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Joachim Wagner

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Joachim Wagner
Leuphana University Lueneburg
and IZA

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

The German Manufacturing Sector is a Granular Economy*

Using the approach suggested by Gabaix (Econometrica 2011) this paper demonstrates that idiosyncratic shocks in the largest firms are important for an understanding of aggregate volatility in German manufacturing industries. The implications of this finding for theoretical and empirical research and for economic policy are discussed.

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Corresponding author:

Joachim Wagner
Leuphana University Lueneburg
Institute of Economics
P.O. Box 2440
21314 Lueneburg
Germany
E-mail: wagner@leuphana.de

* All computations for this study were done inside the research data center of the Statistical Office of Berlin-Brandenburg. The firm level data used are confidential but not exclusive; see Zühlke et al. (2004) for a description of how to access the data. To facilitate replication the Stata do-file is available from the author on request.

1. Motivation

Standard macroeconomic reasoning usually discards the possibility that idiosyncratic microeconomic shocks to firms may lead to large aggregate fluctuations by referring to a diversification argument. A classical case in point is the argument put forward by Robert Lucas (1977) that such microeconomic shocks would average out and, therefore, would only have negligible aggregate effects. In a recent Econometrica paper Xavier Gabaix (2011) proposes that, contrary to this traditional view, idiosyncratic firm-level shocks can indeed explain an import part of aggregate economic movements and provide a microfoundation for aggregate shocks. He shows that the "averaging out" argument breaks down if the size distribution of firms is fat-tailed and very large firms play an important role in an economy. This is the case in the United States, where, according to the findings of Gabraix (2011), the idiosyncratic movements of the largest 100 firms appear to explain about one-third of variations in output growth. In his view, many economic fluctuations are attributable to the incompressible "grains" of economic activity, the large firms. Therefore, he names this view the "granular" hypothesis.

The granular view does not neglect the role of aggregate shocks like changes in monetary, fiscal, and exchange rate policy as important drivers of macroeconomic activity. It only argues that such aggregate shocks are not the only important drivers, and that firm specific idiosyncratic shocks, too, are an important, and possibly the major, part of the origin of business-cycle fluctuations (Gabaix 2011, p. 764).

Gabaix (2011, p. 737) argues that granular effects are likely to be even stronger outside the United States, as the United States is more diversified than most other countries and that it would be interesting to apply his approach to other countries. This paper aims to do so for an important part of the German economy, the manufacturing sector, keeping in mind that ‘the credibility of a new finding that is based on carefully analyzing two data sets is far more than twice that of a result based only on one’ (Hamermesh 2000, p. 376).

The rest of the paper is organized as follows. Section 2 describes the firm level data used and presents evidence that the German manufacturing sector as a whole and the various industries that are part of it can be characterised as economies with fat-tailed size distributions of firms. Section 3 reports evidence that supports the hypothesis that the German manufacturing sector is a granular economy. Section 4 concludes.

2. Data and descriptive evidence

The firm level data used in this study are taken from the monthly report for establishments in manufacturing industries, a survey that is conducted by the German statistical offices and that is described in detail in Konold (2007). This survey covers all establishments from manufacturing industries with at least twenty persons (including the owners) working in the local production unit or in the company that owns the unit as a whole. Participation of firms in the survey is mandated in official statistics law. The information collected at the establishment level has been aggregated at the enterprise level and over the month in a year. Therefore, the data are annual data for the population of enterprises in manufacturing industries in Germany with a minimum of twenty persons working in it.

From the percentage shares of the largest 10, 50 and 100 enterprises in total sales in manufacturing industries in West Germany[1] in 2005 – 2008 that are

[1] This paper looks at West Germany only. Even 15 years after unification with the former communist East Germany the economic conditions still differ by order of magnitude between both parts of

documented in Table 1 it is evident that the sales of manufacturing enterprises are highly concentrated. The share of the 10 largest enterprises (that make up 0.03 percent of all firms in 2008) is about one fifth, and more than one third of total sales is due to the largest 100 enterprises. The very large firms, therefore, represent a large part of the economic activity in the manufacturing sector.

[Table 1 near here]

In Table 2 the estimated power law exponents for sales are reported for all firms and for firms from 23 2-digit-level manufacturing industries. A power law is a relation of the type $Y = k*X^{ß}$, where Y and X are variables of interest, ß is the power law exponent, and k is a constant.[2] A popular way to estimate the power law exponent ß for the firm size distribution (where firm size is measured by sales here) is to compute the rank of each firm in the size distribution and to run an OLS regression of log(rank) on a constant and log(size). The estimated regression coefficient of log(size) is an estimate for ß. Gabaix and Ibragimov (2011) show that this procedure leads to strongly biased estimates in small samples. They provide a simple practical remedy for this bias by suggesting to use rank – ½ instead of rank and then run log(rank – ½) = *k* - ß*log(size). They show that the shift of ½ is optimal and reduces the bias to a leading order. Note that the standard error of ß is not the OLS standard error reported by the computer program, but is asymptotically given by $(2/n)^{½} *|b|$ (where n is the number of firms used in the estimation).

Germany. A separate analysis of the East German manufacturing sector is not possible because the number of firms in many industries is far too small.

[2] Gabaix (2009) is a comprehensive survey of power laws and applications in economics and finance.

[Table 2 near here]

The estimated power-law coefficient is statistically significantly different from zero at an error level of 5 percent or (much) better in German manufacturing as a whole and in every 2-digit industry. According to the R^2-value the fit is very tight.[3] These results indicate that sales are power-law distributed in all industries. Descriptive results, therefore, indicate that the German manufacturing sector as a whole and the various industries that are part of it can be characterised as economies with a fat-tailed firm size distribution.

3. The granular nature of manufacturing industries in West Germany

Gabaix (2011) uses annual U.S. Compustat data from 1951 to 2008 for the 100 largest firms in a respective year to document the granular nature of the U.S. Economy. Comparable data are not available for Germany, so a replication of this approach is not feasible. Instead, I use the data for enterprises from 23 manufacturing industries that are described in section 2 and consider the role of the 10 largest firms in each industry.

The empirical approach closely follows Gabaix (2011, p. 750ff.). The idiosyncratic firm-level sales shock is measured by the "granular residual" that is computed as follows. g_{it} is the growth rate of sales for firm i and year t, computed as $\log(sales_{it}) - \log(salesi_{it-1})$. $g10_t$ is the average of the growth rates of the 10 largest firms (according to sales in year t-1) in an industry. The granular residual is a

[3] The power law exponent ß and its standard error are estimated by the method suggested in Gabaix and Ibragimov (2011); see text.

weighted sum of the 10 largest firm's growth rate minus $g10_t$, where the weights are the shares of the firms in total sales of all firms in an industry in year t-1.

The growth rate of total sales in an industry, defined as log(total sales in 2008) minus log(total sales in 2007), is regressed on the granular residual from the industry and lagged values of this granular residual plus a constant. Following Gabaix (2011, p. 753) two variants of this empirical model were estimated that use one or two lagged values of the granular residual. Furthermore, the models are estimated without observations from industries 16 (manufacture of tobacco products) and 23 (manufacture of coke, refined petroleum products and nuclear fuel) because the number of firms in these industries is extremely small in 2008 (14 and 44 enterprises, respectively).

Results are reported in Table 3. These regressions are supportive of the granular hypothesis. The estimated coefficient for the contemporaneous granular residual is highly statistically significant in all four variants of the empirical model, and the same holds for the granular residual with a one-year lag when the two extremely small industries 16 and 23 are excluded from the estimation.[4] If only aggregate shocks were important for the growth rate of total sales in an industry, then the R^2 of the regressions in Table 3 would be zero. They are not. Idiosyncratic movements of the top 10 firms in an industry seem to explain a large fraction (more than one third up to slightly less than half, depending on the specification) of sales fluctuations. This good explanatory power of the granular residual is inconsistent with a representative firm framework. The German manufacturing sector is a granular economy.

[4] Note that the granular residuals lagged two and three years are very highly positively correlated in the sample of industries without industries 16 and 23 (r = 0.904) which leads to insignificant coefficients when two lags are included in the empirical model.

[Table 3 near here]

4. Concluding remarks

This paper demonstrates that, like in the U.S., idiosyncratic shocks in the largest firms are important for an understanding of aggregate volatility in German manufacturing industries, too. This finding has implications for both theoretical and empirical research and for economic policy.

Theoretical models should drop the assumption of homogeneous representative firms and consider heterogeneous firms instead – like, for example, in the rich literature from the *new new trade theory* surveyed in Redding (2010).

Empirical studies that investigate the role of the largest firms need to be based on firm level data, and an easy access to these data (that are often confidential like the micro data from official statistics used in this study) for researchers is a must to foster research that will help us to understand what drives aggregate movements of the economy. While it is not possible to identify the names of the largest firms from confidential firm level data like this, fortunately the usual suspects are well known and published annual reports or information available in commercial data bases can be used to investigate the concrete shocks to large players (like Daimler, Siemens, Volkswagen, BASF or Bosch in German manufacturing).

Policy makers should be aware of the decisive role of a small number of very large firms for the development of the economy as a whole. These firms should be closely monitored. In a discussion of changes in laws and policy measures, and in evaluations of such changes, special emphasis should be put on the impact on the big players.

In sum, the granular approach introduced by Gabaix (2011) suggests a road that should be travelled in the analysis of a number of topics that are highly relevant for theorists, empiricists and policy makers (and their advisors).

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Table 1: Concentration of sales in manufacturing industries, West Germany, 2005 – 2008

Year	Percentage share of largest … enterprises			Number of
	10	50	100	enterprises
2005	20.55	32.24	37.80	32,419
2006	20.61	31.73	37.14	31,615
2007	19.49	30.55	36.06	31,358
2008	19.21	30.30	35.86	31,683

Note: All figures refer to enterprises with at least 20 employed persons (including owners)

Table 2: **Estimated power law exponents for sales in manufacturing industries, West Germany, 2008**

Industry	ß	t-value	R^2
All	-0.6747	-125.70	0.9169
15	-0.5894	-46.05	0.8775
16	-0.8763	-2.65	0.9601
17	-0.5963	-17.42	0.9317
18	-0.5961	-12.37	0.9097
19	-0.6160	-8.37	0.9202
20	-0.5697	-22.25	0.9216
21	-0.7386	-26.06	0.9495
22	-0.5995	-32.59	0.9229
23	-1.0024	-4.69	0.9762
24	-0.8545	-24.45	0.9617
25	-0.6712	-33.70	0.9421
26	-0.6591	-25.38	0.9362
27	-0.8458	-19.62	0.9558
28	-0.6358	-51.61	0.9394
29	-0.7214	-51.67	0.9412
30	-0.8179	-8.28	0.9518
31	-0.7245	-29.12	0.9400
32	-0.7374	-13.82	0.9023
33	-0.6065	-29.27	0.9107
34	-0.8404	-19.92	0.9404
35	-0.7778	-10.91	0.9253
36	-0.6413	-25.00	0.9335
37	-0.7455	-7.45	0.9430

Note: For a definition of the industries and the number of enterprises see the appendix table. The power law exponent ß and its standard error are estimated by the method suggested in Gabaix and Ibragimov (2011); see text.

Table 3: Explanatory power of the granular residual for sales growth in manufacturing industries, West Germany, 2007/2008

Independent variable: sales growth 2007/2008 (percentage)

		All manufacturing industries		Without industries 16 and 23	
Granular residual 2007/2008	ß	0.0089	0.0106	0.0153	0.0139
	P	0.002	0.000	0.008	0.009
Granular residual 2006/2007	ß	0.0014	-0.0009	0.0137	0.0182
	P	0.480	0.648	0.000	0.206
Granular residual 2005/2006	ß		0.0075		-0.0036
	P		0.160		0.739
Constant	ß	1.3242	0.7928	2.1188	2.3418
	P	0.316	0.531	0.094	0.149
Number of industries		23	23	21	21
R2		0.3636	0.4530	0.4471	0.4522

Note: ß is the estimated regression coefficient, p is the prob-value. For a definition of the industries see the appendix table. For a definition of the granular residual see text.

Appendix I: Definition of manufacturing industries and number of enterprises in 2008

No.	Industry	No. of enterprises
15	Manufacture of food products and beverages	4,242
16	Manufacture of tobacco products	14
17	Manufacture of textiles	610
18	Manufacture of wearing apparel; dressing and dyeing of fur	309
19	Tanning and dressing of leather; manufacture of leather goods	139
20	Manufacture of wood and products of wood except furniture	995
21	Manufacture of pulp, paper and paper products	679
22	Publishing, printing and reproduction of recorded media	2,131
23	Manufacture of coke, refined petroleum products and nuclear fuel	44
24	Manufacture of chemicals and chemical products	1,198
25	Manufacture of rubber and plastic products	2,280
26	Manufacture of other non-metallic mineral products	1,293
27	Manufacture of basic metals	772
28	Manufacture of fabricated metal products, except machinery and equipment	5,283
29	Manufacture of machinery and equipment n. e. c.	5,348
30	Manufacture of office machinery and computers	138
31	Manufacture of electrical machinery and apparatus n. e. c.	1,699
32	Manufacture of radio, television and communication equipm. and apparatus	385
33	Manufacture of medical, precision and optical instruments, watches, clocks	1,721
34	Manufacture of motor vehicles, trailers and semi-trailers	797
35	Manufacture of other transport equipment	241
36	Manufacture of furniture, manufacturing n. e. c.	1,253
37	Recycling	112

Note: The 2-digit-industries are defined according to the German classification WZ 2003.