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Product Differentiation and Profitability in German Manufacturing Firms

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Product Differentiation and Profitability in German Manufacturing Firms[*]

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Abstract:

We use a unique rich newly built data set for German manufacturing enterprises to investigate the product differentiation – firm performance relationship. We find that an increase in the degree of product diversification has a negative impact on profitability when observed and unobserved firm characteristics are controlled for. The effects are statistically significant and large from an economic point of view. This helps to understand the – at least, at a first glance – surprising fact that nearly 40 percent of all manufacturing enterprises with at least 20 employees in Germany are single-product firms according to a detailed classification of products, and that multi-product enterprises with a large number of goods are a rare species.

Keywords: Product differentiation, profitability. Germany

JEL Classification: D21, L60

[*] All computations were done in the research data centre of the Statistical Office in Berlin. Many thanks to Ramona Pohl for building the data set and her help in many ways.

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1. Motivation

A cartoon published in *The New Yorker* shows a manager sitting at his desk when his secretary enters the office saying “Your mother called to remind you to diversify”. Mothers’ advices, as we all know, are too often ignored (“Boy, don’t drink that much at the party tonight”, etc.). Manufacturing enterprises in Germany are a case in point. Nearly 40 percent of all manufacturing enterprises with at least 20 employees in Germany are single-product firms according to a detailed classification of products, and they do not diversify in product-space. Multi-product enterprises producing a large number of goods are a rare species (Wagner 2008). Mothers’ advices, however, are usually derived from life experience, and following these advices might be expected to pay. So why should a firm diversify, i.e. why should a firm produce more than one good and spread activities across markets when it goes for a better performance?

According to the resource view (Montgomery 1994:167f.) firms that have an excess capacity in productive factors – for example, special knowledge the firm has accumulated through time, and that can be used in other markets without reducing the use in the market the firm is already active in - can reap economies of scope by expanding into different product markets. Alternatively, the firm may sell this specific asset to another firm active in this market. However, it is reasonable to expect that market failure does exist when it comes to trade in intangible assets like knowledge, and this is an incentive to internalize the use of the assets. Furthermore, productive factors of this type are often closely linked to persons who can not simultaneously work for several firms producing different products. If a firm owns intangible assets of this type that make it successful in one market, and if these assets can be used in other markets, too, one would expect diversification into other product markets to be positive for firm performance. However, there are extra costs to be considered, too,

because producing for a new market usually is connected to costs for developing and introducing the new product, including costs for market research and marketing.

A second line of reasoning points to the reduction of risk and uncertainty that can be reached by diversification across product markets (Lipczynski and Wilson 2001: 324f.). Demand shocks or new competitors may have a negative impact on sales and profits in a product market in an unpredictable manner. A single-product firm, therefore, is highly vulnerable to adverse shocks that hit their market. A multi-product firm can substantially reduce this vulnerability, especially if the risks on the various product markets are randomly distributed or negatively correlated (for a formal model see Hirsch and Lev 1971). Risk reduction will lead to more stable profits. More stable profits may be positively related to growth because they can secure the funds for investment at lower costs, and this may have a positive influence on the level of profits. Again, there are extra costs associated with the serving of different product markets that have to be considered, too.

Whether product diversification is good or bad for firm performance, and to which extent, therefore, is an empirical question. Results so far are mixed. Hall (1995:26) summarizes the findings of a number of studies as follows: “The relationship between diversification and organisational performance has been the subject of numerous studies over the years …, with results suggesting: negative relationships …, positive relationships …, and lack of relationship …. Regardless of how diversification is measured …, the corporate diversification literature has failed to reach consensus about the relationship between firm diversification and performance.” Similarly, Montgomery (1994: 172) argues that the literature surveyed by her “clearly shows that diversification is not a guaranteed route to success.”

This paper contributes to the literature by using a unique rich newly built data set for German manufacturing enterprises to investigate the product differentiation –

firm performance relationship. We find that an increase in the degree of product diversification has a negative impact on profitability when observed and unobserved firm characteristics are controlled for. These effects are statistically significant and large from an economic point of view.

The rest of the paper is organized as follows: Section 2 introduces the data used. Section 3 presents some stylized facts for product diversification in German manufacturing firms. Section 4 reports the results of our econometric investigation. Section 5 concludes.

2. Data

In Germany data on the number of different products produced by a firm[1] and on the turnover realized with each product became available for researchers who are not working inside the statistical agencies only recently. As a first step the so-called producer-product-panel was built that merged information from the cost structure survey and from the survey of products produced for a sample of manufacturing enterprises and for the years from 1995 to 2001 (see Görzig, Bömermann and Pohl 2005). This data set has been used to compute various measures of diversification for manufacturing industries in the years covered and for comparisons over time (see Zloczysti and Faber 2007; Görzig, Gornig and Werwatz 2007a, 2007b). Furthermore, descriptive studies investigated the relationship between the expansion and the reduction of the number of goods produced and changes in the profitability of enterprises (see Görzig, Gornig and Pohl 2007; Görzig and Pohl 2007; Gornig and Görzig 2007).

[1] The expression “firm” is used here to describe either an enterprise (a legal unit) or an establishment (a local production unit). In the empirical investigations data at the enterprise level are used; some of these data were collected at the establishment level and aggregated to the enterprise level.

This study uses a data set that extends the producer-product-panel in three ways: All manufacturing enterprises with at least 20 employees are covered; information from the so-called monthly report of manufacturing establishments (aggregated over all months, and all establishments belonging to an enterprise) is added; and the time frame has been extended to cover the years 1995 to 2004.[2]

The focus of this study is on the relationships between product differentiation and profitability. Given that information on profitability is available from the cost structure surveys only, the sample of firms used here is limited to the enterprises that took part in these surveys. The annual cost structure survey covers all enterprises from manufacturing industries with 500 and more employees. Smaller enterprises, however, are sampled, and as a rule the samples are replaced after four waves, leading to a rotating panel design. Different from this rule in the period covered by the data set used in this study new samples were drawn in 1995, 1997, 1999 and 2003. Because longitudinal data are needed to investigate the consequences of product differentiation for firm performance in the econometric investigations this study uses data from a panel of enterprises that participated in the cost structure survey from 1999 to 2002.

3. Descriptive evidence on product differentiation and profitability in German manufacturing enterprises

To give a first impression on the evidence of product differentiation in German manufacturing enterprises, some information is given below. We focus on 2000, a year in the middle of the period considered in the econometric investigations.[3] In 2000 61.25 of all 30,955 enterprises covered in the survey of products reported that

[2] The data are confidential but not exclusive. They can be used by researchers on a contractual basis via remote data access in the research data centres of the statistical offices in Germany; for details, see Zühlke et al. (2004).
[3] Detailed descriptive results for 1995 to 2004 are reported in Wagner (2008).

they produced more than one product. A product here is defined by the most detailed 9digit-level of the manual for the survey of products (*Güterverzeichnis für Produktionsstatistiken*) used by German official statistics. At this rather detailed level, for example, brandy, whisky, rum, and gin are different products, and the same holds for automobiles with a cubic centimetres stroke volume of up to 1,500, between 1,500 and 2,500, and more than 2,500. It comes as a surprise (at least, for us) that nearly 40 percent of all manufacturing enterprises with at least 20 employees are single-product firms according to this detailed classification. Multi-product enterprises on average produce 4.35 different goods; firms with a large number of goods, however, are rare – only 3.2 percent of all firms produce more than 10 different goods. Over time the pattern of diversification is rather stable. Among the 17,792 enterprises we have information for in the data set for 1995 to 2004 56.4 (30.9) percent were a multi-product (single-product) enterprise in each year.

Product diversification is measured in two ways, by the *share of sales of the most important product in total sales,* and by the *Berry-index* defined as one minus the sum of squared shares of sales of all products in total sales. By definition, for a single-product firm the share of sales of the most import product in total sales is One, and a decreasing value of this measure shows an increase in diversification. The Berry-index is by definition Zero for a single-product firm, and an increase in its value shows an increase in diversification.

To illustrate the distribution of the measures of product differentiation in the sample of enterprises used in our econometric investigation figure 1 and figure 2 show kernel density estimates of the share of sales of the most import product in total sales and of the Berry-Index in 2000. Due to the high share of single-product

enterprises both distributions are highly skew, and it can be seen that only a small portion of all enterprises is very highly diversified according to both measures.[4]

[Figure 1 and figure 2 near here]

Profitability is measured as a rate of return, defined as gross firm surplus (computed as gross value added at factor costs minus gross wages and salaries minus costs for social insurance paid by the firm) divided by total sales (net of VAT) minus net change of inventories, using information from the cost structure surveys.[5] Figure 3 shows a kernel density estimate of the rate of return (in percentages) for 2000.[6] The distribution is rather symmetric around the positive mean value, and extreme positive or negative values are rare.

[Figure 3 near here]

3. Econometric investigation

Our econometric investigation of the relationship between profitability and product differentiation uses pooled data for the years 1999 to 2002 and fixed-effects estimators to control for unobserved time-invariant enterprise heterogeneity.[7] Table 1

[4] Both measures of diversification are highly positively correlated over time (see Wagner 2008, table 11), and, therefore, the kernel density estimates look identical for all the years covered. The correlation between the share of sales of the most important product in total sales and the Berry-Index is extremely high in each year; the value for 2000 is -0.986 (see Wagner 2008, table 10). Note that the fact that the graph in figure 1 shows values below one, and that the graph in figure 2 shows values below zero and above one, for the measure of product diversification is caused by the smoothing technique used in the estimation of the kernel density estimates.

[5] Note that the data set does not have any information on the capital stock, or the sum of assets or equity, of the firm, so that it is not possible to construct profit indicators based thereon like return on assets or return on equity.

[6] The kernel density estimates look identical for all the years covered in this study.

[7] We experimented with both a propensity score matching approach (that considers product diversification as a binary treatment, with diversified firms as the treatment group and single-product firms as the control group) and with a generalized propensity score matching approach (that considers product differentiation as a continuous treatment). In both cases the approach turned out to be not computationally feasible. Matching was never successful, and the balancing property was not fulfilled.

reports mean values and standard deviations of the variables used in our empirical study. It can be seen that both the profitability and the degree of product differentiation vary not only between enterprises (as shown in the figures above) but also over time within the enterprises. Note that the variation in profitability across enterprises is about twice as large as that observed within an enterprise over time, while the variation of both measures of the degree of product differentiation across enterprises is more than four times larger than that observed within the enterprises over the four years.

[Table 1 near here]

Results from fixed effects regressions for profitability are reported in table 2. Two variants of empirical models are estimated, one that includes only the measure of the degree of product differentiation (plus dummy variables for the years, and a constant), and one that adds a number of control variables. In all models the fixed enterprise effects control for unobserved firm characteristics that do not vary over time. These fixed effects control for the industry affiliation of the enterprise, too, because only few enterprises tend to change industries between the years; this is important because profitability might be expected to vary between industries due to variation in the intensity of competition or regulation.

[Table 2 near here]

As can be seen from table 2 the inclusion of the control variables does not change the results for the estimated link between profitability and product differentiation substantially. The regression coefficients for both measures of product

differentiation are statistically highly significant, and they indicate a negative relationship – the higher the degree of product differentiation (i. e., the lower the share of sales of the most important product in total sales, and the higher the value of the Berry-Index), the lower is the profitability, controlling for observed and unobserved enterprise heterogeneity.[8]

[Table 3 near here]

To illustrate the economic importance of product differentiation for profitability, single product enterprises (with a share of sales of the most important product in total sales on One, and a value for the Berry-Index of Zero by definition) are compared to firms with different degrees of product differentiation using the estimated regression coefficients from the empirical models with the control variables. Results documented in table 3 indicate that a growing degree of product differentiation is accompanied by a substantial reduction in profitability. For example, for an average firm in our sample a decrease of the share of sales of the most important product from 100 to 60 percent means a reduction in the rate of profitability by nearly one percentage point, and the same holds when the Berry-Index increases from Zero to 0.40.

A question open for discussion is whether the negative ceteris paribus association between profitability and product differentiation can be interpreted to indicate a causal negative impact of the degree of product differentiation on profitability, or whether there is (instead of this, or additionally to this) a causal effect

[8] These findings are in line with the results from descriptive studies using the producer-product panel (mentioned in section 2) by Görzig, Gornig and Pohl (2007) and Görzig and Pohl (2007) who report that enterprises that reduce the degree of product differentiation show the largest improvement in profitability. Note, however, that these studies do not control for unobserved firm heterogeneity. In a robustness check we tested for a non-linear relationship between the degree of product differentiation and profitability by adding a squared term of the share of the most important product in total sales and of the Berry-Index to the empirical model used. All estimated coefficients for the measures of product differentiation in these augmented models turned out to be statistically insignificant at any conventional level.

running from profitability to product differentiation. While reverse causality can not be excluded *per se* in the fixed effects regression framework used in our study,[9] we argue that there are no economic arguments that can explain why the profitability of a firm should have any impact on the number of products produced, or the share of sales of a product in total sales, of an enterprise in the same year. Therefore, we argue that the negative association between profitability and degree of product differentiation that results from the fixed effects panel regressions can be interpreted to indicate a negative impact of a higher degree of product differentiation on profitability.

4. Concluding remarks

We use a unique rich newly built data set for German manufacturing enterprises to investigate the product differentiation – firm performance relationship. We find that an increase in the degree of product diversification has a negative impact on profitability when observed and unobserved firm characteristics are controlled for. The effects are statistically significant and large from an economic point of view. These findings indicate that the extra costs associated with serving different product markets tend to be greater than the extra profits reaped from diversification across these markets. Concentration on a core market pays. This might help to understand the – at least, at a first glance – surprising fact that nearly 40 percent of all manufacturing enterprises with at least 20 employees in Germany are single-product firms according to a detailed classification of products, and that multi-product enterprises with a large number of goods are a rare species.

[9] As stated in footnote 7 we experimented with matching approaches to solve this problem, but these approaches turned out to be not computationally feasible. Furthermore, note that using lagged values of the degree of product differentiation in the empirical models offers no solution here, since the measures of product differentiation are nearly perfectly positively correlated between adjacent years.

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Table 1: Descriptive statistics for profitability, product diversification, and control variables used in the empirical models

Variable	Mean	Standard Deviation[1]			Observations	
		Overall	Between	Within	Firms * Years	Firms
Profitablity (percentage)	12.360	12.817	11.590	5.664	47,699	12,387
Share of sales of most important product In total sales	0.777	0.236	0.231	0.051	47,699	12,387
Berry-Index	0.291	0.283	0.277	0.055	47,699	12,837
Number of employees	306.67	2348.88	2303.92	113.60	47,696	12,387
Share of sales in Germany in total sales (percentage)	78.915	23.947	23.438	4.667	47,693	12,387
Labour productivity (sales per employee; Euro)	158,100	266957	220492	146702	47,696	12,387
Human capital intensity (wages and salaries per employee, Euro)	29,828	8965.9	8776.7	2037.7	47,696	12,387
Research and development intensity (share of employees in R&D)	0.017	0.046	0.043	0.017	47,699	12,387

1 The overall standard deviation (computed for all observations) is decomposed into a between (the standard deviation computed for the average values of the firms over the years) and a within (the standard deviation computed for the deviations of the values for individual years from the mean value over the years, plus the global mean over all observations to make results comparable) component. To illustrate the interpretation of these figures, note that the variation in profitability across enterprises is about twice as large as the that observed within an enterprise over time, while the variation in the Berry-Index across enterprises is more than four times larger than that observed within an enterprise over the four years.

Table 2: Results from fixed effects regressions for profitability in German manufacturing enterprises, 1999 – 2002[1]

Model		1	2	3	4
Exogenous variable					
Share of sales of most important product in total sales	ß	2.402	2.355		
	p	0.002	0.003		
Berry-Index	ß			-2.370	-2.342
	p			0.001	0.001
Number of employees	ß		0.00045		0.00047
	p		.233		0.222
Number of employees (squared)	ß		6.20e-11		-3.01e-11
	p		0.977		0.989
Share of sales in Germany in total sales (percentage)	ß		-0.041		-0.041
	p		0.000		0.000
Labour productivity (sales per employee; €)	ß		1.16e-6		1.15e-6
	p		0.300		0.300
Human capital intensity (wages and salaries per employee; €)	ß		0.000069		0.000069
	p		0.001		0.001
Research and development intensity (share of employees in R&D)	ß		-0.416		-0.431
	p		0.865		0.860
Year 2000 (Dummy-variable)	ß	-0.186	-0.285	-0.188	-0.287
	p	0.013	0.000	0.012	0.000
Year 2001 (Dummy-variable)	ß	-1.034	-1.201	-1.036	-1.204
	p	0.000	0.000	0.000	0.000
Year 2002 (Dummy-variable)	ß	-1.822	-2.057	-1.822	-2.057
	p	0.000	0.000	0.000	0.000
Constant	ß	11.241	12.304	13.798	14.808
	p	0.000	0.000	0.000	0.000
Number of observations		47,699	47,693	47,699	47,693
Number of firms		12,387	12,387	12,387	12,387

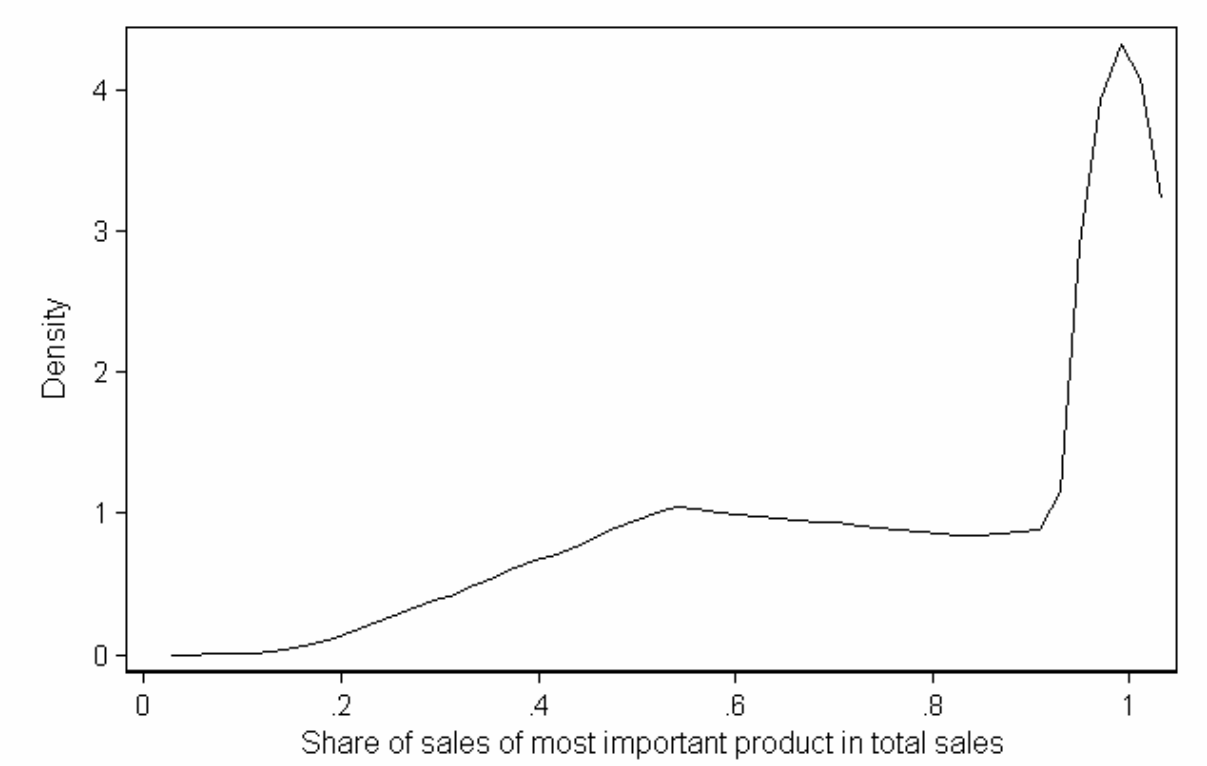
[1]Robust standard errors of the regression coefficients were adjusted for the firms as clusters.

Table 3: The estimated relation between profitability and product differentiation

Share of sales of the most important product in total sales	Estimated change in the rate of profitability (percentage points) compared to a single-product enterprise[1]
.80	-0.471
.60	-0.942
.40	-1.413
.20	-1.884
Berry-Index	
.20	-0.468
.40	-0.936
.60	-1.404
.80	-1.872

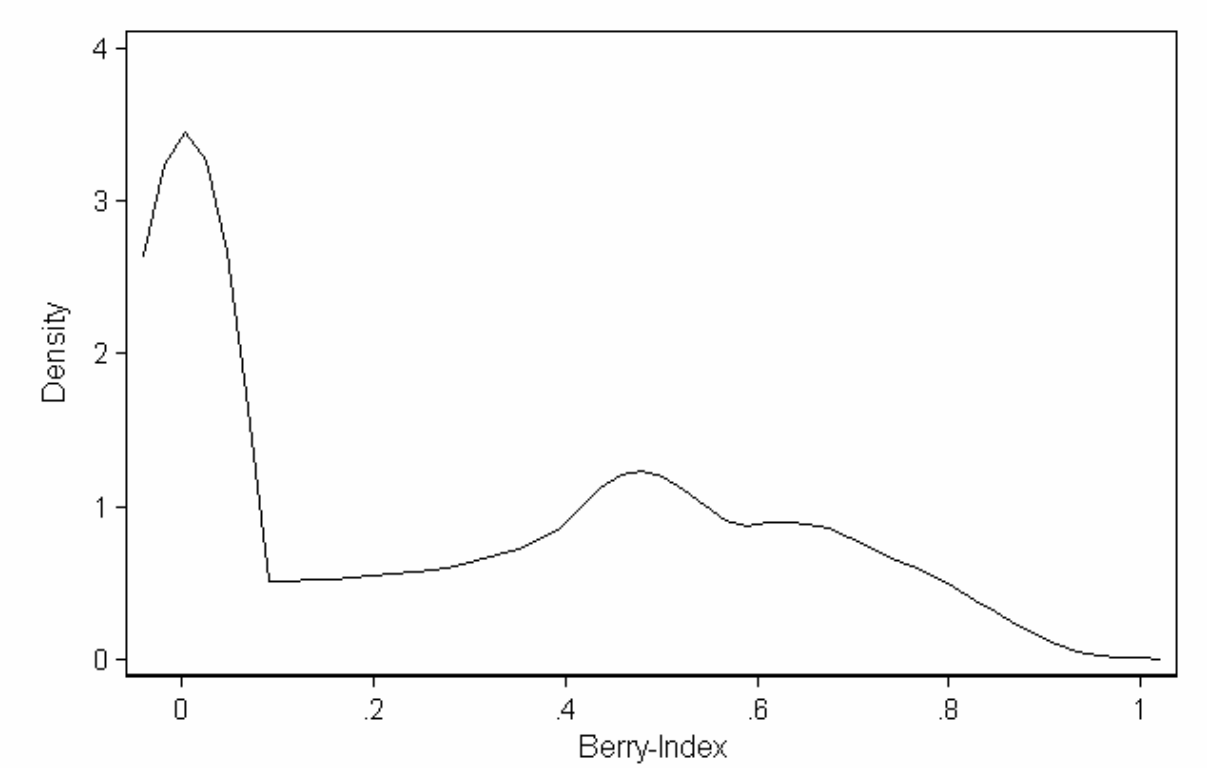
[1]The estimates are based on the results reported in column 2 and column 4 of table 2

Figure 1: Share of sales of most important product in total sales, manufacturing enterprises in Germany, 2000[1]



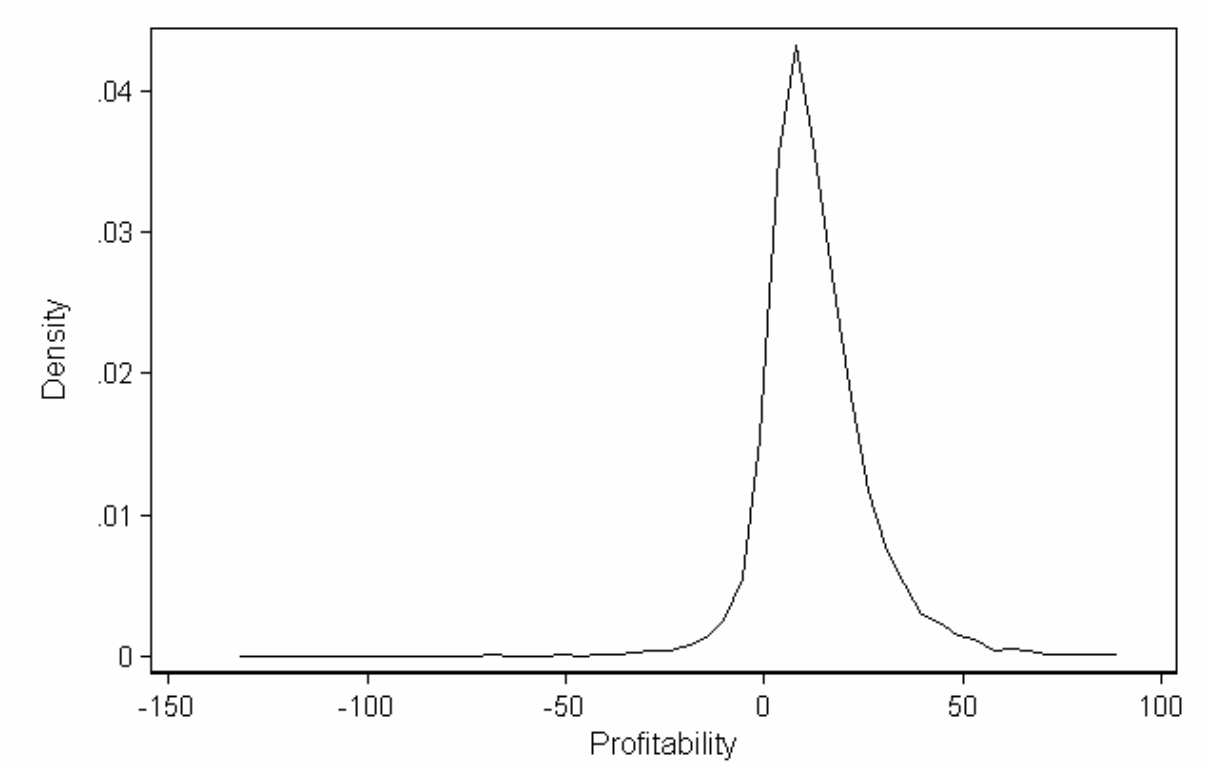
[1] Kernel density estimate with epanechnikov kernel

Figure 2: Berry-Index, manufacturing enterprises in Germany, 2000[1]



[1] Kernel density estimate with epanechnikov kernel

Figure 3: Profitability in manufacturing enterprises in Germany, 2000[1]



[1] Kernel density estimate with epanechnikov kernel

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