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ASSESSING RISK FACTORS OF BUSINESS FAILURE IN THE MANUFACTURING SECTOR: A COUNT DATA APPROACH FROM SWEDEN

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Abstract

The paper investigates risk factors of business failure of small-sized manufacturing firms in Sweden. Traditionally, linear models are applied to estimate the influence of risk factors on business failure by using continuous data. By contrast, in this study a count data approach is employed to deduce consistent Poisson, Quasi-Poisson, and Negative-Binomial estimators by using bankruptcy count data of small-sized Swedish manufacturing firms. Findings confirm that interest and exchange rates are significant determinants of business failure. Moreover, we found that openness is a determinant of business success. Our main finding highlights the role of business productivity, which turned out to be the main risk factor of business failure.

Keywords: Business Failure, Risk Factors, Small-Sized Manufacturing Sector, Count Data, Negative Binomial Estimators

INTRODUCTION

The objective of this study is to investigate the risk factors of business failure of small-sized manufacturing firms in Sweden. In contrast to previous studies, which typically apply traditional (i.e. linear) regression models to estimate the influence of risk factors on business failure, a different methodological approach is used in this paper. Previous studies are usually based on *continuous* data, thus, have produced potentially biased estimates since the specificities of *count* data, like non-negativity and discreetness, cannot be considered (Fox & Monette, 1992; Cameron & Trivedi, 1998). Thus, by incorporating the prior econometric literature on business failure and by using count data, the paper represents a first attempt in finding empirical evidence whether major macroeconomic risk factors can determine firms' failure rate. More precisely, *count data* of small manufacturing firms from Sweden are analysed through a Generalized Linear Model (GLM) (Weddeburn, 1974; Winkelmann, 2008). More technically, a Poisson Maximum Likelihood Model (ML) and a Negative Binomial Maximum Likelihood Model (NB) are implemented in order to deduce unbiased estimators, like Poisson, Quasi-Poisson (QML), and Negative Binomial Maximum Likelihood estimators (NBMLE) estimators, respectively.

The large majority of empirical research on business failure still takes place in a business context, while, as presented below, only few research on small business failure is conducted in an economics (i.e. econometrics) context (Salman et al., 2011). Early research on business failures starts with the seminal paper by Fitz Patrick (1932). The author proposed a set of accounting-ratios as valuable indicators for bankruptcy of 20 firms. Moreover, the first quantitative multivariate study conducted by Altman (1968) predicted business failures of manufacturing firms by using a five factor-based Multivariate Discriminant Analysis (MDA) model. When citing the first econometric study on business failure one can again refer to Altman (1983). The same author employed an Augmented Distributed Lag (ADL) model that gained empirical findings showing that macroeconomic variables, like Gross National Product (GNP), gross corporate profits, money supply (i.e. "M2"), and investors' expectations show a significant impact on a firm's likelihood to survive. Indeed, the study by Altman (1983) can be considered as the first econometric study on business failures, as for the first time macroeconomic variables were considered.

In a subsequent econometric study which employs an Autoregressive Distributed Lag (ADL) Model, Wadhwani (1986) points at the significant impact of both, nominal interest rates and inflation rates on business failure. Later, Turner et al. (1992) are using a Polynomial Distributed Lag (PDL) Model to econometrically test the impact of economic factors on business failures. The authors found out that companies' profitability, liquidity (measured as the flow of bank-lending to the company sector), and the growth of money supply, are key economic determinants of business failure. Moreover, Cuthbertson and Hudson (1996) demonstrated that interest rates and firm profitability are the key drivers affecting the risk of business failures. Similarly, Sharabany (2004) argues in his econometric study that unexpected inflation and increasing rates of interest can be considered as significant determinants of corporate failures. Interestingly, especially small- and medium-sized enterprises (SME) are most affected by this type of credit rationing.

Moreover, Liu and Wilson (2002) can show that beyond economic variables, like interest rates, rates of business formation, price levels, profitability levels, and credit conditions also bankruptcy legislation is a significant determinant of businesses failures. More concretely, according to these authors, in the period between 1986 and 1998, the '*1986 Insolvency Act*' provoked a reduction of the overall level of business failures in the UK. In a further econometric study, Vlieghe (2001) and Liu (2004) are modelling the short and long-run effects of risk factors on corporate failures. By analysing macroeconomic variables through means of Time Series Cointegration and Error Correction Models (ECM), Vlieghe (2001) found out that the debt/GDP ratio, the real interest rate, the deviation of the GDP from the trend, and the level of real wages can be considered as significant long-run determinants of business failures. By contrast, the birth of new companies, the index of property prices, and the nominal interest rate demonstrate significant short-run effects on the rate of business failures. Similar findings obtained by Liu (2004) indicate that businesses' failure rates are affected by interest rates, credit levels, profits, inflation; however, the effect of corporate birth rates on business failure is differing significantly in the short and in the long-run. Of these macroeconomic variables, in particular interest rate appears to be the most significant factor influencing business failure rates. Thus, it can be considered as a feasible policy instrument to reduce the incidence of corporate failures. Similarly to his previous study (Liu & Wilson, 2002), the mitigating effect of the '*Insolvency Act 1986*' on business failures has been confirmed (Liu, 2004).

By employing both, a Times Series Cointegration (TSC) and an Error Correction Model (ECM) approach, Salman et al. (2011) found out that in the long-run, firms' failure rates are negatively related to the level of money supply ('M2'), the Gross National Product (GNP), the rate of economic openness (i.e. measured by the level of exports in relation to the GNP), and the general level of industrial activity. In contrast, business failure rates are positively related to real wage levels. By using a Seemingly Unrelated Regression (SUR) model, Fabling and Grimes (2005) explained the phenomenon of business failure by factors, like economic activity, financial variables and collateral values. Interaction effects among these variables show that an increase of economic activity can reduce the rate of insolvencies. However, this effect disappears after periods of region-specific price shocks, such as increasing property prices or rising inflation rates. Very recently, Harada and Kageyama (2011) made an interesting attempt to further enhance the understanding of macroeconomic aspects of bankruptcy dynamics in Japan by using a Vector Auto Regression (VAR) model. Interestingly, their results show consistent relationships between economic shocks and aggregate bankruptcies, where the absence of price shocks and an expansive monetary policy seem to be able to prevent firms' failure rates.

To sum up, the studies conducted by Liu (2004), Salman et al. (2011), and Harada and Kageyama (2011) are the only ones based on business failure data gained in countries with a Civil Law system. According to Liu and Wilson (2002), bankruptcy laws are key determinants to prevent firm failure. However, all cited studies are based on *continuous* data. This circumstance prevents the consideration of the specificities of *count* data, such as non-negativity and discreetness (Fox & Monette, 1992). As this flaw can lead to potentially biased estimates (Cameron & Trivedi, 1998), the study at hand proposes a first attempt to use count data of small-sized Swedish manufacturing firms. Both, business failure and macroeconomic data is used in the context of a Generalized Linear Modelling (GLM) approach in order to find unbiased evidence of those macroeconomic factors that determine the risk of businesses failures in Sweden (Weddeburn, 1974; Winkelmann, 2008).

The preceding discussion on (i.e. risk-averse) firms is adopted in the specification of the econometric models proposed in this study. From a theoretical perspective, this study further develops the models proposed by Wadhwani (1986), Greenwald and Stiglitz (1993), Cuthbertson and Hudson (1996), and Vlieghe (2001). However, as mentioned, in contrast to previous research, and as suggested by Winkelmann (2008), in this study a count data approach is employed. More precisely, two econometric models are implemented to deduce Poisson, Quasi-Poisson (QML), and Negative Binomial estimators (NBMML), respectively. Previous literature typically applied traditional linear models to estimate the risk of business failures on the base of *continuous data* (Vlieghe, 2001; Sharabany, 2004; Liu, 2004; Salman et al., 2011; Harada & Kageyama, 2011). However, in order to deduce consistent estimators we analyse bankruptcy *count data* of the Swedish (i.e. small-sized) manufacturing sector by using a Generalized Linear Model (GLM) approach. As postulated in the macroeconomics literature (Blanchard, 2011), findings confirm that new enterprises, interest rates, and exchange rates are significant determinants of business failure. However, to our knowledge, no previous research exists, which applies techniques, like Poisson, Quasi-Poisson (QML), and Negative Binomial estimators (NBMML), to model business failures on the base of *count data*. Thus, in order to gain unbiased estimators, with the proposed count data approach we aim to solve the entire system of equations by taking into account any possible empirical correlation between the included independent model variables (Fox & Monette, 1992; Winkelmann, 2008).

The objective of this study is to investigate the risk factors of business failure of small-sized manufacturing firms in Sweden during the period 1986 (Q1) to 2008 (Q4). In contrast to former studies on business failures, economic factors, such as labour productivity, competitive pressure on international markets, productivity of invested capital and innovations will additionally be considered as independent variables to empirically explain the phenomenon of business failure.

The paper is organized as follows: section 2 discusses the theoretical background of the model building procedure. Section 3 presents and critically discusses the variables included in the proposed econometric model. The methodology section 4 introduces into the methods which are applied to analyse count data. Thereby the process of model specification is highlighted. Section 5 critically discusses the gained results from model estimation in the light of the economic literature. Finally, the conclusion and policy recommendations section sums up major findings and sketches the agenda of future research.

THEORETICAL BACKGROUND

Economic literature explains large parts of businesses' economic behaviour by the assumption that firms behave in a risk-averse manner (Stiglitz, 1974; Snowdon & Howard, 2005). Thus, first of all, several macroeconomic theories pointing at firms' risk-aversion will be explored (Blanchard, 2011). Subsequently, the consequences of these findings are examined (Levi, 2014). A first and most obvious explanation which corroborates the assumption on risk-averse firms traces back to imperfections in the equity market. While in traditional Keynesian theory no distinction is made whether a firm's financing base is derived from equity markets or debt markets (Fletcher, 1989), this is a central issue for New Keynesian economists (Mankiw & Romer, 1991a; Mankiw & Romer, 1991b). More concretely, in the case of an equity-based financing regime, firms are sharing risks with the suppliers of financial capital. However, firms have no fixed obligations to repay. By contrast, in the case of a debt-based financing regime, firms clearly have fixed obligations to repay. However, if they fail to meet their obligation to repay, businesses can easily be forced to run into bankruptcy. Thus, if firms do not have sufficient access to equity-based financing, they will especially tend to behave in a risk-averse manner and are, therefore, more likely pushed to debt-based financing regimes (Bondt & Thaler, 1994). In fact, despite the seemingly advantageous equity-based financial sources, firms are typically financing only a relatively small fraction of their investments on the base of equity-linked capital. One possible explanation is the fact that the market values of businesses tend to decline when new equity is issued. Put differently, markets tend to misinterpret the issuing of equity as a signal of economic weakness (Bondt & Thaler, 1994).

Economic literature offers further explanations why firms can be considered as risk-averse (Driscoll & Holden, 2014). One major strand of the literature emphasizes that modern corporations are controlled by managers acting in a highly risk-averse manner, and, although managerial incentive schemes may attempt to reduce this behaviour, they do so only imperfectly (March & Shapira, 1987; Coles et al., 2006). Thus, when stressing the relationship between microeconomic risk-behaviour and macroeconomic outcomes with regard to business failures, it should be considered how managerial risk-aversion affects the behaviour of the firm (Nelson, 1984; Ilmakunnas & Topi, 1999; Weintraub, 2001). More concretely, according to theory, a risk-averse firm will be sensitive to risks associated with any action, including inaction (Laffont & Kihlstrom, 1979). Thus, any production process is considered as risky, since it requires capital investments, takes future time, and there are especially no guarantees that the market will absorb the full amount of produced goods. Thus, firms are uncertain about the consequences of their actions (i.e. so-called '*instrument uncertainty*'), while firms' uncertainty grows with the size of changes of processes and structures (Asplund, 2000). Accordingly, firms are typically showing higher levels of knowledge about their status-quo, than about the consequences of possible managerial actions (Tseng, 2011). Indeed, management decisions in firms are affected by the managers' perceptions of risks, comprising both 'instrument uncertainty' as well as the uncertainty associated with the value of various assets and resources of the firm (Agrawal & Seshadri, 2000).

It can be concluded that at least three factors are influencing managers' perception of specific risk, and thus, their willingness to also bear those risks. One key factor affecting risk perception is the overall state of the economy in terms of economic boom and recession (Holmström, 1998). A second factor is the firm's liquidity condition: in order to maintain its present level of productivity, changes in a firm's cash position are affecting both its liquidity as well as capital needs, respectively. In turn, the cash position is affected by the firms' profitability. Since profits are considered as residuals in economic terms (Jensen, 1986; Bondt & Thaler, 1994), even small price changes may have relatively large effects on profits, thus, on liquidity, especially for those businesses which are showing a high debt-equity ratio. Consequently, the third major factor that is influencing the firms' willingness to bear economic risks is a change of product or commodity prices, respectively. Since almost all debts of businesses are licenced in nominal terms, price changes are showing especially large effects on a firm's liquidity position, thus, on the risk of business failures (Leyden & Link, 2000).

Model Variables

After having briefly examined the theoretical background and the literature about the impact of risk factors on business failures, the objective of this section is to introduce and briefly discuss the variables included in the proposed econometric model.

Openness

This model variable represents the effect of competitive pressure on international markets. More concretely, when the productivity of a certain sector rises, it tends to rise especially for firms that are producing traded goods. Thus, higher productivity is associated with declining prices of traded goods relative to non-traded goods (Levi, 2014). As a result, the demand for firms' internationally traded goods will rise. However, if a firm's productivity is lagging behind, its goods become relatively more expensive. In this study the openness to the (i.e. international) market is proxied by the ratio of Swedish export volume to GNP multiplied by 100.

Productivity

This model variable is broken down into two sub-components:

Labour productivity (Productivity-L)

This variable represents the value added per working hour. The variable is measured by relating the working hours to the value added (per hour) in the small-sized Swedish manufacturing sector. According to economic theory, this variable is considered as an indicator for the efficiency of the employed labour resources (Weintraub, 2001; Blanchard, 2011). Therefore, it is hypothesized that productivity is one of the major factors that enables enterprises to stay in the market by outperforming its competitors. Thus, companies showing a high (aggregated) productivity level will more likely survive and prosper in the context of an open market regime.

Productivity of innovation (Productivity- In)

Based on the ideas of Schumpeter (1942), Romer (1993), together with Ball et al. (1988), developed a new growth theory. More precisely, according to "New Growth Theory", innovations lead to new or improved techniques of production as well as new and improved product outcomes. In turn, this leads to the birth of new firms, but at the same time to the replacement of some older, less productive, firms. Thus, following Romer (1993), we hypothesize in this study, that increasing expenditure rates of new firm-capital and improved techniques (i.e. innovation) within the Swedish manufacturing sector will reduce the number of business failures (Salman et al., 2013). In our study, the productivity of innovation is reflected by a variable measuring the value-added of total expenditures on new capital and improved techniques (innovation).

Real Interest Rate (Interest)

Risk-averse behaviour of firms also explains various aspects of the cyclical behaviour of an economy, such as imperfections within equity markets (Greenwald & Stiglitz, 1993), and the differing extent of leveraging on equity across the various economic sectors (Asplund, 2000). The small- and medium-sized Swedish manufacturing sector, for instance, is characterized by firms with a relatively limited access to equity markets. As a consequence, small-sized manufacturing firms are typically borrowing bank credits in order to finance their ongoing investment activities. However, by doing so, a relatively higher failure risk is achieved, as future returns might not be sufficient in order to meet all fixed debt-based obligations. These extra costs of debt associated with bankruptcy are defined as '*marginal bankruptcy cost*' (Leyden & Link, 2000).

Ideally, both the debt variable and the expected inflation should be taken into account in the proposed econometric model. However, the series of these variables are not available. Thus, in order to overcome this lack of data, we have included in our study the (i.e. adjusted) real interest rate as a proxy for borrowing costs and the expected inflation. This procedure is justified, because changes in the level of prices are directly affecting a firm's debt value (i.e. debts are usually denominated in *nominal* terms). Accordingly, we hypothesize that an increase of real interest rates relative to the cost of borrowing (i.e. obligations to repay), will increase the number of business failures. Thus, in order to most accurately reflect the true cost of borrowing in our econometric model, the real interest rate is adjusted by subtracting the expected change of the level of prices (i.e. inflation).

Nominal Exchange Rate

Theories and studies on the risk-averse behaviour of firms explain why shocks to the economy, whether real or monetary ones, can induce real, large, and persistent economic effects (Greenwald & Stiglitz, 1993). For instance, decreasing export prices lead exporters to reduce their supply as well as their demand for inputs from suppliers, thereby reducing the level of economic net worth (Leyden & Link, 2000). Moreover, this unexpected decline in demand will lead to lower price levels as compared to other sectors. Finally, this effect is accompanied by adverse effects on firms' assets, liquidity positions and investments, respectively.

Globalization

In this study the globalization variable (GL) represents the international degree of economic liberalization. Starting in the early 1990s, most European governments removed existing restrictive regulations regarding financial institutions in order to liberalize financial markets and to embark on the (financial) globalization process by opening up their countries' capital markets to capital flows from abroad (Stiglitz, 2000). This resulted in a lending boom in which banks especially credited the small-sized business sector. This trend was accelerated by lending of massive foreign-borrowing, expanding at rates close to 20% p.a. (Kaminsky & Schmukler, 2008). However, due to weak bank regulation and supervision, losses on loan began to mount. This, in turn, was causing erosions of the bank's capital-base and worth (Hellmann et al. 2000; Semmler & Young, 2010). Nevertheless, the process of financial globalization allows many new small-sized businesses to enter the market. In this study, the degree of the liberalisation of (i.e. European) markets is measured by a quarterly dummy variable (GL). The variable shows a value of one for the period since Sweden is a member of the European Union (i.e. after 1994), and is zero for the period before.

To sum up, as for the statistical signs of the parameters of this study, we expect a negative sign related to labour productivity, capital productivity, exports (openness), and the dummy variable globalization (GL). In contrast, we expect positive signs of the estimated parameters for the interest rate and the exchange rate. All economic data used in the below discussed econometric model testing are official data gained from the Swedish statistical offices (SCB), the Swedish Agency for Growth Policy Analysis, and the the Swedish Central Bank (*Riksbanken*), respectively. All the model variables, except the dummy variable (GL), are variables based on data expressed in Billions of Swedish Krona. The models are tested on the base of quarterly data ranging from 1986 (Q1) to 2008 (Q4). A slight problem of multi-collinearity occurred between the *Productivity-L* and *Productivity-I* variable. Thus, in order to avoid any estimation bias, the proposed model is empirically tested by two equations as discussed in more detail in the next section.

METHODOLOGY: A COUNT DATA APPROACH

This section aims at empirically testing the significance of the discussed risk factors of business failure in the small -sized manufacturing sector of Sweden. We specify two models by separately testing the adequacy of a properly chosen variable sequence for each count data model and by applying various diagnostic tests. More precisely, the method used for testing the presence of generalized multi co-linearity and model misspecification is based on a procedure proposed and implemented by Fox and Monette (1992). The objective is to develop and present a well performing econometric model that best satisfies underlying statistical assumptions and, at the same time, is fully conform to the previously formulated hypotheses.

Traditional estimation methods are based on Ordinary Least Square (OLS) techniques and derived models, such as Generalized Least Square (GLS) and Generalized Methods of Moments (GMM), respectively (Hill et al., 2008). All these types of estimator techniques work most appropriately with *continuous data* (Cameron & Trivedi, 2005). However, they cannot be used to reliably analyse discrete and non-negative data, respectively. Thus, as previously stated, in the study at hand we empirically test a set of equations by using a *count data* approach. More specifically, in order to deliver estimates that converge to unique Maximum Likelihood (ML) parameters, we apply, both, Poisson, Quasi-Poisson, as well as Negative Binomial estimation techniques, respectively (Winkelmann, 2008). Moreover, in order to assess potential problems of overdispersion we utilize a series of Likelihood-Ratio (LR) tests (Weddeburn, 1974). Finally, the model's Goodness of Fit is assessed by the Akaike Information Criterion (AIC) (Schwert, 2009).

The relatively simplest count data model is the Poisson Model (Cameron & Trivedi, 1998). It is widely used in social sciences and can be found in an econometrics context as well (Winkelmann, 2008). The model is based on a Poisson distribution, while estimates are empirically derived by using a Maximum Likelihood (ML) process. Major strengths of Poisson Maximum Likelihood (Poisson ML) estimators are their simplicity as well as the absence of both, the assumption of normality and homoscedasticity, respectively. Finally, if a model is correctly specified it can be considered as robust, even if data is not distributed according to a Poisson random variable (Weddeburn, 1974). The major weakness of the Poisson ML model is that it rarely meets the assumption of equidispersion (i.e. mean and variance of the data are equal).

In order to solve this methodological drawback, Weddeburn (1974) proposed a technique which deduces parameters on the base of a Quasi-Poisson Maximum Likelihood process (Poisson QML). This approach keeps estimators similar to estimators deduced by the original Poisson ML approach. However, it alters the value of the standard deviation, thereby changing the inferential capacity of the model. Consequently, the model's reliability improves as sample size increases: thus, while a Poisson ML-based model can deduce statistical inferences on the base of also relatively small samples, with a Poisson QML model one is forced to use relatively large samples. The second approach to overcome the problem of overdispersion is based on a Negative-Binomial Maximum Likelihood process. This technique can be considered as a generalization of the Poisson regression model, since it has the same mean structure as the Poisson regression approach, plus an extra parameter which controls for overdispersion (Allison & Waterman, 2002). As the major drawback, the Negative-Binomial model is not robust at the condition of underdispersion. Although this condition takes place most seldom, the dispersion parameter is tested in this study. Put differently, in order to avoid any problem of underdispersion it has been ensured that the parameter is statistically larger than zero.

In fact, in this study all the proposed econometric models were subject to various test procedures in order to prove models' reliability and the goodness of fit with the empirical data. More concretely, while for all proposed models a Likelihood Ratio (LR) test was conducted in order to test the criteria of overdispersion, the Negative-Binomial model is also tested for the presence of underdispersion (Fox & Monette, 1992). Moreover, for all models we have tested the criteria of generalized multi-collinearity (Hill et al., 2008; Schwert, 2009, p. 142-143). Finally, in order to assess the models' Goodness of Fit, instead of McFadden pseudo R-square, we used the Akaike Information Criterion (AIC), as in the context of count data the former index is not considered as reliable (Schwert, 2009, p. 771). Originally, we believed that both labour and capital productivity can jointly be integrated in the model. However, test results indicate the existence of collinearity between these two variables. Hence, below we present two different models to estimate the effects of various risk factors on business failures in the Swedish small-sized manufacturing sector.

First of all, we examine the dependent variable which relates to labour productivity (Productivity-L) in model 1; subsequently, we examine the dependent variable with the productivity of the new firm-capital for innovation (Productivity-I) in model 2. The two models are estimated by all three described techniques to analyse count data, namely, Poisson, Quasi-Poisson, and Negative-Binomial Maximum Likelihood approaches, respectively (Weddeburn, 1974; Allison & Waterman, 2002; Winkelmann, 2008). In this study, we examine quarterly time series data from 1985 (Q1) to 2008 (Q4). All independent variables are transformed into the natural logarithms (Cameron & Trivedi, 2005), while the data variable is indexed (i.e. year 2000 = 100). Moreover, the degree of the liberalisation of (i.e. European) markets is measured by a quarterly dummy variable (GL). The variable shows a value of one for the period since Sweden is a member of the European Union (i.e. after 1994), and is set to zero for the preceding period. All economic data analysed in this study are gained from the *Swedish Statistical Central Bureau* (SCB, 2009), while the exchange rate data were received from the *Swedish Central Bank*. Estimations were conducted with the statistical program packages STATA (Ver. 11) and E-Views (Ver. 8), respectively. The models are specified as follows:

Model 1

Number of business failures = $\beta_0 + \beta_1 \text{Exchange rate} + \beta_2 \text{GL} + \beta_3 \text{Openness} + \beta_4 \text{Real interest rate} + \beta_5 \text{Productivity} - \text{L} + \varepsilon_i$

Model 2

Number of business failures = $\beta_0 + \beta_1 \text{Exchange rate} + \beta_2 \text{GL} + \beta_3 \text{Openness} + \beta_4 \text{Real interest rate} + \beta_5 \text{Productivity} - \text{I} + \varepsilon_i$

EMPIRICAL RESULTS

As discussed in this paper, the theoretical specification of the model consists of five variables (i.e. openness, innovation productivity, labor productivity, exchange rate, and real interest rate). In addition to these macroeconomic factors proposed by theories pointing at managers' risk-aversion, the model also considers the effect of globalization and competitiveness on the liberalized (i.e. European) market by a dummy variable (GL). In order to improve the robustness of the results, the sample of time series data starts at 1985 (Q1) and ends in 2008 (Q4), thereby excluding effects of the financial crisis on economic sectors (Stiglitz, 2000; Semmler et al., 2010).

Before discussing estimated model parameters, we provide basic statistics gained by the analysis tool STATA (version 11). Table 1 shows Pearson correlation coefficients between included model variables, while table 2 displays means, standard deviation and other descriptive statistics.

Table 1: Correlation among Independent Variables

Correlation	Openness	Productivity_I	Productivity_L	GL	Exchange rate	Interest rate
Openness	1					
Productivity-I	-0.393	1				
Productivity-L	0.737	-0.417	1			
GL	0.474	-0.267	0.812	1		
Exchange Rate	-0.791	0.089	-0.407	-0.238	1	
Interest rate	0.581	-0.097	0.875	0.815	-0.368	1

Table 2: Descriptive Statistics of Model Variables

	Openness	Productivity_I	Productivity_L	GL	Exchange Rate	Interest rate	SMEF
Mean	29.652	6.052	2.415	0.625	7.114	12.117	256.968
Median	29.322	5.843	2.309	1.000	6.925	12.066	215.500
Maximum	37.292	9.422	4.463	1.000	9.420	14.237	676.000
Minimum	20.175	4.516	0.848	0.000	5.630	10.630	104.000
Std. Dev.	4.645	1.031	0.936	0.486	0.978	0.976	129.396
Skewness	-0.168	0.891	0.156	-0.516	0.505	0.225	1.966
Kurtosis	1.888	3.540	1.932	1.266	2.174	1.989	6.016

Table 2…

Jarque-Bera	5.395	13.876	4.951	16.284	6.801	4.896	98.223
Probability	0.067	0.000	0.084	0.000	0.033	0.086	0.000
Sum	2846.638	581.038	231.871	60.020	683.03	1163.25	1388.069
Sum Sq. Dev.	2049.974	101.166	83.320	22.501	90.972	90.620	1926735.54
Observations (N)	96	96	96	96	96	96	96

Below we present and discuss significance results gained by employing a count data approach. As mentioned, the Poisson ML, the Poisson QML and the Negative Binomial ML techniques have been applied in order to reliably quantify the effect of risk factors on business failures in the small – size Swedish manufacturing sector. The parameters for the proposed econometric models (1) and (2) are estimated with the statistical software package '*R*', thereby using the sub-modules 'MASS', 'AER', 'CAR', and 'LMTEST' (Venables & Smith, 2015). Table 3 provides estimation results pair-wise for model (1) and (2), respectively.

Table 3: Estimation Results

	Poisson ML		**Poisson QML**		**Negative Binomial ML**	
Variable	(1)	(2)	(1)	(2)	(1)	(2)
Constant	**3.857**	**5.821**	**3.857**	**5.821**	**4.066**	**6.184**
	(0.263)*	(0.217)*	(0.683)*	(0.676)*	(0.630)*	(0.665)*
GL	**0.565**	**0.452**	**0.565**	**0.452**	**0.592**	**0.504**
	(0.025)*	(0.023)*	(0.086)*	(0.086)*	(0.059)*	(0.079)*
Exchange Rate	**0.175**	**0.132**	**0.175**	**0.132**	**0.170**	**0.128**
	(0.012)*	(0.012)*	(0.032)*	(0.036)*	(0.029)*	(0.035)*
Interest Rate	**0.140**	**-0.034**	**0.140**	**-0.034**	**0.127**	**-0.072**
	(0.014)*	(0.013)*	(0.037)*	(0.047)	(0.036)*	(0.042)
Openness	**-0.028**	**-0.053**	**-0.028**	**-0.053**	**-0.028**	**-0.051**
	(0.003)*	(0.003)*	(0.008)*	(0.009)*	(0.008)*	(0.009)*
Productivity-L	**-0.347**		**-0.347**		**-0.349**	
	(0.021)*		(0.048)*		(0.0519)*	
Productivity-I		**0.071**		**0.071**		**0.079**
		(0.007)*		(0.025)*		(0.021)*
ln(Alpha)					-4.026	-3.716
					(0.255)*	(0.205)*
AIC	1253.709	1485.923	1253.709	1485.923	969.465	1035.766
Log-Likehood	-620.854	-707.243	-620.854	-707.243	-477.732	-490.167
LR Chi²(5)=	4502.475	4329.698	4502.470	4329.698	4788.719	4763.849
LR Test P-Value	0.000	0.000	0.000	0.000	0.000	0.000

Standard error in parentheses; * Sign at 1% level; p-Values calculated on the base of Z-test

By looking at the LR test, which is a test of the overdispersion parameter Alpha, it can be shown that the data are affected by overdispersion (Fox & Monette, 1992). In cases where the overdispersion parameter Alpha is zero, the Negative Binomial (NB) distribution is equal to a Poisson distribution (Weddeburn, 1974). In our case, however, Alpha is significantly different from zero. This indicates that the results obtained from both, the Poisson ML models and the Poisson QML models should not be considered as sufficiently valid (Schwert, 2009). Therefore, we will concentrate our discussion in subsequent sections exclusively on results gained from the Negative Binomial Maximum Likelihood model, as shown in column 5 and 6, respectively (Table 3). Moreover, next to overdispersion, we tested the Negative Binomial ML model also for underdispersion. As can be seen from the ln Alpha test, the parameter is always different from zero (Table 3). Finally, equation in column 6 (Table 3) is favored by the Akaike Information Criterion (AIC).

Coefficients of the Negative Binomial ML model can be interpreted as semi-elasticities. This is the case, since a count data model is equivalent to the GLM method with a natural logarithm link function as typically shown by log-linear models (Hill et al., 2008, p. 93). Put differently, the coefficients indicate the relative variation of the conditional expected value for a variation of the i^{th} unit of the covariate, leaving other estimators constant (Weddeburn, 1974).

Results for Negative Binomial ML model (1)

According to our model estimates, *globalization* (GL), measuring the degree of competitiveness on European markets, shows a clear propensity to increase business failures. While, in fact, during the period of the analysis the competitiveness among European manufacturing firms strongly increased, a marginal increment of the Globalization variable increases the number of business failures by 59.2% per quarter (Table 3). Interestingly enough, if compared with other independent variables, it can easily be shown that this variable has the relatively strongest impact on the risk of business failures in the Swedish manufacturing sector.

As hypothesized in this study, and successfully tested in previous studies (Liu & Wilson, 2002; Sharabany, 2004), also the (i.e. nominal) *exchange rate* shows the power to significantly affect business failures. More precisely, a marginal increment of the exchange rate variable might increase the number of business failures by 17% per quarter (Table 3). This clearly implies that monetary policies seem to have a relatively strong influence on the risk of business failures of certain economic sectors.

As discussed in this paper, previous studies have empirically shown that the (real) *interest rate* has a significant influence on the number of business failures (Cuthbertson & Hudson, 1996; Vlieghe, 2001; Liu, 2004). These findings should also hold true especially for the study at hand, as the manufacturing sector is dominated by small and medium-sized firms with a relatively limited access to equity markets. Therefore, companies are expected to be particularly volatile, as future returns might not be sufficient to meet fixed obligations from borrowing (Stiglitz, 2000). Accordingly, theory on risk-aversion has been successfully applied when studying management behavior under risk (March & Shapira, 1987; Bondt & Thaler, 1994). Also in the study at hand, the (i.e. real) interest rate shows a significantly positive effect on business failures, as a marginal increment of the interest rate variable might increase the number of business failures by 12.7% per quarter (Table 3).

As shown in previous research (Salman et al., 2011), also the empirical estimates gained by this study show that the *openness* variable is significant and has the expected (i.e. negative) sign. More precisely, a marginal increment of market openness might decrease the number of business failures by 2.8% per quarter (Table 3).

The productivity of labour (*Productivity-L*) is considered as one of the main macroeconomic determinants responsible for the survival of businesses (Weintraub, 2001; Blanchard, 2011). Labour productivity effects are, first of all, determined by both, the levels of experience, education, and skills of the actual work force (Benjamin et al., 2007). However, as theorized by Schumpeter (1942), and later by Romer's (1993) "New Growth Theory", labour productivity can be explained by the practiced management styles within business systems as well. In fact, if a company is poorly managed, business processes and structures are less improved, poorly designed and organized, labour productivity will be impaired. Thus, the employed staff will make less value-added per hour. In fact, in the econometric study at hand, the labour productivity variable is significant and shows the hypothesized negative effect on business failures within the Swedish manufacturing sector. More concretely, a marginal increment of the labor productivity variable might decrease the number of business failures by 34.9% per quarter (Table 3).

Results for Negative Binomial ML Model (2)

Like for the Negative Binomial ML Model (1), the temporal dummy variable *globalization* (GL), measuring the competitiveness on (i.e. European) trade markets, shows a relatively strong impact on business failures of (small and medium-sized) manufacturing firms in Sweden. In fact, during the analysis period (i.e. 1985–2008), competitiveness among European manufacturing firms strongly increased. More precisely, a marginal increment of the globalization variable (GL) increases the number of business failures by 50.4% per quarter (Table 3).

As hypothesized, the (i.e. nominal) *exchange rate* significantly affects business failures in the Swedish manufacturing sector (Sharabany, 2004). According to the gained results, a marginal increment of the exchange rate variable might increase the number of business failures in the Swedish manufacturing sector by 12.8% per quarter (Table 3). Similar to the analysis outcomes of the Negative Binomial ML Model 1, this implies that monetary policies have a relatively strong influence on the risk of business failures.

Interestingly enough, contrary to some previous studies (Cuthbertson & Hudson, 1996; Vlieghe, 2001; Liu, 2004), the Negative Binomial ML Model (2), reveals that the (i.e. real) *interest rate* does not show any significant effect on business failures in the Swedish manufacturing sector (Table 3).

However, similar to the analysis outcomes of the Negative Binomial ML Model (1), the *openness* variable (i.e. measured as the ratio of the export volume to GNP) is strongly significant. In line with findings by Salman et al. (2011), results show that the factor is negatively related to the dependent variable, thus, leading to a reduction of business failures. More precisely, a marginal increase of the openness variable might decrease the number of business failures within the Swedish manufacturing sector by 5.2% per quarter (Table 3). In our study, the openness variable (i.e. ratio of export to GNP) shows the relatively smallest effect on business failures. Finally, it is important to note that between the openness variable and the globalization (GL) variable a moderate positive correlation (i.e. r = 0.474) exists (Table 1). In fact, due to its potential to increase competition, the variable could also increase business failure. In this case, the openness variable would be positively related with the business failures variable.

As theorized by *New Growth Theory* (Romer, 1993), the productivity of innovation is considered as the main factor that positively affects the number of firms going into business. As a consequence, a higher productivity of innovation within a specific economic sector may lead to higher aggregate demand and, finally, the birth of new firms. Thereby, however, a downward pressure is put on the existing stock of firms, whose likelihood of going out of business will be increased. In fact, also in the econometric study at hand, the measured effect of the productivity of innovation variable (*Productivity-I*) is significant and shows the hypothesized (i.e. positive) effect on business failures within the Swedish manufacturing sector. More concretely, a marginal increment of the innovation productivity variable might increase the number of less innovative firms going out of the business by 7.9% per quarter (Table 3).

CONCLUSION AND POLICY RECOMMENDATIONS

In this paper we investigated the macroeconomic risk factors of business failure of small-sized manufacturing firms in Sweden during the period 1986 (Q1) - 2008 (Q4). Former empirical research on risk factors of business failures is typically based on *Ordinary Least Square* (OLS) techniques and derived models, such as Generalized Least Square (GLS) and Generalized

Methods of Moments (GMM), respectively (Liu & Wilson, 2002; Sharabany, 2004; Liu, 2004; Harada & Kageyama, 2011). Although these methods of parameter estimation are most suitable for the analysis of *continuous data*, they cannot be used to reliably analyse *count data* (Cameron & Trivedi, 2005). Thus, in order to draw more reliable and subtle inferences as well as to overcome difficulties caused by count data, we employed a *count data* approach (Weddeburn, 1974). More precisely, when analysing bankruptcy *count data* of Swedish manufacturing firms and in order to deduce consistent estimators we implemented a Poisson ML, a Quasi-Poisson ML, and a Negative Binomial ML model, respectively (Winkelmann, 2008). While the Poisson ML models were considered as biased due to overdispersion, both, the Quasi-Poisson ML and the Negative Binomial ML models turned out to be robust (Fox & Monette, 1992). Finally, the Akaike Information criterion (AIC) indicated that the results of the Negative Binomial ML models should be favoured over those of the Quasi-Poisson ML model (Allison & Waterman, 2002). Thus, in this paper, the results of the Negative Binomial ML models were exclusively adopted for our interpretation.

To sum up, as hypothesized by the theory of the firm regarding risk-averse management behaviour (March & Shapira, 1987; Bondt & Thaler, 1994; Coles et al., 2006), and by '*New Growth Theory*' (Romer, 1993), macroeconomic determinants such as, the exchange rate, the (i.e. real) interest rate, the ratio of the manufacturing export volume to GNP (i.e. *openness* variable), and labour productivity (i.e. *productivity–L*), emerged as the most significant risk factors of business failure in the small and medium-sized Swedish manufacturing sector. Moreover, it is worth mentioning the positive sign of the productivity of innovation variable (*productivity-I*), which is considered as one of the main factors that positively affects the number of firms going into business (Romer, 1993). Thus, a higher innovation rate may lead to higher aggregate demand and births of new firms, thereby putting downward pressure on the existing number of firms going out of business. In fact, also in the study at hand, the innovation productivity variable (*Productivity-I*) is significant and shows the hypothesized positive effect on business failures. Finally, by using a temporary dummy variable (GL), we have also investigated whether liberalization trends on the (i.e. European) trade markets should be considered as a significant driver of business failures in the Swedish manufacturing sector. Starting with 1995, the gained econometric results show that the Swedish manufacturing sector is facing an increasing level of international competition. In fact, this liberalization trend on European trade markets is showing the relatively strongest impact on the risk of business failures of manufacturing firms in Sweden.

To conclude, by applying a Negative Binomial ML model the proposed econometric study supported various supply-side economics hypotheses deduced from 'New Growth Theory'

(Romer, 1993) and new & old Keynesian theories of the firm regarding risk-averse management behaviour (Greenwald & Stiglitz, 1993). It is planned to repeatedly apply the proposed *count data* approach, which has been successfully implemented and validated in this study when assessing the risk factors of business failures in other economic branches than the manufacturing sector. However, future econometric studies using a count data approach will consider additional factors that co-determine the risk of business failure, such as government regulations and consumer behaviour (Liu, 2004).

STUDY LIMITATIONS AND FURTHER RESEARCH

Some authors, such as Alesin et al. (2000), postulate a trade-off between economies of scale and ethnic heterogeneity. Indeed, it is known from previous studies, that ethnic heterogeneity is correlated with the number of newly established small–sized businesses (Salman et al., 2013). Thus, the main limitation of this study is related to the difficulty to empirically consider an ethnic heterogeneity variable. Glaeser & Saks (2004) argue that, if there are many ethnic groups in a society, politician and bureaucrats tend to display an ethnocentric behavior, implying that members of a specific ethnic group continue to support politicians of their own ethnic group, even by knowing that these politicians are corrupt. This, however, heavily influences governances, which create a bias to incentive fractionation of new firms and, therefore, also affect the formation of social capital (ibid, 2004).

Second, additional reasonable economic variables, such as inflow of foreign direct investment, are omitted in this study due to collinearity problems. Further research could, thus, extend the proposed model by looking especially at those factors that co-determine the survival of small-sized firms in different sectors of the economy, given that these sectors use different technologies and have different skill requirement as well as levels of profitability. From a methodological perspective, more robust results could be obtained by using panel data analytical techniques (Hsiao, 2003). Finally, the present study can be extended by employing both micro- and macro-economic data, especially in order to analyze the effects of differing tax regimes on small-sized firms' survival rate and profitability within various sectors of an economy (Peng & Luo, 2000; Anderson et al., 2002).

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