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

by

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

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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.

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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]

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[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.[3] 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.

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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	ß	4.26e-6	3.16e-06
	P	0.003	0.000
Labor productivity	ß	-1.25e-11	-4.09e-12
(squared)	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. ß 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.

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