



Access to finance for innovative SMEs since the financial crisis



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ABSTRACT

In the wake of the 2008 financial crisis, there has been increased focus on access to finance for small firms. Research from before the crisis suggested that it was harder for innovative firms to access finance. Yet no research has considered the differential effect of the crisis on innovative firms. This paper addresses this gap using a dataset of over 10,000 UK SME employers. We find that innovative firms are more likely to be turned down for finance than other firms, and this worsened significantly in the crisis. However, regressions controlling for a host of firm characteristics show that the worsening in general credit conditions has been more pronounced for non-innovative firms with the exception of absolute credit rationing which still remains more severe for innovative firms. The results suggest that there are two issues in the financial system. The first is a structural problem which restricts access to finance for innovative firms. The second is a cyclical problem has been caused by the financial crisis and has impacted relatively more severely on non-innovative firms.

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1. Introduction

The fallout from the 2008 financial crisis has focused attention on access to finance for small and medium sized enterprises (SMEs). The roots of the financial crisis lay in overvalued assets, mainly those backed by mortgages. As these assets began to lose value, it was unclear who owned them and so was exposed to the losses. Banks were unwilling to lend to each other, and restrictions in lending fed through into the wider economy: the 'credit crunch' (Cowling et al., 2012). Five years after the initial shock to the economy, bank lending had still not recovered—particularly for smaller firms. There is now a general consensus that this held back the economic recovery of many countries, including the United Kingdom (UK) (Filippetti and Archibugi, 2011).

However, while policymakers talk in general terms about enterprise and small firms, not all firms will drive the economic recovery. SMEs constitute almost 60 per cent of private sector employment

in the UK and are an important area of government policy (BIS, 2013a). However, the majority of SMEs create few jobs (Storey, 1994; Cowling et al., 2004) with only a small minority having a disproportionate impact on the national economy (Mason and Brown, 2013; Nightingale and Coad, 2014). In particular, innovative small firms – those introducing new products, processes or business models – are most likely to create new markets, achieve rapid growth, and help the economy recover. External finance may be particularly important for innovative small firms, as they can lack the internal resources to successfully commercialise innovations (Beck and Demirguc-Kunt, 2006; Schneider and Veugelers, 2010).

Yet it is innovative small firms which often find it the hardest to obtain finance (Freel, 2007; Schneider and Veugelers, 2010; Hutton and Lee, 2012; Mason, 2013; Mina et al., 2013). Innovative firms tend to have riskier business models, which are important to create new markets but are also difficult for banks to value. They are often more reliant on intangible assets, rather than physical property, but intangibles are difficult to value as they are context specific, and thus hard to use as collateral for lending. The evidence on this point is not conclusive, but some authors suggest that the most important firms for the economy often find it hardest to obtain finance (Freel, 2007).

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However, while there is good evidence of a general problem in access to finance in the economy, there is little evidence on how the credit crunch and its aftermath has impacted on access to finance for innovative small firms in particular. This led [Mina et al. \(2013: 26\)](#) to argue that the “specific short- term and long-term effects of the post-2007 financial crisis are an open question on which further research is much needed.” Studies have suggested innovation investments may have been reduced in this period. For example, [Paunov's \(2012\)](#) important study shows firms with significant public financial support were less likely to reduce their innovation investments during the crisis.

This paper investigates these issues using the UK Small Business Survey – a government survey of over 10,000 SME employers – in 2007/8, 2010 and 2012. This gives rich data on firm characteristics including innovation and applications for finance. It also provides sufficient sample size and comparability between years to allow us to investigate how financing for innovative firms changed in the crisis. We use a combination of simple quantitative analysis and econometric analysis to investigate the link between innovation and access to finance while controlling for both firm characteristics and likelihood of applying. We also draw out the policy implications of our research findings.

Our results suggest that innovative SMEs – those introducing entirely new products or processes – have a higher probability of applying for finance than other firms (higher demand), but that they are more likely to find it difficult to access finance (restricted supply). From our bivariate results, innovative firms who apply for finance are more likely to find it difficult to obtain. This absolute credit rationing effect has worsened significantly since the crisis. When controlling for the other characteristics of the firm and their likelihood of applying we find that whilst access to finance has worsened for innovative firms overall (in absolute terms), but that in relative terms the gap with non-innovative firms in credit access (quantity rationing) has generally closed. The one notable, and important, exception is for absolute credit rationing from all sources which has worsened in absolute and relative terms for innovative firms.

This suggests that there are two distinct effects operating. First, we find a significant structural issue in the UK financial system which means it is harder for innovative firms to access finance per se. Second, we find evidence of a cyclical issue caused by significant reductions in bank lending since the credit crunch. This cyclical problem has caused problems for all firms. The worsening absolute credit rationing problem for innovative firms is of concern. Thus, we have an interesting dual effect at work: less credit is available in general (quantity rationing), but even though there is a narrowing of the ‘gap’ between innovative and non-innovative firms, it remains the case that innovative firms still find it harder to access credit. Of even greater concern is that innovative firms are increasingly more likely to face absolute credit rationing in the market during and after financial crises.

This paper makes a number of contributions to the literature on access to finance for small innovative firms. It is the first to empirically consider how access to finance for innovative small firms has changed since the crisis. To date the majority of the finance-innovation literature has focused exclusively on Venture Capital and other equity instruments ([North et al., 2013](#)). Instead, we focus on more standard, but more widespread, forms of finance. We also extend the analysis beyond R&D intensive, high-technology industries ([Hall, 2002](#)). Moreover, our measure of innovation is more inclusive than that in other studies which have tended to focus on R&D activity.

The remainder of this paper is structured as follows. Section 2 considers the literature on access to finance for innovative firms. Section 3 describes the data, the Small Business Survey, and how we define access to finance and innovation. Section 4 presents

descriptive results and shows that innovative SMEs are more likely to apply for finance than other firms (higher loan demand), but find it harder to obtain (lower loan supply). Section 5 estimates a series of probit regression models, with Heckman selection effects, which investigate this further. Section 6 considers implications for research and government policy in this area.

2. Access to finance for innovative SMEs

Since the analysis of Schumpeter, finance has been seen as a vital part of innovation processes ([O'Sullivan, 2005](#); [Mazzucato, 2013](#)). Yet it is not always clear that innovative firms are able to access the finance they need. For some time, researchers have been concerned about the potential for structural problems in the UK financial system which make it harder for innovative firms to access the finance they need ([Freel, 2007](#)). In addition, the credit crunch of 2008 will have had a cyclical effect. Restrictions in credit will have worsened the availability of finance for all firms and may also have exacerbated problems for certain firms in particular, such as younger or smaller firms.

2.1. Structural problems in the supply of finance for innovative SMEs

There are three main reasons why there may be a structural problem of access to finance for innovative small firms. First, the returns to innovation may be uncertain and thus make innovation riskier to finance ([Hall, 2002](#); [Coad and Rao, 2008](#); [Mazzucato, 2013](#)). Only a fraction of firms tend to experience significant growth following investments in innovative activity, with many products failing to be successfully commercialised or simply failing in the marketplace. There is no guarantee that investments in research and development (R&D) activity will lead successfully to new products. Failure rates are often high, making innovation an inherently risky activity.

This problem of uncertainty may be particularly acute for small and medium sized enterprises (SMEs) who lack the scale to invest in multiple projects and so risk ‘putting all their eggs in one basket’ ([Freel, 2007: 23](#)). Past research has shown that the returns from innovation may be highly uneven, with a small number of innovative projects leading to significant gains but most yielding little ([Coad and Rao, 2008](#)). Large firms are able to field more diverse portfolios and, even if they have more failures, they are also more likely to achieve at least one highly profitable innovation.

Second, there may be information asymmetries making it harder for banks to value innovative investments ([O'Sullivan, 2005](#)). In part, this stems from the problems of uncertainty outlined above. But it might also be because innovative products are by definition new—they may require specialist valuation, such as that provided by a Venture Capitalist (VC). The skills needed to evaluate innovative investments may be different from those for other types of SME lending and investment and may be highly sector specific. As banks are less interested in the value of the business, compared to VCs or other outside investors, they are less likely to finance innovation as a key criterion in banks loan evaluation process is the judgement of ‘serviceability’, the ability of the stream of cash-flow generated by an investment to repay the capital and interest ([Mina et al., 2013](#)). One view is that these ‘information opaque’ SMEs require different sorts of lending focused on long-term relationships—although it may also make them more reliant on credit scoring technologies ([Berger and Udell, 2006](#)). Because the firm has more information on the potential success of innovations than the financier, in some cases the market for innovation finance can resemble [Akerlof's \(1970\)](#) ‘market for lemons’—a lack of information on which firms

are worth financing increases the cost of finance and reduces the probability of successful applications.

Third, new innovations may be highly context specific. Intangible capital produced as part of a research process may not be useful collateral outside the firm itself (Mina et al., 2013). For example, a new process innovation may apply only within the firm in which it operates. Overall, these reasons may make it harder for innovative small firms to access finance, or may mean banks provide finance at a higher cost (Hall, 2002; Hutton and Nightingale, 2011).

Several studies have found evidence for a structural problem in the supply of finance for innovative firms. Research has focused more on the ability of firms to access the finance they need to innovate. Canepa and Stoneman (2007) suggest that finance is more likely to be a factor hampering innovation for small firms and those in high technology sectors, a finding echoed by studies using different datasets (Czarnitzki, 2006). Freel (2007) shows that small firms which apply find it harder to successfully obtain loans than others, although his results are more conclusive for R&D intensive small firms than those which introduce 'novel' products and processes (a closer measure to that used in this paper).

A second study with a similar focus on access to finance is Mina et al. (2013), who study both UK and US firms in the period before the recession. Their results show a considerable degree of nuance, depending on the measure of innovation used. When using R&D intensity as a measure, they find that innovative firms are no more (or less) likely to obtain finance than other firms. Using other measures of innovation – whether firms introduce new products, processes or organisational innovation – they find that innovative firms are actually more likely to obtain finance than other firms in the United States, but not in the United Kingdom. Alongside this, a wider literature focusing on new technology based firms also suggest that financing can be a problem for this sub-set of innovative firms (Revest and Sapio, 2010).

2.2. Cyclical changes in access to finance

There is considerably less evidence on the existence of any cyclical effect, at least for innovative firms specifically. The Schumpeterian process of creative destruction will have two impacts (Archibugi et al., 2013a). In the first place, firms will replace older products, processes and services with newer and more efficient versions. Alongside this, weaker firms and those with less efficient business models will be forced to close. This dual process shows how recessions can contribute to technological progress, but this Schumpeterian theory also has implications for financing. In the downturn, firms will experience reduced demand for their products. In response, they will make investments in innovative products or services which they will expect to become commercially successful as the economy makes its cyclical recovery. Because of this, Schumpeterian theory (1939) makes an argument for counter-cyclical investment in innovation, with increased demand for finance in the downturn.

However, evidence suggests that investment in innovation is strongly pro-cyclical—the 'demand-pull' theory of innovative activity suggested by Schmooller (Kleinknecht and Verspagen, 1990; Filippetti and Archibugi, 2011). Rather than a Schumpeterian view of innovative firms seeking external finance as part of a wider system, under this view firms invest internal resources into innovative activities. Because reductions in demand will also impact on firm balance sheets, and so the availability of internal finance, recessions may limit their investments in innovation. A potential effect of this is that innovative firms are forced to increase their demand for external finance to ensure they can bring products to market and take advantage of a return to economic growth.

Since the financial crisis of 2008, lending to small firms declined significantly (Cowling et al., 2012; Armstrong et al., 2013; Mason,

2013). There were fewer lenders as foreign institutions left the market, while existing banks became more risk averse. The criteria lenders used for lending changed in this period: firm size and track records became particularly important determinants for lending, meaning that micro and young firms became restricted in their access to capital (Cowling et al., 2012). Considering the standard Dun & Bradstreet risk assessment measures used by banks, SMEs became riskier. Fraser (2009a: 6) notes that the share of firms considered to have a very high risk of going out of business in the subsequent year jumped from 4.4 per cent of businesses in 2004 to 21.7 per cent in 2008.

The most relevant study on the effect of the crisis is North et al. (2013) who consider finance gaps for technology based small firms (TBSFs) before and after the crisis, using a survey of 100 firms. They show that the availability of finance for these firms worsened considerably in the crisis. However, they focus on only a small sample of innovative firms and cannot compare their experience with the wider business population. No studies have considered whether this effect is more general, and whether the cyclical effect has impacted particularly on innovative firms.

In summary, research has suggested a number of theoretical reasons for a structural effect which would reduce the chances of innovative firms successfully applying for finance, and a number of studies have considered this issue empirically. There is less evidence, however, on any cyclical effect which would disproportionately effect finance for innovative firms in a recession. In the remainder of this paper we set out to investigate these issues.

3. Defining innovative SMEs and finance gaps

3.1. The Small Business Survey

Our data is the UK Small Business Survey, a government dataset of Small and Medium Sized Enterprises (SMEs). These firms are defined as those with fewer than 250 employees, although we exclude those without employees as these firms may face particular issues relating to finance¹. We use three waves of the data: 2007/8, 2010 and 2012. Note that firms sampled in the 2007/8 survey were surveyed before the financial crisis (Williams and Cowling, 2009).

The sample frame for the SBS is the Dun & Bradstreet database. The survey is conducted using Computer Assisted Telephone Interviewing (CATI) with interviewers asking to speak to owners, proprietors, managing directors or other 'senior decision makers'. The sample is stratified by nation, size and sector with some boosts (dealt with through weights, which are used by the UK Department for Business, Innovation and Skills to make findings representative of the general business stock). There is no resampling between waves and given the scale of the sample such resampling is unlikely to be a significant problem. Once ineligible firms are excluded from the sample, the response rate was just over 58 per cent in 2012, up from 52 per cent in 2010 (BIS, 2013b)².

The sample is divided into two sets: before the recession (2007/8) and after (2010 and 2012)³. To ensure that our statistics are comparable with published statistics we also only include firms which employ people ('SME Employers'). The final sample is 10,708 firms, considerably larger than other similar work.

¹ The survey was called the "Annual Small Business Survey" in 2007/8.

² Response rates are not available for the 2007/8 survey.

³ We do this for two reasons. First, to ensure clarity of interpretation between the pre- and post- recession results. Second, because small samples can lead to erratic results in probit models, we do it to ensure the results are robust.

Table 1
Descriptive results, sample sizes.

	Percentage of firms (weighted)	Number of firms (unweighted)		
		All	2007/8	2010/12
Innovators	11.3	1381	963	418
Non-innovators	88.7	9327	6388	2939
Total	100	10708	7351	3341

Source: Small Business Survey, 2007/8, 2010 and 2012. Weights applied.

3.2. Identifying innovative firms

Our measure of innovation is whether a firm has introduced a new product in the previous 12 months, where the innovation is new to the market not just new to the firm. This measure is relatively tightly defined, as it does not include firms who simply adopt new innovations from elsewhere. For example, a manufacturing firm which simply copies a product produced elsewhere will not be included in this measure—but one which develops an entirely new product will be. Table 1 gives details on the number of innovative firms by year. In total, 1381 of 10,708 firms are innovative (a weighted 11 per cent of the sample).

There are a number of strengths to this measure. First, it is an output measure of innovation, rather than an input. Because of this, it complements other research which tends to use R&D, an input measure. It is also similar to the measure of product or process innovation used by work such as Freel (2007) and Mina et al. (2013). Second, our measure is suitable for more mundane innovation in services alongside high-technology sectors. An alternative innovation measure would be patenting, but only 4 per cent of innovation active firms actually do this (Hall et al., 2013). Similarly, research and development (R&D) spending is likely to have a distinct sectoral bias. But our measure is also wide enough to include firms who introduce innovations which are not patented but which represent new products or services, or other 'soft' innovations. Finally, the measure seems to be a good predictor of subsequent growth.

As with all measures of innovation this has some limitations. First, it is not possible to account for the significance of new products—a significant new drug will seem the same as a more prosaic new product. In particular, we cannot tell the extent to which firms successfully commercialise the new innovations and their impact on subsequent business performance. To address this problem, we use a relatively tight definition of innovation (and one correlated with subsequent growth). Second, the results may be biased by sector. To address this problem we control for sector in our regressions. All measures of innovation, including R&D, will be biased towards particular sectors. Our measure is at least broadly applicable across the economy.

3.3. Identifying problems in accessing finance

We use four measures of both the incidence and severity of credit constraints (see Lee and Drever, 2014, for a similar application). In the SBS, firms are asked first whether they apply for finance: "Have you tried to obtain finance for your business in the past 12 months?" Firms which have applied for finance are then asked a second question, "Did you have difficulties obtaining this finance from the first source?"⁴ This gives three potential levels of difficulty for firms which have applied for finance:

- (1) Firms which had trouble getting finance from the first source they tried.
- (2) Firms which did not get all the finance they needed from the first source they tried.
- (3) Firms which did not manage to get any finance from the first source they tried.

These are not mutually exclusive, so firms which are in the final category will also be included in the previous two.

Measures (1)–(3) are useful as they give an indication of the difficulty firm's face in access to finance. These measures capture quantity rationing, not being able to access all the credit one sought, and also provides an indication of potential search costs as initial applications are refused and firms seeks alternative sources. However, some firms may go on to obtain finance from elsewhere so we supplement it with an additional variable:

- (4) Whether firms fail to obtain finance from any source.

This is the purest measure of difficulties in accessing finance. A key strength of this measure is that we identify problems faced in accessing finance of any source, and so include banks—commonly seen as the body least likely to appropriately provide finance for innovative firms (Freel, 2007). This captures absolute credit rationing.

3.4. Bivariate results: Access to finance

First, we consider simple bivariate relationships between innovation and problems accessing finance. Table 2 gives summary statistics for innovative SMEs and their ability to obtain finance. The first finding is that innovative firms are more likely to apply for external finance than other firms. Moreover, innovative firms sampled after the recession were slightly more likely to apply for finance than before the recession: 35 per cent applied in the latter period compared to 29 per cent beforehand. This reflects a general trend, with applications also slightly higher for non-innovative firms (from 23 to 25 per cent). Research suggests that riskier firms may be discouraged borrowers who do not apply for finance because they do not believe they can obtain it (Han et al., 2009). Overall, the results here suggest this innovative firms were not discouraged from applying for finance and are not consistent with the view that innovative firms are particularly likely to be discouraged.

However, while innovative firms are more likely to apply for finance they are also more likely to have trouble obtaining it—the share of innovative firms finding it hard to obtain finance has worsened since the crisis. In the period after the recession, 56 per cent of innovative firms who seek finance had trouble obtaining finance, compared to only 36 per cent beforehand—a jump of almost 20 percentage points. This highlights a significant problem faced by innovative firms since the crisis, with a steep increase in the share finding access to finance hard to obtain. The percentage of innovative firms who get no finance from any source has more than doubled. Before the recession, 14 per cent of innovative firms who sought finance were unable to obtain anything. Since the recession, this figure has reached 30 per cent. In simple regressions,

⁴ The SBS asks for finance from a number of sources, the most common being (in 2012): bank loans, overdrafts, grants and leasing and hire purchase. Specialist sources of finance such as Venture Capital are included, but these are only relevant to a small share of SMEs (around 1 per cent of those who apply for finance).

Table 2
Has access to finance worsened for innovative firms?

	Applied for finance (per cent)	Share of all firms which apply:			
		(1) Had trouble obtaining finance from first source	(2) Did not get all finance needed from first source	(3) Did not get any finance from first source	(4) Did not get any finance from any source
Innovator (2010/12)	34.8	55.8	39.1	32.2	29.6
Innovator (2007/08)	28.6	36.4	29.1	21.9	13.7
Non-innovator (2010/12)	25.2	49.2	37.5	30.6	22.5
Non-innovator (2007/08)	22.9	24.0	16.60	12.7	11.4
All firms (2010/12)	26.0	50.0	37.7	30.8	23.4
All firms (2007/8)	23.6	25.7	18.6	13.4	11.8
Total	24.2	33.0	24.1	19.0	15.1

Source: Small Business Survey, 2007/8, 2010 and 2012. Sample size 10,708. Weights applied.

this is statistically significant ($p = 0.001$). We can also see that since the crisis, almost all innovative firms that do fail to obtain finance from the first source do not subsequently obtain any finance from any other source either. This was not the case before the crisis, where 22 per cent did not get finance from the first source and 14 per cent did not get finance from any source⁵.

4. Innovative firms and the crisis

4.1. Empirical strategy

The results above may be driven by other firm characteristics, with innovative firms more likely to aim to grow or having other, different characteristics which are correlated with access to finance. To control for this, we estimate a series of probit regression models for whether firms have difficulty obtaining finance (see Fraser, 2009b; Mina et al., 2013; Lee and Drever, 2014 for similar applications). These take two forms: (1) probit regressions where the dependent variable is either application for finance or one of the measures access to finance discussed above, or the choice to apply, and (2) Heckman regressions which also consider success of application for finance but which also control for selection effects in the likelihood of firms to apply for finance. In addition, we include a set of independent variables which control for the other characteristics of the firm which may be associated with both applications for finance and the success of the applications.

4.2. Independent variables

We also include control variables for a set of these firm characteristics—firm size, age and sector, the gender, ethnicity and qualifications of the management, the number of directors and recent changes in firm turnover. While many of these controls are standard (see Armstrong et al., 2013) we include a fuller set of controls than in some other similar work, in part because otherwise our innovation measures may be correlated with omitted variables (Mina et al., 2013). In the following we justify our selection of control variables more closely.

First, firm size is likely to be important. Larger firms are seen as less risky and so preferred by lenders. Moreover, firm size will influence valuation costs, although it is not clear whether there will be economies of scale or whether increased complexity of larger firms will raise costs (Canton et al., 2012). We control for three size

categories: micro (1–9 employees) and small (10–49 employees), with large firms being the reference category (50+ employees)⁶.

Second, older firms will tend to have entrenched business models with a steady track record and reputation and so will be less risky. We control for this with three age categories—whether firms are aged 5–10 years or 11+ years. The reference category is less than five years. In the recession, older firms found it easier to access credit, although this was sometimes due to their larger size (Cowling et al., 2012).

Third, we control for a series of owner characteristics. Studies have suggested that gender discrimination is unlikely to be significant in access to finance, but that gender may be correlated to other factors – such as different working patterns or childcare responsibilities – which are associated with reduced access to finance (Carter and Rosa, 1998). Because of this, we expect the sign on this variable to be negative.

A number of studies have considered ethnic discrimination and whether ethnic run firms are more, or less, likely to obtain business finance (Fraser, 2009b). These have tended to suggest that ethnic discrimination is not a significant problem, at least when controlling for the characteristics of firms and entrepreneurs.

The qualifications of entrepreneurs will be important in determining their access to finance. Better qualified entrepreneurs may have their own financial resources, and this will change the type of finance they are applying for. They may be better able to present their case to banks, and have access to contacts who can help them do so. Yet it may be that qualified entrepreneurs are more ambitious when applying for finance, and so are more likely to be refused. Nevertheless, we expect a positive sign on this coefficient.

Additionally we control for the number of directors. We expect larger numbers of directors to be associated with greater success in accessing external finance, as it will provide access to better external connections and sources of knowledge.

We also control for the growth ambitions of the firm in this sample for two reasons. First, firms which aim to grow may need external funding to do so and so will be more likely to apply. Moreover, these firms will be applying for different sources of finance. However, it is unclear whether their applications are more or less likely to be successful, controlling for this.

We use two measures of firm finance. The first is whether a firms' turnover is increasing. If so, balance sheets are likely to be better and firms are more likely to be applying for growth capital. We expect this to be associated with greater likelihood of access to finance. Conversely, firms where the turnover is decreasing are

⁵ An important question is differences between the 2010 and 2012 samples. We conducted some exploratory analysis on this point and – while it seemed access to finance had become easier for innovative firms in this period, we found no statistically significant changes. This is an important question for future research on this topic.

⁶ An alternative would be to insert the variable as a continuous measure of total employment, however we prefer to include these dummy variables to account for potential non-linearities in the data. Estimating the regression using continuous data does not change the key results.

Table 3
Variable list and summary statistics.

Variable name	Description	Mean	Std. Dev.	Min	Max
Innovator	1 if firm has introduced an entirely new product or process in previous 12 months; 0 if not.	0.129	0.335	0	1
Post-recession	Firm is sampled in 2010 or 2012 (0 if 2007/8)	0.314	0.464	0	1
Micro (1–9)	Firm has between 1 and 9 employees	0.419	0.494	0	1
Small (10–49)	Firm has between 10 and 49 employees	0.395	0.488	0	1
Large (50+)	Firm has between 50 and 249 employees	0.186	0.389	0	1
Female led	Firm is majority led by women	0.123	0.329	0	1
Ethnic led	Firm is majority led by a person from a minority ethnic group	0.053	0.225	0	1
Qualified	Owner or manager has a formal qualification	0.770	0.421	0	1
No. of directors	Number of partners/directors in day to day control of the business	2.6	2.4	1	50
Aims to grow	Aims to grow the business	0.744	0.436	0	1
Turnover increasing	Turnover is increasing	0.452	0.498	0	1
Turnover decreasing	Turnover is decreasing	0.211	0.408	0	1
Age > 10	Firms is aged more than 10 years	0.420	0.494	0	1
Age 5–10	Firm is aged 5–9 years	0.395	0.488	0	1
Age < 5	Firm is younger than 5 years	0.186	0.389	0	1

A total of 10,724 observations. Summary statistics are unweighted.

likely to be have worse risk profiles and to be borrowing money for different uses, for example to support declining cash-flows.

Finally, we include 13 sector dummies. We expect sector to be a significant determinant of access to finance, in part because firms in different sectors will be seeking to access finance for different reasons. For example, manufacturing firms are likely to ask for more money than service firms because manufacturing is relatively capital intensive and scale of investments are typically larger.

Summary statistics for the sample are given in Table 3. Only around 13 per cent of the firms in the sample (a weighted 11.3 per cent) are innovators. Most firms were sampled before the recession, and while there is some bias towards micro firms (42 per cent) there are also a significant number of small (40 per cent) and medium sized firms (19 per cent). A small share of firms are majority run by women (12 per cent) and members of ethnic minorities (5 per cent). A large share have qualifications (77 per cent) and aim to grow (74 per cent). The average number of directors or partners is 2.6, and more firms report increasing (45 per cent) than decreasing turnover (21 per cent). The firms are generally relatively old, with 42 percentage being older than 10 years, 40 per cent being aged between 5 and 9 and a minority younger than 5 (19 per cent).

4.3. Basic results

Our basic results are given in Table 4, which present probit regressions where the dependent variable is whether firms have applied for finance (columns 1 and 2) or one of the four measures of difficulty in accessing finance (columns 3 to 10), and the independent variables are the set of controls outlined above.

Models one and two consider the likelihood of firms applying for finance. Compared to firms in the reference category, innovative firms are more likely to apply for finance than other firms. While the coefficient for the period after the recession is positive, it is not significant at standard levels. In column 2 we break the sample into the categories of innovative firms before and after the recession. While the coefficient on both variables is positive, it is not significant in either case. The magnitude of any effect seems to be slightly larger for innovators after the recession, however. Micro and small firms are more likely to apply than larger firms, as are qualified entrepreneurs, SMEs with more directors, those which

aim to grow and those which are either experiencing growth or decline.

Columns 3 to 10 give the results of regressions for the four measures of success in accessing finance. The results suggest that innovative firms are more likely to find it difficult to obtain finance than firms which do not innovate, even controlling for relevant factors such as size and sector. The coefficient on the 'innovator' variable is significant against each of the first three variables for trouble in accessing finance. We also find that they are more likely to face absolute credit rationing from all sources, although the coefficient is only significant at the 10 per cent significance level. Our results suggest that the inability to finance innovative firms appears to be a structural problem across the financial system.

Our evidence also shows that firms in 2010/12 are more likely to be turned down for credit than those in 2007/8. The coefficient for the '2010/12' dummy is significant in all models. Credit conditions have worsened in the period for all firms, even controlling for whether they are innovative or not, reflecting the cyclical impact of the crisis.

Models 4, 6, 8 and 10 include three dummy variables to consider in more detail the links between innovation and access to finance before and after the crisis (the reference category is non-innovators in 2007/8). They show that access to finance became worse for non-innovative firms: the coefficient is positive and significant for all models. However, the coefficient is largest for innovative firms in the latter period: it is significant and positive against all four measures of trouble accessing finance. But, whilst it is still the case in absolute terms that innovative firms are more likely to be rationed in the market, in relative terms this gap with non-innovative firms closes when considering our measures of quantity rationing. The notable exception to this general pattern is for absolute rationing from all sources. Before the financial crisis, innovative firms were not particularly likely to be unable to find finance from any source—since the crisis, they are much more likely to face absolute credit rationing.

The control variables yield further insights into the type of firms who have problem accessing finance. Size seemed only marginally important, with micro firms slightly more likely to report finding it difficult to access finance, albeit at only the 10 per cent significance level. There is also some limited evidence that female led firms find it harder—firms run by females are more likely to claim

Table 4
Probit regression results: Problems accessing finance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Applied for finance		Had trouble accessing finance from first source		Didn't get all finance needed from first source		Didn't get any finance from first source		Didn't get any finance from any source	
Innovator	0.125** (0.0605)		0.266*** (0.0785)		0.289*** (0.0870)		0.258*** (0.0947)		0.183* (0.0995)	
2010/12	0.0315 (0.0448)		0.357*** (0.0568)		0.354*** (0.0624)		0.374*** (0.0675)		0.254*** (0.0694)	
Non-innovator (2010/12)		−0.00171 (0.0511)		0.366*** (0.0608)		0.380*** (0.0671)		0.396*** (0.0726)		0.237*** (0.0750)
Innovator (2007/8)		0.112 (0.0710)		0.287*** (0.0948)		0.349*** (0.105)		0.311*** (0.115)		0.139 (0.126)
Innovator (2010/12)		0.154 (0.110)		0.589*** (0.134)		0.543*** (0.148)		0.552*** (0.158)		0.501*** (0.160)
Micro (1–9)	0.272*** (0.0375)	0.280*** (0.0366)	0.0818 (0.0505)	0.0822 (0.0505)	0.0797 (0.0556)	0.0808 (0.0556)	0.0238 (0.0609)	0.0250 (0.0609)	0.0842 (0.0639)	0.0836 (0.0640)
Small (10–49)	0.438*** (0.0508)	0.447*** (0.0502)	−0.0766 (0.0730)	−0.0757 (0.0731)	−0.0322 (0.0798)	−0.0287 (0.0799)	−0.0648 (0.0881)	−0.0617 (0.0881)	−0.102 (0.0989)	−0.104 (0.0992)
Female led	−0.0299 (0.0631)	−0.0375 (0.0619)	0.0668 (0.0817)	0.0663 (0.0817)	0.144* (0.0870)	0.142 (0.0869)	0.103 (0.0924)	0.102 (0.0923)	−0.00236 (0.101)	−0.00107 (0.101)
Ethnic led	−0.0244 (0.0810)	−0.0240 (0.0810)	0.117 (0.0973)	0.117 (0.0972)	0.162 (0.102)	0.160 (0.102)	0.110 (0.111)	0.107 (0.111)	0.0714 (0.115)	0.0725 (0.115)
Qualified	0.110** (0.0480)	0.113** (0.0479)	0.198*** (0.0698)	0.199*** (0.0698)	0.211*** (0.0796)	0.213*** (0.0795)	0.224** (0.0881)	0.225** (0.0881)	0.100 (0.0937)	0.0993 (0.0937)
Number of directors	0.0347*** (0.0115)	0.0366*** (0.0112)	0.0361*** (0.0139)	0.0360*** (0.0139)	0.0218* (0.0130)	0.0212 (0.0130)	0.0110 (0.0155)	0.0104 (0.0155)	0.0417** (0.0172)	0.0421** (0.0172)
Aims to grow	0.312*** (0.0477)	0.316*** (0.0475)	0.252*** (0.0667)	0.252*** (0.0667)	0.222*** (0.0730)	0.223*** (0.0730)	0.237*** (0.0794)	0.237*** (0.0795)	0.272*** (0.0847)	0.272*** (0.0847)
Turnover increasing	0.0838* (0.0468)	0.0862* (0.0467)	−0.0239 (0.0656)	−0.0241 (0.0656)	0.00876 (0.219)	−0.102 (0.0728)	−0.0458 (0.0807)	−0.0461 (0.0809)	−0.149* (0.0845)	−0.148* (0.0845)
Turnover decreasing	0.142*** (0.0544)	0.143*** (0.0541)	0.283*** (0.0702)	0.283*** (0.0702)	0.304*** (0.0762)	0.305*** (0.0761)	0.377*** (0.0825)	0.376*** (0.0824)	0.272*** (0.0874)	0.273*** (0.0873)
Age 10+	−1.094*** (0.108)	−0.653*** (0.141)	−1.866*** (0.150)	−1.765*** (0.188)	−2.007*** (0.222)	−2.017*** (0.222)	−2.364*** (0.266)	−2.372*** (0.265)	−2.187*** (0.244)	−2.182*** (0.244)
Age 5–9	−0.194*** (0.0507)	0.0187 (0.0780)	−0.266*** (0.0670)	−0.293*** (0.0926)	−0.0488 (0.108)	−0.0497 (0.108)	0.0756 (0.120)	0.0750 (0.120)	0.0212 (0.128)	0.0223 (0.128)
Obs	10,560	10,560	10,476	10,476	10,476	10,476	10,476	10,476	10,497	10,497
Pseudo R ²	0.0397	0.0397	0.0638	0.0638	0.0718	0.0723	0.0745	0.0749	0.0612	0.0614

Probit model estimated with standard errors 13 sector dummies included. Age = less than 5 years and ACT = agriculture, hunting and forestry. For innovator/year variables, reference category = non-innovator, 2007/8. Weights applied. Regressions 1 and 2 also include variables for legal status.

Significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 5
 Probit regression results, with Heckman selection: access to finance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Had trouble accessing finance from first source		Didn't get all finance needed from first source		Didn't get any finance from first source		Didn't get any finance from any source	
Innovator	0.305*** (0.101)		0.317*** (0.107)		0.276** (0.116)		0.174* (0.0980)	
2010/12	0.579*** (0.137)		0.502*** (0.108)		0.523*** (0.113)		0.275*** (0.0698)	
Non-innovator (2010/12)		0.588*** (0.146)		0.525*** (0.128)		0.550*** (0.130)		0.253*** (0.0759)
Innovator (2007/8)		0.321*** (0.123)		0.381*** (0.128)		0.340** (0.139)		0.122 (0.127)
Innovator (2010/12)		0.857*** (0.202)		0.699*** (0.200)		0.697*** (0.206)		0.525*** (0.160)
Micro (1–9)	–0.0576 (0.136)	–0.0588 (0.139)	–0.0204 (0.106)	–0.0110 (0.115)	–0.0976 (0.134)	–0.0930 (0.142)	0.0820 (0.0635)	0.0808 (0.0637)
Small (10–49)	–0.321 (0.237)	–0.323 (0.243)	–0.191 (0.169)	–0.170 (0.185)	–0.243 (0.208)	–0.232 (0.221)	–0.104 (0.0975)	–0.108 (0.0980)
Female led	0.133 (0.120)	0.133 (0.120)	0.215* (0.127)	0.210 (0.129)	0.157 (0.129)	0.156 (0.130)	–0.0171 (0.104)	–0.0177 (0.105)
Ethnic led	0.197 (0.135)	0.197 (0.135)	0.240* (0.139)	0.233* (0.138)	0.170 (0.151)	0.165 (0.150)	0.108 (0.116)	0.108 (0.117)
Qualified	0.205** (0.0911)	0.204** (0.0913)	0.207** (0.0987)	0.204** (0.0972)	0.224** (0.112)	0.222** (0.112)	0.0788 (0.0957)	0.0809 (0.0961)
Number of directors	0.0398** (0.0190)	0.0396** (0.0192)	0.0205 (0.0179)	0.0209 (0.0180)	0.00129 (0.0227)	0.00109 (0.0231)	0.0494*** (0.0182)	0.0497*** (0.0181)
Aims to grow	0.183 (0.120)	0.182 (0.123)	0.160 (0.101)	0.168* (0.102)	0.163 (0.122)	0.167 (0.125)	0.277*** (0.0862)	0.275*** (0.0864)
Turnover increasing	–0.0890 (0.0995)	–0.0898 (0.101)	–0.171* (0.101)	–0.165 (0.105)	–0.0954 (0.113)	–0.0938 (0.116)	–0.150* (0.0854)	–0.148* (0.0854)
Turnover decreasing	0.347*** (0.0954)	0.346*** (0.0955)	0.351*** (0.0976)	0.344*** (0.0972)	0.459*** (0.106)	0.454*** (0.106)	0.268*** (0.0874)	0.271*** (0.0873)
Age 10+	–0.299** (0.125)	–0.299** (0.125)	–0.329** (0.126)	–0.328*** (0.125)	–0.206 (0.143)	–0.208 (0.142)	–0.223* (0.117)	–0.222* (0.117)
Age 5–9	–0.0513 (0.137)	–0.0517 (0.137)	–0.0805 (0.138)	–0.0772 (0.137)	0.0956 (0.154)	0.0956 (0.153)	0.0226 (0.131)	0.0217 (0.131)
Constant	–1.666*** (0.438)	–1.665*** (0.450)	–1.956*** (0.343)	–1.992*** (0.342)	–2.337*** (0.430)	–2.361*** (0.435)	–2.234*** (0.249)	–2.225*** (0.249)
Log-likelihood	–2169.884 2177.813		–2116.568		–2069.881		–2044.676	
Obs: first stage	10,454		10,454		10,454		10,490	
Obs: second stage	3146		3146		3146		3182	

Probit Heckman selection model estimated with robust standard errors. All regressions include 13 sector dummies. Selection variables: legal structure and region. Reference categories for age = less than 5 years, for size = medium (50–249 employees). For innovator/year variables, reference category = non-innovator, 2007/8. Weights applied.

Significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

they do not get all the finance needed, although the coefficient is only significant at the 10 per cent significance level. The results also support other work which, controlling for selection, finds little evidence for ethnic discrimination (Fraser, 2009b). Similarly, firms which have qualified owners, more directors or aim to grow are more likely to find it hard to apply for finance in various ways. Each of these results is surprising, and so suggests that selection may be an issue and that these firms may be more likely to apply for finance. Less surprisingly, firms which are experiencing declines in their turnover tend to find it harder to access finance across all four measures of difficulty. Finally, we find evidence that age matters and younger firms find it harder to access finance.

4.4. Results with Heckman selection

One potential issue with the results of Table 4 is selection bias, as firms with certain characteristics are more likely to apply for finance than others and firms which do not apply for finance cannot be refused. To deal with this, we use a Heckman selection model to correct for the probability of firms applying for finance (see Mina et al., 2013 for a similar application). This essentially estimates two models. The first estimates the probability of a firm applying for finance, based on observable characteristics. The estimated probability of applying is then used to 'correct' the second model which estimates whether a firm finds it hard to obtain the finance they seek. Table 5 presents the results. Note that we do not report the first stage regressions as these are very similar to the 'applied for finance' regressions in Table 4 (columns 1 and 2).

The results controlling for selection support our core result: even controlling for selection effects, innovative firms are more likely than others to find it difficult to access finance. The coefficient is positive and statistically significant in almost every case. We also find that, even controlling for likelihood of applying, firms in 2010/2012 are significantly more likely to find it difficult to access finance. As other research has suggested, it has become significantly more difficult for firms to access finance than before the recession (Cowling et al., 2012)⁷.

However, we find less evidence that it has become relatively harder for innovative firms specifically. In fact there is a general narrowing of the relative gap between innovative and non-innovative firms, with one notable exception. It is still true that innovative firms are more likely in all periods to face absolute credit rationing from all sources and importantly that this effect is exacerbated in periods of crisis. This suggests that the value of additional search, which imposes a cost to the firm, is lower for innovative firms than their non-innovative peers. The increased likelihood of innovative firms being turned down for finance since the crisis which was documented above is due to a general worsening of credit conditions and the characteristics of innovative firms, rather than their innovative nature per se except for absolute rationing from all sources⁸.

The results controlling for selection reveal a number of potential factors. Firms which aim to grow are particularly likely to come

⁷ A referee notes an alternative explanation: a significant reduction in the quality of SMEs since the crisis. While this may be a possibility, given the weak labour market experienced in this period and the increases in self-employment the UK experienced, it is unlikely to account for the scale of the change we identify. Moreover, it is possible that average firm quality actually increased as firms with weaker business models closed during the recessionary period.

⁸ A reviewer suggests running regression with differential year samples. While the smaller sample size makes the results less robust the results of this approach seem to confirm the results here. When controlling for sample selection and considering the basic measure of problems accessing finance, the coefficient for innovative firms is statistically significant in the earlier but not the later sample (although $p = 0.105$). The coefficient is significantly smaller in magnitude (0.22 compared to 0.31). This suggests than an interpretation that there has been a convergence of difficulties in accessing finance is correct.

Table 6
Credit scores—innovative and non-innovative SMEs.

Credit risk	Share of firms in each category:		
	Non-innovator	Innovator	All
1—Minimal	20.3	21.6	20.4
2—Low	32.3	27.3	31.9
3—Average	35.5	41.1	35.9
4—Above average	11.9	10.0	11.8
Total	100	100	100

Source: Small Business Survey 2012. Sample size: 2276. Weights applied.

away with no finance, perhaps reflecting a more ambitious outlook which means they are asking for larger amounts of finance. Once we control for selection and the increased likelihood of larger firms applying for finance, size does not matter. There is some evidence that both female led and ethnic led firms are more likely to not get all the finance needed. Firms with more directors are more likely to have trouble accessing finance, and are particularly likely to fail to get finance from any source. Again, this may reflect the finance they apply for, with multiple directors leading to more ambitious applications.

As expected, firm performance, captured by sales change, is important. Firms with reduced turnover are more likely to find it difficult to access finance—a result common across all measures. Older firms were also more likely to find it difficult to get finance, but not necessarily to come away with nothing, an indication of quantity rationing.

4.5. Credit scores and access to finance

One important issue for the interpretation of our results is that we do not have an objective measure of the 'quality' of the firm and nor do we have full credit details of the firm. It might be, for example, that innovative firms have worse credit scores and a lack of supply of external finance results from this, not their innovativeness per se. Unfortunately, the early versions of the SBS do not have a credit score variable which means we are unable to compare credit scores before and after the recession. However, the 2012 survey does come linked to credit scores which allows us to test for these effects. These credit scores are calculated by Dun & Bradstreet using data on the individual firm, including their past credit history, legal judgements and the profile of their directors. These are very similar to the actual credit scores which would be used by banks to evaluate any loans. Table 6 presents the distribution of these credit scores.

Overall the results suggest there is little difference in the credit scores of innovative firms compared to the general SME population. Innovative firms are slightly more likely to be in the 'average' credit rating compared to other firms (41 per cent against 36 per cent). And they are slightly less likely to be in the 'low' credit risk' (27 per cent against 32 per cent). These differences are not statistically significant against standard metrics. In short, any difficulties in access to finance faced by innovative firms do not appear to be caused by their objective risk criteria.

5. Conclusions and policy implications

In the wake of a major financial crisis, there are concerns that access to finance is an increasingly significant barrier to business growth. This is particularly problematic if it prevents innovative firms from accessing the finance they need to bring innovative products and processes to market, grow and create jobs in the recovery. This paper has used a large scale survey of UK SMEs from before and after the crisis to investigate the differential impact of the 'credit crunch' on innovative firms. The results show

that innovative firms find it harder to access finance than other firms, but that the worsening in the availability of credit, and more specifically the amounts available, over the past two years has been systemic, for all firms rather than specifically for innovative SMEs. Indeed, in some respects the recession narrowed the gap between the two sets of firms—perhaps indicating an oversupply of credit generally before the crisis. However, these general findings do not hold when we explicitly consider *absolute* credit rationing from any source (i.e. firms unable to obtain any finance at all). Innovative firms started at an absolute disadvantage compared to their non-innovative peers. Yet while financing worsened in the crisis for both types of firms, innovative firms have done relatively worse in this respect and are particularly likely to face absolute credit rationing.

Our findings have some implications for theory in this area. Our evidence strongly shows that innovative firms have higher demand for external capital, and that this demand seems to have increased since the financial crisis: before the crisis, 28.6 per cent of innovative firms had applied in the year previously; after the crisis, 34.8 per cent had. These findings accord to a *Schumpeterian* (1939) view of counter-cyclical investment in innovation, with firms investing after the crisis to take advantage of the cyclical return to economic growth. However, these results are not statistically significant once controlling for other firm characteristics. Indeed, part of the effect may be due to the changed composition of firms, as some firms close in the crisis period. They are also consistent with the demand-pull theory with worsened balance sheets reducing the potential for firms to make investments using internal capital, and so ensuring they seek finance from outside.

These theories are also consistent with our finding that while access to finance has worsened overall the relative gap between innovative and non-innovative firms has closed. With reduced credit availability, banks may have been looking more closely at firms which were able to make an increased investment in growth. Yet it is harder to reconcile them with our finding that absolute credit rationing has worsened for innovative firms in both absolute and relative terms. The explanation may be more mundane, with banks willing to provide a certain amount of incremental working capital to sustain firms but not willing to provide large sums of investment to commercialise new innovations.

Our results suggest that problems remain for innovative small firms, and that this is not simply due to risk profiles. In fact, using standard credit scores, there are very few substantive differences in risk profiles between innovative and non-innovative firms. This means they add a new level to long-standing concerns about the nature of bank finance for innovative companies in the UK (Mina et al., 2013). In particular, there is a risk of discouragement with innovative firms being increasingly less likely to seek finance (Hutton and Nightingale, 2011). Our results suggest that innovative firms are, if anything, more likely to apply for finance now than before the recession. We cannot tell, however, whether this is driven by an increased demand for working capital rather than long-term finance.

The results have implications for policy. First, they have implications for the financial system. They suggest that access to credit may be restricting the growth of innovative firms. But firms do not have a 'right' to access to finance, and if firms are not receiving credit this is not necessarily a problem – indeed, oversupply of credit before the crisis may have been a more significant issue (Mason, 2013). As Freel (2007: 32) notes, there is “little or no evidence” that bank lending decisions are not “rational and legitimate appraisals of the risk profile of innovative small firms”. Yet, while clearly the decisions may be rational for the bank, there may be a public good argument for investments in innovative firms. One way of addressing this would be through efforts to diversify types of lending, either through increasing diversity in the banking system or newer forms of finance such as crowdfunding.

A second implication is for economic policy. In times of crisis, new firms may introduce new products and enter markets, with this being an important driver of growth (Archibugi et al., 2013b). If access to finance is not available, this may lead to a long-term drag on the economy, particularly if firms are then deterred from introducing new products in response (D'Este et al., 2012). Policies to address this may include those which help ensure new innovative companies are established, although identifying the firms likely to innovate and grow may be challenging (Archibugi et al., 2013b; Mason and Brown, 2013).

The results of this paper suggest some important areas for future research. First, our results are for SMEs only and we lack data on the availability of finance for larger firms. Yet large firms may face different challenges in applying for finance than larger firms. Future work may consider this issue and also consider disaggregating our results according to different ages of firms, sectors and so on. When data with larger samples become available, an important application would be to consider how things changed in the period since the crisis. Second, researchers may want to test these findings using other measures of innovation, such as R&D. It would also be valuable to test for the significance of innovations and the extent to which they are successfully commercialised⁹. An important limitation of our research is that we have only limited information on the quality of both the innovation and, more broadly, the firm. While we have tried to address this using credit scores, future work may be able to address it using better data as it becomes available. A third useful extension would also be to consider whether the results are UK specific or more general. It might be the case, for example, that firms in countries such as Germany with more diversified banking systems will find it easier to access finance (Filippetti and Archibugi, 2011). Mina et al. (2013) find evidence that the financing of innovation differs between the UK and US. Comparative work would help investigate these issues.

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⁹ A reviewer adds the useful suggestion that the Community Innovation Survey could be used to undertake research along these lines.

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