Is there evidence of creative destruction in the Turkish manufacturing sector? Lessons from a cross-industry analysis of aggregate productivity growth

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This paper examines the Schumpeterian creative destruction process by decomposing and analysing aggregate industry-level productivity growth in three Turkish manufacturing industries. The results are somewhat supportive of the Schumpeterian hypothesis given that the productivity effects within plants contributed the most to the aggregate level productivity growth. However, the results generally contradict the insight that plants entering the market have higher productivity than plants that exit the market. This supports Caballero and Hammour’s (NBER Working Paper No. 7720, 2000) arguments that institutional and market constraints may interfere with the proper functioning of Schumpeter’s creative destruction process.

I. INTRODUCTION

Schumpeter (1942, p. 83) coined the term ‘Creative Destruction’, where he described it as follows:

The fundamental impulse that keeps the capital engine in motion comes from the new consumers’ goods, the new methods of production and transportation, the new markets...[The process] incessantly destroying the old one, incessantly creating a new one. This process of creative destruction is the essential fact of capitalism.

In terms of productivity growth analysis, the Schumpeterian notion of creative destruction may be taken to mean that least efficient firms exit the industry while survivors become more productive; and innovative new firms enter the market. In this case, it would be expected that new entrants should be more productive than the firms that exit and that surviving firms becomes more productive over time.

There is growing empirical evidence that supports the presence of creative destruction in different sectors of the economy and for different countries.¹ Most of these empirical studies have taken advantage of the availability of microlevel longitudinal data to analyse the productivity dynamics of firms and to test the presence (or absence) of creative destruction. Virtually all of these studies decompose some aggregate measure of industry productivity growth to determine whether the sources of increased

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aggregate productivity are indeed supportive of the Schumpeterian creative destruction hypothesis. In general, the empirical evidence supports the notion of creative destruction and several stylized facts have consistently emerged (see Foster et al., 1998, 2001; Bartelsman and Doms, 2000). One such stylized fact is that the within firm/plant productivity improvements and the net entry of more productive firms have been the dominant contributors to aggregate level productivity growth. This result clearly supports the Schumpeterian hypothesis.

Note, however, that most of these studies have focused their analysis on manufacturing industries in more developed (or industrialized) countries. Looking at the issue of creative destruction in the context of a low-middle income economy can provide insights that previous studies have not revealed. These insights may be important given Caballero and Hammour’s (2000) work that point to several obstacles in capturing the productivity effects of the creative destruction process. Caballero and Hammour (2000) argue that the proper functioning of the creative destruction process can be adversely affected by market imperfections (i.e. financial underdevelopment) and institutional constraints (i.e. political short-sightedness, inadequate contracting environments). It can be argued that these imperfections would be more prevalent in low-middle to low income economies, and yet there have been limited published studies that investigated the creative destruction process in this context.

The objective of this paper, therefore, is to investigate the creative destruction process by decomposing and analysing aggregate productivity growth in three Turkish manufacturing industries. The results are somewhat supportive of the Schumpeterian hypothesis given that the productivity effects within plants contributed the most to the aggregate level productivity growth. However, in general, the results contradict the insight that plants entering the market have higher productivity than plants that exit the markets, which supports Caballero and Hammour’s (2000) arguments.

The remainder of the paper is organized as follows. The next two sections discuss the plant level data and the empirical approach used in the study. Results of the analysis are presented in Section IV. Conclusions are discussed in the last section.

II. DESCRIPTION OF THE DATA

This study utilizes unbalanced panel data of plants with more than 25 employees for the textile (ISIC 3212), apparel (ISIC 3222), and motor vehicle and parts (ISIC 3843) industries from 1987–1997. The textile industry has 513 plants, the apparel industry has 2531 plants, and the motor vehicle and parts industries have 646 plants in the sample. These plants have data from 1987 to 1997. The data was collected by the State Institute of Statistics in Turkey from the Annual Surveys of Manufacturing Industries, and was uniformly altered by a constant for the purpose of confidentiality. The data was classified based on the International Standard Industrial Classification (ISIC Rev. 2).

Output \((Y)\) is the value of aggregate output deflated by the corresponding price index. The changes in the stock of output are considered in calculation. In other words, \(Y\) is defined as total shipments plus changes in inventories of finished goods and work-in-process. As for the calculation of material \((M)\) input value, the expenditures on inputs are used, considering the changes in stocks. The value of fuel is added to that of electricity to obtain energy \((E)\). The nominal values of inputs is divided by the corresponding price deflators to find the constant dollar value quantities on inputs at 1987 prices.

The quantity of labour \((L)\) is calculated based on data of total hours worked in production, i.e., the product of average hours worked times the number of employees in manufacturing. The method of gross investment is utilized to compute the capital input. The gross investment data (domestic plus imported capital purchases less sales, with maintenance investment added in) deflated by a capital price index is used, and sum them over time using depreciation rates to compute the aggregated capital data. In order to calculate the initial benchmark three-year averages of the growth rate of investment are used. After calculating the capital benchmark, the capital stock is cumulated from that point using the investment data and a depreciation rate. In other words, the capital stock is estimated by applying the perpetual inventory method (PIM) on the fixed assets, which requires estimated years of lifetime capital equipment: \(K_t = K_{t-1}(1 - \delta) + I_{t-1}\), where \(K_t\) is the capital stock in period \(t\); \(\delta\) is the depreciation rate of capital; and \(I_t\) is the level of the investment during the period. The descriptive statistics for establishments employing more than 25 employees in the years 1987 to 1997 are reported in Table 1.

III. EMPIRICAL FRAMEWORK

The empirical approach taken here is to first study the distribution of individual plant level productivity within
each industry, over time. This gives an indication of how the plant level productivity distribution changes over time. Although this approach gives an idea of how productivity changes over time, it does not give insights as to the sources of aggregate industry growth. In this case, the effects of industry dynamics and plant heterogeneity on aggregate productivity growth cannot be captured. Hence, the longitudinal data are also analysed using the aggregate productivity decomposition framework proposed by Foster et al. (1998). This approach allows the sources of aggregate productivity growth to be determined and the creative destruction process in the Turkish manufacturing context to be explored.

**Plant-level productivity analysis**

The measure of productivity used in this study is total factor productivity (TFP). In the plant-level analysis, a multilateral index is constructed to measure the plant-level TFP.
for the period 1987–1997. In this study, the Good et al. (1996) approach is used for computing the multilateral TFP index. In their approach, different hypothetical plant reference points are constructed for each crosssection, and then the hypothetical plants are linked together over time. This type of multilateral index has the advantage of providing measures either from year-to-year or from a sequence of years, through the process of chain-linking.

In this study, the multilateral TFP index measure for plant $j$, which produces a single output $Y_j$, using inputs $X_{jft}$ with cost shares $S_{jft}$, is calculated as follows:

$$
\text{Ln } TFP_{jt} = (\ln Y_j - \text{Ln } Y_f) + \sum_{k=2}^{t} (\ln Y_k - \ln Y_{k-1})
$$

$$
- \left[ \sum_{j=1}^{n} 1/2(S_{jft} + S_{jft})(\ln X_{jft} - \ln X_j) + \sum_{k=2}^{t} \sum_{j=1}^{n} 1/2(S_{jk} + S_{jk-1})(\ln X_{jk} - \ln X_{jk-1}) \right]
$$

where $\ln Y_f$ and $\ln X_j$ are the natural log of the geometric mean of output and the natural log of the geometric mean of the inputs (capital, energy, labour, and material inputs) across all plants in time $t$, respectively. The first two terms in the first line measure the plant’s output relative to the hypothetical plant in the base year. The first term describes the deviation between the output of plant $f$ and the representative plant’s output, $\ln Y_f$, in year $t$. This first sum allows comparisons to be made between cross-sections. The second term sums the change in the hypothetical plant’s output across all years, while chaining the hypothetical plant values back to the base year. This allows the change in output of a typical plant over years to be measured. The following terms provide similar information. However, it is for inputs using revenue shares and arithmetic average revenue shares in each year as weights. The resulting measure is the total factor productivity of plant $f$ in year $t$ relative to the hypothetical plant in the base year (1987, in this case).

**Aggregate industry-level productivity analysis**

Once the distribution of plant-level productivity is computed, the aggregate industry-level productivity can then be calculated and decomposed in order to assess the process of creative destruction in the three Turkish manufacturing industries examined in this study. The aggregate industry level productivity ($\text{Ln } ITFP$) is calculated as the weighted average of plant-level productivity for all plants:

$$
\text{Ln } ITFP = \sum_{i=1}^{N} S_{it}(\text{Ln } TFP_{it})
$$

where $N$ is the number of plants; $S_{it}$ is industry output share at $i$th plant and year $t$, $S_{it} = (X_{it}/Y_i)$. The changes in the industry level total factor productivity growth between time period $t_k$ to $t$ is then calculated as:

$$
\Delta \text{Ln } ITFP = \text{Ln } ITFP_t - \text{Ln } ITFP_{t-k}
$$

Note that this aggregate TFP measure does not allow the effects of entry, exit, and reallocation of resources on productivity changes to be examined. Thus, a framework is needed that would allow the industry level productivity changes to be decomposed and would also explain how productivity changes based on firm level dynamics. One approach is to decompose the aggregate industry level productivity measure into four sources: (1) changes from within plant productivity; (2) changes from reallocation of factors towards more productive plants; (3) changes from plant entry; and (4) changes from plant exit. To accomplish this, the plants must be classified into three groups: (1) survivors (those plants that survived/operated the entire time period); 2) exiters (those plants that were in the market in year $t_k$, but quit in year $t$); and (3) entrants (those plants that were not in the market in year $t_k$, but entered in year $t$). The decomposition of industry level productivity can then be illustrated as follows:

$$
\Delta \text{Ln } ITFP = \sum_{j\in s} \Delta \text{Ln } ITFP_{jt}(S_{jt-k})
$$

$$
+ \sum_{j\in e} \Delta S_{jt}(\text{Ln } TFP_{jt})
$$

$$
+ \left[ \sum_{j\in e} \text{Ln } TFP_{jt}(S_{jt}) - \sum_{j\in q} \text{Ln } TFP_{jt-k}(S_{jt-k}) \right]
$$

where $\text{Ln } TFP_{jt}$ is the logarithm of total factor productivity at the plant $j$; $\text{Ln } ITFP_t$ is the industry level total factor productivity; $S_{jt}$ is the output share at the $i$th plant; $\Delta$ represents the change from year $t_k$ to $t$; and the subscripts $s$, $e$, and $q$ represents the exporters, the entrants, and the exiters, respectively. The first term of the right side of Equation 4 stands for the productivity improvements within individual plants (within-plant effect). The following term is the productivity effect coming from the reallocation of resources toward high productivity plants (the reallocation or between effect); the third term represents the entry effect which will occur if entrants are more productive than the survivors; and the last term indicates

\[\text{Ln } TFP = \sum_{i=1}^{N} S_{it}(\text{Ln } TFP_{it})\]

\[\Delta \text{Ln } ITFP = \text{Ln } ITFP_t - \text{Ln } ITFP_{t-k}\]

\[\Delta \text{Ln } ITFP = \sum_{j\in s} \Delta \text{Ln } ITFP_{jt}(S_{jt-k})\]

\[+ \sum_{j\in e} \Delta S_{jt}(\text{Ln } TFP_{jt})\]

\[+ \left[ \sum_{j\in e} \text{Ln } TFP_{jt}(S_{jt}) - \sum_{j\in q} \text{Ln } TFP_{jt-k}(S_{jt-k}) \right]\]
the exit effects which occur if low productivity plants exit. The difference between entry and exit effects is called the turnover effect (or the net entry effect), which is just the productivity effect of entry less the productivity effect of exit.

The decomposition in Equation 4, however, has been criticized because of the calculation of the net entry effect. Note that the contribution of net entry is just the difference between the weighted average of the entrants’ and the exiters’ productivity effects. Therefore, the above decomposition will result in a positive net effect if the output share of entrants is higher than that of the exiters; regardless of whether or not they have the same productivity at the beginning and end of the period. That is, even if there are no differences in productivity between entering and exiting plants, a positive net entry effect can be concluded just because the output share of the former is greater than the latter.

In light of this shortcoming, an alternative decomposition methodology suggested by Foster et al. (1998) is used in this study:

$$\Delta \ln \text{ITFP}_j = \left[ \sum_{j \in s} \Delta \ln \text{ITFP}_{j}(S_{j-t}) \right] + \left[ \sum_{j \in s} \Delta S_j (\ln \text{ITFP}_{j-t} - \ln \text{ITFP}_{t-k}) \right]$$

$$+ \left[ \sum_{j \in s} \Delta \ln \text{ITFP}_{j} \Delta S_j \right] + \left[ \sum_{j \in s} S_j (\ln \text{ITFP}_{j-t} - \ln \text{ITFP}_{t-k}) \right] - \left[ \sum_{j \in s} S_{j-t} (\ln \text{ITFP}_{j-t} - \ln \text{ITFP}_{t-k}) \right]$$

where the first term represents the within plant effect (weighted by the initial industry output shares); the second term reflects the reallocation effect (weighted by the divergence of the initial plant productivity from the initial industry productivity); the third term is a cross-effect (i.e., covariance between LnITFP and output); and the last two terms reflect the entry effect and exit effect, respectively. The net entry effect (also called the turnover effect) is just the difference between the entry and exit effect. The within plant effect is the part of industry-level productivity growth due to efficiency improvements within each plant. If the only reason industry productivity grew was that every single plant was becoming uniformly more productive, this term would capture all of the increase in productivity. The reallocation effect on the other hand captures the aggregate productivity improvements coming from output shares being reallocated from less productive surviving plants to more productive ones. The cross effect is a covariance measure that shows how interrelated changes in plant-level productivity and changes in market share really are. In a sense, this term captures the aggregate productivity improvements of growing plants (i.e., plants that are in the process of becoming more productive) that have increasing market shares. A greater positive cross-effect implies that share of the industry output going to growing plants are increasing.

In this decomposition approach, an increase in the output share affects the reallocation effect positively only if their productivity is higher than the average initial industry level productivity. The exit effect will be positive only if the plants that exit have lower productivity than the average initial industry level productivity. Similarly, the entry effect will be positive only if the entrants have a higher productivity than the average initial industry level productivity.

IV. RESULTS

Plant-level productivity analysis results

Kernel density estimates for the plant-level TFP measure are used to summarize the distribution of plant productivity. Figures 1–3 gives the cross-section kernel density estimates of productivity for the three industries considered in this study. The kernel density was estimated for two time periods, from 1987–1992 and 1992–1997, to examine how the productivity distribution changes from the first half of the period under consideration (1987–1997) to the second half of the time period (i.e. whether there are productivity improvements or declines).

For the textile industry, there is a clear rightward shift in productivity during the period 1992–1997 (Fig. 1). Hence, there is an improvement in the plant-level productivity distribution from the initial period to the second. On the other hand, the distribution of plant level productivity for the apparel industry seemed to have shifted to the left over time (Fig. 2). This indicates that the apparel industry experienced productivity declines over the time periods considered. For the motor vehicle and parts industry, there was no significant productivity shifts from the 1987–1992 period to the 1992–1997 period (Fig. 3). This is an indication that the productivity of plants in the motor vehicle and parts industry remained relatively stable over the two time periods.

See Foster et al. (1998) for further discussion.
Aggregate industry-level productivity analysis results

Based on the plant-level analysis above, the textile industry seem to be experiencing productivity improvements, the apparel industry seem to be experiencing productivity declines, and the motor vehicle and parts industry seem to have constant productivity. These results may lead to the conclusion that the process of creative destruction is strong in the textile industry. However, in order to assess the case for creative destruction more fully, it is necessary to examine the microfoundations of aggregate industry-level productivity growth using the decomposition methodology described above.

Table 2 presents the results of the aggregate industry-level productivity growth decomposition for the Turkish textile, apparel, and motor vehicle and parts industries. Together with the aggregate industry-level TFP measure (2nd column), Table 2 shows the decomposition of this aggregate measure into the within-plant effect, the reallocation effect, the cross-effect, the entry effect, the exit effect, and the turnover effect. The decomposition results for the textile, apparel, and motor vehicle and parts industries are discussed below, in turn.

In the textile industry, the turnover effect had the largest contribution to aggregate industry-level productivity growth for the whole time period under consideration (1987–1997). The second biggest positive contribution for this time period came from the within plant effect. The other sources of aggregate productivity growth, except the entry effect, contributed negatively. These results suggest that from 1987–1997 the major sources of improved productivity were due to the entrance of more productive plants and productivity improvements of existing plants.

Even with these general results it is helpful to examine the results of the decomposition analysis for different time periods within the ten-year period considered in the study, as in the plant-level analysis. For the period 1987–1992, the productivity decomposition results in the textile industry are very similar with the ten-year (1987–1997) decomposition results. Majority of the aggregate productivity growth in this period came from entering plants and within plant productivity enhancement. However, for the period 1992–1997, the results are substantially different. In this period, majority of growth in the textile industry is from the cross-effect and the exit effect. In addition, the turnover effect in the textile industry is negative in this period. These results suggest that productivity growth came mainly from reallocation of output shares to existing plants with growing productivities. The negative turnover effect, on the other hand, suggests that exiting plants were more productive than entering plants for this time period.

In the apparel industry, the major contributors to aggregate productivity growth for the whole period (1987–1997) were the cross effect and the entry effect. This suggests that
entry of more productive plants and the increasing shares of existing plants with increasing productivity is what drove the aggregate growth in the period 1987–1997. This decomposition result is very similar to results from the initial period from 1987–1992. However, the decomposition results from the time period 1992–1997 is slightly different. In this period, the cross effects is still dominant but the turnover effect now became negative. This means that exiting plants in the apparel industry seem to be more productive than entering plants for this time period (which is the same result as in the textile industry). Note that the decomposition results for the textile and apparel industries are very similar, especially for the period 1992–1997.

In the motor vehicle and parts industry, the within effect is the most dominant and the only positive contributor to aggregate productivity growth for the whole time period 1987–1997. This means that productivity improvements from within each of the existing plant in the industry was the only source of growth. When only the period from 1987–1992, is considered the within effect is still the most dominant source of growth but there is also a positive contribution from the cross effect. For the period 1992–1997, on the other hand, only the cross effect had a positive contribution to growth. Interestingly, for both the whole period (1987–1997) and the two subperiods considered here (1987–1992 and 1992–1997), the turnover effect was consistently negative. Again, this suggests that exiting plants are more productive than entering plants in the time period considered.

In general, the empirical regularities that can be drawn from the aggregate decomposition analysis are: (1) the dominant contribution of either the within or the cross effects in all of the industries, and (2) the negative turnover effect (especially in the period 1992–1997). Clearly the positive within-plant and cross effects support the general Schumpeterian notion of creative destruction in the sense that competition provides incentives for existing plants to better themselves and improve their productivity. However, the negative turnover effect does not support the creative destruction hypothesis because this negative effect suggests that exiting plants are more productive than entering plants. This is especially interesting for the textile industry because when the plant-level productivity measures are used it can mistakenly be concluded that the right-ward productivity distribution shift supports Schumpeter’s creative destruction hypothesis. But in fact, the decomposition results suggest otherwise since there is a strong negative turnover effect in this industry for the period 1992–1997.

The negative turnover effects in the three Turkish manufacturing industries deserve more discussion here given that this is not one of the empirical regularities observed in the empirical literature and it does not support the Schumpeterian notion of creative destruction. First consider the Turkish textile and apparel industries. Note that in these two industries the negative turnover effect occurred in the period 1992–1997. Prior to this period, many firms/plants entered the market due to the improving export market situation and the impending membership of Turkey to the European Custom Union. Together with low sunk costs of entry, these two factors gave incentives for firms/plants to enter the industry without a thorough

<table>
<thead>
<tr>
<th>Time period</th>
<th>Total effect</th>
<th>Within effect</th>
<th>Between effect</th>
<th>Cross effect</th>
<th>Entry effect</th>
<th>Exit effect</th>
<th>Turnover effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Textile industry</td>
<td>Whole period: 1987–1997</td>
<td>0.090</td>
<td>0.059</td>
<td>-0.085</td>
<td>-0.031</td>
<td>0.051</td>
<td>-0.096</td>
</tr>
<tr>
<td></td>
<td>Sub-periods: 1987–1992</td>
<td>0.185</td>
<td>0.039</td>
<td>-0.067</td>
<td>0.001</td>
<td>0.116</td>
<td>-0.096</td>
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<tr>
<td></td>
<td>1992–1997</td>
<td>-0.090</td>
<td>-0.057</td>
<td>-0.020</td>
<td>0.062</td>
<td>-0.036</td>
<td>0.035</td>
</tr>
<tr>
<td>B. Apparel industry</td>
<td>Whole period: 1987–1997</td>
<td>0.100</td>
<td>-0.072</td>
<td>-0.007</td>
<td>0.161</td>
<td>0.025</td>
<td>0.007</td>
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<tr>
<td></td>
<td>Sub-periods: 1987–1992</td>
<td>0.074</td>
<td>0.003</td>
<td>-0.019</td>
<td>0.077</td>
<td>0.014</td>
<td>0.001</td>
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<tr>
<td></td>
<td>1992–1997</td>
<td>0.039</td>
<td>-0.010</td>
<td>-0.091</td>
<td>0.181</td>
<td>-0.019</td>
<td>0.022</td>
</tr>
<tr>
<td>C. Motor vehicle and parts industry</td>
<td>Whole period: 1987–1997</td>
<td>0.170</td>
<td>0.196</td>
<td>-0.039</td>
<td>0.034</td>
<td>-0.046</td>
<td>-0.025</td>
</tr>
<tr>
<td></td>
<td>Sub-periods: 1987–1992</td>
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<td>0.164</td>
<td>-0.050</td>
<td>0.058</td>
<td>-0.017</td>
<td>-0.008</td>
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<tr>
<td></td>
<td>1992–1997</td>
<td>0.016</td>
<td>-0.006</td>
<td>-0.033</td>
<td>0.107</td>
<td>-0.066</td>
<td>-0.014</td>
</tr>
</tbody>
</table>
analysis of the institutional and market situation. These entering plants were equipped with new technologies and are more productive than existing ones. However, the institutional structure in Turkey was not set-up to support the increased capacity in this sector. In addition, the presence of market imperfections (i.e. financial underdevelopment) and sluggish textile/apparel export demand caused the exit of the productive firms that entered prior to 1992–1997. Consistent with Caballero and Hammour’s (2000) insights, the productivity effects of the efficient market entrants was not fully captured in the long-term because of the institutional and market constraints in the economy.

The situation for the Turkish motor vehicle and parts industry is slightly different. Note that this industry can be characterized as a highly concentrated industry with high sunk costs. Hence, the existing plants in this industry have already incurred the high sunk cost and have operated efficiently over the years. Since entering plants will need to incur this high sunk cost and, given that competition is stiff in a highly concentrated industry, this suggests that it is more likely for these entrants to be less productive than existing plants and those plants that are exiting the market (Lambson, 1991). Thus, this will result in a negative turnover effect. The institutional constraint of Caballero and Hammour (2000) that prevents the proper functioning of the creative destruction process in this case is the high sunk cost.

V. CONCLUSIONS

This article empirically investigates the Schumpeterian notion of creative destruction using Turkish manufacturing data. The analysis primarily used an aggregate productivity decomposition framework for analysing the sources of productivity growth and to shed light on the creative destruction process for the case of a low-middle income economy like Turkey. The estimation results are supportive of the creative destruction hypothesis in the sense that productivity enhancements in existing firms (even in the presence of simultaneous exit and entry) is the main source of productivity growth in the textile, apparel, and motor vehicles and parts industries of Turkey. However, the results contradict the Schumpeterian concept of creative destruction in the sense that exiting firms in the Turkish manufacturing industry do not seem to be less productive than entering firms. This supports Caballero and Hammour’s (2000) contention that institutional constraints and market imperfections may lead to the non-functioning of the creative destruction process.

These results point to the need for low middle-income economies to strengthen their institutional and market structures first if they want Schumpeter’s creative destruction process to function properly and sustain economic growth. Since lower income economies are more likely to have more institutional and market constraints, it is not a leap to conjecture that this could also be true for these developing/low income economies. With respect to the Turkish economy in particular, it is believed that the creative destruction process can be strengthened with the presence of an institutional support mechanism that would help potential entrants examine industry structure, dynamics, and trade patterns more carefully before they enter the industry. This mechanism will allow these potential entrants to plan and organize more effectively. Consequently, if they decide to enter, this advanced planning and organization may enable them to be more productive and survive much longer in the industry.

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