

Raff, Horst; Wagner, Joachim

**Working Paper**

## Productivity and the product scope of multi-product firms: A test of Feenstra-Ma

Working Paper Series in Economics, No. 257

**Provided in Cooperation with:**

Institute of Economics, Leuphana Universität Lüneburg

*Suggested Citation:* Raff, Horst; Wagner, Joachim (2012) : Productivity and the product scope of multi-product firms: A test of Feenstra-Ma, Working Paper Series in Economics, No. 257, Leuphana Universität Lüneburg, Institut für Volkswirtschaftslehre, Lüneburg

This Version is available at:

<https://hdl.handle.net/10419/73184>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

**Productivity and the Product Scope of Multi-product  
Firms: A Test of Feenstra-Ma**

---

by

Horst Raff and Joachim Wagner

University of Lüneburg  
Working Paper Series in Economics

**No. 257**

December 2012

[www.leuphana.de/institute/ivwl/publikationen/working-papers.html](http://www.leuphana.de/institute/ivwl/publikationen/working-papers.html)

ISSN 1860 - 5508

# Productivity and the Product Scope of Multi-product Firms: A Test of Feenstra-Ma\*

Horst Raff and Joachim Wagner

[This version: December 7, 2012]

## Abstract

Feenstra and Ma (2008) develop a monopolistic competition model where firms choose their optimal product scope by balancing the profits from a new variety against the costs of “cannibalizing” sales of existing varieties. While more productive firms always have a higher market share, there is no monotonic relationship between firms’ productivity level and their choices of product scope. In the model having a higher market share means that firms are hurt more by the “cannibalization effect”. Therefore, the incentive to add more products weakens as productivity rises. This leads to Lemma 3 in Feenstra and Ma (2008): *There is an inverted U-shaped relationship between firms’ productivities and the range of varieties they choose to produce.* This empirical note takes this Lemma to the data for firms from German manufacturing industries. Empirical evidence is in line with the results from the theoretical model.

JEL classification: L1, L6

Keywords: Multi-product firms, productivity, optimal product scope, Germany

\* The data used in this note are confidential but not exclusive; see Zühlke et al. (2004) for information on how to access the data. To facilitate replication the Stata do-file is available from the second author on request.

Prof. Horst Raff, Ph.D.

University of Kiel, Kiel  
Institute for the World Economy  
and CESifo  
Department of Economics  
Wilhelm-Seelig-Platz 1  
D-24098 Kiel, Germany

e.mail: [raff@econ-theory.uni-kiel.de](mailto:raff@econ-theory.uni-kiel.de)

Prof. Dr. Joachim Wagner

(corresponding author)  
Leuphana University Lueneburg  
and CESIS, Stockholm  
Institute of Economics  
P.O. Box 2440  
D-21314 Lueneburg, Germany

e-mail: [wagner@leuphana.de](mailto:wagner@leuphana.de)

## 1. Motivation

Multiproduct firms play an important role in manufacturing industries. Germany is a case in point. In 1995 – 2004 more than 60 percent of all enterprises with at least 20 employees produced more than one good (defined according to the 9-digit classification of products), and the share of multiproduct firms in total turnover was more than 80 percent. On average a multiproduct firm produced about 4.4 products, and slightly over 3 percent of all firms produced more than 10 products (see Wagner 2009).

Theoretical models of multiproduct firms can help to understand the behavior of these firms and they can guide empirical investigations. Feenstra and Ma (2008) develop a monopolistic competition model where firms choose their optimal product scope by balancing the profits from a new variety against the costs of “cannibalizing” sales of their other varieties. A discussion of the details of this model is beyond the scope of this empirical note; this model, however, has an interesting empirically testable implication. While more productive firms always have a higher market share, there is no monotonic relationship between firms’ productivity level and their choices of product range. In the model having a higher market share means that firms are hurt more by the “cannibalization effect”. Therefore, the incentive to add more products weakens as productivity rises. This leads to Lemma 3 in Feenstra and Ma (2008): *There is an inverted U-shaped relationship between firms’ productivities and the range of varieties they choose to produce.* To state it differently, there is a non-monotonic relationship between productivity and the range of products, where firms

at an intermediate level of productivity develop the largest range of products, while the most productive and the least productive firms have smaller ranges.<sup>1</sup>

This empirical note takes this Lemma 3 of Feenstra and Ma (2008) to the data for firms from German manufacturing industries. Section 2 describes the data and gives an outline of our econometric strategy to test for an inverted U-shaped relationship between firms' productivities and the number of products produced. Results are reported in section 3.

## **2. Data and econometric strategy**

Data used in this note come from two sources. Information on the number of different products produced by an enterprise is taken from the survey of products. A product here is defined by the most detailed 9-digit-level of the manual for the survey of products 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 centimeters stroke volume of up to 1,500, between 1,500 and 2,500, and more than 2,500. Information on productivity comes from a second source, namely the monthly report for establishments in manufacturing enterprises. Results were aggregated over the months to compute annual data; furthermore, for multi-establishment enterprises results were aggregated at the level of the enterprise. Productivity is defined as labor productivity and computed as turnover per employee.<sup>2</sup>

---

<sup>1</sup> Interestingly, this prediction contrasts with that of other recent models of multi-product firms, notably Bernard et al. (2010) and Mayer et al. (2011), that exhibit a monotonic relationship between productivity and product range. These two papers do not feature a cannibalization effect.

<sup>2</sup> Note that information on value added is not available. The same holds for the capital stock of the firm, and, therefore, total factor productivity cannot be computed.

Data from the two surveys are linked using the unique firm identifier. Data are available for 1995 to 2006.

The empirical model used to test for an inverted U-shaped relationship between firms' productivities and the number of products produced regresses the number of products on labor productivity plus a set of control variables for the industry (measured at the 4-digit level, the most detailed level available) to take care of inter-industry differences in both the extent of product differentiation and labor productivity.

Usually, the presence or not of an inverted U-shaped relationship between a variable  $y$  (e.g., number of products) and a variable  $x$  (e.g., productivity) is tested in a regression framework by adding a squared term of  $x$ . If the estimated regression coefficients of  $x$  and  $x$ -squared are both statistically different from zero at a chosen error level, if they have opposite signs (with  $x$  being positive and  $x$ -squared being negative) and if the computed maximum value based on these estimated coefficients lies inside the data range, the hypothesis of an inverted U-shaped relationship is accepted.

However, in a recent paper Lind and Mehlum (2010) show that statistically significant regression coefficients of a variable and its squared term that have opposite signs, plus a computed extreme value based on these estimated coefficients that lies inside the data range, are only necessary but not sufficient to prove the existence of a U-shaped (or inverted U-shaped) relationship. Lind and Mehlum (2010: 110) argue "that this criterion is too weak. The problem arises when the true relationship is convex but monotone over relevant data values. A quadratic specification may then erroneously yield an extreme point and hence a U shape."

They point out that standard testing methodology is no longer suitable for the U shape test of the *composite* null hypothesis that the relationship is decreasing at the left hand side of the interval *and/or* is increasing at the right hand side (resp. the opposite in case of an inverted U shape). Lind and Mehlum (2010) adopt a general framework developed by Sasabuchi (1980) to test for the presence of a U-shaped or inverted U-shaped pattern, and they propose the Fieller (1954) method to compute the confidence interval for the estimated extreme value. In the empirical investigation we adopt this procedure. All computations use Stata 10.0 and the ado-file *utest* provided by Lind and Mehlum.

### 3. Results

Results are reported in Table I for 1995 and 2006, the first and the last year for which data were available.<sup>3</sup> The estimated regression coefficients for labor productivity and its squared value are highly statistically significant and have the opposite sign. Results for the Sasabuchi-test indicate that there is indeed an inversely u-shaped relationship between the number of products and labor productivity. This empirical evidence is in line with the Lemma 3 from the theoretical model of Feenstra and Ma (2008). This indicates that this theoretical model of multiproduct firms can help to understand the behavior of these firms and can guide empirical investigations.

---

<sup>3</sup> Results for the other years are very similar; details are available on request.

## References

- Bernard A.B., Redding S.J. and Schott P.K. (2010), 'Multi-product Firms and Product Switching'. *American Economic Review* 100 (1), 70-97.
- Feenstra, R. and H. Ma (2008), Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition. In: E. Helpman, D. Marin and T. Verdier (Eds.), *The Organization of Firms in a Global Economy*. Cambridge, MA and London, England: Harvard University Press, pp. 173-199.
- Fieller, E. C. (1954). 'Some problems in interval estimation'. *Journal of the Royal Statistical Society, Series B*, 16: 175-185.
- Lind, J. T. and Mehlum, H. (2010). 'With or Without U? – The Appropriate Test for a U- Shaped Relationship'. *Oxford Bulletin of Economics and Statistics* 72 (1): 109-118.
- Mayer, T.M., Melitz, M.J. and Ottaviano, G.I.P. (2011). 'Market Size, Competition, and the Product Mix of Exporters'. NBER Working Paper 16959.
- Sasabuchi, S. (1980). 'A test of a multivariate normal mean with composite hypotheses determined by linear inequalities'. *Biometrika*, 67 (2): 429-39.
- Wagner, J. (2009), 'Produktdifferenzierung in deutschen Industrieunternehmen 1995 – 2004: Ausmaß und Bestimmungsgründe'. *Jahrbücher für Nationalökonomie und Statistik / Journal of Economics and Statistics* 229 (5), 616-642.
- Zühlke, S., M. Zwick, S. Scharnhorst and Th. Wende (2004), The research data centres of the Federal Statistical Office and the statistical offices of the Länder. *Schmollers Jahrbuch / Journal of Applied Social Science Studies* 124 (4), 567-578.



Table I: Test of an inversely U-shaped relationship between the number of different products produced and labor productivity in German manufacturing enterprises, 1995 and 2006

---

Year		1995	2006
Labor productivity	$\beta$	4.26e-6	3.16e-06
	P	0.003	0.000
Labor productivity (squared)	$\beta$	-1.25e-11	-4.09e-12
	P	0.001	0.000
Test of joint significance of labor productivity variables (p-value)		0.003	0.000
Sasabuchi-test of inverse U-shape in labor productivity (p-value)		0.002	0.001
Estimated extreme point (Euro)		170,400	386,308
(bounds of 95% Fieller interval)		121,211; 208,162	314,295; 524,482
Number of enterprises		27,376	25,426

---

Note: Enterprises from the bottom / top one percent of the distribution of labor productivity were dropped from the sample used in the estimations.  $\beta$  is the estimated regression coefficient from an OLS-regression, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. The models include a set of 4-digit industry dummy variables.

# Working Paper Series in Economics

(recent issues)

---

- No.256: *Christian Pfeifer and Joachim Wagner*: Is innovative firm behavior correlated with age and gender composition of the workforce? Evidence from a new type of data for German enterprises, December 2012
- No.255: *Maximilian Benner*: Cluster Policy as a Development Strategy. Case Studies from the Middle East and North Africa, December 2012
- No.254: *Joachim Wagner und John P. Weche Gelübcke*: Firmendatenbasiertes Benchmarking der Industrie und des Dienstleistungssektors in Niedersachsen – Methodisches Konzept und Anwendungen (Projektbericht), Dezember 2012
- No.253: *Joachim Wagner*: The Great Export Recovery in German Manufacturing Industries, 2009/2010, November 2012
- No.252: *Joachim Wagner*: Daten des IAB-Betriebspanels und Firmenpaneldaten aus Erhebungen der Amtlichen Statistik – substitutive oder komplementäre Inputs für die Empirische Wirtschaftsforschung?, Oktober 2012
- No.251: *Joachim Wagner*: Credit constraints and exports: Evidence for German manufacturing enterprises, October 2012
- No.250: *Joachim Wagner*: Productivity and the extensive margins of trade in German manufacturing firms: Evidence from a non-parametric test, September 2012 [published in: Economics Bulletin 32 (2012), 4, 3061-3070]
- No.249: *John P. Weche Gelübcke*: Foreign and Domestic Takeovers in Germany: First Comparative Evidence on the Post-acquisition Target Performance using new Data, September 2012
- No.248: *Roland Olbrich, Martin Quaas, and Stefan Baumgärtner*: Characterizing commercial cattle farms in Namibia: risk, management and sustainability, August 2012
- No.247: *Alexander Vogel and Joachim Wagner*: Exports, R&D and Productivity in German Business Services Firms: A test of the Bustos-model, August 2012
- No.246: *Alexander Vogel and Joachim Wagner*: Innovations and Exports of German Business Services Enterprises: First evidence from a new type of firm data, August 2012
- No.245: *Stephan Humpert*: Somewhere over the Rainbow: Sexual Orientation Discrimination in Germany, July 2012
- No.244: *Joachim Wagner*: Exports, R&D and Productivity: A test of the Bustos-model with German enterprise data, June 2012 [published in: Economics Bulletin, 32 (2012), 3, 1942-1948]
- No.243: *Joachim Wagner*: Trading many goods with many countries: Exporters and importers from German manufacturing industries, June 2012 [published in: Jahrbuch für Wirtschaftswissenschaften/Review of Economics, 63 (2012), 2, 170-186]
- No.242: *Joachim Wagner*: German multiple-product, multiple-destination exporters: Bernard-Redding-Schott under test, June 2012 [published in: Economics Bulletin, 32 (2012), 2, 1708-1714]
- No.241: *Joachim Fünfgelt and Stefan Baumgärtner*: Regulation of morally responsible agents with motivation crowding, June 2012
- No.240: *John P. Weche Gelübcke*: Foreign and Domestic Takeovers: Cherry-picking and Lemon-grabbing, April 2012

- No.239: *Markus Leibrecht and Aleksandra Riedl*: Modelling FDI based on a spatially augmented gravity model: Evidence for Central and Eastern European Countries, April 2012
- No.238: *Norbert Olah, Thomas Huth und Dirk Löhr*: Monetarismus mit Liquiditätsprämie Von Friedmans optimaler Inflationsrate zur optimalen Liquidität, April 2012
- No.237: *Markus Leibrecht and Johann Scharler*: Government Size and Business Cycle Volatility; How Important Are Credit Constraints?, April 2012
- No.236: *Frank Schmielewski and Thomas Wein*: Are private banks the better banks? An insight into the principal-agent structure and risk-taking behavior of German banks, April 2012
- No.235: *Stephan Humpert*: Age and Gender Differences in Job Opportunities, March 2012
- No.234: *Joachim Fünfgelt and Stefan Baumgärtner*: A utilitarian notion of responsibility for sustainability, March 2012
- No.233: *Joachim Wagner*: The Microstructure of the Great Export Collapse in German Manufacturing Industries, 2008/2009, February 2012
- No.232: *Christian Pfeifer and Joachim Wagner*: Age and gender composition of the workforce, productivity and profits: Evidence from a new type of data for German enterprises, February 2012
- No.231: *Daniel Fackler, Claus Schnabel, and Joachim Wagner*: Establishment exits in Germany: the role of size and age, February 2012
- No.230: *Institut für Volkswirtschaftslehre*: Forschungsbericht 2011, January 2012
- No.229: *Frank Schmielewski*: Leveraging and risk taking within the German banking system: Evidence from the financial crisis in 2007 and 2008, January 2012
- No.228: *Daniel Schmidt and Frank Schmielewski*: Consumer reaction on tumbling funds – Evidence from retail fund outflows during the financial crisis 2007/2008, January 2012
- No.227: *Joachim Wagner*: New Methods for the Analysis of Links between International Firm Activities and Firm Performance: A Practitioner's Guide, January 2012
- No.226: *Alexander Vogel and Joachim Wagner*: The Quality of the KombiFiD-Sample of Business Services Enterprises: Evidence from a Replication Study, January 2012 [published in: Schmollers Jahrbuch/Journal of Applied Social Science Studies 132 (2012), 3, 379-392]
- No.225: *Stefanie Glotzbach*: Environmental justice in agricultural systems. An evaluation of success factors and barriers by the example of the Philippine farmer network MASIPAG, January 2012
- No.224: *Joachim Wagner*: Average wage, qualification of the workforce and export performance in German enterprises: Evidence from KombiFiD data, January 2012 [published in: Journal for Labour Market Research, 45 (2012), 2, 161-170]
- No.223: *Maria Olivares and Heike Wetzel*: Competing in the Higher Education Market: Empirical Evidence for Economies of Scale and Scope in German Higher Education Institutions, December 2011
- No.222: *Maximilian Benner*: How export-led growth can lead to take-off, December 2011
- No.221: *Joachim Wagner and John P. Weche Gelübcke*: Foreign Ownership and Firm Survival: First evidence for enterprises in Germany, December 2011
- No.220: *Martin F. Quaas, Daan van Soest, and Stefan Baumgärtner*: Complementarity, impatience, and the resilience of natural-resource-dependent economies, November 2011

- No.219: *Joachim Wagner*: The German Manufacturing Sector is a Granular Economy, November 2011 [published in: *Applied Economics Letters*, 19(2012), 17, 1663-1665]
- No.218: *Stefan Baumgärtner, Stefanie Glotzbach, Nikolai Hoberg, Martin F. Quaas, and Klara Stumpf*: Trade-offs between justices , economics, and efficiency, November 2011
- No.217: *Joachim Wagner*: The Quality of the KombiFiD-Sample of Enterprises from Manufacturing Industries: Evidence from a Replication Study, November 2011 [published in: *Schmollers Jahrbuch/Journal of Applied Social Science Studies* 132 (2012), 3, 393-403]
- No.216: *John P. Weche Gelübcke*: The Performance of Foreign Affiliates in German Manufacturing: Evidence from a new Database, November 2011
- No.215: *Joachim Wagner*: Exports, Foreign Direct Investments and Productivity: Are services firms different?, September 2011
- No.214: *Stephan Humpert and Christian Pfeifer*: Explaining Age and Gender Differences in Employment Rates: A Labor Supply Side Perspective, August 2011
- No.213: *John P. Weche Gelübcke*: Foreign Ownership and Firm Performance in German Services: First Evidence based on Official Statistics, August 2011 [forthcoming in: *The Service Industries Journal*]
- No.212: *John P. Weche Gelübcke*: Ownership Patterns and Enterprise Groups in German Structural Business Statistics, August 2011 [published in: *Schmollers Jahrbuch / Journal of Applied Social Science Studies*, 131(2011), 4, 635-647]
- No.211: *Joachim Wagner*: Exports, Imports and Firm Survival: First Evidence for manufacturing enterprises in Germany, August 2011
- No.210: *Joachim Wagner*: International Trade and Firm Performance: A Survey of Empirical Studies since 2006, August 2011 [published in: *Review of World Economics*, 2012, 148 (2), 235-267]
- No.209: *Roland Olbrich, Martin F. Quaas, and Stefan Baumgärtner*: Personal norms of sustainability and their impact on management – The case of rangeland management in semi-arid regions, August 2011
- No.208: *Roland Olbrich, Martin F. Quaas, Andreas Haensler and Stefan Baumgärtner*: Risk preferences under heterogeneous environmental risk, August 2011
- No.207: *Alexander Vogel and Joachim Wagner*: Robust estimates of exporter productivity premia in German business services enterprises, July 2011 [published in: *Economic and Business Review*, 13 (2011), 1-2, 7-26]
- No.206: *Joachim Wagner*: Exports, imports and profitability: First evidence for manufacturing enterprises, June 2011 [published in: *Open Economies Review* 23 (2012), 5, 747-765]
- No.205: *Sebastian Strunz*: Is conceptual vagueness an asset? Resilience research from the perspective of philosophy of science, May 2011
- No.204: *Stefanie Glotzbach*: On the notion of ecological justice, May 2011
- No.203: *Christian Pfeifer*: The Heterogeneous Economic Consequences of Works Council Relations, April 2011
- No.202: *Christian Pfeifer, Simon Janssen, Philip Yang and Uschi Backes-Gellner*: Effects of Training on Employee Suggestions and Promotions in an Internal Labor Market, April 2011

(see [www.leuphana.de/institute/ivwl/publikationen/working-papers.html](http://www.leuphana.de/institute/ivwl/publikationen/working-papers.html) for a complete list)

Leuphana Universität Lüneburg  
Institut für Volkswirtschaftslehre  
Postfach 2440  
D-21314 Lüneburg  
Tel.: ++49 4131 677 2321  
email: brodt@leuphana.de

[www.leuphana.de/institute/ivwl/publikationen/working-papers.html](http://www.leuphana.de/institute/ivwl/publikationen/working-papers.html)