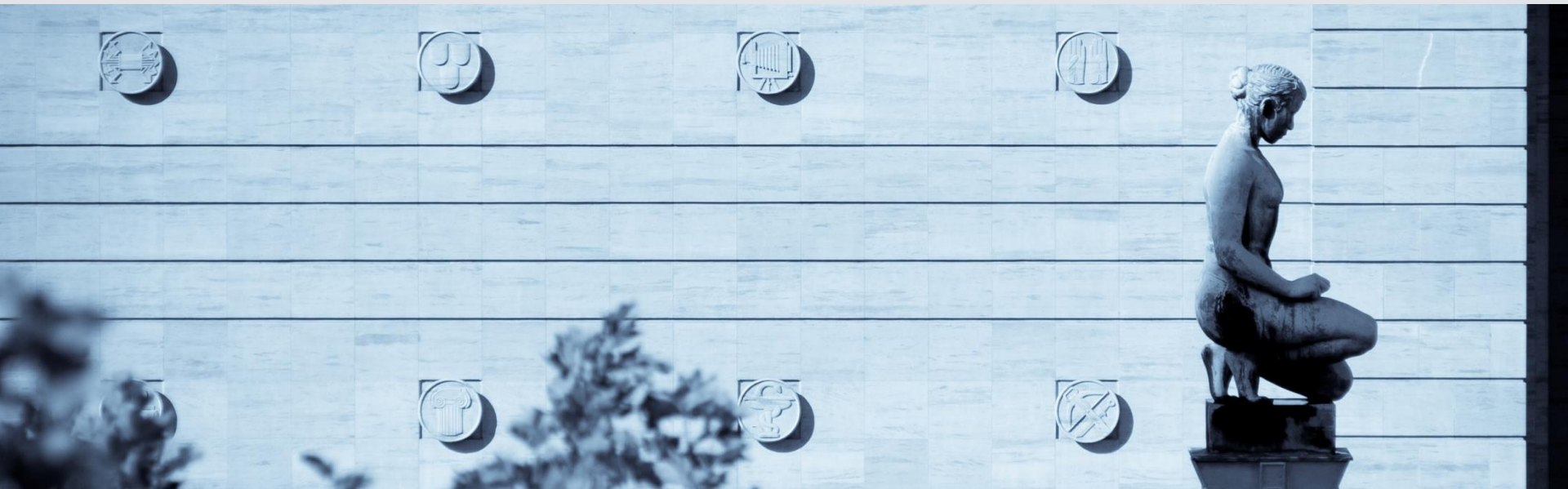# Why do manufacturing firms produce services? Evidence for the servitization paradox in Belgium

ESCB Research Cluster 2 workshop

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INTERN

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Banque **Nationale** Bank
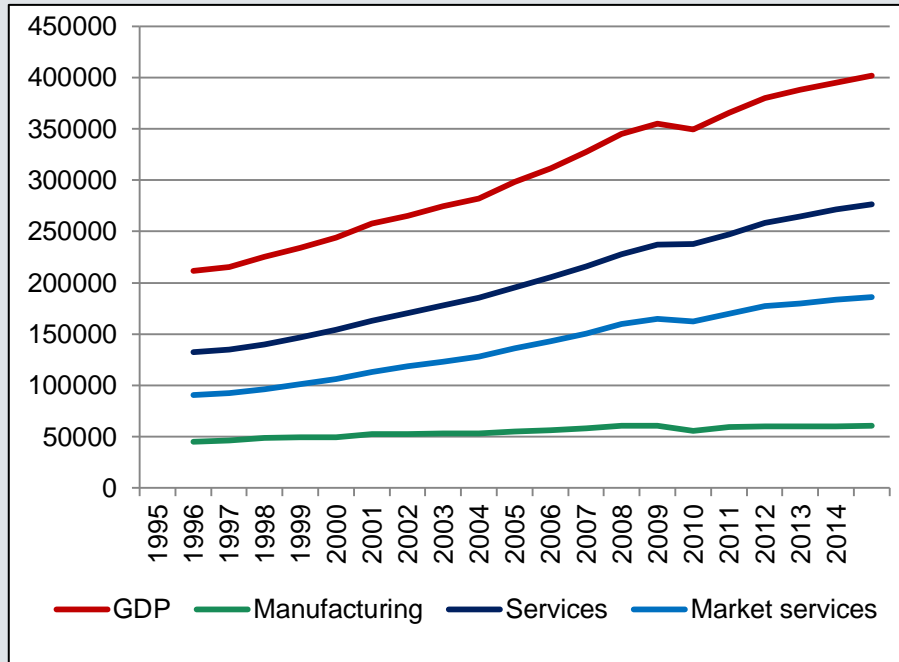DE BELGIQUE   VAN BELGIË
Eurosystem

Motivation

► **Servitization :** Reallocation of production towards services

- At the macro level
  - increasing share of services in GDP, international trade, employment, …

- At the micro level
  - servitization refers to the provision of services by a company whose main or initial activity is the production of goods

► **Why is this important?**

- At the macro level
  - impact on growth, TFP growth, …
  - impact on employment, labour force composition, …

- At the micro level
  - changes the view of what is a manufacturing industry/firm
  - impact on firm competiton within and between sectors
  - may affect firm performance (profits), dynamics (higher exits), investment, labour demand (in terms of workforce composition and skills)
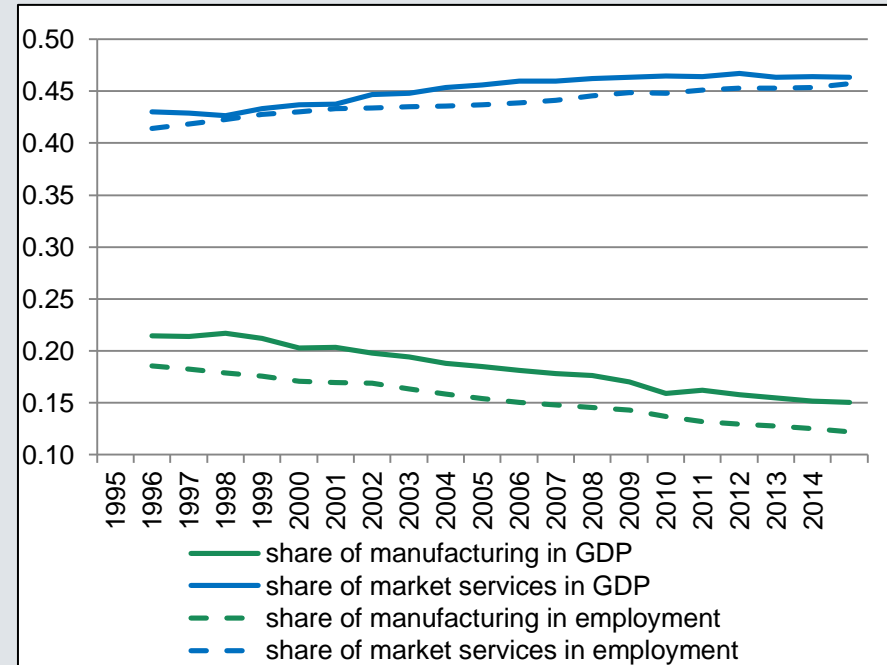
Motivation : Evidence at the macroeconomic level

Value added by broad sector (millions euro)

Legend: GDP, Manufacturing, Services, Market services

Share of value added/employment in total economy

Legend:
- share of manufacturing in GDP
- share of market services in GDP
- share of manufacturing in employment
- share of market services in employment

Source: National Accounts - NSI

Employment consequences:

The manufacturing sector lost 1 job over four in twenty years

Employment in services increased by 30% over the same period

Issue for external trade/competitiveness?

The trade balance positive thanks to net exports of services

Motivation : Evidence at the microeconomic level

► **Servitization at the micro level:**

  ▪ provision of services by a firm whose main or initial activity is the production of goods

► **Decomposition in extensive and intensive margin**

  ● Extensive margin of servitization: change of main activity

  ● Intensive margin of servitization: firms that belong to the manufacturing sector and provide services

$$\Delta X_t = \left(\sum_{i \in I} X_{it} - \sum_{i \in I} X_{it-1} \right) + \left(\sum_{i \in N} X_{it} - \sum_{i \in X} X_{it-1} \right) + \left(\sum_{i \in Sin} X_{it} - \sum_{i \in Sout} X_{it-1} \right)$$

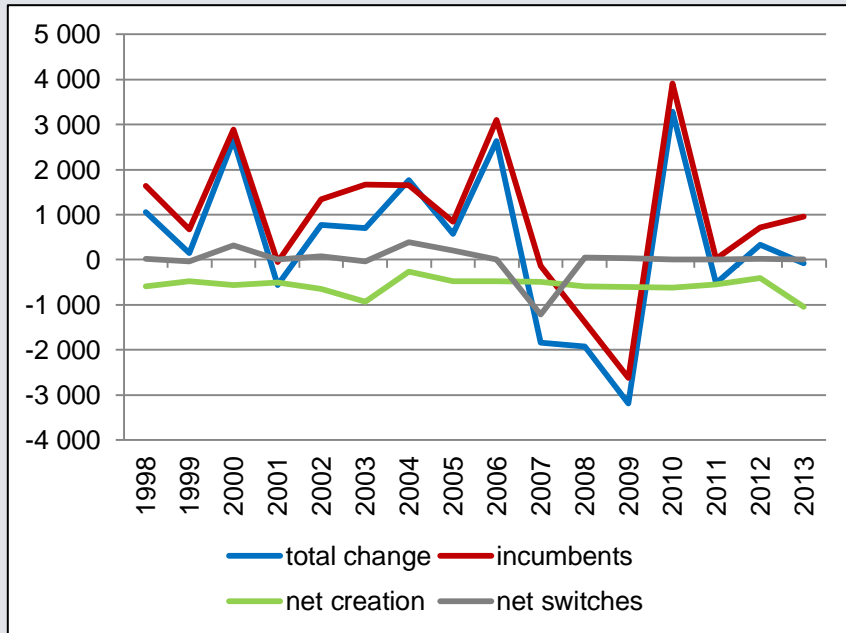| **Incumbents**	**New firms**	**Deaths**	**Entering firms**	**Exiting firms**
active in sector S in t and t-1	active in S in t not active in t-1	active in S in t-1 not active in t	active in S in t active in J≠S in t-1	active in S in t-1 active in J≠S in t

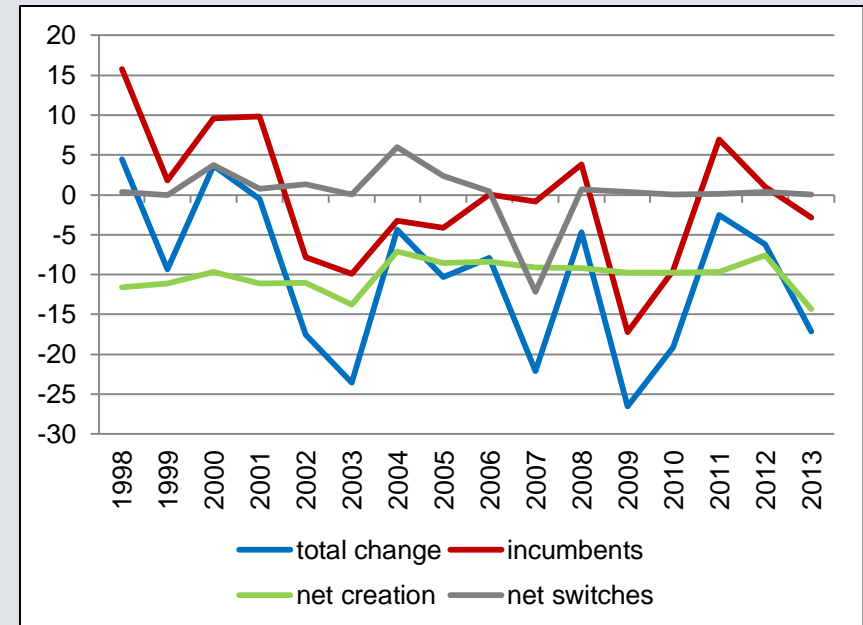| **Incumbents**	**Net creation**	**Net switches**

Motivation : Evidence at the microeconomic level

Total manufacturing value added changes
(in million euro)

Total manufacturing employment changes
(in thousands)

The extensive margin plays a minor role - > focus on the intensive margin

Motivation : Theoretical rationale

► **Costly and risky investment**
- organisational costs
- changes in workforce composition
- change in business model, marketing, …
- higher risk of failure

► **Why do firms engage in servitization?**

- product differentiation
- market advantage and barrier to entry
- response to other firms servitization strategy
- strengthening customer relationships

► **-> servitization paradox:**
- small and young firms may use servitization to penetrate the market
- large and profitable firms may use it to protect or extend their market share

► **This paper**
- theoretical model
- empirical evaluation

Relevant literature

► **Theoretical models**

- Breinlich, Soderbery and Wright (2014)
  - Monopolistic competition, differentated products
  - Rivalry in the allocation of expertise between goods and services production
  - Separability between demand for goods and demand for services
  - Empirics: goods tariff reduction boost services provision, vary wrt sector or capital intensity

- Ariu, Mayneris, Parenti (2017)
  - Complementarity between demand for goods and services
  - Monopolistic competition vs oligopolistic competition
  - Exports of services increases performance of exports of goods
    through quantities under mon. comp. and through prices under olig. comp.
    Confirmed by an empirical evaluation

- Lee et al. (2016)
  - Complementarity between demand for goods and services
  - Comparison of two market models: firms produce both goods and services vs
    some firms produce goods while some others provide services

► **Empirical evaluations**

- Bernard, Smeets, Warzynski (2016) : focus on production services and change of main activity
- Crozet and Millet (2014) : description of servitization and relation with firm characteristics
- Crozet and Millet (2015) : impact of starting servitization on firm performance; vary across sectors
- Dachs et al. (2014) : U-shape relation between firm size and servitization;
  varies wrt sector innovation intensity

Theoretical model : Demand

► **Quadratic utility function**

$$U = \alpha \int_0^N q_i^c \, di - \frac{1}{2}\gamma_g \int_0^N \left(q_i^c\right)^2 di - \frac{1}{2}\left(\int_0^N q_i^c \, di\right)^2$$

$$+ \alpha \int_0^N y_i^c \, di - \frac{1}{2}\gamma_s \int_0^N \left(y_i^c\right)^2 di - \frac{1}{2}\left(\int_0^N y_i^c \, di\right)^2 + \theta \int_0^N q_i^c y_i^c \, di$$

- *L* consumers, *N* varieties of goods, q_i and services y_i
- γ_g, γ_s: product differentiation
- θ: complementarity between goods and services ($0 \le \theta \le \gamma_g$ and $0 \le \theta \le \gamma_s$)

► **Monopolistic competition on markets for goods and for services**

► **Market demand for goods, q_i, and services y_i**

$$q_i = L\left(a - bp_i^g - cp_i^i + d\bar{P}^g + e\bar{P}^i\right)$$

$$y_i = L\left(a' - cp_i^g - b'p_i^i + e\bar{P}^g + d'\bar{P}^i\right)$$

- *a, b, c, a', b', c', d, d', e* depend on *N*, γ_g, γ_s, θ and α

Theoretical model : Production

► **Production of goods and services** (as in Breinlich et al. 2014)

$$q_i = T_{ig}L_{ig} \qquad\qquad y_i = T_{is}L_{is}$$

T_i firm-specific productivity and L_{ig}, L_{is} labour inputs

► **Allocation of expertise across the production of goods and services**

$$T_i = \left(T_{ig}^t + T_{is}^t\right)^{\frac{1}{t}}$$

depends on the degree of non rivalry t, (with $0 < t < \infty$)

► **At equilibrium**

$$\frac{T_{is}}{T_{ig}} = \left(\frac{y_i}{q_i}\right)^{\frac{1}{1+t}}$$

$$q_i = \frac{L}{2}\left(a + d\bar{P}^g + e\bar{P}^s - \frac{bw}{T_{ig}} - \frac{cw}{T_{is}}\right)$$

$$y_i = \frac{L}{2}\left(a' + e\bar{P}^g + d'\bar{P}^s - \frac{cw}{T_{ig}} - \frac{b'w}{T_{is}}\right)$$

Theoretical model : Prediction for servitization

► **Comparative static**

$$\frac{dT_{is}}{dT_i} = \left(\frac{T_{is}}{T_i}\right)^{1-t}\left(\frac{T_{ig}A}{T_{is}B + T_{ig}A}\right)$$

$$A = \left(\frac{cwL}{2T_{ig}}\left(\left(\frac{T_{is}}{T_{ig}}\right)^{1+t}\frac{b}{c} - 1\right) - (1+t)y_i\right) \qquad B = \left(\frac{cwL}{2T_{is}}\left(\left(\frac{T_{ig}}{T_{is}}\right)^{1+t}\frac{b'}{c} - 1\right) - (1+t)q_i\right)$$

dT_{it}/dT_i may be >0 or <0 depending on N, L, γ_g, γ_s, θ and α, t, T_i.

► **Servitization varies with**
- firm characteristics : non linear relationship with efficiency
- Product characteristics: complementarity between goods and services, product differentiation
- Production characteristics: extent of expertise rivalry
- Market conditions: demand elasticity and extent of competition

-> Low performing firms as well as high performing firms engage in servitization
-> The relationship between servitization and firm efficiency varies across sectors

Data and measure of servitization

► **Sample coverage**

- manufacturing firms in Belgium over 1997-2013 with at least 20 employees

► $serv_{it}$: **firm servitization rate**

- share of firm sales that does not refer to industrial goods
- Data on firm total sales (from VAT declarations)
- Data on firm industrial goods sales (from Survey of Industrial Production, Prodcom)
- $serv_{it} = \frac{sales_{it} - goods\ sales_{it}}{sales_{it}}$
- Trimming: focus on $serv_{it}$ within [-0,05, 1,05] and winsorize at [0, 1]

► **Firm-level variables**

- $size_{it}$: log(employment) (from annual accounts)
- $wage_{it}$: firm average wage bill (from annual accounts)
- age_{it}: from firm offical starting date (from Crossroads Bank for Enterprises)
- tfp_{it}: TFP estimated based on Ackerberg et al. (2015) (L predetermined, intermediate inputs as proxy)

► **Sector-level variables**

- $Herfindahl_{st}$: Herfindahl index on $sales_{it}$
- $\overline{servitization}_{st}$: average servitization rate
- $\sigma(servitization)_{st}$: dispersion (standard deviation) of servitization rate
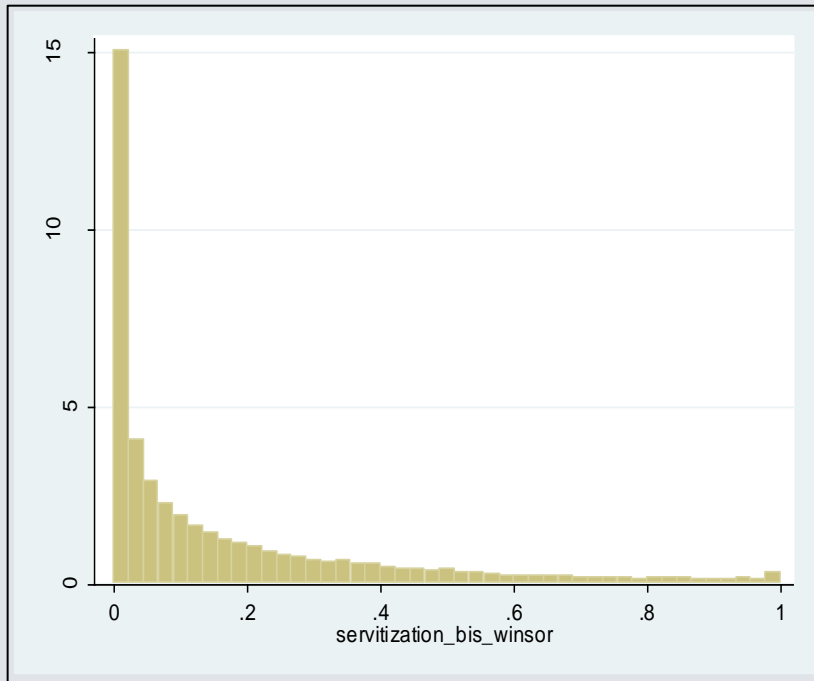
Descriptive statistics on servitization
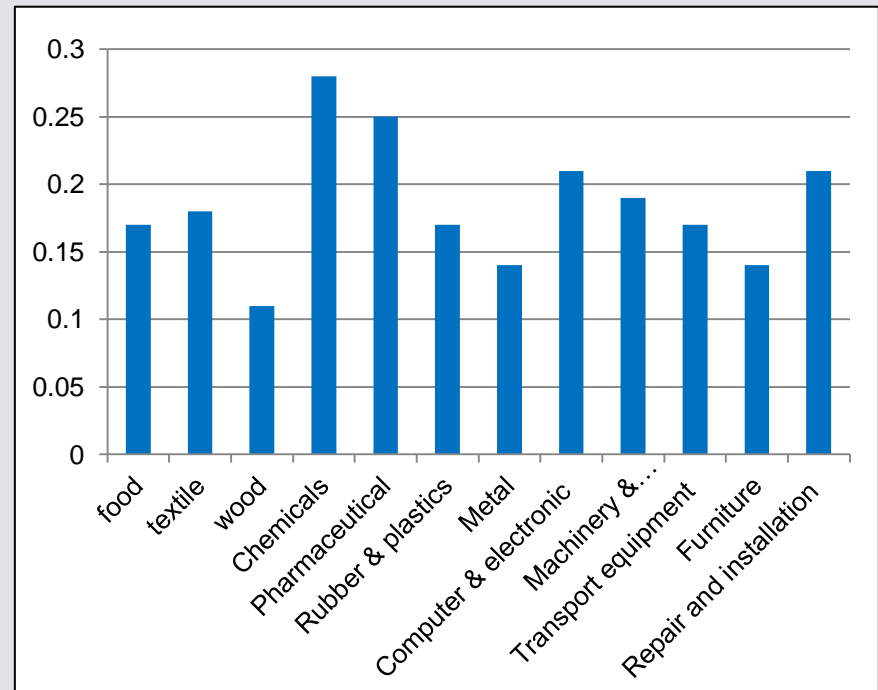
average($serv_{it}$) : 0,17   std($serv_{it}$) : 0,23

Heterogeneity across firms
Most firms do not produce services

Heterogeneity across sectors

Econometric evaluation

Fractional Probit model with multiplicative heteroscedasticity and Chamberlain-Mundlak correction

	(1)	(2)	(3)	(4)	(5)
tfp_{it}	-0.291***	-0.248***	-0.230**	-0.233***	-0.222***
	(0.102)	(0.093)	(0.091)	(0.087)	(0.085)
tfp_{it}^2	0.015***	0.013**	0.012**	0.011**	0.011**
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
age_{it}		-0.039*	-0.035	-0.025	-0.021
		(0.022)	(0.022)	(0.020)	(0.020)
$size_{it}$			-0.043***		-0.036**
			(0.015)		(0.014)
$wage_{it}$				0.136***	0.128***
				(0.031)	(0.031)
$\overline{servitization}_{st}$	1.424***	1.316***	1.297***	1.249***	1.229***
	(0.353)	(0.332)	(0.327)	(0.312)	(0.309)
$\sigma(servitization)_{st}$	0.235	0.195	0.205	0.131	0.144
	(0.263)	(0.245)	(0.242)	(0.227)	(0.226)
$Herfindahl_{st}$	-0.131	-0.153	-0.142	-0.148	-0.140
	(0.159)	(0.151)	(0.149)	(0.140)	(0.140)
constant	0.067	-0.126	-0.265	-3.865***	-3.762***
	(0.840)	(0.782)	(0.791)	(1.043)	(1.037)
Observations	36850	36850	36850	36846	36846
Log likelihood	-16344	-16314	-16289	-16182	-16178

All regressions include year and sector effects,
Estimation by Quasi Maximum Likelihood. Robust clustered standard errors

Econometric evaluation: fractional Probit model

Predicted servitization rate for alternative values of TFP
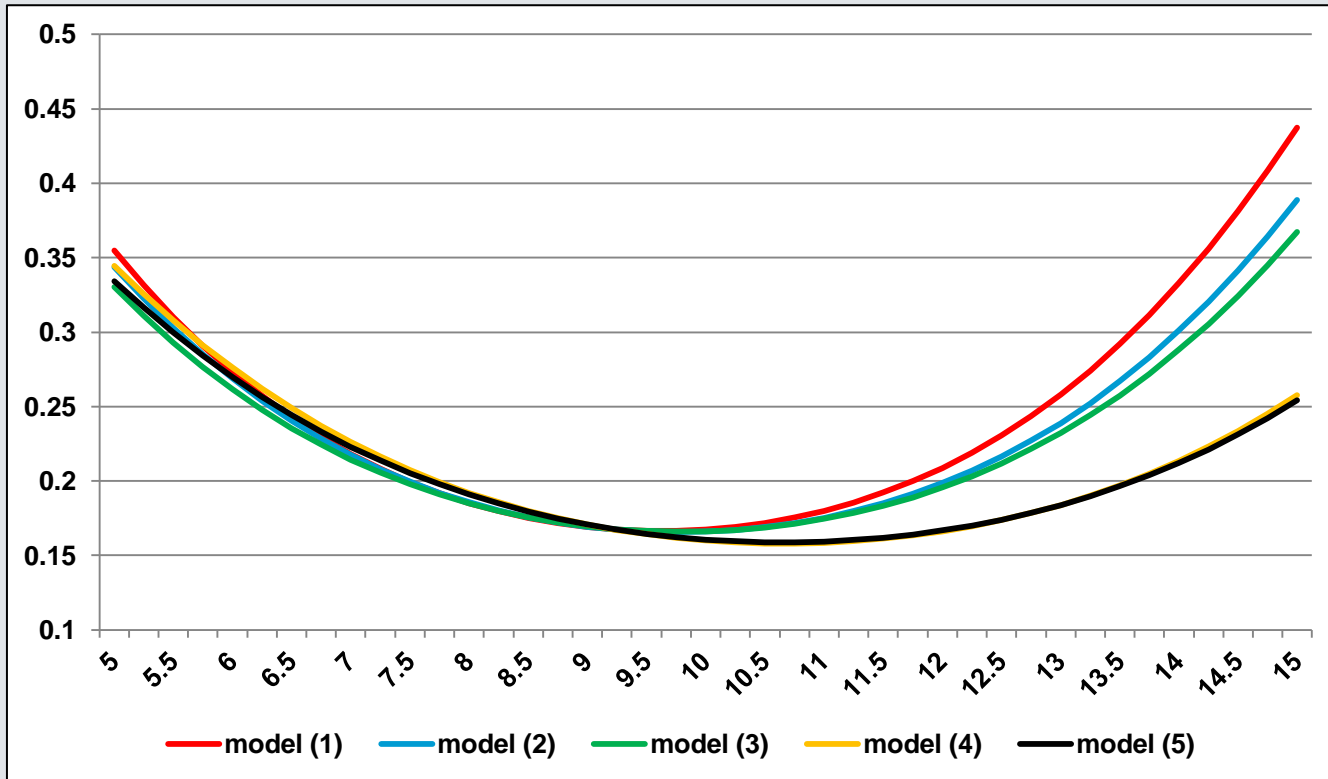
model (1): tfp_{it} tfp_{it}^2 sector-level variables, sector and year effects
model (2): tfp_{it} tfp_{it}^2 age_{it} sector-level variables, sector and year effects
model (3): tfp_{it} tfp_{it}^2 age_{it} $size_{it}$ sector-level variables, sector and year effects
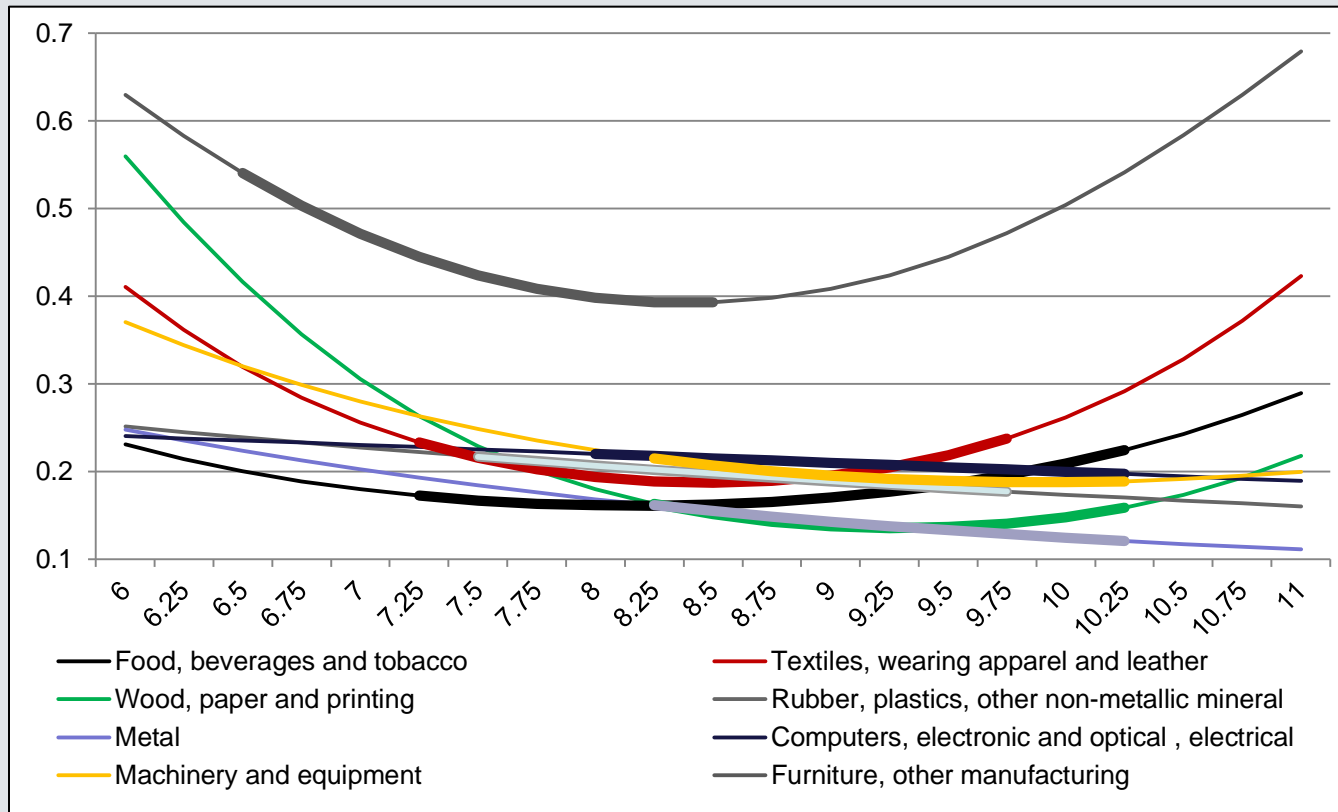model (4): tfp_{it} tfp_{it}^2 age_{it} $wage_{it}$ sector-level variables, sector and year effects
model (5): tfp_{it} tfp_{it}^2 age_{it} $size_{it}$ $wage_{it}$ sector-level variables, sector and year effects

-> Low performing firms as well as high performing firms engage in servitization

Econometric evaluation: fractional Probit model

Predicted servitization rate for alternative values of TFP

Legend:
- Food, beverages and tobacco
- Textiles, wearing apparel and leather
- Wood, paper and printing
- Rubber, plastics, other non-metallic mineral
- Metal
- Computers, electronic and optical , electrical
- Machinery and equipment
- Furniture, other manufacturing

regressions include tfp_{it} tfp_{it}^2, sector-level variables, sector and year effects
the bold line represents values that lie within the [P1-P99] range of the TFP distribution of the
corresponding broad sector of economic activity

-> The relationship between servitization and firm efficiency varies across sectors

Conclusions - Summary

► **Theoretical model with**
- The demand side accounts for complementarity between goods and services
- The supply side allows for non-rivalry in the allocation of expertise between goods production and services provision
- Monopolistic competition, differentiated products, firm heterogeneity in efficiency

► **Theoretical predictions**
- Both less performing firms and high performing firms engage in service production
- The form of the relationship depends on product characteristics, production technology, market environment

► **Empirical evaluation**
- U–shape relationship between servitization and TFP
- The relationship varies across sectors