then examines the various ways in which the necessary dynamic externalities might manifest themselves. This immediately suggests a simple empirical test. Section III then presents results of the test for Turkey. A final section contains some concluding observations and suggestions for further work. The data and details of procedures for estimation are given in the Appendix.

## I. The Infant Industry Argument

It is simplest to state the infant industry case in naive form, and then to consider the conditions under which it would be valid. The basic argument, crudely put, is that:

A. Some newly established activities are initially high cost relative to established foreign enterprises and it requires time for them to become competitive.

B. It does not pay any individual entrepreneur to enter an infant industry at free trade prices; but

C. The industry, if developed, would be economic enough to permit a reasonable rate of return on the initial losses; and therefore

D. The industry requires a *temporary* period of protection or assistance during which its costs will fall enough to permit it to survive international competition without assistance.

The first proposition is essentially that costs of a new activity may initially be high. Reasons put forth as to why they might be high include learning by doing and the possibility that there are "linkages" between industries set forth by Albert Hirschman (1958). If the latter, then in the early stages of development, the absence of complementary activities or small size of the industrial sector of an economy might constitute a reason why all industrial activities would initially be high cost.

The reasons why there might be learning by doing are numerous. Workers might require a period of training. There might be an initial shake-down period as the activity became operational. Management itself might gain in experience. These possibilities have been neatly encapsulated by Kenneth Arrow (1962) in the notion that output per unit of input might increase as cumulative output within a given line of activity (the plant? the firm? the industry? the entire industrial sector?) increased.[4] Regardless of which reason is put forth, an essential feature of the infant industry notion is that a new activity will initially be high cost, but that unit costs will decline over time.

The second proposition is that, while costs will decline, they will do so in a way that individuals initially starting the activity will not reap the full rewards. Otherwise, there would be no case for protection: if start-up costs are high but the activity is economic, it would pay an individual entrepreneur to incur those costs in order to reap later benefits. For there to be a case for intervention, there must be positive externalities from the development of an infant activity which accrue to individuals other than those undertaking the activity initially. Thus, the presence of externalities is necessary in order to show that private activity will not generate the optimal development of infant industries in a market-oriented economy. Whether the externalities are at the individual industry level, or rather at the level of the entire industrial sector is an open question, discussed further in Section II. Clearly, whatever infant industry assistance is provided should be provided to the industry, group of industries, or sector generating the externalities at a relatively uniform rate. Different levels of protection to different activities would be warranted only if the sector containing the more-protected activity were expected to experience greater cost reductions than the less-protected sector.[5]

The third proposition asserts that the losses associated with an initial period of high costs must be recovered (with interest) at a later date, although not by the individual entrepreneur starting up the activity. In essence, the costs of production of those benefiting by the development of the activity must fall enough to repay the initial losses and to provide a reasonable rate of return on those losses (since resources could otherwise have been allocated to unprotected activities with incremental international value-added).

The fourth proposition is really a logical consequence of the first three. All analysts have been willing to concede that if the first three propositions were valid, some form of assistance (and intervention with a *laissez-faire* outcome) to the externality-generating activity is warranted. However, protection would never be first best (contrasted with a production subsidy), and might not even achieve its intended purposes, as argued by Baldwin.

For the present, the important aspect of the infant industry case seems summarizable in the proposition that, in order for it to be empirically valid, a necessary (but not sufficient) condition is that costs in (temporarily)

[4]See Baldwin as to other mechanisms by which externalities have been said to affect profitability of start-up of new activities.

[5]It might be contended that a more-protected sector would generate greater externalities accruing to other activities. The unresolved question in that case is why protection should be temporary. If it were not temporary, infant industry considerations do not apply.

assisted or protected industries should have fallen over time more rapidly than costs in nonprotected or less-protected industries. This interpretation coincides with the case where it is assumed that prices in the rest of the world are given, and do not change over time due to differential rates of technical change in the rest of the world.[6] If there were also technical change in the corresponding industries abroad, the infant industry case would need to be reformulated to state that intervention would be warranted only if unit costs were expected to decline more rapidly in the infant industry than in the mature industry abroad (with the same qualifications as above regarding externalities and recovery of the initial investment with interest). For the purposes of this paper, it is assumed that world prices are given, so that a decline in costs in one industry at a more rapid rate than in another constitutes more of an infant industry case.

## II. A Simple Empirical Test

There are two ways that one industry's costs per unit of output (or value-added) can change relative to another's: either its share-weighted inputs per unit of output must fall more (or rise less) than the other's, or the relative price of the factor it uses relatively intensively in production must fall.

This can readily be seen as follows. Define the total cost, $C$, of the $i$th industry as

$$(1) \qquad C_i = \sum_j W_j V_{ji},$$

where $W_j$ is the reward to the $j$th factor of production and $V_{ji}$ is the quantity of the $j$th factor employed in the $i$th industry.

Clearly, the change in $i$'s costs is

$$(2) \qquad dC_i = \sum_j dW_j V_{ji} + \sum_j dV_{ji} W_j,$$

and the change in cost per unit of output is

$$(3) \quad d\left(\frac{C_i}{X_i}\right) = \sum_j \frac{dW_j}{W_j}\frac{W_j V_{ji}}{C_i}\frac{C_i}{X_i} + \sum_j \frac{dV_{ji}}{V_{ji}}\frac{W_j V_{ji}}{C_i}\frac{C_i}{X_i} - \frac{dX_i}{X_i}\frac{C_i}{X_i}.$$

Denoting the share of the $j$th factor in total costs in industry $i$ by $\alpha_{ij}$, equation (3) can be rewritten:

$$(4) \quad d\frac{[C_i/X_i]}{C_i/X_i} = \sum_j \alpha_{ij}\frac{dW_j}{W_j} + \sum_j \alpha_{ij}\frac{dV_{ji}}{V_{ji}} - \frac{dX_i}{X_i}.$$

Thus, the proportionate change in costs per unit of output in the $i$th industry represents the share-weighted sum of changes in input prices plus the share-weighted sum of factor inputs less the rate of change of output. Let $\dot{C}_i$ represent the proportionate rate of change in costs per unit of output. Contrasting changes in costs between the $i$th and the $k$th industry yields

$$(5) \quad \dot{C}_i - \dot{C}_k = \sum_j (\alpha_{ij} - \alpha_{kj})\frac{dW_j}{W_j} + \left[\sum_j \alpha_{ij}\frac{dV_{ji}}{V_{ji}} - \frac{dX_i}{X_i}\right] - \left[\sum_j \alpha_{kj}\frac{dV_{jk}}{V_{jk}} - \frac{dX_k}{X_k}\right]$$

The first term on the right represents the change in relative costs due to changing relative input prices. Clearly, that relative input prices may change in the process of growth is not grounds for infant industry protection.[7]

[6] It might be anticipated that the world price of a particular commodity would rise over time (for reasons other than technical change), and therefore a presently uneconomic industry might become economic. This would not constitute a case for infant industry protection, however, because: (*i*) it is not clear that because the price in the future will rise, activity now is economic; and (*ii*) there is no reason for intervention since those undertaking the activity now will benefit from the higher future price.

[7] As a practical matter, changes in relative factor prices do not seem to be a major source of relative cost changes. Turkey had a very large change in relative

If there is to be a dynamic cost reduction, it must be reflected in a difference between the two bracketed terms on the right-hand side.

We are thus led to the straightforward proposition that if there are dynamic factors warranting intervention, they will be reflected in a difference in the two right-hand terms of equation (5). Define, now,[8]

$$\frac{dA_i}{A_i} = \frac{dX_i}{X_i} - \sum_j \alpha_{ij} \frac{dV_{ji}}{V_{ji}}. \tag{6}$$

Substituting (6) into (5), and dropping the first term as irrelevant for infant industry purposes,

$$\dot{C}_i - \dot{C}_k = \frac{dA_k}{A_k} - \frac{dA_i}{A_i}. \tag{7}$$

In order for infant industry considerations to have warranted intervention in favor of industry $i$, costs per unit of output must have fallen more in $i$ than in $k$. Equation (7) shows that a necessary condition for this to occur is that inputs per unit of output decrease more rapidly in industry $i$ than in industry $k$. As formulated, this unit cost reduction could come about because of technical change, the overcoming of indivisibilities, the realization of scale economies, or for genuine infant industry reasons.

This, then, is the empirical test. Should industry $i$ have been protected on infant industry grounds and its costs have fallen relative to $k$, it will be judged that there were some dynamic factors in industry $i$ that *may* have warranted intervention (although there is no presumption whatsoever that intervention was optimal). Passing the test is a necessary condition for there to have been an infant industry. It is not sufficient to prove that infant industry protection was warranted because: (*i*) the industry might have developed anyway; (*ii*) the rewards may all have gone to the entrepreneurs in the industry; (*iii*) the reduction in costs might have come about for reasons other than externalities; or because (*iv*) the reduction in costs was not sufficient to provide an adequate rate of return on earlier losses. It might not have been optimal because an alternative intervention instrument or a lower level of protection might have achieved the same or better results with lower costs.

If, however, costs in industry $i$ did not fall relative to industry $k$, clearly protection was not warranted.[9] It is in this sense that a contrast of rates of growth of output per unit of input between more- and less-protected industries constitutes a test for the empirical validity of the infant industry argument.

Before proceeding to the empirical results, two questions remain. A first question is the time period over which infant industry considerations might warrant intervention. The second pertains to the range of activities over which the test should be carried out.

The first is the simpler question, since all that is required is a period sufficiently long so that, if cost reductions were not incurred, it could reasonably be concluded that the costs of protection would not in all likelihood be recovered. Since the Turkish data pertain to a period of thirteen years (and longer), we note simply that with a real rate of return of 10 percent,[10] the present value of

factor prices due to government intervention in the labor market, and yet the changes in costs that these could have induced seem relatively small. See Table A2 for the calculations. It has also been suggested that commercial policies themselves might induce changes in relative factor prices and that this is a dynamic factor that should be considered. However, if commercial policies *caused* changes in relative factor prices, they would clearly increase costs in protected industries and thus tend to weaken whatever dynamic case there was for intervention.

[8]The $dA/A$ is nothing other than the conventional formula for total factor-productivity growth, which is the rate of growth of output less the share-weighted rate of growth of inputs per unit of output. For present purposes, however, the assumptions necessary to justify use of $dA/A$ as a measure are far weaker than those necessary for a total factor-productivity growth interpretation.

[9]This does not prove that there might not have been an infant industry case. It is conceivable that incentives other than those created by the forms of protection actually used might have induced entrepreneurs to engage in cost-reducing activities. See our 1981 paper for an analysis of the effects of the trade regime on incentives in Turkey.

[10]Most observers would put the real rate of return in Turkey at a number substantially higher than this.

cost savings ten years' hence is less than 40 percent of the anticipated amount. It seems doubtful whether protection for a period of more than ten years, with no beginning of a reduction in costs, could conceivably come under the heading of justified infant industry protection.

The second question is the more difficult. It will be recalled that the infant industry argument presumes *both* dynamic factors *and* externalities. The test described above is straightforward in evaluating for the presence of dynamic factors, but does not indicate to which units it might apply. Since protection is granted at different rates to different industries, it seems natural to suppose that the relevant $i$ and $k$ to contrast would be different industries subject to different levels of protection. Having done so, a higher $dA/A$ would be required for a more-protected industry than for a less-protected one to satisfy the infant industry test. Most proponents of the infant industry argument seem to adopt this notion that the benefits are external to the firm but internal to the industry. This would appear to imply that rates of growth of output per unit of input should be higher for the industry than for new firms (or new investments of existing firms). It is also possible, however, that externalities spread across new entrants, and do not affect more traditional firms within industries. In that event, one would expect output per unit of input to grow more rapidly in newly established firms or activities than in preexisting ones.

Both of these possible relationships imply that the relevant unit for externalities to be recaptured is somewhere within a given, protected, industry. While this seems the most plausible infant industry interpretation (and the one used here), some might argue that the benefits of new industries are spread across the entire industrial sector, and are not centered in the protected industries themselves. One might be skeptical of the argument, on the grounds that it is hard to see why different levels of temporary protection should be accorded to different industries unless their own costs would fall differentially. But if the relevant source of externalities is the entire industrial sector, the industrial sector as a whole should be observed to have experienced a relatively high rate of growth of output per unit of input in contrast to the rest of the economy (in contrast to mature industrial economies). Comparison of output per unit of input across countries is inherently difficult, but nonetheless can provide a partial check on the plausibility of this possibility.

## III. Results

As already mentioned, Turkey has provided protection, on infant industry grounds, to a variety of new industries. Protection has been largely automatic because the authorities have generally prohibited imports of any good once domestic production began.[11] Rates of effective protection have been fairly high, and estimates must be based upon direct price comparisons rather than upon tariff schedules. The best available estimates are given in Table 1 below.

The details of data sources and procedures for estimating output per unit of input are given in the Appendix. Here, only three points need to be noted. First, there are two sets of estimates available: one from a sample of 92 firms and the other for two-digit manufacturing industries in the private sector of the Turkish economy. Secondly, the main thrust of import substitution activity (on infant industry grounds) in Turkey was during the early and mid-1960's. The two-digit industry data cover the period 1963–76, while data for individual firms cover at least that period when the firms were already in existence but shorter periods in some instances when the firms started operation in the late 1960's. Finally, since much of the import-substitution process consists of replacing imported inputs with domestic materials, estimates were generated for three separate inputs: labor, capital, and material inputs.[12]

Table 1 gives the main findings. The Appendix gives sources and procedures and the

[11] One would anticipate that, in the absence of expected monopoly power from entering a given line of activity first, the automatic protection mechanism would provide an incentive for the more economic among the import-competing industries to be developed first.

[12] No data were available with which to estimate changes in skills of the labor force.

TABLE 1—EFFECTIVE RATES OF PROTECTION AND RATES OF GROWTH OF OUTPUT PER UNIT OF INPUT

| Industry | $ERP_1$ | $ERP_2$ | $DRC$ | Rate of Growth of Output/Input | |
|---|---|---|---|---|---|
| | | | | Firm Sample | Industry |
| Food Products | 13 | n.a. | 18 | .25 | .16 |
| Fur and Leather Products | 14 | −24 | −15 | n.a. | −1.17 |
| Wood and Cork Products | 16 | 58 | −13 | −3.34 | −.55 |
| Furniture and Fixtures | 16 | n.a. | n.a. | n.a. | −.56 |
| Nonmetallic Mineral Products | 23 | −27 | 1 | 1.61 | .72 |
| Textiles | 42 | −23 | 12 | .72 | .84 |
| Apparel and Footwear | 42 | 47 | n.a. | 5.24 | 4.10 |
| Metal Products | 57 | 140 | 682 | −.05 | 1.61 |
| Chemicals | 60 | 200 | 21 | −.04 | .46 |
| Electrical Machinery | 63 | 113 | 36 | 5.76 | 1.41 |
| Paper and Products | 72 | 105 | 97 | n.a. | 1.55 |
| Rubber Products | 77 | N-IVA | 279 | n.a. | 4.27 |
| Basic Metals | 80 | 113 | 14 | 2.21 | −.93 |
| Nonelectric Machinery | 142 | 132 | 36 | n.a. | .62 |
| Petroleum Refining | n.a. | 236 | n.a. | n.a. | −8.80 |
| Transport Equipment | 209 | 134 | 131 | n.a. | .94 |
| All Manufacturing | | | | 1.91 | 1.84 |

*Source:* $ERP_1$: Özfirat estimates given in Krueger, Table IX-2; $ERP_2$: Baysan estimates given in his Table 1, p. 126. *DRC*: Krueger, Table VIII-1.

*Notes:* 1) Beverages and Tobacco are not reported here due to lack of a measure of effective protection; both are traditional. Estimated rates of growth of output per unit of input are 4.31 percent annually for Beverages and 5.97 percent for Tobacco. 2) All rates of growth are continuous natural rates. N-IVA denotes negative international value-added.

underlying data on rates of growth of outputs and inputs from which these estimates were derived.

The first three columns of Table 1 give three different estimates of sectoral protection all pertaining to the late 1960's. The first are based on sectoral averages computed by the State Planning Organization for 1968. Sectors are listed in order of increasing protection based on these estimates. The second are based on input-output tariff data adjusted for the estimated additional protection accorded by import quotas and prohibitions. The third are domestic resource-cost estimates taken from a sample of firms. While the last are most closely based on price comparisons, they suffer from the drawback that levels of protection vary so much within each sector that sampling error is probably fairly large.[13] This variability stems partly from the fact that an import-licensing regime inherently provides varying levels of protection to the same industry at different points in time. Even more important is the consideration that there are import-substitution industries within "traditional" sectors (such as synthetic textiles), and "traditional" activities within import-substitution sectors (such as copper processing within basic metals). Thus, the variability reflects the underlying reality that levels of protection differ widely even within particular industries.[14]

Despite the wide variability, the three sets of estimates together provide a fairly good indication of the height of protection in the mid- to late 1960's, and its differential across industries. Essentially, the first seven are all regarded as traditional industries within Turkey; the last nine are regarded as the import-substitution sectors.[15] The latter are

[13]See Krueger, where the variance in the estimated sectoral means was also calculated.

[14]While data in nominal terms are available for three- and four-digit industries, no appropriate price deflators or detailed estimates of effective protection rates are available.

[15]The import substitution industries generally experienced more rapid growth of output. See Table A1.

those that were encouraged in the early 1960's, and were the focus of Turkey's import-substitution polices on infant industry grounds. The positive rates of protection for the traditional sectors probably did little more than offset currency overvaluation in the late 1960's; the Turkish lira was devalued by 66 percent in 1970.

The last two columns in Table 1 give estimated rates of growth of output per unit of input. The firm sample column gives estimated rates for the sample of firms. As can be seen, there were some industries for which no firm data were available. In some instances (such as petroleum refining) this was because the activity is undertaken primarily by one large firm; in other instances, there were simply no firms in the sample data. Rates for the industry cover the years 1963–76, the period for which State Institute of Statistics data are available.

As can be seen, there is no systematic tendency for more-protected firms or industries to have had higher growth of output per unit of input than less-protected firms and industries. Two industries—apparel and footwear and rubber products—appear to have experienced relatively rapid growth of output per unit of input. Apparel and footwear is a traditional industry in Turkey, and its medium rate of effective protection reflects currency overvaluation and the negative protection to textiles, rather than positive nominal protection directed toward apparel and footwear. Rubber products is a sector with a sizable traditional component and import-substitution activities consisting primarily of tire production. This latter activity was extremely high cost, as reflected both in Tercan Baysan's estimate that international value added was negative and in a very high *DRC* estimate. No firms producing rubber products were in the sample, so only a sectoral rate is available.

There is likewise no apparent tendency for the new activities, as reflected by the firm data, to have experienced rates of growth of output per unit of input systematically higher or lower than the industry to which they belonged. Thus, the externality argument does not seem borne out by the data: if anything, sample firms experienced a slightly higher rate of growth of output per unit of input than their corresponding industries, but surely the difference is well within the margin of error of the calculations.

Finally, there is the question as to whether externalities could have been realized elsewhere in the manufacturing sector. Here, the only way of judging is to evaluate the estimated rate of growth of output per unit of input in the manufacturing sector as a whole. That, in turn, involves a comparison of the rate realized in Turkey with that in other countries. Because data are not entirely comparable, and because the estimates are residuals and therefore subject to fairly wide margins of error, such comparisons are necessarily extremely hazardous. Estimates typically range from 3–4 percent for developed and other developing countries.[16] Despite problems of comparability, it hardly seems plausible that differences in measurement account for the lower figure in Turkey.

To see just how low the estimated rates of growth of output per unit of input are, consider the following. Suppose a firm initially experienced a 50 percent cost disadvantage (i.e., required 50 percent effective protection). Output per unit of input would have to grow 4 percent annually more rapidly than in other industries in order for it to be able to survive without protection ten years hence.[17] This, however, would provide no return on the initial loss. It is thus an underestimate of the differential in growth of output per unit of input that would be necessary to warrant protection of the infant industry.

For the Turkish case, when all manufacturing was experiencing increased output per

[16]Edward Chen (1977) estimated rates of manufacturing total factor productivity growth of 2.29, 3.47, 3.50, and 3.75 percent for Hong Kong, South Korea, Taiwan and Singapore, respectively, for the 1960's. Estimated rates for developed countries include 3.5 percent for Norway (V. Ringstad, 1971), 3.66 for Japan (Mieko Nishimizu and Charles Hulten, 1978), 3.75 for Italy (Vittorio Conti and Renato Filosa, 1979), and 2.9 percent for the United States (John Kendrick, 1976). In some of these cases, quality adjustments have been made to estimated inputs. Using unadjusted data would raise those estimates, making the contrast with Turkey even sharper.

[17]This number is found by solving $I_t = I_0 (1 - r)^t$ for $r$ when $I_t = .667$, $I_0 = 1$ and $t$ equals 10.

unit of input at a rate of 1.8 annually, this would imply that industries experiencing 50 percent protection should increase output per unit of input at a rate of at least 5.8 percent annually. More concretely, consider rubber products, the "best" Turkish case. If the *low* estimate of the *ERP* for rubber products is accepted, the output per unit of input would have to grow at 7.34 percent annually in order for their costs to fall enough for them to become competitive in ten years. At their existing rate of growth of output per unit of input, it would require twenty-three years for them to become competitive.[18] Even that calculation takes the low estimate of the rate of protection, allows for no return on the investment over the twenty-three-year interval, and is for the two-digit industry with the highest estimated rate of growth of output per unit of input. Obviously, for "infant" industries such as paper where outputs per unit of input grew at less than the average rate of all manufacturing, there can never be a "catch up" as long as existing relative rates are maintained.

## IV. Conclusions

This paper has attempted two things: to develop an empirical test for the validity of the infant industry argument; and to use that test on Turkish data. The test is simple and straightforward: input per unit of output must fall more rapidly in more protected industries if there is to be any rationale for infant industry protection. In the Turkish case, there was no such tendency over the period covered.

The fact that protected Turkish industries did not experience rapid increases in output per unit of input is sufficient to prove that protection was not warranted. It does not, however, prove that there were no infant industries. It might be that the trade regime itself provided the wrong incentives. It is at least possible that, under an alternative incentive structure, output per unit of input might have grown more rapidly in some, or possibly even all, Turkish industries.[19] What can be concluded is that, at least in the Turkish case, protection did not elicit the sort of growth in output per unit of input on which infant industry proponents base their claim for protection.

## Appendix

The major thrust of import substitution into new industries occurred in the early and mid-1960's. For the period 1963–76, there are industry-level data available with which to estimate inputs and outputs. A Census of Manufacturers and Annual Survey of Industries provides detailed data on number of employees, wage bill, value of purchased inputs, value of output, investment made by firms, and number of firms for private activities within each industrial sector employing ten or more employees. These data, combined with estimates of capital stock provided by the State Planning Organization and appropriate price deflators[20] form a data set from which it is possible to infer the behavior of inputs and outputs for two-digit manufacturing industries in the private sector in Turkey.[21] Since much of the import-substitution process consists of replacing imported inputs with domestic materials, three inputs were separately estimated: labor, capital, and material inputs.

A second set of data is at the firm, rather than industry, level. It covers those firms which received loans from the Turkish Industrial Development Bank. For them, data were available on a variety of their attributes (size, date of inception, precise composition of output, etc.) and also for annual invest-

[18]This calculation is based on the assumption that output per unit of input in rubber products continues to grow at 4.27 percent annually while in the entire manufacturing sector it continues to grow at 1.84 percent annually.

[19]See our earlier paper for an attempt to trace the links between the growth of output per unit of input and the ebbs and flows of the trade regime.

[20]Wholesale price indices were available for outputs of each two-digit industry. These data were then used, in conjunction with the Turkish input-output tables, to obtain a weighted input price for each sector's purchases. The same price deflators were used for two-digit industries and for the firm data described below.

[21]In our earlier paper the behavior of the private and public sectors is analyzed and contrasted, and a fuller description of the data is given.

TABLE A1—UNDERLYING GROWTH RATES OF OUTPUT AND INPUT FOR PRIVATE SECTOR INDUSTRIES AND SAMPLE FIRMS

| | Industries' 1963–76 Growth Rate of: | | | Sample Firm Growth Rate of: | | |
|---|---|---|---|---|---|---|
| | Labor | Capital | Real Output | Labor | Capital | Real Output |
| Food Products | 4.6 | 14.2 | 7.7 | 7.5 | 13 3 | 9.5 |
| Beverages | 18.0 | 14.2 | 22.5 | – | – | – |
| Tobacco | −3.3 | −.3 | 5.7 | – | – | – |
| Textiles | 4.6 | 13.3 | 11.0 | 6.2 | 14.1 | 10.2 |
| Apparel and Footwear | 23.3 | 13.3 | 28.3 | 1.9 | 8.0 | 6.8 |
| Wood and Cork Products | 10.0 | 14.2 | 12.6 | 9.1 | 27.9 | 15.8 |
| Furniture and Fixtures | 4.7 | 14.2 | 6.6 | – | – | – |
| Paper and Products | 16.7 | 26.0 | 23.7 | – | – | – |
| Chemicals | 8.4 | 15.4 | 15.1 | 4.2 | 12.4 | 12.0 |
| Rubber Products | 5.1 | 13.3 | 16.8 | – | – | – |
| Fur and Leather Products | 7.8 | 17.0 | 8.6 | – | – | – |
| Petroleum and Coal Products | 28.1 | 60.5 | 33.7 | – | – | – |
| Nonmetallic Minerals | 8.0 | 16.7 | 15.3 | 5.0 | 7.4 | 7.4 |
| Basic Metals | 18.1 | 25.3 | 21.5 | 7.6 | 14.9 | 15.8 |
| Metal Products | 7.8 | 13.1 | 11.8 | 9.0 | 17.1 | 13.3 |
| Nonelectrical Machinery | 15.2 | 17.6 | 17.9 | – | – | – |
| Electrical Machinery | 12.5 | 20.1 | 19.8 | – | – | – |
| Transport Equipment | 22.7 | 30.5 | 30.1 | – | – | – |

*Note:* All rates of growth are continuous natural rates, computed by running a logarithmic regression of each variable on time.

ments, annual labor force and wage bill, annual purchases of raw materials and intermediate goods and inventory changes, sales, profits, depreciation, and so on. Altogether, there are 91 firms for which data were available on a reliable basis for a period of more than five years.[22] Most new investments of these firms were undertaken in response to incentives provided by the trade regime, although some were in more traditional industries. Since there was credit rationing in Turkey, there is some presumption that borrowers from the Industrial Development Bank were firms of above-average quality, according to the criteria used by the Bank for its lending.

On the basis of these data, it was possible to compute an estimated capital stock for each firm using perpetual inventory techniques. Doing so was judged better than using balance sheet estimates (which were also available) since the latter made no allowance for price level changes in their capital stock in the context of a relatively high rate of inflation. Depreciation rates were estimated from American engineering data found in W. R. Park,[23] and then scaled to equal the State Planning Organization's estimate of the average rate for all manufacturing. Investment deflators available from the State Planning Organization were first employed to convert nominal investment into constant-price estimates of additions to capital stock. Investment in a given year was treated as becoming effective capital only at the beginning of the following year.[24] Period $t-1$'s capital stock was depreciated, and then real

[22] Interviews were held with more than a quarter of the firms, which provided a check on the reliability of the data, and also provided additional information on characteristics of firms and their management.

[23] It is an interesting question whether one should a priori expect depreciation rates to be lower or higher in Turkey than in the United States. On one hand, cheaper labor should encourage more maintenance and thus a longer economic life. On the other hand, poor and irregular materials quality, irregular supplies of electric power, and workers with less experience in the care of equipment might tend to the opposite result.

[24] For some older firms, data were not available from inception. In those cases, initial balance sheet data were converted to an estimate of real capital stock based on knowledge of the firm's history and starting date.

investment in $t-1$ was added to obtain capital stock in period $t$.

In addition, data from the firms could be directly used for the number of workers. Purchased inputs, adjusted for inventory changes, were deflated to yield an estimate of material inputs. Finally, for some firms a physical indicator of homogeneous output (for example, tons of cement) was available and used to indicate output. For others, it proved preferable to take deflated sales adjusted for inventory change as the measure of output.

Thus, for both firms and industries, data were available on materials inputs, outputs, labor inputs, and capital stock inputs, along with the shares of the respective factors in the value of output. For purposes of estimating changes in input per unit of output, the *average* share (over the life of the firm and for the entire 1963–76 period for two-digit industries) of labor, material, and capital was used. This procedure was judged superior to employing a Divisia index because of the volatility of shares from year to year.[25]

Table A1 provides the estimates of rates of growth of labor and capital inputs and outputs. All rates are computed for the period 1963–76 at the industry level. For firms, rates were computed over the period for which data were available, and a minimum of five years. In some instances, firm data span a period of twenty years, but some newer import substitution activities did not start until the late 1960's; data on these firms are also included in the estimates.

Table A2 gives data on the wage share in each two-digit industry and computes the maximal rate of change in relative costs that could have been associated with the very steep increase in real wages that occurred in Turkey during the period. The real wage increase was the result of labor legislation and did not reflect underlying labor market conditions: urban unemployment was rising rapidly during most of the period.

[25]Initial estimates, based on Divisia indices, yielded occasionally bizarre results. For example, for firms or industries suffering losses, the capital share was negative, and firms with heavy investment were calculated to have increased output per unit of input!

TABLE A2—COMPUTATION OF POSSIBLE CHANGES IN RELATIVE COSTS DUE TO CHANGES IN RELATIVE FACTOR PRICES

| Industry | Wage Share of Value-Added | Rate of Cost Change |
|---|---|---|
| Food Products | .264 | −0.4 |
| Beverages | .101 | −2.0 |
| Tobacco | .183 | −1.3 |
| Textiles | .368 | 0.3 |
| Apparel and Footwear | .521 | 1.7 |
| Wood and Cork Products | .485 | 1.4 |
| Furniture and Fixtures | .381 | 1.5 |
| Paper and Products | .372 | .4 |
| Chemicals | .319 | −.1 |
| Rubber Products | .274 | −.5 |
| Fur and Leather Products | .484 | 1.4 |
| Petroleum and Coal | .016 | −2.8 |
| Nonmetallic Minerals | .326 | −0.0 |
| Basic Metals | .201 | −1.2 |
| Metal Products | .384 | 0.5 |
| Nonelectric Machinery | .320 | −0.1 |
| Electrical Machinery | .332 | 0.0 |
| Transport Equipment | .562 | 3.7 |
| All Manufacturing | .245 | 0.0 |

*Notes:* Real wages are estimated to have risen at a continuous rate of 6 percent from 1963 to 1976, based on average weekly earnings covered under social insurance. The median share of labor was 33 percent. Relative cost changes were computed be weighting these rates of change by each industry's actual (1968) shares. For the median industry's costs to have remained constant, capital costs would have had to decline at a continuous rate of 2.95 percent.

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ISSN 0253-2131