Export Orientation, Import Competition and Plant Survival in Indian Manufacturing

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ABSTRACT

While there have been a large number of studies on survival of industrial plants and firms, most undertaken for industrialized countries, there is hardly any such study for India. In this paper, survival of organized sector manufacturing plants in India is analyzed by estimating the Cox Proportional Hazard Model from two sets of plant-level data, one for the period 1998-99 to 2012-13 and the other for the period 2006-07 to 2012-13, both drawn from the Annual Survey of Industries (Central Statistics Office, Government of India). The main issue investigated is how survival probability of Indian manufacturing plants is impacted by (a) their export orientation and (b) the import competition they face in domestic markets. The results of the econometric analysis indicate that increased export orientation of manufacturing plants in India tends to improve their survival probabilities, consistent with the finding of several similar studies undertaken for other countries, and that enhanced import competition in India, particularly from China, tends to reduce survival probabilities of manufacturing plants. Also, there is indication from the empirical analysis that the 2008-2012 global recession had increased the risk of closure of manufacturing plants in India.

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The views and opinions reflected in this paper are that of the authors alone.

1. Introduction

There has been a large number of studies on the determinants of survival and closure (or exit) of manufacturing plants or manufacturing firms (based on plant-level or firm-level data). Most of these studies have been undertaken in the context of developed countries, though such studies for emerging nations or developing countries are also available. The Cox Proportional Hazard Model has commonly been applied in such studies to examine the impact of various factors on the survival (or risk of closure) of manufacturing plants/ firms (other models such as Probit or Complementary log-log have also been applied).[1] A variety of determinants have been considered for the analysis, and accordingly the focus of the studies has varied. The issues investigated include the impact of trade on plant/firm survival and whether plants belonging to multinational firms have lower survival probabilities than plants belonging to domestic firms. Other issues considered in the studies include the impact of productivity and the size of the plant/firm on survival probability. There has been hardly any study on the survival of manufacturing plants/firms in India. One notable exception is the study of survival of pharmaceutical firms in India undertaken by Chadha and Ying.[2] They have examined the restructuring that has taken place in India's pharmaceuticals industry after TRIPS and how that restructuring has impacted the survival probabilities of pharmaceutical firms. This paper makes an attempt to analyze the impact of export orientation of manufacturing plants in India on their survival probabilities. The impact of import competition on plant survival is also examined. The analysis is undertaken by estimating the Cox Proportional Hazard Model[3] from plant-level data for manufacturing drawn from the Annual Survey of Industries (Central Statistics Office, Government of India). In trying to link trade with plant survival, this study is perhaps the first of its kind for India.

Trade is expected to have a significant impact on survival probabilities of manufacturing plants. Going by the findings of earlier studies (discussed later), it seems logical to hypothesize that greater export orientation of a manufacturing plant will enhance its survival probability whereas an increased import competition will lower its survival probability. These two hypotheses are empirically tested in this paper by using data on organized sector manufacturing plants in India. The paper is organized as follows. The next section discusses briefly the findings of some of the earlier studies on plant/firm survival which had a focus on the impact of trade and globalization. Section 3 describes the data sources used for the present study and the construction of variables. Section 4 presents an analysis of export orientation of manufacturing plants in India. Section 5 is devoted to the analysis of plant survival. It presents the estimates of the Cox Proportional Hazard Model and discusses the results obtained. Finally, in Section 6, some concluding remarks are made.

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1 Probit model has been applied for survival analysis in Andrew B. Bernard and J. Bradford Jenson, "Firm Structure, Multinationals and Manufacturing Plant Deaths," *Review of Economics and Statistics* 89, no. 2 (2007): 193; Holger Görg and Marina-Eliza Spaliara, "Financial health, Exports, and Firm Survival: Evidence from UK and French Firms," *Economica* 81, no. 323 (2014); Complementary log-log model has been applied in Ana M. Fernandes and Caroline Paunov, "The Risks of Innovation: Are Innovating Firms Less Likely to Die?," *World Bank Policy Working Pape*r, no. 6103 (2012).

2 Alka Chadha and Zhiliang Ying, "TRIPs, Innovation and Survival of Indian Pharmaceutical Firms," *Editorial Express*, 2008, https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IIOC2008&paper_id=229 (accessed November 18, 2015).

3 This is a standard and commonly used technique of survival analysis and hence details are not provided in the paper. Interested readers may see, among others, A. Colin Cameron and Pravin K. Trivedi, *Microeconometrics: Methods and Applications* (Cambridge: Cambridge University Press, 2005), 573.

2. Findings of Some Earlier Studies

As mentioned above, a large number of studies have been undertaken on the determinants of survival and closure/exit of manufacturing plants or manufacturing firms. One group of studies has looked into the co-relation of plant/firm survival to foreign direct investment. Bernard and Jensen, for instance, in their study of manufacturing plants in the US, find that plants belonging to multi-plant firms and those owned by US multinationals are less likely to exit.[4] They point out, however, that the superior survival chances are due to the characteristics of the plants and not because of the nature of the firms. Thus, when they control for plant and industry attributes, they find that plants owned by multi-plant firms and US multinationals are more likely to close. Similar findings have been reported by Bandick from a study of Swedish manufacturing plants. He finds that plants belonging to MNEs (multinational enterprises) are more likely to quit than non-MNE plants.[5] Among non-MNE plants, the probabilities of exit are higher in non-exporting ones than in exporting ones. The study also comes to the conclusion that the increased foreign presence in Swedish manufacturing may have caused higher exit rates of plants that are non-exporting and non-MNE. The issue of why plants belonging to multi-plant firms tend to have a higher probability of exit has been examined by Inui et al by using data on Japanese plants.[6] They find that such a relationship arises because the domestic multi-plant firms often close the weakest element of the group. As for multi-plant multinationals, their analysis reveals that such firms are more likely to shut plants that lie further upstream in the production process relative to the rest of the firm.

It should be pointed out here that the empirical evidence on the impact of foreign ownership on the probability of firm closure is mixed (although dominated by studies finding the risk of closure to be higher for plants belonging to MNEs than the plants belonging to domestic firms). Studies undertaken by Colombo and Delmastro for Italy,[7] Görg and Strobl for Ireland,[8] Bernard and Sjöholm for Indonesia,[9] et al for Spain,[10] and Gullstrand for Sweden[11] have found that the probability of closure is greater for foreign owned plants than domestically owned plants. The findings of the studies of Bernard and Jensen for the US, and Bandict for Sweden mentioned earlier also point in the same direction. By contrast, some studies do not find this result or have found the opposite result. For instance, the study undertaken by Mata and Portugal for firms in Portugal does not find any marked difference between domestic firms and MNEs in regard to survival probabilities.[12] It

4 Bernard and Jenson, "Firm Structure, Multinationals and Manufacturing Plant Deaths," 193.

5 Roger Bandick, "Multinationals and plant survival in Swedish manufacturing," *University of Nottingham*, 2007,https://www.nottingham.ac.uk/gep/documents/conferences/2007/2007postgradconf/bandick-pgrconf07.pdf (accessed November 12, 2015).

6 Tomohiko Inui et al., "What Causes Plant Closure within Multi-Plant Firms?," *The University of Nottingham*, 2010, http://www.nottingham.ac.uk/gep/documents/papers/2010/10-20.pdf (accessed November 12, 2015).

7 M.G. Colombo and M. Delmastro, "A Note on the Relation between Size, Ownership Status and Plant's Closure Sunk Costs vs. Strategic Size Liability," *Economics Letters*, 69, no. 3 (2000): 421.

8 H. Görg and E. Strobl, "Multinational Companies, Technology Spillovers and Plant Survival," *Scandinavian Journal of Economics* 105, no. 4, (2003): 581.

9 A. B. Bernard. and F. Sjoholm, "Foreign Owners and Plant Survival," *National Bureau of Economic Research*, 2003, http://www.nber.org/papers/w10039 (accessed January 22, 2016).

10 Silviano Esteve Pérez, et al. "The Determinants of Survival of Spanish Manufacturing Firms," *Review of Industrial Organization* 25, no. 3 (2004): 251.

11 Joakim Gullstrand, "Industry Dynamics in the Swedish Textile and Wearing Apparel Sector," *Review of Industrial Organization* 26, no. 3 (2005): 349.

12 José Mata and Pedro Portugal, "The Survival of New Domestic and Foreign-Owned Firms," *Strategic Management Journal* 23, no. 4 (2002): 323.

may be added here that Ferragina et al have studied firm survival in Italy and come to the conclusion that, during the period 2005-07, the foreign MNEs had a greater probability of exit than national firms, but the domestic MNEs had a higher chance of survival.[13]

In a number of studies, the link between export orientation and survival of plants/firms has been explored. A common finding is that greater export orientation improves survival probabilities. As mentioned above, Bandick in his study of Swedish plants finds that among non-MNE plants, the probabilities of exit are higher in non-exporting firms than in exporting firms. A study of Japanese firms undertaken by Kimura and Fujii brings them to the conclusion that global commitments help the Japanese firms improve their survival chances.[14] Small firms benefit from exporting activity, whereas large firms gain from foreign direct investment and foreign outsourcing.

To give a few more examples, Harris and Li have studied survival of UK firms and have found that exporting firms have better survival prospects.[15] The firms that are exporting on a continuous basis have better survival probabilities than the firms that sell only to the domestic markets. The firms that intermittently enter and exit the export market have distinctly higher survival probabilities. In a study of Chinese firms, Dai et al find that exporters have higher survival probabilities than non-exporters irrespective of the trade regime.[16] Similarly, in the previously mentioned study of Spanish firms undertaken by Pérez et al, the authors find that survival probability is relatively higher for exporting firms and firms that are engaged in R&D.[17]

Turning now to import competition, a number of studies have found that import competition tends to enhance the probability of closure among domestic manufacturing firms. To give some examples, Gullstrand found such an effect of import competition on firm survival for Swedish textile firms.[18] Baggs found that tariff reductions in Canada raised the hazard rate of closure of Canadian firms.[19] The study of US manufacturing plants undertaken by Bernard, et al has revealed that competition from imports from low wage countries adversely affects survival of manufacturing plants in the US.[20] They find evidence that the domestic firms adjust their product mix in response to import competition. Harris and Li, in their study of UK firms mentioned earlier, have found that an increase in import penetration leads to higher hazard for the firms that have never participated in international markets and that have exit from exporting.[21]

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13 Anna Maria Ferragina, et al., "Does Multinational Ownership Affect Firm Survival in Italy," *Journal of Business Economic and Management* 15, no. 2 (2014): 335.

14 Fukunari Kimura and Takamune Fujii, "Globalizing activities and the rate of survival: Panel data analysis on Japanese firms," *Journal of the Japanese and International Economies* 17, no. 4 (2003): 538-560.

15 Richard I.D. Harris and Qian Cher Li, "Export-market dynamics and the probability of firm closure: Evidence for the United Kingdom," *Scottish Journal of Political Economy* 57, no. 2 (2010): 145.

16 Meihong Dai et al., "Exports and Firm Survival: Do Trade Regimes and Productivity Matter?," *Applied Economic Letters* 23, no.6 (2016): 457.

17 Pérez, et al., "The Determinants of Survival of Spanish Manufacturing Firms," 251.

18 Gullstrand, "Industry Dynamics in the Swedish Textile and Wearing Apparel Sector", 349.

19 Jen Baggs, "Firm Survival and Exit in Response to Trade Liberalization," *Canadian Journal of Economics* 38, no. 4 (2005): 1364

20 Andrew B. Bernard, et al., "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of US Manufacturing Plants," *Journal of international Economics* 68, no. 1 (2006): 219.

21 Harris and Li, "Export-market Dynamics and the Probability of Firm Closure: Evidence for the United Kingdom," 145.

3. Data Sources and Construction of Variables

The basic data source for this study is the Annual Survey of Industries (“ASI”) which is brought out by the Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. ASI covers organized sector industrial units. It covers units registered under Sections 2m(i) and 2m(ii) of the Factories Act, 1948 (this includes factories employing 10 or more workers with the use of power or 20 or more workers without the use of power). It also covers bidi and cigar manufacturing establishments under the Bidi & Cigar Workers (Conditions of Employment) Act, 1966 with coverage same as above. Bulk of the industrial units or plants covered by ASI belongs to manufacturing and a small portion of the units covered does not belong to manufacturing. In the empirical analysis presented in the paper, only the manufacturing plants have been considered.

For the industrial units surveyed each year, ASI unit-level data contains information on their operational status (whether they were in operation, and if not in operation, whether they were closed or non-existent or open but not operating, etc.). This information has been obtained from unit-level ASI data for surveys for different years, which has then been used to ascertain spells of survival and time points of closure of factories selected for the study. This could be done because there are common factory identifiers across unit-level data of different surveys, from 1998-99 to 2012-13.

To explain this further, in the survey for 2012-13, nine codes have been given for the status of surveyed industrial units. These are: (1) open/operating, (2) closed (for less than three years), (3) non-operating (for less than or equal to three years), (4) deleted, (5) existing but closed and the owner/occupier is not traceable, (6) not existing and the owner/occupier is not traceable, (7) non-response because production not started or accounting year not closed, (8) non-response for other reasons (e.g., relevant records are with court), and (9) deleted due to de-registration or other reasons. Of these codes, code (1) has been treated as survival i.e. the unit is surviving, and codes (2) to (6) have been treated as failure, i.e. the unit is not surviving. The survey data reveal that in 2012-13 about 80% of the surveyed units were open/operating, about 18% of the units were closed, non-operating, deleted or non-existent, and the remaining 2% were non-response cases for other reasons.

It should be pointed out that the ASI survey has two components – the census sector and the sample sector. The census sector covers units employing 100 or more workers. It also covers all eligible units in the north-eastern states of India, whether the employment is above or below 100 (as long as it is registered under the Factories Act or Bidi and Cigar Workers Act i.e. either employing 10 or more with power; or employing 20 or more without power). The units having employment less than 100 and not belonging to north eastern states may also get included in the census sector under certain conditions. When the number of units in the frame for a stratum (a particular four-digit industry, according to National Industrial Classification (“NIC”), in a particular state) falls below a specified limit (at present, the limit for inclusion in the census sector is 4 units or less), all units are taken in the census sector. The census sector units are completely enumerated. The remaining units form the sample sector. Out of the sample sector units, a portion is covered in the survey each year based on probability sampling (in 2012-13, the average sampling proportion was 12%).

The nature of sampling procedure adopted in ASI, described above, is such that some units (relatively large ones or those in north eastern states) get covered each year, while others get covered with a gap (some may not get covered at all within a particular period under consideration). Accordingly, for some units, the year of transition from operating to non-operating state can readily be identified. But, for others, such precise information on the time-point of transition is not available. Yet, one can find from the survey data, the last year when a particular industrial unit was covered in the survey and what was its operational status in that year, which is sufficient for estimating the Cox Proportional Hazard Model, used in this paper for studying the survival of plants. Two datasets have been prepared for the empirical analysis undertaken in this paper. The first dataset covers about 2300 plants. These are those plants which began production in the years 1991-92 to 1998-99 and were found be operational in the ASI survey undertaken for 1998-99. These 2300 plants are traced till 2012-13. The second dataset contains information on around 14,000 plants. These plants started production in the years 2000-01 to 2006-07 and were found to be operational in the ASI survey for 2006-07. These plants have been traced till 2012-13.

Attention may be drawn here to the fact that a unit which is not operational in a year may turn into an operating unit in a subsequent year. This introduces the possibility of multiple spells for a factory – closing down and becoming non-operational in one year and then reviving again in a subsequent year. In the survival analysis literature, econometric techniques have been suggested to handle multiple spells.[22] However, the analysis in this paper has been kept simple. Only the first spell of the selected factories during the period under study has been considered for the analysis; this is from the time a factory starts production and till the time the factory becomes non-operational or till the time the factory becomes right-censored, i.e., the factory was in operation at the last time it was surveyed and no information on its operational status is available for subsequent years.

As explained above, the information on the status of surveyed units in unit-level data of ASI provides data on survival spells of factories needed for the estimation of the Cox Proportional Hazard Model. Additionally, data is needed on covariates or regressors. For a factory selected for the study, data on some of the covariates such as ownership and organizational form of the firm to which the selected factory belongs, and the location of the factory (the state in which the factory is located; whether it is in a rural area or in an urban area) has been obtained from the unit-level data of ASI. Since the focus of the study is on the impact of trade on survival of manufacturing plants, some trade related variables have been incorporated in the model estimation. This is further explained below, along with the data sources used.

In the analysis based on the first dataset which covers the period 1998-99 to 2012-13, an attempt has been made to relate inter-temporal changes in the global trade scenario and import competition in India to the survival of manufacturing plants. Thus, the growth rate in world exports[23] and the growth rate in India's non-oil imports have been taken as explanatory variables. Data on India's imports has been taken from Handbook of Statistics on Indian Economy published by the Reserve Bank of India. Data on global exports has been taken from International Trade Statistics (World Trade Organization).

In the analysis based on the second dataset which covers the period 2006-07 to 2012-13, a much more analysis treatment has been given to trade orientation of manufacturing plants and import

22 Cameron and Trivedi, *Microeconometrics: Methods and Applications,* 640.

23 Since the analysis of the first dataset focuses on inter-temporal changes in the trade scenario and the factory level data on export share in output is available only for a limited period, the years 2008-09 to 2012-13, but not for earlier years, export orientation of factories has not been included as an explanatory variable in the models estimated from the first dataset.

competition faced by them. The ratio of exports to output has been obtained for the selected factories for the years 2008-09 to 2012-13 from unit level data of ASI and an average for the five years has been taken for each firm.[24 25] A second set of variables have been formed at the four-digit industry level of NIC. The variables are the ratio of imports to domestic production and the ratio of imports from China to total imports from all sources. Computation of these ratios required data on India's imports and data on domestic production. All these data are needed at four-digit NIC level. Domestic production data at industry-level have been taken from the published reports of ASI. Trade data have been taken from UN COMTRADE by using the WITS software of the World Bank. The advantage of using this source is that trade data are available in ISIC (International Standard Industrial Classification) Revision-3 which can be matched with domestic production data obtained from ASI.

Two sets of ratios have been computed: one for the years 2005-06 to 2007-08 and the other for the years 2008-09 to 2012-13. In the former case, the production and trade data could be well matched for a majority of four-digit industries comprising manufacturing (because trade data could be obtained according to ISIC revision-3, and it is this classification that was the basis of the industrial classification used by ASI). In the latter case, i.e., ratios for the years 2008-09 to 2012-13, there were some difficulties in matching (because from 2008, ASI shifted to a classification based on ISIC revision-4, whereas the WITS provides data at ISIC revision-3) the production and trade data. The aforesaid two ratios relating to imports could be computed for a majority of the four-digit industries, but the matching of trade data with domestic production data was not as good as that obtained for the years 2005 to 2007. For use in the econometric estimation of the model, the import related ratios have been averaged over years; one set of ratios is the average for the period 2005-06 to 2007-08 and the other set is the average for the period 2008-09 to 2012-13.

4. Export Intensity of Manufacturing Plants

Analysis of the impact of trade on plant survival is presented in the next section, i.e., Section 5. One of the hypotheses put to test is that relatively greater export orientation of manufacturing plants enhances their survival probabilities. As an initial step towards the analysis of the link between export orientation and plant survival, it would be useful to study inter-plant variation in export intensity of plants. This is attempted in this section.

It should be pointed out here that the information on export intensity of plants provided in unit-level data of ASI is not regarded as entirely reliable as this piece of information is not a validated one. Nonetheless, an analysis of export intensity of plants in ASI unit-level data may provide valuable insight into export behavior of manufacturing plants in India. Table 1 shows the percentage distribution of plants according to the reported level of export share in output for the year 2012-

24 For a portion of the factories, this information on export intensity is not available. The reason is that such factories were covered in the 2006-07 ASI survey, but did not get covered in the surveys for the years 2008-09 to 2012-13. Consequently, when export intensity is used as a regressor for the estimation of the Cox model, a sizeable part of the observations cannot be used. The same problem is there with the import competition variable. In this case too, the required information is missing for a sizeable part of the observations.

25 It should be pointed out that for some factories data on export intensity is available for five years, 2008-09 to 2012-13, but for some others, it is available for only for one or two years. The average has been computed accordingly. The factories for which export intensity data are not available at all get excluded from the model when export orientation is included as an explanatory variable.

13. The percentage of all manufacturing plants (about 54,600 plants) and manufacturing plants belonging to private limited and public limited companies (about 23,700 plants) has been shown in the second and third columns of the table respectively. In the last column, a comparison is made with distribution of manufacturing companies according to their export intensity (ratio of exports to sales). The data on manufacturing companies (about 6000 companies for 2012-13) has been taken from the Ace Equity database.

TABLE 1: PERCENTAGE DISTRIBUTION OF PLANTS/FIRMS ACCORDING TO EXPORT INTENSITY, 2012-13

Export intensity range	All manufacturing plants in ASI survey, 2012-13 (%)	Manufacturing plants in ASI survey 2012-13 belonging to private and public limited companies (%)	Manufacturing companies (%)
Nil	92.0	87.1	65.3
Positive and up to 1%	0.4	0.8	5.1
Above 1% and up to 5%	0.8	1.5	6.9
Above 5% and up to 10%	0.6	1.1	3.7
Above 10% and up to 25%	1.1	2.1	7.3
Above 25% and up to 50%	1.1	1.9	4.9
Above 50%	4.0	5.5	6.8
All	100.0	100.0	100.0

(Source: Authors' computations based on unit-level data of ASI for 2012-13, and firm-level data taken from Ace Equity database.)

It is seen from Table 1 that the distribution of all plants according to their level of export intensity is not very different from that for corporate sector plants. In the former case, about 92% of plants report no exports. In the latter case, the corresponding figure is 87%.

The last column of the table brings out that about 35% of manufacturing companies have positive exports. This figure is substantially higher that the corresponding figure (about 13%) for manufacturing plants belonging to private and public limited companies. The gap does not necessarily point to a serious deficiency in the export intensity data in ASI. One needs to allow for the possibility that a company may own several plants and if any of the plants is engaged in exports, the export intensity of the company will be found to be positive whereas some of its plants will be recording zero exports in ASI data. In sum, therefore, the export intensity data available from ASI, despite its known limitations, may be good enough for use in empirical analysis of export behavior and related issues.

Inter-plant variation in export intensity

To study inter-plant variation in export intensity, an export function has been estimated. Data on export intensity of manufacturing plants for the year 2011-12 has been used for this analysis. The analysis is confined to 20 major states.

The estimated exports function is presented in Table 2. The dependent variable is export intensity, i.e., ratio of exports to output. The explanatory variables used for the model are (a) plant size-measured by logarithm of value of fixed assets, (b) ratio of imported materials to total materials consumed, (c) technical efficiency of the plant which has been obtained by estimating a stochastic frontier production function,[26] (d) share of contract workers out of total workers employed, (e) effective excise duty on the plant measured by the ratio of excise duty payment made by the plant to the value of output, and (f) a dummy variable reflecting whether the plant is located in urban areas. In addition to these variables, industry dummy variables (at two-digit NIC level) and state dummy variables have been included in the model to take into account industry-specific and state-specific effects. For a very high proportion of plants (over 90%), the reported export intensity is zero (as indicated by Table 1 which shows the distribution for 2012-13). Thus, the Tobit model has been applied for econometric estimation, taking the lower limit of the dependent variable as zero and upper limit as 100%.

From the estimated export function shown in Table 2, the following inferences may be drawn: (a) Export intensity is positively related to plant size, i.e., *ceteris paribus*, export intensity is relatively higher for bigger plants. (b) Export intensity is positively related to import intensity of a plant. A plant in which imported materials form a relatively high portion of total materials used has higher export intensity than a similar plant that does not use imported materials. (c) Export intensity bears a positive relationship with the level of technical efficiency of a firm. Thus, relatively more efficient firms have relatively higher export intensity.

TABLE 2: DETERMINANTS OF EXPORT INTENSITY OF MANUFACTURING PLANTS, 2011-12, ESTIMATES OF TOBIT MODEL

Explanatory variables	Coefficient	t-statistic
Plant size (logarithm of net fixed capital stock)	15.24	32.38#
Ratio of imported materials to total materials consumed	0.84	18.19#
Technical efficiency of the plant (estimated with the help of a stochastic frontier production function)	32.75	5.93#
Share of contract workers out of total workers employed	15.64	5.99#
Effective excise duty rate (excise duty paid by the plant in a year divided by annual output)	-294.8	-10.06#
Located in urban areas (dummy)	11.05	5.48#
Industry effects (two-digit industry dummies)	Yes	
State effects (state dummies)	Yes	
Pseudo R-squared	0.09	
No. of observations	37,088	

 # statistically significant at one percent level.
(Source: Authors' computations using unit level data of ASI for 2011-12.)

26 The form of the production function is taken as Cobb-Douglas. Value added is taken as the measure of output and labour and fixed capital are taken as two inputs. The estimation of technical efficiency by using a stochastic frontier production function is a standard econometric technique, and hence the methodological details are not provided here. Interested readers may see, Subal C. Kumbhhkar and C.A. Knox Lovell, *Stochastic frontier analysis* (Cambridge: Cambridge University Press, 2003).

One may here raise an econometric issue that export intensity may have a two-way relationship with import intensity – the two variables may be interdependent. The same issue may be raised about the relationship between export intensity and technical efficiency of a plant. For properly addressing this econometric issue, the instrumental variable method needs to be applied.[27] This is not done in this paper. Yet, it seems it would not be wrong to infer that higher levels of technical efficiency and the use of imported materials enable manufacturing plants to attain a relatively higher level of export intensity.

The estimates of the export function given in Table 2 indicates that, *ceteris paribus*, a plant located in an urban area has higher export intensity than a similar plant located in a rural area. This is perhaps a reflection of greater availability of infrastructure in urban areas and greater awareness of international markets. Interestingly, the use of contract workers seems to bear a positive relationship with export intensity. This is possibly a reflection of the flexibility needed for serving international market which is provided by the use of contract workers.

Another interesting finding is the strong negative relationship observed between the effective rate of excise duty on a plant and the export intensity of the plant. Since the exported items of a manufacturing plant are not subject to excise duty, the observed negative effect is probably a reflection of the financial constraint a plant faces because of excise duty burden. This matter needs further investigation which is beyond the scope of this paper.

Inter-state differences in export intensity of manufacturing plants

While examining inter-plant variation in export intensity, an interesting issue to investigate is how different states in India fare in this regard. Such an analysis is difficult to undertake using company balance sheet data. But, ASI data has an advantage. In ASI unit-level data, the location of the plant is known and it becomes easier to compare states in terms of export intensity of manufacturing plants. The comparison is shown in Table 3 in respect of 20 major states. First, the average export intensity of all (organized sector) manufacturing plants is shown for different major states, and then the ratio is shown for relatively bigger plants – those employing 50 or more persons. The last column of the table gives the estimated coefficients of the state dummy variables in the exports model presented in Table 2. The advantage in examining the coefficients of state dummy variables is that differences in industry composition and certain other factors such as plant size, import intensity, efficiency have been controlled for.

Table 3 brings out that export intensity of manufacturing plants is relatively high in Haryana, Karnataka, Kerala, Maharashtra, Tamil Nadu and Uttar Pradesh, whereas it is relatively low in Assam, Bihar, Chhattisgarh, Goa, Himachal Pradesh, Jharkhand, Madhya Pradesh, Odisha, and Uttarakhand.

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27 For a discussion on instrumental variable method, see, among others, Marno Verbeek, *A Guide to Modern Econometrics* (New Jersey: John Wiley & Sons, 2008).

TABLE 3: EXPORT INTENSITY OF MANUFACTURING PLANTS, BY STATE

State	Average export intensity (%), all plants	Average export intensity (%), plants with 50 or more employees	Coefficient of the state dummy variable in the estimated export model@
Andhra Pradesh	3	6	-37.1(-8.7)#
Assam	2	1	-23.4(-3.0)#
Bihar	1	0	-54.3(-4.3)#
Chhattisgarh	1	1	-68.8(-5.8)#
Goa	2	3	-80.0(-5.7)#
Gujarat	4	5	-33.7(-9.5)#
Haryana	15	21	21.2(5.1)#
Himachal Pradesh	1	1	-73.7(-9.0)#
Jharkhand	0.3	1	-102.8(-5.6)#
Karnataka	7	10	-16.9(-4.3)#
Kerala	10	17	33.2(6.6)#
Madhya Pradesh	1	1	-99.1(-9.8)#
Maharashtra	8	11	0
Odisha	1	1	-91.9(-6.8)#
Punjab	5	9	-8.4(-2.0)
Rajasthan	4	6	-28.3(-5.5)#
Tamil Nadu	9	14	-4.6(-1.5)
Uttar Pradesh	14	22	24.0(6.9)#
Uttarakhand	1	1	-89.1(-11.5)#
West Bengal	6	9	-4.5(-1.0)
All 20 states	6	10	

 # statistically significant at one percent level. @ Maharashtra taken as base category, t-statistic shown in parentheses. (Source: Authors' computations using unit level data of ASI for 2011-12.)

Considering the coefficients of the state dummy variables shown in the last column along with the average export intensity shown in the previous two columns, it seems reasonable to conclude that as compared to manufacturing plants in Maharashtra, the manufacturing plants in Bihar, Chhattisgarh, Himachal Pradesh, Jharkhand, Madhya Pradesh, Odisha, and Uttarakhand have relatively low export orientation. Probably infrastructure bottlenecks and other such factors, including difficulties caused by state level policies, are coming in way of the manufacturing units fully realizing their export potential. This issue needs further investigation, but is beyond the scope of the present paper.

5. Plant Survival: Cox Proportional Hazard Model

This section is divided into two sub-sections. Section 5.1 presents an analysis of plant survival based on the first dataset which covers the period 1998-99 to 2012-13. Section 5.2 presents an analysis of plant survival based on the second dataset which covers a much larger number of plants, but for a shorter time period, 2006-07 to 2012-13. The analysis has been done by applying the Cox Proportional Hazard Model. The analysis in Section 5.1 primarily focuses on inter-temporal variation in determinants of plant survival, while the analysis in Section 5.2 focuses on cross-sectional variation in determinants of plant survival.

5.1. Plant Survival Analysis, 1998-99 to 2012-13

The estimated Cox Proportional Hazard Model is presented in Table 4. Five explanatory variables have been considered. Three of them are plant specific (dummy variables), i.e., (1) whether the plant is located in urban areas, (2) whether the plant belongs to a private limited or public limited company, and (3) whether there is government ownership in the plant. The other two explanatory variables are common to all plants but vary over time. These are: (i) growth rate in India's non-oil imports, and (ii) growth rate in world exports. For each plant, the values of these two time-varying variables are taken for the year in which the plant was last observed in the dataset. The estimates of the model, shown in Table 4, indicates that the risk of closure or exit is higher for a plant located in urban areas than a plant located in rural areas.[28] The survival probability is relatively greater for a plant belonging to a private limited company or public limited company than a plant belonging to other forms of organization such as proprietorship or partnership. Also, if there is government ownership in the plant, the survival probability is significantly higher than a similar plant which is entirely privately owned.

Turning now to the trade variables, it is seen from Table 4 that a relatively high rate of growth in India's non-oil imports is associated with enhanced risk of plant closure. This is arguably the impact of import competition. The hazard ratio for the variable representing growth in global exports is less than one and the difference is statistically significant. The interpretation of this result is that a relatively faster growth in global trade tends to bring down the risk of closure of Indian manufacturing plants.

TABLE 4: ESTIMATES OF THE COX PROPORTIONAL HAZARD MODEL, INDIAN MANUFACTURING PLANTS, 1998-99 TO 2012-13

Explanatory variables	Hazard ratio	t-statistic
Growth rate in India's non-oil imports	1.063	12.78***
Growth rate in world exports	0.961	-6.38***
Located in urban area (dummy)	1.321	3.79***
Belongs to a private limited or public limited company (dummy)	0.824	-2.58***
Government ownership (dummy)	0.254	-2.36**
log likelihood	-5606.5	
LR chi-square [Prob.>Chi-square]	331.5 [0.000]	
No. of observations	2295	

/ statistically significant at five and one percent level respectively.*
(Source: Authors' computations based mainly on unit-level data of ASI.)

28 In Table 4, the coefficients of the estimated Cox Proportional Hazard Model are shown in terms of hazard ratios. Whether the hazard ratio for an explanatory variable is above one or below one indicates the direction of effect of the explanatory variable on the hazard. If the hazard ratio is above one, then an increase in the value of the explanatory variable increases the probability of plant closure (since the hazard ratio is found to be more than one for the urban dummy variable, it may be inferred that if the urban dummy variable changes value from zero to one, the hazard increases). If the hazard ratio is below one, an increase in the value of the explanatory variable reduces the probability of plant closure. Whether the hazard ratio is significantly above one or below one is given by the t-statistic.

The finding that a fast or slow growth in global exports (as the case may be) tends to accordingly lower or raise the risk of closure of manufacturing plants in India (in the model estimate shown in Table 4) would imply that the risk of plant closure had gone up in the recent global economic crisis. This is corroborated by the results of analysis of plant survival based on the Kaplan-Meier estimator of survivor function. When data for the period 1998-99 to 2012-03 is used, it is found that the survivor function falls by about 30% in the first nine years. By contrast, when data for 2006-07 to 2012-13 is used, the survivor function falls by 30% in six years. This shows that the risk of failure was greater in the latter period within which most years were marked by global recession.

5.2. Plant Survival Analysis, 2006-07 to 2012-13

The estimates of the Cox Proportional Hazard Model using data for the period 2006-07 to 2012-13 are is shown in Table 5. The following explanatory variables (or regressors) have been used:

A. Ratio of imports to domestic production in the four-digit industry to which the plant belongs (average for 2005-06 to 2007-08, and average for 2008-09 to 2012-13);

B. Share of China in imports of relevant category of products corresponding to the four-digit industry to which the plant belongs (average for 2005-06 to 2007-08, and average for 2008-09 to 2012-13);

C. Export intensity of the plant (average for 2008-09 to 2012-13);

D. Whether the plant is located in an urban area (dummy variable);

E. Whether plant is located in one of the states with high industrial concentration (dummy variable, assigned value one for Andhra Pradesh, Gujarat, Maharashtra & Tamil Nadu, and zero for other states);[29]

F. Whether the plant belongs to a private limited or public limited company (dummy); and

G. Whether there is government ownership in the plant (dummy).

As noted earlier in the paper, for variables A and B, two variants have been used, because the trade and domestic production data match well for the year 2005-06 to 2007-08, but not for subsequent years. Nonetheless, in both cases, the values of the variables are not available for a portion of four-digit industries. Hence, the model is estimated from a much smaller number of plants than what is available (about 14,000 plants) in the dataset prepared for 2006-07 to 2012-13.[30] The estimates of the model clearly indicate that a plant located in an urban area has higher risk of closure than a plant located in a rural area. This finding is consistent with the estimates of the model presented in Table 4 using data for a smaller number of plants for the period 1998-99 to 2012-13. Similarly, there is indication that a corporate sector plant has lower risk of closure, which is consistent with the results in Table 4. The hazard ratio for the variable representing government ownership is less than one, as in Table 4, but the coefficient is not statistically significant. Nonetheless, considering the two sets of results together, it may be inferred that a plant with government ownership has lower risk of closure than a similar plant entirely under private ownership.

29 These four states have been chosen as their share in the number of factories in ASI data was 9 percent or more.

30 The ratio of imports to domestic production takes very high values for certain industries. Hence, winsorization at 99th percentile has been done so that the model results do not get affected by high values of this variable for certain observations.

TABLE 5: ESTIMATES OF THE COX PROPORTIONAL HAZARD MODEL, INDIAN MANUFACTURING PLANTS, 2006-07 TO 2012-13

Explanatory variable	Model-1		Model-2		Model-3	
	Hazard ratio	t-statistic	Hazard ratio	t-statistic	Hazard ratio	t-statistic
Located in urban area (dummy)	1.475	8.09***	1.455	7.91***	1.478	8.76***
Plant belongs to a corporate sector firm, private or public limited company (dummy)	0.771	-5.38***	0.824	-4.08***	0.785	-5.40***
Government owned (dummy)	0.636	-1.19	0.864	-0.36	0.548	-1.59
Located in a state with high industrial concentration (dummy)	1.266	4.76***	1.252	4.67***	1.236	4.64***
Export intensity of the plant	0.978	-8.76***	0.977	-9.53***	0.977	-9.51***
Ratio of Imports to domestic production in the industry, 2008-12	1.179	2.55**				
Ratio of Imports to domestic production in the industry, 2005-07			1.150	2.21**		
Share of China in imports of the relevant category of products, 2008-12	1.632	3.77***				
Share of China in imports of the relevant category of products, 2005-07			1.329	2.57**		
No. of observations	8536		8603		9766	
Log-likelihood	-15258		-16020.2		-17870.2	
LR chi-squared [prob.>chi-squared]	259.9 [0.000]		256.5 [0.000]		276.5 [0.000]	

Explanatory variable	Model-4		Model-5		Model-6	
	Hazard ratio	t-statistic	Hazard ratio	t-statistic	Hazard ratio	t-statistic
Located in urban area (dummy)	1.403	8.21***	1.374	7.27***	1.388	6.84***
Plant belongs to a corporate sector firm, private or public limited company (dummy)	0.785	-5.86***	0.826	-4.36***	0.740	-6.25***
Government owned (dummy)	0.583	-1.52	0.912	-0.24	0.688	-0.98
Located in a state with high industrial concentration (dummy)	1.175	3.81***	1.188	3.85***	1.245	4.42***
Export intensity of the plant						
Ratio of Imports to domestic production in the industry, 2008-12					1.200	2.81***
Ratio of Imports to domestic production in the industry, 2005-07			1.135	2.14**		
Share of China in imports of the relevant category of products, 2008-12					1.560	3.42***
Share of China in imports of the relevant category of products, 2005-07			1.393	3.25***		
No. of observations	13399		11869		8540	
Log-likelihood	-21174.		-19023.6		-15332.6	
LR chi-squared [prob.>chi-squared]	122.8 [0.000]		97.3 [0.000]		129.4 [0.000]	

***, *** statistically significant at five and one percent level respectively.*
(Source: Authors' computations based mainly on unit-level data of ASI)

The results indicate that a plant located in a state with high industrial concentration has a relatively greater risk of closure. The hazard ratio for this dummy variable is consistently above one and the coefficient is statistically significant at one percent level. One would expect industrial agglomeration to provide greater strength to the factories and, hence, enhance their survival probabilities. But, an opposite result is obtained. This is perhaps a reflection of the fact that in industrially concentrated states there is more intense competition and this raises the risk of plant closure.

Turning now to the trade related variables, export intensity variable has a hazard ratio below one and the coefficient is statistically significant at one percent level. It may be inferred, therefore, that export orientation improves survival probabilities of plants vis-à-vis the plants that do not export. This finding is in agreement with the findings of earlier studies. Regarding import competition, the results clearly indicate that an increase in import competition raises the risk of plant closure. The risk is relatively greater if import competition is from Chinese goods.

To check the robustness of the econometric results obtained, the Cox Proportional Hazard Model has been estimated from data for corporate sector plants, i.e., plants belonging to private limited or public limited companies. The results are reported in Table 6. Two new variables have been added. One is plant size measured by logarithm of fixed capital stock (in 2006-07). The other is a dummy variable to capture the multi-plant character of the firm to which the plant belongs. This dummy variable is assigned value one if the plant belongs to a company that has more than one plant, and zero otherwise.

The model estimates in Table 6 are similar to those in Table 5 and, thus, do not require a detailed discussion. Three points need to be highlighted. First, the results indicate that bigger plant size is associated with relatively lower risk of closure. Second, a plant belonging to a company that has more than one plant has relatively greater risk of closure. This is consistent with the finding of earlier studies (refer to Section 2 of the paper). Third, import competition seems to have less adverse effect on survival probabilities of corporate sector plants. However, when the competition is from Chinese goods, such plants seem to be adversely affected as in the case of plants not belonging to the corporate sector.

TABLE 6: ESTIMATES OF THE COX PROPORTIONAL HAZARD MODEL, CORPORATE SECTOR PLANTS, INDIAN MANUFACTURING, 2006-07 TO 2012-13

Explanatory variable	Model-1		Model-2		Model-3	
	Hazard ratio	t-statistic	Hazard ratio	t-statistic	Hazard ratio	t-statistic
Located in urban area (dummy)	1.347	3.85***	1.423	4.64***	1.392	4.67***
Government owned (dummy)	1.083	0.19	1.006	0.01	0.846	-0.41
Located in a state with high industrial concentration	1.226	2.64***	1.187	2.28**	1.194	2.53**
Export intensity of the plant	0.979	-5.69***	0.979	-6.00***	0.980	-5.96***
Ratio of Imports to domestic production in the industry, 2008-12	1.153	1.46				
Ratio of Imports to domestic production in the industry, 2005-07			1.178	1.92*		
Share of China in imports of the relevant category of products, 2008-12	2.480	4.29***				
Share of China in imports of the relevant category of products, 2005-07			2.592	5.10***		
Plant belongs to a corporate sector firm, which has more than one plant (dummy)	1.220	2.48**	1.226	2.61***	1.234	2.85***
Plant size (logarithm of fixed capital stock)	0.835	-10.45***	0.838	-10.17***	0.833	-11.24***
No. of observations	4011		3869		4624	
Log-likelihood	-5800.0		-6025.1		-6988.5	
LR chi-squared (prob.>chi-squared)	225.2 [0.000]		227.7 [0.000]		239.2 [0.000]	

, **,* statistically significant at ten, five and one percent level respectively.*
(Source: Authors' computations based mainly on unit-level data of ASI.)

As a further check on the robustness of the results of econometric analysis presented in Tables 5 and 6 above, Models 1, 2 and 3 of Table 5 have been re-estimated by including plant size (measured by logarithm of value of fixed capital stock) as an additional explanatory variable. The results are reported in Table 7.

It is evident from the results presented in Table 7 that plant size has a major impact on survival probabilities. The risk of closure is greater for small-size plants. The hazard ratio is below one and it is statistically significant. This is in agreement with the results reported in Table 6 for plants belonging to the corporate sector.

The results in Table 7 in respect of variables representing plant location in an urban area and plant location in a state with high industrial concentration are similar to that in Table 5. The same holds true for the export intensity of the plants. It may be inferred that an export oriented plant has a better survival probability than a plant that does not export. Also, other things remaining the same, a plant located in an urban area or in a state marked by high industrial concentration, or both, has relatively greater risk of closure.

The hazard ratio in respect of government owned plants is less than one but statistically insignificant as in the results reported in Table 5. However, the hazard ratio for corporate sector dummy variable is found to be greater than one in the results reported in Table 7. This result is at variance with the results reported in Tables 4 and 5. It appears that the previous finding that a corporate sector plant has relatively lower risk of closure is to a large extent attributable to the fact that corporate sector plants are generally bigger in size than plants belonging to proprietorship or partnership firms, and once the effect of plant size is controlled for, the corporate sector plants do not have an advantage in survival probabilities. Rather, the fact that the hazard ratio is consistently above one in all three models estimates in Table 7 and statistically significant in two cases seems to suggest that after controlling for plant size, the risk of closure is relatively larger for corporate sector plants.

As regard the import competition variables, the results in Table 7 are similar to those in Table 5. The hazard ratio for the variable representing Chinese import competition is well above one and statistically significant. Thus, taking together the results reported in Tables 5, 6 and 7, there is a clear indication that import competition, particularly from China, tends to increase the risk of closure of indigenous manufacturing plants in India.

TABLE 7: ESTIMATES OF THE COX PROPORTIONAL HAZARD MODEL, INDIAN MANUFACTURING PLANTS, 2006-07 TO 2012-13, ROBUSTNESS CHECK

Explanatory variable	Model-1a		Model-2a		Model-3a	
	Hazard ratio	t-statistic	Hazard ratio	t-statistic	Hazard ratio	t-statistic
Located in urban area (dummy)	1.394	6.73***	1.401	6.91***	1.390	7.19***
Plant belongs to a corporate sector firm, private or public limited company (dummy)	1.095	1.53	1.130	2.11**	1.133	2.27**
Government owned (dummy)	0.851	-0.42	0.985	-0.04	0.727	-0.84
Located in a state with high industrial concentration (dummy)	1.261	4.57***	1.260	4.68***	1.238	4.57***
Export intensity of the plant	0.982	-7.23***	0.981	-7.95***	0.982	-7.84***
Ratio of Imports to domestic production in the industry, 2008-12	1.170	2.41**				
Ratio of Imports to domestic production in the industry, 2005-07			1.176	2.57**		
Share China in imports of the relevant category of products, 2008-12	1.551	3.30***				
Share China in imports of the relevant category of products, 2005-07			1.318	2.47**		
Plant size (logarithm of fixed capital stock)	0.876	-10.91***	0.882	-10.29***	0.870	-12.23***
No. of observations	8341		8404		9553	
Log-likelihood	-14536.9		-15309.2		-17061.3	
LR chi-squared [prob.>chi-squared]	363.9 [0.000]		351.2 [0.000]		405.7 [0.000]	

, statistically significant at five and one percent level respectively.*
(Source: Authors' computations based mainly on unit-level data of ASI.)

6. Concluding Remarks

Survival of manufacturing plants and firms in India and the factors that determine the risk of closure and exit has remained, by and large, a neglected area of research although a large number of studies on these issues have been undertaken for other countries, particularly industrialized countries. This paper has made an attempt to fill this important gap in the literature. The focus of the paper was on the impact of export orientation and import competition on survival of manufacturing plants in India. Other determinants of plant survival (and risk of closure) have also been considered. The Cox Proportional Hazard Model has been used for the analysis, which has found wide application for survival analysis.

It is found from the econometric analysis that export orientation improves survival probabilities of manufacturing plants while intensification of import competition raises the risk of plant closure. These findings of the study are in agreement with the findings reported in the international literature on plant/firm survival.

To highlight some other findings of the study, it is found that a plant belonging to the corporate sector has greater survival probability than a plant not belonging to the corporate sector. But, this advantage is essentially due to relatively bigger size of plants belonging to corporate sector firms. The econometric results indicate that the survival probability of a plant tends to increase with plant size. Once this factor is controlled for, the advantage of corporate sector disappears. Instead, the results seem to suggest that after controlling for plant size, corporate sector plants have relatively greater risk of closure. Also, among corporate sector plants, it is found that a plant belonging to a company having multiple plants has greater risk of closure than a plant belonging to a company that has only one plant. This finding about multi-plant firms is consistent with the findings reported in several other studies.

While there is a concern about import competition from Chinese goods in India, substantial econometric evidence has not been presented till now to indicate that imports of Chinese goods are adversely affecting Indian manufacturing. This paper presents some econometric evidence to that effect. The analysis presented in the paper clearly indicates that in the recent past, import competition from Chinese goods has raised the risk of closure and exit of manufacturing plants in India.