Who Dies? International Trade, Market Structure, and Plant Closures

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Abstract: This paper examines the shutdown of manufacturing plants. Industry and plant-specific factors contributing to plant shutdown are developed in a variety of models. Predictions of market structure models of endogenous plant heterogeneity such as Hopenhayn (1992) are tested on industry and plant level data. In addition, the implications of endowment-based Heckscher-Ohlin trade models for plant entry and exit are tested on 20 years of data for the entire US manufacturing sector. The market structure models correctly predict that entry and exit rates will covary positively across industries. High entry costs cause both low entry and low exit probabilities. The market structure models do poorly in predicting differences in net entry rates across industries. In contrast, Hecksher-Ohlin trade models provide predictions both for which industries will grow (positive net entry rates) and for which regions will see high turnover and net entry of plants. In a country such as the US that is augmenting both its physical and human capital, the least capital-intensive, least skill-intensive plants are correctly predicted to be the most likely to exit. In addition, increases in regional capital and skill intensity are associated with higher probabilities of shutdown, especially for plants and industries with low initial capital and skill intensities. Results are also presented on the role of plant attributes such as ownership structure, efficiency, exporting, and the number of products produced at the plant.

KEY WORDS: entry and exit, firm dynamics, selection, entry costs, Heckscher-Ohlin, Ricardo, multi-plant firms, multi-product plants

JEL Classification: F11, L16, L60

PLANT SHUTDOWN WILL TAKE OUT 275 JOBS
`08/18/1999 Associated Press Newswires`
`VAN WERT, Ohio (AP) - One of the county's largest employers is closing despite an offer of $15 million in government assistance.`

BELGIUM TO SUE RENAULT OVER PLANNED PLANT CLOSURE
`03/03/1997 Dow Jones News Service`

1. Introduction

Closures of manufacturing plants are big news. Local communities and plant workers mobilize to protest the closures, while local politicians often offer financial carrots and sticks to keep the plants open.[1] Increasingly in recent years, headlines accompanying plant closure notices have cited international forces as the reasons behind the shutdowns. In this paper, we examine the empirical implications of existing general equilibrium models of industry structure on plant entry and exit. More importantly, we provide the first evidence on the predictions of international trade models for plant closure.

While the effects of international trade on domestic economies are the subject of heated debate, surprisingly little is known about the actual mechanisms by which trade affects the economy. Trade theory offers predictions about the evolution of industries and economies over the long run, but is usually silent on the means by which the transformations occur. Heckscher-Ohlin trade models, for example, predict changes in industry composition as a result of changing endowments within a country. In a country such as the US which has been increasing both its physical and human capital intensity as shown in Figure 1, these models predict that the mix of industries will change

[1] In contrast, the closure of service sector establishments rarely merits front page headlines.

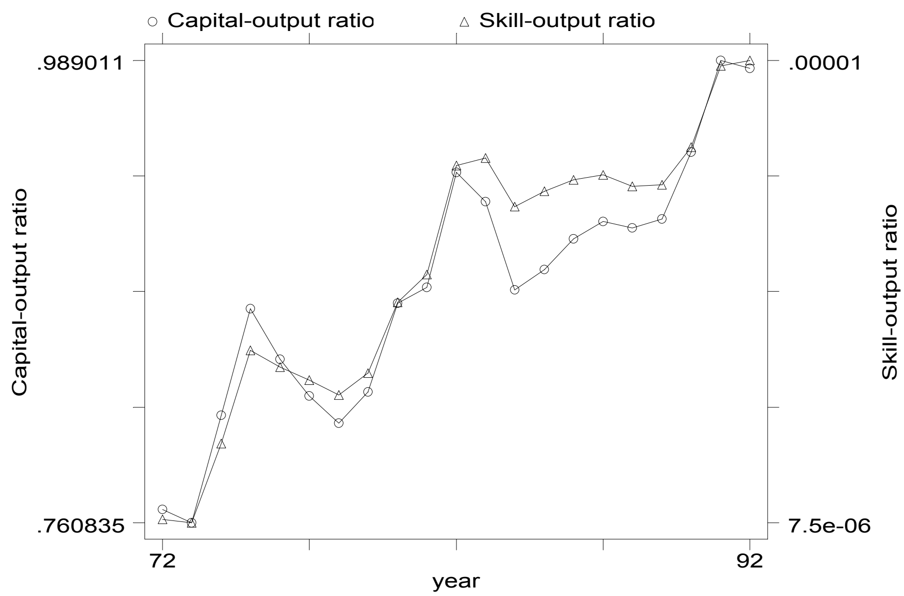

Figure 1: Increases in Capital and Skill Intensity in the US, 1972-1992

towards more capital intensive products.[2] Hanson and Slaughter (1999) report such a shift of product mix in US states in response to increased immigration during the 1980s.[3] Similarly, in Ricardian trade theory, changes in relative productivity can alter the industrial mix. Relatively low productivity industries decline and relatively high productivity industries grow. The models themselves usually do not predict how these changes will show up in the economy. One possibility is for industries to adjust the mix of products entirely at existing plants, simultaneously changing the factor intensities and/or produc-

[2]The data underlying Figure 1 come from Harrigan and Zakrajsek (2000). Skilled labor is measured as the workforce with some secondary education. If we were interested in the factor content of trade we would want to look at the US endowment changes relative to the rest of the world.

[3]Schott (1999) provides evidence on the cross-sectional variation in goods produced by countries with different capital-labor ratios.

tivity at those facilities. At the other extreme, the adjustment comes entirely through exits and entrants as outdated plants are shuttered and new facilities are opened.

In this paper we focus on one possible adjustment margin, the decision to shut down manufacturing facilities and by implication the decision to open new plants. In any five year period, more than 35 percent of existing US manufacturing plants are closed.[4] Typically, smaller establishments are the most likely to exit, but closures are relatively frequent events even for the large facilities that garner so much news coverage. Of plants with more than 250 employees, over 16 percent will close in any five year interval accounting for 7.8 percent of manufacturing employment.

The starting point for most dynamic industry models are the seminal empirical findings of Dunne, Roberts and Samuelson (1988, 1989). Using data on the entire manufacturing sector from 1963-1987, Dunne, Roberts and Samuelson (1988, 1989) find that plant entry and exit rates are correlated across industries. Figure 2 shows the variation in entry and exit rates within and across two digit industries in the US manufacturing sector for 1987-1992.[5] Entry and exit rates do indeed appear to have a strong industry-specific component. Apparel (SIC 23), lumber (24), furniture (25), printing and publishing (27), and misc manufacturing (39) have above average entry and exit rates in most of their 4-digit subsectors. In contrast, paper (26), chemicals (28), petroleum and coal (29), primary metals (33), and fabricated metals (34) show below average entry and exit rates. Hopenhayn (1992a) constructs a dynamic model of industry evolution that attempts to match these facts. In his model, industry-specific entry costs provide for positive covariation in entry and exit rates. One striking attribute

[4] The large number of shutdowns is substantially offset by the large number of new establishments created over a five year period. See Dunne, Roberts, and Samuelson (1988) for evidence on entry and exit from 1963-1987.

[5] Each two digit industry is represented by a pair of box and whisker plots with entry on the left and exit on the right. The boxes represent the interquartile range, the 25th to the 75th percentile. The line within the box is the median. The whiskers extend to ± 1.5* the interquartile range.

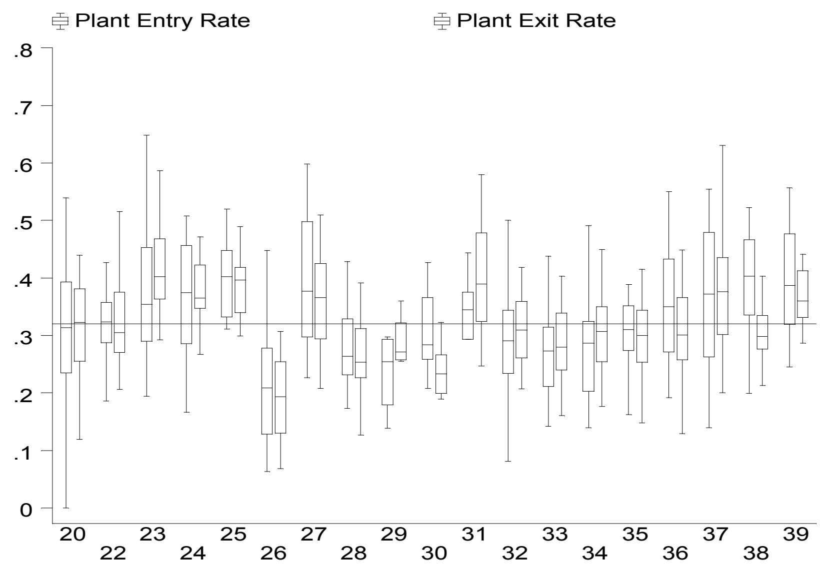

Figure 2: Entry and Exit Rates, 4-Digit (SIC) Industries, 1987-1992

of this class of models is that entry and exit exactly offset one another allowing for no net entry differences across industries.

As reported, but usually overlooked, in Dunne, Roberts and Samuelson (1988), the comovement of entry and exit rates across industries is largely due to persistent industry effects. They find that, controlling for time-invariant industry effects, entry and exit rates move in opposite directions. The variation in net entry rates across four-digit industries is substantial. Figure 3 reports the variation in net entry rates within and across two-digit industries. Again there appear strong industry effects as apparel (23), petroleum (29) and leather (31) have negative net entry for almost all 4-digit industries while subsectors in plastics (30) and instruments (38) almost all have positive net entry. We turn to a simple Heckscher-Ohlin model of endowment-based international trade to understand what is driving the substantial heterogeneity in net entry rates across industries.

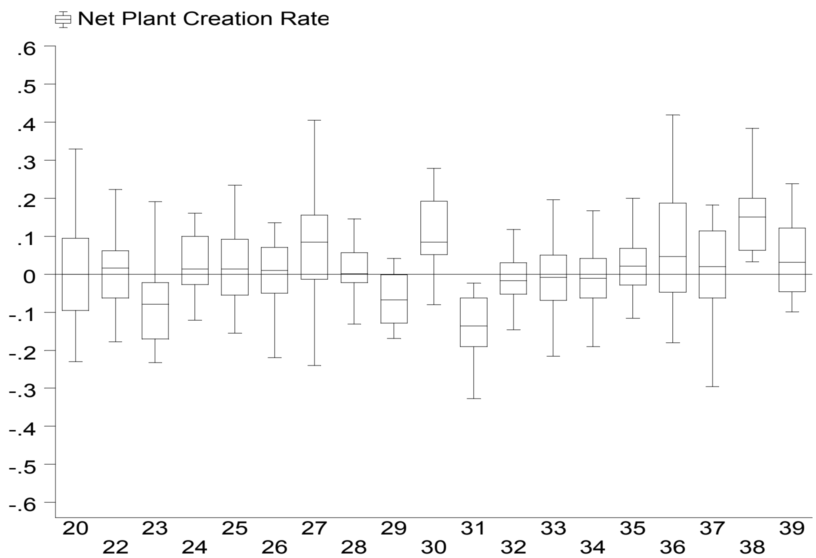

Figure 3: Net Plant Creation Rates, 4-Digit (SIC) Industries, 1987-1992

This paper examines the shutdown of manufacturing plants from both cross and within-industry perspectives. Industry and plant-specific factors contributing to plant shutdown are developed in a variety of models. Predictions of market structure models of endogenous plant heterogeneity such as Hopenhayn (1992a) are tested on industry and plant level data. In addition, we develop the implications of endowment-based Heckscher-Ohlin trade models for plant entry and exit. Heckscher-Ohlin models have predictions for entry, exit, and net entry rates across industries, regions, and plants. In turn we examine each of these levels of disaggregation.

The market structure models correctly predict that entry and exit rates will covary positively across industries. High entry costs cause both low entry and low exit probabilities. Because of their inherent focus on steady state equilibria, the market structure models cannot predict variation in net entry rates. The entry cost proxies that correctly predict the comovement in industry entry and exit rates explain none of the heterogeneity in net entry rates across industries.

In contrast, Hecksher-Ohlin trade models provide predictions both for which industries will grow (positive net entry rates) and for which regions will see high turnover and net entry of plants.[6] In a country augmenting both its physical and human capital such as the US, the least capital-intensive, least skill-intensive plants are correctly predicted to be the most likely to exit. In addition, we develop a new component of the plant-level data and exploit the geographic detail available in the data by dividing the US into individual labor market regions.[7] As predicted by the Heckscher-Ohlin model, regions within the country that have the biggest endowment changes are associated with higher exit rates and higher entry rates. For regions accumulating capital, the endowment-based trade model correctly predicts that net entry rates are higher for capital-intensive industries.

With the exception of the papers discussed above, much of the literature on within industry plant closure focuses on exit from declining industries. Typically in such studies the focus is on the pattern of plant closure within an industry with the 'decline' of the industry taken as exogenous. Ghemawat and Nalebuff (1985) show that in a duopoly with Cournot competition, equal costs and declining demand, the largest firms exits first as the smaller producer will be a successful monopolist for longer. Allowing for cost advantages for large firms can overturn the theoretical results if the cost differentials are substantial enough. Whinston (1988) shows that the single plant assumption is important for the results on size and exit and argues that plants in multi-plant firms may be more likely to exit. Reynolds (1988) and Dierickx, Matutes, and Neven (1991) predict that high variable cost

[6] Of course, the Heckscher-Ohlin model is silent on the sources of covariation in entry and exit.

[7] In this paper, we do not take a stand on whether plants in these regions face the same factor prices. The regional predictions developed below hold if the US regions are in either a single or multiple factor price equalization cones.

plants should exit first. Gibson and Harris (1996) look specifically at plant exit during a period of trade liberalization and quota reduction in New Zealand. However, they choose to frame their hypotheses in the context of the declining industry literature and ignore any specific predictions from trade theory. The results from the related empirical literature are mixed, although all studies find that larger plants are less likely to exit, confirming the results of Dunne, Roberts, and Samuelson (1989) on the entire range of US manufacturing industries.

In our plant-level analysis, we draw on the market structure, trade, and declining industry models. We test and confirm the predictions of the market structure models that lower productivity, lower capital intensity, younger, and smaller establishments are more likely to fail. We present extensions of both Ricardian and Heckscher-Ohlin trade models incorporating within industry plant heterogeneity and find substantial support for them in the data. In addition we provide evidence on the marginal contributions of exporting and multinational ownership on plant shutdown. Exporting reduces the probability of plant closure at the margin while multinational ownership increases the probability of closure.

The rest of the paper proceeds as follows: Section 2 contains the industry and regional analysis. We detail the predictions for industry and regional entry, exit and net entry from market structure models and a simple Heckscher-Ohlin trade model. The description of the data, the basic empirical specification, and main results follow. In Section 3, we develop and test predictions on the probability of plant exit. Conclusions are presented in Section 4.

2. Industry Entry and Exit Rates

In this section we examine the empirical predictions of existing industry models of plant exit and entry. We then develop a set of testable hypotheses from a basic Heckscher-Ohlin model of trade about entry and exit for both industries and regions. Finally, using data on US manufacturing plants from 1972-1992, we test the models.

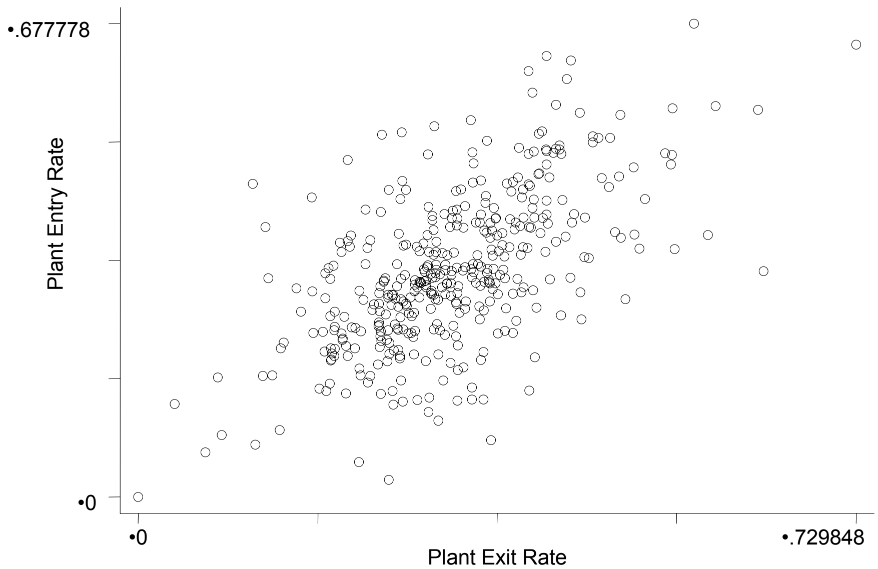

Figure 4: Industry Entry and Exit Rates, 1987-1992

There is a growing body of both theoretical and empirical research on plant entry and exit stimulated largely by the seminal work of Dunne, Roberts, and Samuelson (1988, 1989). Dunne, Roberts and Samuelson (henceforth DRS) focused attention on several stylized facts about plant closures which have guided the subsequent theoretical and empirical literature. Looking across industries, DRS (1988) find that plant entry and exit rates at the level of the four digit (SIC[8])industry are strongly positively correlated, and that the correlation persists over time. This can be seen in Figure 4 for the 1987-92 period. Entry rates are plotted against exit rates for 4-digit manufacturing industries and show a strong positive correlation.[9] However,

[8]Standard Industrial Classification

[9]The entry rate in the figure is defined as

$$ER_{it} = \frac{Births_{t \to t+5}}{All\ Plants_{t+5}}$$

once they control for persistent industry effects, DRS find that entry and exit rates are negatively correlated. They conclude that there are substantial persistent structural factors that move entry and exit rates in the same direction and industries are more consistently characterized by turnover than net entry rates.

In DRS (1989), they consider the role of plant size, age, and ownership type as determinants of plant failure. They find that failure rates decline as size and age increase and that multiunit plants have lower failure rates than single-unit plants, even controlling for size and age. However, these results all control for a full set of industry-year interactions and again leave open the question of what industry characteristics are important for the variation in exit rates.

These findings and conclusions of DRS had a strong impact on the subsequent theoretical literature generating a variety of market structure models. In his influential papers, Hopenhayn (1992a,b) develops a general equilibrium model of entry and exit to largely match the DRS facts. Hopenhayn's model focuses on a steady state with balanced entry and exit. Comparative static exercises reveal that increases in entry costs lower both entry and exit rates causing them to move together. In addition, the models have the characteristics that failure rates are decreasing in both size and age of the firm, matching the within-industry facts offered by DRS (1989).

Surprisingly, there has been little empirical work on the cross-industry determinants of entry and exit rates. Dunne and Roberts (1991) find that industries with lower entry and exit rates are more capital intensive, have higher average firm size, and higher price-cost margins. In our subsequent empirical work, we use these variables and other proxies for the entry costs envisioned by Hopenhayn (1992a) and provide evidence on the source of the positive correlation between industry entry and exit rates. In addition, both the theoretical and

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and the exit rate as

$$XR_{it} = \frac{Deaths_{t \to t+5}}{All\ Plants_t}.$$

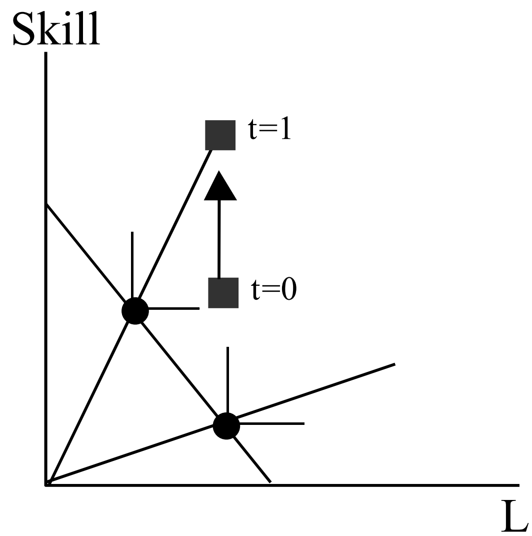

Figure 5: H-O Model: 2 factors, 2 goods, 1 region

empirical literatures have ignored the DRS (1988) fact that controlling for persistent industry effects entry and exit rates are negatively correlated at the industry level. We attempt to rectify this omission and consider the implications of models of international trade in determining industry entry and exit rates as well as differences in net entry rates across industries.

2.1. Heckscher-Ohlin, Entry and Exit

In this section we consider the implications of a Heckscher-Ohlin trade model on plant entry and exit. For ease of exposition, we will start with the simplest version of the H-O model with two factors and two goods. Figure 5 shows the factor accumulation path for a country over time. As the country moves from point 0 to point 1 accumulating skill, the labor intensive industry decreases in size until it finally shuts down.

Even this basic model gives some natural predictions about where we should expect to see plant shutdowns. If the US occupies a single cone and is accumulating skill, then we would expect to see higher exit rates in labor-intensive industries and higher entry rates in skill-intensive industries.[10]

In addition to accumulating skill, the US has been increasing its capital-intensity substantially during the 1970s and 1980s. The simple H-O model predicts that, conditional on skill-intensity, shutdowns would be highest in the least capital-intensive sectors. One problem with looking at industry capital intensity is that it may signal higher barriers to entry in the form of fixed capital accumulation, i.e. autos versus socks. If so, then the intra-industry model of Hopenhayn (1992a) would predict that both entry and exit rates would be lower in capital-intensive industries (autos) and higher in labor-intensive industries (socks). However, while entry and exit rates might both be lower, the H-O model predicts that the net entry rate across industries would be positively related to capital intensity, i.e. we would expect to see more net entry in the auto industry than in the hosiery business. The steady state market structure models have no predictions about net entry rates as entry and exit are always balanced.

2.1.1. Regions in the H-O model

One interesting attribute of the H-O model is that it yields predictions not only about heterogeneity in industry entry and exit but also about which regions are most likely to experience substantial plant turnover. If the regions of the US have different factor endowments, even if they occupy a single factor price equalization cone, then the

[10] One problem with the basic H-O trade model is that it has no predictions on intra-industry structure. The reduction in output in the labor-intensive industry could come through plant shutdowns or reductions in plant size. Even the complete disappearance of the industry could occur with existing plants changing products. Throughout this paper we assume some of the output adjustment margin will occur through net exit. In our empirical work this is a maintained hypothesis.

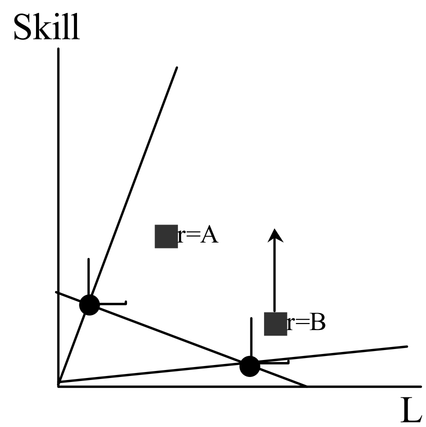

Figure 6: H-O Model: 2 factors, 2 goods, 2 regions

HO model contains additional predictions about the location and factor intensity of plant shutdowns. In Figure 6, region B is accumulating skilled labor while endowments in region A are unchanged. As a result, both the exit rate and entry rates should be higher in region B than in region A.[11] The size of the change in the regional endowment matters for plant closure and birth. Regions with relatively small changes in endowments would see fewer shutdowns and startups. In addition, the exit rates should be higher in the labor intensive industries in region B than in the same industries in region A and the entry rates should be higher in the skill intensive industries in region B than those in region A. The H-O model with multiple regions thus predicts that regional exit and entry rates should be correlated with regional endowment changes. Perhaps more importantly, the interaction of

[11] While the H-O model does not comment on entry and exit in the absence of endowment changes, we would expect both regions to experience positive exit and entry rates for the reasons outlined in the market structure models.

increased regional skill (and capital) with industry skill (capital) intensity should be positively correlated with entry rates and negatively correlated with exit rates.[12] Moreover, both of these effects would remain even if the regions were in different factor price cones.

The H-O model yields several predictions about entry and exit that differ from the market structure models discussed above. In a country that is accumulating capital and skills such as the US, plant closures will occur more frequently in the least capital and skill-intensive industries and plant births will occur more often in the most capital and skill intensive industries. In addition, regions that are changing their endowments rapidly will be more likely to experience plant turnover, both entry and exit, and within these regions, the industries with factor intensities at odds with the new endowments will be more likely to have high exit rates while industries with similar factor usage most similar to the new endowments will experience higher entry rates.

2.2. Data

The predictions from the market structure and trade models presented above are essentially medium to long-run in nature. To test them, we use data from the Census of Manufactures (CM) conducted every fifth year from 1972 to 1992 and contained in the Longitudinal Research Database of the Bureau of the Census. This data has been described in detail elsewhere and was the source employed by DRS in their studies which covered the period 1963-1987.

Several attributes of the data are especially important for our analysis. First, we characterize a plant exit or death as the case when an establishment is in a Census in year t but not in year t+5. If that plant were to reappear in a subsequent Census, either under the same or different management, we would register an entrant or birth.

[12] Note that with identical factor prices across the regions, there is no incentive for factors to migrate. Of course, we must take changes in regional factor endowments as exogenous.

The entry rate for industry i in year t is defined as[13]

$$ER_{it} = \frac{Births_{t \to t+5}}{0.5\,(All\ Plants_t + All\ Plants_{t+5})} \tag{1}$$

and the exit rate as

$$XR_{it} = \frac{Deaths_{t \to t+5}}{0.5\,(All\ Plants_t + All\ Plants_{t+5})} \tag{2}$$

and the net entry rate as

$$NR_{it} = \frac{Births_{t \to t+5} - Deaths_{t \to t+5}}{0.5\,(All\ Plants_t + All\ Plants_{t+5})}. \tag{3}$$

For our industry and regional analysis, we employ a variety of measures at the industry level including capital intensity, skill intensity, plant size, markups, and concentration.[14] These are all calculated in year t for the interval from t to t+5. For our measures of industry capital intensity, skill intensity, and plant size, we employ the level for the median plant in the industry of log capital per worker, share of non-production wages in total wages, and log total employment, respectively.[15] Markups at the plant level are defined as shipments less variable costs divided by shipments, and the industry measure is again the value for the median plant. For our concentration measure, we construct a Herfindahl index based on total shipments.

[13] We use these definitions of entry, exit, and net entry rates in all the empirical specifications. These definitions allow us to calculate measures even when no plants are operating in the cell in one of the years.

[14] Throughout the paper, industry refers to a 4-digit Standard Industrial Classification. We have dropped all industries with a code ending in the number 9, as these typically group heterogeneous products not elsewhere classified. In addition, we drop SIC 21 due to the small number of firms. We are left with 387 out of 449 industries.

[15] A substantial number of very small plants do not receive a long form Census questionnaire. We exclude these plants when we calculate our median industry measures. They are included in the calculation of the industry and regional entry and exit rates. We also exclude them from any plant level specifications later in the paper.

One main problem in attempting to test the predictions of the market structure models is the lack of data on the sunk entry costs which are the primary unambiguous determinants of industry exit and entry rates. Hopenhayn (1992a) points out that changes in sunk entry costs have a potentially ambiguous impact on firm size and that profits and market share will be higher for large firms but not necessarily for small firms. We employ measures of total employment, markups and concentration of output at the industry level in an attempt to proxy for factors that may act as barriers to entry.

Turning our attention to the endowment data, we construct proxies for both physical and human capital intensity. Our measure of capital intensity is log capital per worker.[16] However, the only distinction of labor varieties in the data are non-production and production workers. Ideally, we would like to have a better measure of skilled or educated workers at the plant but the limitations of the Census preclude a finer measure. The main problem with the non-production worker share is that it includes both high-education (engineers) and low-education (janitors) workers. To obviate this problem as much as possible, in all our empirical work, we use the wage share of non-production workers instead of their employment share.

Perhaps the most interesting prediction from the Heckscher-Ohlin model has to do with the interaction of changing regional endowment and initial industry factor intensity. Since we are interested in regions that correspond to factor markets, we use the definition of a Labor Market Area (LMA) given by the Commerce Department rather than US states or the coarser Census regions. LMAs can cross state boundaries, as in the New York, NY LMA, or be contained within states, as

[16] Results from higher dimension trade theory suggest we should employ input-output ratios as our measure of factor intensity for the industry or plant, i.e. $\frac{K}{Q}$ where Q is value-added, rather than the capital-labor ratio, $\frac{K}{L}$. However, across industries and plants factor intensities vary inversely with multi-factor productivity levels and thus do not allow us to separately identify the role of factor usage and productivity. We therefore choose to use the log capital-labor ratio and non-production wage share in our empirical specifcations.

in the San Francisco-Oakland-San Jose LMA. These regions are based on county groups with common commuting patterns recorded in the 1970 and 1980 population censuses. According to these definitions, there are 183 LMAs in the US of which we use 181.[17]

The trade model points to the importance of changes in factor endowments of the regions and the interaction of those changes with initial industry factor usage. In constructing measures of regional factor endowments, we face two problems. First, we only observe factors employed in manufacturing, a problem we cannot solve given the data. Second, individual plant shutdowns might affect regional endowment measures. To avoid problems with endogeneity, when we construct regional measures of relative factor endowments, we exclude factor usage within the same two digit SIC.[18] The variables of interest are the changes in log capital-labor ratios and non-production wage shares for the LMA and the interactions of those changes with the industry levels in the initial year.

2.3. Empirical Results (Industry)

For the industry level results, we estimate OLS specifications with standard errors adjusted for potential heteroskedasticity within industries of the form

$$ER_{it} = c + \beta IC_{it} + d_t + e_{it} \tag{4}$$

$$XR_{it} = c + \gamma IC_{it} + d_t + \nu_{it} \tag{5}$$

$$NR_{it} = c + \delta IC_{it} + d_t + \nu_{it} \tag{6}$$

[17] Over time commuting distances have lengthened and increasingly distant counties have become part of the same labor market. As a result of the 1990 census, the number of labor market areas has been reduced to 172. Given the time span of our data, we chose to work with the larger number of regions based on the earlier censuses. We exclude Hawaii and Alaska from the analysis.

[18] In other words, for a plant in two-digit industry Y in region 1, the change in the regional K/L ratio is the change in the K/L ratio for all plants outside of industry Y in region 1.

where c is a constant, d_t is a set of year dummies to control for aggregate factors such as business cycles, and IC_{it} is vector of industry characteristics.

For industry entry rates, we expect negative coefficients on each of the market structure variables: size, markup and concentration. For the non-production wage share, our proxy for human capital intensity, we expect a positive coefficient. For physical capital the sign of the coefficient is ambiguous. If physical capital intensity acts a barrier to entry, then we would expect a negative correlation. However, given the increase in capital intensity in the US during the period, the H-O model predicts a positive correlation between physical capital and entry rates.

Expected coefficients in the industry exit rate regressions should be negative for all the variables. Higher entry costs (size, markup, concentration, capital intensity) should reduce exit rates, and exit rates should be lower for industries intensive in both physical and human capital.

Table 1 reports the univariate regressions for each of the industry characteristics for both entry rates and exit rates. The size and markup measures have the expected sign in both the entry and exit rate specifications, although only the markup measure is not statistically significant for entry rates. Similarly the non-production wage share has the correct sign in both cases, with a significant positive coefficient for industry entry rates and a negative and insignificant coefficient in the exit specification. High skill industries have higher entry and lower exit rates. The capital-labor ratio has the expected negative and significant relationship with exit as predicted by both the market structure and H-O trade models. Higher industry capital intensity is significantly negatively associated with entry rates suggesting that the market structure effects dominate. The only surprise relative to the predictions of the theory is the positive coefficient on the industry Herfindahl index for entry rates. In the univariate specifications, entry is higher and exit is lower for more concentrated industries.

We report the results including all the measures in a single regression in Table 2. Again, with the exception of the concentration measure, all the variables have the predicted signs and are significant at the 1 percent level.[19] As predicted by the market structure models, both entry and exit rates are lower in industries with larger plants, higher markups and greater capital intensity. Skill intensity is correlated with higher entry rates and lower exit rates as suggested by the H-O trade model with human capital accumulation.

One important distinction between the market structure and H-O trade models is the implication for net entry rates. As reported by DRS (1988), conditioning on industry effects, entry and exit rates are negatively correlated. The market structure models by construction have no net entry in steady state. This suggests that measures such as size and markup should have no relation to net entry rates. The H-O trade model, on the other hand, focuses precisely on the changing composition of output in response to factor accumulation. This model predicts that net entry rates should be positively correlated with both physical and human capital intensity.

Tables 3 and 4 report the results for industry net entry rates for both the univariate and multivariate specifications. As predicted, both physical and human capital intensity are positively correlated with net entry rates at the industry level. The market structure measures of plant size and markups are not significantly correlated with net entry in either specification suggesting that they may indeed be proxying for persistent industry characteristics that affect both entry and exit rates proportionately. The concentration measure does not conform to the predictions of the model as it has a positive and significant correlation with net entry.

2.4. Empirical Results (Region-Industry)

We turn now to the region-industry predictions of the H-O trade model. As described above, we have 181 regions and 387 industries

[19] The non-production wage share is significant only at the 10% level in the exit specification.

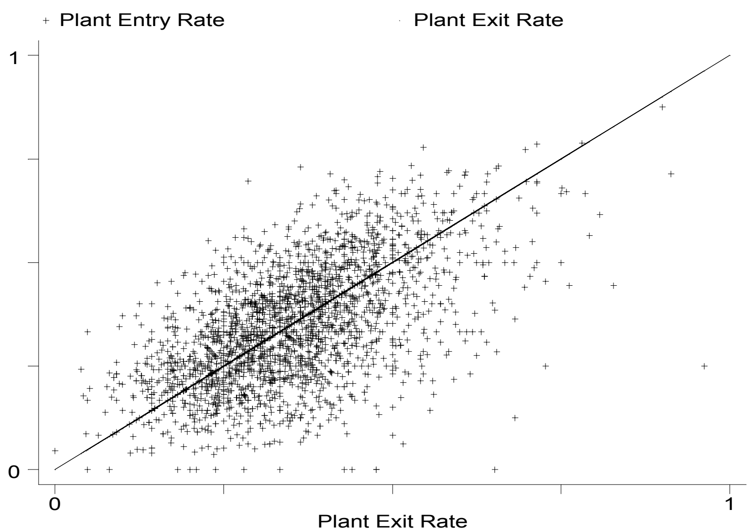

Figure 7: Region-Industry Entry and Exit Rates, 1987-1992

in our data. Of course not every region contains a full range of industries; on average only 47 percent of the region-industry cells have active plants. There is a large amount of industry mixing both within and across regions. As with the four-digit industries, entry and exit rates are positively correlated across region-industry cells as shown in Figure 7.[20] However, only 30 percent of the variation in entry rates can be explained by exit rates. In any given five year interval, 15 industries completely shut down and 20 new industries start up in the average region. In this section, we consider two related components of regional entry and exit. First, we consider exactly which region-industry pairs are the most likely to experience entry, then we consider magnitude of the entry, exit, and net entry rates in light of the two types of models.

[20]Only region-industries cells with more than 20 plants and more than 10 firms are shown.

To understand where entry is occurring we estimate probits of the form

$$
\begin{aligned}
\Pr(ER_{irt} &> 0) = f\left(c + IC_{it} + d_t\right) + e_{it} \qquad (7)\\
\Pr(ER_{irt} &> 0) = f\left(c + \delta \Delta RE_{rt} + d_t\right) + e_{it}\\
\Pr(ER_{irt} &> 0) = f\left(c + IC_{it} + \delta \Delta RE_{rt} + \gamma\left(\Delta RE_{rt} \cdot IC_{it}\right) + d_t\right) + e_{it}
\end{aligned}
$$

where IC_{it} is a vector of industry characteristics, ΔRE_{rt} is a vector of changes in regional endowments (human and physical capital) and $\Delta RE_{rt} \cdot X_{it}$ is a vector of interactions between regional endowment changes and industry factor intensities.

We expect the probability of entry in a region-industry cell to be increasing in industry capital intensities (H-O trade model), both human and physical, and decreasing in the sunk cost of entry for the industry proxied by plant size, markup, and concentration (market structure model). As before the sign on industry log capital labor ratio is ambiguous as it encompasses elements from both models. The H-O trade model predicts that regions with larger increases in human and physical capital will have higher entry (and exit) rates. For a given region, entry will occur most often in industries with compatible factor needs, i.e. regions with rapidly increasing physical and human capital will see a higher probability of entry in high capital industries. The expected signs on the interaction terms are positive.

Table 5 contains the results from the univariate and multivariate specifications. As expected, high industry non-production wage shares are associated with a higher probability of entry. The measure of industry capital intensity have a negative and significant coefficient suggesting, as in the industry results above, that capital intensity is associated with high entry costs. Both the regional endowment measures are positive and significant at the 1 percent level. Regions with increasing human and physical capital stocks are more likely to see entry. Finally, among the proxies for entry costs, the size and concentration measures have the expected sign. Industries with high markups, however, have higher, not lower probability of entry.

The last specification in Table 5 contains all the variables including the interaction terms. Both the interaction terms have positive signs and are significant at the 1 percent level exactly as predicted by the H-O trade model with multiple regions. Indeed, all the variables have the expected signs and most are significant at the 1 percent level.[21]

In Table 6, we report results for entry and exit rates for the region-industry cells. We calculate entry and exit rates as in Equations 1 to 3. As mentioned above, there are large numbers of regions with industries shutting down and starting up in every five year period. As a result, our dependent variables will be censored on both ends. We employ univariate and multivariate tobit estimators for entry and exit rates of the form

$$\begin{aligned} R_{irt} &= f\left(c + IC_{it} + d_t\right) + e_{it} \qquad (8) \\ R_{irt} &= f\left(c + \delta\Delta RE_{rt} + d_t\right) + e_{it} \\ R_{irt} &= f\left(c + IC_{it} + \delta\Delta RE_{rt} + \gamma\left(\Delta RE_{rt} \cdot IC_{it}\right) + d_t\right) + e_{it} \end{aligned}$$

with the variables defined as above.[22]

Both sets of estimates again largely conform to our priors from the two models. In the univariate specifications, larger regional endowment changes are positively associated with both exit and entry rates as predicted by the H-O trade model. Higher skill shares have positive and significant coefficients for both entry and exit, the former is predicted by the model while the higher exit rate is not consistent with the H-O predictions. Industry capital intensity, median plant size and concentration ratios are negatively correlated with both entry and exit as in the industry regressions.[23]

In the multivariate specification, we find that again the industry variables enter with the predicted signs and are usually significant at

[21] The coefficients on the regional endowment changes are now negative. While we expect the unconditional coefficients to be positive, once we have added interaction terms we have no prior on the expected signs.

[22] The tobit estimator relies heavily on the assumption of normality for consistency of the estimates.

[23] The markup measure has the wrong sign and is significant for entry rates.

the 1 percent level. Of particular interest are the interactions between changes in regional endowments and industry factor intensities. For both capital intensity and non-production wage share the interaction terms have the expected signs and are all significant at least at the 5 percent level. Regions increasing human and physical capital gain industries that are relatively human and physical capital intensive at faster rates and lose labor intensive industries. Even within the US, we see clear evidence that regional factor endowments affect the location and type of industries in the manner predicted by endowment-based trade theory. These findings are confirmed in Table 7 where we run tobits for net entry rates. Regions acquiring human and physical capital have significantly higher net entry of capital-intensive industries as predicted by the H-O model.

In this section, we have explored plant exit and entry across industries and regions. We confirm the well-known stylized fact that entry rates and exit rates are positively correlated across industries. Using the predictions of market structure models, we confirm that proxies for high entry cost are positively correlated with both higher entry and higher exit rates across industries. We show that net entry rates are substantial and have significant variation across industries and regions.

To explain this industry heterogeneity in net entry, we turn to a simple Heckscher-Ohlin model of trade. In a country that is accumulating both physical and human capital such as the US, the H-O model predicts that industry capital intensity should be positively correlated with net entry. We confirm this in the data and show that most of the entry cost measures are uncorrelated with net entry, again as predicted by the market structure models.

Finally, we consider regional variation in industry entry and exit rates. While the market structure models are silent on where industries should locate, the H-O trade model predicts that increases in regional capital intensity should be correlated with higher exit and entry rates. We find significant evidence for this correlation. In addition, the H-O model predicts that entry in capital-deepening regions should be in capital intensive industries and exit in labor intensive industries. Once again we find support for this hypothesis.

This work at the industry and regional levels confirms the importance of the market structure models in explaining industry level comovements in plant entry and exit rates.[24] More importantly, we introduce endowment-based trade theory as an important additional component of the ongoing evolution of the US manufacturing sector. While the market structure models had little role for net entry, a simple H-O trade model does well in not only predicting which industries should see net entry but also where those capital-intensive industries will locate. We now turn our attention to the plants themselves and consider the probability of failure for individual establishments.

3. Heterogeneous plants and exit

We start by reviewing the predictions of the market structure models for evidence on which plants within an industry are most likely to fail. We then introduce two new models of international trade with heterogenous plants, one an extension of the standard Ricardian trade model and the other an extension of the endowment-based H-O model that has performed so well already. Finally we outline predictions from the large literature of partial equilibrium models on plant closures. We present results on the probability of plant closure using plant-level observations from 1972-1992 for the entire US manufacturing sector.

3.1. Market structure models

While we have discussed many of the implications of the market structure model of Hopenhayn (1992a) in section 2., in this section we

[24] This may not be especially surprising given that the theory models were motivated by the DHS stylized facts. However, until now, no one had taken the predictions of the theory back to the data.

briefly focus on its prediction for intra-industry failure probabilities.[25] All the market structure models are driven by idiosyncratic paths for plant productivity. If productivity falls far enough, plants exit the industry. As a result, all the models predict that low productivity plants are unconditionally more likely to exit. In addition, the evolution of industry structure in these models means that younger plants are also much more likely to fail, usually because they are more likely to be low productivity establishments. Adding the capital stock as a state variable that can affect the productivity distribution as in Olley and Pakes (1996), we add the prediction that low capital intensity plants are more likely to exit. In our empirical specification of individual plant shutdown, we include both industry and plant measures of size, age, and log capital intensity as well as an intra-industry measure of relative log TFP.

3.2. A Ricardian model of trade

The plant level Ricardian model of international trade comes from Bernard, Eaton, Jensen, and Kortum (2000) (henceforth BEJK).[26] In this framework, plants use identical bundles of inputs to produce heterogeneous products in a setting of monopolistic competition. Within a country without international trade, plants are differentiated by their efficiency levels with only the most efficient producer actually supplying the domestic market. In other words, each active plant is associated with a unique product so that no two active plants within a country supply identical goods.

With international trade and trade costs in a multi-country world,

[25] Other models with heterogenous plants include Jovanovic (1982), Ericson and Pakes (1995), and Melitz (1999) which generate broadly similar predictions. Pakes and Ericson (1998) demonstrate testable differences between these models. Our focus on plant age, size and capital intensity as determinants of failure probabilities are common to all the models. Melitz (1999) also predicts that exporting plants will be less likely to fail.

[26] For a formal exposition of the model in a multi-country framework, see BEJK (2000).

a plant will produce for the home market if two conditions hold. First, it must be the most efficient domestic producer of a particular variety. Second, any foreign producer must not be a lower cost supplier once trade costs are considered. A domestic plant will be an exporter if it produces for the domestic market and if, net of trade costs, it is the low cost producer for a foreign market. Finally, a foreign plant will supply the domestic market if it is the low cost producer in its home country and, net of trade costs, it is also more efficient than the lowest cost domestic plant.

In equilibrium, no single country produces the full range of goods, i.e. all countries import some products, and every country is a exporter for some subset of the goods produced for the domestic market. Because of the existence of positive trade costs, exporters are typically plants with higher than average productivity.

The model is inherently a general equilibrium framework but is completely static. To generate predictions about which plants will continue and which will shut down in response to an exogenous shock, some additional assumptions are required. BEJK consider two potential shocks: a 10 percent rise in the domestic exchange rate and a uniform global lowering of trade costs by 10 percent.[27] We are interested precisely in the effects of increasing trade and fluctuating exchange rates on the probability of plant closure.

BEJK attribute the exchange rate increase to increased productivity in some other traded sector such as agriculture. The increase in the exchange rate is identical to a rise in domestic factor costs, or alternatively a reduction in factor costs in the rest of the world. The exchange rate increase has two main effects. Some plants that were producing just for the domestic market no longer are the low price producers and must shut down. These plants are typically of lower than average efficiency. In addition, some plants that were exporting are no longer the low cost supplier in the foreign market and cease exporting. These former exporters may or may not continue to supply

[27] BEJK also consider a case where the U.S. reverts to autarky due to large rise in trade barriers. We ignore that case here.

the domestic market but their shutdown rates will be lower than those for domestic-only suppliers. The model predicts that appreciations will lead to increased plant closure and the probability of closure will be highest among the least productive plants and lower among current exporters.[28]

A worldwide reduction in trade costs leads to increases in both imports and exports. The effects on domestic-only producers and exporters are qualitatively similar to an exchange rate increase with the difference that substantial numbers of plants now enter the export market. Again we expect to see the highest failure rates among low productivity plants producing solely for the domestic market.

The basic form of the model abstracts completely away from both heterogeneity in input usage and from any differences across industries. In our empirical framework, we consider only variation in intra-industry productivity as a determinants of shutdown. We predict that the probability of shutdown will be higher for relatively low productivity plants within all industries. While this is comparable to the predictions of the market structure model, the Ricardian model has the addition implication that exporters will fail less often, even conditioning on their observed productivity levels.

3.3. Heckscher-Ohlin and heterogenous plants

In this section we extend the traditional Heckscher-Ohlin model to allow for heterogenous plants. The simplest extension is essentially a misclassification model where industries include goods with similar end use characteristics but have differing factor intensities.[29] Examples of models with these attributes include Xu (1993) and Davis and Weinstein (1998). Schott (1999) provides additional evidence that the same industries in different countries comprise of goods with

[28] These prediction are similar to those in the model of heterogeneous plants and trade in Melitz (1999).

[29] The Standard Industrial Classification used in the Census of Manufactures is an end use classification scheme, not an input based classification.

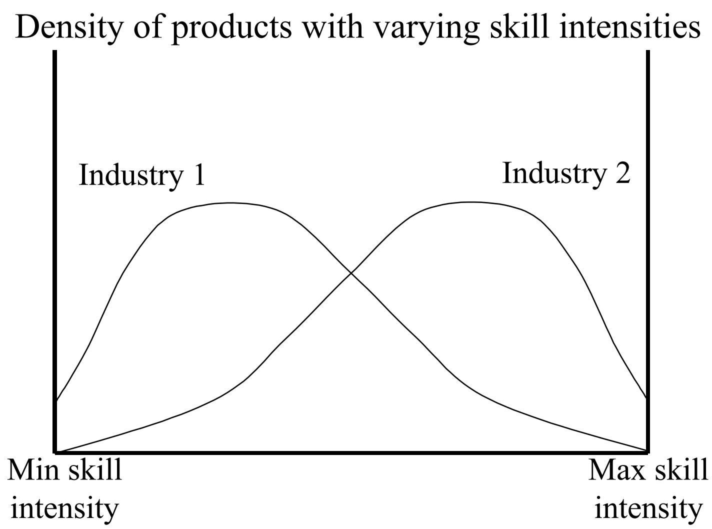

Figure 8:

heterogenous factor intensities.

We extend the two factor, two good world presented in Figure 5 to include underlying heterogeneity of goods. Figure 7 gives an example of two industries with different distributions of products by skill intensity. Industry 2 is relatively skill intensive compared to industry 1 because it contains more skill intensive products. As the skill intensity of a region increases, as before production is shifted from labor intensive goods towards skill intensive goods. However, now there is within industry reallocation as well as cross-industry reallocation of factors. Within an industry, plants producing skill-intensive products increase their output share and plants producing low-skill items reduce production and increasingly shut down. Across industries, output is increasing in industry 2 as in the homogeneous goods case, but now this occurs because industry 2 is relatively dense in skill-intensive products.

In turning to the empirical implications of this modified H-O model, we first assume that we can associate plants with individual products, or groups of products with similar factor intensities. Now both the industry factor intensity and the relative factor intensity of the plant within the industry will be relevant for the shutdown decision. In addition, regional capital deepening will be associated with exit in low capital industries and relative low capital plants. The appropriate term in our empirical specification is the regional endowment change interacted with the plant factor intensity.

3.4. Declining industries and plant exit

As noted in the introduction, much of the existing literature on plant closure focuses on exit from declining industries. While our predominant focus is on predictions from general equilibrium models, in this section, we summarize the relevant theoretical predictions from the theoretical literature on exit from declining industries.

In industries characterized by imperfect competition and declining demand, the order of exit may depend on plant capacity, the ownership structure of the firm (multi-plant versus single plant), markups and variable costs, industry concentration, and plant age. While we do not focus exclusively on industries facing declining demand, we recognize the importance of market structure on the probability of plant closure and want to ensure the robustness of our results.

The testable hypotheses of the existing exit literature can be summarized as follows:[30]

1. High variable cost (low markup) plants should exit (Dierickx et al., Reynolds).

2. Larger plants should exit if the firm is single-plant and the industry is imperfectly competitive (Ghemawat and Nalebuff).

3. Plants owned by multi-plant (Whinston) or diversified (Baden-Fuller) firms should exit .

[30] This list draws heavily on Gibson and Harris (1996).

4. Younger plants are more likely to exit (Baden-Fuller) or are less likely to exit (Deily).

In addition to this existing set of hypotheses, we also consider the nature of the output of the plant. Multi-product plants are more likely to be able to survive declines in demand for one of their goods by reallocating resources within the plant at lower cost.

5. Single-product plants should exit.

Obviously, most of these hypotheses are common to the market structure models and the declining industry literature, including the predictions on markups and age. However, unlike the results reported by DHS on the lower probability of exit for plants in multi-unit firms, Whinston (1988) and Baden-Fuller (1989) predict higher marginal probability of exits for plants in multi-plant firms and for diversified firms. We include two dummies for the ownership status of the plant: both equal one if the plant is part of a multiunit firm, however, the first equals one only if there are other plants producing in the same 4-digit industry classification, and the second equals one if there are no other plants in the firm in the same industry.

3.5. Data

Table 8 contains a complete list of variables and their expected coefficients for our plant level exit probit. Our basic specification is a binary choice model with the dependent variable being an indicator variable for the disappearance of a plant from one Census to another, i.e. a plant exit or closure. In the market structure and Ricardian trade model, plant efficiency is the most important determinant of exit. Since we do not observe efficiency directly, we construct plant-specific measures of log TFP from four factor industry Cobb-Douglas production functions with Olley-Pakes (1996) corrections.[31] For our industry variables as before, we use the value for the median plant. Within industry measures, i.e. relative plant characteristics, are given by the difference of the plant's characteristics from that of the median plant in the four digit industry. For example, relative plant efficiency within industries is measured as the difference of log TFP for the plant from that for the median plant. Age is given by the number of years since the plant first appeared in a Census of Manufactures with the industry plant age given by the median plant.

In addition to the plant ownership dummies described above, we include dummies for multi-product plants with 2, 3, and 4+ product plants entered separately.

3.6. Empirical results (plants)

For our binary choice model, we estimate a probit, pooled across the four sub-periods in the data allowing for potential heteroskedasticity due to repeated observations on individual plants. Table 9 contains unconditional results for some of the market structure and H-O variables. As predicted by the extended H-O model, both physical and human capital intensity within and across industries are negatively associated with the probability of shutdown. Regional endowment changes are positively associated with shutdown and the interaction of plant factor intensity and regional endowment changes have the expected negative coefficients. Size and age have the expected negative signs both across and within industries, however, the plant measure of markup is positive and significant, suggesting surprisingly that within industries high markup plants are more likely to exit.

[31] For each Census, the coefficients on the industry production function were estimated on unbalanced panels from the annual observations in the preceding Annual Survey of Manufactures. The four factors in the production function are capital, production workers, non-production workers, and other purchased inputs. See Bernard and Jensen (1999) for more details on the estimation procedure for the productivity measures. We do not include a measure of industry TFP as cross-industry levels are not comparable.

The results of the probit for the full specification with all the variables included are given in Table 10. Industry and plant capital intensity, size, age, and markups remain negatively and significantly correlated with plant shutdowns. Relative plant log TFP is also negatively associated with exit. Similarly, regional endowment changes enter with positive coefficients and the region-plant and region-industry interaction terms have the expected negative and significant coefficients(although only the coeffients on the non-production wage share varaibles are significant). Only the measures of skill intensity, the non-production wage share, enter with the wrong sign.

Unlike the results of DHS(1989), we find that being part of a multi-unit firm actually increases the conditional probability of shutdown by a substantial amount (7 - 12 percent). This holds for plants that are unique in their industry within the firm and for plants in firms with more than one establishment in the same industry. On the other hand, multi-product plants are significantly less likely to close with the probability of exit declining in the number of products.

3.7. Empirical results (exporters and MNCs)

While the previous results largely confirm the predictions of trade theory in plant entry and exit, we do not have many direct measures of trade at the plant level. To consider the direct effects of international factors in the probability of plant closure, we look both at whether the plant is part of a US multinational and whether the plant reports direct exports. In order to consider these plant attributes, we must limit our analysis to a single five year panel, 1987-1992, for which all the information is available.[32]

The predictions of the Ricardian trade model in section 3.2 suggest that exporting plants should be less likely to close, both in the face of a reduction in trade costs and in the face of an exchange rate appreciation. The unconditional closure rates for exporters are indeed

[32] We do not have data on ownership by foreign multinational firms, nor can we observe indirect exports by the plant.

much lower than the closure rates for non-exporters, 25% and 50% respectively. However, exporters have significant advantages in terms of size, productivity, capital intensity and skill intensity, all of which are associated with lower exit probabilities. This prediction holds in the model even conditioning on the efficiency level of the plant.

The effect of multinational ownership is less obvious. Multinationals are among the largest firms and thus should have greater access to internal financial resources that would enable them to continue production in the face of temporary adverse demand shocks. This would suggest that multinationals should be less likely to shutter plants. In fact, only 26.2% plants owned by US multinationals close in any five year interval as opposed to a 47.5% closure rate for other facilities. On the other hand, multinationals are able to shift production abroad more easily than purely domestic firms since they either have existing facilities for the product or have lower costs for the creation of new facilities. This would suggest that they would be more likely to close plants. In particular, multinationals can respond readily to exchange rate appreciations by shifting production abroad to take advantage of relative price movements.

To test this hypothesis that exporting reduces the probability of closure, we include a dummy for the export status of the plant in our specification of plant closure probabilities. To distinguish between the competing hypotheses regarding multinational ownership and plant shutdown, we include a dummy for plants owned by US multinationals.[33] The coefficients on the dummies are reported in Table 11.[34] The export status of the plant is negatively and significantly associated with plant closure as predicted by the Ricardian model. At the margin, exporters are 6.7% more likely to survive from 1987 to 1992 than non-exporters. Conversely, the marginal effect for US multinational ownership is positive and significant, increasing the probability

[33] A firm is classified as a multinational if more than 10% of its assets are located outside the US.

[34] Signs on the other coefficients are largely unchanged and are suppressed to save space.

of closure by 4.5%. US multinationals use the shutdown margin more often than other firms.[35]

4. Conclusions

In this paper, we take a comprehensive look at the closure of US manufacturing plants. Building on early empirical work using the Census of Manufactures by Dunne, Roberts and Samuelson (1988, 1989), we confirm the well-known stylized facts that entry and exit rates are positively correlated across industries. However, we also document the large degree of heterogeneity in net entry rates across industries and across regions within the US. Heretofore, the theoretical and empirical literature on entry and exit has largely ignored the variation in net entry.

Using the population of US manufacturing plants from 1972-1992, we find strong support for the predictions of both the market structure and Heckscher-Ohlin trade models at the industry and regional level. Market structure models do well in predicting the comovement of plant entry and exit rates across industries. Industries with high entry costs have lower entry and lower exit rates. With their focus on steady state outcomes, the market structure models provide no insight on the variation in net entry and in fact our proxies for entry cost are uncorrelated with net entry.

In contrast, the H-O trade model correctly predicts that capital and skill intensive industries should have higher net entry rates than labor intensive industries in a country that is accumulating skill and capital. The H-O model also contains implications for regional variation in entry, exit, and net entry. Regions with rapidly changing endowments are correctly predicted to have both higher entry and exit rates. In addition, the interactions of regional endowment accumulation and industry factor intensity are positively correlated with

[35] The other category includes both purely domestic plants and plants owned by foreign multinationals.

net entry rates. Regions accumulating capital have higher net entry in capital intensive industries.

Finally, we develop a set of predictions for the correlation of plant characteristics and plant shutdown. In the market structure models, plants that are younger, less productive and less capital intensive are correctly predicted to have higher failure probabilities.[36] An extension of the H-O model to incorporate heterogeneous plants correctly predicts that it is the plants at odds with the new input mix that are the most likely to close. This means a low-skill, labor-intensive plant in region that is rapidly deepening its capital stock is more likely to close than a high-skill, capital intensive plant in the same region. Unconditionally, relative skill intensity is correlated with lower probabilities of shutdown but once a range of other plant attributes are included in the specification this relationship disappears.

These results provide the first attempt to provide an explanation for the substantial heterogeneity in net entry rates across industries in the US manufacturing sector. A simple Heckscher-Ohlin trade model does a good job of identifying the characteristics of industries and regions associated with plant closure as well as predicting within industries which plants are the most likely to shut down. Much work remains to be done. The implications of endowment-based trade theory for dynamic industry models have yet to be explored. In addition, future research should consider more carefully the effects of macroeconomic variables such as exchange rate movements as well as the link between these results on plant closure to issues of factor prices, especially wage levels and inequality.

[36]A Ricardian trade model with heterogeneous plants also hypothesizes that relative low productivity plants will be more likely to close. The extended H-O trade model also contains the prediction that low capital-intensity plants will close.

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Table 1: Industry Entry and Exit Rates, 1972-1992

		Entry			*Exit*		
Spec.	RHS Variable	Coef.	S.E.	p-value	Coef.	S.E.	p-value
1.	Log capital-labor ratio	-0.037	0.004	0.00	-0.054	0.003	0.00
2.	Non-production wage share	0.276	0.032	0.00	-0.010	0.025	0.67
3.	Log total employment	-0.036	0.004	0.00	-0.044	0.003	0.00
4.	Markup	-0.036	0.026	0.18	-0.118	0.020	0.00
5.	Industry Herfindahl index	0.253	0.069	0.00	-0.101	0.053	0.06

Table 2: Industry Entry and Exit Rates, 1972-1992

		Entry			*Exit*		
Spec.	RHS Variables	Coef.	S.E.	p-value	Coef.	S.E.	p-value
1.	Log capital-labor ratio	-0.032	0.004	0.00	-0.045	0.003	0.00
	Non-production wage share	0.253	0.032	0.00	-0.039	0.023	0.08
	Log total employment	-0.024	0.005	0.00	-0.035	0.003	0.00
	Markup	-0.069	0.025	0.01	-0.119	0.018	0.00
	Industry Herfindahl index	0.334	0.066	0.00	0.014	0.047	0.77

Table 3: Industry Net Entry Rates, 1972-1992

Spec.	RHS Variable	*Net Entry* Coef.	S.E.	p-value
1.	Log capital-labor ratio	0.017	0.007	0.01
2.	Non-production wage share	0.285	0.055	0.00
3.	Log total employment	0.007	0.008	0.35
4.	Markup	0.083	0.055	0.13
5.	Industry Herfindahl index	0.359	0.117	0.00

Table 4: Industry Net Entry Rates, 1972-1992

Spec.	RHS Variables	*Net Entry* Coef.	S.E.	p-value
1.	Log capital-labor ratio	0.126	0.007	0.05
	Non-production wage share	0.291	0.065	0.00
	Log total employment	0.011	0.010	0.26
	Markup	0.050	0.047	0.29
	Industry Herfindahl index	0.325	0.120	0.01

Table 5: Region-Industry Entry Probits, 1972-1992

Spec.	RHS Variable	*Entry* Coef.	S.E.	p-value
1.	Log capital-labor ratio	-0.052	0.001	0.00
2.	Non-production wage share	0.381	0.011	0.00
4.	Change in regional log K/L ratio	0.007	0.001	0.00
5.	Change in regional non-production wage share	0.043	0.008	0.00
6.	Log total employment	-0.156	0.002	0.00
7.	Markup	0.080	0.008	0.00
8.	Industry Herfindahl index	-2.342	0.063	0.00

Spec.	RHS Variables	Coef.	S.E.	p-value
9.	Log capital-labor ratio	-0.028	0.001	0.00
	Non-production wage share	0.191	0.012	0.00
	Change in regional log K/L ratio	-0.020	0.004	0.00
	Change in regional non-production wage share	-0.042	0.026	0.11
	Interaction- regional change and industry level			
	Log capital-labor ratio	0.011	0.001	0.00
	Non-production wage share	0.213	0.069	0.00
	Log total employment	-0.123	0.002	0.00
	Markup	-0.049	0.009	0.00
	Industry Herfindahl index	-1.731	0.051	0.00

Table 6: Region-Industry Entry and Exit Tobits, 1972-1992

		Entry			*Exit*		
Spec.	RHS Variable	Coef.	S.E.	p-value	Coef.	S.E.	p-value
1.	Log capital-labor ratio	-0.215	0.004	0.00	-0.118	0.004	0.00
2.	Non-production wage share	1.435	0.031	0.00	0.105	0.025	0.00
4.	Change in regional log K/L ratio	0.024	0.008	0.00	0.001	0.008	0.86
5.	Change in regional non-production wage share	0.174	0.046	0.00	0.004	0.460	0.92
6.	Log total employment	-0.542	0.005	0.00	-0.162	0.004	0.00
7.	Markup	0.267	0.027	0.00	-0.206	0.023	0.00
8.	Industry Herfindahl index	-7.589	0.098	0.00	-1.504	0.083	0.00

Spec.	RHS Variables	Coef.	S.E.	p-value	Coef.	S.E.	p-value
9.	Log capital-labor ratio	-0.134	0.004	0.00	-0.091	0.004	0.00
	Non-production wage share	0.827	0.034	0.00	0.041	0.028	0.14
	Change in regional log K/L ratio	-0.129	0.024	0.00	0.162	0.026	0.00
	Change in regional non-production wage share	-0.177	0.141	0.21	0.319	0.145	0.03
	Interaction- regional change and industry level						
	Log capital-labor ratio	0.060	0.008	0.00	-0.052	0.009	0.00
	Non-production wage share	0.862	0.367	0.02	-0.849	0.366	0.02
	Log total employment	-0.416	0.005	0.00	-0.140	0.004	0.00
	Markup	-0.216	0.028	0.00	-0.301	0.024	0.00
	Industry Herfindahl index	-5.149	0.097	0.00	-1.011	0.082	0.00

Table 7: Region- Industry Net Entry Tobits, 1972-1992

Spec.	RHS Variable	Net Entry Coef.	S.E.	p-value
1.	Log capital-labor ratio	-0.005	0.004	0.18
2.	Non-production wage share	0.249	0.025	0.00
4.	Change in regional log K/L	-0.031	0.008	0.00
5.	Change in regional non-pro	0.046	0.045	0.31
6.	Log total employment	0.016	0.004	0.00
7.	Markup	0.123	0.023	0.00
8.	Industry Herfindahl index	1.063	0.075	0.00

Spec.	RHS Variables	Net Entry Coef.	S.E.	p-value
9.	Log capital-labor ratio	-0.015	0.004	0.00
	Non-production wage share	0.224	0.028	0.00
	Change in regional log K/L	-0.269	0.026	0.00
	Change in regional non-pro	-0.414	0.142	0.00
	Interaction- regional change and industry level			
	Log capital-labor ratio	0.080	0.008	0.00
	Non-production wage share	1.260	0.359	0.00
	Log total employment	0.020	0.004	0.00
	Markup	0.115	0.024	0.00
	Industry Herfindahl index	1.003	0.077	0.00

Table 8: Predicted Signs for RHS Variables in Plant Exit Probits

Variable	Expected Sign	Model
Industry median log capital-labor ratio	Negative Negative	Market Structure (MS) H-O
Plant relative log capital-labor ratio	Negative	MS, modified H-O
Industry median non-production wage share	Negative	H-O
Plant relative non-production wage share	Negative	Modified H-O
Change in regional log K/L ratio	Positive*	H-O
Change in regional non-production worker share	Positive*	H-O
Interaction – regional change & plant factor intensity, log capital-labor ratio	Negative	Modified H-O
Interaction – regional change & plant factor intensity, non-production worker share	Negative	Modified H-O
Industry median log total employment	Negative	MS
Relative plant log total employment	Negative	MS
Industry median markup	Negative	MS
Plant relative markup	Negative	declining industry (DI)
Industry median plant age	Negative	MS
Relative plant age	Negative	MS
Industry Herfindahl	Negative	MS
Plant relative log TFP	Negative	MS, Ricardian
Multi-unit plant (other plants in industry)	Negative Positive	DI Dunne, Roberts, Samuelson
Multi-unit plant (no other plants in industry)	Negative Positive	DI Dunne, Roberts, Samuelson
Multi-product plants	Negative	

* This is the unconditional prediction. Once the interaction terms are included the regional endowment changes may be positive or negative.

Table 9: Plant Exit Probits, 1972-1992

Spec.	RHS Variable(s)	*Exit* Coef.	S.E.	p-value
1.	Industry median log capital-labor ratio	-0.053	0.001	0.00
	Plant relative log capital-labor ratio	-0.021	0.001	0.00
2.	Industry median non-production wage share	-0.069	0.004	0.00
	Plant relative non-production wage share	-0.057	0.003	0.00
3.	Industry median log total employment	-0.032	0.001	0.00
	Plant relative log total employment	-0.077	0.005	0.00
4.	Industry median markup	-0.147	0.005	0.00
	Plant relative markup	0.064	0.003	0.00
5.	Industry median plant age	-0.017	0.000	0.00
	Plant relative age	-0.010	0.000	0.00
6.	Change in regional log K/L ratio	0.021	0.005	0.00
	Change in regional non-production wage share	0.245	0.024	0.00
	Interaction- regional change and industry level			
	Log capital-labor ratio	-0.015	0.002	0.00
	Non-production wage share	-0.508	0.056	0.00

Table 10: Plant Exit Probits, 1972-1992

Spec.	RHS Variables	Coef.	S.E.	p-value
1.	Industry median log capital-labor ratio	-0.044	0.001	0.00
	Plant relative log capital-labor ratio	-0.017	0.001	0.00
	Industry median non-production wage share	0.054	0.006	0.00
	Plant relative non-production wage share	-0.001	0.004	0.84
	Change in regional log K/L ratio	0.001	0.005	0.79
	Change in regional non-production wage share	0.218	0.042	0.00
	Interaction- regional change and industry level			
	Log capital-labor ratio	-0.003	0.002	0.19
	Non-production wage share	-0.483	0.109	0.00
	Interaction- regional change and relative plant level			
	Log capital-labor ratio	-0.003	0.003	0.24
	Non-production wage share	-0.312	0.086	0.00
	Industry median log total employment	-0.024	0.001	0.00
	Plant relative log total employment	-0.058	0.001	0.00
	Industry median markup	-0.145	0.005	0.00
	Plant relative markup	-0.020	0.004	0.00
	Industry median plant age	-0.009	0.000	0.00
	Plant relative age	-0.004	0.000	0.00
	Industry Herfindahl index	0.093	0.031	0.00
	Plant relative TFP	-0.056	0.002	0.00
	2 Products	-0.018	0.002	0.00
	3 Products	-0.055	0.002	0.00
	4+ Products	-0.071	0.001	0.00
	Multi-unit firm (other plants in industry)	0.070	0.002	0.00
	Multi-unit firm (no other plants in industry)	0.116	0.002	0.00

Table 11: Plant Exit - Marginal Effect of MNC Ownership and Exporting (1987-1992)

	Coef.	S.E.	p-value
Exporting plant	-0.067	0.004	0.00
US Multinational	0.045	0.006	0.00