THE DETERMINANTS OF FIRM START-UP SIZE: A COMPARISON OF IRELAND AND PORTUGAL

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Abstract

In this paper we provide empirical evidence on the determinants of firm start-up size using data for the manufacturing sector in Ireland, and compare our results with recent findings for Portuguese manufacturing industries (Mata and Machado, 1996). To allow for firm heterogeneity between firm entrants we use quantile regression techniques for our empirical estimation. We find that the determinants of start-up size differ in their importance for small and large-scale entrants. In particular, industry size and industry growth seem to affect large-scale entrants only.

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I Introduction

The entry of new firms into markets has attracted considerable interest in the theoretical and empirical literature in industrial economics. Not least since Schumpeter's (1934) work have economists recognised the importance of new firms for the constant evolution and renewal of industries. In recent years, a large body of empirical literature has appeared, analysing mainly the determinants of entry (Acs and Audretsch, 1989a, 1989b; Audretsch and Acs, 1994; Cable and Schwalbach, 1991; Mata, 1993; Wagner, 1994a) and the subsequent performance and life duration of new entrants (Audretsch, 1991; Audretsch and Mahmood, 1995; Boeri and Bellmann, 1995; Mata and Portugal, 1994; Wagner, 1992, 1994b; Weiss, 1998).[1] An issue that has received much less attention is the start-up size of firms, even though studies of the life duration of firms acknowledge that the size of firms at entry is an important determinant of a firm's probability of survival.

There has been one recent exception, namely, the study by Mata and Machado (1996) which examines the determinants of firm start-up size using empirical data for Portugal. Their data source is an annual survey conducted by the Portuguese Ministry of Employment which covers all manufacturing firms employing 5 or more employees. The sample used consists of 1,079 manufacturing firms for which data were available for 1984. Mata and Machado use regression quantile (RQ) estimation techniques to analyse the determinants of firm start-up size. They argue and provide evidence that the RQ estimator can provide more accurate information on the determinants of start-up size than the commonly used OLS regression models, which only estimates a single measure of the central tendency of the size distribution.

In this paper we extend the approach developed by Mata and Machado (1996) to obtain additional empirical evidence on firm start-up size using data for the manufacturing

[1] See Geroski (1991, 1995) and Caves (1998) for concise reviews of the literature on firm entry.

sector in Ireland, another small open economy at the periphery of the EU.[2] Our paper additionally serves as an extension of previous work (Görg and Strobl, 1999) where we analyse the determinants of firm entry into Irish manufacturing industries where entry is defined in terms of firm numbers only. Here we also take into consideration the size of new entrants which, as pointed out above, is recognised to have implications for firm performance and firm survival.

The paper is structured as follows. Section 2 discusses the determinants of firm start-up size. Section 3 presents the econometric methodology used to estimate the empirical model, discussing the advantages of RQ estimation, while Section 4 introduces the data for the Irish manufacturing sector. Section 5 presents the econometric results and compares the findings for Ireland with those obtained by Mata and Machado (1996) for the Portuguese manufacturing sector. Finally, Section 6 summarises our results and presents concluding comments.

II Determinants of Firm Start-up Size

The determinants of a firm's start-up size have been discussed extensively by Mata and Machado (1996), who suggest a number of industry characteristics that may impact upon a firm's choice of initial size. Following their analysis, we postulate the following empirical model of the relationship between the start-up size of firm *i*, S_{it}, measured in terms of employment size, and several industry characteristics:[3]

$$S_{it} = b_0 + b_1 MES_{jt} + b_2 SUB_{jt} + b_3 IND_{jt} + b_4 TUR_{jt} + b_5 GRO_{jt} + b_6 D_t + e_t \qquad (1)$$

where MES_{jt} represents the minimum efficient scale in industry *j* at time *t*, SUB_{jt} is the percentage of employment employed in firms with less than MES (i.e., operating at suboptimal

[2] A comparison of Ireland and Portugal is of particular interest as both are designated Objective 1 regions and cohesion countries within the European Union.

scale), IND_{jt} is the log of the industry size, TUR_{jt} denotes turbulence in industry *j* and GRO_{jt} denotes the growth rate of industry *j*. D_t is a time dummy to control for time-specific effects, such as changes in the macroeconomic environment over time, and e_{jt} is the remaining white noise error term.

MES_{jt} is measured as the log of average employment size.[4] As Mata an Machado suggest, it seems reasonable to assume that, the higher MES in an industry, the larger, on average, will be new start-ups in order to be able to compete effectively in the market. We would, therefore, expect a positive relationship between the size of entrants and the MES.

SUB_{jt} is a measure of the proportion of employment in firms operating at less than minimum efficient scale, i.e., at suboptimal scale. As such, it provides an indirect measure of the cost disadvantage such firms have to face in the industry. All other things equal, the larger the proportion of firms operating at suboptimal scale, the lower seems to be the cost disadvantage to such firms and, hence, the lower may be the start-up size a new entrant will choose.

The size of the industry, IND_{jt} is measured as the log of total employment in the industry. The rationale for including this variable is that, the larger the industry (for a given MES), the larger will be the size of new entrants, as the probability of retaliation from incumbents is likely to be lower in a large than in a small market. Also, a large market allows the entrant to set a relatively larger scale of output than in a small market, representing a higher market potential to the entrant.

[3] Since we want to compare our results with the findings for Portugal we confine ourselves to using the same empirical model as Mata and Machado (1996).

[4] Lyons (1980) suggests an alternative measure of MES, namely, one half of the average number of workers in a firm that, on average, operate 1.5 plants. We do not have data available to calculate such a measure.

TUR_{jt} is measured as the product of employment shares in firms that enter or exit industry *j*.[5] Turbulence provides us with an indirect measure of sunk costs, as a high rate of simultaneous entry and exit in an industry can be taken as evidence of low sunk costs. Assuming that entrants are risk averse, one may expect that, the lower are sunk costs, the higher will be the start-up size of new entrants as the losses associated with a possible failure are lower.

The growth rate of the industry, GRO_{jt} is calculated as the difference, in natural logs, between the level of employment in the industry in subsequent years. In a fast growing industry, the probability of a firm surviving is higher than in a slow growing (or declining) industry as incumbents may be less likely to retaliate in a fast growing market. This implies that firms may choose to enter at a larger size in fast growing markets, due to the higher probability of success.

III Econometric Methodology

We estimate the above model using Regression Quantile (RQ) estimation techniques.[6] Mata and Machado (1996) point to a number of advantages in using the RQ estimator instead of standard least square regression models in examining the determinants of start-up size. For one, the RQ estimator allows one to investigate different conditional distributions rather than focusing on a single tendency measure, such as the mean in the least square regression models, and thus may provide further information on the distribution of firm start-up size. Secondly, it also allows one to take account of possible heterogeneity across firm sizes that is not captured by industry level covariates. If, for example, start-up size reflects to some degree access to funds, then the effect of the MES in a particular industry may be different for small relative to large firms. On a similar note, the available industrial breakdown may not be detailed enough

[5] Even though Beesley and Hamilton (1984) originally proposed measuring turbulence as the sum of entry and exit in an industry, Mata and Machado (1996) suggest measuring it as the product of entry and exit because

to allow the distinction between intermediate suppliers and direct competitors within an industry; the effect of the covariates on start-up size is likely to differ at least somewhat for these two groups of firms.

Thirdly, the authors also point out that the least square estimators can be sensitive to even modest deviations of the residuals from normality, whereas the RQ is robust to such. Finally, under the assumption that the distribution of firm size was approximately lognormal, a standard practise in the literature on firm size has been to use the logarithmic transformation of the dependent variable. If, however, the distribution is actually not lognormal, then the OLS estimator may not be optimal given that it is only equivariant to linear transformations of the dependent variable in estimation. In contrast, the RQ estimator is equivariant to both monotonic linear and non-linear transformations of the dependent variable.

IV Data

Our data source is an annual employment panel survey carried out for the Irish manufacturing sector since 1973 by Forfás, the policy and advisory board for industrial development in Ireland. It covers all known active manufacturing companies. The response rate to this survey has on average been extremely high, generally over 99 per cent. The unit of observation is the individual plant, for which the number of permanent full-time employees is reported. Each plant is, amongst other things, identified by a unique plant number, year of start-up and its 4-to-5 digit NACE code sector of location. These identifiers are only changed if there is an actual change of ownership.

In order to make our sample comparable to the sample for Portugal used by Mata and Machado (1996) we exclude firms with less than 5 employees. This leaves us with 4,603 observations on firms in the Irish manufacturing sector for the period 1973 – 1996. The

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the product "will only attain high values if entry and exit are both important" (p. 1311).

[6] The RQ estimator was suggested by Koenker and Bassett (1978), Bassett and Koenker (1982).

summary statistics presented in Table 1 show that mean firm start-up size for our sample is at roughly 19 employees, although the high standard deviation implies that there is a large spread of sizes around this mean. This average is slightly higher than the mean for the Portuguese sample used by Mata and Machado, where the mean start-up size stands at approximately 17 employees. The coefficient for skewness in Table 1 indicates that the distribution of firm start-up sizes is highly right skewed which is also shown by the result that the median of 10 is far less than the (arithmetic) mean size of 19 employees. This can be compared with the Portuguese data, which show a coefficient of skewness of 6.55 and a median size of 10, i.e., they are very similar to the figures found for the Irish data. The maximum firm size, however, is higher for the Irish (557) than for the Portuguese sample (335) of Mata and Machado.[7]

The distribution of firm start-up size in Ireland is illustrated in Figure 1, which shows the high clustering of sizes in the low size classes, around 5 - 7 employees. As pointed out above, standard OLS estimation techniques can be sensitive to even modest deviations of the residuals from normality, whereas the RQ is robust to such deviations. Figure 1 suggests that the firm start-up size distribution does not conform to a normal distribution, and a formal test for normality based on skewness and kurtosis (see D'Agostino et al., 1990) allows us to reject the hypothesis that the start-up size is normally distributed. Hence, we may conclude that a straightforward OLS estimation would not be optimal for our purposes.

V Econometric Results

In order to analyse the determinants of firm start-up size we estimate equation (1) using data for the Irish manufacturing sector described above. The results are reported in Table 2.[8] In the first column we present the results obtained using the standard OLS

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[7] This may be due to the fact that a large proportion of manufacturing firms in Ireland are foreign-owned firms. One may expect that foreign-owned firms, which are likely to be subsidiaries of multinational companies, are larger than Irish-owned firms (see Ruane and Görg, 1996).

[8] All estimations were performed in Stata. The regressions include time dummies, the coefficients of which are not reported but can be obtained from the authors upon request.

procedure, i.e., the estimation of the conditional mean using least squares technique. In the further columns we report the regression results for five different quantiles of the firm size distribution. In accordance with Mata and Machado (1996) we estimate the equation for the 0.15, 0.25, 0.5 (i.e., median), 0.75 and 0.9 quantile. The results obtained by Mata and Machado for firm start-ups in Portugal are reproduced in Table 3 and it is apparent that our results are broadly consistent with theirs.

The location estimates, which are the point estimates of the conditional mean and quantiles, evaluated at the covariates sample mean, are very similar in the Irish and Portuguese data for the 0.15, 0.25 and 0.5 quantiles. The location estimates in the higher quantiles are larger for the Irish data, which indicates that there are larger entrants in the Irish sample, as also suggested by the higher maximum start-up size in Table 1.

Looking at the standard OLS results we find that, as expected, MES, industry growth and turbulence all exert statistically significant positive effects on firm start-up size in Ireland. The coefficient on the suboptimal scale variable is statistically significant negative, which is also in line with prior expectations, while the industry size variable does not exert any statistically significant effect on firm start-up size. The coefficients are similar to the estimates obtained by Mata and Machado in terms of signs and statistical significance. The coefficients for the Irish sample, however, seem to be larger than the coefficients obtained for the Portuguese sample.

While the OLS regression describes the central tendency of the data, the regression quantile results give a more precise picture of the importance of the explanatory variables for the different quantiles. Comparing the results in Table 2 for the different quantiles shows that the magnitude of the coefficients changes as we move along the size distribution of firms. The coefficients for MES and turbulence are higher for the higher quantiles than for lower ones which suggests that they become more important variables for larger start-ups. Suboptimal scale also increases in (economic) significance in the negative direction, as we move to higher quantiles. In other words, suboptimal scale seems to be more of a negative factor for larger than for smaller firms. These results are also found by Mata and Machado, as Table 3 shows.

Industry size does not seem to exert any impact on firm start-up size in Ireland in the estimations of the 0.15 – 0.75 quantiles, as the statistically insignificant coefficients indicate. Only in the 0.9 quantile do we find a statistically significant negative effect of industry size, a result which is contrary to our expectations as formulated above. We would have expected a positive effect of industry size on start-up size, as the probability of retaliation by incumbents in a large market is likely to be lower than in a small market.

The growth of the industry is, for the Irish sample, a statistically insignificant explanatory variable in the 0.15 and 0.25 quantiles but it is statistically significant in the higher quantiles. The magnitude of the coefficients for this variable also increases in the higher quantiles. Hence, the start-up size of large entrants appears to be positively influenced by a growing industry, but this does not seem to be the case for small sized start-ups in Ireland. This may suggest that particularly large firms choose to enter at a larger size in fast growing markets than they would otherwise have, due to the higher probability of success in a fast growing market. Contrary to our result for Ireland, Mata and Machado only find a statistically significant effect of industry growth on firm start-up size for the 0.15 and 0.25 quantiles. Thus, industry growth seems to be a determinant of firm start-up only for small firms in Portuguese manufacturing.

While a glance at the results reported for the Irish sample thus far seems to show that the sizes of the coefficients differ between quantiles, we need to test this more rigorously. Table 4 presents the results of t-tests for the null hypothesis of equality of coefficients across different quantiles for the estimations reported in Tables 2. As the tests show, we can reject the hypothesis of equal coefficients for all cases.

We also tested for the equality of coefficients in the regressions for the Irish sample (Table 2) and the coefficients for the Portuguese data obtained by Mata and Machado (Table 3). As Table 5 shows, we cannot reject the null hypothesis of equal coefficients in the Irish and Portuguese regressions for the MES variable in the 0.15 and 0.25 quantile, while the standard t-test is only significant at the 10 per cent level of confidence in the median regression. The test statistics for all other variables, however, allow us to reject the null hypothesis for the respective coefficients.

The differences in the coefficients obtained for the Irish sample for the different quantiles suggest that it seems prudent to analyse how sensitive the coefficients are to the choice of the respective quantile. To investigate this issue we estimated the regressions at each quantile between 0.15 and 0.9 and plotted the coefficients for the different variables in Figures 2 – 6. It is obvious that the coefficients do not seem to be overly sensitive to the choice of quantile, as the coefficients are generally increasing (in absolute values) over the quantiles for all variables. There are slight fluctuations, however, for the industry size and industry growth variables but these do not appear to be so grave as to cause any major concerns for the estimation results. It is noteworthy that these two variables are the ones for which we got results that were not as clear cut as the results for the other variables in the estimation.

As pointed out above, the data used by Mata and Machado (1996) relate to firms with five or more employees and we also excluded firms smaller than five employees from the Irish sample to compare our results with those for Portugal. However, since our data set for Ireland includes all firms with size one or more we are also able to investigate the determinants of start-up size for firms with less than five employees. Our data set includes 6,816 observations on firms with start-up size smaller than five employees.

The results of this estimation are reported in Table 6. Comparing these results to those for the 0.15 quantile in Table 2, we note that the results for MES and industry size are very similar. Minimum efficient scale exerts a positive impact on firm start-up size, while industry size does not seem to matter for a firm's choice of initial size. However, the results in Table 6 suggest that small firms choose a larger start-up size the larger is the proportion of firms entering at suboptimal scale, i.e., the lower is the cost disadvantage of entering at suboptimal scale. Also, turbulence has a negative impact on firm start-up size amongst small firms, while industry growth impacts positively on a firm's choice of initial size. The results for the latter three explanatory variables contrast with the results obtained for the 0.15 percentile in Table 2. The differences in the results may be due to the fact that the majority of small entrants, namely 4,583, enter at a size of less than three employees, while 2,620 firms had a start-up size of one. These firms are likely to be self-employed professionals or family businesses, where the choice of start-up size may respond differently to market conditions than the choice in larger firms.

VI Summary and Conclusions

The start-up size (or initial size) of a firm has been found to be an important determinant of a firm's subsequent performance and prospects of survival. However, the determinants of firm start-up size have, to the best of our knowledge, not attracted much interest in the literature, with the exception of a recent paper by Mata and Machado (1996) which analyses data for the Portuguese manufacturing sector. In this paper, we present further empirical evidence into the determinants of start-up size, using data for manufacturing firms in Ireland over the period 1973 – 1996. We compare our results with the findings obtained by Mata and Machado (1996).

In our empirical analysis we take account of firm heterogeneity between entrants, i.e., differences in the choice of start-up size, using quantile regression techniques. We find that the determinants of start-up size for Irish manufacturing firms differ in their importance for small and large-scale entrants. The size of the smallest new entrants does not appear to be influenced by industry size and industry growth, i.e., factors that give information about the actual size and growth of the market into which the firm enters. Also, while the effects of minimum efficient scale and sunk costs are significant for small firm, their impact is quite small compared with larger firms.

For the largest entrants, the model of the determinants of start-up size is much more conclusive. Large firms do not appear to enter markets where minimum efficient scale is low, i.e., where economies of scale are negligible, or where sunk costs are not important. Also, market conditions, *viz.*, industry size and growth are important determinants taken into considerations by large entrants. While our results are fairly similar to the results obtained by Mata and Machado (1996) for Portugal, there are significant differences particularly with regard to the effect of industry size and industry growth on the choice of start-up size.

A natural extension of the present analysis is to study the effects of firm start-up size on firm performance and firm survival. As pointed out in the Introduction, there is a large body of literature that has studied these relationships using data for different countries but, to the best of our knowledge, the only analysis of this issue undertaken for the Irish economy thus far is by Walsh (2000). While such an analysis is beyond the scope of the present paper, it is an issue we hope to take up in future research.

Tables

Table 1: Summary statistics for firm start-up size

	Irish Sample	Portuguese Sample [a]
Observations	4,603	1,079
Mean Size	19.13	17.21
Standard Deviation	30.89	25.59
Minimum	5	5
Median	10	10
Maximum	557	335
Skewness	6.88	6.55
Kurtosis	75.32	61.13

[a] Data for Portuguese sample reprinted from Mata and Machado (1996), Table 1, with permission from Elsevier Science.

Table 2: Quantile regression results for Irish sample [a]

Quantiles	OLS	0.15	0.25	0.5	0.75	0.9
MES	9.122	0.354	0.621	2.163	6.656	19.373
	(12.659)***	(6.839)***	(6.296)***	(11.529)***	(12.445)***	(15.581)***
Suboptimal Scale	-81.072	-4.442	-7.905	-25.795	-65.013	-141.217
	(-7.119)***	(-5.496)***	(-5.054)***	(-8.706)***	(-7.456)***	(-6.786)***
Industry Size	-0.203	0.042	-0.005	-0.135	-0.280	-1.827
	(-0.369)	(1.027)	(-0.072)	(-0.943)	(-0.699)	(-2.126)**
Turbulence	1528.410	50.736	110.344	470.144	1834.417	4512.668
	(7.904)***	(3.211)***	(3.904)***	(9.315)***	(13.749)***	(16.540)***
Industry Growth	37.110	0.444	0.908	2.179	14.568	32.412
	(7.472)***	(1.205)	(1.360)	(1.686)*	(3.710)***	(3.442)***
Constant	2.596	4.680	5.875	8.082	13.875	20.179
	(0.486)	(11.882)***	(7.998)***	(5.803)***	(3.597)***	(2.441)**
Location Estimates	19.128	5.586	6.533	10.455	20.098	40.944
R^2	0.06	0.01	0.01	0.02	0.05	0.10
F (H_0: β_i=0)	12.28	7.09	5.63	12.33	14.05	18.72

[a] t-statistics in parentheses. Regressions include time dummies. Asterisks denote statistical significance at 1 per cent ***, 5 percent **, 10 percent * level.

Table 3: Quantile regression results for Portuguese sample [a, b]

Quantiles	OLS	0.15	0.25	0.5	0.75	0.9
MES	5.406	0.507	0.607	1.935	4.567	13.858
	(4.978)***	(3.703)***	(2.926)***	(4.011)***	(4.260)***	(4.571)***
Suboptimal Scale	-16.353	-1.529	-2.205	-6.322	-14.448	-41.785
	(-3.486)***	(-2.010)**	(-2.498)**	(-3.123)***	(-4.026)***	(-5.033)***
Industry Size	1.201	0.244	0.150	0.366	0.577	1.014
	(1.545)	(3.252)***	(1.138)	(1.367)	(0.979)	(0.926)
Turbulence	445.960	59.873	99.316	217.944	488.754	889.744
	(3.253)***	(2.894)***	(2.660)***	(3.159)***	(3.799)***	(4.636)***
Industry Growth	12.901	2.713	3.985	5.592	9.234	7.710
	(1.857)*	(3.133)***	(1.851)*	(1.381)	(1.238)	(0.460)
Constant	-12.938	1.579	2.905	-0.093	-3.585	-20.807
	(-1.673)	(1.908)*	(2.220)**	(-0.036)	(-0.611)	(-2.054)**
Location Estimates	17.205	5.855	6.674	10.294	18.164	34.097

[a] t-statistics in parentheses. Regressions include time dummies. Asterisks denote statistical significance at 1 per cent ***, 5 percent **, 10 percent * level.

[b] Reprinted from Mata and Machado (1996), Table 2, with permission from Elsevier Science.

Table 4: Test for equality between coefficients at different quantiles for Irish sample

	0.15-0.25	0.25-0.5	0.5-0.75	0.75-0.9
MES	-162.651	-493.683	-537.812	-637.464
Suboptimal Scale	133.452	362.269	288.920	229.149
Industry Size	37.205	54.346	23.118	110.699
Turbulence	-124.901	-422.010	-648.861	-598.295
Industry Growth	-41.235	-59.286	-203.355	-118.653

Table 5: Test for equality between coefficients in regressions for Ireland and Portugal

	0.15	0.25	0.5	0.75	0.9
MES	-1.3592	0.1536	1.8653	16.0745	39.2947
Suboptimal Scale	-46.7265	-71.7314	-186.1268	-284.7227	-290.0135
Industry Size	-2.0442	-4.4835	-12.0260	-28.2085	-91.9272
Turbulence	-36.6951	25.9882	336.2292	683.0881	54.4685
Industry Growth	-23.7468	-53.7934	-73.9580	77.2291	177.0546

Table 6: OLS Regression for Irish Firms with less than 5 Employees

MES	0.113
	(5.343)***
Suboptimal Scale	1.234
	(3.875)***
Industry Size	0.020
	(1.221)
Turbulence	-16.209
	(-2.908)***
Industry Growth	0.429
	(2.987)***
Constant	2.223
	(13.907)***
R^2	0.10
F (H_0: β_i=0)	25.52

[a] t-statistics in parentheses. Regressions include time dummies. Asterisks denote statistical significance at 1 per cent ***, 5 percent **, 10 percent * level.

Figures

Figure 1: Distribution of Firm Start-up Size in Ireland

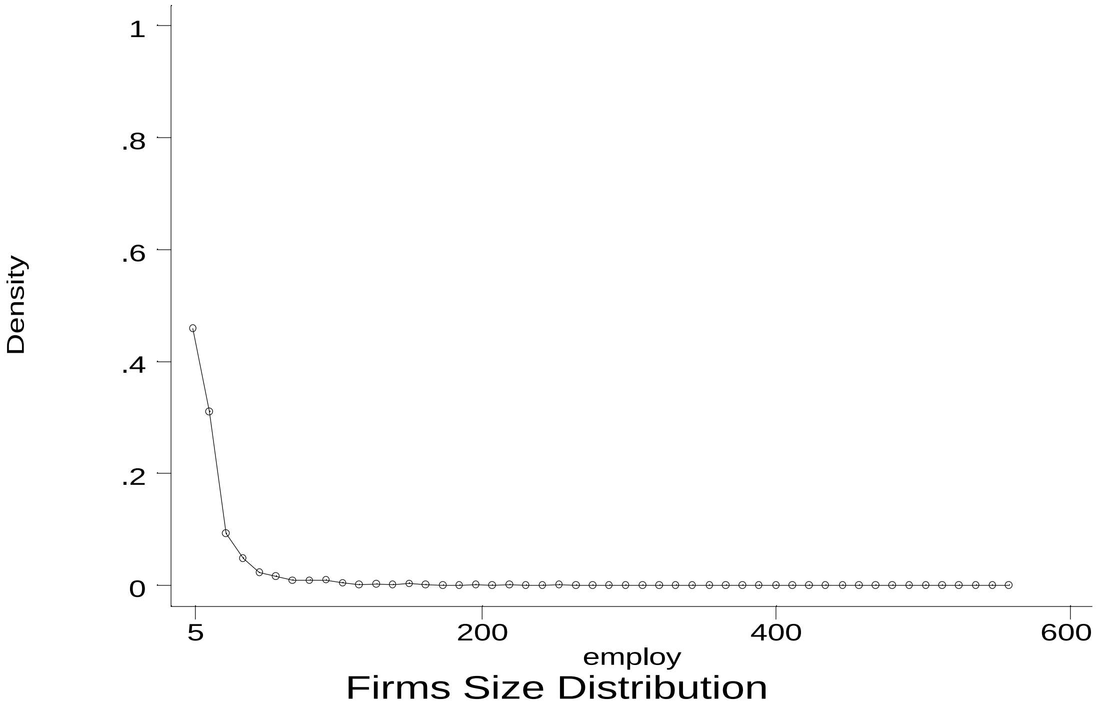


Figure 2: Coefficients for Minimum Efficient Scale

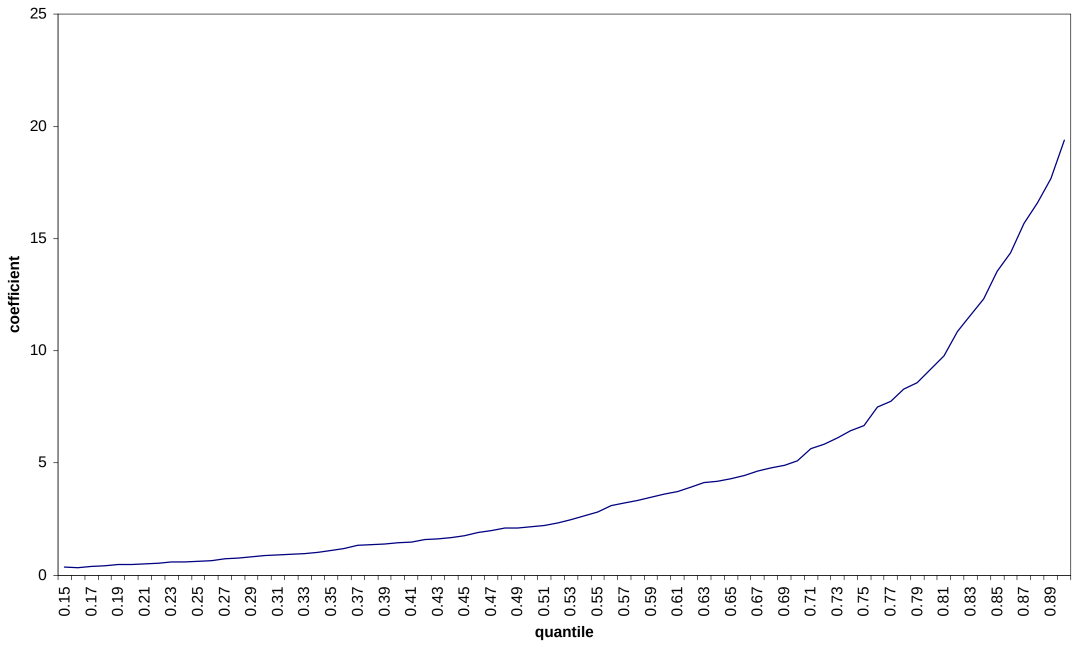


Figure 3: Coefficients for Suboptimal Scale

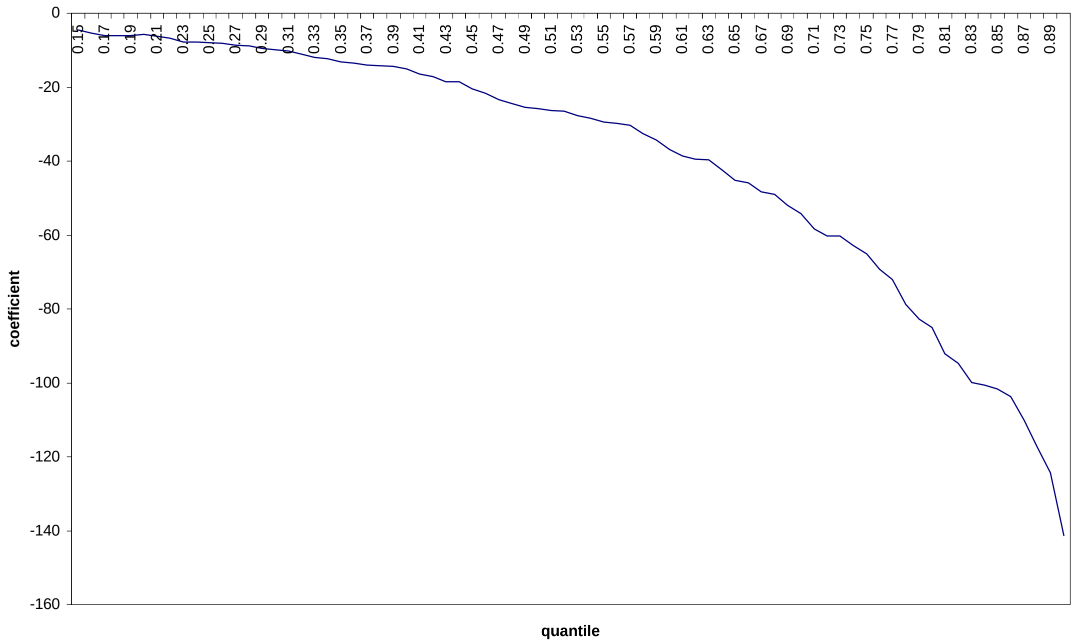


Figure 4: Coefficients for Industry Size

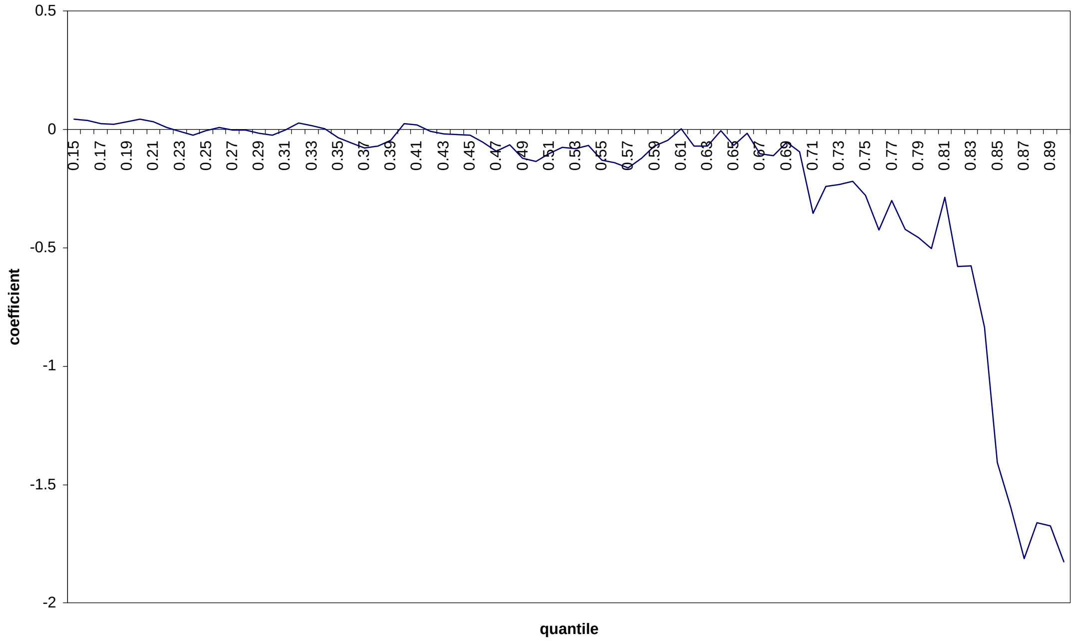


Figure 5: Coefficients for Turbulence

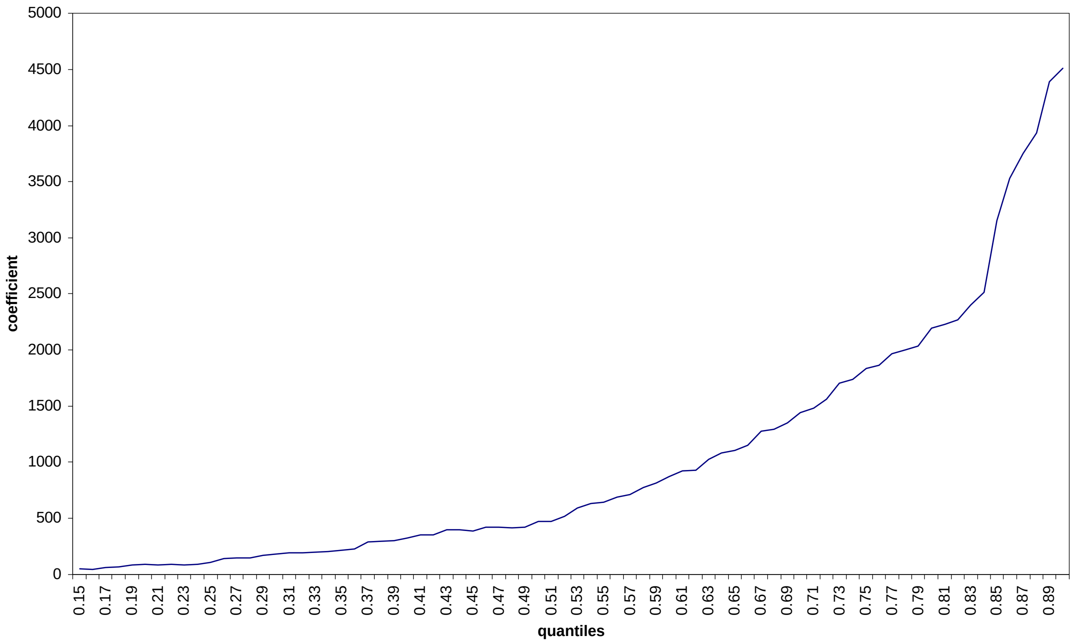
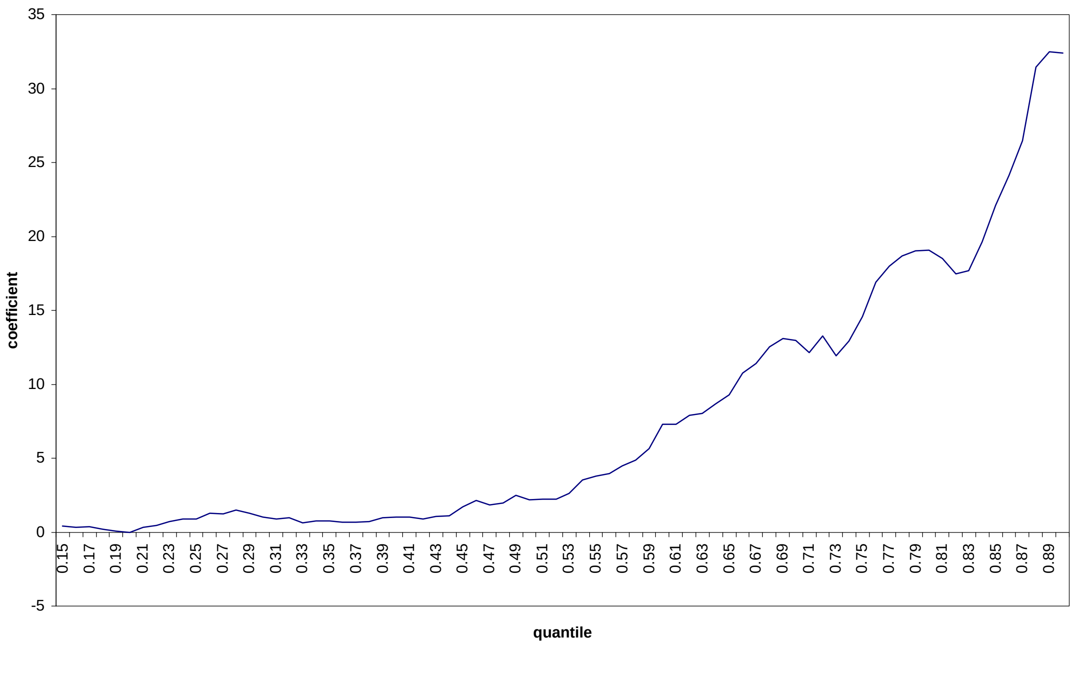


Figure 6: Coefficients for Industry Growth



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