Raff, Horst; Wagner, Joachim

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

University of Lüneburg 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, University of Lüneburg Working Paper Series in Economics, No. 257, Universität Lüneburg, Institut für Volkswirtschaftslehre, Lüneburg

This Version is available at:
http://hdl.handle.net/10419/73184

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

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

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
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.¹

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.²

¹ 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.
² 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. 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.

---

3 Results for the other years are very similar; details are available on request.
References


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

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

Note: Enterprises from the bottom / top one percent of the distribution of labor productivity were dropped from the sample used in the estimations. β 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.
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>Is innovative firm behavior correlated with age and gender composition of the workforce? Evidence from a new type of data for German enterprises</td>
<td>Christian Pfeifer and Joachim Wagner</td>
<td>December 2012</td>
</tr>
<tr>
<td>252</td>
<td>Daten des IAB-Betriebspanels und Firmenpaneldaten aus Erhebungen der Amtlichen Statistik – substitutive oder komplementäre Inputs für die Empirische Wirtschaftsforschung?</td>
<td>Joachim Wagner</td>
<td>Oktober 2012</td>
</tr>
<tr>
<td>251</td>
<td>Credit constraints and exports: Evidence for German manufacturing enterprises</td>
<td>Joachim Wagner</td>
<td>Oktober 2012</td>
</tr>
<tr>
<td>250</td>
<td>Productivity and the extensive margins of trade in German manufacturing firms: Evidence from a non-parametric test</td>
<td>Joachim Wagner</td>
<td>September 2012</td>
</tr>
<tr>
<td>249</td>
<td>Foreign and Domestic Takeovers in Germany: First Comparative Evidence on the Post-acquisition Target Performance using new Data</td>
<td>John P. Weche Gelübcke</td>
<td>September 2012</td>
</tr>
<tr>
<td>248</td>
<td>Characterizing commercial cattle farms in Namibia: risk, management and sustainability</td>
<td>Roland Olbrich, Martin Quaas, and Stefan Baumgärtner</td>
<td>August 2012</td>
</tr>
<tr>
<td>247</td>
<td>Exports, R&amp;D and Productivity in German Business Firms: A test of the Bustos-model</td>
<td>Alexander Vogel and Joachim Wagner</td>
<td>August 2012</td>
</tr>
<tr>
<td>246</td>
<td>Innovations and Exports of German Business Services Enterprises: First evidence from a new type of firm data</td>
<td>Alexander Vogel and Joachim Wagner</td>
<td>August 2012</td>
</tr>
<tr>
<td>245</td>
<td>Somewhere over the Rainbow: Sexual Orientation Discrimination in Germany</td>
<td>Stephan Humpert</td>
<td>July 2012</td>
</tr>
<tr>
<td>244</td>
<td>Exports, R&amp;D and Productivity: A test of the Bustos-model with German enterprise data</td>
<td>Joachim Wagner</td>
<td>June 2012</td>
</tr>
<tr>
<td>243</td>
<td>Trading many goods with many countries: Exporters and importers from German manufacturing industries</td>
<td>Joachim Wagner</td>
<td>June 2012</td>
</tr>
<tr>
<td>242</td>
<td>German multiple-product, multiple-destination exporters: Bernard-Redding-Schott under test</td>
<td>Joachim Wagner</td>
<td>June 2012</td>
</tr>
<tr>
<td>241</td>
<td>Regulation of morally responsible agents with motivation crowding</td>
<td>Joachim Fünfgelt and Stefan Baumgärtner</td>
<td>June 2012</td>
</tr>
<tr>
<td>240</td>
<td>Foreign and Domestic Takeovers: Cherry-picking and Lemon-grabbing</td>
<td>John P. Weche Gelübcke</td>
<td>April 2012</td>
</tr>
</tbody>
</table>
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.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.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.218:  Stefan Baumgärtner, Stefanie Glotzbach, Nikolai Hoberg, Martin F. Quaas, and Klara Stumpf: Trade-offs between justices, economics, and efficiency, November 2011


No.215:  Joachim Wagner: Exports, Foreign Direct Investments and Productivity: Are services firms different?, September 2011


No.211:  Joachim Wagner: Exports, Imports and Firm Survival: First Evidence for manufacturing enterprises in Germany, August 2011


No.208:  Roland Olbrich, Martin F. Quaas, Andreas Haensler and Stefan Baumgärtner: Risk preferences under heterogeneous environmental risk, August 2011


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


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