

IDENTIFYING POTENTIAL FAST GROWTH FIRMS IN THE POLISH SMALL
FIRM STRATUM

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Abstract

Polish small firm policy stresses the importance of fast growing small firms. This paper examines the statistical work emerging from survey data of the Polish small firm sector in 1999 which tested for the optimism of this stratum with respect to immediate growth prospects and EU accession. The statistical analyses reveal the following variables correlated with such optimism: the region of establishment, branch of activity, ownership of other national enterprises, extent of internet use, knowledge of EU markets, the difficulty of obtaining a bank loan, the existing level of exports and franchising activity, a recent increase in the level of fixed assets and income, the level of human capital and the technological level of a small firm's products. On this basis a profile of the potential fast growing Polish small firm is drawn. Policy implications are explored particularly the need for a differentiated policy for firms at different stages of growth and in regions of different development levels.

JEL classification: C22, C52, L00, P27

Key Words: Polish small firms; surveys, statistical analysis; regional development; fast growth.

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1. Introduction

The Polish government after 1989 introduced an unprecedented economic reform plan known as the Economic Transformation Program designed to stabilise the economy and promote structural reforms. Poland benefited from the difficult but effective introduction of truly market-driven mechanisms into the economy and became the first country in the region to rebound from transformational recession and exceed GDP levels experienced before post-communist reforms. A moderate recovery during 1992-1993 was followed by robust growth from 1994-1999 - the fastest in Central Europe. This was driven by the rapid expansion of the new private sector. Poland's GDP was 20% larger in 1999 than in 1989 and 70% of the economy had been privatised with the creation of over 2 million new small businesses. The economy decelerated towards the end of the decade and there was also a slow down in small firm development. Poland's privatisation strategy, rather than concentrating principally on large state enterprises, has been "bottom-up" and small firm policy has been an important plank of the reform process. Government has become more active in such policy in Poland since 1995 and considers it vital to encourage the growth of small firms so that they play a larger role in the economy and employ more numbers. Therefore a vital policy question is the identification of the firms most likely to grow.

Two surveys were completed in 1999 in the small firm sector in the Gdansk and Lublin regions. Various descriptive papers and statistical investigations resulted using data gained from these two surveys in 1999. This purpose of this paper is to examine the

statistical investigations in order to build a profile of what a potential "winning" firm in the Polish small firm sector looks like. The motivation of the paper is to examine the contribution of faster growing small firms to employment growth in Poland in the context of EU accession and to explore policy implications flowing from this.

The structure of this paper is as follows. After the introduction, Part 1 gives a short background to the policy justification of small firm growth in Poland. Part 2 gives an account of the surveys and the results of the statistical investigations. Part 3 reflects on the results and presents the profile of the winning small firm. Part 4 concludes.

1. The Policy of Small Firm Growth.

In 1999 small firms in Poland accounted for 38% of GDP, 54% of the gross value added of all businesses, 99% of the number of total business and 47% of market sector employment. (Dzierzanowski 2001 p31). However despite their impressive growth in the 1990s by the end of the decade there was a marked slowdown particularly accentuated by the Russian foreign currency crisis of 1998. In 1999 the numbers working in the small sector decreased (by 1.6%) for the first time in the decade and the number of small businesses only increased by 2% - a small figure compared to the 18% and 7% increases of 1997 and 1998 respectively. Such a slowdown was a major contribution to the increase in unemployment in the Polish economy from 10.4% in 1998 to 13.1% in 1999.

The Polish Foundation for Small and Medium-Sized Enterprise (SME) Promotion and Development commenting on the present government SME programme¹ says ... "the main objective is to create friendly conditions for business start-ups and the full exploitation of SME development potential" (Piasecki et alia 1998 p16). In particular it is stressed that there is a substantial difference in firm size structure between Poland and other EU states. If we include micro firms², which are numerous in Poland, the average size of firms in Poland is 1.7 employees while in the EU it is 6. In the light of this their first policy recommendation states

"If SMEs are to make a full contribution to economic development and employment generation in Poland, it is important that more of the very small and small firms grow into larger firms. Identifying and addressing the support needs of firms with growth potential in these size bands is therefore a policy priority." and again...."The potential role of SMEs in economic development and in national competitiveness has become increasingly important...[there] is an important role for policies in supporting the growth potential of existing firms survey findings point at a significant correlation between the growth of sales and the growth of employment and provides a strong justification for tying the support extended by the policy instruments to a firm's growth orientation and its economic performance." (Piasecki et alia 1998 p 23).

¹ "Directions of Government Activities in Relation to SMEs till 2002".

² Official definition of SMEs in Poland follows EU conventions of number of employees thus: micro = 1-9, small = 10-49, medium = 50-249. However in practice definitions vary.

The identification of such firms with potential to grow is clearly a major policy priority. It is the intention of this paper to use the statistical evidence from the 1999 surveys to build a profile of such firms.

2. Surveys and Results of Statistical Investigation

Two sample surveys were carried out on small firms in Poland in the areas of Gdansk and Lublin in 1999. Gdansk is a developed region in Northwestern Poland known for its port and shipbuilding. Lublin is far less developed region in Southeast Poland depending mostly on agriculture. They may be viewed as representatives of Poland A and B respectively - Poland A, west of the Vistula river, loosely comprising Western Poland, is closer to the European union and has with higher levels of economic development. Poland B, on the other hand, is significantly less developed, more agrarian, and has closer ties with its Eastern neighbours. These surveys were part of a research programme “An Empirical Study of Small and Medium Size Enterprises in Poland: Phase 11”.³ Small firms were defined as employing between 10 and 49 employees⁴ and the NACE sectors of industry, trade, construction, transport and services were included in the population. The questionnaires consisted of 58 general questions many of which had sub-sections. Considerable data was collected. Professional enumerators were employed to ensure maximum quality and minimum non-sampling error. The sampling technique used a proportionate stratification sampling method across the chosen sectors. Micro enterprises

³ These surveys were financed by the European commissions PHARE ACE PROGRAMME 1997, Contract Number p97-8123-R.

⁴ The small firm definition (10-49 employees) is in accord with the EU and also with recent Polish legislation (1999 “Law on Economic Activity”).

with less than 10 employees were not included since such data was not regarded as reliable.

The surveys was carried out in Lublin and Gdansk in 1999. They sampled around 5% of small enterprises in both regions. In the area of Gdansk 239 firms were selected by a stratified sampling technique out of a population of 4706 firms. In Lublin 137 small firms were similarly sampled out of a population of 2740. The data from these two regions was statistically examined by two teams: firstly Ghatak, Manolas, Rontos and Vavouras (2001) - hereafter GMRV who analysed the data using a dichotomous logit model; and secondly GMS team⁵ who analysed the data using censored estimation techniques and OLS. The purpose of these investigations by GMVR and GMS was to test for the optimism of small firms with respect to EU accession for Poland (the GMRV dependent variable) as well as the ir optimism concerning expansion plans in the two years following the survey (the GMS dependent variable). The methodology and detailed results of both investigations are given in the appendix. Both dependent variables related to a different aspect of optimism. However taken together they can be interpreted as the overall drivers of optimism in the Polish small firm sector. They indicate, from the point of view of small firms themselves, the profile of small firm potential "winners", i.e. those most likely to succeed in the Polish transformation leading to EU accession.

GMVR reported general optimism about accession to the EU within the Gdansk and Lublin areas: 61% of small firms were optimistic about accession, 35% were pessimistic while only 4% did not respond to this question. The results of the logit statistical

analysis⁶ showed that this optimism concerning accession was correlated with 6 variables:

the region of establishment - Gdansk more optimistic than Lublin. Gdansk is the more developed regions and greater optimism was expected.

branch of activity - most sectors, with the exception of manufacturing, expected to gain from accession. However tourism (restaurants and hotels) was the most unequivocal. The breakdown according to sector is given in Table 1.

ownership of other enterprises - this probably reflected a belief that economies of scale and scope would be highly beneficial in a wider European market.

extent of internet use - this was believed by small firms to be important for reaping the benefits of the EU. This probably reflected the awareness of the need for a leap in communication technology in the face of enormously expanded market possibilities.

knowledge of EU markets - this was, unsurprisingly, related to optimism concerning the impact of the EU on small firms.

⁵ Called thus to hide identity of authors and working paper.

⁶ Methodology and table of results given in appendix 1.

the difficulty of obtaining a bank loan - this reflected the widespread view that the cost of credit is a major restriction on small firm expansion and the possibility of growing within the EU market.

[INSERT TABLE 1]

The GMS team testing the data from Lublin's small firms for those variables that influenced optimism concerning economic growth in the two years following the survey showed cautious optimism for expansion possibilities. Their results indicated that the more efficient firms and those with proven competitive advantage were optimistic about expansion. These were firms that would have already expanded in the growth period of the 1990s and were confident they could outride the deceleration in the later part of the decade. Using the method of ordinary least squares GMS's results showed the following variables to be determinants of Polish small firms' intentions to expand production:

the existing level of export activity - those firms already exporting were expected to be better placed to continue expansion in the immediate future.

the existing level of franchising - this probably indicates the degree of modernisation and internationalisation achieved by a select number of firms and their optimism about continued expansion.

a recent increase in fixed assets is an indicator of investment for the future and clearly those firms who had invested anticipated and were better prepared for expansion in the short term.

the difficulty in obtaining a bank loan proved significant in the GMS analysis (also significant in the GMRV results) and further illustrates the ubiquity of this complaint.

the level of human capital proved significantly correlated with expansion plans and emphasises the importance of this variable for productivity and growth. In general the higher the level of human capital in the firm the greater its plans for expansion.

the technological level of a small firm's products points to the important connection between technological advancement, productivity and growth. This variable proved to be non-linear however indicating that at higher levels of technological product development there was less belief in expansion in the coming two years. This may indicate that firms at the lower end of the technological spectrum were less in danger of competition than those more developed - Macejski (1995) drew similar conclusions. These less developed firms would probably be exclusively serving local niche markets. Such non-linearity may also reflect expectations of deceleration affecting the faster growth firms. At the very least it indicates large catch-up gains for firms with lower level technology.

the estimated proportionate change in income from 1997 to 1999 - this variable is intuitively related to immediate growth prospects based on the simple expectation that

past performance is significantly related to immediate short term future performance. This variable could also be used as a proxy for profits (the data for which is difficult to get in Poland from small firms). Profits are clearly related to investment plans and the capacity to invest. Again this variable proved to be non-linear perhaps indicating that the larger of the small firms, or those growing faster, were anticipating more competition than those who were smaller and growing less fast. Again catch-up gains for certain firms are indicated.

3. Reflections on the Results and the Profile of Winning Small Firm.

We have already noted the awareness of Polish institutions concerning the connection between SME growth and employment possibilities. Analysis by external sources confirms this. In assessing SME's preparedness for EU accession Smallbone et alia's (2001) first recommendation, in the light of SMEs small size, low value added contribution and technological disadvantages, was for government to "target support on growth-orientated micro and small businesses that have the potential to grow into larger businesses". But what does this potentially "winning" firm look like? A profile of the Polish "winning" small firm may be formed, we suggest, from the significant variables of the above statistical investigations - those firms that are optimistic about growth and accession are, we argue, the potential "winners". Such a firm is likely to be in the Gdansk, private, service sector. It has a greater international and technological presence than average, with some levels of exporting, franchising and sub-contracting. It has

overcome the difficulties of the credit market probably affording high cost loans or by financing growth out of profits. It typically has more ownership of other national firms than average, more extensive use of the internet and greater knowledge of the EU markets. Its work force is more highly educated and its change in income and investment in recent years has been higher than average. We can infer that such a firm has already had success in the expansion of the 1990s with significant improvements in turnover, profits, investment and productivity. Such a firm may not be among the fastest growers in terms of turnover and may not be among the higher technological group - both of these variables proved to be non-linear. However it would be among the best performers in terms of investment growth.

The above empirical picture is theoretically consistent with research into small firm success. There is for example a significant literature on SME share of manufacturing industry. Their natural disadvantages of size (implying lack of economies of scale for example) may sometimes be overcome by efficiency and innovation gains - e.g. increasing productivity or incorporating new technologies. Mentioning only a few authors - Acs and Audretsch (1989) have demonstrated that U.S. SMEs with technological and innovation improvements can improve their share. Carlsson (1984) has shown the same phenomenon for SMEs that incorporate new technologies. Mata (1993), in the case of Portuguese SMEs, has also shown a positive correlation between SME share and innovation activity. Ming-Wen Hu (1999) in the case of SMEs in Taiwan found correlation between SME share and relative labour productivity. This is also consistent with the empirical work of Smallbone et alia (1996) specifically in the Polish manufacturing

sector where a picture of comparatively under-powered SMEs emerges and recommendations that target productivity and technology improvements are set out. However for Poland our research suggests that it is early catch-up gains that are indicated for the small firms stratum.

One should, however, bear in mind that knowing the picture of the small firm "winner" is different from picking potential winners - the former is "winning" already, while the latter may do so given help. Here are some key points.

Firstly, we suggest that on the basis of the above profile the *potentially* "winning" firms would have advanced significantly in many of the variables indicated by the profile but are probably held back by some key constraints. For example there may be a lack of credit or appropriate technology; there may be a lack of marketing skills and information for its exports plans; some firms may wish to relocate from a backward to a more developed region but need help with the finding of low cost premises. Such firms would be a fruitful target for government help. The profile of the potential fast growing small firm is not to be used for rigid policy making. It needs to be creatively and imaginatively used by policy makers in order to promote small firm development. For example the profile of the potentially winning small firm shows it to be located in the Gdansk service sector. This may indicate that it is fruitful to target fast growth firms who are either in or are *trying to locate* within a more developed region; it may indicate that not only service sector firms but also those manufacturing firms who have moved some activities into service provision (e.g. consultancy) would benefit from targeted help. At the other end of

the spectrum such a profile would indicate that helping a manufacturing firm in a less developed region that had made changes in neither its technology, the training of its workforce, nor its investment programme, and which had made no attempt at sub-contacting, franchising, or a creative export drive would be a waste of tax payers money from the point of view of employment generation - however it might be done for social or other reasons. Table 2 outlines the profile of a potential "winning" small firm and the kinds of interpretations that policy makers might put on each variable.

[INSERT TABLE 2]

Policy makers may benefit from reflection upon the certain elements of the profile of the "winning" Polish small firm - after all a lot more of them need to be "winning". The general picture is clear that help for small firms should encourage: greater international presence, higher levels of technology, greater knowledge of EU markets (and regulations), greater use of the internet and information technology, improvements in productivity and capital structure, as well as greater use of networking arrangements including sub-contracting and franchising. These firms especially need help overcoming credit difficulties.

Secondly, significant regional differences in small firm development exist in Poland. Small firm policy clearly needs to be differentiated to provide specific help in the less developed regions. In those regions, of which Lublin is an example, small firm policy needs to be a lot simpler. For example it should be concerned with promoting start ups, providing elementary information and training; it should emphasise retraining into new work areas. Fast growth of small firms can be expected in the early stages because many

are starting from a very low productivity level. For example, for many very small firms it is not a question of encouraging advanced information technology but more a question of simply encouraging the use of a basic computer - after all 60% of Polish firms do not use one and 80% do not use the internet (Dzierzanowski 2001 p16).

Thirdly, in these surveys small firms explain clearly the following: that bank credit, although available, is too costly; that exporting, though possible, is difficult due to lack of foreign partners, lack of specialists and marketing difficulties; that taxation is too heavy (probably referring to non-wage costs) - all these are areas that government can do something about and a great deal is to be learned from the EU.

Fourthly, fast growth, according to our results, is not to be expected only by the larger of the small firms. Two of our key variables are non-linear: *the technological level of a small firm's products* and *the estimated proportionate change in income from 1997 to 1999*. This indicates that there is more growth expected (and therefore more employment to be generated) in those small firms which are in the early stages of technology growth and also in those who have grown less fast (income growth) in the 1997-1999 period. Note however that such firms would have grown somewhat in this period and would have advanced in their technology - it is just that they may not be in the top league. This indicates that there are considerable "catch-up" gains for small firms in the early periods of growth.

4. Conclusion

Small firm policy in Poland clearly states the importance of the growth of small firms as a major policy objective. Growth in small firm turnover leads, in their experience, to growth in employment. An important question is therefore the identification of potential "winning" small firms, i.e. those capable of fast growth. Two surveys in 1999 explored the small firm sector and statistical analyses were carried out testing for the optimism of the small firm sector with respect to the prospects for growth in the two years following the survey and also for EU accession. The significant variables emerging from these analyses can be identified as the drivers of optimism in the small firm sector. This paper argues that these are important ingredients in the profile of a "winning" small firm. We also argue that the picture that emerges is broadly in line with other empirical work on SMEs in other parts of the world as well as being consistent with the detailed work of investigators of the small firm sector in Poland. Of course such a profile has limitations. It is not exclusive - other variables will be important - and these variables can change over time. Also policy makers will be aware of other factors of importance - for example the importance of the macro, legal and political environment. However this research is not addressing the overall needs of the small firm sector. It is only addressing one important question - the profile of the potential fast growing small firm. This paper also points to policy suggestions on the basis of this profile. Naturally these have to be treated circumspectly and put into the overall context of policy making in Poland. However, an important implication is the need for a differentiated small firm policy at regional level.

Tables

Branch	Negative	Positive	Total
Manufacturing	38	32	70
Construction	18	23	41
Trade	56	83	139
Hotels-Restaurants	0	12	12
Communication	5	21	26
Financial intermediation	1	9	10
Other services	5	44	49
Total	123	224	347

Variables	Interpretation
Location	Either located in or wishing to locate in a developed region
Form of ownership	Private - perhaps moving away from sole proprietorship towards a more developed legal form
Sector of economy - in order of optimism	Hotels-Restaurants; Financial Intermediation; Communication; Other services; Trade; Construction; Manufacturing
Exports	Either increasing exports already or with significant export potential
Franchising	Franchising already or engaging in other creative relations with other firms - especially foreign
Sub-contracting	Evidence of sub-contracting in appropriate industries
Credit difficulties	Evidence of overcoming difficulties of bank lending
Ownership of other national firms	Evidence of expansion by owning other firms or setting up different branches
Use of internet	Demonstrable business use of the internet
Knowledge of EU markets	Demonstrable and increasing knowledge of these markets
Education of work force	Evidence of higher than average education levels and/or improvements in training of workforce
Level of technology*	Higher than average levels of technology/ evidence of recent betterment of technological level
Income*	Higher than average recent turnover levels
Investment	Recent increases in investment
Productivity	Recent increases in productivity

* These firms do not have to demonstrate the highest levels of income growth or technological level of products.

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Appendix 1 GMVR Methodology and Results

Methodology

Commenting on the methodology of their paper the GMRV team (2001) state:

“To achieve the objectives of our paper, we use the dichotomous logit analysis. A Conditional Forward Stepwise Method is also selected. A Logit Analysis is useful in our case as we would like to know the structural characteristics and other factors that explain the dependent variable that is defined by the choice of individuals over a finite and unordered set of alternatives. More specifically, we study the positive or negative influence of the accession of Poland to the European Union on the performance of the small enterprises. For the estimation of our model, we use the maximum likelihood approach. The statistical significance of ‘b’ coefficients has been tested by the Wald statistic which is equal to the square of the well known ‘t-statistic’ as it is preferred in the case of logit analysis. After choosing the best model, the probability of an enterprise with certain characteristics and economic performance to be positively influenced due to the possible accession to the EU can be predicted by using the following formula :

$$P = \frac{1}{1+e^{-(\Sigma\beta)}} \quad (1)$$

where β are the regression coefficients of the categories to which the enterprise belongs. The expression e denotes the exponential function.

A brief description of the logit model is also undertaken here. Let P_i be the probability that the i th enterprise will have a positive influence from Poland’s accession to the EU and let $Q_i = 1-P_i$ be the probability that the enterprise will have a negative impact from the accession. In the specification of the model it is natural to define P_i as an ordinate of a cumulative distribution function (CDF) since P_i lies between zero and one, i.e.

$$P_i = F(t) \quad (2) \quad \text{where } F(.) \text{ is a distribution function. If } f(.) \text{ is the associated density function, then we have:}$$

$$P_i = \int_{-\infty}^t f(z)dz \quad (3)$$

This expression will be made more specific in the context of the subject examined by expressing the upper limit t as a function of the characteristics and the performance of the individual enterprise having the view. Thus, we may put $t = X_i\beta$ (4) where $X_i = (X_{i1}, X_{i2}, \dots, X_{ik})$ is a vector of the determinants of the probability of “having a positive or negative impact” and β is a vector of unknown coefficients.

Hence equation (3) can be written

$$P_i = \int_{-\infty}^{X_i\beta} f(z)dz = F(X_i\beta) \quad (5)$$

$$\text{and } Q_i = 1-P_i = 1-F(X_i\beta) \quad (6)$$

defining: $Y_i = 1$ if the i th enterprise has a positive impact and $=0$ otherwise then we have

$$\Pr \{Y_i = 1\} = F(X_i\beta) \quad (7)$$

$$\Pr \{Y_i = 0\} = 1-F(X_i\beta) \quad (8)$$

Assuming that $F(\cdot)$ is taken to be cumulative distribution function of the standardized logistic distribution; viz.:

$$F(t) = \frac{1}{1+e^{-t}}, \quad -\infty < t < \infty \quad (9)$$

then we can define the logit p_i by using (2), (4), (9) as

$$\text{logit of } P_i = \frac{1}{1+e^{-X_i\beta}} \quad (10)$$

or

$$\log \frac{P_i}{1-P_i} = X_i\beta \quad (11)$$

The model can be estimated by maximizing the likelihood function

$$L(Y_i/X_i) = \prod_{i=1}^n [F(X_i\beta)]^{Y_i} [1-F(X_i\beta)]^{1-Y_i}$$

The log likelihood is

$$L = \sum_{i=1}^n Y_i \ln F(X_i\beta) + \sum_{i=1}^n (1-Y_i) \ln [1-F(X_i\beta)] \quad (13)$$

setting to zero the first and second order derivatives of the above equation with respect to β and specifying the cdf, $F(\cdot)$, we can obtain an estimator of β .

We emphasize the use of non linear methods of estimation, such as logit and probit analysis when a number of qualitative variables have to be tested for their association with a set of alternatives as these models assume that all explanatory factors determine the dependent variable simultaneously. Alternative methods that could be used are either test χ^2 in cross tabulated data or multiple regression analysis. Neither of these two methods could be considered satisfactory. The former assumes that the various casual factors work quite independently of each other in determining the variable examined, whilst the latter overcomes these problems only to provide results which are neither statistically efficient nor unambiguously determined when the dependent variable is a dummy variable.

The logit analysis suggested here overcomes these problems and provides a powerful tool for the examination of discrete decisions or points of views in this or other areas.”

Results from GMVR team (2001)

Table A						
Variable	Category	Code	B coef.	S.E.	Wald Stat	Sign. Level
Region		A				
	Gdansk	1	0.31	0.14	4.87	0.027
Branch of Economic Activity		B			14.48*	0.024
	Manufacture	1	-1.87	1.48	1.6	0.2
	Construction	2	-1.26	1.49	0.71	0.39
	Trade	3	-1.23	1.47	0.7	0.4
	Hotels	4	5.54	8.69	0.41	0.52
	Transport-Storage					
	Communication	5	-1.05	1.54	0.47	0.49
	Financial Intermediation	6	-0.3	1.74	0.03	0.86
Ownership of other enterprises		C				
	No	1	-0.73	0.41	3.21	0.07
Extent of Internet use		M			7.96*	0.019
	No use	1	-0.48	0.2	3.73	0.05
	Yes, to a slight extent	2	-0.36	0.19	3.68	0.05
Knowledge level of EU markets		I			17.21*	0.0002
	High	1	0.67	0.26	6.55	0.01
	Medium	2	0.28	0.19	2.32	0.13
Difficulty of getting a loan		V			3.2*	0.2
	No	1	0.323	0.18	3.11	0.08
	Yes	2	-0.26	0.22	1.35	0.24
Constant			2.32	1.52	2.35	0.12

* Shows the significant value of the Wald Statistic at the aggregate level.

Appendix 2

Y Team: methodology and results

Methodology

Commenting on the methodology of their paper the Y team (2000) state.....

“The dependent variable that we model is denoted Y. This variable indicates the intention of an enterprise to decrease, maintain or increase (and if so by how much) production over the coming two years. The values assigned to Y correspond to each of the five possible responses to the question of a firm’s intention to expand output. In respective order these values are, 1 (decrease production), 2 (maintain production), 3 (increase production by less than 5%), 4 (increase production by 5% to 10%) and 5 (increase production by more than 10%).

The values of the dependent variable are represented by integers ranging from 1 to 5. However, the upper and lower values include unbounded data, that is, Y taking a value of 5 corresponds to a small firm’s intention to increase production by *more* than 10%. Similarly, when Y is 1 this means that firms’ production will decrease by some unspecified amount. We will therefore consider censored estimation. We employ the Quadratic Hill Climbing optimisation algorithm with a normally distributed error using the EViews 3.1 software. We estimate the model to ensure that the values of Y predicted by the model lie between 0.51 and 5.49. Allowance of an extra 0.49 units on either side of the boundary provides a consistent range of values surrounding each integer that correspond to each response. Hence, each integer value can be identified through the process of rounding. Censoring the dependent variable to lie between 0.99 and 5.01 produced almost identical results suggesting estimation is robust to the censoring values used.

For comparative purposes we also apply the method of ordinary least squares (OLS). This method provides more information, in terms of diagnostic testing, which turns out to inform the specification of our model. In particular, it suggests the use of a non-linear functional form. We outline both the linear and non-linear forms of the model.

The general specification in which estimated linear and non-linear models are nested are:

$$Y_i = \sum_i \beta_i X_i + u_i \tag{1}$$

$$Y_i = \sum_i \beta_i X_i^2 + u_i \tag{2}$$

where u_i is a stochastic error.

All models are of the dependent variable, Y, use the same 162 cross-sectional observations and are estimated by OLS. OLS T denotes OLS t-ratios and White T White’s heteroscedasticity adjusted t-ratios. Adj R² represents the adjusted coefficient of determination, s is the regression’s standard error and DW is the Durbin-Watson statistic. FSC1 is a modified F-version of Breusch-Godfrey’s test for first-order serial correlation, FFF1 is the F-version of Ramsey’s Reset test for non-linear functional form, $\chi^2 N2$ is the Jarque-Bera test for normality and FH1 is an F-version of White’s test for heteroscedasticity. F(1→) is an F-test for the variables deleted from the general regression to obtain the reported equation. Figures in squared parentheses denote probability values.”

Results from GMS team (2001)
Alternative OLS and Censored Non-Linear Regression Estimates

Table B					
Model →	OLS 4			Censored 4	
	Coeft	OLS T	White T	Coeft	T-ratio
Intercept	1.849	9.491	10.473	1.849	9.766
Exporting activity	0.459	2.397	2.665	0.459	2.467
Franchising activity	0.840	1.908	3.212	0.840	1.963
Tech.level of product	0.983	3.796	4.190	0.983	3.906
Increase in fixed assets: 97-99	0.612	5.012	4.979	0.612	5.157
Human capital	0.006	1.920	1.884	0.006	1.976
Bank loan difficulty	-0.308	-1.975	-1.985	-0.308	-2.032
Change in income: 97-99	0.006	4.214	4.293	0.006	4.336
L ²	-0.399	-2.272	-2.595	-0.399	-2.338
AdjR ²	0.459			0.465	
S	0.847			0.842	
DW	2.072				
QLB1				0.185 [0.667]	
QLB2				0.601 [0.741]	
FSC1	0.243 [0.623]				
FFF1	3.885 [0.051]				
χ ² N2	3.995 [0.136]			4.373 [0.112]	
FH1	0.066 [0.797]				
F(1→)	1.128			1.094	

Both OLS and censored regression models are reported. The distribution is F(30, 123) and the 5% critical value is approximately 1.68 – this statistic is based on the distribution F(30, 120).

