

Mature Micro-Firms and Their Experience of Funding Shortages

Gavin C. Reid*

ABSTRACT. Funding shortages are analysed in the context of a simple neoclassical model of the micro-firm that uses financial capital for its operations. It predicts that a response to funding shortages is to substitute part-time workers for full-time workers, under the assumption that the latter are the more financial capital intensive employees. The experience of funding gaps in finance capital by long-lived micro-firms is investigated using data which were obtained by telephone interviews. The micro-firms examined had an average size of six full-time and two part-time workers, and an average age of fifteen years. Using probit estimators of the probability of experiencing funding shortages it is found that a strong and significant negative association exists between the number of part-time workers and the probability of experiencing funding shortages, refuting the simple neoclassical hypothesis, and suggesting an alternative hypothesis, emphasising the flexibility advantages of part-time employees in averting funding shortages. A ten per cent increase in part-time employees is shown to reduce the probability of experiencing funding shortages by two and a half per cent. A regional effect was also discovered, and bivariate probits gave results which were consistent with univariate probits.

1. Introduction

The size distribution of firms is a reverse J-shape, implying not only that the small firm is the modal firm type, but also that the most populous category is the very small or micro-firm. The typical micro-firm examined in the literature (e.g. Mata, 1994; Storey, 1994, Ch. 3) is very young: at, or close to, financial inception. It might experience a variety of effects (e.g. very high growth, acute funding shortage) which are a consequence of its

relative youth as a firm. However, youth is only a temporary phase, and one expects a more standard neoclassical view of the micro-firm to be applicable when it becomes mature. Proportionately few micro-firms sustain early high growth rates, and those that survive typically remain small. Thus mature micro-firms are an important object of analysis. They are the focus of this paper.

A neoclassical view of the mature micro-firm is expounded in Section 2, extending the standard analysis to embrace the use of money capital within the enterprise, and to consider the implications of financial capital scarcity. The acquisition of primary source data to test these implications is discussed in Section 3, which shows how telephone interviews generated evidence on experience of funding shortages in long-lived (average age fifteen years) very small (average size six employees) enterprises. In section 4, these data are subject to empirical analysis using probit models to test the core predictions of Section 2, as well as a number of auxiliary hypotheses (e.g. on sectoral and regional effects). The main conclusions are summarised in Section 5, and emphasise the importance of part-time employees in averting funding shortages in mature micro-firms.

2. The funding constraint

The theoretical point of departure in this paper is a micro-firm which needs financial (i.e. money) capital for its operations (e.g. factor hiring, product sales), but may not always have enough of it fully to fund its operations. If it is subject to a financial capital constraint, the usual neoclassical optimal factor hiring conditions are modified: it is shown that the micro-firm will substitute the less financial capital intensive factor input for the more intensive. Thus if we focus on two factor

Final version accepted on June 28, 1995

*Centre for Research into Industry, Enterprise,
Finance and the Firm (CRIEFF),
Department of Economics,
University of St. Andrews,
St. Salvator's College,
St. Andrews, Fife KY16 9AL,
Scotland, U.K.*

inputs, full-time and part-time workers, and the second input is less financial capital intensive than the first, the effect of the funding constraint is to encourage the substitution of part-time for full-time workers. Further details on the hypothesis are developed in this section. Then the hypothesis is tested by probit models in Section 4, using new primary source data (Section 3).

To demonstrate the essential point of the argument, consider a neoclassical micro-firm which sells a single product (Q) at a given price (P) utilising two factor inputs: full-time workers (F) and part-time workers (T). These workers receive competitive wage rates of f and t respectively. The micro-firm's financial capital requirements depend positively on the volume of production (Q), and therefore sales (PQ), and on the level of hiring of factors F and T . To simplify, suppose financial capital requirements are: (a) proportional to factor hiring, being αF and βT for full-time and part-time workers respectively; and (b) increasing in sales, $g(Q)$, $g' > 0$. Consider $Q = h(F, T)$ as a smooth, concave neoclassical production function, and M , the finance capital available to the firm. Then (putting aside debt servicing, for simplicity) the quantity sold by the micro-firm, and the level of hiring of factor inputs F and T cannot make a greater call on financial capital than the amount available M . Thus the funding constraint is:

$$g[h(F, T)] + \alpha F + \beta T \leq M \quad (1)$$

If this constraint is not binding then, following Vickers (1987, Ch. 4) we would describe the micro-firm as being 'saturated' in financial capital, and the marginal product of financial capital would be zero. The usual marginal productivity conditions would hold, with the ratio of the marginal product of full-time labour to the marginal product of part-time labour being equal to the ratio of their respective wage rates:

$$(h_F/h_T)_u = f/t$$

where the subscript denotes 'unconstrained'.

However, if the constraint (1) is binding, then there is an impediment to the fulfilling of the condition (2). To simplify further, suppose that only the hired factors make a call on financial capital; then the micro-firm's maximand is the constrained profit function:

$$Ph(F, T) - fF - tT + \gamma(M - \alpha F - \beta T)$$

with Lagrange multiplier γ . This is maximised when:

$$(h_F/h_T)_c = (f + \gamma\alpha)/(t + \gamma\beta) \quad (3)$$

where the subscript c denotes 'constrained'.

When the funding constraint is binding, financial capital is a scarce resource to the micro-firm, and its implied marginal product is positive rather than zero. The implication of this for optimal factor hiring is given by comparing conditions (2) and (3). Clearly we have:

$$(h_F/h_T)_u < (h_F/h_T)_c \quad (4)$$

provided $(\alpha/f) > (\beta/t)$. This requires that the financial capital intensity of full-time workers (measured as the ratio of the full-time worker's financial capital requirement to its unit hiring cost) exceeds that for part-time workers. This implies a tendency, given smooth, convex isoquants $Q^1 = h^1(F, T)$, for part-time workers to be substituted for full-time workers in the financial capital constrained case.¹ That is, the micro-firm has a tendency to hire more of the less financial capital intensive factor input (here, part-time labour T) if it is financial capital constrained.

The dependent variable of the empirical probit analysis in Section 4 is defined by reference to the finance capital constraint (1) above. This dependent variable is unity if the equality holds in (1) and zero if the inequality holds. If the strict inequality is satisfied, the micro-firm has *not* experienced a funding shortage. If a funding shortage is experienced, then the argument attaching to the inequality (4) follows: for such firms, part-time workers will tend to be substituted for full-time workers. This is the key implication to be tested in Section 4. First, the data on which these tests are to be performed are described.

3. The data and the questionnaire

The data used for estimation were gathered by telephone interviews using a structured administered questionnaire schedule. The sample was drawn from the membership list of Scottish members of the Federation of Small Businesses (formerly the National Federation of the Self-Employed and Small Businesses).² There are 93

firms in the sample, which were chosen from a membership population of 3,584 small firms in Scotland. The method of stratified proportional random sampling was used, with the nine regions providing the strata.³ In terms of regional breakdown, the division between the Highlands and Islands (Region 1) (25%) and the rest (75%) is the main one of significance.⁴ The refusal rate for interviews was approximately 10%. This low figure can be attributed to the use of the Federation of Small Businesses as a "gatekeeper" to this population of micro-firms. Legitimising access in this way typically enhances response rates, and increases the quality and volume of data.

The sectoral representation of the sample was as follows: agriculture (2%), heavy manufacturing (3%), light manufacturing (20%), construction (12%), wholesale & retail distribution (32%), hotel & catering (9%), repairs, transport & storage (9%) and services (13%). Best represented were distribution, and hotel & catering. The full range of sectors by SIC codes was represented, with the highest proportion being in SIC category 6, which includes repairs, retailing, hotel & catering and garage services.

Telephone interviews of some twenty minute duration were conducted using an administered questionnaire.⁵ This investigated, with variable success, the existence (or not) of funding shortages, capital structure (including debt, equity, ownership and risk sharing), awareness and use of venture capital, and the likely benefit of new financial arrangements for small businesses (e.g. easier trade credit).

The key question posed to owner managers asked whether they had experienced a lack of funding in running their businesses. The evidence from the telephone interview is that a minority of micro-firms ($31\% \pm 10\%$) had experienced a lack of funding, although it was usually perceived not to be serious. In most cases (66%) this shortfall was met by a bank loan, typically of the order of £12,000. For the 69% of micro-firms which had not experienced lack of funding, the average number of full-time workers was (to the nearest integer) seven (with $\sigma = 10.1$) and the average number of part-time workers was three (with $\sigma = 5.6$). By contrast, for the 31% of micro-firms which *had* experienced lack of funding, the average number of full-time workers was five

($\sigma = 7.1$) and of part-time workers was one ($\sigma = 1.4$). This suggests that the micro-firms which did not experience funding shortage had a higher ratio of part-time to full-time workers. Putting the latter point more precisely, the average ratio of part-time to full-time workers for micro-firms which had not experienced lack of funding was 0.59566 ($\sigma = 0.80517$) and for those which *had* experienced funding shortage was 0.34124 ($\sigma = 0.61923$). Thus there appears to be almost twice the ratio of part-time to full-time workers for micro-firms which had not experienced lack of funding compared to those which had. A 90% confidence interval for the difference ($\pi_1 - \pi_2$) in this ratio of part-time to full-time workers, between the two types of micro-firms is $\text{Pr}(0.00065 < \pi_1 - \pi_2 < 0.58799) = 0.90$ which does not contain the origin, refuting the hypothesis that the ratios are identical. Taken overall, the simplest view of the evidence is therefore that it does not support the neoclassical prediction of Section 2 above. This proposition will be examined in more detail in the next section, using univariate and bivariate probit estimation.

4. Probit analysis

The goals of this section are: (a) to test the hypothesis suggested by the model of a financial capital constrained neoclassical micro-firm developed in Section 2; (b) to test auxiliary hypotheses on attitudinal variables and regional/sectoral effects; and (c) to test the robustness of the estimates found to be most satisfactory by embedding them in a bivariate probit model.

The question in the administered questionnaire which generated the dependent variable of the probit analysis was: 'Have you experienced a lack of funding in your business?' A response of 'Yes' was coded as unity ($y = 1$); and a response of 'No' as zero ($y = 0$). The y variable is given as *Fundlack* under I in Table I. The constraint (1) above suggests that sales, full-time and part-time workers should provide some explanation of the experience of funding shortage at the firm level, and these were prime candidates for inclusion in the x vector of a univariate probit model $y = x'\beta$. The variables used from the questionnaire, *Turnover*, *Fulltime* and *Parttime* respectively, are defined in Table I under II. The *Parttime* variable

TABLE I
Variables used in probit analysis

I	Fundlack	Unity for experience of lack of funding, zero otherwise
II	Age	Age in years from inception
	Fulltime	Number of full-time employees
	Parttime	Number of part-time employees (excluding seasonal and casual workers)
	Turnover	Annual sales turnover (including VAT) in £m.
III	Famsup	Unity if benefit from financial support from friends and relatives, zero otherwise
	Laxbank	Unity if benefit from more relaxed attitude to granting loans, zero otherwise
	Tradcred	Unity if benefit from more relaxed attitude to extending trade credit, zero otherwise
	Redbus	Unity if benefit from a reduced level of business rates, zero otherwise
	Hithresh	Unity if benefit from a higher threshold for VAT exemption, zero otherwise
	Redtax	Unity if benefit from a reduced level of corporation tax, zero otherwise
	Lowint	Unity if benefit from a reduced level of interest on bank loans, zero otherwise
	Reshed	Unity if benefit from rescheduling of debt, with no change in interest, zero otherwise
	Redint	Unity if benefit from reduction of interest on loan with no rescheduling, zero otherwise
IV	D1, D2...D8	Sectoral dummies, equal to unity if sector appears, zero otherwise
	D	Sectoral dummy, based on SIC coding equal to unity if SIC = 0 to 5, zero otherwise
	Highdum	Sectoral dummy equal to unity for Highlands, zero otherwise
V	Hearvc	Unity if heard of venture capital backing of a business
	Knowvc	Unity if understood venture capital

excluded seasonal and casual workers, thus reducing the measurement error and volatility of this variable, and allowing more systematic effects to show through. To check whether, even for mature micro-firms, life-cycle effects might yet play a prominent role in the experience of funding shortage, *Age* was included as another explanatory variable, being measured in years from financial inception of the micro-firm. The variables under II in Table I constitute the core set of explanatory variables in terms of conventional neoclassical hypotheses about the micro-firm.

Additional variables included in the univariate probit modelling are also listed in Table I, and they can be regarded as further control variables. They are basically of two types: attitudinal and technical. The attitudinal variables fall under headings III and V. Under III are listed a variety of measures which may benefit the micro-firm, and therefore which may play some role in ameliorating experience of funding shortage. For example those micro-firms who believe they might benefit from financial support from friends and relatives are more likely to report experience of funding shortage than those who do not. This attitude is measured by the variable *Famsup*, defined in Table I. Under V are listed two further attitudinal

variables, which are concerned with perception and knowledge of venture capital.⁶ Finally, under IV of Table I, three types of technical variables are used: firstly, dummy variables (D_i) for the full range of sectors represented in the sample; secondly, a service/non-service sector dummy (D); thirdly, a regional dummy (*Highdum*), this being relevant to regime differences between the Highlands & Islands and the rest of Scotland.

The first probit estimates reported upon are given in Table II.⁷ The key hypothesis is addressed by the inclusion of the full-time (F) and part-time (T) variables suggested by the constraint (1) in the model of Section 2 (now appearing in empirical estimates as the variables *Fulltime* and *Parttime*). The money finance constraint is further investigated with the (PQ) variable of Section 2 (appearing here as *Turnover*); and possible life-cycle dependency is captured by the *Age* variable. Coefficients, t-ratios, and Hencher-Johnson weighted elasticities are given in the table, as are relevant critical values. In this and subsequent Tables, C^2 denotes χ^2 divided by degrees of freedom. On a likelihood ratio test the model has a 5% probability level, and the Cragg-Uhler R^2 (0.34) is high for cross-sectional models of this sort. The percentage of correct predictions is also

TABLE II
Binary probit for full set of control variables with single sectoral dummy variable

Variable	Coefficient	t-Ratio	Weighted elasticity
Age	0.11627.10 ⁻²	0.72023.10 ⁻¹	0.14863.10 ⁻¹
Fulltime	-0.38573.10 ⁻¹	-1.3459	-0.17237
Parttime	-0.28245	-2.4998***	-0.25776
Turnover	1.4487	2.1194**	0.38162
Famsup	0.67545	1.6402*	0.10155
Laxbank	0.86761	2.1610**	0.55289
Tradcred	-0.68106	-1.8866*	-0.23444
Redbus	-0.13849	-0.25142	-0.10446
Hithresh	-0.71803.10 ⁻¹	-0.20310	-0.24472.10 ⁻¹
Redtax	-0.29928	-0.77198	-0.61974.10 ⁻¹
Lowint	0.56798	0.71591	0.47288
Reshed	0.36520	0.80431	0.20502
Redint	-0.91286.10 ⁻¹	-0.18307	-0.59033.10 ⁻¹
Hearvc	0.20875	0.38780	0.71447.10 ⁻¹
Knowvc	-0.46672	-0.77877	-0.11338
D	-0.11115	-0.27178	-0.27090.10 ⁻¹
Constant	-1.2070	-1.1928	-1.0583

Likelihood ratio test: Prob. value = 0.05 [$C^2 = 1.601 \approx C^2_{0.05}(16) = 1.64$].

Cragg-Uhler $R^2 = 0.33862$.

Log-likelihood = -44.905.

Binomial Estimate = 0.3118.

Sample size (n) = 93.

Percentage of Correct Predictions = 76%.

Critical t-values: $t_{0.01} = 1.289^{(*)}$, $t_{0.05} = 1.658^{(*)}$, $t_{0.025} = 1.980^{(**)}$, $t_{0.001} = 2.358^{(***)}$.

high, at 76%. On statistical criteria, therefore, the model is satisfactory. No age related effect is detected, arguing against a life-cycle dimension to experience of funding shortages by these mature enterprises. *Parttime* as a variable has a highly significant ($\alpha = 0.001$) coefficient with a negative sign, and a relatively high elasticity. This elasticity is unit free and a useful predictive tool. Specifically, a 10% increase in part-time employees within the micro-firm, *ceteris paribus*, is associated with a decrease in the probability of experiencing a funding shortage of 2.5%. This result rejects the prediction of Section 2, to the effect that the financial capital constrained micro-firms will have higher levels of part-time employees than finance saturated micro-firms.⁸ That prediction hinged on the presumed lower intensity of the finance capital requirement for part-time, compared to full-time, employees. That presumption is denied by the data. An alternative explanation would emphasise the flexibility which part-time employees offer to the owner-manager. It is easier to adjust part-time employees' hours,

compared to full-time employees' hours, in response to unexpected shocks. For many micro-firms, the wage bill is a principal cost driver.⁹ Fine tuning of this wage bill to lower the probability of experiencing a funding shortage can be achieved in a flexible fashion especially by varying that part of it which is attributable to part-time employees. The relative maturity of these micro-firms makes such adjustments possible over a considerable period of time.

Amongst the attitudinal variables three features are noteworthy. (a) The predisposition to want banks to be more liberal in their lending (*Laxbank*) is positively and significantly ($\alpha = 0.025$) associated with the experience of funding shortage. The desire to resolve a funding shortage through greater bank liberality is consistent with the pecking order theory of finance of Myers (1984), according to which, if a firm requires external finance, it will first start with debt finance. The *Laxbank* variable's weighted elasticity is the largest of all in the fourth column of Table II, suggesting the prominence of this form of outside

finance in the pecking order. (b) Less obvious in interpretation is the negative association, which is marginally significant ($\alpha = 0.05$), between the desire for a more permissive granting of trade credit (*Tradcred*) and the experience of funding shortage. It suggests marginal costs always exceed marginal benefit for this form of outside finance, with costs arising from loss of goodwill being particularly serious. (c) The desire for better family support for the business (*Famsup*) is associated positively, and marginally significantly ($\alpha = 0.01$), with experience of funding shortage, but the elasticity is small. In terms of pecking order one would expect this type of outside equity finance to be less desirable than additional debt finance, and hence to have a lesser quantitative significance for funding shortages. Taken as a group, attitudinal variables like *Laxbank* and *Famsup* suggest that micro-firms find financial slack desirable (e.g. in terms of unused debt capacity). All other attitudinal variables are insignificant in this probit model. The three main results on attitudinal variables imply that an extension of an overdraft facility from a bank, or (less so) an injection of funding by friends and/or family were regarded as sound methods of coping with funding shortages, whereas the extension of trade credit was viewed as unsound. This suggests that owner managers of micro-firms are relatively happy to negotiate extensions to overdraft facilities, which seems rational given the usual requirement for collateral; but that they do not regard trade credit as a substitute for other forms of finance. The problem with trade credit is that its terms are very much in a discretionary or 'grey' area. Failing to honour bills within conventional, but often not legally agreed, limits is very damaging to continued harmonious relations with micro-firms' suppliers. It puts at risk the 'customer goodwill' emphasised in the theory of the firm literature from Alfred Marshall through Philip Andrews to Brian Loasby [(cf. Reid (1987, Ch. 5)]. It seems that few owner-managers in the sample, when confronted with experience of funding shortage, appeared willing to run the risks, and to bear the costs, associated with prolonging, over time or in magnitude, trade credit. Familiarity with (*Hearvc*) and knowledge of (*Knowvc*) venture capital show no association with experience of funding shortage. Not a single firm in the sample

had gained access to venture capital. This form of equity typically comes bottom of the pecking order of outside finance. The dummy variable (*D*) for the manufactures/services dichotomy performs badly, indicating no significant difference in experience of funding shortages between these broad categories of activities for micro-firms. Of course, this does not rule out the possibility of more disaggregated sectoral effects on funding shortages.

This possibility, amongst others, is investigated in the probit model reported in Table III. None of the dummy variables ($D_1, D_2, \dots, D_8$), introduced to capture sectoral effects at the single digit SIC level,¹⁰ had a significant coefficient, and all the corresponding weighted elasticities were small. This amplifies the result of the single sectoral dummy variable in the probit of Table II. Taken together, the evidence does not support any sectoral effects for this sample of Scottish micro-firms. Given this, the view in certain policy quarters that manufacturing might require, or deserve, favoured treatment compared with services, seems unjustified so far as experience of a funding gap is concerned.

Considering the probit of Table III more generally, the main change in specification is the dropping of a large number of insignificant variables contained in the original specification of Table II. The general diagnostic results at the foot of Table III, as regards goodness of fit etc, are again satisfactory. Signs and significance of coefficients, and the relative sizes of weighted elasticities are qualitatively the same as in Table II. There is slightly stronger evidence in Table III of the general advantage of control of the wage bill in avoiding the strict equality version of (1) above (i.e. funding shortage). Having resolved the issue of sectoral effects (*viz.* there are none) and shown that major influences on experience of funding shortages are stable in their consequences between alternative specifications, a search for a more parsimonious probit model is indicated.

An example of such a 'lean' model is given in Table IV, where a probit for just three conventional economic variables and three attitudinal variables is reported. No sectoral effects are incorporated, in view of the results of Table II and 3. In this 'lean' model, all coefficients are significant, and none at less than the 5% level. On a likelihood

TABLE III
Binary probit with sub-set of control variables and full set of sectoral dummy variables

Variable	Coefficient	t-Ratio	Weighted elasticity
Fulltime	-0.44287.10 ⁻¹	-1.6940*	-0.19963
Parttime	-0.25350	-2.2395**	-0.24300
Turnover	1.4833	2.1701**	0.38256
Famsup	0.66952	1.6388*	0.10721
Laxbank	0.95655	2.4547***	0.62203
Tradcred	-0.56021	-1.6301*	-0.19273
D1	0.69793	0.62904	0.18224.10 ⁻¹
D2	-1.4964	-0.39398.10 ⁻¹	-0.32299.10 ⁻⁵
D3	0.51872	0.48850	0.13806.10 ⁻¹
D4	-0.52338.10 ⁻¹	-0.64322.10 ⁻¹	-0.30206.10 ⁻²
D5	0.19096	0.28882	0.24920.10 ⁻¹
D6	0.92465.10 ⁻¹	0.16514	0.41182.10 ⁻¹
D7	0.23177	0.24890	0.68884.10 ⁻²
D8	0.14738	0.21673	0.14223.10 ⁻¹
Constant	-1.0366	-1.7131*	-0.92583

Likelihood ratio test: Prob. value ≈ 0.05 [$C^2 = 1.68 \approx C^2_{0.05}(14) = 1.69$].

Cragg-Uhler $R^2 = 0.31468$.

Log-likelihood = -45.936.

Binomial Estimate = 0.3118.

Sample Size (n) = 93.

Percentage of Correct Predictions = 77%.

Critical t-values: $t_{0.01} = 1.289^{(*)}$, $t_{0.05} = 1.658^{(*)}$, $t_{0.025} = 1.980^{(**)}$, $t_{0.001} = 2.358^{(***)}$.

TABLE IV
Parsimonious binary probit

Variable	Coefficient	t-Ratio	Weighted elasticity
Fulltime	-0.04404	-1.7699*	-0.20323
Parttime	-0.25927	-2.4980***	-0.24970
Turnover	1.4489	2.2882**	0.38268
Famsup	0.65217	1.6678*	0.10458
Laxbank	0.93175	2.5826***	0.60705
Tradcred	-0.57061	-1.7572*	-0.19756
Constant	-0.87083	-2.3425**	-0.78508

Likelihood ratio test: Prob. value < 0.005 [$C^2 = 3.80 > C^2_{0.005}(6) = 3.09$].

Cragg-Uhler $R^2 = 0.30560$.

Log-likelihood = -46.321.

Binomial Estimate = 0.3118.

Sample Size (n) = 93.

Percentage of Correct Predictions = 74%.

Critical t-values: $t_{0.01} = 1.289^{(*)}$, $t_{0.05} = 1.658^{(*)}$, $t_{0.025} = 1.980^{(**)}$, $t_{0.001} = 2.358^{(***)}$.

ratio test, the model is significant at less than the 0.5% level, the percentage of correct predictions is 74% and the R^2 is high for cross-sectionally estimated models of this sort. No qualitative results are altered by going to this more parsimonious model, and even quantitative results (e.g. the weighted elasticities) are very similar. One can

therefore restate the claim with some confidence, using the weighted elasticity for the *Parttime* variable, that a 10% increase in part-time employees is associated, *ceteris paribus*, with a decrease in the probability of experiencing a funding shortage of 2.5%. Comparing the models of Table III and Table IV using a likelihood ratio

test one gets a χ^2 statistic of 0.761, which is very much less than the $\chi^2_{0.01}(8)$ critical value of 20.1 or even its 5% value of 15.5. That is, the data do not accept the extra restrictions imposed in the probit of Table III compared to Table IV. The parsimonious probit of Table IV is therefore preferred.

Finally, one is interested in the possibility of regional effects on funding shortages. Given the small size of some regional strata, it is not always easy to get strong estimates of regional effects, though there is some evidence that they do exist, to varying degrees. Given the new institutional arrangements for enterprise stimulation in Scotland, replacing the old planning institutions of the Scottish Development Agency (SDA) and the Highlands & Islands Development Board (HIDB), the most important regional distinction is between the Highlands & Islands and the rest of Scotland. To test for a regional effect along these lines, the probit in Table V has another variable added to it, compared to that of Table IV, namely a dummy variable (*Highdum*) to represent the effects of the Highlands compared to the rest of Scotland. The Highlands dummy is highly statistically significant, though it does not have as high an elasticity as most other significant control variables. It clearly suggests that micro-firms in the Highlands are significantly less likely to experience funding shortages than their Lowland (i.e. rest of Scotland) counterparts. Exploring this further, one finds that

15% (= 4/26) (p_1) of the small firms in the Highlands had experienced funding shortages compared to 37% (= 25/67) (p_2) in the Lowlands. Computing 95% confidence intervals for these proportions one finds they are, respectively, $(0.04 < \pi_1 < 0.34)$ and $(0.27 < \pi_2 < 0.50)$, which overlap very little. More precisely, a 95% confidence interval for the difference in proportions between the Highlands and the Lowlands is given by $(-0.40 < \pi_1 - \pi_2 < -0.04)$ which does not contain the origin, implying that this difference is statistically significant. Explanations of this effect would require a detailed independent study: the main purpose here is to establish that it exists. Whilst the most obvious explanation would tend to focus on differences in grant regimes between the regions, differences in entrepreneurial culture may also be important. The farming tradition is stronger in this area, which tends to foster an entrepreneurial attitude, and part-time working and multiple job holding are more common.

A likelihood ratio test for comparing the probits of Table IV and Table V produces a χ^2 statistic of 3.842 which is greater than the $\chi^2_{0.05}(1)$ significance point of 3.840, implying the data accept the additional Highland dummy variable restriction at a probability level of approximately 0.05. Thus the final preferred specification for this paper is the probit of Table V. Looking at all seven restrictions, this probit stands up well on the likelihood ratio test, having a very small probability of occurring

TABLE V
Parsimonious probit with Highlands dummy variable

Variable	Coefficient	t-Ratio	Weighted elasticity
Fulltime	-0.03726	-1.5095	-0.16653
Parttime	-0.27479	-2.6792***	-0.25697
Turnover	1.2233	1.9397*	0.31619
Famsup	0.58318	1.4363*	0.08381
Laxbank	0.77610	2.1812**	0.46799
Tradcred	-0.70409	-2.0712**	-0.23691
Highdum	-0.92564	-2.3671***	-0.16321
Constant	-0.41193	-1.0969	-0.35481

Likelihood ratio test: Prob. value < 0.005 [$C^2 = 3.80 > C^2_{0.005}(7) = 2.90$].

Cragg-Uhler $R^2 = 0.35016$.

Log-likelihood = -44.400.

Binomial Estimate = 0.3118.

Sample Size (n) = 93.

Percentage of Correct Predictions = 76%.

Critical t-values: $t_{0.01} = 1.289^{(*)}$, $t_{0.05} = 1.658^{(*)}$, $t_{0.025} = 1.980^{(**)}$, $t_{0.001} = 2.358^{(***)}$.

by chance (< 0.005). The fading from high significance of the full-time employees variable is not problematical, for it is consistent with the behaviour of this variable in a variety of alternative specifications. The upshot of all this detailed discussion of results is that one ends up with a parsimonious probit model which emphasises the importance of part-time workers and location in explaining the micro-firm's experience of funding shortages.

The probit analysis can be extended in a number of directions, of which the only one reported upon here, for the purpose of robustness testing, is the case of bivariate probits. This method has been previously used in biological and sociological contexts, but is also of interest to economists.¹¹ The economic focus of interest is still on explaining the lack of funding experienced by micro-firms, and the statistical focus is on the robustness of the probit results reported in Tables II to V. It will be noted from Table VI that the between equation error correlation (ρ) is positive and significant, confirming the value of this multivariate extension. In Table VI, the first of the pair of probits is based on that of Table IV, with even further simplification. Under bivariate estimation, the influence of part-time employees (*Parttime*) is again important, and consistent in its effect, further emphasising the robustness of this result.

TABLE VI
Bivariate probit model: full information maximum likelihood estimates

Model:		
Fundlack = F_1 (Parttime, Turnover, Tradcred)		
Laxbank = F_2 (Lowint, Tradcred)		
Variable	Coefficient	t-Ratio
Probit 1		
Parttime	-0.23028	-2.266**
Turnover	0.59373	1.447
Tradcred	-0.32895	-1.059
Constant	-0.23352	0.2432
Probit 2		
Lowint	1.4021	1.951*
Tradcred	0.64898	2.089**
Constant	-1.1256	-1.642*

$\rho = 0.3929$ (2.225)**.

Critical t-values: $t_{0.01} = 1.289^{(*)}$, $t_{0.05} = 1.658^{(*)}$, $t_{0.025} = 1.980^{(**)}$, $t_{0.001} = 2.358^{(***)}$.

The turnover and trade credit variables behave as before in a qualitative sense, but here their coefficients are no longer significant. The second probit is less familiar in conventional economic terms, and is influenced by sociological applications¹² which have used bivariate probits, in that all the variables are attitudinal. The t-ratios on the control variables all lie in critical regions. The second probit says that if you have the attitude that lower interest rates or easier trade credit would be good for your kind of micro-firm, you would tend to think that banks should adopt a more lenient attitude towards granting loans to customers who run such businesses. This empirical finding is not trivial, because one knows from earlier probits that the low interest and trade credit variables have opposite effects on the lack of funding. Banks are currently very sensitive to the views that their micro-firm customers take of the conduct of banking business,¹³ and the second probit gives some insight into what governs these attitudes.

5. Conclusion

The central hypothesis to be explored in this paper concerned the response of the neoclassical micro-firm, in terms of its factor hiring (especially of labour), when it is financial capital constrained. The principal conclusion of the paper is that:

- (a) Variation of part-time employees provided the most powerful leverage on the probability of experiencing a funding shortage. A ten per cent increase in part-time employees, other things being equal, lowers the probability of experiencing funding shortages by two and a half per cent. This refutes a simple neo-classical hypothesis of the financially constrained micro-firm, which suggests those firms which are financially constrained will favour hiring part-time employees. In fact, those firms which are *not* financially constrained favour part-time employees. This suggests a flexibility advantage of part-time employees which is successfully exploited by these mature micro-firms to avert funding shortages. A number of auxiliary hypotheses were also explored, leading to the following further conclusions.

- (b) High turnover firms are more prone to funding shortages than low turnover firms, suggesting that a reason for funding shortages could be over-trading.
- (c) Sectoral effects were found to have no bearing on funding shortages, arguing against any sector-specific form of positive discrimination on the policy front (e.g. special help for manufactures).
- (d) Regional differences in experience of funding shortages were detected. Specifically, by reference to current regional arrangements, small firms under Highland and Islands Enterprise experienced funding shortages significantly less often than those under Scottish Enterprise.
- (e) Owner-managers of small firms that had experienced funding shortages tended to think that their plights could be improved by more financial support from friends and family, and by a more permissive bank lending policy, but that they would only be worsened by an extension of trade credit.

Conclusion (b) refutes a neoclassical financial constrained hypothesis and suggests an alternative hypothesis, appealing to the flexibility of part-time employees in averting funding shortages. Conclusions (c) and (d) have significant policy implications for sectoral and regional selectivity, suggesting the relative efficacy of the latter. Conclusion (e) demonstrates the potential usefulness of attitudinal variables. Overall, it is hoped that these conclusions enrich the currently rather limited evidence on mature micro-firms.

Acknowledgements

This research has been supported by funding from the Centre for Financial Markets Research, University of Edinburgh and by the Esmée-Fairbairn Trust. Grateful acknowledgement is made to Margo Anderson for research assistance on the database and to Jonathan Seaton for estimation advice and an econometric audit of the results. Previous versions of this paper have been presented to audiences at the Scottish Economic Society Conference, University of Dundee, and the Industrial Economists Study Group Meeting at UMIST, Manchester. The author is grateful to

delegates for the lively and informative discussions which were generated, and the useful critical commentary which was received. He also acknowledges the detailed comments of two academic referees, and the advice of the commissioning editor, Zoltan Acs, which have led to significant modifications which have materially improved the paper. The author alone remains responsible for the views expressed herein, the conclusions reached, and any errors of omission or commission that may have been perpetrated.

Notes

* Professor in Economics and Director of the Centre for Research into Industry, Enterprise, Finance and the Firm (CRIEFF), University of St Andrews.

¹ Thus flexibility is assumed to be a capability of the micro-firm in the sense of its hiring policy. By exercising a flexible part-time hiring capability, the micro-firm can adapt to a constraint on financial capital. This notion of flexibility extends that of technological flexibility in the work of authors like Acs, Audretsch and Carlsson (1990).

² A detailed account of the database, covering sample design, instrumentation and summary statistics is available in Reid and Anderson (1992) so here the account will be very much abbreviated. Statistics were obtained from the Federation of Small Businesses' research office in Glasgow.

³ Highlands and Islands (25%), Grampian (13%), Tayside (5%), Central (3%), Fife (2%), Lothian (6%), Strathclyde (43%), Borders (1%), Dumfries and Galloway (3%).

⁴ The new enterprise arrangements put in place in Scotland since 1989 set up a distinct institutional arrangement for the Highlands and Islands to replace the old Highlands and Islands Development Board (HIDB). Elsewhere in Scotland another new system, Scottish Enterprise, replaced the old Scottish Development Agency (SDA). See *Towards Highlands and Islands Enterprise* (1989) and *Towards Scottish Enterprise* (1989) for further details. They each created a framework for local enterprise companies (LECs) being the focus of delivery for enterprise stimulating policies.

⁵ A description of the instrument and a reproduction of the full schedule is in Reid and Anderson (1992).

⁶ Which, in this case, is almost certainly likely to be of the 'business angel' or informal investor variety.

⁷ These and other estimates were obtained by the author using the Shazam 6.2 econometric software package. For the estimates reported, an iterative maximum likelihood procedure, based on the Davidson-Fletcher-Powell algorithm, was used, as implemented by coding due to John Cragg. For a tolerance of 0.001 convergence was usually achieved within five or so iterations. The results reported were subjected to independent audit, by Dr Jonathan Seaton, of the University of Loughborough, to whom I am grateful. He used the LIMDEP 6 econometric package, with coding due to W. H. Greene. There, the algorithm used is Newton-Raphson. Convergence was again rapid, though typically with a

somewhat larger number of iterations, and the final estimates obtained agreed with the earlier set to at least four digit accuracy.

⁸ This hypothesis can also be tested in ratio form. For example, if the parsimonious probit of Table IV below is re-estimated using the ratio of part-time to full-time employees (*Pfratio*), rather than the levels of both part-time and full-time employees, variables have similar effects on experience of lack of funding, but *Pfratio* has an asymptotic t-ratio of -1.5626 which is just marginally significant. Whilst this indeed suggests that the higher the ratio of part-time to full-time employees, the lower the probability of experiencing a funding shortage, the empirical case is more strongly made by the estimates reported in the main text.

⁹ There is ample qualitative evidence for this reported in Reid, Jacobsen and Anderson (1993, pp. 30, 46, 98, 105). The best quantitative estimate currently available (from a CRIEFF Leverhulme project on the life cycle effects in small firms) on wages as a cost driver for a similar sample of firms (though generally younger), is that wages are the principal cost driver (25%) followed by raw materials (18%), stocks (11%) and rents (11%).

¹⁰ Only eight dummy variables, rather than the usually required nine, were required to represent ten sectors because one sector was unrepresented in this sample (Sector 2: minerals extraction, chemical industry etc.)

¹¹ The method is due to Ashford and Sowden (1970) and a fairly full treatment of theory and extension is available in Amemiya (1985, Ch. 9). In the bivariate probits case, two latent dependent variables, which, because of threshold effects can be mapped into binary variables, are assumed to be distributed as the bivariate normal distribution with zero means, unit variances and correlation coefficient. The parameters of the probits may be jointly estimated by the method of maximum likelihood. The estimates of Table VI were obtained using the software package LIMDEP 6 referred to in footnote 7.

¹² Ashford and Sowden (1970) applied the model to breathlessness in coal miners, and Muthen (1979) to attitudes of parents towards their children. Greene (1984) gives a mixed sociological/economic example for illustrative purposes, which analyses voting decisions in a school tax referendum.

¹³ See article (p.17) in *The Scotsman* newspaper on 15th April 1992.

References

- Acs, Z. J., D. B. Audretsch and B. Carlsson, 1990, 'Flexibility, Plant Size and Industrial Restructuring', in Z. J. Acs and D. B. Audretsch (eds.), *The Economics of Small Firms: A European Challenge*, Dordrecht: Kluwer Academic Publishers, pp. 141-154.
- Amemiya, T., 1985, *Advanced Econometrics*, Oxford: Basil Blackwell.
- Ashford J. R. and R. R. Sowden, 1970, 'Multivariate Probit Analysis', *Biometrics* 26, 535-546.
- Greene, W. H., 1984, 'Estimation of the Correlation Coefficient in a Bivariate Probit Model Using the Method of Moments', *Economic Letters* 16, 285-291.
- Industry Department for Scotland, 1989, 'Towards Highlands and Islands Enterprise', Edinburgh: HMSO.
- Industry Department for Scotland, 1989, 'Towards Scottish Enterprise', Edinburgh: HMSO.
- Mata, J., 1994, Firm Growth During Infancy, *Small Business Economics* 6, 27-39.
- Muthen, B., 1979, 'A Structural Probit Model with Latent Variables', *Journal of the American Statistical Association* 74, 807-811.
- Myers, S. C., 1984, 'The Capital Structure Puzzle', *Journal of Finance* 39, 581-582.
- Reid, G. C., 1987, *Theories of Industrial Organization*, Oxford, U.K.: Basil Blackwell.
- Reid, G. C., L. R. Jacobsen and M. E. Anderson, 1993, *Profiles in Small Business: A Competitive Strategy Approach*, London: Routledge.
- Reid, G. C. & M. E. Anderson, 1992, 'A New Small Firms Database: Sample Design, Instrumentation and Summary Statistics', Department of Economics and CRIEFF Discussion Paper, University of St. Andrews.
- Storey, D. J., 1994, *Understanding the Small Business Sector*, London: Routledge.
- Vickers, D., 1987, *Money Capital in the Theory of the Firm*, Cambridge, U.K.: Cambridge University Press.

Copyright of Small Business Economics is the property of Kluwer Academic Publishing / Business and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.