Small Business Economics (2007) 28:23–35
DOI 10.1007/s11187-005-6058-6

Are Small Innovators Credit Rationed?

Mark S. Freel

ABSTRACT. Drawing upon a sample of 256 small firms who applied for bank loans, the current paper is concerned with the extent to which 'innovativeness' is associated with a lower level of loan application success. The paper records the proportion of loan successfully applied for and estimates a series of tobit models utilising a number of proxy measures for innovation (in terms of inputs, outputs, and commercial significance to the firm) and incorporating standard controls. In general, the models suggest (as anticipated) that the most innovative firms are less successful in loan markets than their less innovative peers – though there is some variation by proxy. Moreover, there is tentative evidence that 'a little innovation may be a good thing'.

1. Introduction

It is generally held that '…a strict reliance on a market system will result in underinvestment in innovation, relative to the socially desirable level' (Martin and Scott, 2000, p. 438). Innovation is essentially a speculative process. In the main, the resources must be committed prior to receipt of the revenues which these resources hope to generate (Brophy and Shulman, 1993). Furthermore, costs and revenues are inevitably difficult to anticipate with any precision (Moore and Garnsey, 1993). R&D projects, broadly defined, '…typically require large fixed costs which are independent of the size of the market for the innovation' (Symeonidis, 1996, p. 17) and the 'assets' purchased are frequently idiosyncratic, with limited scrap or resale value (Baldwin et al., 2002; Tylecote, 1994). In other words, the costs incurred are sunk, committed prior to production, and largely orthogonal to the anticipated gross return from any successful innovation. In addition, firms must confront uncertainties relating to the levels of expected future cashflows and their ability to adequately appropriate returns (in the face of, for example, imitating competitors) (Seaton and Walker, 1997). Assuming that firms exploit innovations through their own output, this is particularly disadvantageous for small firms – in which the ability of gross rates of return (i.e. expected sales) to meet initial costs is often marginal at best (Cohen, 1995). Moreover, whilst '…large firms may diversify their innovative projects and obtain more stable cash flows' (Giudici and Paleari, 2000, p. 40), small firms are, more often, constrained to 'put all their eggs in one basket', developing single research projects that require considerable funding relative to turnover base. The consequence of the foregoing is a high degree of project risk, in the face of an uncertain return. Accordingly, '…there is bound to be some discrimination against investment in inventive and research activities' (Arrow, 1971, p. 153), and such discrimination may be most marked in the small firm sector.

In light of the foregoing, and drawing on a sample 256 small firms who applied for bank loans, the current paper is concerned with the extent to which 'innovative' firms are 'credit rationed', or credit constrained, relative to their less innovative peers. Or, to restate, the extent to which the most innovative small firms are likely to be less successful loan applicants.

Final version accepted on April 22, 2005

Mark Freel
School of Management
University of Ottowa
136 Jean-Jacques Lussier Street,
Ottowa, ON K1N 6N5,
Canada
E-mail: Freel@management.uottowa.ca

2. Background

It seems clear that, if finance is required (i.e. factors inputs must be paid for) in advance of receipt of revenues from the sale of project outcomes, '…then the growth of the project will always require funding from outside the project' (Brophy and Shulman, 1993, p. 65). In many

instances this will include investment of retained profits from other income streams – and there is substantial evidence that this is the preferred option of most firms (Guidici and Paleari, 2000; Oakey et al., 1988). However, on the simplest level, firm size is likely to mean, of itself, that internally generated funds, for the financing of an innovation project of a given size, will be less available in smaller firms than larger firms (Canepa and Stoneman, 2002). In the face of such internal cash constraints, firms must either abandon or reject the innovation project, or seek access to external finance. Indeed, the consistently high proportion of small firms reportedly employing, either solely or principally, internal funds for innovation may indicate a general aversion to high cost, high risk projects and, ultimately lost opportunities. In light of these observations, considerable academic and policy discussion has recently been concerned with understanding, evaluating and improving the external funding environment confronting small would-be innovators (in the UK, for example, see Bank of England, 1996, 2001; CBI, 1996; HM Treasury, 1998; Oakey, 1997).

A greater part of these discussions has revolved around the unsuitability of debt and the merits of equity (generally venture capital) as sources of external finance for small firm innovation – with equity invariably portrayed as patient and committed capital and, given the uncertainty and volatility of cashflows, debt as less likely to meet the peculiar needs of innovative firms. Indeed, there appears to exist (at least to the extent that such a thing may exist) a general consensus, both within and between the polity and the academy, with regards the inappropriateness of debt as a means of funding innovation. Nonetheless, irrespective of the details of this argument, empirical evidence suggests that very few small firms appear either willing or able to access sources of genuine risk capital. Such evidence (frequently investigating highly specific samples)[1] invariably reports fewer than 5% of firms accessing external equity (see, for example, Freel, 1999; Giudici and Paleari, 2000; Oakey et al., 1988). Moreover, there appears to be a clear preference hierarchy; running from self-financing, through short-term and long-term bank debt, with equity financing acting as funding of last resort. This is often termed the 'pecking-order hypothesis' (Myers, 1984), which '…occurs because external financing is costly, but also because firms often do not choose the optimal financing policy, but attempt to maintain the maximum level of autonomy versus banks and financial markets, adopting suboptimal choices' (Giudici and Paleari, 2000, p. 41). Recently, Giudici and Paleari (2000), for a sample of small Italian high technology firms, recorded a clear preference pecking-order; running from self-financing (including retained profits and internal equity), through short-term debt (bank overdrafts and trade credit) and long-term debt. These authors note that 'external equity is almost never issued' (p. 46). In sum, the key issue, irrespective of the relative merits of debt and equity, is that firms are generally shown to be more likely to borrow capital than sell equity at ratios of between five and ten to one.

3. Small firm innovation and credit rationing

General academic and policy discussions, with respect to the financing of small firms, have tended to concentrate on the firm's ability to access bank debt under conditions of inevitable asymmetric information; or, to rephrase, the extent to which small firms are debt, or credit, 'rationed' (Cressy, 1996). Whilst there is some ambivalence in the literature, on balance (at least within the UK) ''…the major empirical studies of…the small business loan finance market do not suggest the existence of either market failure or credit rationing on a major scale'' (Storey, 1994, p. 241). Notwithstanding this general observation, exceptions are commonly made with respect to technology intensive firms, specifically, (Westhead and Storey, 1997) and small innovative firms, more generally (Freel, 1999).

Classically, credit rationing is defined as '…the situation where some loan applicants are denied a loan *altogether*, despite (i) being willing to pay more than banks' quoted interest rates in order to obtain one, and (ii) being observationally indistinguishable from borrowers who do receive a loan' (Parker, 2002, p. 163). Keeton (1979) terms this 'Type II' credit rationing and,

in practice, it is difficult to establish. In contrast, the current paper is concerned with 'Type I' credit rationing – i.e. the case in which all or some firms receive a smaller loan than they would wish at the quoted interest rate. Thus, following Guiso (1998), I define a firm to be credit rationed if, at the prevailing rate of interest, it seeks to access a larger amount of credit, but cannot. In such circumstances, banks are literally rationing credit.

A number of reasons are commonly advanced to explain small firm disadvantages in loan markets. Principal amongst these is a presumed high level of risk due to; the higher relative probability of failure (Jensen and McGuckin, 1997), fixed costs in assessing applications for finance (Symeonidis, 1996), greater scope for information asymmetry and moral hazard (Ennew and Binks, 1995) and proportionately higher due diligence and monitoring costs (Boocock and Woods, 1997). Any concerns over excess risk are likely to be exacerbated when funding applications are based upon an intended innovation. This is related, at least in part, to the uncertain and intangible pay-backs (noted earlier) and an inability, on the part of funding providers, to adequately assess technological viability and related market potential (HM Treasury, 1998). Moreover, bank perceptions of risk are likely to be further aggravated by the inability to use [many of] the innovation 'assets' purchased to help collateralise the loan. Accordingly, one would anticipate that small firms investing in innovation would be more likely to be credit-constrained than similar firms undertaking investment in more traditional areas (Stiglitz, 1993). Such a finding would be consistent with previous research which reports a large proportion of small firms citing access to finance as a considerable barrier to innovation (see Hoffman et al., 1998). This then provides the central hypothesis of this paper: namely, that small innovators are more likely to be 'Type 1' credit rationed than are their less and non-innovative peers.

4. Data

The data presented represent a sub-set of a larger sample collected as part of a wide-ranging 'Survey of Enterprise in Northern Britain[2]' – i.e. those firms identified as having applied for bank debt during the period covered by the survey (1998–2001). This larger project drew heavily, in style and substance, upon the successful Cambridge studies (see SBRC, 1992, CBR, 1996, 1998, 2000, 2003) and, in common with the Cambridge studies, the sample frame used in constructing the database was the Dunn and Bradstreet UK Marketing Database (D&B). This database has its origins in the credit-rating business and, as such, it is likely that it over-represents expanding firms in search of finance. Moreover, the database is known to under-represent single person self-employed, sole proprietors and partnerships in comparison to the overall enterprise sector (Bullock and Hughes, 2000). Accordingly, one obvious consequence of using this database is the likely under-representation of the smallest firms, relative to the UK business stock. However, studies of firm-level innovation processes (such as the CIS), as a result of concerns over data adequacy, response-rates and issue relevance, invariably under-survey micro-firms. Whilst there is some evidence to counter these presuppositions (Cosh et al., 1998), custom and practice, and indeed commonsense, continues to underwrite their veracity. In the context of the current paper, the principal consequence of this skew is likely to be an over-estimate of population levels of innovation, R&D expenditure, employment of qualified scientists and engineers (QSEs), and so on. However, when this caveat is borne in mind (i.e. that the survey did not seek to represent, in any isomorphic manner, the notional population), then the legitimacy of the subsequent analyses should not be compromised.

Work on the original sample has given cause for confidence in its statistical reliability, though clearly, as with all survey work, there are likely to be unresolved issues arising from respondent and non-respondent bias (see Freel, 2003 for further details). The current subset represents approximately 19% of the original sample. As the proportion of the sample applying for bank debt, this is considerably less than *ex ante* expectations. Freel (1999), for instance, reports 25% of firms applying for bank debt specifically to fund innovation. With respect to non-specific

TABLE I
Descriptive statistics: firms applying for bank debt relative to original sample

	Firms used in current analysis (n = 256)		Original Sample (n = 1347)	
	Mean	SD	Mean	SD
Age (years)	25.04		25.98	33.18
Size (FTEs)	33.71		33.84	99.66
	Service	Manufacturing	Services	Manufacturing
Sector (%)	56.3	43.8	55.7	44.3

As a cursory glance at the data would suggest, none of the observed differences are statistically significant.

application for funding (as is the case here), a recent Cambridge report (CBR, 2000) notes over 80% of firm approaching banks for finance (though no distinction is made with between overdrafts and term-loans). However, questions relating to capital structure and financing were positioned towards the end of the [detailed] questionnaire and the level of non-responses were significantly higher than in other sections. Whilst the smaller than anticipated sub-sample is certainly disappointing, there is little reason to believe that it will invalidate the analyses presented below. Indeed, as Table I indicates, along the most easily identifiable characteristics, the sub-sample is remarkably consistent with its parent sample.

5. Methods

In investigating the extent to which small innovators are credit rationed, one is necessarily confronted with difficulties in operationalising 'innovation'. Perhaps disappointingly, there is no universally adopted measure of innovation (Cohen, 1995). Empirical studies tend to employ one of a variety of measures depending upon data availability or the specifics of the project. Accordingly, innovation is variously proxied by input measures (e.g. R&D or qualified scientists and engineers) and output measures (e.g. patents or new product/process introductions). Occasionally, often in instances where the innovation is itself the unit of analysis (e.g. classically project SAPPHO – SPRU, 1972), some account is taken of the technological or commercial significance of the innovation – though this is less common. Clearly, there is a distinct possibility that the extent of credit rationing may vary by measure of innovation, not least because they represent differing aspects of target and technological uncertainty. To this end, the current study benefits from the availability of a variety of innovation measures (Table II). In addition to standard input and output measures (including some consideration of the relative novelty of product and process innovations)[3], the current study has been able to proxy the 'innovation intensity' of sample firms (by measuring the proportions of turnover and profits that may be attributed to products and services

TABLE II
Measures of innovation and control variables

Innovation proxies	
QSEs	Proportion of staff who are qualified scientists, engineers or technologist
Product innovation	Two dummy variables representing 'novel' and 'incremental' product innovation
Process innovation	Two dummy variables representing 'novel' and 'incremental' process innovation
R&D Expenditure	R&D expenditure as a proportion of turnover. Series of four dummy variables. No R&D expenditure is the reference category
Innovation in turnover	Proportion of turnover from newly introduced ('last three years') products/process. Series of four dummy variables. 'None' is the reference category
Innovation in profits	Proportion of profits from newly introduced ('last three years') products/process. Series of four dummy variables. 'None' is the reference category

TABLE III
Descriptive statistics and ANOVAs – proportion of loan granted

	Descriptive statistics and ANOVAs				
Product innovation	$\bar{x}$	σ	N	F	df
None	51.91	40.28	65	1.266	(2, 236)
Incremental	60.46	40.86	54		
Novel	48.64	40.57	102		
Process innovation					
None	56.18	40.86	98	0.987	(2, 232)
Incremental	50.55	40.06	86		
Novel	47.22	41.67	37		
R&D expenditure as a proportion of turnover					
None	55.27	40.72	81	1.932	(4, 240)
1–5%	56.12	39.92	95		
6–10%	44.10	43.42	20		
11–20%	38.86	37.17	14		
20% +	33.36	41.74	11		
Proportion of turnover from new/improved products and processes					
None	62.27	41.70	30	3.944[a]	(4, 237)
1–5%	63.42	39.00	48		
6–10%	56.25	39.58	32		
11–20%	54.11	39.49	27		
20% +	40.80	39.87	84		
Proportion of profit from new/improved products and processes					
None	57.58	41.88	36	6.196 [a]	(4, 237)
1–5%	69.52	36.35	56		
6–10%	45.61	41.04	31		
11–20%	49.91	37.35	23		
20% +	40.96	40.19	75		

[a]Significant at 1% level.

introduced within the period covered by the study). These measures view innovation as a commercial endeavour rather than a purely technological endeavour (Love and Roper, 1999). In all instances, the dependent variable is the proportion of loan successfully applied for.

In the first instance, a series of simple bivariate test were undertaken. To this end, Table III details descriptive statistics (means and standard deviations) and ANOVAs for the measures of innovation available (excepting employment of QSEs)[4]. A cursory reading of the data on mean loan awards would tend to indicate a negative relationship between the degree of innovativeness and loan success. Intriguingly, the data relating to product innovation may suggest that 'a little innovation is a good thing' and we return to this later. However, only with respect to the two measures of 'innovation intensity' are these observations statistically significant. In terms of the bivariate analyses, whilst the data may be suggestive, there appears to be no robust relationship between the success of loan applications and the level and type of innovation output or R&D intensity. However, just as the observed negative associations between 'innovation intensity' and loan success may simply reflect the co-relation of these variables to a third (or more) unobserved variable, so might the absence of statistical relationships between our other innovation measures and loan success be rationalised with reference to missing variables. For instance, studies invariably report a positive relationship between firm size and access to bank credit and between firm size and R&D expenditure. We wish to know, for firms of a given size, how R&D expenditure impacts upon their ability to access credit. Accordingly, whilst the simple bivariate analysis reported has the benefit of clarity, a multivariate framework

TABLE IV
Control variables used in regression analyses

Variable	Description	Anticipated Effect
Age	Firm age in years	–
Size	Full-time-equivalent employees	+
Sector	Dummy variable: manufacturing = 1, services = 0	–
Turnover growth	Annualised rate of growth in sales turnover	–
Exporting	Proportion of sales sold in export markets	+

is more appropriately required to investigate the marginal or unique contribution, of our various innovation variables, to 'explaining' loan success/failure.

Moreover, one of the most intractable difficulties, in any investigation of credit rationing, relates to the idea that loan proposals are qualitatively homogeneous (Parker, 2002). Clearly, they are not. Rather, the dilemma revolves around the researcher's ability to control for those firm-level sources of heterogeneity which are most likely to impact upon the success of funding applications. Again, this is unlikely to be perfect[5]. However, the current study is able to control for a variety of factors which have been shown in the literature, with a degree of consistency, to influence the firm's ability to access credit. Table IV outlines these control variables and their *a priori* anticipated impact upon loan applications. Thus: (i) due to acknowledged 'liabilities of newness' (see classically Stinchcombe, 1965) younger firms[6] are less likely to successfully access credit than older firms; (ii) a lesser ability to collateralise loans and lower visibility (or 'information opaqueness') (Levenson and Willard, 2000), will result in smaller firms being disadvantaged relative to larger peers; (iii) problems of collateral are likely to be particularly acute in growth firms (Binks and Ennew, 1996), and growth firms are more likely to be credit constrained in consequence; (iv) higher relative borrowing requirements may lead manufacturing firms to encounter greater constraints than service firms (Westhead and Storey, 1997); (v) generally higher margins and more sophisticated management, may result in a positive relationship between exporting and loan application success. Certainly, a recent World Bank study, covering 10,000 firms in 80 countries (Beck et al. 2003), notes a positive relationship between exporting and access to bank finance[7].

Since loan application success is a truncated rather than continuous variable, the appropriate estimation technique is tobit, with lower and upper tail censoring at zero and 100. That is, firms may either receive all, none or some of the funds they seek. Tobit, in common with all varieties of multiple regression, is sensitive to high correlation among the independent variables. However various tests of multi-collinearity (using correlation matrices and estimating variation inflation factors[8] (Tabachnik and Fidell, 2001)) suggest little cause for concern (Table V). Unsurprisingly, there is a reasonably high degree of bivariate correlation between the various measures of innovation. Accordingly, following Westhead and Storey (1997), we estimate separate models for each of the innovation measures. Also in line with Westhead and Storey (1997), we estimate both full- (Table VI) and 'best fit' (Table VII) models. Reassuringly, all models are significant at the 1% level.

6. Results

Turning to results of the multiple regressions: the base model (Model 1), containing only the control variables, largely confirms our *a priori* expectations. In all instances, the sign on the β coefficient is as anticipated, and the observed associations are significant in the case of firm size, growth and exporting. In other words, larger firms and exporters appear more likely to have enjoyed loan application success, whilst faster growing firms are less likely to have been similarly successful. In the main these observations hold across the range of 'full' models – though, in the case of innovation intensity (Models 6 and 7) the negative association

TABLE V
Correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Age (years)											
2. Size (FTEs)	0.329[a]										
3. Sector	0.139[b]	0.419[a]									
4. Turnover growth	−0.054	−0.025	−0.018								
5. Exports	−0.013	0.144[b]	0.198[a]	0.037							
6. QSEs	−0.005	0.142[b]	−0.046	0.085	0.100						
7. Product innovation	0.057	0.252[a]	0.154[b]	−0.005	0.247[a]	0.192[a]					
8. Process innovation	0.075	0.101	0.234[a]	−0.115	0.100	0.009	0.116				
9. R&D expenditure	−0.065	0.146[b]	0.040	0.091	0.280[a]	0.201[a]	0.358[a]	0.155[b]			
10. Innovation in turnover	−0.037	0.150[b]	0.166[a]	0.145[b]	0.246[a]	0.150[b]	0.346[a]	0.128	0.336[a]		
11. Innovation in profits	0.018	0.079	0.091	0.098	0.173[a]	0.143[b]	0.278[a]	0.113	0.310[a]	0.853[a]	

[a]Significant at 1% level; [b]Significant at 5% level (2-tailed) – Pearson's *r* and Spearman's rho as applicable.

between firm age and loan application success is significant.

With regards to the relationships between innovativeness and loan application success, the models relating to standard input (QSEs and R&D) and output (new product and process introductions) – i.e. Models 2–5 – indicate tentative support for the implied hypothesis. That is, firms employing proportionately more QSEs, engaged in relatively more R&D, and introducing relatively 'novel' products or processes, appear likely to have been less successful in obtaining the desired amounts of bank credit. However, these observations are significant at the 10% level only[9]. Whilst suggestive, one must necessarily be cautious when interpreting these observations and assessing their implications. Moreover, in the 'best-fit' models (Table VII), the employment of QSEs or the presence and level of process innovation do not appear to be statistically significant predictors of loan application success. In the former case this may merely reflect the distance of the proxy from actual 'innovativeness' – in this study qualified scientists and engineers need not hold doctorates. In the latter instance, it may reflect the lower levels of uncertainty (at least from the lender's perspective) attendant upon process innovation. It seems reasonable to postulate that, in the main, there is a greater degree of risk attendant upon product innovation than upon process innovation. Product innovators are often involved in the development of new technologies and may be required to enter new markets or educate existing markets. Process innovators, by contrast are driven by cost minimisation and minor product differentiation (Adams, 1982). The greater assurance offered by continued sales of an essentially 'tried-and-tested' product has obvious ramifications for the risk profile of process innovators *vis á vis* their product innovating counterparts. This notion finds support in the results of the recent Cambridge study (CBR, 1998), which reported loan application failure rates of 13.5% for process innovators compared to 18.1% for product innovators. In contrast, the introduction of 'novel' products is significantly negatively associated with loan application success in both the 'full' and 'best-fit' models. A similar finding is noted with respect to relatively higher expenditure on R&D. That is, one may note with reasonable confidence, that R&D intensity is negatively associated with access to bank credit.

Finally, perhaps the most notable observations relate to the two measures of innovation-intensity identified – i.e. those which most clearly account for innovation as a commercial phenomenon. As Tables VI and VII (Models 6 and 7) indicate, highly innovation-intensive firms (in both turnover and profits) were significantly more likely to have been granted a smaller proportion of funds, than their less innovative counterparts. In other words, firms that draw upon new/improved products or processes for (in excess of 20% of) both sales

TABLE VI
Tobit models of loan application success

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Firm age (years)	−0.279 (−1.46)	−0.267 (−1.414)	−0.257 (−1.308)	−0.218 (−1.107)	−0.348 (−1.780) [c]	−0.363 (−1.768) [c]	−0.368 (−1.812) [c]
Firm size (FTEs)	0.217 (1.70)[c]	0.213 (1.842)[c]	0.214 (1.741)[c]	0.224 (1.767)[c]	0.304 (2.169)[b]	0.203 (1.536)	0.208 (1.543)
Sector	−9.407 (−0.72)	−14.309 (−1.088)	−4.072 (−0.306)	−6.891 (−0.501)	−13.420 (−1.017)	0.067 (0.005)	−2.972 (−0.225)
Turnover growth	−29.175 (−2.14)[b]	−25.637 (−1.978)[b]	−28.456 (−2.160)[b]	−32.039 (−2.257)[b]	−17.145 (−1.095)	−25.262 (−1.978)[b]	−30.060 (−2.191)[b]
Exports	0.561 (1.76)[c]	0.609 (1.909)[c]	0.733 (2.263)[b]	0.643 (2.011)[b]	0.663 (2.036)[b]	0.725 (2.223)[b]	0.706 (2.226)[b]
QSEs		−93.338 (−1.736)[c]					
Incremental products			9.495 (0.539)				
Novel products			−27.883 (−1.737)[c]				
Incremental processes				−0.682 (−0.048)			
Novel processes				−33.872 (−1.671)[c]			
R&D (1%–5%)					−3.832 (−0.268)		
R&D (6%–10%)					−27.834 (−1.247)		
R&D (11%–20%)					−52.759 (−1.948)[b]		
R&D (>20%)					−65.743 (−1.825)[c]		
Innovation in T/O (1%–5%)						2.882 (0.132)	
Innovation in T/O (6%–10%)						−22.166 (−0.919)	
Innovation in T/O (11%–20%)						−22.568 (−0.887)	
Innovation in T/O (>20%)						−51.616 (−2.466)[a]	
Innovation in π (1%–5%)							25.808 (1.283)
Innovation in π (6%–10%)							−30.823 (−1.356)
Innovation in π (11%–20%)							−23.845 (−0.954)
Innovation in π (>20%)							−43.931 (−2.286)[b]
Constant	64.273 (6.68)[a]	68.123 (6.964)[a]	66.424 (4.937)[a]	61.810 (5.492)[a]	73.575 (6.113)[a]	82.689 (4.609)[a]	75.601 (4.513)[a]
Left-censored	57	57	56	56	53	55	55
Uncensored	94	94	89	88	91	87	87
Right-censored	77	75	67	66	75	72	72
N	228	226	212	210	219	214	214
Log Likelihood	−669.294	−666.225	−627.241	−622.061	−641.810	−617.328	−613.590
LR χ^2	15.01[a]	16.68[a]	19.06[a]	16.21[a]	21.82[a]	26.00[a]	33.48[a]

[a]Significant at 1% level; [b]Significant at 5% level; [c]Significant at 10% level.

Statistics shown: Beta coefficients (and t-stats in parenthesis).

TABLE VII
'Best fit' Tobit models of loan application success

	Model 1*	Model 2*	Model 3*	Model 4*	Model 5*	Model 6*	Model 7*
Firm age (years)					−0.341 (−1.772)[c]		
Firm size (FTEs)					0.277 (2.196)[b]		
Turnover growth	−28.612 (−2.13)[b]	−28.239 (−2.121)[b]	−28.475 (−2.202)[b]	−28.438 (−2.116)[b]		−24.204 (−1.937)[b]	−26.621 (−2.041)[b]
Exports	0.696 (2.2)[b]	0.637 (2.012)[b]	0.835 (2.558)[a]	0.677 (2.139)[b]	0.606 (1.893)[c]	0.818 (2.515)[a]	0.814 (2.569)[a]
Novel products			−28.628 (−2.154)[b]				
R&D (11%–20%)					−54.084 (−2.170)[b]		
R&D (>20%)					−63.424 (−1.863)[c]		
Innovation in T/O (>20%)						−42.033 (−3.008)[a]	
Innovation in π (1%–5%)							43.557 (2.677)[a]
Innovation in π (>20%)							−25.212 (−1.697)[c]
Constant	59.274 (8.393)[a]	58.792 (8.379)[a]	67.254 (7.370)[a]	54.497 (7.545)[a]	61.730 (7.353)[a]	70.772 (8.335)[a]	53.027 (5.048)[a]
Left-censored	57	57	56	56	53	55	55
Uncensored	94	94	89	88	91	87	87
Right-censored	77	75	67	66	75	72	72
N	228	226	212	210	219	214	214
Log Likelihood	−671.859	−670.053	−629.644	−625.379	−643.898	−620.814	−617.155
LR χ^2	9.88[a]	9.02[a]	14.25[a]	9.58[a]	17.64[a]	19.03[a]	26.35[a]

[a]Significant at 1% level; [b]Significant at 5% level; [c]Significant at 10% level.

Statistics shown: Beta coefficients (and t-stats in parenthesis).

and profits appear to be discriminated against in standard loan markets. Intriguingly, the 'best-fit' model relating to the proportion of profits derived from new/improved products (Table VII, Model 7*), appears to hint that 'a little innovation may be a good thing' when applying for bank loans. That is, loan application success is positively associated with a contribution to profits, by new/improved products, of between 1% and 5%. It would appear that, whilst banks may consider that higher levels of innovation intensity negatively impacts upon the risk profile of small firms, a lack of innovative activity might also act as a poor signal.

7. Concluding remarks

The data presented seem to indicate, fairly unequivocally, an affirmative answer to the question posed in the paper's title. In other words, small innovators do appear to be credit rationed or, less contentiously, credit constrained relative to their less and non-innovative peers. Whilst one is necessarily cautious when interpreting the 10% significance levels observed for process innovation and the employment of qualified scientists and engineers, one may be correspondingly more confident when considering the results relating to product innovation, R&D expenditure and 'innovation intensity'. However, it is one thing to point to the existence of a 'problem'. Formulating solutions – or, indeed, agreeing upon the essential causes[10] – is likely to prove less straightforward.

Nonetheless, it is fairly common practice to paint banks as the villains of this piece. A recent UK Treasury report, for instance, noted that "…risks are often over-emphasised compared with the returns" and that "Loan finance is particularly hard to come by" (HM Treasury, 1998, p. 18). Giudici and Paleari (2000, p. 40) talk in terms of the 'poor ability to evaluate the business', on the part of banks, whilst the Bank of England (1996, 2001), itself, observed that capital market imperfection, arising from information asymmetries, may adversely affect both the quantity and price of debt and, consequently, the potential risks. Undoubtedly, however, the most frequent lament concerns the capital-based risk assessment methods, which prevail, and the attendant emphasis upon provision of collateral or security (Freel, 1999). Such standard approaches inevitably work against small firms generally, and small innovators particularly – given the limited scrap or resale value of many 'input' investments and the intrinsic uncertainty surrounding the intended 'outputs'.

Yet, to define the problem wholly, or even largely, in supply-side terms is, at best, naïve. Indeed, there is a growing body of literature which recognises the existence of *demand-side* financial constraints in small firms (see Cressy and Olofsson, 1997). However, by and large this has been concerned with the extent of 'control aversion' (i.e. the reluctance of entrepreneurs, even those wishing to grow, to sell equity). Debt aversion, on the other hand, is often simply inferred from the 'pecking-order', and the predominant use of internal funds. Whilst intuition and anecdote suggest that it exists, clearly establishing this empirically and better understanding its causes remains a challenge.

However, regardless of the extent of such demand-side considerations, one must recognise that banks are commercial endeavours whose remit involves maximising shareholder value. There is little or no evidence that bank assessment methods, and the resultant decisions, do not reflect rational and legitimate appraisals of the risk profile of innovative small firms. For a variety of reasons, it is widely acknowledged that innovative small firms represent a greater risk of loan default than their less innovative peers – and banks are only too aware that failure is endemic across the small firm sector. In situations marked by high levels of information asymmetry and limited security, one would anticipate that the rational lender would actively adversely select with a view to minimising the number of 'lemons'. Certainly, it is in no-one's interest to counsel banks to accept bad risks.

However, there is plainly a 'consensus of the literature that reliance upon market processes alone will result in underinvestment in research and development [broadly defined], from a social point of view' (Martin and Scott, 2000, p. 439). That is, a belief that the social rates of return to innovative activity often exceed the private (or market) rates. In such circumstances, public sector intervention may be a legitimate

means to achieve anticipated welfare gains. Moreover, since it is the relatively higher level of risk involved which leads to a less than optimal investment in innovation (Arrow, 1971), public policy ought to best be addressed at either altering the level of risk or, perhaps, the perceptions of risk[11]. On this latter point, there has been an increasing focus, at least within the UK, upon improving the 'investment readiness' of many small innovators (under the auspices of, for example, the Small Business Service's SMART scheme, United Kingdom Business Incubation and university technology transfer activity), though there is undoubtedly room to do more (Bank of England, 2001). However, these activities have been exclusively directed at *investment* readiness (i.e. equity) and not at *credit* readiness. Indeed, and given prevailing opinion this may not be surprising, many of the recent developments in the UK funding environment have been concerned with improving the flow of risk capital outside of formal institutional venture capital (e.g. Regional Venture Capital Funds, University Challenge Funds, and Business Angel Network development) (see Bank of England, 2004). This, of course, leads one back to the relative merits of debt and equity as sources of funding for innovation. Yet, irrespective of the nuances of this debate (and it is a great deal more nuanced than is often allowed), bank debt is, by some margin, the most common source of external funding, both for small firms generally and small innovators specifically. Accordingly, efforts to improve 'credit readiness' may prove fruitful.

With regards to the former issue (i.e. ameliorating risk), the obvious response would be to call for more grant funding. To this end, it is argued that grant schemes are 'perceived by the financial community to limit risk, as they provide support and an 'accreditation' of the technology involved' and are likely to improve gearing (CBI, 1996, p. 21). Moreover, Murray and Lott (1993) found that small firm loan applications were less likely to succeed unless the firm could point to success in securing some form of government-backed funding. However, a recent study of West Midlands manufacturers (Freel, 1999) noted in excess of 20% of firms accessing grant funding and wondered at the extent to which much more could be done (at least in terms of the volume of grant funding available). Grant funding is necessarily highly selective.

This then leaves one with the issue of ameliorating risk in debt contracts. To that end, any public sector intervention, whilst encouraging banks to take greater account of the non-financial characteristics of the owner manager and product market, should aim primarily at reducing both the perceived (discussed above) and the actual level of risk. On the latter issue a perfectly serviceable policy instrument may already exist in the form of the Small Firms Loan Guarantee Scheme (SFLGS). However, the SFLGS continues to suffer from poor take-up and marketing, and, in direct consequence of its own parameters, is inevitably viewed as funding (or, strictly speaking, funding guarantee) of last resort. For many would be innovators, the terms upon which SFLGS can be accessed (including a 2% per annum interest rate premium), may be considered sufficiently punitive as to alter adversely their assessment of the risk/return profile of the venture. One is prompted to ask whether there is a case for a targeted (and adequately marketed) variant of the Small Firm Loan Guarantee Scheme (SFLGS), which emphasises specific types of investment and offers terms to suit?

Acknowledgements

I am grateful for the particularly constructive comments of two anonymous referees. Nonetheless, the usual caveat remains.

Notes

[1] Often exclusively small technology-based firms.

[2] For the present purposes 'Northern Britain' encompasses Scotland and the Northern English countries of Northumberland, County Durham, Tyne and Wear, Teesside and Cumbria

[3] 'novel' innovators are those who had introduced at least one product/process *new to the industry* during the period 1998–2001; 'incremental' innovators are those who had introduced at least one product/process *new to the firm only* during the same period; and, non-innovators are those who introduced *no new products/processes*.

[4] A simple correlation test involving proportionate employment of QSEs and loan application success returns $r = -0.91$ ($P = 0.15$).

[5] Ideally, given its prominence in discussions of small firm–

bank relationships, some measure of the firm's ability to collateralise loans should be included in the models (perhaps proxied by the level of fixed assets). Similarly, one would expect current and expected cash-flows to impact upon the firm's ability to service a loan and, accordingly, loan application success (most commonly proxied by profitability). In the first instance, the data is simply, and regrettably, not available. In the latter, concerns over tax disincentives to declared profit and lower response rates conspire to make profits both unreliable and unworkable in the current study. Though these omissions are regrettable, the absence of proxies for either collateral or cash-flow does not render the subsequent analysis invalid.

[6] Increases in the supply of a firm's product often require outlays which are large in relation to its capital base (Binks, 1979).

[7] Though one may quibble about the arrow of causation, the cross-sectional association is clear.

[8] Bivariate collinearity can be determined from viewing a correlation matrix of the independent variables. In the current sample none of the non-innovation independent variables give cause for concern. However, correlation matrices will not reveal higher order collinearity. Accordingly, Variance Inflation Factors (VIFs) were computed. While there is no definitive threshold which determines multi-collinearity, a common rule-of-thumb holds that values in excess of four indicate problems. In all instances VIFs were less than 1.5 (where 1 indicates no collinearity).

[9] With the exception of R&D expenditure between 10–20% of sales turnover, which is significant at the 5% level.

[10] For instance, a reviewer offered an intriguing possible explanation for loan scaling (i.e. type I credit rationing): The correlation of innovativeness with loan scaling is simply due to the presence of optimism amongst the population of entrepreneurs. More optimistic entrepreneurs are more likely to present optimistic forecasts of future performance and are more likely to be scaled down by realistic (older) bank managers. Unfortunately, as the reviewer appreciates, without information on the proprietor *and* bank manager, this is difficult to test.

[11] Undoubtedly, there are a great many ways to mitigate risk which do not require direct intervention in financial markets (e.g. improving the education infrastructure, labour flexibility, taxation system, and so on). However, these are clearly beyond the scope of the current paper. Moreover, ameliorating risk is likely to involve, to a greater extent, transferring risk with the associated incentive problems (Arrow, 1971). The effect on incentives is not considered here.

References

Adams, A., 1982, Barriers to Product innovation in Small Firms: Policy Implications, *European Small Business Journal* **1**, 67–86.

Arrow, K., 1971, Economic Welfare and the Allocation of Resources for Invention, in K. Arrow (eds.), *Essays in the Theory of Risk-Bearing*, Chicago: Markham.

Baldwin J., G. Gellatly and V. Gaudreault, 2002, Financing innovation in new small firms: New evidence from Canada, 11F0019, No. 190, Micro-Economic Analysis Division, Statistics Canada.

Bank of England, 1996, *The Financing of Technology-Based Small Firms*, London, October.

Bank of England, 2001, *The Financing of Technology-Based Small Firms*, London, February.

Bank of England, 2004. *Finance for Small Firms – An Eleventh Report,* London, April.

Beck T., A. Demirgüç-Kunt and V. Maksimovic, 2003, Bank Competition, Financing Obstacles, and Access to Credit, World Bank Policy Research WP 2996.

Binks M., 1979, Finance for expansion in the small firm, *Lloyds Bank Review*, October.

Binks, M. R. and C. T. Ennew, 1996, Growing Firms and the Credit Constraints, *Small Business Economics* **8**, 17–25.

Boocock, G. and M. Woods, 1997, The evaluation criteria used by venture capitalists: evidence from a UK venture fund, *International Small Business Journal* **16**, 36–57.

Brophy, D. and J. Shulman, 1993, Financial Factors which Stimulate Innovation, *Entrepreneurship Theory and Practice* **17**, 61–75.

Bullock A. and A. Hughes, 2000, The Survey Method, the SME Panel Database and Sample Attrition, in CBR *British Enterprise in Transition*, ESCR Centre for Business Research, University of Cambridge.

Canepa A. and P. Stoneman, 2002, Financial constraints on innovation: A European cross country study, United Nations University, Institute for New Technologies, Maastricht, NL.

CBI, 1996. *Tech Stars: Breaking the growth barriers for technology-based SMEs*, London.

Centre for Business Research (CBR), 1996, *The Changing State of British Enterprise*, Department of Applied Economics, University of Cambridge.

Centre for Business Research (CBR), 1998, *Enterprise Britain*, Department of Applied Economics, University of Cambridge.

Centre for Business Research, 2000, *British Enterprise in Transition*, Department of Applied Economics, University of Cambridge.

Centre for Business Research (CBR), 2003, *Enterprise Challenged*, Department of Applied Economics, University of Cambridge.

Cohen, W., 1995, Empirical Studies of Innovative Activity, in P. Stoneman (eds.), *Handbook of the Economics of Innovation and Technological Change*, Oxford: Blackwell, 182–264.

Cosh A., A. Hughes and E. Wood, 1998, Innovation surveys and very small enterprises, WP89, Centre for Business Research, University of Cambridge.

Cressy, R., 1996, Are Business Startups Debt Rationed, *The Economic Journal* **106**, 1253–1270.

Cressy, R. and C. Olofsson, 1997, European SME Financing: An Overview, **9**, 87–86.

Ennew, C. and M. Binks, 1995, The Provision of Finance to Small Firms: Does the Banking Relationship Constrain Performance?, *Journal of Small Business Finance* **4**, 69–85.

Freel, M., 1999, The Financing of Small Firm Product Innovation in the UK, *Technovation* **19**, 707–719.

Freel, M., 2003, Sectoral Patterns of Small Firm Innovation, Networking, and Proximity, *Research Policy* **32**, 751–770.

Giudici, G. and S. Paleari, 2000, The Provision of Finance to Innovation: A Survey Conducted Among Italian Technology-based Small Firms, *Small Business Economics* **14**, 37–53.

Guiso, L., 1998, High-tech Firms and Credit Rationing, *Journal of Economic Behaviour and Organization* **35**, 39–59.

HM Treasury, 1998, *Financing of High Technology Businesses: A report to the Paymaster General*, London, November.

Hoffman, K., P. Milady, J. Bessant and L. Perren, 1998, Small firms, R&D, Technology and Innovation in the UK: A Literature Review, *Technovation* **18**, 39–55.

Jensen, J. B. and R. H. McGuckin, 1997, Firm Performance and Evolution: Empirical Regularities in the US Microdata, *Industrial and Corporate Change* **6**, 25–47.

Keeton, W., 1979, *Equilibrium Credit Rationing*, New York: Garland Publishing.

Levenson, A. R. and K. L. Willard, 2000, Do Firms Get the Financing They Want? Measuring Credit Rationing Experienced by Small Businesses in the U.S., *Small Business Economics* **14**, 83–94.

Love, B. and S. Roper, 1999, The Determinants of Innovation: R&D, Technology Transfer and Networking Effects, *Review of Industrial Organisation* **15**, 43–64.

Martin, S. and J. Scott, 2000, The Nature of Innovation Market Failure and the Design of Public Support for Private Innovation, *Research Policy* **29**, 437–448.

Moore, I. and E. Garnsey, 1993, Funding for Innovation in Small Firms: The Role of Government, *Research Policy* **22**, 507–519.

Murray, G. and J. Lott, 1993, Have UK Venture Capitalists a Bias against Investment in New Technology-based Firms?, *Research Policy* **24**, 283–299.

Myers, S. and N. Majluf, 1984, Corporate Financing and Investment Decisions when Firms have Information that Investors do not, *Journal of Financial Economics* **13**, 187–221.

Oakey R., 1997, *A Review of Policy and Practice Relating to High Technology Small Firms in the United Kingdom*, WP 359, MBS, University of Manchester.

Oakey R., R. Rothwell and S. Cooper, 1988, *Management of Innovation in High Technology Small Firms*, Pinter, London.

Parker, S., 2002, Do Banks Ration Credit to New Enterprises? And should Governments Intervene?, *Scottish Journal of Political Economy* **49**, 162–195.

SBRC, 1992. The State of British Enterprise, Department of Applied Economics, University of Cambridge.

Seaton, J. and I. Walker, 1997, The Pattern of R&D Finance for Small UK Companies, in R. Oakey and S.-M. Mukhtar (eds.), *New technology-based firms in the 1990s*, London: Paul Chapman, 71–91.

Stiglitz J., 1993. Endogenous growth and cycles, NBER WP 4286.

Stinchcombe, A. L., 1965, Social Structure and Organizations, in J. G. March (eds.), *Handbook of Organizations*, Chicago: Rand McNally & Company, 142–193.

Storey D., 1994. *Understanding the Small Business Sector*, London, Routledge.

Symeonidis G., 1996. *Innovation, Firm Size and Market Structure: Schumpeterian Hypotheses and Some New Themes*, Economics Dept. WP 161, OECD, Paris.

Tabachnik B. and L. Fidell, 2001. *Using multivariate statistics*, 4th ed., Pearson, Needham Heights, MA.

Tylecote, A., 1994, Financial Systems and Innovation, in M. Dodgson and R. Rothwell (eds.), *The Handbook of Industrial Innovation*, Cheltenham: Edward Elgar, 259–267.

Westhead, P. and D. Storey, 1997, Financial Constraints on the Growth of High-Technology Small Firms in the United Kingdom, *Applied Financial Economics* **7**, 197–201.