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TANGIBLE AND INTANGIBLE SUNK COSTS AND THE ENTRY AND EXIT OF FIRMS IN AUSTRIAN MANUFACTURING

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by

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Abstract

The present paper provides further evidence on the importance of sunk costs as determinant of the turnover, entry, and exit of firms by studying the Austrian manufacturing industry using a 14-year panel. This study explicitly considers sunk costs related to investment in dedicated intangible assets such as investment relating to organizational and goodwill capital. The empirical results confirm the relevance of sunk costs as mobility barriers, their symmetry in respect to entry and exit and suggest that the influence of sunk costs is robust to aggregation. Sunk costs relating to capital expenditure and to organizational capital are found to be symmetric. Sunk costs relating to advertising expenditures seem to be only barriers to entry but not mobility barriers. Industry growth and profitability growth are found to be asymmetric, having a positive influence on entry and a negative on exit. Export growth is found to reduce the turnover of firms and to have a negative effect on exit suggesting that the decision to export may be associated with substantial sunk costs.

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Keywords

Sunk costs, Mobility barriers, Austian Manufacturing, Symmetry of entry and exit barriers.

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Abstract

The present paper provides further evidence on the importance of sunk costs as determinant of the turnover, entry, and exit of firms by studying the Austrian manufacturing industry using a 14-year panel. This study explicitly considers sunk costs related to investment in dedicated intangible assets such as investment relating to organizational and goodwill capital. The empirical results confirm the relevance of sunk costs as mobility barriers, their symmetry in respect to entry and exit and suggest that the influence of sunk costs is robust to aggregation. Sunk costs relating to capital expenditure and to organizational capital are found to be symmetric. Sunk costs relating to advertising expenditures seem to be only barriers to entry but not mobility barriers. Industry growth and profitability growth are found to be asymmetric, having a positive influence on entry and a negative on exit. Export growth is found to reduce the turnover of firms and to have a negative effect on exit suggesting that the decision to export may be associated with substantial sunk costs.

1 Introduction

Entry and exit are central elements of industry evolution where entrants displace incumbents. New entry is often considered to represent more efficient capital and new ideas while exit retires old, inefficient capital and ideas. The turnover of firms is seen to promote competition, technological and structural change and hence efficiency. The question of what fosters new entries is an important question not only in academic research but also in the policy discussion in most industrial countries. Public programs to promote new entries are common practice at least in the countries of the European Union.

Models of industrial dynamics suggest that sunk costs are an important determinant of firm behavior and industry evolution over time. Examples include the models by Dixit (1989), Sutton (1991, 1998), Lambson (1991) and Amir and Lambson (2003). The basic idea behind these models is that sunk costs increase the costs of entry and of exit and thereby creating a zone of inaction where entrants are less likely to enter and incumbents less likely to exit, predicting that entry, exit and the turnover of firms over time is lower in high sunk cost industries. The empirical literature on sunk costs does concentrate on tangible sunk costs relating to physical capital and intangible sunk costs relating to advertising (e.g. (Kessides 1991, Rosenbaum and Lamort 1992, Lambson and Jensen 1998, Gschwandtner and Lambson 2002). But at least dating back to Marshall economists have recognized that firms are organizations that store and accumulate knowledge that influences their efficiency in production. Intangible and almost unobservable assets share with tangible sunk costs the characteristic that they are highly specialized and nearly irrecoverably lost upon exit. In this paper sunk costs relating to managerial and technological expertise and incremental organizational capital emphasized by Nelson and Winter (1982), Breschi et al. (2000), Metcalfe (1998) and Atkeson and Kehoe (2002) are studied in their relationship to the turnover of firms and entry and exit processes.

This study is motivated by the fact that while the theory linking intangible sunk costs to industry dynamics is well developed, the empirical evidence is more limited for small countries (for surveys see (Siegfried and Evans 1994, Gersoki 1991, Geroski 1995, Caves 1998)). The empirical research methodology is to use the information of different measures of industrial dynamics (turnover, entry and exit of firms) in order to study whether sunk costs are symmetric, as emphasized in the theoretical research. Overall, the results confirm that intangible sunk costs are an important determinant of industry evolution.

The data used in this paper covers the period 1981-1994 for the Austrian manufacturing sector. The Austrian manufacturing sector expanded its share of nominal value added in the European Union between 1988 and 1998 by more than a third, although there are known structural deficits regarding the specialization patterns within the Austrian industries (e.g. (Aiginger 1987, Hutschenreiter and Peneder 1997). The ambiguity of the pronounced lack of specialization in technology driven industries and the successful macroeconomic performance led observers to speak of an Austrian Paradox of old industrial structures but a good aggregate performance (Peneder 1999, Tichy 2000). This is mirrored in the findings regarding entry into the Austrian manufacturing sector. Hauth (2001) finds that Austria has a low level of Greenfield entry but a much higher survival rate in comparison with other industrial countries.

The paper is organized as follows. Section 2 presents a short review of the theoretical and empirical findings on sunk costs and entry and exit processes. In section 3 the database is described. Sections 4 and 4 discuss the specification of the empirical model to study the turnover, entry and exit processes in Austrian manufacturing. The results are presented in section 6. Section 7 concludes that turnover and exit and entry processes in Austrian manufacturing was highly influenced by the presence of sunk costs.

2 Sunk costs as mobility barriers

Entry is a response to perceived profit opportunities by new entrepreneurs. High market growth and new opportunities should attract new entry. The exit of incumbents is induced by expected losses and provides a release of productive resources to alternative uses. The literature on entry barriers - pioneered by Bain – emphasized that there are market conditions that allow incumbents to raise prices above costs persistently without attracting entry. The distinctive element of entry barriers is that they create an asymmetry between incumbents and potential new entrants. Barriers to entry are rents derived from incumbency (Gilbert 1989) which impose an entry cost to entrants, which incumbents do not have to pay. Barriers to entry relate the specific production and selling technologies and are related to production technology (structural entry barriers) or they are created strategically (behavioral entry barriers). Sunk costs related to specific dedicated assets are a central ingredient in any theory of entry barriers. Martin (2002) shows that sunk costs make entry unprofitable because of their effect on post entry costs of incumbents.

To qualify for sunk costs the assets under consideration must be committed for a long time and be product- firm or establishment-specific and the value of its service to a particular economic activity exceeds its value in alternative use. Specific dedicated assets impede the mobility of capital out of an industry by imposing an exit cost. Exit costs in turn increase the costs of entry into an industry. Thereby they reduce the turnover of firms. Sunk costs build up mobility barriers which are symmetric with regard to entry and exit. They not only constitute a barrier to entry to new firms but also a barrier to exit to incumbents and create a mobility barrier in the sense that the turnover of capital and ideas through entry and exit is the lower the higher sunk costs are (e.g. (Eaton and Lipey 1980, Caves and Porter 1977)).

This suggests that sunk costs are an important determinant of firm behavior and industry evolution over time. The basic logic is the following (e.g. (Lambson 1991, Dixit 1989):

Suppose a firm must pay an entry cost to enter an industry and a fraction of this cost is sunk. Only the resale (scrap) value of the entry cost (and the later investment) can be recouped upon exit. Two effects must be distinguished: First, there is a direct effect reducing the expected firm value of entrants because of the uncertainty of recovering the sunk fraction of entry costs. As any entering firm needs to recoup their sunk cost, their post-exit output prices must be higher (or the risk of exit lower) if sunk costs are higher. Consequently the level of entry is the lower the higher sunk costs are. Second, there is an indirect effect on entry deriving from the expected behavior of incumbents. As incumbents enjoy more protection from future entry when sunk costs are higher, they are more willing to endure deteriorating conditions without exiting, as the outside options to reallocate their assets into alternative uses are not attractive. Incumbents will act more aggressively, as they are forced to remain in the market. The two effects together lead to a higher entry threshold (in terms of expected profitability) and a lower exit threshold in the presence of substantial sunk costs, resulting in lower entry and exit rates. Theory predicts that the effect of sunk costs are symmetrically negative for entry and exit and that the resell or scrap values is symmetrically positive. The turnover and the volatility of firms should be the lower the higher sunk costs are.

In regard to tangible capital Lambson and Jensen (1998) have found that firm value variability is explained by sunk costs rather than by size related variables for a large sample of US firms. Gschwandtner and Lambson (2002) have shown that sunk costs relating to capital expenditures are a significant determinant of the variability of the number of firms in a number of developed and developing countries. Ghosal (2003) finds that higher sunk costs together with uncertainty reduce the number of firms in the US industry, leading to a less skewed firm size distribution for high sunk cost industries. Empirical studies of the determinants of entry and exit exhibit a more mixed picture. Entry studies give a good indication that higher capital requirements provide strong entry barriers (e.g. (Shapiro and Khemani 1987, Mata 1993, Fotopoulos 1998)). However, Mayer and Chapell (1992) and Acs and Audretsch (1990) found no evidence that entry is related to capital requirements. As regards exit a number of studies (e.g. (MacDonald 1986, Dunne and Roberts 1991, Fotopoulos 1998)) find that capital requirements are a barrier to exit, while other studies (e.g. (Rosenbaum 1993, Roberts and Thompson 2003) find no evidence of capital being a barrier to exit.

Asset specificity is not only related to dedicated capital goods but also to dedicated intangible assets. Investment in advertising and marketing are asset specific. And technological knowledge and human capital form complementary and dedicated assets to the products produced. Sutton (1991) notes that there are industries with low set-up costs where industry growth goes hand in hand with increasing concentration, as an endogenous escalation of sunk costs in the process of competition leads to a situation where only a small number of firms survives and dominates the market. Sutton (1998) emphasizes that a similar process relates also to R&D expenditures. However, experience and knowledge related economies do not necessarily create a barrier to entry, their existence may actually facilitate entry when spillovers are high. However, if experience lowers the expected costs to achieve a patent, the more experienced firms have an advantage (e.g. (Fudenberg, R., Stiglitz, and Tirole 1983)). Experience related costs asymmetries can be considered to be sunk costs, when the acquisition of experience is considered to be the built-up knowledge on how to use and modify technology and products. Upon exit or radical technological change this specific knowledge is lost. This interpretation builds on the learning models of industry evolution proposed by Nelson and Winter (1982), Jovanovic (1982) and the model of organizational capital of Atkeson and Kehoe (2002) which emphasize firm-specific productivity shocks. Organizational capital then refers to the quality of the routines of incumbent firms. However, the literature of industry turbulence, which links intra-industry dynamics and cross-sectional differences to the source of knowledge that produces innovation (e.g. (Malerba and Orsenigo 1995, Winter 1984)) holds that differences in knowledge-related sunk costs are industry specific. A number of contributions have shown that industry-specific characteristics play a fundamental role in explaining the evolution of specific industries (e.g. (Gort and Klepper 1982, Audretsch 1991, Malerba and Orsenigo 1995, Breschi, Malerba, and Orsenigo 2000)). Winter (1984) distinguishes between an entrepreneurial regime which is favorable to entrants due to the radical character of innovations, and a routinized regime favoring incumbents due to the cumulative nature of the knowledge associated with innovation. The two regimes are related to different technologies of innovation and production and therefore related to size, vertical integration and sunk costs. A routinized regime should be associated with significant sunk costs and a high degree of vertical integration while an entrepreneurial regime is characterized by lower degree of sunk costs and vertical integration.

3 The Data

3.1 Entry, Exit and the Turnover of firms

For the present study gross entry, gross exit, turnover and volatility data for firms in the Austrian manufacturing sector are derived from the membership statistics of the Austrian Chamber of Commerce for the years 1981-1994. The data unfortunately pertain only to the two-digit level of industrial classification and are coded according to the code system by institutional aspects of the Austrian Chamber of Commerce (KS - Kammersystematik der Österreichischen Wirtschaftskammer). Albeit no exact correspondence between KS and ISIC Rev. 2 or NACE exists, it is approximately comparable to a two digit ISIC and classifies the firms according to activities (Pfaffermayr 1999). In Austria membership in the Chamber of Commerce is compulsory for every firm. Each new entry active at least 6 months is associated with a new membership in the related industry (Fachverband) and each exit with the cancellation of the membership. There exists also the classification of inactive members, which, in the context of the present study were eliminated. The re-entry of an inactive member is thus considered to be a new entry. Under the assumption that no new entry enters the population of inactive firms, exits were recalculated as the difference of memberships in the year before plus entries minus memberships in this year[1]. The term *firm* refers to legal units. The membership is a necessary but not a satisfying condition for actual production, as the membership needs not be associated with actual production activities. Therefore, entries must be interpreted as relating to the population of firms including newly entering firms, and entrepreneurial experimentation at a late stage as well as diversifying entry. This fact introduces a bias into the data: Entry and exit are likely to be more strongly correlated to each other than in other data as serial entrepreneurship is likely to overstate entry and exit. However, as there is no reason to expect a systematic relationship of the correlation between entry and exit and sunk costs this bias should not influence our analysis. The between entry and exit across all observations correlation is 0.512 and significant at the one percent level. However, it is a stylized fact - which also resurfaces in our model - that within-industry replacement dominates between-industry replacement (Cable and Schwalbach 1991, Geroski 1995) which suggests that the correlation should be positive and significant.

In order to neutralize the impact of changes in regulation we use time dummies in the regression analysis. A comparison with other data on industrial dynamics in Austria shows that a) the net entry in terms of memberships is highly correlated to the net entry of plants derived from the industrial statistics and b) that the data overestimates greenfield entry. The data from the membership statistics has also advantages, as it covers entries of all sizes.[2] A study of mobility barriers requires both entry and exit data. However, some industries were excluded from the present study: mining industries, industries with a 100% concentration ratio, as well as industries for which

[1] $EX_{it} = N_{it-1} + EN_{it} - N_{it}$, where EX_{it} is the number of exits, N_{it} the number of active memberships and EN_{it} the number of entries in time t for industry i. This procedure was suggested by the evidence that most entrants have enough financial means to survive their first year (e.g. (Santarelli and Vivarelli 2002, Adretsch, Prince, and Thurik 2000)).

[2] A comparison with greenfield entry data from the "Gründerstatistik" (founder statistics) of the Austrian Chamber of Commerce (Hauth 2001) showed that our entry data would overestimate greenfield entry. However we are not only interested in greenfield entry but also in diversifying entry. The main disadvantage of other available data is that no gross data are available (industrial statistics) or no gross exit is available (founders statistics).

Table 1: Summary statistics of dependent variables, 1981-1994

Variable		Mean	Std. Dev.	Min	Max
Entry	overall	27.344	25.592	0.000	99
	between		25.344	1.077	82.846
	within		6.903	5.498	63.498
Exit	overall	30.697	25.297	0.000	94.000
	between		24.993	2.077	78.846
	within		7.026	8.158	58.158
Turnover	overall	57.593	49.575	0.000	177
	between		49.718	3.000	156.769
	within		10.986	19.824	101.670
Volatility	overall	49.339	45.110	0.000	170.000
	between		45.014	1.846	147.385
	within		10.916	13.955	84.109
Entry rate	overall	0.063	0.029	0.000	0.273
	between		0.011	0.049	0.093
	within		0.027	-0.003	0.269
Exit rate	overall	0.076	0.038	0.000	0.364
	between		0.016	0.062	0.123
	within		0.035	-0.047	0.316
Turnover rate	overall	0.139	0.059	0.000	0.636
	between		0.019	0.117	0.190
	within		0.056	-0.051	0.586
Volatility rate	overall	0.151	0.075	-0.003	0.720
	between		0.030	0.124	0.239
	within		0.069	-0.091	0.631

the data was not consistent over time period studied.

In this paper a population approach is taken and the number of firms is used to indicate entry and exits processes. In order to account for the turnover and the volatility of producer identities two additional indicators are used in the empirical study. The turnover measures the total activity of entry and exit and is defined as the sum of entries in and exits from the industry. The turnover reflects the dynamics in terms of changes of the identities of producers in the industry. The turnover accounts for both the changes in market size and replacement effects. Thereby, it allows to investigate whether barriers to entry are also barriers to exit, that is mobility barriers. In order to account only for replacement effects the volatility of the producer turnover is used, which measures the excess turnover, that is the turnover in identities of firms which is not due to changes in the size of the market. Volatility is defined as turnover minus the absolute value of the difference of entry and exit. Industries with high volatility are those industries where large numbers of new firms displace a large number of old firms without affecting the total number of firms (Geroski 1995). By construction the volatility measure indicates what triggers the replacement of incumbents by new firms. The turnover and the volatility measures capture different aspects of industry entry and exit dynamics and must be regarded as indicators of their own right (Dunne and Roberts 1991, Fotopoulos 1998).

Table 1 shows the descriptive statistics for entry, exit, turnover and volatility expressed in numbers and as rates[3]. The summary statistics show that there is both within and between industry variation for each of the turbulence indicators.

3.2 Sunk Costs

The sunk costs indicators used in this paper are related to tangible and intangible sunk costs. Tangible sunk costs are related to capital expenditures, intangible sunk costs to accumulated knowledge and advertising, respectively.

As a large part of capital can be considered to be sunk (Ramey and Shapiro 2001, Asplund 2000), capital requirements are considered to represent a measure of tangible sunk costs. Arguing that capital costs forms a large component of entry costs a number of authors used capital stock (e.g. (Lambson and Jensen 1998)) as a proxy for sunk costs. For this purpose capital requirements (CAPRE) were proxied as the ratio of deflated fuel and energy expenditures over deflated total production value. CAPRE is a proxy of capital intensity because energy expenditure is closely related to mechanisation (Shapiro and Khemani 1987, Fotopoulos 1997). CAPRE captures machinery but not buildings. Machinery is usually considered to be more product-specific. CAPRE is, of course, not a perfect measure of start-up costs. However, it is highly plausible that energy costs are positively correlated with the tangible capital expenditure part of entry costs. Hence CAPRE is considered to be a reasonable proxy for tangible sunk cost. Tangible sunk costs are expected to be a mobility barrier, that negatively influencesentry and exit. Under the expected symmetry CAPRE is expected to be significant and negative for both the turnover and volatility of firms.

Tangible capital is not the only potentially non-recoverable asset lost upon exit. Non-

[3]Rates are defined as the ratio of the industry dynamics indicator of interest to the number of firms active in the previous year.

capital costs such as the opportunity costs of entrepreneurship and the sunk costs of acquired competence, routines, product-specific know-how and a skilled workforce constitute important part of organizational capital. Organizational capital related to training, employee voice and work design has significant impacts on productivity, wages and labor demand. Mueller and Supina (2002) confirm that goodwill capital related to R&D is both large and persistent. However, part of the reason why there is no systemic measure of organizational capital is the disagreement on what should be measured. Here we use as (industry) proxy for intangible sunk costs related to organization capital and organization-specific knowledge the complexity of operations in an industry. The measure of vertical integration proposed by Adelman (1955), value added over gross production value, can be used as proxy for the complexity of operations (Pennings and Sleuwagen 2000). In economic relations, asset specificity and sunk costs may lead to ex-post opportunism and influence thereby the ex ante contracting between agents (1975). In order to avoid the hold up problem vertical integration is preferred to contracting on the market. As asset specificity is related to complexity of the contracts which in turn is related to complexity of operations, higher complexity should be associated with a higher degree of higher vertical integration ((1984). Vertical integration is interpreted as organizational capital stored in the routines of incumbent firms. Value-added equals sales less the costs of material and intermediate inputs. However, the value added over gross production measure is not without problems. First as profitability is an important component of value added, however the adjustment proposed by Tucker and Wilder (1977) is not applicable, as no reliable information regarding net income and income taxes were available. COMP (complexity of operations) is expected to reflect the complexity of operations and to be a proxy for experience related sunk costs relating to organizational capital and associated to the particular knowledge base of the innovation process in the different industries. COMP is expected to have a negative effect on both entry and exit. As COMP is expected to be symmetric, the coefficient of COMP is expected to be significant and negative in the turnover and volatility regressions.

For entry COMP is expected to be negative. If COMP would display a strong downward tendency over time then the expected sign would also be negative as declining vertical integration would suggest new opportunities for entrants (spin-offs) taking up outsourced activities. This was not the case for the study period. Table 2 reports that the between industry variation for COMP is considerably larger than the within industry variation. Furthermore, there is no evidence for massive outsourcing of activities by looking at COMP: In the sample period the (not weighted) average value of change in complexity is 0.0007, suggesting that the degree of vertical integration remained almost the same.

Advertising is related to product differentiation. Product differentiation implies a barrier to entry in the sense that the producer of one brand cannot replicate another brand without incurring a disadvantage in costs or sales. Thereby advertising and market expenditures serve to impede the mobility of capital in an industry by exacerbating the effects of scale economies on the profitability of entry. If advertising has a long-lasting effect on sales then past advertising expenditures form goodwill capital which is specific to the firm, where goodwill is a measure of the success of product differentiation (e.g. (Mueller and Supina 2002)). Successful entry requires the building up of this goodwill capital, a large part of which is likely not to be recoverable upon exit. There will exist an asymmetry between incremental costs and risks faced by incumbents and potential entrants (Kessides 1991). Advertising is an important element of endogenous sunk costs (Sutton 1991). In order to proxy goodwill capital we use advertising intensity (ADVINT) measured as expenditures for advertising and related activities over sales. The advertising intensity is derived from Austrian Input-Output statistics for the years for 1983 and 1990. No time-series data are available. However, industry advertising expenditures to sales ratios are quite stable over time. The data were converted to the classification of the Austrian Chamber of Commerce with advertising intensity calculated as advertising expenditures over sales (Appendix A.0.1 provides details). This measure is not perfect, however, it seems plausible that advertising intensity is related to the goodwill capital part of entry costs. The coefficient for ADVINT is expected to be negative for both entry and exit. As ADVINT is expected to be symmetric, the coefficient of ADVINT is expected to be significant and negative in the volatility and turnover regressions.

Problematic in the context of the present study could be that there is no information available regarding the resale value of the firms assets as this introduces an omitted variable bias. There are however reasons to believe that this is not a serious shortcoming for the interpretation of the results ((Gschwandtner and Lambson 2002). It is highly plausible that the degree of sunkness is high in all of the industries, as most of a firm's assets are if not product-specific they are industry specific. The value of highly specialized machinery is probably no more valuable than scrap metal outside of the industry. Asplund (2000) reports that the sunk cost component ranges between 50 to 80 percent for metalworking machinery. Ramey and Shapiro (2001) report similar salvage values of capital assets in the US aerospace industry. This indicates that there is only a very thin market for used capital goods. The same is true for organizational and goodwill capital as the costs of assembling an organizational structure or goodwill of the consumer is lost when, at firm's closing, the employees go separate ways and the products are no longer on the market. To the extent that the resale or scrap values are uniformly low the variation in assets will be large in relation to the variation of the resale value. This leads to the expectation that the bias of the estimate is small. Moreover, as theory predicts the coefficient on resale value to be positive, and it is likely that the resale value is positively correlated with the measure of the specific capital, the bias in the estimates of sunk costs is likely to be positive.[4] Thus a negative estimate of a sunk costs coefficient provides strong support to the prediction derived from the theory that the coefficient is negative.

3.3 Other Variables

In order to isolate the influences of tangible and intangible sunk costs from other determinants influencing industry evolution, a number of control variables are included in the regression analysis. The growth rate of price cost margins (PCMGR) is the first of these variables. PCMGR is used to proxy the changes of average profitability in the industry. The price cost margin is defined as annual value added from industrial activity minus expenditures for wages and salaries over turnover. The growth rate of profitability was used in order to make this indicator comparable across the

[4] Greene (1997) provides the algebra of the omitted variable bias in the multivariate OLS case. This result carries over to a broad array of models which include a linear function of several variables as part of their specification, as long as the relationship is monotonic as in the case of the Poisson and Negative binomial models considered in the present paper.

Table 2: Summary statistics of independent variables

Variable		Mean	Std.Dev.	Min	Max
PCMGR	overall	0.085	0.599	-3.231	5.414
	between		0.153	-0.012	0.487
	within		0.580	-3.632	5.013
EMPLGR	overall	-0.021	0.037	-0.160	0.049
	between		0.020	-0.069	0.000
	within		0.032	-0.138	0.052
COMP	overall	0.350	0.081	0.131	0.570
	between		0.080	0.190	0.522
	within		0.022	0.277	0.424
COMP*KR	overall	1.785	1.755	0.167	8.192
	between		1.692	0.225	5.976
	within		0.611	-0.202	4.042
CAPRE	overall	5.430	5.828	0.557	31.522
	between		5.674	0.713	21.647
	within		1.876	-2.712	15.306
ADVINT	overall	0.008	0.003	0.003	0.013
IMPGR	overall	0.064	0.093	-0.143	0.391
	between		0.039	0.012	0.141
	within		0.085	-0.139	0.341
EXPGR	overall	0.068	0.101	-0.230	0.360
	between		0.026	0.026	0.124
	within		0.097	-0.217	0.344

industries, as price cost margins do not adequately reflect the level of profitability: Capital, R&D and advertising expenditures are not accounted for. Moreover, as Kessides (1991) argues, high profits may on one hand indicate opportunities to entrants but can also indicate a high probability to retaliate by incumbents to defend their rent, leading to blockaded entry. PCMGR does not relate to an absolute level of profitability but to short-run changes in industry profitability conditions. In order to account for industry growth the growth rate employment (EMPLGR) is used.

The formulation in terms of rates gets rid of the identification problem associated with the use of levels. EMPLGR is used instead of the growth rates of sales as indicator of industry growth, as EMPLGR is less afflicted than sales data by the distortive influence of inflation. EMPLGR is expected to have a positive effect on entry and a negative effect on exit. The entry decision depends on sufficient growth to justify additional industry capacity in an industry. The probability of exit is lowered by industry growth.

As Austria is a small open economy, imports and exports are expected to be important for industry dynamics and for entry and exit processes. Export orientation is generally thought to enhance opportunities to satisfy demand beyond the given domestic limits, and thus to encourage entrants. Imports on the other hand should discourage entry. In this study we use growth rates of imports and exports per industry. The export and import data are from the OECD STAN database, as the only available data for the classification of the Austrian chamber of commerce were inconsistent due to classification changes. Import and export data were converted to the classification of the Austrian Chamber of Commerce. Plausibility tests performed in comparison to available data showed that the growth rates of imports and exports were nearly identical (except in the years of classification changes).

Expectations are central to both entry and exit decisions. This suggests that entry and exit are likely to respond with some delay or anticipation to changes in profitability and market growth. Therefore PCMGR, EMPLGR, IMPGR and EXPGR are constructed by using the average between the actual and the lagged growth rates. With continuous explanatory variables there may the danger of reverse causality. Reverse causality is is less a problem for relatively time-invariant variables than for variables which vary primarily with time. However, in the case of profitability and market growth there is a trade-off between the risk of reverse causality and the role of expectations.

In order to control for industry size effects two indicators are used. First the log of the number of firms (NF_{t-1}) is a control in order to adjust for the industry size bias. The second control variable (AVMES) is used to control for sub-market heterogeneity within the industries related to the minimum efficient scale of plants. AVMES is defined as average plant size over Minimum efficient plant size. Minimum efficient plant size was calculated in a way similar to that suggested by Pashigian (1969) in terms of employment as a weighted average measure of the form: $MES = \sum (A_i/n_i)(A_i/A)$where A_i is total employment in the i-th size class, n_i the number of firms in the size i-th size class and A total industry employment (Fotopoulos 1998). AVMES is a measure of the distance between average plant size and MES. Only if average firm size is close to MES then economies of scale are a relevant barrier to entry. The effect of scale economies on entry and exit rates as mobility barrier is not conclusive in the literature (Siegfried and Evans 1994, Geroski 1995). This may be related to small market niches (sub-markets) and the argument that there may exist a range of umbrella pricing by larger firms which may provide a basis for small fringe producers to survive in the industry.

4 Specification Issues

Most empirical studies of entry and exit start from a limit-profit specification for entry and exit dating back to the pioneering article by Orr (1974). While the precise specification varies the basic set up relates entry and exit to indicators relating to mobility barriers, market opportunities and control variables. An entry decision is realized when expected profits for the entrant are positive, that is when the expected value of the enterprise exceeds the entry costs. A firm exits (or is forced to discontinue its operations) when the expected value of continued operations is lower than the exit costs. This type of modeling was used in a great number of empirical studies of entry and exit with a slightly different specification. IIlmakunnas and Topi (1999) and Roberts and Thompson (2003) are recent examples. Baldwin (1995) and Caves (1998) provide critical reviews of this model. Caves (1998) points out that the inclusion of concentration variables and price cost margins as separate regressors runs the risk to add redundancy if one accepts the view proposed by the Structure-Conduct-Performance paradigm where structural characteristics constrain the number of firms in the market and lead to an equilibrium characterized by concentration. Caves suggests that his may be the reason why some results are highly sensitive to specification changes. Structural and strategic entry barriers may also introduce a difficulty, insofar as they are different in one specific characteristic. Strategic entry barriers are essentially an ex-ante phenomenon. It is often argued that whether entry triggers retaliation or is followed by accommodation is a separate issue (Roberts and Thompson 2003). However, as in this paper only mobility barriers relating to sunk costs are considered, the difference of whether they result from technology or are created endogenously by competitive interaction (Sutton 1998) does not matter as long as they have a long-run structural characteristic. However, this issue is closely related to Baldwin's (1995) critique of the Orr-type methodology which in its original form is derived from the limit-price model and assumes that an entrant augments existing output, thereby neglecting the stochastic replacement view of entry which assumes that entry is a dynamic process involving both the partial and complete replacement of incumbents by entrants. The stochastic replacement view is closely related to the "try and see" behavior of entrants as emphasized in the model of noisy selection put forward by Jovanovic (1982) where entrants discover through a learning process their efficiency. The try and see behavior of entry is consistent with the high correlation between entry and exit rates. In the present study we aim at evading these critiques. In particular we do not use concentration measures and price cost margins. This is related on the one hand to the fact that we are bound to work on the two-digit level of industrial classification, where measures of market concentration do not make much sense, on the other hand the theory of industrial dynamics does not call explicitly for the inclusion of concentration measures. We use the growth rate of price cost margins instead of price cost margins in order to evade endogeneity problems.[5]

The use of the two-digit level of industrial classification may introduce an aggregation

[5]However, we will use price cost margins to study the robustness of our results.

bias. Basically, using data at this level of aggregation makes it impossible to interpret the results as relating to competitive market outcomes, as in fact we do not study markets but industries which are collections of a number of markets and sub-markets in the sense of Sutton (1998). Competition between firms is much less intense between markets and sub-markets than within each. Therefore the present study cannot claim to explain the process of entry and exit on the level of the sub-market and claim to test specific models of competition. However, if sunk costs have a large structural component, and technology, market environments as well as competitive behavior are much more similar within than between the grouping of two-digit industries then it can be assumed that the grouping based on outputs does not lead to a substantial aggregation bias. Therefore, it is a plausible conjecture that the grouping is made primarily on the basis of the independent variables. It can be ruled out with certainty that it is made on the basis of the dependent variables. Therefore the conditional mean of the disturbance term should be close to zero for the values of sunk costs. We are testing whether (admittedly rough) structural attributes relating to sunk costs give an indication about turnover (entry and exit) regimes.

In the light of the empirical evidence (which supports the importance of sunk costs as determinant of the turnover of firms and the variability of firm value) this implies that a confirmation of sunk costs as a central element of industry dynamics confirms the robustness of the theory with regard to aggregation. A rejection of the importance of sunk costs would not invalidate the theory of sunk costs, it would first of all indicate that competitive dynamics based on sunk costs are not related primarily to similarity in output and technology. If the theory is confirmed, it would suggest that the structural characteristics of product markets and the technological foundations of production processes (including the knowledge properties of the innovation process) play an important role in determining the level of sunk costs.

5 The Empirical Model

We examine the effect of sunk costs on the turnover and volatility and the underlying entry and exit processes across Austrian manufacturing industries for the 1981 to 1994 time period. First we present specifications for the turnover and the volatility of producer identities. The basic empirical specifications for volatility and turnover is:

$$\begin{aligned} \text{Volatility}_{it} &= a_1 + a_2 SC_{it} + a_3 X_{it} + a_4 C_{it} + \epsilon_{it}^v \\ \text{Turnover}_{it} &= b_1 + b_2 SC_{it} + b_3 X_{it} + b_4 C_{it} + \epsilon_{it}^t \end{aligned}$$

The dependent variables are the turnover or the volatility of producers expressed in terms of the number of firms in industry i in year t. The vectors SC_{it}, X_{it}, C_{it} represent mobility barriers related to the existence of sunk costs, industry specific indicators relating to incentives to entry and exit, and control variables. The components of the SC_{it} vector are CAPRE, COMP and ADVINT. Mobility barriers relating to sunk costs (dedicated capital goods, goodwill capital and organizational capital) are relatively time-invariant vectors which are expected to increase entry and exit costs symmetrically. The choice of these variables was suggested by the models of industrial dynamics. The components of the X_{it}vector are - as presented in the previous section - EMPLGR, PCMGR, IMPGR and EXPGR. The first two variables were selected on the basis of economic theory and the latter two because Austria is a small open economy. The vector C_{it} consists of INDSIZE and AVMES. In order to control for macroeconomic influences and potentially influencing changes in taxation or regulation, time dummies are used. Entry and exit are estimated in a similar fashion:

$$\begin{aligned} \text{Entry}_{\ it} &= \alpha_1 + \alpha_2 SC_{it} + \alpha_3 X_{it} + \alpha_4 C_{it} + \epsilon_{it}^{n} \\ \text{Exit}_{\ it} &= \beta_1 + \beta_2 SC_{it} + \beta_3 X_{it} + \beta_4 C_{it} + Entry_{i,t-1} + \epsilon_{it}^{x} \end{aligned}$$

with the important exception that in the exit specification the lagged number of entry is included as control variable. If simultaneity between entry and exit due to a replacement effect does exist the two-equation system would not be identified (Geroski 1991).

The explanatory variables are expressed in terms of number of firms. Therefore the dependent variable can take only nonnegative integer values. For this kind of data Poisson and Negative Binomial Models have been used. In modeling the turnover, volatility, entry and exit processes in the Austrians manufacturing industries entry exit and turnover as well as volatility are considered to be events in a count process. The most common method to specify a count process is the Poisson model (see Winkelmann 2000 for a survey of count data models in economics). The basic form of the Poisson process assumes, that the arrival rate of the events is a time independent constant. An entry (exit) process is said to follow the Poisson distribution, if (i) the probability of an entry (exit) in a short time interval is proportional to the length of the interval, (ii) the probability of more than one occurrence of the entry (exit) in a short interval is negligible, (iii) that the entries (exits) in an industry are independent of one another and (iv) that a certain mean number of entries (exit) is characteristic for the industries and other industries with the same property. The mean itself is assumed to depend on the covariates (industry characteristics). In the case of entries, exits and even turnover and volatility these assumptions are likely to be met. The mean μ_i is assumed to have a generalized linear form given by:

$$\mu_i = e^{\left(A_0 + \sum_{j=1}^{n} A_j x_{ij} \right)}$$

where μ_i is the mean number of entries (exits) in industry i in a given year, $\mathbf{x}_i$is the vector of n covariates ($SC_{it},$, X_{it} and C_{it}), and $\mathbf{A}$ is the vector of n+1 coefficients to be estimated. Then the Poisson model takes the form:

$$P(y_i) = \frac{e^{-\mu_i} \mu^{y_i}}{y_i!}$$

where $\mathrm{P(y}_i)$ is the probability of y_i entries (exits) in industry i. However, the Poisson model implies a strong restriction, as it is assumed that the conditional mean and variance of the event given the covariates are equal. Many count data sets do not satisfy this assumption. In the case of overdispersion, when the variance exceeds the mean, this can cause unduly small standard errors of the estimated parameters as the model underestimates the amount of dispersion in the outcome. The negative binomial regression model addresses this failure of the Poisson regression model by adding a quadratic term to the variance representing overdispersion. The basic idea is that a random effect represents unobserved heterogeneity and that if the random effect would be observable the data would be Poisson. This exposition follows the NEGBIN II model (1986), which has the variance-mean ratio linear in the mean. In this specification it is assumed that the random effect has a gamma distribution with parameters a = b = $1/\alpha$where α is the variance of the unobservable effect. The unconditional distribution of the outcome is a negative binomial distribution with density

$$P(y_i) = \frac{\Gamma(1/\alpha + y_i)}{y_i!\Gamma(1/\alpha)} \left(\frac{1}{\mu_i\alpha + 1}\right)^{\frac{1}{\alpha}} \left(\frac{\alpha\mu_i}{\alpha\mu_i + 1}\right)^{y_i}$$

For the mean and the variance it follows that $E(y_i) = \mu_i$ and $Var(y_i) = \mu_i(1+\alpha\mu_i)$. α is called overdispersion parameter. The larger α, the greater the overdispersion. For α=0 the negative binomial model converges to the Poisson model. The estimates of the parameters are derived by maximizing the respective log-likelihood functions.

6 Estimation Results

Table 3 gives the negative binomial estimation results for turnover and volatility, and Table 4 the negative binomial estimation results for entry and the Poisson estimation results for exit. While the turnover, volatility and the entry regression results lend support for the negative binomial model, the exit regressions lend support to the Poisson model.

A number of tests are preformed for specification purposes. First we examine whether the data would be subject to multicollinearity. We use the highest condition index. The condition indices are reported in Tables 3 and 4. The highest condition index is always below the critical value of 30 suggested by Belsely et al. (1980).

We test the appropriateness of the NEGBIN II specification against the Poisson specification by using three tests. First we test the significance of the overdispersion parameter α within the negative binomial regression. However, the usual Gaussian test of α=0 occurs on the boundary. In such cases, the limiting distribution of the maximum-likelihood estimate of the parameter is bounded from below. The asymptotic normality of the estimate does not hold under the null hypothesis that the Poisson model is appropriate. However, it can be shown that the likelihood ratio statistic has a distribution with probability mass of 0.5 at 0 and a chi-square with 1 degree of freedom for positive values (Winkelmann 2000). This modified likelihood-ratio test which is valid on the boundary has been used and is reported beneath the rows with heading "LR test α". "α" reports the estimated value of the overdispersion parameter. The p-value reported is one-half of the probability that a chi-square with 1 degree of freedom is greater than the calculated LR test statistic (Winkelmann 2000, p. 105). In order to check this result we used the regression based approach and a LM test (Cameron and Trivedi 1986). The regression based test is carried out

Table 3: Estimation results for turnover and volatility in Austrian Manufacturing, 1981-1994

	1-1	1-2	1-3	2-1	2-2	2-3
	turnover	turnover	turnover	volatility	volatility	volatility
	Negbin II	Negbin II	Negbin II	Negbin II	Negbin II	Negbin II
PCMGR	0.003 [0.031]	0.001 [0.031]	0.000 [0.031]	0.012 [0.037]	0.009 [0.038]	0.008 [0.037]
EMPLGR	0.417 [0.522]	0.404 [0.517]	0.570 [0.525]	1.748* [0.679]	1.651* [0.680]	1.913** [0.684]
COMP	-0.739** [0.265]		-0.763** [0.266]	-1.179** [0.328]		-1.196** [0.331]
CAPRE	-0.009** [0.003]		-0.009** [0.003]	-0.006 [0.004]		-0.006 [0.004]
COMP*CAPRE		-0.034** [0.009]			-0.025* [0.012]	
ADVINT	-11.360 [6.953]	-8.922 [6.837]	-12.344+ [7.216]	-16.055+ [9.227]	-12.135 [9.1735]	-16.474+ [9.625]
AVMES	-0.188 [0.156]	-0.282+ [0.149]	-0.216 [0.157]	-0.338+ [0.199]	-0.477* [0.193]	-0.369+ [0.201]
NF_{t-1}	0.962** [0.019]	0.954** [0.019]	0.963** [0.019]	1.022** [0.024]	1.005** [0.024]	1.021** [0.025]
EXPGR			-0.034+ [0.020]			-0.038 [0.026]
IMPGR			0.269 [0.363]			0.403 [0.472]
CONSTANT	-1.362** [0.161]	-1.549** [0.136]	-1.297** [0.166]	-1.636** [0.203]	-1.921** [0.172]	-1.564** [0.210]
α	0.01**	0.01**	0.01**	0.03**	0.03**	0.03**
Lrtest α	28.22	24.98	25.26	80.56	73.14	76.31
Observations	221	221	221	221	221	221
logl	-769.23	-770.1	-767.75	-788.66	-793.4	-787.54
logl_0	-1118.47	-1118.47	-1118.47	-1084	-1084	-1084
Condition index	15.59	12.02	17.94	15.59	12.02	17.94

Notes: Standard errors in brackets; + significant at 10%; * significant at 5%; ** significant at 1%
Coefficients for time dummy variables not shown

by regressing

$$z_i = \frac{(y_i - \mu_i)^2 - y_i}{\mu_i \sqrt{2}}$$

where μ_i is the predicted value from the regression, on either a constant term or μ_i without a constant term. The t-test of whether the coefficient is significantly different from 0 tests the hypothesis of no overdispersion versus the hypothesis of overdispersion. And thirdly we use a Lagrange Multiplier model. As the Poisson model can be obtained from the negative binomial model as a parameter restriction a LM statistic can be computed (see Cameron and Trivedi 1986 for details). The LM statistic is chi-squared with one degree of freedom. Both tests confirmed the results of the LR-test reported in the regression tables.

Three specifications were estimated for turnover and volatility, the results are reported in table 3. The first one is the baseline model, the second replaces COMP and CAPRE by the interacted variable COMP*CAPRE, and the third adds export growth and import growth. The same three specifications were run also for entry and exit including a fourth variant including contemporaneous exit and entry in the entry and exit equation respectively.

The results in Table 3 indicate that organizational capital and organization-specific knowledge (COMP) and tangible capital (CAPRE) are strong mobility barriers, as they have a significant negative effect on the turnover of firms. The coefficients for these two sunk costs indicators are also negative in the volatility regressions. The interacted variable COMP*CAPRE is significant in the volatility regression. However, in the volatility equations only COMP is significant, which suggests that CAPRE is not really symmetric with regard to entry and exit. This is easily verified by taking the estimation results for entry and exit in table 4 into account. COMP is negative and significant for both entry and exit (it is almost significant in the baseline regression 4-1 for exit) and therefore both a barrier to entry and a barrier to exit. COMP captures nicely the implications of the symmetry thesis of mobility barriers. The symmetric negative effect on entry and exit translates into an effect with a much higher statistical significance for both the turnover and the volatility regressions. As CAPRE is negative for both entry and exit but significant only for exit, it is first of all a barrier to exit. The symmetry hypothesis is confirmed in strong form for COMP and to a somewhat less extent also for tangible capital (CAPRE). The strong results for COMP may be related partly to the particular history of Austrian manufacturing. It is a stylized fact that quality upgrading strategies are mostly carried out by incumbent firms, while more radically new products are introduced mostly by new firms. The strong symmetric influence of experience related capital may hinge partly on the fact that the Austrian industry is specialized in technologies with a strong cumulative knowledge base ((Tichy 2000, Peneder 1999) where the obsolescence of experience and knowledge capital is low.

Table 5 reports the economic significance of the results in terms of percent changes in expected count for a standard deviation increase in the independent variable. As CAPRE and COMP are always negative the percent changes are also negative. For example, a standard deviation increase of COMP leads to 6 percent less turnover, 9.3 percent less volatility, 6.6 percent less entry and 4.2 percent less exit. These numbers are quite substantial.

Table 4: Estimation results for Entry and Exit in Austrian Manufacturing, 1981-1994

	3-1 entry	3-2 entry	3-3 entry	3-4 entry	4-1 exit	4-2 exit	4-3 exit	4-4 exit
	Negbin II	Negbin II	Negbin II	Negbin II	Poisson	Poisson	Poisson	Poisson
PCMGR	0.067 [0.045]	0.066 [0.046]	0.064 [0.045]	0.072 [0.045]	-0.045 [0.038]	-0.048 [0.0380]	-0.046 [0.038]	-0.045 [0.038]
EMPLGR	2.709** [0.790]	2.664** [0.785]	2.736** [0.797]	2.983** [0.774]	-1.482** [0.553]	-1.4524** [0.5537]	-1.2265* [0.563]	-1.2651* [0.565]
COMP	-0.864* [0.390]		-0.842* [0.393]	-0.627+ [0.377]	-0.458 [0.304]		-0.527+ [0.307]	-0.513+ [0.307]
CAPRE	-0.005 [0.005]		-0.005 [0.005]	-0.004 [0.005]	-0.013** [0.004]		-0.012** [0.004]	-0.012** [0.004]
COMP*CAPRE		-0.023+ [0.014]				-0.0403** [0.0107]		
ADVINT	-39.568** [9.985]	-37.022** [9.866]	-38.076** [10.456]	-43.632** [10.065]	14.6267* [7.2595]	15.865* [7.1952]	12.412+ [7.541]	12.676+ [7.548]
AVMES	-0.708** [0.227]	-0.828** [0.217]	-0.698** [0.229]	-0.724** [0.220]	0.274 [0.1734]	0.207 [0.163]	0.238 [0.176]	0.240 [0.176]
NF_{t-1}	1.016** [0.028]	1.007** [0.028]	1.014** [0.029]	0.864** [0.047]	0.9254** [0.034]	0.923** [0.034]	0.928** [0.035]	0.922** [0.035]
EXPGR			-0.005 [0.029]	-0.002 [0.028]			-0.053* [0.021]	-0.0515* [0.021]
IMPGR			0.276 [0.531]	0.113 [0.511]			0.253 [0.3838]	0.236 [0.385]
ENTRY $_{t-1}$					0.000 [0.001]	0.000 [0.001]	0.000 [0.001]	-0.001 [0.002]
ENTRY								0.001 [0.002]
EXIT				0.006** [0.002]				
Constant	-2.117** [0.239]	-2.336** [0.199]	-2.125** [0.248]	-1.513** [0.285]	-2.105** [0.201]	-2.229** [0.185]	-2.000** [0.206]	-1.976** [0.208]
α	0.02**	0.02**	0.02**	0.02**	0.00	0.00	0.00	0.00
Lrtest α	26.76	24.04	26.03	17.66	1.06	0.84	0.51	0.48
Observations	221	221	221	221	221	221	221	221
logl	-663.4	-664.81	-663.25	-656.03	-652.48	-651.63	-648.87	-648.61
logl_ 0	-956.14	-956.14	-956.14	-956.14	-2952.65	-2952.65	-2952.65	-2952.65
Condition index	15.59	12.02	17.94	25.66	22.74	14.64	25.09	26.26

Notes: Standard errors in brackets; + significant at 10%; * significant at 5%; ** significant at 1%
Coefficients for time dummy variables not shown

Table 5: Percent change in expected count for a standard deviation increase

	1-3 turnover	2-3 volatility	3-3 entry	4-3 exit
EMPLGR		7.3 %	10.7 %	-4.4 %
COMP	-6.0 %	-9.3 %	-6.6 %	-4.2 %
CAPRE	-5.3 %			-6.9 %
ADVINT	-3.4 %	-4.6 %	-10.2 %	3.6 %
AVMES		-4.2 %	- 7.8 %	
EXPGR	-3.6 %	-4.0 %		-5.5 %

Note: percent change shown only for variables with significance higher than 15 percent

The results of ADVINT in table 3 are as expected. They suggest that advertising intensity is a mobility barrier as the sign is always negative. However, the low significance of ADVINT is surprising. For turnover ADVINT is only significant for specification 1-3, for volatility the coefficient is significant for specification 2-1 and 2-3. Table 4 shows that ADVINT is a strong barrier to entry but not a barrier to exit. On the contrary, a higher advertising intensity leads to more exit. This may be related to idiosyncrasies of the structure in Austrian manufacturing. However, the fact that industries with a high advertising intensity experienced higher exit rates than other industries can be explained along the theory of competitive escalation in advertising. Advertising competition leads most likely to a negative influence of goodwill capital on behalf of the firms which loose the escalation battle. Repeated advertising creates a barrier to entry through 'overinvestment' (e.g. (Ishigaki 2001)). Actions by competitors or simply 'wrong' advertising projects lead to a devaluation of the economic value of the accumulated goodwill capital (see also (Mueller and Supina 2002)). When the economic value of the goodwill capital erodes, also the sunk cost effect with regard to exit erodes. The firm has less and less reason to delay exit. A new entrant or (more likely) an incumbent may take over the market of the exiting firm. This may be a reason for the unexpected asymmetry of ADVINT. Table 5 presents the economic significance of ADVINT. As the entry barrier effect is much stronger than the exit inducing effect, the "aggregated" effects of ADVINT on volatility and turnover are negative.

The effect of the growth rate of industry margins is not significant in any regression, even if the signs are as anticipated, suggesting a symmetric relationship with regard to entry and exit. Because of statistical insignificance PCMGR is not reported in table 5. The insignificance of price cost margins was reported also in other studies. Geroski (1995) lists the slow reaction of entry to changes in profitability as stylized result.[6] For Austria it has to be taken in account that the size of the growth of price

[6]The evidence suggests that the impact of entry on average profit margins is extremely modest (Geroski 1991, 1995). The reason for this is that most entry is quite small in relationship to the market. Therefore it is more likely that entry reacts to profitability than the other way around. Price cost margins vary much more between industries than within industries and seem to be persistent. Geroski (1991) suggests 15 – 20 years to be the minimum appropriate time scale to track activities of entrants and look for effects on margins. Bresnahan and Reiss (1990) did not find strong short

cost margins may not reflect the whole story. This measure is only fully appropriate, when a closed economy is considered. The effect of foreign competition in both the domestic and foreign markets is likely to have a more distortive effect on PCMGR than for EMPLGR. Thus EMPLGR takes up implicitly also an effect reflecting the relative efficiency of domestic producers with respect to foreign producers, which is partly controlled for when EXPGR and IMPGR are included.

EMPLGR carried the expected sign in all regressions. Table 4 confirms that industry growth is asymmetric with respect to entry and exit. Higher industry growth increases entry and reduces exit. Table 5 shows that the economic effect of EMPLGR is much stronger in the entry equation than in the exit equation. This explains why the results reported in table 3 show a positive effect of EMPLGR on turnover and volatility. However, the coefficient is significant only for volatility. This suggests that industry growth leads to a increased change of producer identities.

The coefficient of the lagged number of firms, NF_{t-1}, included to control for inter-industry size differences carried the expected positive sign and significant coefficient in all equations. The coefficient is close to one in all models. This suggests that what we are explaining are in fact entry and exit rates. AVMES is asymmetric. As it is negative and significant for entry but positive and insignificant for exit it is negative and significant for volatility and negative for turnover. Past entry did not carry a significant sign in the exit estimations.

Import growth (IMPGR) has an insignificant effect on entry and exit. This result seems odd, especially if one considers the evidence for other countries (e.g. (von der Fehr 1991, Angostaki and Louri 1995)). One would expect that firms are more discouraged to enter when the market is open to strong pressure from international competition. A possible explanation for the significance of import growth may be the fact that in Austria manufacturers are often at the same time recipients and distributors of imported goods, leading to the insignificant but positive relationship between import and entry. It may well be that this result reflects a situation where entrants are not discouraged to enter in the presence of international competition. The results for export growth seem also to be counterintuitive at first sight, as export growth has a negative and significant effect on turnover and a negative albeit not significant effect on volatility. However, table 4 shows that EXPGR is symmetrically negative for both entry and exit, but significant only for exit. We expected that export growth has a positive influence on entry, which is not the case. However, if one considers that nonexporters have to incur sunk costs to enter foreign markets (1997) then the relationship becomes clear. Export growth reduces exit as higher export growth is absorbed by the expansion of incumbents which have already incurred sunk costs of the exporting decision rather than new firm entry.

To gauge the robustness of our sunk costs results, a number of checks were carried out. The most important check of robustness of our results concerns the potential mismeasurement of entry and exit. As discussed previously, our entry and exit data may display an excessive correlation between entry and exit. If this introduces a significant bias into our interference then the results should change when contemporaneous exit (entry) is introduced into the entry (exit) equation. The results should also change in the case that our sunk costs proxies capture industry specific effects other than sunk

run effects on price cost margins resulting from the entry into isolated monopoly markets for new cars.

Table 6: Additional results: expected count for a standard deviation increase

	turnover	volatility	entry	exit
specification	Negbin II	Negbin II	Negbin II	Poisson
PCM $_{t-1}$	-0.624+	-0.760	-0.213	-1.077**
	[0.370]	[0.481]	[0.543]	[0.409]
ADVINT	-5.949	-9.659	-37.996**	23.749**
	[7.723]	[10.146]	[11.288]	[8.095]
COMP (averaged)	-0.635*	-0.974*	-0.943*	-0.283
	[0.316]	[0.399]	[0.467]	[0.353]
CAPRE	-0.008*	-0.004	-0.005	-0.009*
	[0.004]	[0.004]	[0.005]	[0.004]

Note: percent change shown only for variables with significance higher than 15 percent

costs. Therefore the introduction of contemporaneous entry (exit) into the exit (entry) variable is a strong check of robustness. Columns 3-4 and 4-4 in Table 3 report the results of this experiment. The introduction of contemporaneous entry and exit did not alter the results in a meaningful way. The coefficients of the sunk costs remained almost the same, the most visible change relates to the coefficient of COMP in the entry equation. However, the significance level remained the same. Given the nature of our entry and exit data it is difficult to interpret the contemporaneous entry and exit in terms of replacement or displacement. Serial entrepreneurship or changes of ownership would imply that entry and exit are correlated. But it is interesting to note that entry is not significant in the exit equation while exit is highly significant in the entry equation. This may be related to the fact that exit dominates entry in Austrian Manufacturing over time, which in turn would suggest that exit has a much higher autonomous component than entry.[7] In addition to this check of robustness and the estimates reported in the two tables, we experimented with alternative specifications and other estimation approaches:

I/ As the industry size control is close to one, the models are re-estimated by constraining this coefficient to one. The results do not change in a significant way. This result shows that what is estimated in the original regressions are in fact turnover, volatility, entry and exit rates. Therefore it is not surprising that OLS (and Tobit) estimation using rates as dependent variable led to very similar results and do not alter the conclusions.

[7]This is confirmed by a simple regression analysis (standard errors in brackets; *, ** denote significance at 95%, 99%):

Entry =	-13.93*	+ 0.78**	exit	+ 3.19*	NF_{t-1}
	[5.56]	[0.06]		[1.26]	
Exit =	-32.71**	+ 0.56**	entry	+ 8.60**	NFt_{-1}
	[4.22]	[0.04]		[0.91]	

This results seem to suggest a method to differentiate between entry and exit and to construct measures of entry and exit which do not contain dependence between entry and exit. The resulting indicators would not be meaningful as the high and significant contemporaneous correlation between entry and exit is a stylized fact which holds for developed and developing countries alike (Geroski 1995).

II/ In order to check whether the complexity variable is influenced by changes in profitability over the business cycle, we re-run the regressions by using the industry specific mean of COMP instead of the contemporaneous values. The regression results changed insofar, as the coefficients for COMP gained higher statistical significance. Moreover, the models were re-estimated by augmenting the specification with the lagged value of the price cost margins. This modification changed the results. Table4 presents the results for price cost margins and sunk costs indicators. The lagged price cost margins were significant only in the exit regressions using averaged COMP. The significance remain approximately as in Table 3 and 4. The differences may be related to the fact that PCM_{t-1}captures much of the expenditure on the capital stock and advertising. However, the signs remained in each case the same. PCM is negative for entry albeit not significant. This may be explained in terms of blockaded entry. Kessides (1991) suggested that in industries with high sunk costs, entry and exit and the price cost margins could move in opposite directions if the threat of retaliation outweighs the incentive to enter.

III/ Fixed effect Poisson and fixed effect negative binomial regressions leads to dramatically different results. The advertising intensity had to be dropped as it does not display within variation. All other sunk costs variables were insignificant. This result is understandable as it is related to the nature of the fixed effect regression. By estimating the fixed effect regression the variables are purged of most of the between variation which is captured by the industry fixed effects. This has been recorded for a number of studies of entry and exit and is due to the fact that entry barriers and exit barriers are quite time invariant (Geroski 1995).

IV/ Finally, instead of EMPLGR we used the growth rate of deflated industry sales in order to account for market growth. Also this modification did not alter the interferences reported in Tables 3 and 4.

7 Concluding Remarks

This paper used relatively aggregated industry data to study the determinants of entry, exit and the turnover of firms in the manufacturing sector of a small open economy, dominated by small and medium sized firms. The inter-industry analysis has concentrated on the study of the effect of tangible and intangible sunk costs on the turnover, entry and exit of firms. The results confirm that sunk costs are important determinants of industry dynamics as the theory of industrial dynamics predicts. The evidence of sunk costs as determinants of producer turnover is strongly confirmed. However, it is shown that the effect on the turnover cannot always be captured by looking on entry and exit alone. The symmetry of mobility barriers is an important source of limiting the producer turnover, as by definition symmetric entry and exit barriers have a stronger influence on the turnover of firms. The symmetry assumption embodied implicitly in much of the literature is conformed for intangible investment relating to organizational capital and to a lesser extent for physical capital. However, goodwill capital in the form of advertising do not conform to the symmetry hypothesis as advertising is found to reduce the turnover in producer identities but this effect is related to the fact that advertising is a strong barrier to entry but not a barrier to exit. This may be related to the potentially high rate of depreciation of advertising capital for firms loosing the competitive struggle. The thesis that the exporting decision involves substantial sunk costs was confirmed at a (for industrial economics) aggregate level.

The overall impression is that the negative influence of sunk costs is a strong empirical regularity, likely to be robust to aggregation. Our results indicate the importance of sunk costs for competition policy where the likelihood of actual and potential entry needs to be evaluated. The results suggest that sunk costs influence firm (plant) size distribution in industries via the large negative impact on entry and exit.

This study was conducted to obtain broad insights. Detailed industry specific studies may better control for underlying factors related to sunk costs. As it cannot be ruled out that the specific history of Austrian manufacturing, characterized by an expansion of industrial production relative to other industrial countries (while remaining specialized in relatively traditional sectors) may be driving our results. This would be related to the conjecture that the nature of technological change is related to level of sunk costs and vice versa. A detailed study of this conjecture is left for future research.

A Data and Data Definitions

A.0.1 Advertising intensity

Austrian industrial statistics do not provide any information about advertising expenditures. Therefore data from the input-output tables for 1983 and 1990 (Güterkonten: Verwendung for 935 Dienstleistungen des Werbe-, Messewesens, etc.) was used to construct a proxy for advertising intensity. As this data is not available for the classification of the Austrian Chamber of Commerce, the data was aggregated to the 2-digit level according table 7. The expenditures for advertising were divided by nominal sales in 1983 and 1990 and the average was used as advertising intensity proxy in the regressions.

Table 7: Avertising intensity

KS			Own BS-68 to KS	VALUE
3	Stein- und Keramische Industrie	Stone and ceramic industry	47x	0.0080
4	Glasindustrie	Glass and glass product manufacturing	48x	0.0064
5	Chemische Industrie	Chemical industries	44x, 45x	0.0104
6	Papiererzeugende Industrie	Manufacture of pulp and paper	411	0.0063
7	Papierverarbeitende Industrie	Paper processing industry	412, 413, 415	0.0037
10	Holzverarbeitende Industrie	Furniture and fixtures	38x	0.0098
11	Nahrungs- und Genußittelindustrie	Food and tobacco industry	31x+32x	0.0105
12	Ledererzeugende Industrie	Leather producing industry	36	0.0084
13	Lederverarbeitende Industrie	Leather processing industry	35+36	0.0070
14	Giessereiindustrie	(mills – except steel mills)	513	0.0070
15	NE-Metallindustrie	(basic metal products – except mills)	512, 515	0.0061
16	Maschinen- und Stahlbauindustrie	Machinery and appliances, except electrical	54x, 55x, 59x	0.0066
17	Fahrzeugindustrie	Transportation Equipment Manufacturing	58x	0.0075
18	Eisen- und Metallwarenindustrie	Fabricated metal products except machinery	52x, 53x	0.0098
19	Elektroindustrie	Electrical Equipment, Appliance, and Component Manufacturing	56x, 57x,	0.0063
20	Textilindustrie	Manufacture of textiles except clothes	33x	0.0093
21	Bekleidungsindustrie	Manufacture of clothes	34x	0.0065

A.0.2 Import and export data

Austrian industrial statistics do not provide any information about imports and exports. The available data could not be used due to classification changes which introduced significant breaks. Therefore we used data from the OECD STAN database. As this data is not available for the classification of the Austrian Chamber of Commerce, the data was aggregated to the 2-digit level according table 7. The data for industries 6 and 7 was disaggregated according the ratios derived from the export and import data according to the Austrian chamber of Commerce. The imports and exports were deflated by industry-specific output-deflators.

As the Austrian statistical office does not provide data on real production values or specific output-deflators, the index of physical production and nominal production values were used to calculate the desired industry-specific deflators. The current value of production for the quantity produced in 1995 for each year was calculated by multiplying the nominal production with the index of production (100 = 1995). Then industry-specific output-deflators are obtained by dividing the current value of the quantity produced in 1995 by the nominal production value in 1995.

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