Sunk Costs and the Growth and Failure of Small Business

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Abstract

We model the growth and failure of small business in Irish Manufacturing during the period 1973-1994. We estimate the effect of start-up size on the employment growth while controlling for the business cycle, the life cycle and the probability of business survival, amongst other factors. Learning models of firm selection and evolution are accepted in Homogenous Goods but rejected in R&D sectors. Due to high (low) entry and failure costs in R&D (Homogenous Goods) sectors, learning is undertaken ex-ante (ex-post), inducing entry with certainty (uncertainty) concerning ex-post performance, causing Gibrat's law to hold (fail).

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I. Introduction

We examine the employment growth and failure of Irish business that entered the Irish Manufacturing sector in the aftermath of EC entry, 8,141 in all, during the period 1973 through to 1994. Such business is small, 90 per cent having less than 40 employees, and co-exists alongside large indigenous and foreign owned firms across all homogenous good (exogenous sunk cost) and Research & Development (endogenous sunk cost) sectors of Irish manufacturing.

As documented by Walsh and Whelan (1999), the large presence of small business in each 3-digit sector of Irish manufacturing by 1994 resulted from the structural changes that took place since entry into the European Union in 1973. For three decades up to 1973 government policy in Ireland adopted a twin track approach of self-sufficiency and export promotion within all 3-digit sectors, which cultured a dualistic structure in the market orientation of firms. In 1973 3-digit sectors of manufacturing hosted firms that evolved either within an extremely protected environment or with a focus on export markets, despite the presence of trade restrictions.[1] Firms that historically produced for the domestic market gradually declined, becoming close to extinction by 1994. In contrast,

[1] Using *effective* measures of protection McAleese (1971) documents that while the degree of protection varied across sectors, protection in all cases was extremely high by international standards. Before the Anglo-Irish Free Trade Area Agreement (AIFTA) in1966 the average *effective* tariff level was nearly four times the level observed in trading partners. In the run up to EC entry in 1973 the average *effective* tariff level still remained more than twice the level observed in trading partners.

employment in historical export oriented firms and *de novo* foreign firms grew persistently since 1973 inducing an increasing amount of *de novo* (new) small business activity within 3–digit manufacturing sectors overtime. In 1994 *de novo* Irish business account for 62 per cent of all businesses based in Ireland, 28 per cent of manufacturing employment and 50 per cent of indigenous employment.

The focus of this paper is to estimate the effect of start-up size on the employment growth of small Irish business while controlling for the business cycle, the life cycle, probability of business survival and sunk cost, amongst other factors. The main result that we motivate throughout the paper is that Gibrat's Law of Proportionate effect holds for business in endogenous sunk cost, but fails in exogenous sunk cost sectors.[2]

The failure of Gibrat´s law is motivated by the Jovanovic (1982) theory of firm selection and industry evolution under ex-ante uncertainty concerning the ex-post performance of firms.[3] A new firm does not know its full relative efficiency before entering a market. This is only revealed through a process of learning from its ex-post entry performance. When expected outcomes do not materialise this can lead to entry followed by exit. When ability exceeds expectations, firms that enter below minimum efficient scale expand rapidly.

[2] If surviving small firms, even after controlling for their probability of survival, grow faster than large firms, Gibrat's (1931) Law of Proportionate effect is deemed to fail. For a comprehensive review of this literature, the reader is referred to Sutton (1997). This Law states that the expected value of the increment to a firm's size in each period is proportional to the current size of the firm. Hence, proportionate growth rates are independent of firm size.

The theory of noisy selection explains why it is not surprising to see small firm turnover in an industry and, in addition, strong growth in surviving small firms, thereby leading to the breakdown of Gibrat's (1931) Law. There is substantial evidence that growth is negatively related to size and age across industries and time (Hall, 1987; Wagner, 1992, 1994; Mata, 1994; Audretsch, 1995). Sunk costs have a minimal effect in this framework. Low costs of entry and failure encourage plants to enter sectors so that their true ex-post-relative efficiency can be revealed. Hence the breakdown of Gibrat's law is predicted, and observed, in small business in homogenous good sectors.

The literature suggests that the presence of R&D seems not to change the general patterns of firm entry, growth and exit. The dynamics behind the size distributions of firms seem to be similar across industries and time (Audretsch, 1995; Geroski, 1995). Yet theory, such as Sutton (1991), predicts that entry, exit and growth should be curtailed by endogenous sunk cost expenditures by firms. In the presence of R&D the technical requirements and cost of entry ensure that firm selection and industry evolution can afford little uncertainty concerning ex-post performance of firms. A new firm is assumed to know its full relative efficiency before entering the market through a process of learning ex-ante. Start-up sizes will be closer to minimum efficient scale, firm turnover low, and Gibrat's Law is predicted to hold.

[3] Extensions of the Jovanovic (1982) can be found in Hopenhayn (1992) and Ericson and Pakes (1995)

As in the early studies of the literature we find that the likelihood of *de novo* Irish business surviving is quite low while being positively related to size and age in all sectors: (Mansfield, 1962; Hall, 1987; Dunne, Roberts and Samuelson, 1989; Audretsch, 1991; Audretsch and Mahmood, 1995). This has been confirmed for other countries including Portugal (Mata, Portugal and Guimaraes, 1994; Mata, 1994), Germany (Wagner, 1994) and Canada (Baldwin and Gorecki, 1991; Baldwin, 1995; Baldwin and Rafiquzzaman, 1995). We find that while the rate of business failure declines with age and size, the same is also true for employment growth rates of non-failing business. The expected growth rate of a business depends on the net effect of these two forces. The impact of initial size on survival only partially offsets expected employment growth in small Irish business in exogenous sunk cost sectors, while it completely offsets the impact of initial size on expected growth in small Irish business in endogenous sunk cost sectors. Such a tendency is also found in firm level panel data in Goos and Konings (1999), for Belgium.

The different results found in relation to Gibrat's Law within our sunk cost dichotomy are also found in the single versus multi-plant dichotomy of Dunne, Roberts and Samuelson (1989) for US manufacturing. The start-up size of plants, growth and survival rates when introduced as part of a multi-plant operation reflect the ex-ante certainty of the nature of its business and induces Gibrat's Law to hold. In contrast, in single plants their true relative efficiency is

only revealed ex-post entry inducing patterns of growth and survival that lead to the failure of Gibrat's Law. In Audtersch et al. (1997) study of firms in retail, hotel and catering in Dutch services sectors Gibrat's Law is also shown to have a tendency to hold. The nature of firm selection and evolution in these services is that firm's experience negligible ex-post entry scale economies inducing Gibrat's Law to hold.

In section II we describe our data set. Section III documents the evolution of small Irish business within manufacturing. In section IV we document the differences in life cycles, survival rates and start-up size for small Irish business within our sunk cost dichotomy. We present out empirical results in sections V and conclusions in section VI.

II. The Data

Our data source is the annual employment panel survey carried out by Forfás since 1973 covering all manufacturing companies. The response rate to the survey generally exceeds 99 per cent. The unit of observation is employment at the business (plant) level, identified by Irish and Foreign ownership and 3-digit NACE-CLIO product level codes. The appearance and disappearance of a positive employment figure in the annual survey defines plant entry and exit, respectively. Homogeneous Good, Advertising and R&D sectors are identified by the Davies and Lyon's (1994) 3-digit NACE industrial

code classification. For our analysis we group sectors into either exogenous sunk cost (homogeneous good) and endogenous sunk cost (Advertising and R&D) sectors. The advertising sectors without R&D are classified as having endogenous sunk costs, as in Sutton (1991). Given the small presence of the latter we classify endogenous sunk cost sectors (Advertising and R&D) as simply R&D sectors. For a more complete overview of the data we refer you to Barry, Strobl and Walsh (1998).

In table 1 we provide a summary of the data. The data set contains 6,418 non-failing business in 1994 with another 7,568 that failed over the period 1973 to 1994. The focus of this study is on *de novo* Irish business. In 1994 we observe 3,992 non-failing *de novo* Irish business, of which 2,858 were in homogenous good (exogenous sunk cost) sectors and 1,134 operated in R&D (endogneous sunk cost) sectors. Such Irish business can be characterised as small with 90 per cent having less than 40 employees. Their size (log employment) distributions, within our sunk cost dichotomy, can be found in table 2 and in figures 1 and 2 for homogenous and R&D manufacturing, respectively.

As documented in Walsh and Whelan (1999), only export oriented traditional firms survived the rigours of globalisation. In addition, the entry into the EC market made Ireland an attractive location for US high-technology

companies to use as a gateway to the European Market.[4] These two categories of firms represent expanding large business in Ireland during the period 1973 to 1994. Their size (log employment) distributions, within our sunk cost dichotomy, can be found in figures 3 and 4 for homogenous and R&D manufacturing, respectively

In 1994, documented in figures 5 and 6 for homogenous and R&D manufacturing, we observe that large firms were spread across all 3-digit sectors of manufacturing. In addition, *de novo* Irish small business coexisted, sometimes in large numbers, within all 3-digit sectors. Given their size, we infer, what is commonly known, that many where vertically linked to the larger export oriented firms within each sector.

As outlined in table 1, *de novo* Irish business accounted for 62 per cent of all plants based in Ireland and 28 per cent of employment, or 72 per cent of all Irish owned plants and 50 per cent of indigenous employment in 1994. Over the period 1973 to 1994, 4,149 *de novo* Irish business failed; 3, 078 in homogenous good sectors and 947 in R&D sectors. Over the period 1973-1994, this represents 55 per cent of all business failure in Ireland and 62 per cent of Irish owned business failure. In table 3 we examine the evolution of plant turnover rates averaged (weighted by share of the plant population) over 3-digit sectors of homogenous good and high-tech manufacturing. The annual plant

[4] The Irish government followed a very aggressive strategy using tax incentives and capital grants to attract FDI into Ireland. Such aspects of Irish Industry Policy are well documented in Ruane and Görg (1996).

turnover rate in homogenous good manufacturing represents, on average, 11, 14 and 8 per cent of the plant population pool averaged over 1973-78, 1979-87 and 1988-94. The vast majority of plant turnover (entry and exit) rates within 3-digit sectors of homogenous good manufacturing are in small Irish business. The annual plant turnover rate in high-tech manufacturing represents, on average, 15, 16 and 10 per cent of the high-tech plant population pool averaged over the defined time periods. The vast majority of plant turnover (entry and exit) rates within 3-digit sectors of high-tech manufacturing were also in small Irish business.

The fact that the businesses are tracked over twenty-one years is an extremely attractive feature of these data. This will allow us to control for right censoring of the data, life cycles and business cycles in a very effective way. Our sub-sample of *de novo* Irish business contains as many failing as non-failing business. In the next section of the paper we document further the large-scale structural adjustment that took place in Irish Manufacturing over the period 1973-1994.

III. Structural Change in Irish Manufacturing

As documented in the introduction, the large presence of small Irish business in each 3-digit sector of Irish manufacturing by 1994 was an outcome of export lead growth in historical export oriented firms and *de novo*

multinationals that grew persistently since 1973. Figures 7 through to 9 portray the changes in the stock of employment. In figure 7 we plot the evolution of total manufacturing employment decomposed into the contributions made by business that existed pre-1973 and after 1973. The demise of employment in business that operated under protectionist regimes is very evident. The decline in pre-73 plant employment was mainly due to the closure and downsizing of Irish and UK business that targeted the domestic market. Historically exported oriented Irish pre-1973 survived the onslaught of trade liberalisation and induced the small business culture in homogenous good manufacturing. In figure 8 we document the gradual but persistent rise in *de novo* Irish owned employment in exogenous sectors. In figure 9 we document the gradual but persistent rise in *de novo* (large firms) Foreign owned employment in R&D sectors. Such a foreign presence in high-technology manufacturing induced the emergence of the small business culture in endogenous sunk cost sectors of manufacturing.

Using the methodology of Davis and Haltiwanger (1992), we analyse the dynamics or employment flows that generated the aforementioned trends in employment. The employment growth rate of an individual business i at each date t is computed as,

$$g_{it} = \frac{n_{it} - n_{it-1}}{(n_{it} + n_{it-1})/2} \qquad (1)$$

where n_{it} is the employment level of business i in period t. This measure incorporates both the entry and exit of businesses, adopting a value of +2 in the former case and –2 in the latter. The net employment growth of manufacturing (*NET*) is equal to the aggregate gob creation rate (*POS*) net of aggregate job destruction rate (*NEG*). The job destruction rates can be decomposed into that induced by the exit of businesses and that induced by the contraction of employment in incumbent plants. We define a restructuring index (RES) as the sum of the job creation and job destruction rates net of the absolute value of the net employment growth rate. This measures the excess job reallocation over and above that necessary to generate the observed changes in aggregate employment. We formally define these indexes in the following set of equations,

$$
\begin{aligned}
POS_t &= \sum_{i=1}^{N} \left(g_{it} \times S_{it} \right) \quad \forall\, g_{it} > 0 \\
NEG_t &= \sum_{i=1}^{N} \left(\left| g_{it} \right| \times S_{it} \right) \quad \forall\, g_{it} < 0 \\
NET_t &= POS_t - NEG_t \\
RES_t &= POS_t + NEG_t - \left| NET_t \right|
\end{aligned}
\tag{2}
$$

where S_{it} as business's i share in total manufacturing employment. The aggregate flows and net changes in employment growth are documented in section I of table 4. The presence of simultaneous expansion and contractions of plant level employment at each point in the business cycle is very evident

over the period 1974-94. A jump in the annual job destruction rate to 11 per cent of manufacturing employment, of which 4 per cent was explained by plant failure, was very evident in the period between 1980-87.

In section II of table 4 we express the contributions, in percentage terms, of six subsections of manufacturing to the overall flows. This documents the importance of each subsection to the employment flows taken as a percentage of manufacturing employment. Convention would express flows as a percentage of the stock of employment within a defined subsection. We note that most of the aggregate job destruction, plant downsizing and exit, is concentrated in home and foreign owned business that existed pre-1973. These plants historically sold into the domestic market and still explained 46 per cent of the job destruction rate in the period 1988-94. Aggregate job creation was concentrated in traditional Irish owned exporting firms, *de novo* foreign owned business in endogenous sunk cost sectors, and *de novo* Irish small business across all sectors but particularly in homogenous goods sectors. Multinationals in high-technology sectors and *de novo* Irish plants counted for 65 per cent of the aggregate job creation rate over the period 1988-94. One should note that the *de novo* Irish small business experienced a sizeable amount of turnover. During the period 1988-94 40 per cent of the job exit rate is explained by business failure in *de novo* Irish business.

In this paper we set out to model the factors that determine employment growth and failure of *de novo* Irish business. To this end, in the next section we document the differences in start up-size, life cycles and survival rates and the importance of the business cycle for *de novo* Irish business within our sunk cost dichotomy.

IV. Characteristics of *de novo* Irish Business

We have already documented the contributions of *de novo* Irish business to the evolution of employment stocks and flows over the period 1974-94. *De novo* Irish business in homogenous good sectors generated relatively more net and gross employment changes when compared to their counterparts in R&D sectors.

We now document the need to control for the business cycle, life cycle and the probability of plant survival when testing Gibrat's Law for *de novo* Irish business within our exogenous and endogenous sunk cost dichotomy. In figure 10 we document the start-up size and age distributions in 1994 of *de novo* Irish business by our dichotomy. On average, the start-up size of small business in the R&D sectors is larger in terms of employment when compared to homogenous good sectors. This may reflect the higher degree of certainty that these firms need ex-post entry due to the nature of sunk costs. In addition we observe that many *de novo* Irish businesses in R&D sectors are under ten

years of age in 1994. This reflects the arrival of large multinationals in high-technology sectors during the 1980s. In contrast, the coexistence of small Irish business and large traditional Irish firms went back in some case for the full 21 years of restructuring.

In figure 11 we plot Kaplan-Meier (1958) estimates of survivor functions by our dichotomy averaged over the entire period. We note that the probability of survival for *de novo* Irish business is higher in endogenous compared to exogenous sunk cost sectors at each stage of the life cycle, reflecting more certainty in the average ex-post entry survival.

In table 5, we undertake a stratified log-rank test for equality of survivor functions in our dichotomy for the whole period 1974 to 1994 and for sub-periods 1974 to 1979, 1980 to 1987 and 1988 to 1994. The null that the survivor functions are equal is only accepted for the period 1980-87. The difference in the probability of survival for *de novo* Irish business across our dichotomy is less marked during a period of deep macroeconomic recession. This illustrates that macroeconomic conditions are also important as determinants of plant survival as well as performance.

In the next section we empirically model the post entry employment growth and failure of *de novo* Irish small business. We estimate the effect of start-up size on the employment growth of *de novo* Irish business, test Gibrat's Law, while controlling for the business cycle, the life cycle and the probability

of firm survival, amongst other factors. We run split regressions to test and allow for the impact of the common determinants of post entry employment growth and failure of small business to vary across exogenous and endogenous sunk costs sectors of Irish Manufacturing.

V. The Empirical Model

We first model the year to year employment growth rates of *de novo* Irish business that did not fail since their date of entry in the data set. The key explanatory variables are initial start-up size, age, time and sector dummies. The regressions are conditioned on Irish owned small business that entered Irish Manufacturing after 1973 into either Homogenous good or R&D sectors.

In line with the literature, assuming a random selection process to the group of non-failed business, employment growth is expected to decline with age and size. In addition strong non-linearities can be expected in the relationship between non-failing employment growth and size and age. The life cycle and size effects can follow an inverted U-shape pattern. Young business can have an initial disadvantage that diminishes with age. Eventually age can again become a disadvantage at the end of the life cycle. Small business that enters below minimum efficient scale may grow relatively faster than other small businesses. This effect will diminish as start-up size increases putting

businesses at or above their revealed minimum efficient scale, ex-post entry. We write down the non-failing regression model as the following,

$$g_{it} = f(\, size_{ito}, \quad age_{it}) \quad if \; g_{it} \neq -2 \tag{3}$$

where employment growth, g_{it}, as in (1), is a discrete measure of growth that varies year to year with employment size in year zero, $size_{ito}$, and age overtime, $age_{it.}$ In section I of table 6 and 7 we present the results for exogenous and endogenous sunk cost sectors, respectively, assuming a random selection to our sample of non-failing businesses. As in the literature we find that Gibrat's Law fails in both samples of small businesses. In addition we find the expected inverted U-shape in both initial size and age.

These results depend strongly on the fact that the exit process or the probability of plant survival is not related to initial size, the life cycle, and business cycle and sector specific effects. Yet as outlined in the introduction, the literature to date finds that business failure rates decline with initial size and age. This sample selection bias can overstate the marginal impact of our explanatory variables. Correcting for such a sample selection bias can theoretically change the sign, magnitude or significance of the relationships found in the non-failing regression.

The usually long time span of this panel data set allows one to test and control for sample selection in a very effective way. We employ the Heckman(1979) two-step estimation procedure. Our selection model is written down as the following,

$$Z_i = f(\, size_{ito},\quad age_{it}\,) \qquad \begin{array}{l} Z_i = 1 \;\; if \;\; g_{it} \neq -2 \\ Z_i = 0 \;\; otherwise \end{array} \tag{4}$$

which is estimated by Maximum Likelihood. The Heckman lambda is computed for each observation in the selected non-failing sample and the following regression models the contributions of our explanatory variables to the expected growth rate of non-failing business,

$$g_{it}\big|_{Z_i=1} = f(\, size_{ito},\quad age_{it},\quad l_i\,) \tag{5}$$

where λ_i is Heckman's lambda. In section II of tables 6 and 7 we present the results for exogenous and endogenous sunk cost sectors, respectively, of the selection model and the expected non-failing employment growth model corrected for sample selection. The probability of business survival is found to increase with initial size and age, among other factors. The inverted U-shape is only found in the size effect. The life cycle has a persistent positive impact on plant survival. In the non-failing business growth model lambda is very significant justifying the sample selection model. The inclusion of non-linearity in our explanatory variables avoids the criticism that the omitted

variable we are controlling for is sample selection and not omitted non-linear forms in our relationships. The positive value of *rho* indicates that the correction process will offset the magnitude of the marginal effects of the explanatory variables previously estimated. For *de novo* Irish business operating in homogenous good sectors, Gibrat's Law fails while the life cycle effects remain intact. For *de novo* Irish business operating in endogenous sunk cost sectors Gibrat's Law is now estimated to hold.

We motivate the failure of Gibrat´s law in small business in homogenous good sectors, as outlined in the introduction, using the Jovanovic (1982) theory of firm selection under ex-ante uncertainty concerning ex-post performance of firms. In contrast, Gibrat's Law holds in R&D sectors. The technical requirements and cost of entry ensure that firm selection and industry evolution cannot afford uncertainty concerning ex-post performance. A new firm is assumed to know its full relative efficiency before entering the market through a process of learning ex-ante. Start-up sizes will be closer to minimum efficient scale, firm turnover low, and Gibrat's Law will hold. Business failure rate and non-failing business employment growth decline with age and size. The expected growth rate of a business depends on the net effect of these two forces. The impact of initial size on survival only partially offsets expected employment growth in *de novo* Irish business in exogenous sunk cost sectors

while it completely offsets the impact of initial size on growth in *de novo* Irish business that subcontract in endogenous sunk cost sectors.

VI Conclusions

The focus was to estimate the effect of start-up size on the employment growth of small Irish business while controlling for the business cycle, the life cycle, and probability of firm survival, amongst other factors, over the period 1973-1994. The main result of the paper is that Gibrat's Law holds for small business that operate in endogenous but fails in exogenous sunk cost sectors. We motivate the failure of Gibrat´s law in homogenous good sectors using the Jovanovic (1982) theory of firm selection. In contrast small business within high sunk costs can not afford the luxury of ex-post entry learning inducing Gibrat's Law to hold. The different results found, with regard to Gibrat's Law, within our dichotomy are also found in the single versus multi-plant dichotomy of Dunne, Roberts and Samuelson (1989) for US manufacturing. Using our sunk cost dichotomy, our results are also found in firm level panel data in Goos and Konings (1999), for the case of Belgium. We have used an extremely rich data set and an interesting Irish case study to reveal that sunk costs do have a role in the determination of firm selection and evolution.

Table 1

Summary of Plant Numbers in 1994

Total Number of (Foreign and Irish) Plants:	6418
Irish Plants:	5585
de novo Irish(new entrant after 1973)Plants:	3992
de novo Irish exogenous sunk costs sectors:	2858
de novo Irish endogenous sunk costs sectors:	1134

(de novo Irish plants present 62 per cent of the total or 72 per cent of all Irish Plants)

Summary of Plant Failures during 1973-1994

Total(Foreign and Irish) Plant Failures:	7568
Irish Plant Failures:	6679
de novo Irish(new entrant after 1973):	4149
de novo Irish exogenous sunk costs sectors:	3078
de novo Irish endogenous sunk costs sectors:	947

(de novo Irish present 55 per cent of the total numbers of failures or 62 per cent of all Irish Plant Failure)

Summary of Employment (Thousands) Statistics in 1994

Employment (Foreign and Irish) Plants:	201194
Irish Plants:	113185
de novo Irish(new entrant after 1973)Plants:	56561
de novo Irish exogenous sunk costs sectors:	37503
de novo Irish endogenous sunk costs sectors:	19058

(In terms of employment, *de novo* represents 28 per cent of total employment and 50 per cent of Irish owned manufacturing employment)

Table 2

Summary of employment size distributions of de novo Irish exogenous sunk costs sectors in 1994

	Percentiles	Smallest		
1%	1	1		
5%	1	1		
10%	1	1	Obs	2858
25%	2	1		
50%	6		Mean	15
		Largest	Std. Dev.	29
75%	16	304		
90%	37	372	Variance	838.4247
95%	62	374		
99%	140	486		

Summary of employment size distributions of de novo Irish endogenous sunk costs sectors in 1994

	Percentiles	Smallest		
1%	1	1		
5%	1	1		
10%	1	1	Obs	1134
25%	3	1		
50%	6		Mean	16
		Largest	Std. Dev.	33
75%	15	228		
90%	34	242	Variance	1133.23
95%	61	460		
99%	170	548		

Table 3

Contributions to Plant Turnover Rates across firms Overtime

	1973-78	**1979-87**	**1988-94**
Homogenous Plant Turnover Rate	.11	.14	.08
***de novo* Irish Small Business**	81%	78%	87%
High-Technology Sectors Plant Turnover Rate	.15	.16	.10
***de novo* Irish Small Business**	82%	81%	73%

Table 4

Section I

Net Employment growth and flows for total manufacturing

Time Period	NET	POS	NEG	EXIT	RES
1974-79	0.02	0.09	0.07	0.02	0.14
1980-87	-0.03	0.08	0.11	0.04	0.15
1988-94	0.01	0.09	0.08	0.03	0.15

Section II

Home and Pre-1973 Traditional Plants (per cent of total)

1974-79	-0.014	35.8%	61.0%	60.2%	45.3%
1980-87	-0.033	20.4%	46.1%	44.3%	20.4%
1988-94	-0.010	16.5%	31.5%	27.3%	18.6%

Home, de novo and Endogenous Sunk Costs Plants (per cent of total)

1974-79	0.004	4.5%	0.9%	1.2%	0.9%
1980-87	0.003	10.3%	4.1%	5.1%	5.8%
1988-94	0.004	13.1%	9.0%	10.7%	9.4%

Home, de novo and Exogenous Sunk Costs (per cent of total)

1974-79	0.012	14.5%	2.8%	3.6%	2.8%
1980-87	0.007	27.4%	12.7%	16.2%	17.8%
1988-94	0.007	27.0%	21.4%	29.2%	22.2%

Foreign and Pre-1973 Traditional Plants(per cent of total)

1974-79	0.006	20.2%	31.7%	31.5%	23.1%
1980-87	-0.015	9.7%	21.1%	15.8%	9.7%
1988-94	-0.004	9.1%	16.0%	14.0%	10.4%

Foreign, de novo and Endogenous Sunk Costs Plants (per cent of total)

1974-79	0.012	13.2%	1.5%	1.4%	01.5%
1980-87	0.007	20.3%	7.6%	8.1%	10.7%
1988-94	0.012	24.5%	12.2%	8.4%	12.7%

Foreign, de novo and Exogenous Sunk Costs Plants (per cent of total)

1974-79	0.009	10.5%	02.6%	04.0%	02.6%
1980-87	0.001	10.1%	06.6%	10.0%	07.9%
1988-94	0.000	06.0%	06.6%	07.1%	05.6%

Table 5

Stratified log-rank test for equality of survivor functions by Irish and Sunk Costs

1974-1979 Sunk Costs	Events observed	expected
Exogenous	131	140.05
Endogenous	43	33.95
Total	174	174.00

chi2(1) = 3.10
Pr>chi2 = 0.0781

1980-1987 Sunk Costs	Events observed	expected
Exogenous	1464	1454.16
Endogenous	407	416.84
Total	1871	1871.00

chi2(1) = 0.32
Pr>chi2 = 0.5694

1988-1994 Sunk Costs	Events observed	expected
Exogenous	1483	1390.09
Endogenous	497	589.91
Total	1980	1980.00

chi2(1) = 23.01
Pr>chi2 = 0.0000

1974-1994 Sunk Costs	Events observed	expected
Exogenous	3078	2984.31
Endogenous	947	1040.69
Total	4025	4025.00

chi2(1) = 12.53
Pr>chi2 = 0.0004

Table 6

De novo Irish Business, Exogenous Sunk Cost Sectors

(1) Non-failing Asuming Random Selection

```
Number of obs =   23100
Sector and Year Dummies included

------------------------------------------------------------------------------
      gr |      Coef.   Std. Err.       t     P>|t|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
 size    |  -.0015018   .0002789     -5.386   0.000      -.0020484   -.0009552
 sizeq   |   5.93e-06   2.18e-06      2.718   0.007       1.65e-06    .0000102
 sizec   |  -7.51e-09   3.34e-09     -2.252   0.024      -1.41e-08   -9.74e-10
 size*age|   .0000396   .0000159      2.484   0.013       8.34e-06    .0000708
 age     |  -.0749143   .0044984    -16.653   0.000      -.0837315   -.0660971
 ageq    |   .0063849   .0005076     12.578   0.000       .0053899    .0073799
 agec    |  -.0001743   .0000168    -10.389   0.000      -.0002071   -.0001414
 cons    |   .1662029   .0402842      4.126   0.000       .0872436    .2451623
------------------------------------------------------------------------------
```

(2) Non-Failing Conditioned on Probability of Survial:

```
Number of obs    =   40661
Sector and Year Dummies included
Heckman selection model
------------------------------------------------------------------------------
      gr |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
size     |  -.0011308   .0002895     -3.906   0.000      -.0016981   -.0005634
sizeq    |   4.10e-06   2.21e-06      1.855   0.064      -2.33e-07    8.43e-06
sizec    |  -5.01e-09   3.37e-09     -1.488   0.137      -1.16e-08    1.59e-09
size*age |   .0000325    .000016      2.036   0.042       1.22e-06    .0000638
age      |  -.0732122   .0044972    -16.279   0.000      -.0820266   -.0643979
ageq     |   .0063715    .000506     12.592   0.000       .0053797    .0073632
agec     |  -.0001731   .0000167    -10.346   0.000      -.0002058   -.0001403
cons     |   .2031251   .0408369      4.974   0.000       .1230863    .2831638
---------+--------------------------------------------------------------------
probit   |
size     |   .0128231   .0010444     12.277   0.000        .010776    .0148702
sizeq    |  -.0000663   7.67e-06     -8.650   0.000      -.0000814   -.0000513
sizec    |   9.00e-08   1.30e-08      6.906   0.000       6.45e-08    1.16e-07
size*age |   -.000141   .0000827     -1.705   0.088       -.000303     .000021
age      |   .0596235   .0163114      3.655   0.000       .0276538    .0915932
ageq     |  -.0019644   .0020059     -0.979   0.327      -.0058958     .001967
agec     |   .0001557   .0000717      2.172   0.030       .0000152    .0002963
cons     |    2.46949   .1255942     19.662   0.000        2.22333     2.71565
---------+--------------------------------------------------------------------
_athrho  |
   _cons |   .1750134   .0378789      4.620   0.000        .100772    .2492548
---------+--------------------------------------------------------------------
_lnsigma |
   _cons |  -1.233027   .0057807   -213.299   0.000      -1.244357   -1.221697
------------------------------------------------------------------------------
     rho      0.17325               [_athrho]_cons  = atanh(rho)
   sigma    .29140914               [_lnsigma]_cons = ln(sigma)
  lambda     .0504861   .0108971
```

Table 7

De novo Irish Business, Endogenous Sunk Cost Sectors

(1) Non-failing Asuming Random Selection

```
Number of obs =    8616
Sector and Year Dummies included
------------------------------------------------------------------------------
      gr |      Coef.   Std. Err.       t     P>|t|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
size     |  -.0036582   .0007849     -4.661   0.000      -.0051968   -.0021197
sizeq    |   .0000318   9.64e-06      3.299   0.001       .0000129    .0000507
sizec    |  -6.14e-08   2.02e-08     -3.038   0.002      -1.01e-07   -2.18e-08
size*age |   .0000539    .000038      1.416   0.157      -.0000207    .0001285
age      |  -.0812812   .0087084     -9.334   0.000      -.0983518   -.0642105
ageq     |   .0068167   .0010086      6.759   0.000       .0048396    .0087937
agec     |  -.0001785    .000034     -5.243   0.000      -.0002452   -.0001117
constant |   .2881895   .0830686      3.469   0.001        .125355     .451024
------------------------------------------------------------------------------
```

(2) Non-Failing Conditioned on Probability of Survial:

```
Number of obs    =   13126
Sector and Year Dummies included
------------------------------------------------------------------------------
      gr |      Coef.   Std. Err.       z     P>|z|       [95% Conf. Interval]
---------+--------------------------------------------------------------------
size     |   .0003394   .0003525      0.963   0.336      -.0003516    .0010303
sizeq    |  -3.35e-07   3.22e-06     -0.104   0.917      -6.64e-06    5.97e-06
sizec    |  -1.13e-09   6.51e-09     -0.174   0.862      -1.39e-08    1.16e-08
size*age |  -.0000102   .0000175     -0.587   0.557      -.0000444     .000024
age      |  -.1209565   .0068111    -17.759   0.000      -.1343061   -.1076069
ageq     |   .0110421   .0007698     14.345   0.000       .0095334    .0125508
agec     |  -.0003026   .0000255    -11.874   0.000      -.0003526   -.0002527
constant |   .4704273   .0552076      8.521   0.000       .3622223    .5786322
---------+--------------------------------------------------------------------
probit   |
size     |   .0135701   .0015406      8.808   0.000       .0105505    .0165896
sizec    |  -.0000727   .0000146     -4.969   0.000      -.0001014   -.0000441
sizeq    |   1.27e-07   3.43e-08      3.695   0.000       5.95e-08    1.94e-07
size*age |  -.0001004     .00011     -0.912   0.362      -.0003159    .0001152
age      |    .095306    .027078      3.520   0.000       .0422342    .1483778
ageq     |  -.0031941   .0034064     -0.938   0.348      -.0098705    .0034824
agec     |   .0001394   .0001245      1.120   0.263      -.0001046    .0003834
constant |   2.361983   .1754866     13.460   0.000       2.018035     2.70593
---------+--------------------------------------------------------------------
_athrho  |
   _cons |   .6514307   .0298598     21.816   0.000       .5929065    .7099549
---------+--------------------------------------------------------------------
_lnsigma |
   _cons |  -1.131401    .009224   -122.658   0.000       -1.14948   -1.113323
------------------------------------------------------------------------------
     rho      0.57263               [_athrho]_cons  = atanh(rho)
   sigma    .32258089               [_lnsigma]_cons = ln(sigma)
  lambda    .18472024   .0078671
```

Figure 1: (Log) Employment Size Distribution of Irish De Novo Firms in Homogenous Industries, 1994

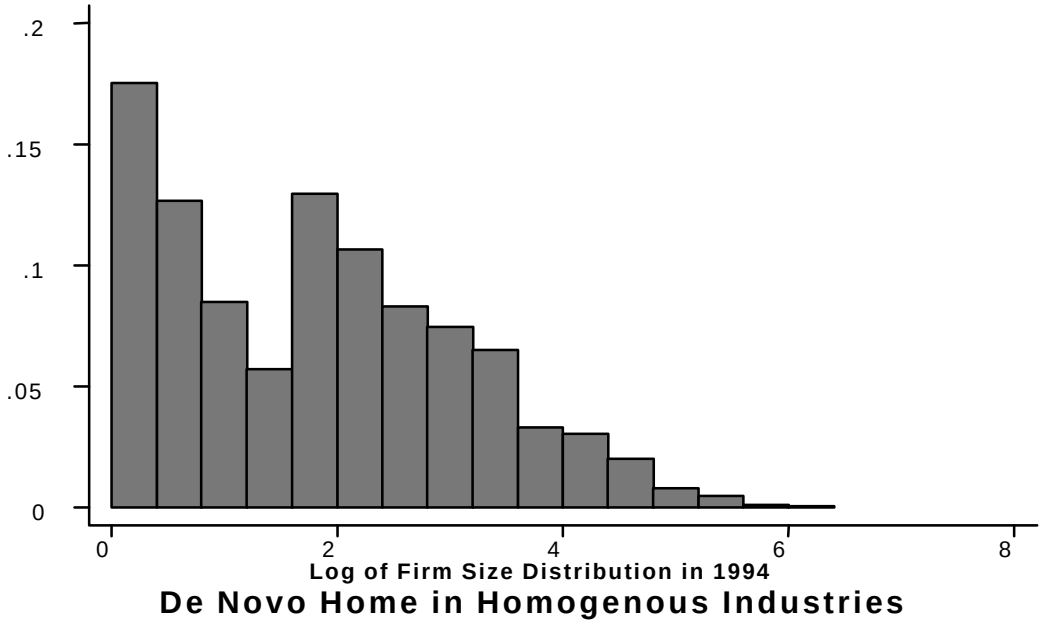


Figure 2: (Log) Employment Size Distribution of Irish De Novo Firms in Hihg Tech Industries, 1994

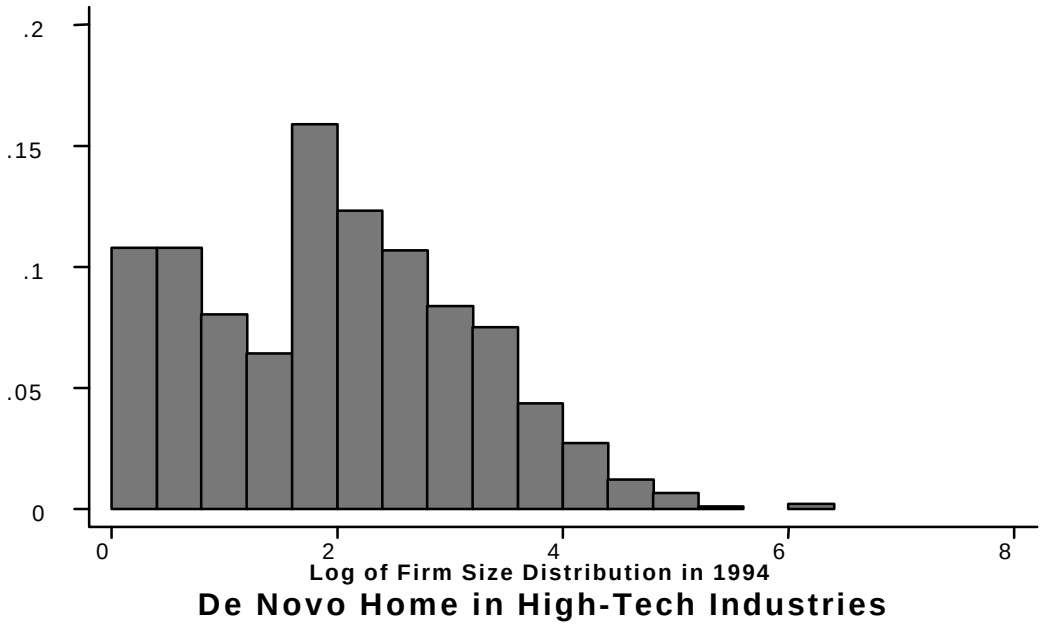


Figure 3: (Log) Employment Size Distribution of Irish Traditional Firms and All Foreign Firms in Homogenous Industries, 1994

Figure 4: (Log) Employment Size Distribution of Irish Traditional Firms and All Foreign Firms in High-Tech Industries, 1994

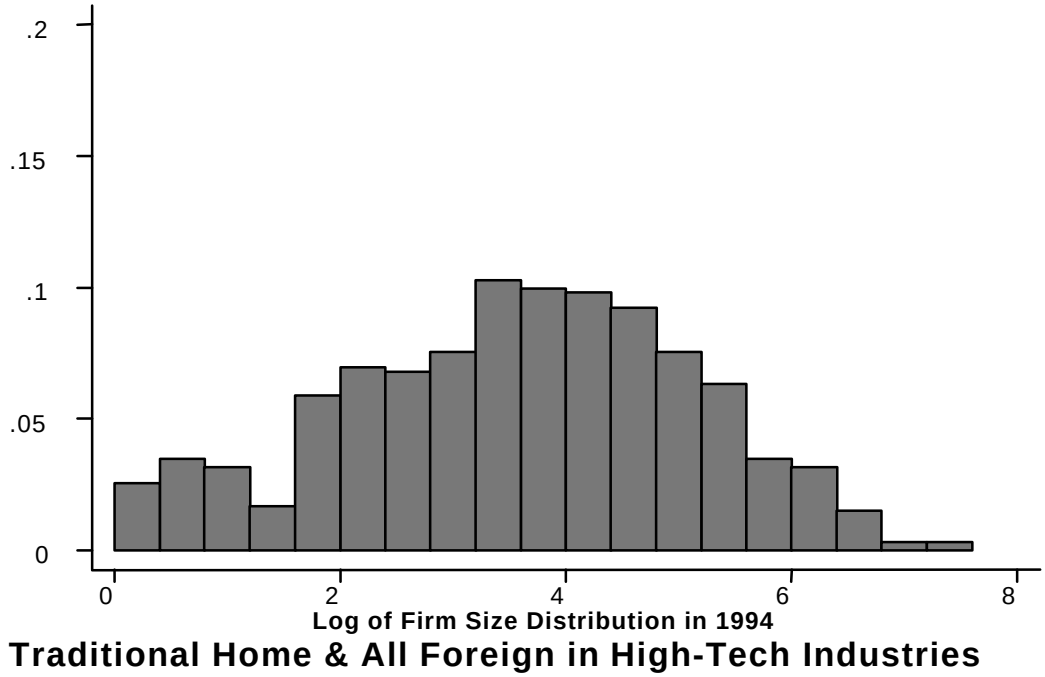


Figure 5: Number of Firms by Sector in Exogenous Sunk Cost Industries, 1994

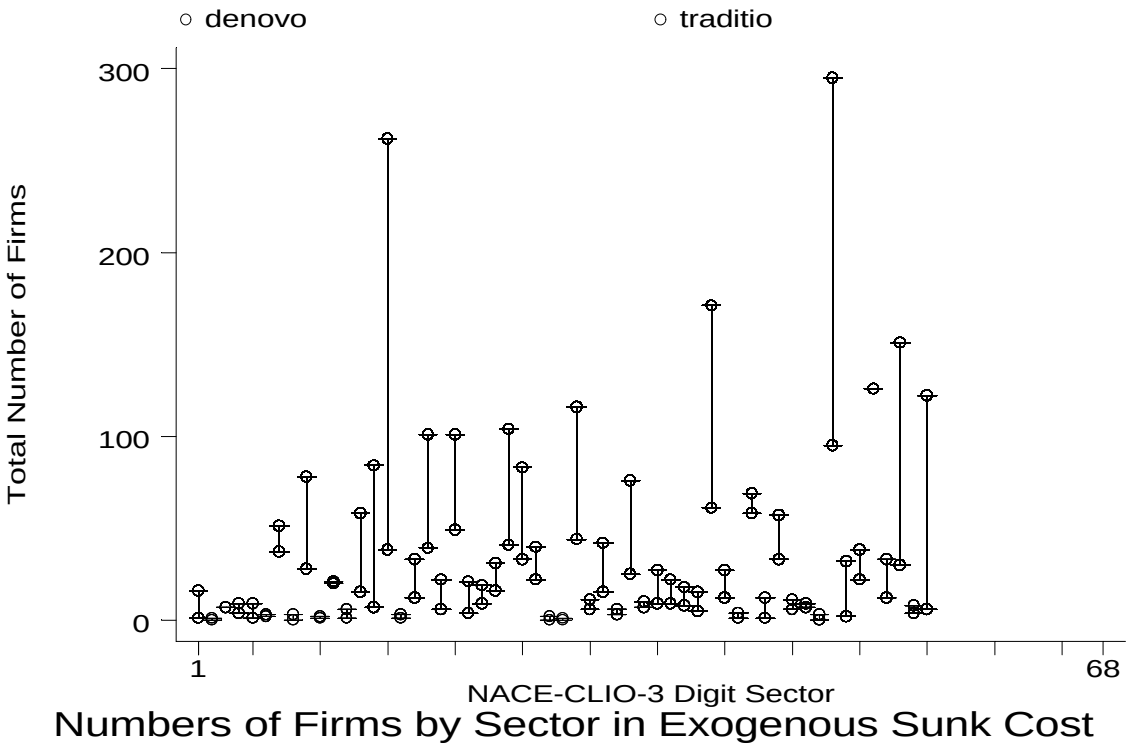


Figure 6: Number of Firms by Sector in Endogenous Sunk Cost Industries, 1994

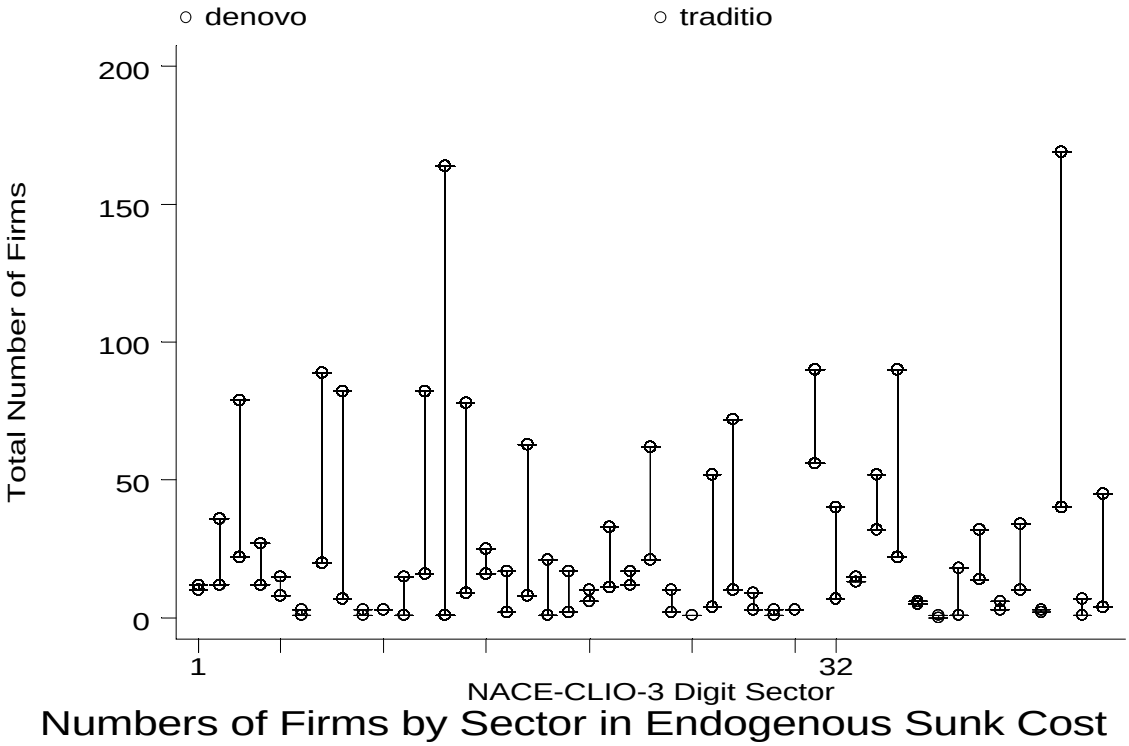
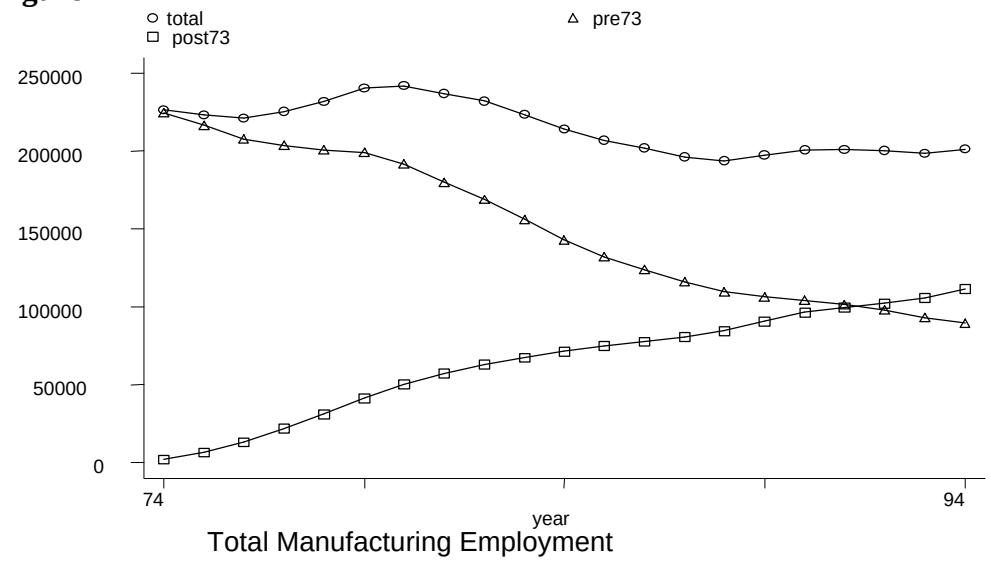
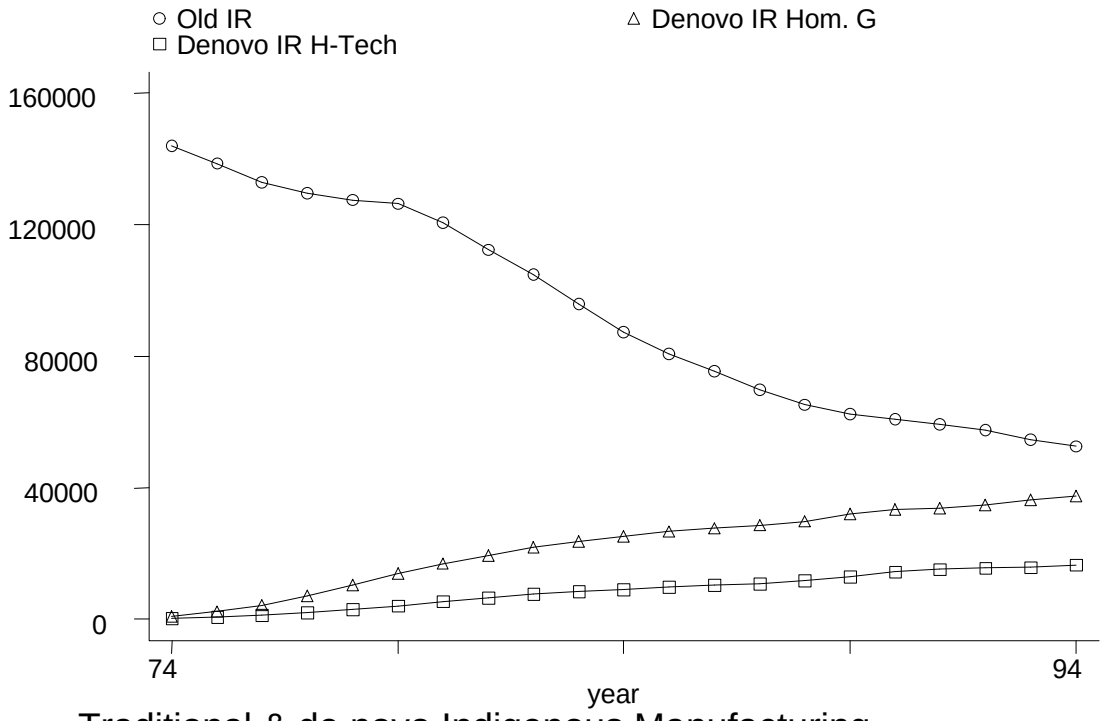


Figure 7



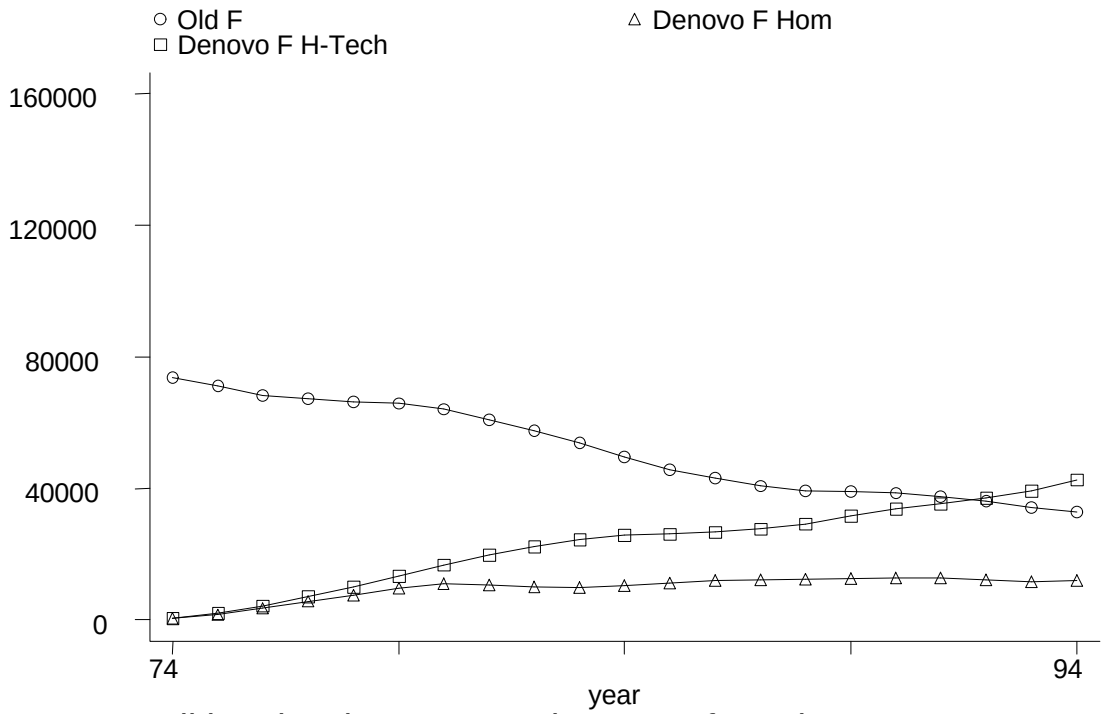
Total Manufacturing Employment

Figure 8



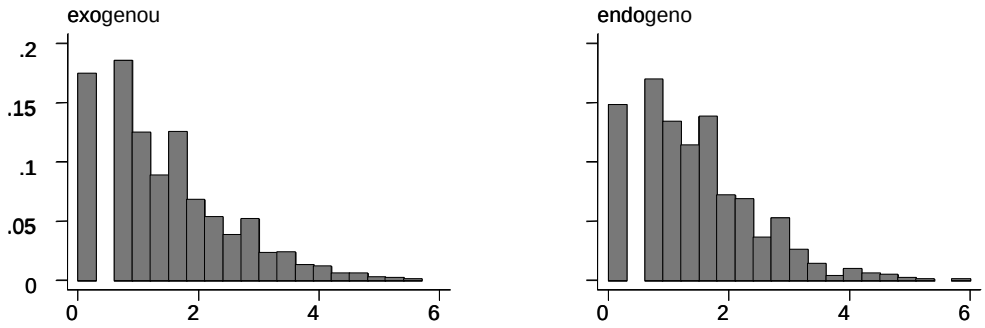
Traditional & de novo Indigenous Manufacturing

Figure. 9



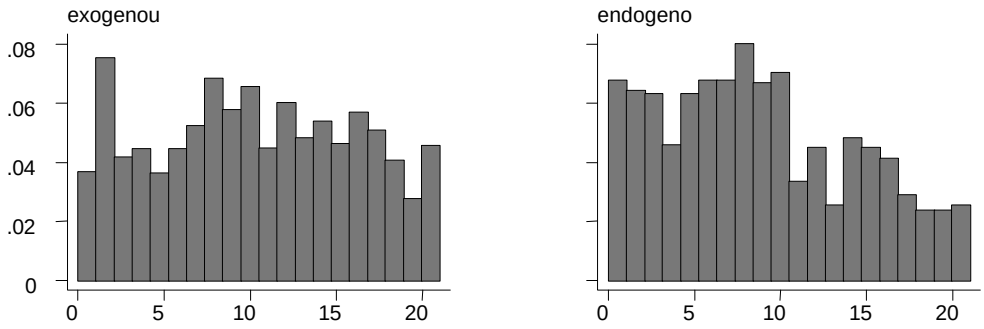
Traditional & de novo Foreign Manufacturing

Figure 10



lnin

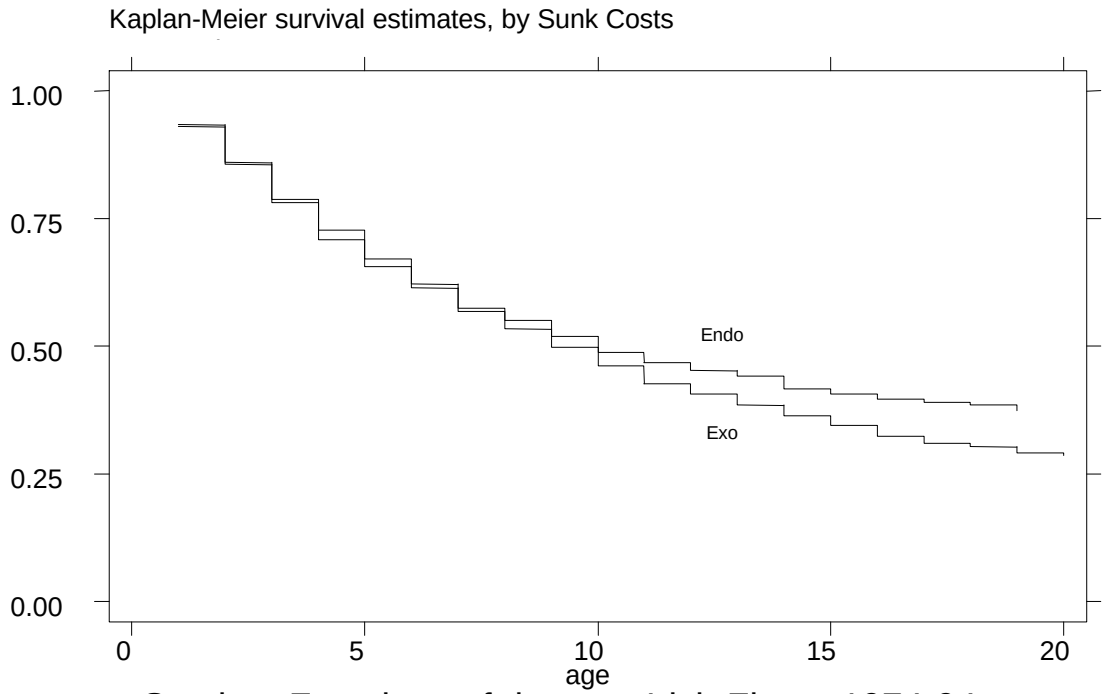
Initial Size Distributions of de nova Irish by Sunk Costs



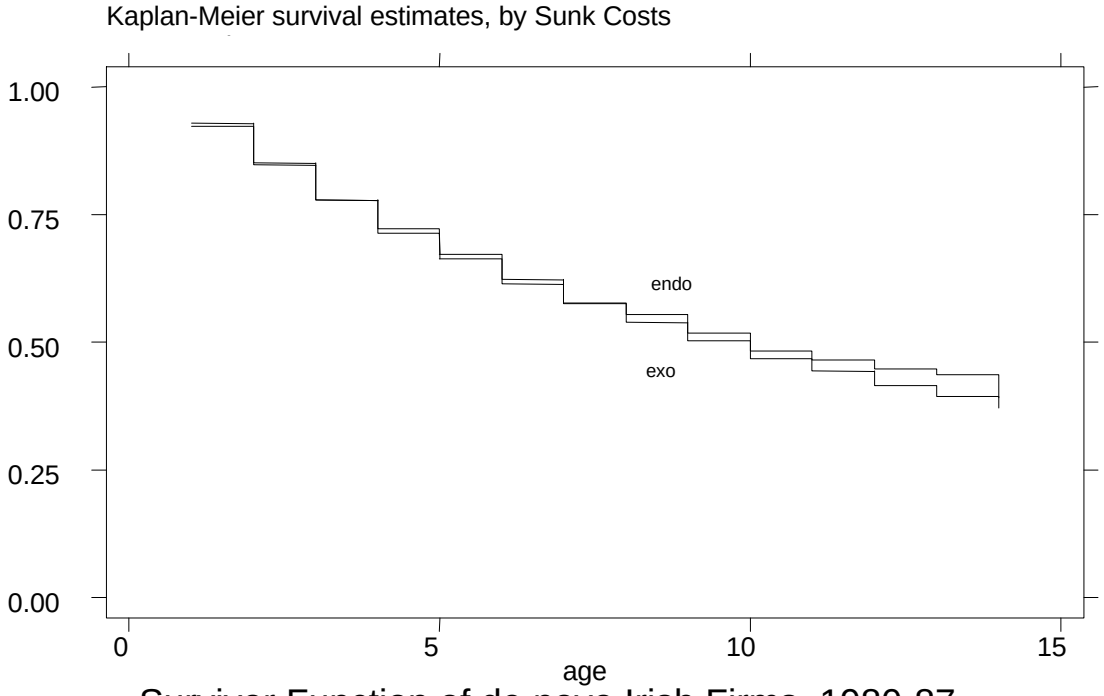
age

Age Distributions of de novo Irish, by Sunk Costs

Figure. 11



Survivor Functions of de novo Irish Firms, 1974-94



Survivor Function of de novo Irish Firms, 1980-87

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