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INNOVATIONS, EXPORTS, AND FINANCING OF SMALL FIRMS IN MANUFACTURING AND KNOWLEDGE-INTENSIVE INDUSTRIES IN LATVIA

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Abstract

This study uses unique micro data on small businesses – Survey of Small Businesses in Latvia (SIBiL) to examine the effect of financial constraints of the innovative and exporting behavior. This paper also documents the financial constraints faced by small firms using both subjective and objective measures of access to credit. The main finding is that, in the seemingly unrelated bilateral probit framework, there is a negative relationship between difficulties of obtaining bank loans and both product innovations and exports. The estimated elasticities of innovating and exporting with respect to financial constraints are -1.46 and -1.91, respectively.

Keywords: *small firms, innovation, financing constraints, exports, Latvia*

JEL: F1, G3, O16, O3

1. Introduction

For developing countries, the ability of firms to innovate and export is widely seen to be keys to technological catching up and economic development (Grossman and Helpman, 1991; Hausmann and Klinger, 2006; Hausmann, Hwang, and Rodrik, 2007). Innovation, often, is about adaptation of products and services produced in advanced economies, whereas exporting may provide knowledge spillover effects that help spur more innovation. However, both activities are costly. Successful innovations require investment in research and development, even if its purpose is adaptation, whereas exporting involves a fixed cost of penetrating new markets (Melitz, 2003). Since Nelson (1959), economists have been aware that various market failures may prevent firms to obtain socially optimal amount of finance for their innovation activities. One reason is that an innovator is unlikely to fully appropriate returns on his innovation, because knowledge is a public good, which is hard to keep secret. Also, investment in innovation is characterized by a high degree of asymmetric information, which makes it difficult for outsiders to judge their potential value. Moreover, firms may be reluctant to reveal details of their ideas to potential investors because of the risk that they might be stolen (Stiglitz and Weiss 1981). Thus, underdeveloped financial markets and difficulty in accessing external financing may prevent firms in emerging markets from exploiting potential complementarities between innovation and export activities, which slows down the catching-up process (Gorodnichenko and Schnitzer, 2010).

There is a substantial literature, mostly using data on OECD countries, examining the effect of financing constraints on innovations (surveyed in Hall and Lerner, 2009), interaction between exports and innovation (see, for example, Roberts and Tybout, 1997; Clerides et al, 1998; and Bernard and Jensen, 1999), or the effect of financing on exports. However, with the notable exception of Gorodnichenko and Schnitzer, few papers examined the interplay between exports, innovations, and financing in a developing country setting.

The purpose of this study is to shed light on two questions of practical interest to policy makers. First, there is an important question whether observed underutilization of external financing by small firms in Latvia is a result of supply-side imperfections (e.g. reluctance to lend to small firms), or of demand-side imperfections (e.g. poor quality of business plans). An additional objective is to produce characterization and

analysis of this interplay between financial frictions, exports, and innovations of small firms in Latvia.

The contribution of this in-depth study to the broader competitiveness study is as follows. Clearly, innovativeness of small firms is a key aspect of what makes them competitive both domestically and in the international markets. Similarly, ability to break into the international markets (i.e. exporting) is a sign of competitiveness. Hence, understanding the set of factors that causally determine both innovations and exports should be of great interest to policy-makers, as it may help to devise policies that would, in the end, improve competitiveness of Latvian firms. However, identification and estimation of causal effects is extremely challenging. This study goes to considerable length to establish whether there is a causal effect between innovations, exports, and financial constraints. Although conventional wisdom seems to suggest that such a link exists, there are other, competing explanations. For example, financial constraints could be due to poor quality of investment ideas, or inability of small business owners to sell their ideas to potential financiers.

First, we find that simple bivariate correlations, as well as multivariate regression models, controlling for other factors, suggest that the there is a positive relationship between experience (or perception) of financial constraints and innovations and exports. This finding, however, could be due to the presence of omitted factors and/or endogeneity between innovations, exports, and financial constraints. For example, more active and able small business owners may be more innovative and perceive high level of financial constraints. Since we cannot measure owners' ability, we may see spurious correlation positive between financial constraints and innovations and attribute it to a causal relationship.

This study seeks to address these issues via a bivariate probit framework, as well as instrumental variables models, which seek to take fuller account of interation between various factors. Specifically, we seek to explain experience of financial constraints by other factors, including trade payables, i.e. debts to suppliers. Once fuller models are estimated, we find financial constraints to have a strong negative effect on innovations. Quantitatively, the estimated effects are very large. The estimated elasticities of innovating and exporting with respect to financial constraints are -1.46 and -1.91, respectively. The latter, for instance, implies that a reduction in the share of firms that experience financial constraints by 1% is associated with a increase in the share of exporting firms by 1.91%, controlling for other factors.

This paper is structured as follows. Section two provides overview of the relevant literature. Section three outlines the empirical methodology. Section four describes the SIBiL dataset and presents summary statistics. Section five reports the main empirical results. Section six concludes.

2. Literature Review

This study is related to several strands of literature. First, there is a last literature, surveyed in Hall and Lerner (2009), that tests for importance of financial frictions for investment in innovations. At its early stages, beginning with a pioneering study by Fazzari, Hubbard, and Petersen (1988), this literature focused on R&D investment, and tested for sensitivity to cash flow shocks. The underlying idea of this approach was that a change in available internal funds should not affect R&D investment, if firms are not financially constrained. Financing constraints were typically measured by cash flow to capital ratios. Many studies employed this approach, mostly using the data on large manufacturing firms in OECD countries, but not with unambiguous results. For example, a study Himmelberg and Petersen (1994) found large and statistically significant effects of financing constraints on the R&D investment of high-tech U.S. firms. However, Harhoff (1998) found that cash flow effects on R&D of both small and large firms in Germany were small. Bond, Harhoff, and Van Reenen (1999) compare UK with Germany and found that cash flows did not matter to German firms' R&D, but had an effect on UK firms R&D investment. Mulkay, Hall, and Mairesse (2001) reported a similar finding comparing U.S. and French firms. More recently, however, the cash flow approach to measuring financing constraints had been challenged by two influential papers by Kaplan and Zingales (1997, 2000), who showed that most of the severely financially-constrained firms in Fazzari, Hubbard, and Petersen sample were, in fact, not constrained at all. Generally, the consensus is that it is not clear whether responsiveness of R&D investment to cash flow is really evidence of financial constraints, as opposed to larger sensitivity to demand signals (Hall and Lerner, 2009).

More recent studies in this literature attempted to identify other measures of financial constraints. For example, Czarnitski and Hottenrott (2009) use a standardized credit rating index for German firms and find internal constraints to be

more decisive for R&D investment (as compared with regular business investment), and also more binding for small firms. Hottenrott and Peters (2009) measure financing frictions using the 2007 wave of Mannheim Innovation Panel in which the firms are asked to imagine that they receive additional cash exogenously and to indicate whether they would spend it on innovation projects. Piga and Atzeni (2007) focus on credit request in survey data, in which firms are interpreted as financially constrained if they report asking the bank for a loan, but not receiving it. Aghion et al (2008) measure credit restrictions based on a direct indicator derived from repayments of trade credits. Using French firm-level data they show that the share of R&D investment over total investment is counter-cyclical without credit constraints, but is less counter-cyclical as firms face tighter credit constraints. Savignac (2008) uses self-reported measure by firms to measure financial constraints in French Community Innovation Survey data, in which firms were asked whether they met obstacles that prevented them to lead or undertake innovative projects. He finds that the probability to have innovative activities is significantly reduced by the existence of financial constraints for French manufacturing firms.

Empirical studies using micro-level data for developing countries are rather rare, with a notable exception by Gorodnichenko and Schnitzer (2010), who use World Bank's Business Environment and Enterprise Performance Survey (BEEPS), on a broad range of transition economies. Using self-reported measures of innovations and financial constraints, and instrumenting the latter with overdue payments to suppliers, and barter transactions with both suppliers and customers, the authors find financial frictions to exert strong negative effect on both exports and innovations.

The second strand of literature examines interaction between exports and innovations. most of existing research suggests that exporters tend to exhibit higher levels of productivity (see reviews by Tybout, 2003, and Greenaway and Kneller, 2007). Two lines of theoretical reasoning have been developed to explain this observation. The first approach, developed in papers such as Bernard et al (2003) and Melitz (2003), suggests that the difference in productivity exists even before exporting begins. Sunk costs associated with entering export markets lead to self-selection of the most productive firms into exporting. The second line of thought suggests the reverse causality, i.e. the firms improve their productivity by exporting, for instance, by using commercial interactions to exchange ideas and increase the stock of knowledge (Grossman and Helpman, 1991). Empirical studies have been

supportive of both the former approach (e.g. Clerides et al, 1998; Bernard and Jensen, 1999), and also the learning-by-exporting hypothesis has also found some empirical evidence (e.g. Girma, Greenaway and Kneller, 2004; Criscuolo, Haskel, and Slaughter, 2005).

Finally, the third strand of literature is related to the effect of financial frictions on exports. Generally, this literature also finds negative relationship between exporting and financial constraints. For example, Manova (2008) finds financially more developed countries are more likely to export and that the effect is more pronounced in financially vulnerable sectors, whereas Greenaway et al (2007) report that financially more healthy firms are more likely to export.

3. Methodology

This section discusses the empirical strategy, specific hypotheses tested in this paper, and the measurement issues.

Our main theoretical predictions are as follows. First, we hypothesize that, the more severe the financial constraints, the less likely it is that the firms engages in innovation or exporting activities. Our second hypothesis postulates that the entrepreneur's level of human capital should have a negative effect on the likelihood of experiencing a financial constraint.

To examine correlation between firm innovations, exports, and financial constraints, the following baseline probit specification are estimated, using pooled data for 2007 and 2009.

$$7 \quad + 8 \quad + 9 \quad + \; + \; + \qquad (1)$$

where I is a dummy variable equal to one if the firm reported a productivity enhancing activity (i.e. innovation or export), and zero otherwise. Survey respondents were asked whether their firm introduced product innovations in the three year period in 2005-2007, or in the two year period in 2008-2009. Product innovations here are defined as new or significantly improved product or services that are novel to the firm, in accordance with the Oslo manual (OECD, 2005). The exact question is C1 in the Appendix. The definition of product innovations used in this paper is rather broad as it includes innovations that are not new to the market, i.e. imitations of

competitors' products. In turn, exports are measured as a dummy variable denoting whether a firm had any sales outside of Latvia. The exact question B4 is in the Appendix.

Further, denotes cumulative distribution function of a standard normal variable; *i*, *s*, and *t* index firms, industry, and time, respectively. In addition to industry ( ) and time (fixed effects, the following variables are included to control for a number of firm-specific factors deemed to be important in the literature:

FC, the main variable of our analysis, is a measure of financial constraints faced by firms. We employ two main measures of financial constraints. The first measure is based on the entrepreneurs' self-reported assessment of obstacles to innovations (Question C30 in the Appendix), including "lack of external financing". We have respondent's assessment of its importance to innovation activities on a four-point scale: 1 – high importance, 2 – average importance, 3 – low importance, 4 – not relevant. These are subjective evaluations, raising concerns of the correlation of responses with respondents' attitudes, which, in turn, may have an effect on self-reported measures of innovations and exports. To mitigate this concern, we use a method suggested by Criscuolo et al (2005). Specifically, for each assessment, we code a dummy variable taking the value of one if the reported degree of importance is higher than the *average* degree of importance reported for all the information sources. For example, if the respondent reports all information sources to be of "high importance", our dummy takes the value of zero for each information source. Our second measure is based on the entrepreneurs' actual experience with bank loans. We construct a composite measure summarizing whether (i) an entrepreneur applied for a loan but the application was rejected (Questions D6, D7, D8 in the Appendix); or (ii) an entrepreneur needed a loan but did not apply for one, because of being sure that the bank would reject the application (Question D14 in the Appendix). The composite measure takes the value of one if the entrepreneur reported experiencing any of the above, and zero otherwise.

L (the number of employees) measures the size of the firm. The argument for including size is that large companies have more resources to innovate and can benefit from economies of scale in R&D production.

Age of the firm is the number of years since the year of registration. It is not *a priori* clear what the effect of age on innovations or exports is. On the one hand, younger firms may be more open to innovation. On the other hand, older firms may have accumulated the stock of knowledge that is crucial for introducing innovations or entering new markets.

Fown and *FMown* measure whether a firm has a foreign owner and whether this foreign owner has more than fifty percent (majority) ownership stake. Both are dummy variables taking the value of one if the above conditions are met, and zero otherwise.

MNE is a dummy variable measuring whether a firm is part of a multinational enterprise, with head office located outside Latvia. It is constructed from responses to questions B3 and B3a (Appendix).

OAge and *Ofem* measure age and gender of the largest business owners. Age is measured in years, whereas gender is measured by the dummy variable taking the value of one for females, and zero for males.

Oedu represents a vector of dummy variables that capture formal education of the largest owner. These measure whether owner's highest level of educational attainment is secondary vocational education, secondary general or less, bachelor's degree, master's degree, or postgraduate (doctoral) degree. The dummy variables are constructed from responses to question F7 in the Appendix.

Estimating the specification above by ordinary least squares or probit may lead to biased estimates of the key parameter of interest . It could be, for example, that firms that intend to innovate are more to hit the financial constraint than firms that do not try innovating. Alternatively, both innovations and the likelihood to experience financial constraints might be positively correlated with third, unobserved, factors, such as managerial ability. Since managerial ability is hard to measure and, therefore, cannot be included in equation (1), a naïve analysis may erroneously conclude that there is a positive relationship between innovations and financial constraints. To correct for the possible endogeneity and omitted variables biases, we estimate recursive bivariate probit model, where the proxy for financial constraints is estimated using the same vector of firm and entrepreneur-specific variables as in equation (1),

as well as the share of trade payables over sales (i.e. debts to suppliers), and the share of fixed assets over sales. This approach rests on the implicit assumption that the share of trade payables and fixed assets exogenously affect the likelihood to experience financial constraints.

4. Data and Descriptive Statistics

This section describes a novel dataset on innovative behavior of small firms in Latvia that is used in this study. It discusses the similarities and differences between the Survey of Innovative Firms in Latvia. SIBiL and major existing datasets, the sampling strategy, design of the questionnaire, and results of the first wave of the survey.

SIBiL combines elements of a number of leading firm level surveys with Business Registry data on 1,254 small Latvian firms, provided by *Lursoft LLC*. The survey part of SIBiL borrows from EuroStat's Community Innovation Surveys (CIS), Panel Study of Entrepreneurial Dynamics (PSED), U.S. Federal Reserve Survey of Small Business Finance, and Djankov et al (2005) survey of entrepreneurs in Russia, Brazil, China, and India. The first wave of the survey was conducted in 2007-2008 by *Latvian Facts*, a premier market research firm, using face-to-face interviews. Then, the survey data were merged with the Business Registry data in 1996-2007.

SIBiL is highly similar to Community Innovation Surveys, which are used to measure innovations in OECD and EU countries (OECD 2005). It uses the same questionnaire as the 4th wave of CIS and covers the same industries. However, compared to the CIS, SIBiL has a number of important advantages. First, SIBiL relies on face-to-face interviews with owners-managers of firms, as opposed to mailed questionnaires typically used by the CIS. Second, SIBiL's target population is small firms with less than 50 employees.[2] In contrast, CIS typically covers firms with more than 10 employees. Thus, SIBiL complements CIS by covering micro-firms with less than 10 employees. Third, SIBiL ensures there is a sufficient representation of firms in high-technology manufacturing and knowledge intensive services, as classified by the Eurostat. Using NACE Revision 1, these are manufacture of aerospace (35.3),

[2] The main reason for not covering larger firms is that it is prohibitively expensive to conduct face-to-face interviews with owners of medium and large businesses.

computers (30), electronics and communications (32), pharmaceuticals (24.4), scientific instruments (33), post and telecommunications (64), computer and related activities (72), and research and development (73). Fourth, SIBiL goes at great length to ensure accurate measurement of firms' innovations activities. By using the data on owners from the Business Registry, we make sure that the interviews are conducted with owners-managers of the firms. In contrast, usually it is not known who is filling out the mailed questionnaires.[3] Also, an important drawback of mailed questionnaires is that they may not provide respondents with a good idea of what is a product innovation.[4] An advantage of SIBiL is that the interviewers were trained to help the respondents with specific examples of product and process innovations in the respondent's industry.

The sampling strategy is also similar to the Community Innovation Surveys. The target population consisted of active firms with less than 50 employees in 2006 as well as firms that were first registered in 2007.[5] The sampling frame is based on the Business Registry, which excludes entities that are not obliged to submit financial reports, such as self-employed, farmers' cooperatives, etc. The industries that are covered in the survey are in the first column of Table 1. The second column provides the NACE codes of these industries.

The target population is broken down into 40 strata, formed by industry classification and employment size, as in a typical CIS. Stratification will typically give results with smaller sampling errors than a non-stratified sample of the same size. The third and fourth columns of Table 1 show the number of firms in the target population in each stratum. For example, there are 1,926 firms with less than 10 employees in manufacturing of food, clothing, wood, paper, publishing and printing, corresponding to NACE codes 15-22. Further, initial samples are formed using simple random sampling with each stratum. Initial sample sizes are determined so as to ensure a reasonable final sample size allowing for non-response rates of 30-40%. Thus, the main rule is that the initial sample size is 104 firms in strata with micro-firms (less than 10 employees), and 66 firms in strata with small firms (10 to 49 employees). Two major exceptions are high-tech industries of "Post and telecommunications" (64) and "Computers and related activities" (72), where larger

[3] Anecdotal evidence suggests that mailed questionnaires are often delegated to accountants, secretaries, or interns.
[4] CIS questionnaires typically contain a brief standard definition.
[5] At the time of allocating the initial sample financial data were only available for 2006.

samples were drawn. Also, census is conducted in most high-tech strata where number of firms in the target population is rather small. For example, the number of micro-firms in "Manufacture of pharmaceuticals" (24.4) is only 19. Thus, all of these firms are included in the initial sample. In total, the size of initial sample is 2,754 firms.

Then, we used Business Registry to obtain the phone number and legal address of each firm in the initial sample. Also, we obtained the name and the last name of the owner and chair of the board of each firm. The market survey firm sought to interview a designated owner-manager for each firm in the initial sample. To boost the response rate, the first step was to send an official letter signed by the principal researcher at the Stockholm School of Economics in Riga, asking to participate in the survey. This was followed up by a phone call from the market research firm to arrange the date for the interview. The fieldwork began in September 2007 and 1,251 full interviews were completed by September 2008. The last two columns of Table 1 summarize the results of the survey in terms of the final sample sizes in each stratum. A major unexpected difficulty was that many firms, especially the smallest ones, could not be found at their official addresses. On average, only 58% of the firms in the initial sample could be contacted. The contactable rate is the lowest for micro-firms – 54% of the initial sample. It ranged from 34% for micro-firms in "technical testing and analysis" (74.3) to 100% for small firms in "manufacture of pharmaceuticals" (24.4). However, the response rate was quite high among the firms that were contacted – on average, 86%.

Further, the survey data were merged with the financial and ownership data from the Business Registry. Specifically, SIBiL has data on the balance sheets and profit statements in 1996-2009, as well as ownership data for 2007-2009.

Finally, the development of SIBiL is tracked over time. In 2010, Latvijas Fakti conducted follow-up interviews with the same firms, using face-to-face interviews. As a result, we also have 940 completed interviews in 2010 (Wave 2). 210 firms went bankrupt or could not be located. 117 firms refused to participate in the survey.

5. Main Results

The main results so far are as follows. Tables 4 and 5 provide some simple cross-tabulations for innovations (product innovations, process innovations, and R&D) and exports. Then, Tables 6 and 7 provide cross-tabulations of the incidence of financial constraints, exports, and innovations. Table 8 proceeds with summary statistics for the main variables of interest. Then, we examine the effects of financial constraints on product innovations in the multivariate regression framework. Probit model with heteroskedasticity-consistent robust standard error is estimated using pooled data for 2008 and 2010. We start with using the self-reported subjective assessment of the importance of external financial constraints to innovations. The estimation results are presented in Table 9. For all regressions we report marginal effects evaluated at means for continuous variables and discrete change from 0 to 1 for dummy variables. Also, all regressions include year dummy, but it is not reported. Heteroskedasticity-consistent robust standard errors are reported for all regressions. Regression (1) is estimated with the dummy variables for whether, in entrepreneur's assessment, the firms is financially constrained. Surprisingly, we find a positive and statistically significant coefficient of 0.051. This implies that financially constrained firms are *more likely* to have a product innovation by 5.1 percentage points. In Regression (2) we include controls for firm's size, as measured by number of employees and its squared term, and age of the firm. Both coefficient estimates are in line with prior expectations and consistent with earlier studies. The coefficient is positive for the first term of the size proxy and negative and significant coefficient for the quadratic term, implying that larger firms are more likely to introduce product innovations, but that the effect is diminishing with size. Age of the firm appears to have a negative and statistically significant effect on product innovations, implying that younger firms are more innovative. The coefficient on the main variable of interest drops in magnitude to 0.039 but remains weakly statistically significant at the 10% level. Further, Regression (3) in Table 9 adds dummies that measure R&D activity, as well as the measures of 'global engagement', e.g. dummies for foreign ownership and being part of a multinational company. The coefficient on the financial constraint variable increases in magnitude and becomes highly significant at the 1% level. The coefficient estimates for both R&D dummies are positive, economically large, and statistically significant at 1% level. In line with the previous literature, I

also find substantial correlation between some of the measures of global engagement and product innovation. Being part of a multinational company increases the probability of introducing product innovation by 23 percentage points and the effect is highly statistically significant at 1% level. Interestingly, however, the coefficient estimates on the foreign owner and majority foreign owner dummies are not statistically significant. Regression (4) is estimated with industry fixed effects. Adding these controls does not result in substantial changes in the estimates of the effect of financial constraints. Finally, in Regressions (5) and (6) we turn to testing the hypotheses that controlling for the quality of business ideas, proxied by the entrepreneur's level of educational attainment, reduces the effect of financial constraints on innovations. The former regression is estimated without industry fixed effects, whereas the latter includes them. However, inclusion of entrepreneur's educational attainment does not change the effect of financial constraints. The estimated coefficients are still positive and significant in both statistical and economic sense.

All in all, estimation results in Table 9 provide no support for the hypothesis that financial constraints result in less innovations. On the contrary, we find that the presence of financial constraints is associated with the *greater* likelihood of having a product innovation. This finding is very statistically significant and robust to inclusion of a broad set of control variables, including those measuring the human capital of the entrepreneur. We replicate the results in Table 9 using an alternative measure of financial constraints that is based on the firms' actual experience with applying for the bank loans. Estimation results are not reported but the main results are qualitatively similar – financial constraints are found to be positively and statistically significantly associated with the incidence of product innovations.

Next, Table 10 presents our results using exports as a dependent variable. Here, the measure of financial constraint is the dummy variables that takes the value of one if the firm experienced either a rejected loan application, or an instance when it needed a bank loan but did not apply for one. As before, for all regressions we report marginal effects evaluated at means for continuous variables and discrete change from 0 to 1 for dummy variables. Also, all regressions include year dummy, but it is not reported. Heteroskedasticity-consistent robust standard errors are reported for all regressions.

Regression (1) is estimated with the main variable of interest only, measuring whether the entrepreneur experienced difficulties in obtaining bank financing. Contrary to the expectations, we find a positive coefficient of 0.13, that is significant at 1% level. This implies that financially constrained firms are *more likely* to be exporters by 13 percentage points. In Regression (2) we include controls for firm's size and age. However, inclusion of these controls does not change the estimate of the coefficient of interest. Next, in Regression (3) we add controls measuring firm's global engagement. Interestingly, the coefficient on financial constraints is decreased to 0.10, indicating that firms with global engagement were more likely to experience financial constraints. Interestingly, and in contrast to results in Table 4, having a foreign investor with less than controlling stake increases the likelihood of the firm being exporter by 30 percentage points. In contrast, being part of a multination has no statistically significant effect on the firm's exporting behavior. Finally, in Regressions (4) and (5) we add industry fixed effects and entrepreneur-specific human capital variables, such as gender, age, and educational attainment. However, adding these additional controls does not change the magnitude of the effect of financial constraints. The coefficient in Regression (5) is positive and highly statistically significant. Re-estimating regressions in Table 10 with our alternative measure of financial constraint produces similar results.[6] Again, the coefficient estimate on the variable of interest is positive and statistically significant at 1% level.

Taken together, the estimation results in Tables 9 and 10 do not support the hypothesis that financial constraints are detrimental to exports. On the contrary, we find *positive* relationship between the experience of financial constraints and exporting. The estimates are surprisingly robust across a wide range of model specifications. This finding, however, could be due to the presence of omitted factors and/or endogeneity between innovations, exports, and financial constraints. For example, more active and able small business owners may be more innovative and perceive high level of financial constraints. Since we cannot measure owners' ability, the resulting positive correlation positive between financial constraints and innovations could be spurious. This study seeks to address these issues via a bivariate probit framework, as well as instrumental variables models, which seek to take fuller account of interation between various factors. Specifically, we estimate a set of

[6] The estimation results are not reported in this paper, but available upon demand.

simultaneous equations models (i.e. bivariate probit), where one of the estimating equations regresses financial constraints on other factors, including trade payables and fixed capital, both measured as a share in total sales. The estimation results from bivariate probit regressions are presented in Table 11. In contrast with the previous tables, we report original probit coefficients for all estimated models. For reference purposes, the second column reports estimated coefficients from the baseline probit model, identical to Regression (6) in Table 9. The third column reports the results using bivariate probit model, which is our preferred specification. The fourth column shows bivariate probit estimation results for the equation with financial constraints as a dependent variable. Strikingly, the results are fully reversed. Financial constraints now have a negative effect on product innovations, controlling for other factors. The effect is statistically significant at the 5% level. The effect is also very large in economic sense. The estimated probit coefficient for financial constraint is -0.904, which corresponds to the marginal effect of -0.284, or the elasticity of product innovations with respect to financial constraint of -1.461. The latter implies that a 1% decrease in the share of firms experiencing financial constraints is expected to increase the share of firms with product innovations by 1.461 percent.

The reversion of estimated coefficients is largely explained by the effect of trade payables on the financial constraints. The fourth column of Table 11 shows that trade payables as a share of sales have a large and positive effect on financial constraints, that is statistically significant at the 5% level. That is, firms with greater unpaid debts to suppliers are more likely to experience financial constraints, which in turn leads to smaller likelihood of introducing product innovations. We obtain similar results using instrumental variables framework, in which financial constraints are instrumented using the same variables as reported in the last column of Table 11.[7]

In a similar set of bivariate probit regressions we also find financial constraints to have a large, statistically significant, and negative effect on exporting. The estimated elasticity of exporting with respect to the financial constraints is -1.91, implying that a 1% reduction in the share of firms experiencing financial constraints is predicted to increase the share of exporting firms by 1.91 percent.

[7] The results using instrumental variables approach are not reported here, but are available upon demand.

All in all, using the bivariate probit framework, we find that financial constraints have a negative effect on both product innovations and exporting. The estimated effects are statistically significant and large in economic sense.

6. Conclusions

First, this study finds that simple bivariate correlations, as well as multivariate regression models, controlling for other factors, suggest that the there is a positive relationship between experience (or perception) of financial constraints and innovations and exports. This finding, however, could be due to the presence of omitted factors and/or endogeneity between innovations, exports, and financial constraints. For example, more active and able small business owners may be more innovative and perceive high level of financial constraints. Since we cannot measure owners' ability, we may see spurious correlation positive between financial constraints and innovations and attribute it to a causal relationship.

This study seeks to address these issues via a bivariate probit framework, as well as instrumental variables models, which seek to take fuller account of interation between various factors. Specifically, we seek to explain experience of financial constraints by other factors, including trade payables, i.e. debts to suppliers. Once fuller models are estimated, we find financial constraints to have a strong negative effect on innovations. Quantitatively, the estimated effects are very large. The estimated elasticities of innovating and exporting with respect to financial constraints are -1.46 and -1.91, respectively. The latter, for instance, implies that a reduction in the share of firms that experience financial constraints by 1% is associated with a increase in the share of exporting firms by 1.91%, controlling for other factors.

The contribution of this study to policy debate is as follows. First, it produces strong causal evidence that small firms innovations are inhibited by access to finance, and there is room for the government policies targeted at small firms in the industries covered by the study (largely manufacturing). Second, it quantifies the effects of financial constraints on both innovations and exporting of small firms. If policy makers are informed about the quantitative effects of alternative policies, they can make better choices regarding allocation of scare resources to promote innovations and exports to policies that result in larger effects.

Also, the in-depth study suggests other areas for public policy by highlighting factors that positively correlate with both innovations and exports. First, there is a robust relationship between firm size and both innovations and exports, suggesting that policies that remove bottlenecks to firms growth can have positive multiplier effects also on innovations and exports. Second, R&D, especially if done on a continuous basis, correlates strongly with innovations. Third, affiliation with multinational enterprises has a strong effect, reinforcing the benefits of openness, etc. Fourth, higher education in the form of a bachelors degree, as compared with vocational education has a highly positive effect. However, higher levels of academic achievement (e.g. a master's degree) are not associated with higher propensity to innovate. These findings, however, are suggestive as subject to concerns about omitted variables and endogeneity biases.

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Figures and tables

Figure 1: Proportion of businesses having credit lines, in U.S. and in Latvia

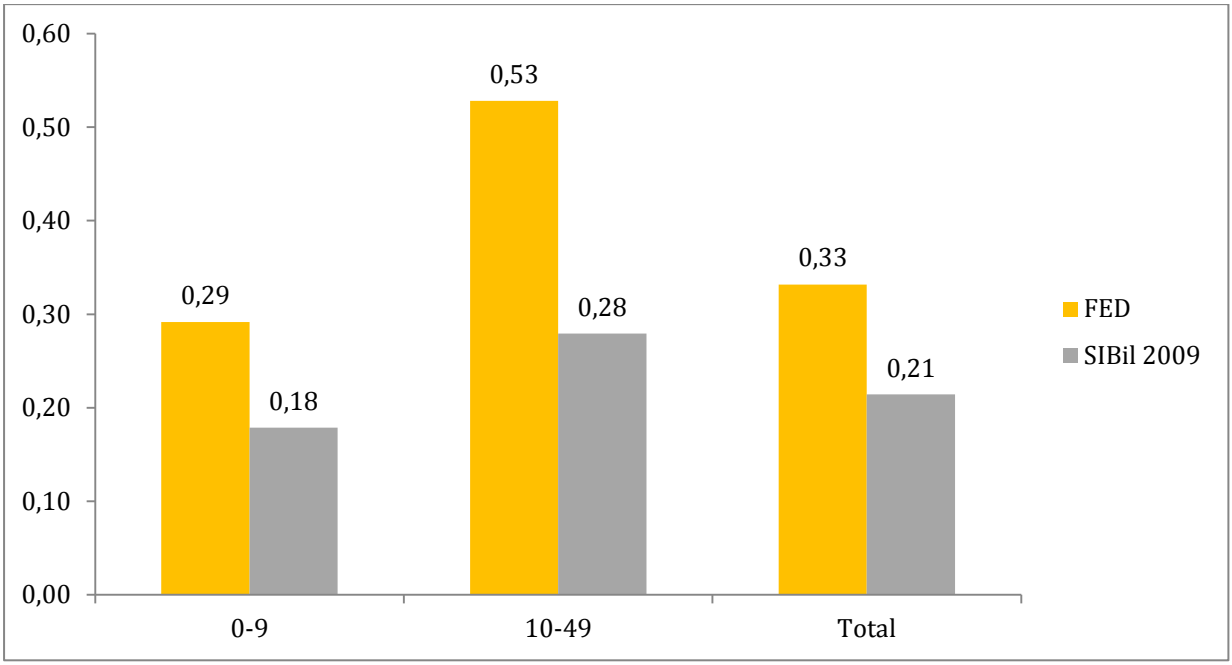

Figure 2: Proportion of firms that needed a loan but did not apply, being sure bank would deny, in U.S. and in Latvia

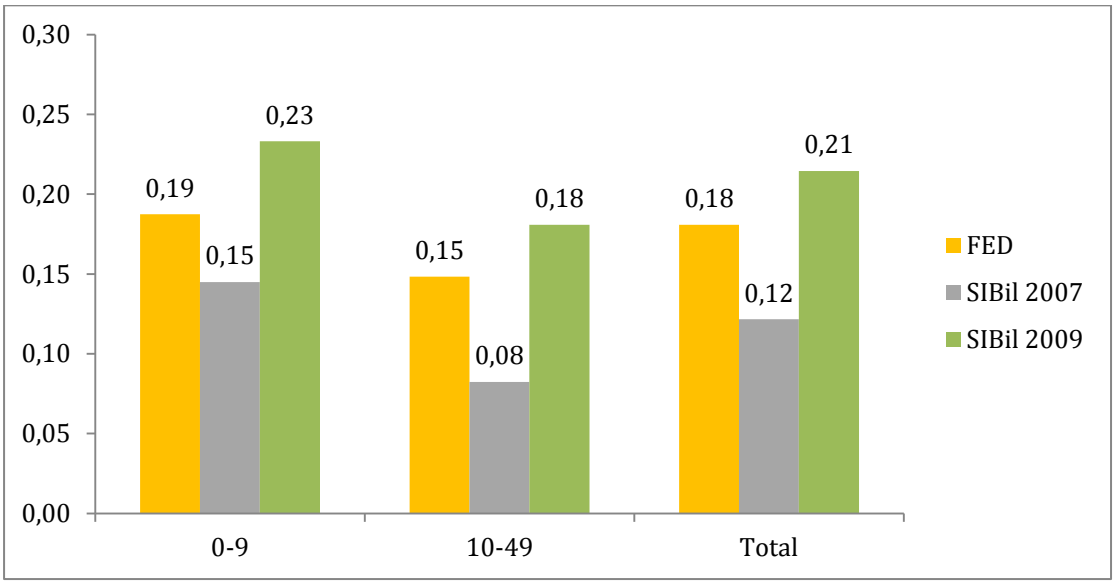

Table 1: Sampling design

		Target population		Initial sample size		Final sample size	
Sector	**NACE**	**<10**	**10-49**	**<10**	**10-49**	**<10**	**10-49**
Mining and quarrying	10-14	37	38	37	38	17	11
Mfr of food, clothing, wood, paper, publishing and printing	15-22	1926	1354	104	66	52	45
Mfr of fuels, chemicals, plastics metals & minerals (except 24.4)	23-29	818	571	104	66	55	40
Mfr of pharmaceuticals	24.4	19	6	19	6	12	2
Mfr of office machinery and computer	30	35	13	35	13	16	9
Mfr of electrical machinery	31	54	24	54	24	29	11
Mfr of electronics and communications equipment	32	36	16	36	16	17	6
Mfr of scientific instruments	33	101	23	101	23	65	18
Mfr of transport equipment (except 35.3)	34-35	84	67	84	67	39	19
Mfr of aerospace equipment	35.3	3	2	3	2	2	1
Mfr not elsewhere classified	36-37	444	221	104	66	49	34
Electricity, gas and water supply	40-41	168	190	104	66	45	29
Wholesale trade	51	4797	2113	104	66	39	36
Transport & storage	60-63	2373	1199	104	66	52	13
Post & Telecommunications	64	219	68	219	68	71	33
Financial intermediation	65-67	418	101	104	68	42	21
Computer & related activities	72	833	137	155	137	80	67
Research and Development	73	82	13	82	13	43	8
Architectural & engineering activities	74.2	631	210	104	68	54	15
Technical testing and analysis	74.3	101	57	101	57	37	17

Notes: This table reports the sizes of the target population, initial sample, and the final sample. NACE classification refers to Revision 1. Each stratum is defined by industry and two classes by size of the firms: micro-firms with less than 10 employees, and small firms with 10 to 49 employees.

Table 2: Response rates by industries and firm sizes, percent

Industry	NACE	Response rate			Contactable rate		
		<10	10-49	total	<10	10-49	total
Mining and quarrying	10-14	90	100	94	57	79	63
Mfr of food, clothing, wood, paper, publishing and printing	15-22	92	94	93	49	74	59
Mfr of fuels, chemicals, plastics metals & minerals (except 24.4)	23-29	85	85	85	56	73	63
Mfr of pharmaceuticals	24.4	86	33	70	74	100	80
Mfr of office machinery and computer	30	80	77	79	57	100	69
Mfr of electrical machinery	31	88	92	89	62	71	64
Mfr of electronics and communications equipment	32	70	70	70	64	63	63
Mfr of scientific instruments	33	89	90	89	70	83	72
Mfr of transport equipment (except 35.3)	34-35	98	88	94	49	79	58
Mfr of aerospace equipment	35.3	100	50	75	67	100	80
Mfr not elsewhere classified	36-37	100	93	96	42	72	53
Electricity, gas and water supply	40-41	92	88	90	47	58	51
Wholesale trade	51	87	78	82	54	58	56
Transport & storage	60-63	91	53	78	52	43	49
Post & Telecommunications	64	91	85	88	54	76	62
Financial intermediation	65-67	72	76	74	52	62	55
Computer & related activities	72	80	81	81	61	66	63
Research and Development	73	87	91	88	57	85	60
Architectural & engineering activities	74.2	85	90	86	58	30	47
Technical testing and analysis	74.3	100	89	96	36	70	43
Total:		87	83	86	54	65	58

Notes: response rate is computed as a percentage of all contacted firms that resulted in completed interviews. Contactable rate is computed as percentage of firms in the initial sample that could be contacted by the survey vendor. NACE classification refers to Revision 1.

Table 3: Percentage of exporters and firms with product innovation by industry, Wave 1

NACE (rev.1)	Industry	All firms		Exporters			Firms with product innovation		
		Number of observations	Percentage out of total	Number of observations	Percentage within industry	Share of sales from exported goods (if export)	Number of observations	Percentage within industry	Share of sales from innovative products (if innovate)
10-14	Mining and quarrying	27	2.23	5	18.5	54.2	11	40.7	30.0
15-22	Mfr of food, clothing, wood, paper, publishing and printing	96	7.93	35	36.5	41.9	51	53.1	40.5
23-29	Mfr of fuels, chemicals, plastics metals & minerals (except 24.4)	90	7.43	29	32.2	44.1	42	46.7	45.8
24.4, 30, 32, 35.3	Mfr of pharmaceuticals, office machinery, computers, electronics, communications and aerospace equipment [a]	65	5.37	27	41.5	43.4	42	64.6	45.9
31	Mfr of electrical machinery	36	2.97	13	36.1	60.0	18	50.0	25.6
33	Mfr of scientific instruments	75	6.19	22	29.3	37.5	62	82.7	42.5
34-35	Mfr of transport equipment (except 35.3)	58	4.79	26	44.8	57.3	26	44.8	45.9
36-37	Mfr not elsewhere classified	80	6.61	28	35.0	35.9	39	48.8	37.0
40-41	Electricity, gas and water supply	71	5.86	2	2.8	5.5	20	28.2	29.7
51	Wholesale trade	79	6.52	21	26.6	35.2	39	49.4	32.8
60-63	Transport & storage	65	5.37	26	40.0	57.6	21	32.3	34.3
64	Post & Telecommunications	96	7.93	16	16.7	58.4	66	68.8	48.7
65-67	Financial intermediation	62	5.12	13	21.0	53.9	30	48.4	33.9
72	Computer & related activities	144	11.89	60	41.7	33.5	99	68.8	48.3
73	Research and Development	49	4.05	19	38.8	54.1	27	55.1	71.1
74.2	Architectural & engineering activities	70	5.78	11	15.7	44.9	25	35.7	40.0
74.3	Technical testing and analysis	48	3.96	14	29.2	29.4	24	50.0	50.1

Notes: [a] These high-technology sectors are merged into one group because separately each of them has a very small sample size.

Table 4: Innovation and export activities

	2007		2009	
	# of observ.	%	# of observ.	%
Product innovations	661	52.8	176	19.1
Process innovations	793	63.5	219	23.7
Intramural R&D	502	40.7	183	14.7
Exporter	372	30.1	270	21.9

Source: SIBiL

Table 5: Innovation and export activities, cross tabulation

		2007		2009	
		Exporter		Exporter	
		no	yes	no	yes
Product innovations	no	466 37.67%	120 9.70%	539 59.36%	196 21.59%
	yes	399 32.26%	252 20.37%	99 10.90%	74 8.15%

Source: SIBiL
Notes:

Table 6: Financial constraints

	2007		2009	
	# of observ.	%	# of observ.	%
Lack of external finance for innovations	522	42.20	364	39.44
Loans denied	43	3.57	53	5.92
Loans need but not applied	171	13.87	161	17.99
Problems to get loans	195	16.25	195	21.89

Source: SIBiL

Table 7: Product innovation, exports, and financial constraints

		Product innovations		Exporter	
		no	yes	no	yes
Lack of external finance for innovations	no	61.08	55.58	59.34	57.90
	yes	38.92	44.42	40.66	42.10
		100	100	100	100
Pearson's (p-value)		0.012		0.536	
Problems to get loans	no	83.58	77.71	83.08	77.29
	yes	16.42	22.29	16.92	22.71
		100	100	100	100
Pearson's (p-value)		0.001		0.002	

Source: SIBiL
Notes: pooled data

Table 8: Summary statistics for control variables by product innovations, Wave 1

	N	Whole sample	Product innovation	
			yes	no
Dummy for product innovation	1253	0.528	1	0
Dummy for patent application	1242	0.056	0.086***	0.024
Owner's personal characteristics				
Dummy for female	1044	0.167	0.136***	0.203
Owner's age, years	988	46.8	45.99**	47.74
Owner's education				
Dummy for basic or secondary general education	990	0.043	0.039	0.048
Dummy for secondary professional or vocational education	990	0.208	0.18**	0.24
Dummy for bachelor's degree	990	0.539	0.538	0.541
Dummy for master's degree	990	0.166	0.188**	0.14
Dummy for postgraduate degree	990	0.043	0.055*	0.031
Firm's global engagement				
Dummy for being an exporter	1238	0.3	0.387***	0.205
Dummy for having a foreign owner	1253	0.137	0.163***	0.108
Dummy for foreign owner having a majority stake	1253	0.105	0.128***	0.078
Dummy for being part of multinational enterprise (MNE)	1244	0.057	0.084***	0.027
Research and Development				
Dummy for performing intramural R&D	1234	0.408	0.567***	0.231
Dummy for performing intramural R&D on a continuous basis	1216	0.278	0.437***	0.102

Notes: *, **, *** pertain to the two-sided t-test that the difference in means is zero and indicate significance at 10%, 5%, and 1% level, respectively.

Table 9: Product innovations and financial constraints

	Dependent variable: Product innovation (=1)					
	(1)	(2)	(3)	(4)	(5)	(6)
Financially constrained (=1)	0.051**	0.039*	0.068***	0.076***	0.074***	0.083***
	(0.0220)	(0.0228)	(0.0244)	(0.0247)	(0.0284)	(0.0288)
Number of employees		0.0084***	0.0066***	0.0071***	0.0094***	0.0086***
		(0.00138)	(0.00144)	(0.00151)	(0.00180)	(0.00187)
Employees squared		-0.000056***	- 0.000048***	- 0.000054***	- 0.000064***	- 0.000061***
		(0.000056)	(0.0000124)	(0.0000135)	(0.0000141)	(0.0000148)
Age of the firm, yrs		- 0.0095***	- 0.0077***	- 0.0076***	- 0.0041	- 0.0040
		(0.00262)	(0.00286)	(0.00293)	(0.00358)	(0.00366)
R&D (=1)			0.24***	0.21***	0.20***	0.17***
			(0.0426)	(0.0438)	(0.0496)	(0.0511)
Continuous R&D (=1)			0.30***	0.30***	0.31***	0.33***
			(0.0478)	(0.0493)	(0.0548)	(0.0562)
Foreign owner (=1)			0.016	0.026	- 0.042	- 0.012
			(0.0695)	(0.0736)	(0.0680)	(0.0775)
Majority foreign owner (=1)			- 0.065	- 0.098	- 0.043	-0.11
			(0.0782)	(0.0773)	(0.0897)	(0.0870)
Multinational (=1)			0.23***	0.25***	0.25**	0.30***
			(0.0684)	(0.0704)	(0.108)	(0.109)
Owner's age, yrs					- 0.0020	- 0.0016
					(0.00137)	(0.00141)
Female owner (=1)					- 0.059	- 0.057
					(0.0368)	(0.0371)
Secondary education (=1)					- 0.025	0.0075
					(0.0673)	(0.0762)
Bachelor's degree (=1)					0.065*	0.074*
					(0.0377)	(0.0398)
Master's degree (=1)					0.11**	0.10*
					(0.0496)	(0.0540)
Doctoral degree (=1)					0.065	0.055
					(0.0745)	(0.0755)

Industry fixed effects	NO	NO	NO	YES	NO	YES
N	2160	2039	1970	1970	1495	1495
Pseudo R^2	0.094	0.111	0.251	0.280	0.257	0.290

Notes: This table reports marginal effects from probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 10: Exports and financial constraints

	Dependent variable: Exporter (=1)				
	(1)	(2)	(3)	(4)	(5)
Financially constrained (=1)	0.13***	0.13***	0.10***	0.094***	0.092***
	(0.0264)	(0.0280)	(0.0291)	(0.0297)	(0.0325)
Number of employees		0.0094***	0.0084***	0.0095***	0.011***
		(0.00116)	(0.00128)	(0.00132)	(0.00160)
Employees squared		-0.000049***	-0.000042***	-0.000049***	-0.000057***
		(0.0000115)	(0.0000119)	(0.0000117)	(0.0000130)
Age of the firm, yrs		-0.0058***	-0.0047*	-0.0057**	-0.0039
		(0.00225)	(0.00247)	(0.00249)	(0.00300)
Foreign owner (=1)			0.30***	0.29***	0.32***
			(0.0667)	(0.0716)	(0.0783)
Majority foreign owner (=1)			-0.11*	-0.097*	-0.12**
			(0.0581)	(0.0586)	(0.0571)
Multinational (=1)			0.086	0.10	0.25**
			(0.0628)	(0.0682)	(0.122)
Owner's age, yrs					-0.00063
					(0.00125)
Female owner (=1)					-0.079***
					(0.0303)
Secondary education (=1)					0.11
					(0.0708)
Bachelor's degree (=1)					0.039
					(0.0330)
Master's degree (=1)					0.15***
					(0.0474)
Doctoral degree (=1)					0.13
					(0.0791)
Industry fixed effects	NO	NO	NO	YES	YES
N	2470	2255	2019	2019	1532
Pseudo R^2	0.017	0.049	0.060	0.165	0.181

Notes: This table reports marginal effects from probit regressions. For continuous variables, marginal effects are evaluated at the mean. For dummy variables, marginal effects are for a discrete change of dummy variable from 0 to 1. Industry fixed effects are at the NACE 2 digit level. Robust standard errors are reported in parentheses. *, **, *** indicate significance at 10%, 5%, and 1% level, respectively.

Table 11: Product innovations and financing constraints; bivariate probit estimations

Dependent variable:	Product innovation (=1)		Financially constrained (=1)
Model	Probit	Bivariate probit	Bivariate probit
Financially constrained (=1)	0.402 ***	-0.904 **	
Trade payables/Total sales			0.246 **
Fixed assets/Total assets			-0.028
Number of employees	0.025 ***	0.010 *	0.005
Number of employees squared	-0.0001	-0.0001	-0.0001 *
Firm age	0.030	0.018	-0.051
Firm age squared	-0.003	-0.002	0.001
Continuous R&D	1.075 ***	0.922 ***	0.061
Occasional R&D	0.228 **	0.153	-0.476 **
Foreign owner (at least one)	0.058	0.231	0.020
Foreign ownership >50%	-0.365	-0.498	-0.382
MNE	0.753 ***	0.470	-0.143
Owner's age, yrs	-0.001	-0.004	-0.002
Female owner (=1)	-0.140	-0.256 **	-0.193
Secondary education (=1)	-0.111	0.003	0.455 **
Bachelor's degree (=1)	0.120 *	0.232 **	0.058
Master's degree (=1)	0.155	0.235	0.212
Doctoral degree (=1)	0.165	0.339	0.446 *
Firm owned by other company	-0.075	-0.109	-0.146
Industry dummies	*Included*	*Included*	*Included*
Dummy 2009	-1.069 ***	-0.920 ***	0.135
Marginal effect w.r.t. "financial constraint"	0.149 ***	-0.284 ***	-
Elasticity w.r.t. "financial constraint"	0.084 ***	-1.461 *	-
Number of observations	1584	1259	1259

Appendix: SIBiL questionnaire (selected questions)

Our records indicate that the principal activity of your company is [NACE CODE DESCRIPTION]**.Is this correct?**

If R asks why we need to know, say: We need to generally classify company's activities. Do they correspond to what is in our records?

1. YES → go to B3
2. NO → go to B2
98. DON'T KNOW → go to B2
99. NA → go to B2

B2. What is the principal activity of this business? Record verbatim. Classify according to NACE.

_____

B3. Is your enterprise part of a multinational enterprise group?

1. YES
2. NO → go to B4
98. DON'T KNOW
99. NA

B3a. In which country is the head office located? IWER: RECORD VERBATIM

_____

B4. Over the last two years of operations, what percent of your sales was in… ?

IWER: If R finds it difficult to answer the question, ask to provide an estimate.
Check that the sum of all the percentages mentioned sums up to 100%

Country	**%**
1. Latvia	
2. Lithuania and Estonia	
3. other EU countries	
4. CIS member countries (i.e. Russia, Belarus, Ukraine, Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Uzbekistan, and Georgia)	
5. Other countries	

PRODUCT INNOVATION

READ:

The purpose of our survey-obtain information only on innovation or innovations for the last two years (2008 – 2009). We begin with the innovations in products (goods and services). Here we define product innovation as an introduction of a new good or service or a significantly improved good or service. **The innovation (whether completely new or improved) must be novel to your enterprise, but it doesn't necessarily need to be new to your sector or market.** Thus, simple resale of new goods purchased from other enterprises and changes of a solely aesthetic nature here are not considered innovations. It doesn't matter, however whether the innovation was originally developed by your enterprise or by other enterprises.

C1. During the last two years 2008 to 2009, did your enterprise introduce new or significantly improved goods or services?

IWER INFO: If R finds it difficult to answer this question, please provide assistance using the following definitions and industry specific examples from the Oslo manual.

1. YES Please in one sentence describe the innovation _____
2. NO ➔ go to C7

…

C30. During the two years 2008 to 2009, how important were the following factors for hampering your innovation activities or projects or influencing a decision not to innovate? SHOW CARD

		Degree of influence				
		High	Medium	Low	Not relevant	Don't know/NA
Cost factors	**A** Lack of funds within your enterprise or group	1	2	3	9	9
	B Lack of finance from sources outside your enterprise	1	2	3	9	9
	C Innovation costs too high	1	2	3	9	9
Knowledge factors	**D** Lack of qualified personnel	1	2	3	9	9
	E Lack of information on technology	1	2	3	9	9
	F Lack of information on markets	1	2	3	9	9
	G Difficulty in finding cooperation partners for innovation	1	2	3	9	9
Market factors	**H** Market dominated by established enterprises	1	2	3	9	9
	I Uncertain demand for innovative goods or services	1	2	3	9	9
Reasons not to innovate	**J** No need due to prior innovations	1	2	3	4	9
	K No need because of no demand for innovations	1	2	3	4	9

…

APPLICATIONS FOR LOANS

READ: This section is concerned with recent applications for credit. This includes applications for lines of credit and other types of loans. Do not include applications for credit cards, loans from owners, or trade credit with suppliers. Also, do not include applications that were withdrawn or that are still pending. All questions in this section refer to the two year time period in 2008-2009, unless said otherwise.

D6. Did you apply once, more than once, or not at all for new loans, excluding renewals of lines of credit?

1. Once ➔ Go to D8
2. More than once ➔ Go to D7
3. Not at all ➔ Go to D14
9. Don't know/NA

D7. Were the most recent loan applications always approved, always denied, or sometimes approved and sometimes denied?

1. Always approved ➔ Go to D14
2. Always denied ➔ Go to read before **D9**
3. Sometimes approved, sometimes denied
9. Don't know/NA ➔ Go to D14

D8. Was this recent application approved or denied?

1. Approved ➔ Go to D14
2. Denied
9. Don't know/NA ➔ Go to D14

D14. During the last three years, were there times when your firm needed credit, but did not apply because it thought the application would be turned down?

1. Yes
2. No ➔ Go to **READ before 15**
9. Don't know/NA ➔ Go to **READ before 15**

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