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Strategy, Scale or Policy? Exit in the Australian Car Industry

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STRATEGY, SCALE OR POLICY?

EXIT IN THE AUSTRALIAN CAR INDUSTRY

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Abstract – This paper estimates the importance of strategy, scale and policy in determining the pattern of exit in the Australian car industry. Previous studies found only a weak role for strategy in exit from declining industries. Using a new dataset and improvements on the specification used in earlier studies, we find stronger evidence that strategy influences the pattern of exit where economies of scale are less important. Protection is also found to negatively influence the likelihood of exit.

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I. Introduction

Over the last forty-two years, the number of assembly plants in the Australian car industry has shrunk from twenty-four to currently just four. This dramatic reorganization occurred while the government actively and extensively intervened to support the industry. Competition, government policy and firm strategies have all shaped the pattern of exit over this period but the importance of each has not been assessed. A recent theoretical literature on firm exit has highlighted how firm strategies may shape the pattern of exit in a declining industry (Ghemawat and Nalebuff (1985 & 1990). Most empirical work though suggests competition effectively determines the pattern, with only plants that achieve economies of scale surviving (Deily (1991) Lieberman (1990)). However, for the car industry in Australia and many other manufacturing industries, especially in Europe and Japan, government intervention may also be important. As speculation continues on the possibility of another domestic car manufacturer closing such a study is timely.

In this paper, we perform an econometric analysis of exit in the Australian car industry. In particular, we estimate a model of exit using a panel of data for nearly all plants that operated between 1920 and 1999. We find a negative relationship between protection and the likelihood of exit. By using a specification that permits different relationships between size and exit at different sizes, unlike in previous work, we estimate strategic behavior also determines the pattern of exit as well as cost advantages due to economies of scale. This new finding may also result from using a differentiated products industry, where cost advantages are less important. Earlier studies used data from homogeneous product industries, like chemicals and steel. Furthermore, we provide a first direct test of the role of cost structure in determining the pattern of exit. We also attempt to assess whether the Button Plan resulted in a different pattern of exit. Finally, the dataset used for this paper is new and is more extensive than that used in earlier empirical studies of the Australian car industry.

The results of our study are significant in several respects. First, we provide the first econometric evidence of strategic effects on the pattern of exit highlighted in the theoretical work. This result, though, still highlights the tension between the strategic behaviour induced by the small numbers of firms and the economies of scale that produced the oligopoly. Beyond relatively small sizes it appears that taking advantage of economies of scale is required to survive in the car industry. Third, we provide mixed evidence of the role of government in the industry. While higher tariffs appear to reduce the likelihood of exit, it appears the Button Plan altered the settings without altering the relationships between the other determinants and the likelihood of exit. Though the model does not enable structural forecasting of the effects of policy changes on exit, the findings are suggestive. Though all four plants feature high, by Australian standards, capacities, further tariff cuts will increase the likelihood of exit and the smallest plant, of Mitsubishi, is the most likely to close. [1]

In the next section of the paper, the theoretical framework and previous empirical work are surveyed. This is followed by background on the industry in which we argue that it is a particularly good case in which to examine these issues. An econometric specification for testing, and the data are introduced. Estimation is performed and the results discussed. Finally, some conclusions are drawn.

II. Theory and Evidence on Exit

In this section we review the economic theory and empirical evidence on the determinants of exit. After reviewing the textbook theory, and subsequent research on

[1] See Clarke, McCormack and Sunderland (1998) for more details on the future of the industry.

the role of strategy and innovation, following Gibson and Harris (1996) we present six hypotheses and then review the empirical evidence in support of each of them.

Textbook microeconomic theory suggests it is the least profitable plants that close when demand falls or cost rises. So when demand declines for an industry with some economies of scale it is the smallest plants that would be expected to close. However, findings from research on industry dynamics and strategy suggest the negative relationship between size and closure when demand declines may not hold.

First, the theoretical literature on industry dynamics suggests exit can result not from declining demand or rising costs but rather failure to innovate. The model of Jovanovic (1982) features entrants with in built quality that is discovered over time after entry. Entrants exit upon discovering they are low quality. Ericson and Pakes (1995) consider firms performing research that determines their quality. Firms that do not or unsuccessfully research exit. In both of these models exit is not directly correlated with demand or size. Jovanovic (1982) implies a negative relationship between age and the likelihood of exit. However, this relationship also results if newer capital equipment has a higher resale value (Baden-Fuller (1989)).

Even if demand in an oligopoly is declining the relationship between size and survival implied in the textbooks may not hold. The striking result of the work of Ghemawat and Nalebuff (1985) (hereafter G&N) is that the subgame perfect equilibrium of an exit game, where firms produce at capacity (without economies of scale), is that firms close in order of size with the largest firms closing first.[2]

The intuition for this result is as follows. There are two firms, one with a larger capacity than the other. Size is built into the model by assuming marginal revenue exceeds marginal cost at all outputs below capacity for both firms. Hence

[2] With sufficient economies of scale the strategic disadvantage is lost (Ghemawat and Nalebuff (1985))

both small and large firms always produce at capacity. Demand declines over time. The game begins when it is no longer profitable for both firms to continue. Firms choose the time of exit. There are two Nash equilibria, each featuring one firm exiting immediately and the other remaining until operating is no longer profitable. Each features a threat to outlast the other firm. The equilibrium in which the large firm exits first, though, is the only subgame perfect equilibrium. This is because, as the small firm is not committed to producing large outputs, only the small firm can credibly commit to outlasting its rival by recovering any losses as a monopoly.

Ghemawat and Nalebuff (1990) further argue that if a firm can continuously shrink rather than only completely close, the largest firms shrink until all firms are similarly sized, after which all firms shrink together. When demand declines, excess capacity has no strategic value so it is shut down. But if firms have to close plants of unequal size, the positive relationship between size and the likelihood of exit no longer necessarily holds. A plant closing conveys benefits to other plants of the firm that it internalizes (Whinston (1988)). However, Ghemawat (1997) surveys further extensions to their papers and finds their main results are generally robust.

Dierickx, Matutes and Neven (1991) consider exit under different types of declining demand for two types of firms. If there is a reduction in consumer willingness to pay for a product due, for example, to the entry of a superior substitute, then the firm with relatively low fixed cost and high variable costs exits first. As the willingness to pay declines (for example, the demand curve shifting downwards), price no longer covers marginal cost. But if there is shrinkage in the customer base (for example the demand curve solely tilting inwards), then the high fixed cost and low variable cost firm exits first. While some customers remain willing to pay a high price for the car, not enough remain to cover the large fixed costs of operating.

This theoretical literature suggests six hypotheses summarized in Table 1.

TABLE 1
List of Hypotheses

Scale: There is a negative relationship between size and the likelihood of exit

Strategy (Strong): There is a positive relationship between size and the likelihood of exit (Ghemawat and Nalebuff (1985)).

Strategy (Weak): There is a positive relationship between the number of plants a firm has and the likelihood of exit (Ghemawat and Nalebuff (1990); Baden-Fuller (1989))

Cost Type: If the willingness to pay declines, there is a greater likelihood of exit for plants with low fixed costs and high variable costs. If the customer base declines, there is a greater likelihood of exit for plants with high fixed costs and low variable costs (Dierickx et al (1991))

Age: There is a negative relationship between age and the likelihood of exit Jovanovic (1982), Baden-Fuller (1989)

Old Age: There is a positive relationship between age and the likelihood of exit Deily (1988)

If the first hypothesis is satisfied competition, under economies of scale, determines the pattern of exit. If the second hypothesis is satisfied, then firm strategy unambiguously determines the pattern of exit. If the third hypothesis is satisfied, this supports strategy as the determinant. However, Harrigan (1980) and Baden-Fuller (1989) argues this result is consistent with multi-plant or diversified firms having effectively lower shut down costs. Hence, satisfying this hypothesis only provides weak support for strategy as a determinant of exit. Similarly, while a negative relationship between age and the likelihood of exit provides support for Jovanovic (1982), arguments in Baden-Fuller (1989) imply newer plants are more likely to close, as they should have a higher resale value. Deily (1988) though argues plants with older capital are more likely to exit because of higher production and maintenance costs, and that the failure to reinvest suggests a gradual exit is taking place.

There have been several previous econometric studies of exit. Lieberman's (1990) findings from a study of a set of declining chemicals industries, supports the scale and strategy (weak) hypotheses. Economies of scale appear to outweigh the strategic disadvantage of size. Deily's (1991) study of the U.S. steel industry also supports the scale hypothesis as she finds demand and cost factors to be the most important determinants of exit – with strategic and firm characteristics, such as firm size, number of plants and diversification, being insignificant or relatively small. Gibson and Harris's (1996) study of manufacturing in New Zealand after trade liberalization finds support for the scale, weak strategy and age hypotheses. Deily (1988), in another study of the U.S. steel industry, finds support for the old age hypothesis.

Further support for the age and scale hypotheses are found in a series of empirical papers on industry dynamics (see Sutton (1997) and Caves (1998) for recent surveys). In particular it is noted that entry and exit rates are highly correlated, with exit rates highest among recent, small, entrants. In addition, the lower the sunk costs associated with entry the greater the association of exit with industry changes.

In summary, while economic theory suggests any of competition, strategy or failed innovation could drive exit, the empirical evidence to date provides only weak support for the hypothesis that strategy determines exit. Instead, there is a consistent pattern of support for first, the textbook hypothesis that competition drives out small high cost plants and, second, that relatively new plants are more likely to close.

III. The Australian Car Industry[3]

In this section, we describe the Australian car industry for two reasons. First, to highlight the features that make it a suitable and distinctive case for testing the hypotheses that scale and strategy determine the pattern of exit. Second, to highlight the role government policy has played in shaping the industry and, hence, as a determinant of exit. We will refer repeatedly to Table 2, which contains some descriptive statistics about the industry.

For strategy to be a possible determinant of exit, the car industry must have been an oligopoly. This is demonstrated in rows two and three of Table 2. Using domestic registration data, we calculate four and eight firm concentration ratios at the midpoints of each of five periods. The four firm ratio has not fallen below 69% and the eight firm ratio has not fallen below 78%. Furthermore, potential competition from imports has been restricted by substantial tariffs and other protective measures.

The second feature required for testing these hypotheses is that the industry experiences declining demand. Though Table 2 suggests registrations declined only between 1974 and 1983, this hides considerable variation across broad groups of cars. Examining exponential growth rates by period for each group of cars by nationality (English, European, Japanese and US) reveals falling registrations for all groups assembling in Australia after 1974 except for the Japanese. Furthermore, registrations for European cars started declining in 1964 and for English cars, from the early 1950s. Hence most assemblers for a substantial proportion of the sample period experienced declining demand.

[3] This section draws on the following sources for historical background: Birney (1985), Conlon and Perkins (1995 and 1997), Darwin (1986), Davidson and Stewart (1974), Davis, P. (1987), Davis, T. (1987), Gregory (1988), Stubbs (1972), Swan (1972) and Wright (1998).

TABLE 2

Descriptive Statistics on the Australian car industry

	Period				
	1920 – 1947	1948 – 1963	1964 – 1974	1975 – 1983	1984 – 1998
Four (Eight) Firm Concentration Ratio	69.2 (78.5)	81.4 (95.8)	78.1 (94.0)	74.3 (95.3)	69.1 (90.1)
Tariff Rate at end of Period.	41.46	35	45	57.5	22.5
Entrants	16	18	5	3	2
Exits	2	16	9	7	6
Average demand growth	8.9%	14.6%*	4%	-0.14%	3%
Industry Capacity (End of Period)	60810	341993	452181	370250	425350
Average Plant Capacity (End of Period)	5068	22800	37682	46281	106338
Number of Plants (End of Period))	14	16	12	8	4

Note: the concentration ratios are calculated using shares of registrations at the midpoint of each period, except for period one, when cumulative registrations, as reported in the 1948 census, are used.
* 1950-1963 - to avoid distortions in the immediate postwar period.

The Australian car industry is distinctive from those considered in earlier studies for three reasons. First, is that differentiated rather than homogeneous products are produced. Differentiation reduces the importance of the strategic disadvantage of size but also the importance of economies of scales. Hence, there is the possibility that strategy plays a greater role in determining exit than in steel and chemicals where economies of scale are likely to be more important.

Differentiation, though, also means exit is no longer identical to plant closure. In a homogeneous products industry, a change in the ownership of assets (keeping industry numbers constant) has no effect on the industry equilibrium. But in a differentiated products industry, a change in ownership while not altering the engineering characteristics of an industry could have competitive consequences.

Hence, a substantial change in ownership will be treated as an exit and entry. For example, when Mitsubishi purchased the Chrysler plants, Chrysler is recorded as having exited, and Mitsubishi as having entered.

The second reason that the car industry is distinctive is that it provides an opportunity to test the cost type hypothesis of Dierickx et al (1991). The car industry is composed of assembly plants and manufacturing plants. A manufacturing plant makes the bodies, the engine (usually) and other components and then assembles the car. Assembly plants receive packs of parts from either a manufacturing plant of the same company, or from another manufacturer. These packs are then assembled, with additional domestic parts. Assembly plants feature low fixed costs but higher variable costs and manufacturing plants feature higher fixed costs and lower variable costs. If the type of demand decline is known, then the importance of cost type can be tested.

The car industry has been regulated in five periods as summarized in Table 3. Each period is distinctive in terms of the mix of instruments used and the aims of the protection. Particularly clear accounts of the degree of protection are provided in Stubbs (1972) Gregory (1988) and the Industry Commission (1997).

Referring to Table 2, like many industries considered in the empirical industry dynamics literature, entry and exit are correlated. In particular, during the high growth period many small assembly plants entered and then exited.

The second feature notable from Table 2 is that the average capacity of assembly plants appears to rise over the period. This suggests that, as in earlier studies, competition eliminates the smaller plants unable to achieve economies of scale. However, the pattern of exit is not strictly in order of size. In particular, several relatively large manufacturers (Volkswagen, British Leyland, Chrysler) exit before the smaller assembly plants of British Leyland, Ford, GMH and Renault. Hence, strategy may have played some role in determining exit. Indeed, much of the entry and exit is concentrated in the small car segment of the marker where Japanese producers replaced the earlier English and European assemblers. Anecdotal evidence suggests Japanese cars were perceived as higher quality – suggesting a falling willingness to pay for the incumbent small cars. Dierickx et al.'s model suggests then that small car assembly plants will close before manufacturing plants.

TABLE 3

Protection in the Industry

Period	Mix of Instruments	Distinctive Features
1920 – 1947	Tariffs on components (not cars). Duty paid depended on components.	Aimed at protection local assemblers and component manufacturers
1948 – 1963	Tariffs on components and (from 1957) cars. Manufacturers exempted from exchange controls and component duties	Aimed at encouraging manufacturing, protecting assemblers and component manufacturers
1964 – 1974	Motor Vehicle Plan – tariffs; exemptions from tariffs for manufacturers and assemblers	Encouraged manufacturing and also small volume assembly. Tariff raised to deter imports.
1975 – 1983	Motor Vehicles plan continued, without small volume plan. Export facilitation introduced (1982)	Tariffs increased and quotas to restrict imports to 20% of market.
1984 – 2000	Button Plan: tariffs falling after 1988; tariff-quota system (til 1988), export facilitation expanded	Aim to create industry that will survive at low rates of protection. Encourage exports.

IV. The Econometric Models

In this section, the set of econometric models estimated in section VI is presented. After discussing how we extend the Basic specification used in other papers for our dataset (discussed in more detail in section V), we introduce two sets of extensions (the Extended and Full specifications), and discuss the sensitivity analysis.

Most related empirical work has begun with a cross section of plants in one period of declining demand. To test the Scale, Strategy (Strong), Strategy (Weak) and, sometimes, Age or Old Age hypotheses, a discrete choice model of the exit decision is estimated. The dependent variable, y_{it} is defined as follows. For the i[th] plant that operating in period t:

$$y_{it} = \begin{cases} 0 \text{ if operating at the end of the period} \\ 1 \text{ if closed at the end of the period} \end{cases} \tag{1}$$

For explanatory variables, measures of size (Size), the number of plants (Multiplant) and age (Age) and other controls, depending on the industry and environment, are used. This is referred to as the Basic specification.

Because our dataset is an unbalanced panel of plants through multiple periods of growing demand and declining demand rather than a cross section, we make one adjustment for our Basic specification. The Strategy (Strong) and Strategy (Weak) hypotheses suggest the sign on Size and Multiplant may differ across different periods with demand. So we create two dummy variables for periods of increasing demand (D_+) and decreasing demand (D_-) so to create four new explanatory variables ($Size_-$, $Multiplant_+$, $Multiplant_-$) as follows:

$Size_+ = Size*D_+$ $\quad\quad$ $Multiplant_+ = Multiplant*D_+$

$Size_- = Size*D_-$ $\quad\quad$ $Multiplant_- = Multiplant*D_-$

The two controls we include in our Basic specification are measures of the growth of demand, D_{mkt}, and the level of protection, Tariff, as summarized in equation (2):

$$y_{it} = f(Size_+, Size_-, Age, Multiplant_+, Multiplant_-, D_{mkt}, Tariff) \tag{2}$$

If the coefficient on all size variables is negative then the Scale hypothesis is supported and competition determines the pattern of exit. If the coefficient on $Multiplant_-$ is positive then the Strategy (Weak) hypothesis is satisfied, providing weak support for a role for strategy in the pattern of exit. If the coefficient on $Size_-$ is positive then the Strategy (Strong) hypothesis is satisfied, providing unambiguous support for strategy as determining exit. If the coefficient on Age is positive then the Age hypothesis is satisfied – otherwise the Old Age hypothesis is satisfied. The coefficient on D_{mkt} is expected to be positive. If the coefficient on Tariff is negative, then protection reduces the likelihood of exit.

For the Extended specification we adjust the Basic specification to allow for different relationships between size and the likelihood of exit depending on the size of the plant. In particular, for large plants, economies of scale should dominate strategic factors or even product differentiation, yielding a negative relationship, whereas for a group of medium sized plants strategic considerations may suggest that a larger plant should close. So we create a new explanatory variable of the square of size ($Size^2$), to allow for a quadratic relationship between size and exit. We also continue to allow for different effects of size in periods of different demand, yielding the Extended specification, as summarized in equation (3):

$$y_{it} = f(Size_+, Size_+^2, Size_-, Size_-^2, Age, Multiplant_+, Multiplant_-, D_{mkt}, Tariff) \quad (3)$$

If $Size_-$ and $Size_-^2$ have different signs this allows for competition and strategy to play different roles in determining exit, depending on the size of the plant. Otherwise the interpretation of the coefficients is as before.

In our Full specification, we introduce two variables to better control for cost differences across plants. In particular, to test the Cost Type hypothesis we introduce the dummy variable (PT_-) defined as follows:

$$PT_{it} = \begin{cases} 0 \text{ if a low fixed cost and high variable cost plant} \\ 1 \text{ if a high fixed cost and low variable cost plant} \end{cases}$$

$$PT_{-,it} = PT_{it} * D_-$$

In addition, we introduce a measure of the number of models assembled at the plant (Models) to capture the failure to achieve economies of scale represented by size. The Full specification is summarized in equation (4):

y_{it} = f(Size$_+$, Size$_+^2$, Size$_-$, Size$_-^2$, Age, Multiplant$_+$, Multiplant$_-$, D_{mkt} ,Tariff, Models, PT$_-$) (4)

The coefficient on Models is expected to be positive. As we have argued that the negative growth reflected a decline in the willingness to pay, if the coefficient on PT$_-$ is negative this supports the Cost Type hypothesis. Otherwise the hypothesis is rejected or the decline in demand is best characterized as a decline in customer base.

Finally, we also perform three sensitivity tests of the results achieved with the first three specifications. First, it is highlighted in Section III that different segments of the industry (English, European, Japanese and US) feature different demand growth in different periods. So we redefine the dummy variables D_+ and D_- as follows. First, define D_{jt} as the growth in registrations for segment j in period t. Dummy variables $D_{+,j}$ and $D_{-,j}$ are compiled for each segment. Finally, D_+ and D_- are compiled by summing across segments of the relevant dummies. In particular, if for the ith plant producing cars of the jth segment in period t,

$$D_{+,ijt} = \begin{cases} 1 \text{ if } \mathrm{D}_{\mathrm{jt}} > 0 \\ 0 \text{ if } \mathrm{D}_{\mathrm{jt}} < 0 \end{cases} \qquad \mathrm{D}_+ = \sum_j D_{+,j}$$

Hence

$$D_{-,ijt} = \begin{cases} 1 \text{ if } \mathrm{D}_{\mathrm{jt}} < 0 \\ 0 \text{ if } \mathrm{D}_{\mathrm{jt}} > 0 \end{cases} \qquad \mathrm{D}_- = \sum_j D_{-,j}$$

The variables, Size$_+$, Size$_+^2$, Multiplant$_+$, Multiplant$_+^2$, Multiplant$_-$, Multiplant$_-^2$ and PT$_-$ are then recalculated using the new dummy variables and the Full specification estimated with the new set of explanatory variables. If segment demand is more important than overall demand, we expect an increase in the explanatory power of the equation and an improved match of the estimated coefficients with those suggested by theory. Otherwise, we conclude that firms form their expectations for investment and exit based on overall market demand movements.

The second test is suggested by the observation that greater entry and exit occurs in the small segment of the market. This test is performed by re-estimating the Full specification on two subsamples: (1) plants that produce primarily for the small car market (2) other plants. If the two markets are different we expect improved explanatory power and a closer match of the coefficients with those predicted by theory.

The final test is suggested by the observation that the aim of protection during the Button Plan is different to that for the earlier periods. The small dataset means we can not perform a full Chow test so we re-estimate the full specification with (1) a dummy variable for the fifth period (D_5) (2) two new variables $Size_{4-}$ and $Size_{5-}$ equal to the product of $Size_-$ and a dummy for the fourth period (D_4) and $Size_-$ and D_5 (3) two new variables $Size_{4-}^2$ and $Size_{5-}^2$ equal to the product of $Size_-^2$ and D_4 and $Size_-^2$ and D_5. If the Button Plan made a difference beyond changing the settings of policy we expect a competitive rather than strategic outcome and an overall reduced likelihood of exit.

V. Highlights of the data

The sample includes all manufacturing plants and nearly all assembly plants that operated in the Australian car industry from 1920 - 2000.[4] For each plant, for each of the five periods as defined in Table 3 in which it operates, the dependant variable, as defined in equation (1) is calculated and a matching set of explanatory variables compiled. As discussed earlier, a plant is stated to have exited if it ceases assembling cars or if there is a change in the main make assembled.

[4] Data is missing for two small assembly plants in the 1950s and the small independent assembly plants in the first period. These plants were mainly assembled British and small American brand cars.

The definitions of the explanatory variables required for each of the models and the sensitivity tests are summarized in Table 4.

TABLE 4

List of Explanatory Variables

Explanatory Variable	Definition
Tariff	Average Tariff rate
D_{mkt}	Average annual growth rates of car registrations.
D_j	Exponential growth rates of registrations for each of the set of US, British, European and Japanese cars sold.
Size	Maximum cars potentially assembled per year divided by the size of the largest plant for the period.
Age	= $Year_{closed} - Year_{opened}$ if closed in period. = $Year_{end\ of\ period} - Year_{opened}$ otherwise.
Models	Typical number of models assembled.
PT	=1 if manufacturing plant. = 0 otherwise
Multiplant	Number of assembly and manufacturing plants in company when plant closed or end of period.
D_+, D_-	D_+ = 1 for periods 1 – 3, 0 otherwise D_- = 1 for periods 4 – 5, 0 otherwise
$D_{English,-}$, $D_{Europe,-}$, $D_{Japan,-}$, $D_{US,-}$	$D_{English,-}$ = 1 for periods 3-5, 0 otherwise $D_{Europe,-}$ = 1 for periods 3-5, 0 otherwise $D_{Japan,-}$ = 1 for period 5, 0 otherwise $D_{US,-}$ = 1 for periods 4-5, 0 otherwise
$D_{English,+}$, $D_{Europe,+}$, $D_{Japan,+}$, $D_{US,+}$	Defined as the complements of $D_{English,-}$, $D_{Europe,-}$, $D_{Japan,-}$, $D_{US,-}$.

Three items of data require further explanation. Relative size is used rather than absolute size to capture the competitive pressure – a 22,000 cars per year plant is large in 1938 but small in 1988. While registrations declined for English cars in period 2, it is treated as an expanding period as nearly all assemblers expanded capacity during the period. Similarly, while registrations growth is (just) positive for Japanese manufacturers in period 5, this is treated as a declining period as tariffs were coming down. Finally, estimates of plant capacities are not obtainable from one source so we trawled various sources to obtain estimates. Engineering estimates are used where possible. If these are unavailable, then maximum registrations for each period are used as a proxy. More details are provided in the data appendix.

VI. Results

In this section, we present the results of estimating the specifications outlined in section IV. First, we estimate the Basic specification and obtain the same results as earlier work that suggests competition drives exit rather than strategy. Then we estimate the Extended specification, which yields a positive relationship between size and the likelihood of exit at smaller plant sizes. The tariff rate is found to be negatively correlated with the likelihood of exit, suggesting government policy reduced the rate of exit. Age squared is found to be negatively correlated with the likelihood of exit consistent with the industry dynamics literature. However, estimating the Full specification does not yield support for the Cost Type hypothesis. The sensitivity tests suggest our results are fairly robust.

(i) Results

The results of estimating the Basic, Extended and Full specifications are presented in Table 5. The specifications vary from those proposed in Section IV in two ways. First $Size_+^2$ is omitted from the Extended and Full models as it is highly correlated with $Size_+$ resulting in the coefficients on both being insignificant from zero. Second, Age^2 replaces Age as it is found to be significant whereas Age is not and together both are insignificant.

TABLE 5

The Results (Probit)

Variable	Basic Model		Extended Model		Full Model	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Constant	5.4017 (2.395)*		8.2061 (2.919)*		8.8443 (2.973)*	
$Size_+$	-2.6826 (-2.903)*	-1.0343	-2.7367 (-2.905)*	-0.9621	-3.2154 (-3.009)*	-1.1239
$Size_-$	-1.9719 (-2.214)*	-0.7603	14.4602 (2.160)*	5.0834	14.4013 (2.027)*	5.0338
$Size_-^2$			-24.1987 (-2.312)*	-8.5069	-23.756 (-1.958)*	-8.3036
Tariff	-0.1035 (-2.308)*	-0.0399	-0.1783 (-2.953)*	-0.0627	-0.2029 (-3.059)*	-0.0709
D_{mkt}	-0.0438 (-0.989)	-0.0169	-0.0536 (-1.158)	-0.0188	-0.0543 (-1.157)	-0.0190
$Multiplant_+$	0.0379 (0.412)	0.0146	0.1545 (1.459)	0.0543	0.1342 (1.237)	0.0469
$Multiplant_-$	0.5244 (1.889)#	0.2022	0.2149 (0.562)	0.0756	0.3484 (0.848)	0.1218
Age	-0.0148 (-1.055)	-0.0057				
Age^2			-0.0006# (1.705)	-0.0002	-0.0006# (-1.888)	-0.0002
PT_-					-0.3194 (-0.251)	-0.1032
Models					0.1957 (1.308)	0.0684
Log Likelihood	-49.276		-43.858		-42.856	
LRT – overall	21.21*		32.04*		34.04*	
LRT Comparison			Extended vs. Basic 10.836*		Full vs. Extended 2.004	

Significant at the 5% level * Significant at the 10% level#

Estimates of the Basic specification are presented in the second and third columns of Table 5. They are similar to the results in other studies. The Strategy (Strong) hypothesis is rejected, the Strategy (Weak) hypothesis is supported, as is the Scale hypothesis. A Wald test that the difference in the coefficients on $Multiplant_+$ and $Multiplant_-$ is significant at 10%. That the coefficient on $Multiplant_-$ is not significantly different from zero suggests that the number of plants did not have a non-strategic effect during the growth periods but we still cannot conclude that the positive coefficient is evidence of a strategic effect. Tariff has a significantly negative effect on the likelihood exit. All together it suggests competition and trade policy drive the pattern of exit with non-conclusive evidence in support of strategy.

Estimates of the Extended specification are presented in the fourth and fifth columns. First, note a likelihood ratio test suggests the Extended specification improves significantly on the Basic specification[5]. Age^2 is now significantly (at the 10% level) negative, supporting the Age hypothesis. More strikingly, the different signs on Size_- and Size_-^2 suggest a hill shaped relationship between size and exit during the period of decline. In particular, for plants with capacity below 30,000 and 41,000 vehicles per year, for periods 4 and 5 respectively, there is a positive relationship between size and exit, suggesting strategy influences the pattern of exit. These include most of the assembly plants, though none of the manufacturing plants. For all larger plants competition, and as before, protection determine exit.

Estimates of the Full specification are presented in columns six and seven. A Likelihood ratio test suggests the Extended and Full models are not significantly different. The coefficients on Models and PT_- are not significantly different from zero, providing no support for the Cost Type hypothesis.

In summary, these estimates provide the first econometric evidence supporting the Strategy (Strong) hypothesis, over relatively small plant sizes. This, though, highlights a tension in the application of game theoretic models to oligopolies. Oligopolies exist when economies of scale combined with barriers to entry result in a

[5] The test is performed comparing the basic specification with an encompassing specification of the two models. The encompassing specification (with a log likelihood statistic of –43.858) is significantly better. The extended and encompassing specification are not significantly different.

relatively small number of firms. And it is in an oligopoly where there is the most scope for strategic competition. But, if oligopolists are heterogeneous, economies of scale provide a substantial advantage to the large oligopolist and limit the opportunities for strategic competition. While game theory suggests much is possible, the empirical significance could well be limited.

(ii) Sensitivity Tests

The first sensitivity test, as described in Section IV is to check whether the car industry is best characterized as featuring separate markets for different types (by origin) of cars. It is not possible to do a nested hypothesis test or construct an estimable encompassing specification to formally test the relative performance of the two versions of the Full specification. However, the differentiated version of the model does not perform as well. The log likelihood statistic is –46.3919, quite a bit higher than for the original specification. And only the coefficients on $Size_+$ and Tariff are significantly different from zero at 10%. This result is consistent with anecdotal evidence that firms form their expectations for investment based on general conditions. In particular, investments in a new model (the P76) by British Leyland and in new capacity by Renault suggest they did not see their prospects in decline even as new registrations fell.

The second sensitivity test is to estimate separate Full specifications for plants producing small cars and large cars separately. The results are presented below in Table 6. For the large producers, PT_- is omitted as it perfectly predicts exit, and $Size_-^2$ is omitted as it adds little but collinearity to the equation.

TABLE 6

Results when sample split between large car and small car plants

	Sample of small car plants		Sample of large car plants	
Variable	Coefficient (z-stat)	Marginal Effect	Coefficient (z-stat)	Marginal Effect
Constant	9.8886 (1.389)		8.5701 (1.765)#	
$Size_+$	-3.6249 (-1.456)	-0.6028	-2.1343 (-1.385)	-0.5810
$Size_-$	358.6054 (2.372)*	59.6297	-2.5028 (-1.038)	-0.6813
$Size_-^2$	-646.8098 (-2.351)	-107.553	Not included	
Tariff	-0.2844 (-1.775)#	-0.0473	-0.2425 (-2.293)*	-0.0660
D_{mkt}	-0.1685 (-1.357)	-0.0280	-0.0514 (-0.690)	-0.0140
$Multiplant_+$	3.5232 (2.507)*	0.5858	0.3854 (2.171)*	0.1049
$Multiplant_-$	-8.7805 (-2.109)*	-1.46	1.4578 (2.347*)	0.3969
Age^2	-.0089 (-2.424)*	-0.0015	-0.0002 (-0.443)	-.0001
Models	0.6917 (1.593)	0.1030	0.2062 (0.631)	0.0561
PT_-	27.2483* (2.209)	0.9949	Not included	
LRT	30.58*		18.25*	
Log Likelihood	-13.3933		-18.2617	

Though a likelihood ratio test cannot be performed to directly test if the sample split improves over specification based on the whole sample, the sum of log likelihood statistics is considerably lower. The estimates based on the sample of small car producing plants are similar to that for the sample as a whole with two exceptions. Both the coefficients on the Multiplant variables and on PT_- are now significantly different from zero. However, the coefficient on $Multiplant_-$ is negative. This could be explained by some plants being replaced by other plants while running together for some time. The positive sign on PT_- is also contrary to expectations. The estimates from the sample of plants producing large cars support the Strategy (Weak) rather than Strategy (Strong) or Scale hypotheses. The results for both of these regressions suggest more is going on but we run into problem with the small sample size.

Finally, we perform a test allowing for the signs and significance of coefficients to change during the Button Plan period. Table 7 summarizes the results of the set of tests:

TABLE 7

Results of testing for differences during the Button Plan

Additional Variables to Full Specification	Log Likelihood Statistic	Significance of variables
D_5	-42.6084	Insignificant from zero
$Size_{-}*D_4$, $Size_{-}*D_5$	-41.5448	Both significant – but not significantly different from each other.
$Size_{-}^2*D_4$, $Size_{-}^2*D_5$	-41.1349	Both significant – but not significantly different from each other

In all cases, allowing for differences across periods 4 and 5 appears to add little to the performance of the model.

In summary, allowing for differences in demand across broad segments or differences between the Button Plan and other periods appear to have little effect on the results. When the sample was split into plants producing small cars and those producing large cars, differences did emerge. However, the small sample size makes it difficult to further develop these differences.

VII Conclusion

In this paper we attempt to assess the importance of economies of scale, firm strategies and government policy in determining the pattern of exit from the Australian car industry over the last eighty years. While the theoretical literature suggests a testable implication of the role of firm strategy, other studies have found only weak evidence in support. Using a new dataset on the Australian car industry we estimate the Basic specification used in other studies and achieve similar results.

However, we then use a more flexible form and discover evidence of strategy playing a role where differences in costs due to economies of scale may be less important. Cost differences due to economies of scale continue to be important for larger plants. Protection consistently reduces the likelihood of plant exit. Further tariff cuts, as part of the current government's plan for the car industry increase the likelihood of further exit, with the smallest producer, Mitsubishi, being at most risk of closure.

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APPENDIX

In this appendix, we detail the construction of the data. The main details are summarized in Table A.1.

TABLE A.1
Explanatory Variables

Name of Variable	Details of Construction	Source
Tariff	(i) 1920 – 1947: Use estimated duty payable as % of factory Cost for 1938 report. (ii) 1948 – 1956 use average estimated ad valorem equivalent rate (iii) 1957 – 1997 For each period, tariff rate on cars.	(i) Tariff Board (1938) (ii) Tariff Board (1957) (iii) Industry Commission (1997), Tariff Board (1965)
D_{mkt}	Average annual growth rates in the sum of registrations of cars and stationwagons for each period	(1) Stubbs (1972) Table 1.7 (Period 1) (2) Stubbs (1972) Table 1.16 (Periods 2 & 3) (3) ABS registrations data (Periods 3,4 & 5)
D_j	Exponential growth rate of registrations by segment	ABS registrations data for 1950, 1964, 1974 and 1983/84 and Glass's Guide (1998) for 1997.
Models	Usually the mode of models produced at the plant by period.	

(i) Registrations and number of models

Two sources are used. First for model specific data up to 1976 and aggregate data thereafter the ABS (and predecessor) publications are used: "Motor vehicles and new registrations" (1949 –1953), "Registrations of new motor vehicles" (1953 – 1965), "Motor vehicles registrations" (1965 – 1993) and "New Motor Vehicles Registrations, Australia (preliminary)" (1993 - 1998). For model specific data from 1976 FCAI (1974 – 1988) and Glass's Guide (1995 – 1998) are used.

(ii) Plant Characteristics

Plant characteristics are compiled from the reports on the car industry by the Productivity Commission and its predecessors, Maxcy (1963), Swan (1972), Wright (1998), FCAI (1959 – 1970), FCAI (1974 – 1988), company annual reports, information provided by manufacturers and newspaper articles.

If capacity is reported as vehicles per day, this is converted to vehicles per year by multiplying by 245 (49 five-day weeks). Where both measures are reported this is typically the work year assumed. Maximum registrations are used for single plant firms. For Ford and GMH, state (with neighbouring states where relevant) registrations data is used for period 2 and, for GMH and Ford in Queensland, period 3, where these companies appeared to be locally supplying cars.

The main sources for the number of models are Automotive Industry Authority reports "Report on the State of the Automotive Industry" from 1985 to 1993, IAC (1974), IAC (1981; Tables A7.7 and A7.8) and Darwin (1983, 1986). This was supplemented by the registrations data described in section (i).

(iii) Other Data.

Before 1957 there were separate tariffs on many components rather than a single tariff on cars. So the import duties paid depended on the components used in each car. We use the estimates of the rate of protection per car compiled by the Tariff Board in the 1938 and 1957 reports. In addition, separate statistics on registrations by make do not exist for the first period so the growth rate in total registrations is used.