Manufacturing enterprises in Germany and their vulnerability to crises – findings of a risk analysis using annual financial statement data

The increasing duration of the financial and economic crisis has also led to the strongly growing awareness of a need for systematic observation and periodic analysis of the risk potential in economic systems. While studies are conducted regularly in the banking sector, say, in the form of stress tests at least of the largest institutions, there have so far been only a few cross-enterprise approaches to measuring and evaluating risk for the real sector, even though the existing close links between the real sector and the financial system mean that it is quite possible for them to interact in ways that impact on the economy as a whole.

The present article classifies the determinants of the risk of non-financial corporations and studies them on the basis of relevant risk metrics using a comprehensive data set from the Bundesbank's Financial Statements Data Pool. The focus is on the enterprises' vulnerability to crises, which manifests itself in poor profits and which can often provide important clues about shortcomings and structural irregularities in the corporate sector long before enforced market exits.

The empirical analysis makes it clear that enterprises which are vulnerable to crises are to be found mainly in industries where demand is highly sensitive to the business cycle and in sectors of the economy with structural problems. Particular drivers of risk in the financial sector are a high level of debt, which places a strain on profitability through the negative leverage effect, and, in operations, relatively rigid cost structures in the case of staff cost and other operating charges. Evidently, crises initially result in considerable cost stickiness if shortfalls in demand force the affected enterprises to cut back their output, resulting in a further deterioration in profitability and liquidity.

The findings of the study also suggest, however, that the German industrial sector possesses a high risk absorption potential. As a result, not only has it come through the financial crisis quite well so far; it is also tended to stabilise the financial system, rather than placing a further strain on it through adverse feedback effects. Even for most of the enterprises that were rated as vulnerable, it has not taken long to remedy the weaknesses in profitability that had become apparent. Although a very open economy, such as Germany's, has a generally high risk exposure, a quite vital part in this is likely to have been played by the German economy's sound price competitiveness and cost-oriented flexibility in production as well with its high degree of regional sales diversification.

The significance of risks to the economy as a whole

Risk potential in the real sector not adequately studied so far

The financial and economic crisis and the resulting strains on the financial system and the real economy have revealed the need for as systematic an analysis as possible of the risks and shortcomings in parts of the economy and the intermediary transmission and feedback mechanisms. While, in the banking sector, risk assessments are conducted regularly, say, in the form of stress tests of systemically important institutions, there have so far been only a few cross-enterprise approaches to a systematic measurement and analysis of the risk situation.[1]

Possible contagion effects from the real sector

The potential risks emanating from the production sector and the non-financial services sector are, admittedly, different in nature from those in the case of internationally operating major banks. The banking system is typically tightly interconnected within a close-meshed network of financial market segments and infrastructures and is shaped by the existence of big systemically important players.[2] By contrast, difficulties experienced by non-financial corporations initially have an impact – via the link between input and output – on suppliers, buyers and employees as well as, specifically in the case of groups, on financially affiliated firms. Joint exposures of parts of the banking sector to certain sectors of the economy also form potential transmission channels for infecting the financial system with real economic shocks.[3] Imbalances in the real sector resulting from demand or cost shocks can thus have a direct and indirect impact on the economy as a whole and cause welfare losses.[4] Seen in that light, it seems obvious to use risk identification approaches to conduct a systematic analysis not only of the financial system, but also of the real sector's vulnerability to crises.[5]

Typical basic risks

To a certain degree, fluctuations in the utilisation of capacity in a market economy are quite normal, however, and do not necessarily lead to deep or protracted recessions. Rather, innovation-driven processes in the corporate sector lead to "creative destruction":[6] market exits by enterprises together with economic structural change constitute typical side effects of an economy that is constantly in the process of searching and adjusting. They are a normal part of a dynamic, changing economy and are an underlying inbuilt risk of the system.

Weak profitability as an indicator of risk potential

Nevertheless, especially over the past few years as a result of the financial crisis, volatility in many markets and the correlations between them have perceptibly increased. This has intensified the fluctuations in profits and the resulting crisis-related stresses and strains on the corporate sector worldwide. Even though it is only such a higher volatility of corporate profit and loss indicators which creates the necessary incentives for firms and investors to price and restructure the risk of their assets and liabilities positions accordingly, they also constitute important indicators of vulnerabilities to crises in the corporate sector. They are a kind of early warning indicator.

1 For an example of such an analysis, see Deutsche Bundesbank, Firm-level and aggregate output volatility, Monthly Report, October 2009, pp 35-48.
2 See Deutsche Bundesbank, Macroprudential oversight in Germany – framework, institutions and tools, Monthly Report, April 2013, pp 39-54.
3 See Deutsche Bundesbank, The European Systemic Risk Board: from institutional foundation to credible macroprudential oversight, Monthly Report, April 2012, pp 29-39.
4 The real estate crises in Spain and Ireland and the resulting large number of distressed housing loans on the balance sheets of those countries' credit institutions are a prime example of how quickly undesirable developments in the real sector can, under certain conditions, be transmitted to the financial system.
5 An analytical approach of this kind is proposed, for example, by the Financial Stability Board and the IMF in the context of the G-20 Data Gaps Initiative (DGI). See Financial Stability Board, International Monetary Fund, The Financial Crisis and Information Gaps, Fourth Progress Report on the Implementation of the G-20 Data Gaps Initiative, Washington 2013, p 7.
6 See J A Schumpeter, Capitalism, Socialism, and Democracy, New York, 1946, p 136 ff.

Theoretical and empirical points of approach to risk analysis in the real sector
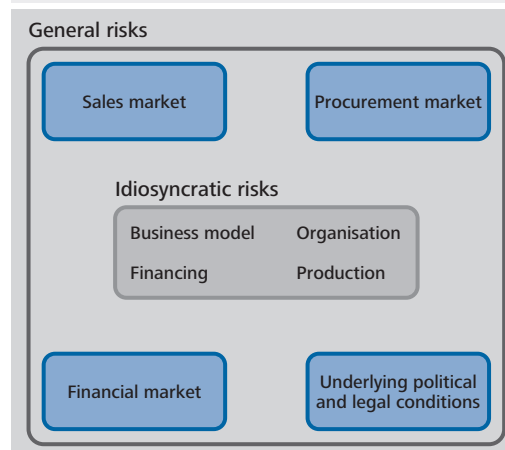
Portfolio-theoretical approach

The relationship between profit and risk is explained, above all, by financial portfolio theory. This states that the risk of a financial investment or an investment in a fixed asset can be identified by the fluctuations in the return, but that, owing to the existence of correlations, not only individual investments, but also the entire portfolio have to be analysed. Following this basic idea, the risks of non-financial corporations can be assessed in the form of uncertain maximum losses using special financial risk scores. Such an approach systematically reveals the corporate sector's vulnerabilities to demand and cost shocks, thus pinpointing weaknesses that may harbour a relevant risk potential for the economy as a whole, mostly long before insolvency forces enterprises to exit the market.

Distinction between idiosyncratic and general risk factors

When looking for the causal factors behind such vulnerabilities, it is generally possible to make a distinction between two levels. First, there are (non-systemic or idiosyncratic) risk factors which lie primarily within the sphere of responsibility of the enterprise itself and which apply equally to many enterprises in the same or a similar way. Such idiosyncratic risks include, in particular, fluctuations resulting from the individual enterprise's business model. The business model comprises all strategic decisions on the deployment of resources and on the in-house process of creating goods and services. Closely interrelated with such fundamental strategic decisions are organisational decisions, which, in turn, may harbour their own risks.

At the higher level are systemic risk factors, which are exogenous determinants of the overall risk to which more or less all enterprises are exposed in a given market or country and which are therefore called "market risk" and "country risk" respectively. From a firm's point of view, this component chiefly comprises the fluctuations on the sales and procurement mar-

kets. The latter includes not only price shocks and exchange rate movements as well as shortages on the commodities and energy markets, but also problems in recruiting suitable skilled staff.

Risk measurement starts with the annual profit or loss before tax

A suitable reference variable for empirical risk analyses using non-financial corporations' annual financial statement data is, first and foremost, the annual profit or loss (before tax). This is expressed as a percentage of sales in order to eliminate any influences of the results due to the considerable size differences between the analysed firms. What argues in favour of the annual profit or loss before tax is the fact that it provides a profit ratio which is not distorted by transfers of profit or loss or by the differences in tax treatment between non-corporations and corporations.[7]
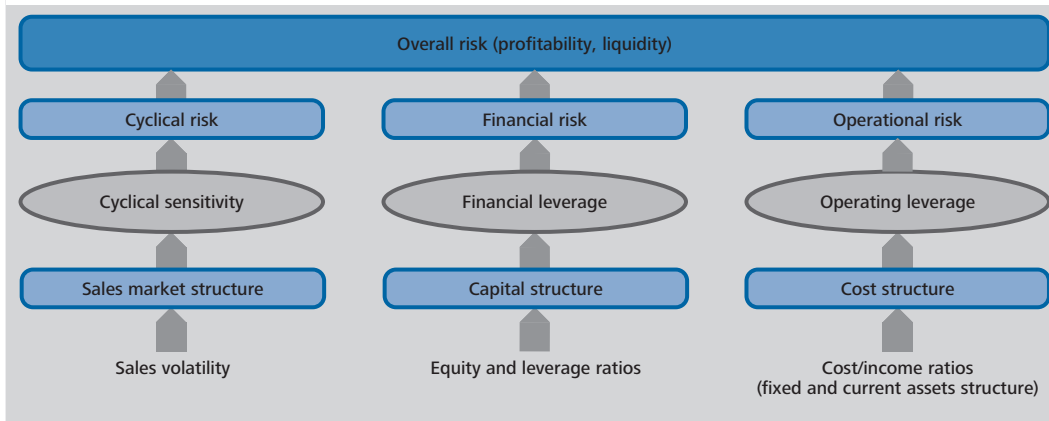
Reduction of the complex causal factors to market risk as well as financial and operational risks

When operationalising the various explanatory factors of the risk exposure, allowances are to be made in comparison with nuanced theoretical analyses, as, in some cases, no empirical information is available for the determinants

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Classification of entrepreneurial risks

General risks

Sales market | Procurement market

Idiosyncratic risks

Business model | Organisation
Financing | Production

Financial market | Underlying political and legal conditions

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7 Cash flow is an obvious choice as an alternative or supplementary profit and loss ratio, since it captures the liquidity situation, which is crucial for maintaining the enterprise's solvency. The results based on cash flow largely match the results based on annual financial statement data, however, and are therefore not shown here.

Key points of approach to risk analysis using annual financial statement data in the real sector

Overall risk (profitability, liquidity)		
Cyclical risk	Financial risk	Operational risk
Cyclical sensitivity	Financial leverage	Operating leverage
Sales market structure	Capital structure	Cost structure
Sales volatility	Equity and leverage ratios	Cost/income ratios (fixed and current assets structure)

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deemed to be relevant in the theory or because firm-specific and general risks overlap, which means that it is often impossible to separate the risks clearly. For those reasons, the empirical analysis requires a reduction to a section of observable and separable risk factors.

The present empirical analysis is confined to three aspects: the cyclical risk, and thus the systemic problems that arise through sales market fluctuations are measured by sales volatility. As firm-specific factors, the focus is on financial and operational risks, which are captured using capital and cost structure ratios. Unfavourable effects on corporate earnings can thus be explained by the capital structure having negative leverage or by operating cost components not being sensitive or only weakly sensitive to sales.

Measurement with the commonly used risk metrics

When measuring the risk profile of enterprises in the manufacturing sector, the study employs conventional risk metrics taken from of financial portfolio theory. These figures were originally developed for investment portfolio management and for managing risks in banks' trading books and are now also used in macroeconomic analyses.[8] Among the various measures, Value-at-Risk (VaR; threshold of a distribution, with precisely 1% of enterprises achieving results below this figure in the following study)[9] and the Conditional Value-at-Risk (CVaR; ex-

pected value of the results below the VaR) as well as Mean Excess Loss (MEL; expected value of the loss of enterprises which are in the red) are used as a traditional measure of risk.[10] Additional aspects, such as the need for a minimum remuneration of the invested capital or the imputed entrepreneurial income left aside in the case of non-corporations, cannot be considered, however, owing to difficulties of statistical quantification.

The empirical study focuses initially on the question of the measurement results of the selected risk metrics and their sensitivity with regard to the financial and economic crisis. To do this, the three aforementioned risk measures, which represent the threshold values for forming the subsamples of tail and non-tail enterprises,[11] are calculated time-invariantly for

Study approach

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8 See, for example, G De Nicolò and M Lucchetta, Systemic Real and Financial Risks: Measurement, Forecasting, and Stress Testing, IMF Working Paper, WP/12/58, 2011, p 6. and M Brun, F Chai, D Elgg et al., Equity Capitalization and Net Worth at Risk, How resilient are non-financial corporations in a crisis environment?, Working Paper of the European Committee of Central Balance Sheet Data Offices, January 2013.
9 The first quantile is generally used in financial analyses as the threshold for the probability of error.
10 These measures are described in greater detail in the methodological annex on pp 62-63.
11 Tail enterprises are to be understood as those firms whose ratios lie at the (lower or upper) end of a distribution when compared with a threshold value and are in this sense described as risky.

Distribution of the return on sales of the manufacturing sector in the period from 2000 to 2011

Relative frequency in %

Gross return on sales in %
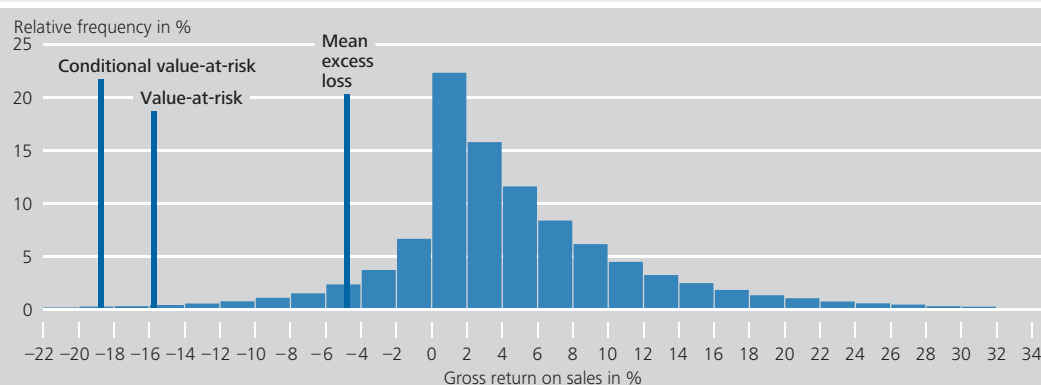
Value-at-risk: first quantile of the gross return on sales; conditional value-at-risk: enterprises' expected loss below the VaR; mean excess loss of enterprise with negative return on sales.
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all the manufacturing enterprises contained in the Deutsche Bundesbank's Financial Statements Data Pool over the entire observation period from 2000 to 2011. Additionally, year-specific risk parameters are calculated on the basis of a reference group of enterprises during the observation period. In this way, it is possible to analyse movements of the risk parameters before, during and after crisis periods. This provides information, in particular, on the shock sensitiveness of the different measures. The conclusion is formed by a detailed analysis of crisis-prone enterprises for the period from 2006 to 2011. This reveals the extent to which the different firms' business models possess specific risk profiles and what factors are crucial in shaping the measured risk of the enterprises in the risky tail.

A comparison of manu-facturing enterprises' risk metrics

Left-tailed distri-bution of the return on sales and …

The distribution of the return on sales, which was calculated on the basis of the entire data-set for manufacturing enterprises in the observation period from 2000 to 2011 and therefore uses around 270,000 annual financial statements from the Bundesbank's Financial State-

ments Data Pool,[12] shows a clearly left-tailed or right-tailed underlying pattern.

… major differ-ences in assess-ment of risk between the metrics

In at least one of those years, a loss can be noted for 18½% of the annual financial statements. Furthermore, it becomes obvious that the three selected metrics lead to major differences in the assessment of risk. The MEL (with the reference value z=0) covers most of the negative range of the distribution given a gross return on sales of -4.8%. This mean of the enterprises with negative performance is 11 percentage points above the VaR (-15.8%) and 14 percentage points higher than the neighbouring CVaR (-18.8%). This clearly shows that the VaR and CVaR refer more to the extreme cases, since they start at the first quantile, while the MEL is directly coupled to the loss threshold and thus based on a deliberately cautious assessment of risk. With the MEL, 6.8% of the enterprises are classified as risky on an average of the whole observation period, since their gross returns on sales are on the other side of the critical threshold of -4.8%. By definition, this share is 1% in the case of the VaR. For the CVaR, only 0.5% of firms fall into this risk group.

[12] See also Deutsche Bundesbank, German enterprises' profitability and financing – an analysis based on a new data set, Monthly Report, October 2005, pp 31-67.

Percentage of enterprises in the tail by economic activity*

Position	Risk parameters		
	Mean Excess Loss[1]	Value at Risk[2]	Conditional Value at Risk[2]
Economic activity			
Manufacture of food products, beverages and tobacco products	4.70	0.53	0.28
Manufacture of textiles	9.04	1.29	0.58
Manufacture of wearing apparel, leather and related products	8.20	1.16	0.47
Manufacture of wood and products of wood and cork	7.03	0.94	0.42
Manufacture of paper and paper products	6.73	1.07	0.51
Publishing and reproduction of recorded media	8.36	0.92	0.48
Coke and refined petroleum products	3.23	0.59	0.00
Manufacture of chemicals and pharmaceutical products	6.60	1.17	0.57
Manufacture of rubber and plastic products	6.34	0.94	0.40
Manufacture of other non-metallic products	8.86	1.37	0.59
Manufacture of basic metals	6.50	0.90	0.40
Manufacture of fabricated metal products	5.98	0.82	0.40
Manufacture of computer, electronic and optical products	7.12	1.23	0.56
Manufacture of electrical equipment	6.55	0.87	0.45
Manufacture of machinery and equipment	6.67	1.06	0.53
Manufacture of motor vehicles, trailers and semi-trailers	8.52	1.44	0.61
Other transport equipment	8.80	1.60	0.97
Manufacture of furniture	8.05	1.09	0.51
Other manufacturing	7.92	1.39	0.61
Repair and installation of machinery and equipment	5.00	0.78	0.44
Legal form			
Corporations	7.21	1.11	0.53
Non-corporations	5.79	0.76	0.35
Size category (total assets)			
< €2 million	8.96	1.51	0.73
€2 million ≤ €10 million	5.95	0.84	0.39
€10 million ≤ €50 million	6.48	0.91	0.44
> = €50 million	6.15	0.84	0.39
Total	6.77	1.00	0.47

* Calculated on the basis of the complete data set for the manufacturing sector with a cumulative 272,000 annual financial statements in the period from 2000 to 2011. **1** With the reference value z = 0. **2** Based on the first quantile.
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Clear risk hierarchy by economic activity

Within the manufacturing sector, these tail percentages differ considerably across economic activities. There is a clear hierarchy of risk based on the weak profitability of enterprises with the poorest performance. In terms of all three risk measures, the textiles, glass and ceramics industries, mining and quarrying as well as the manufacture of transport equipment are classified as relatively high-risk, while the manufacture of coke and refined petroleum products, food, beverages and tobacco as well as the repair and installation of machinery and equipment appear to be more low-risk.

Differences in risks by legal form

The three risk metrics also show quite marked differences in terms of their tails with regard to the legal form categories of corporations and non-corporations. Non-corporations are not represented as strongly in the tail as corporations. Nevertheless, it should be borne in mind that the imputed entrepreneurial income is included in the profit in the case of partnerships and sole proprietorships and that their return situation is overstated according to the available data.

Micro-enterprises most exposed to risk

In differentiating the risk measures by firm size, it becomes evident that it is very small enterprises that are much more highly vulnerable to risk. Using all three risk measures, they show higher tail percentages and are thus more strongly represented in the critical distribution section than the other small firms, as well as medium-sized firms and large firms. Obviously, the still unfavourable capitalisation of such micro-enterprises, which also include the category of young firms, means that they are exposed to a considerable funding risk. By contrast, the sustained improvement in the capital structures of SMEs over the past few years has led to their risk profiles becoming notably more like those of large enterprises.[13]

13 See Deutsche Bundesbank, German enterprises' profitability and financing in 2012, Monthly Report, December 2013, pp 41-55.

Percentage of tail enterprises in the balanced sample*

| Year | Risk parameters | | | | | |
| | Mean excess loss | | Value at risk | | Conditional value at risk | |
	%	Annual change	%	Annual change	%	Annual change
2006	3.3		0.4		0.2	
2007	2.5	− 0.8	0.2	− 0.2	0.1	− 0.1
2008	3.6	1.1	0.4	0.2	0.2	0.1
2009	10.9	7.3	1.6	1.2	0.7	0.6
2010	5.2	− 5.7	0.6	− 1.0	0.3	− 0.4
2011	4.0	− 1.2	0.4	− 0.2	0.2	− 0.1
Total	4.9		0.6		0.3	

* Results of a balanced sample of 9,558 manufacturing enterprises. Non-year-specific threshold values calculated on the basis of the complete data set for the manufacturing sector with a cumulative 272,356 annual financial statements in the period from 2000 to 2011.
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Comparing risk metrics over time

Study on the basis of a balanced sample

In order to study the determinants of fluctuations in profitability over time without distortive changes to the sample, the following observes a balanced sample of enterprises over the period 2006 to 2011; the sample is comprised of around 9,500 manufacturing firms per year for which annual financial statements are available for the whole of the observation period. Because of the additional restriction placed on the data pool in this study in order to ensure availability and comparability of results throughout the period, a sample selection bias may arise, distorting the findings of the study. The potential selection bias derives from the fact that annual financial statements are generally not available or there are no data on insolvent or newly established enterprises. However, the problem is unlikely to be of any great significance in this case, since the corporate sector did not display unusually elevated levels of insolvency or market entry of new enterprises during the observation period. Comparing the results from the balanced sample with calculations based on the full sample also shows that, although the proportion of enterprises in the tail is higher for the full data set, this proportion displays a very similar pattern of change over time. That indicates that valid generalisa-

tions may be derived from the conclusions drawn from the results for the balanced sample.

In this data set, the percentage of firms in the tail according to all three measures varied relatively little in the period 2006 to 2008. Then, in 2009 the huge collapse in profits resulting from the financial crisis rapidly caused the percentage of enterprises with critical performance to more than treble. However, this sharp build-up in potential risk in the manufacturing sector was not of long duration. The percentage halved as early as 2010, and then dropped more or less back to its starting level in 2011. This state of affairs is also visible from the changes in the tail ratios, which can be interpreted as the balance of probability of transition into or out of the negative portion of the distribution. Under all three risk measures, more firms exited the tail than entered it on balance during the healthy economic conditions of 2007. However, this trend reversed itself in 2008 – when the financial crisis was already making itself felt – followed by a multiplication of net tail entries in the crisis year of 2009, until the position was finally made good in the subsequent two years by corresponding countervailing movements. The study results also reveal that healthy enterprises which found themselves in the tail because of the crisis did

Sharp rise in risky firms during the crisis

Average period spent in the tail by subsample			
	Years		
Position	t	t+1	Average
Tail defined by			
Mean excess loss			
Subsample 2006 to 2008	1.32	1.25	1.28
Subsample 2009 to 2011	1.25	1.22	1.23
Value-at-risk			
Subsample 2006 to 2008	1.06	1.11	1.08
Subsample 2009 to 2011	1.02	1.14	1.08
Conditional value-at-risk			
Subsample 2006 to 2008	1.06	1.00	1.03
Subsample 2009 to 2011	1.03	1.04	1.03
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not spend much longer than a year in this problematic loss zone on average. Despite the unfavourable economic environment and the increasing difficulty of generating returns, these firms were able to consolidate their earnings position within a short space of time, and indeed needed somewhat less time to achieve this than enterprises with weak returns in periods of normal economic growth.[14] Nonetheless, according to the insolvency statistics from the Federal Statistical Office, 40.5% more manufacturing enterprises declared themselves insolvent in 2009 than in the previous year. However, the number of insolvencies was back at its pre-crisis level as soon as 2011. It is evident from this that German enterprises have a particularly marked ability to absorb risk, at least for certain types of shock, and were therefore able to handle the huge macroeconomic shock which emanated from the financial and economic crisis without lasting damage to their earning power – in the context of a good overall economic position before the crisis, a well-diversified global sales market as well as a favourable competitive position and robust financing conditions.

Determinants of enterprises' vulnerability to crises and their variability over time

Though it is useful to quantify enterprises' vulnerability to crises using suitable risk parameters, a systematic analysis of risk in the real economy must go further than that. From an economic policy perspective, pinpointing the determinants of the observed profitability situation is just as important. With this in mind, the median values of central balance sheet and profit and loss account metrics were calculated in the three risk categories set out above for firms classed as tail and non-tail enterprises on the basis of their MEL figures. For market risk, the sales variation coefficient, which reflects the cyclical vulnerability of company-specific business, is used as the central indicator. As one might expect, the empirical results show that weak profitability is connected *inter alia* to fluctuations in demand, though the differences in sales volatility between tail and non-tail firms are not particularly marked.[15] It is clear, however, that the business models of enterprises which offer their customers more specialised products – which in terms of manufacturing processes are associated with greater production depth – are more vulnerable to risk than is the case for providers of standardised products. Production structures in which the value added chain requires a high proportion of in-house manufacture also offer little scope for distributing risk in a targeted way (eg risk associated with inventories) to suppliers by means of outsourcing. Both the ratio of tangible fixed assets to total assets and that of staff expenses to material input – which, for lack of more precise indicators, are used to approximate production

High level of market risk derives primarily from sales volatility and product specificity

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14 The amount of time which ailing firms, on the other hand, initially spend in the tail before they become insolvent cannot be ascertained from the available data pool, as the balanced sample only includes enterprises which were operational throughout the observation period 2006 to 2011.

15 The variation coefficient tends to be moderated by the fact that relatively large drops in demand only occur in the small number of crisis years, whilst in times of economic normality, which are more prevalent, sales figures tend to move in relative harmony.

Median values for tail and non-tail enterprises in the manufacturing sector on the basis of Mean Excess Loss (MEL) averaged over 2006 to 2011[*]

Risk factor/indicator	Tail enterprises							Non-tail enterprises
	2006	2007	2008	2009	2010	2011	Average 2006 to 2011	Average 2006 to 2011
Market risk								
Sales volatility[1]	0.18	0.18	0.17	0.19	0.19	0.17	0.18	0.16
Fixed assets ratio	29.81	33.39	35.10	37.82	31.39	30.67	34.51	29.19
Trade receivables ratio	16.21	14.49	11.49	11.36	13.72	13.04	12.71	15.67
Ratio of staff to materials expenses	51.11	53.78	48.04	77.17	63.39	45.99	60.08	45.84
Financial risk								
Equity ratio	11.93	16.25	17.03	20.09	17.14	15.12	17.29	28.08
Bank liabilities ratio	12.48	15.25	15.92	20.64	14.22	14.27	16.75	11.99
Intragroup liabilities ratio	10.68	13.81	12.15	10.81	10.30	15.24	11.41	6.69
Interest expenses ratio	1.31	1.67	1.81	1.66	1.63	1.45	1.58	0.81
Operational risk								
Staff expenses ratio	28.84	28.77	27.36	36.02	32.40	27.23	31.45	24.24
Materials expenses ratio	55.71	56.08	57.48	47.80	52.37	59.04	52.60	53.23
Depreciation ratio	3.05	3.11	3.36	4.29	3.37	2.90	3.60	2.24
Other operating expenses ratio	19.23	19.97	19.69	19.04	19.27	19.37	19.00	14.73

* Results for a balanced sample of 9,558 enterprises in the manufacturing sector. Non-year-specific threshold value calculated on the basis of the full data set for the manufacturing sector with a cumulative total of 272,356 annual financial statements in the period from 2000 to 2011. **1** Sales variation coefficient.
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depth and the degree of specialisation respectively – show much higher median values at tail enterprises. For instance, the median use of fixed assets by risky enterprises is more than five percentage points above the median for enterprises outside the tail, and the ratio of staff expenses to material input at the former – resulting from a growing share of enterprises with very high staff expenses during the crisis in particular – is more than 15 percentage points above the ratio for the non-tail group.

Negative leverage in the capital structure because of low equity ratios and a high proportion of bank liabilities

Furthermore, in times of economic weakness, negative financial leverage in the capital structure has a not inconsiderable effect on earning power and thus on enterprises' risk profile. The financing mix at tail enterprises leads to about one-third more loan capital than at firms outside the tail. Their equity ratio is only 17.3% on average, whilst at the other firms in the balanced sample equity accounts for 28.1% of total assets. The differences in the use of alternative sources of external funding are equally clear. Tail enterprises obtain finance in the form of bank loans to a significantly greater degree than the other firms under observation here. Over the years, the ratio of bank liabilities, at around 16.7%, has been just less than five percentage points higher than at other enterprises in the sample. In the crisis year of 2009, this gap widened to ten percentage points.

Intragroup liabilities also increase financing costs

There are similarly marked divergences in group-based financing methods. At 11.4% compared to 6.7%, tail firms have greater recourse to intragroup lending, although its share of total financing declined significantly in the crisis year. Clearly, part of the reason why periods of downturn have a clear impact on the balance sheet structures of group companies is that the scope for intragroup financing narrows markedly. With risky firms being more dependent on external financing, their interest expenditure, at 1.6% of sales, is twice as high, and thus has a significantly greater im-

Significance tests for risk factors in the manufacturing sector

Statistical t-tests can be used to examine the significance of differences in the explanatory factors between tail and non-tail enterprises classified on the basis of the mean excess loss of gross return on sales.[1] Particular attention is paid in this context to the development before, during and after the major recession of 2009. Corporate data for 2006, 2009 and 2011 are used to ensure the independence of the observations and thus the ability to make a probabilistic statement.

As an indicator of market risk or as a proxy for the fluctuations in the firm's capacity utilisation, the sales volatility of the respective firm in the form of the coefficient of variation in the observation period is used. Financial risk is calculated as the ratio of debt to the balance sheet total. Operational risk is operationalised as the sum of staff costs, write-downs and other operating charges as a percentage of turnover.

The median values provide information about the situation of these explanatory variables in different periods of the business cycle and have the advantage over the arithmetic mean of being invariant to outliers. In order to assess the statistical significance of the empirical differences, standard errors for the medians were calculated using a non-parametric bootstrap. A classical t-test can thus be applied for the median difference of the tail and non-tail enterprises.

In the case of market risk, it is possible to note slight differences in terms of sales volatility between tail and non-tail enterprises. With the crisis, the median values in both subsamples increase relatively clearly, although the growth in the case of the tail enterprises is more than four times higher than that of the non-tail enterprises and the identified differences are statistically highly significant in the crisis year. Furthermore, it emerges that in 2011 market risk in the case of the non-tail enterprises persists at a noticeably higher level than before the crisis and that there are now no longer any

appreciable deviations between the two categories of enterprises.

For financial risk measured using the debt ratio, in all three years there emerge clear differences between the tail enterprises and non-tail enterprises which, even for the median values, attain orders of magnitude considerably higher than 10 percentage points and are highly significant throughout. In the crisis, there was a marked decline in the leverage ratio of both groups, although the fall in the case of the tail enterprises, at 5 percentage points, was clearly stronger than in the case of the non-tail enterprises (3 percentage points), thus reducing the gap from -14.2 to -12.7 percentage points. It is debatable whether the overproportional decline in the debt ratio at the crisis-prone enterprises was primarily due to a more cautious financing policy, as can be observed fairly consistently in the case of the non-tail enterprises. In a process of "voluntary" deleveraging, the latter had continued to expand their capital base, even in times of crisis, thus making themselves less dependent on external sources of funding. The poor earnings situation of the tail enterprises, which left hardly any scope for profit retention, tends to suggest that the crisis led to these enterprises making a considerable cutback in their business activities, reducing the need for funding in some cases, or that they were even subject to effective financing constraints. With the upswing, these problems are evidently no longer relevant and the tail enterprises are sharply expanding their levels of leverage again, so that the difference from the reference group increases to as much as -16.8 percentage points.

The differences are similarly marked in the case of operational risk. First, the median values between the two groups are 11.8 percentage points apart, although, with a probability of error of less than 1%, the differ-

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1 Tail enterprises are firms with a gross return on sales which is smaller than the mean excess loss. The return of the non-tail enterprise lies on or above this threshold.

Median differences

Item	Median values	2006	2009	2011
Market risk	Non-tail	0.1472	0.1541	0.1589
	Tail	0.1663	0.1975	0.1673
	Difference	− 0.0191	− 0.0435	− 0.0084
	t value	− 3.9898*	− 17.0636*	− 1.2555
Financial leverage	Non-tail	76.0554	72.8420	72.0971
	Tail	90.2919	85.5271	88.8489
	Difference	− 14.2365	− 12.6851	− 16.7518
	t value	− 15.3100*	− 14.7012*	− 21.2281*
Operative leverage	Non-tail	45.0161	46.9239	44.2325
	Tail	56.7842	63.7681	54.7088
	Difference	− 11.7681	− 16.8442	− 10.4763
	t value	− 16.6338*	− 26.4455*	− 10.9814*

* Difference in the median values significant at the 1% level.
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ences are also highly significant here. Nevertheless, in the case of operational risk, too, it is apparent that the selected operating costs rise much more sharply (7 percentage points) in the case of the tail enterprises than at the non-tail enterprises, where this cost factor grows by only around 2 percentage points. The tail enterprises are obviously affected by considerable cost stickiness, as the crisis-related adjustment of the business volume does not lead to matching savings on the operating cost side. Along with the cyclical upturn, the tail enterprises' cost pressure returns to normal again and the difference from the reference group in fact goes down to slightly below its pre-crisis level.

pact on their profitability than is the case with the other enterprises selected for the study.

Staff expenses the key risk driver in the crisis in particular …

The most significant risk driver in the real economy proves to be negative operational leverage, which results mainly from a high proportion of fixed cost and delays in adjusting variable cost. A key determinant of differences in performance and risk is the substantial discrepancy in staff expenses. Tail enterprises have a staff expenses ratio of over 31.5%, which is more than seven percentage points higher than that of other enterprises in the balanced sample. Furthermore, the disproportionate level of staff expenses at risky enterprises suddenly rose by almost nine percentage points for a time in the financial crisis in 2009, widening the gap between these enterprises and the others in the group to close to 11 percentage points. This finding suggests that even the variety of human resources measures aimed at making the deployment of staff more flexible in line with utilisation, for instance through working

time accounts, were not adequate or not applied to a sufficient extent to adjust staff expenses in the crisis. The observed rigidity and expansion of this cost factor may also arise from the fact that it was precisely those enterprises which experienced sharp falls in demand in the manufacturing sector which reacted to the crisis by hoarding labour rather than shedding it, in order not to be hampered by labour shortages when the economy recovered and they wanted to step up production.

Similar differences can be seen in other operating expenses, though these differences remained very stable in the course of the crisis. This collective item includes, for example, expenses for temporary workers, rents and leasing instalments, cost for consumables and the like. At 19.0%, the ratio of this cost factor at tail enterprises is an average of 4.3 percentage points above the median values for non-tail firms in the balanced sample. As might be expected, depreciation expenses at risky enter-

… but high levels of other operating expenses and depreciation also increase risk

prises, at 3.8%, are more than 1½ percentage points higher than at non-tail firms in the balanced sample. This higher level of fixed capital consumption is due to differences in the degree of capital intensity and greater production depth, and is reflected in the differences between the two groups of enterprises in the amount of fixed assets on their balance sheets.

■ Summary and conclusions

Flexible labour market structures in particular mitigate risk

The present study, based on available annual financial statements from non-financial corporations in the manufacturing sector in the Bundesbank's Financial Statements Data Pool, makes clear that various risk metrics may be used to capture vulnerability to crises in industry and the causes thereof. The results show that the vulnerability to crises of manufacturing enterprises, measured in terms of weakness in profitability, displays significant differences according to sector, legal form and company size. The key determinants emerge clearly from the empirical data. In terms of market structure, enterprises in a stable demand environment, and thus, in particular, consumption-related sectors which are not heavily dependent on the business cycle, are less prone to risk. A low level of production depth in manufacturing processes and a broadly based product range also reduce risk. On the financing side, a sound capital base and low use of loan capital provide effective protection against the negative leverage effect in times of crisis which leads to rigid or heightened loan capital costs. These place an additional damper on profitability besides the disproportionate rise in unit production costs which is often experienced. Particularly risk-relevant factors on the cost side include staff expenses, other operating expenses and depreciation connected with the structure of manufacturing processes. It is clear from this, once again, that a broad capital base and flexible cost structures, particularly in relation to staff expenses, are key prerequisites for the effective mitigation of enterprises' vulnerability to risk in the non-financial sector.

Marked resistance to crisis in the German economy resulting from a great capacity for shock absorption

The study also shows, on the basis of a balanced sample of enterprises, that German industry displayed a great capacity for shock absorption in the last crisis and proved able to handle a heightened level of risk in a relatively short space of time. This also enabled potential contagion in the financial sector to be avoided. While specific levels of resistance to shock are dependent on the type of shock in question, in general it is the case that competitive products, a strong market presence and sound financing structures, along with a functioning banking system and a high degree of cost-oriented production flexibility, are the key factors in ensuring the stability and sustainability of entrepreneurial and overall economic success.

■ Methodological annex

Risk measurement methods for corporate financial statement analysis

When measuring risk in the corporate sector, the main objectives are to capture unfavourable earnings and liquidity constellations and to identify events and conditions which lead to losses or reduced income. Financial portfolio theory has developed a number of metrics for this, which can be divided into quantile and shortfall measures.[16] The essential difference between the two categories is that in the first category the risk measure is defined indirectly on the basis of a specific measure of distribution location, the quantile. This determines the results threshold which, with given probability α, is not exceeded or undershot, depending on which side of the distribution one is located on. Shortfall measures, on the other hand, make direct use of a

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16 See, for example, P Albrecht and R Maurer, Investment- und Risikomanagement, third edition, Stuttgart, 2008, pp 120 ff.

fixed reference or threshold results value and show with what probability undesired deviations from a given target value or unfavourable results variables (the shortfall), such as losses or liquidity deficits, will occur.

The most important quantile measures and those most commonly used in risk analysis are Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR). VaR is the given value of result X which will not be exceeded within a set time horizon with given probability α. The implicit definition is therefore as follows.[17]

$$P\,[X \leq VaR_\alpha(X)] = \alpha$$

Thus, VaR is the α-quantile for the distribution of X.

However, VaR has a number of methodological weaknesses. For example, it may breach the key axiomatic condition for risk analysis of subadditivity (the aggregate risk must not be larger than the sum of the individual risks), giving rise to the problem of a lack of coherence in risk measurement.[18] In terms of content, it has the disadvantage that it only defines a loss boundary (loss which occurs at least with given α), which may mean that even greater losses at the margin of the distribution on the other side of the VaR value are left out of consideration.

CVaR, which does not have this undesirable property, quantifies the average loss (the average of the VaR values) which arises in the selected (negative) section of the distribution and which is calculated as the centre point of the corresponding margin.

$$CVaR_\alpha(X) := E[X \mid X < VaR_\alpha(X)] =$$
$$VaR_\alpha(X) + E[X - VaR_\alpha(X) \mid X < VaR_\alpha(X)]$$

When deriving the shortfall measures, the first step is to stipulate a critical threshold directly, not a probability. One key shortfall measure is Mean Excess Loss (MEL). This determines the expected excess loss which occurs when the reference loss z is undershot.

Key asymmetrical risk measures
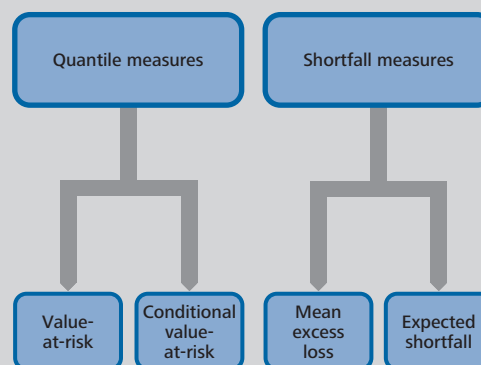
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$$MEL_z(X) = E(X - z \mid X < z)$$

Because of its construction, MEL is closely connected to the unconditional Expected Shortfall (ES).

$$MEL_z(X) = ES_z(X) / P(X < z)$$

If the results variable X has a discrete distribution, this is as follows.

$$MEL_z(X) = \sum_i (x_i - z) \cdot \frac{P(X = x_i \wedge X > z)}{P(X < z)}$$

MEL is thus the mean (additional) loss under the condition that the negative scenario (in relation to the threshold) has occurred.

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17 See J Hanisch, Risikomessung mit dem Conditional Value-at-Risk, Implikationen für das Entscheidungsverhalten, Hamburg, 2006, pp 22-23.
18 See P Jorion, Value-at-Risk: The new benchmark for controlling market risk, New York, 1997, p 115.