## Offshoring and the Functional Structure of Labour Demand in Advanced Economies

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# Motivation

- Due to declining communication and coordination costs MNEs find it profitable to fragment business activities across borders
- Implications for national labour markets (Baldwin,2006)
- Research question:
  - Relationship between technological progress, international offshoring, and the "functional structure of labor demand"
  - 2) Analysis of the bundling of various activities: are there complementarities and substitutability between business functions in offshoring?

# Motivation: contribution

- One of the first papers that looks at the impact of offshoring on changes in labour demand for business activities
  - Previous work focused on effect of OS on skill level/structure
- Cross-country cross-industry panel setting: aggregate implications for advanced economies
  - Extant literature mostly focuses on firm-level studies
- Estimate demand for activities using a translog cost framework, allowing investigation of complementarity and substitutability between business activities in offshoring

## Data

- Detailed time series occupational wage and employment data by industry for US, Japan and 15 pre-2004-EU countries from 1995 onward
- Workers classified by type of activities nine generic functions (Sturgeon & Gereffi, 2009)
  - Production, R&D, sales and marketing, logistics, customer services, management, technology development, back-office, facility maintenance
- Workers mapped into business functions
  - "Functions identified by labour income of workers that perform the function" (?)
- Standard classification of activities in literature: production vs HQ

Here, HQ split into R&D and various other activities

# **Offshoring definition**

- Changes in business functions are related to offshoring
- Narrow definition of offshoring: Imported intermediates by an industry from that industry as a share of total non-energy intermediates
- **Broad definition** of offshoring:

All imported intermediates by an industry as a share of total non energy intermediates

# **Data Sources**

 Occupation data
 Europe: European Labor Force Survey (EU LFS) Structure of Earnings Surveys (SES)
 US: Occupational Employment Statistics (OES)
 Japan: Japan Population Census Wage structure surveys

EUKLEMS database

Variables: ICT and non-ICT capital stock, Employment,

Labour compensation, Value added

3) The World Input-Output Database (WIOD) Variables: Narrow and broad offshoring

# Data and 'Mapping'

- Mapping of occupations is exhaustive since a generic set of functions is used
- Hence, employment shares by business function within each industry add up to one
- Employment data are combined with relative wages to create exhaustive split of shares in labour compensation within each industry

Business function	Example occupation(s)	NOS 2010	OES 2007
1. Production activities	Assemblers; Other machine	61.1	57.6
	operators and assemblers		
2. Research and Development of	Architects, engineers	5.6	6.7
Products, Services, or Technology	and related professionals		
3. Sales and Marketing	Business professionals	7.5	5.0
4. Transportation, Logistics,	Transport labourers	5.6	9.1
and Distribution	and freight handlers		
5. Customer and After-Sales Services	Client information clerks	4.3	5.6
6. General and strategic management;	General managers;	9.7	8.8
Administration, and Back Office	Office clerks		
Functions			
7. Technology and process development	Computing profession als	2.6	2.8
8. Facilities Maintenance	Painters, building cleaners	3.7	4.5
	and related trades workers	*	

Employment shares, e.g. 61.1% of empl in production are assemblers, etc

#### Cost shares of functional labour demand

- Analysis based on cost shares of functional labour demand
- Capital treated as quasi-fixed in the short run
- Capital: ICT capital stock and non-ICT capital stock (to control for the role of new technologies in affecting demand for activities)

	Average			Annual changes		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
$S_{RD}$	5269	0.108	0.101	4892	0.004	0.043
in manufacturing	2273	0.131	0.107	2107	0.005	0.052
in services	2996	0.090	0.092	2785	0.003	0.034
SPROD	5269	0.309	0.234	4892	-0.011	0.092
$in \ manufacturing$	2273	0.491	0.130	2107	-0.012	0.085
in services	2996	0.171	0.199	2785	-0.010	0.098
Soth	5269	0.582	0.250	4892	0.007	0.083
in manufacturing	2273	0.377	0.107	2107	0.006	0.074
in services	2996	0.738	0.212	2785	0.007	0.089
Narrow offshoring share	5269	0.069	0.105	4924	0.001	0.015
$to \ advanced \ economies$	5269	0.053	0.085	4924	-0.0001	0.013
$to \ developing \ economies$	5269	0.013	0.023	4924	0.001	0.006
$in \ manufacturing$	2273	0.124	0.119	2122	0.002	0.019
in services	2996	0.028	0.068	2802	0.0064	0.013
Broad offshoring share	5269	0.266	0.233	4924	0.004	0.026
$to \ advanced \ economies$	5269	0.199	0.199	4924	0.001	0.023
$to \ developing \ economies$	5269	0.075	0.096	4924	0.003	0.017
in manufacturing	2273	0.333	0.192	2122	0.004	0.025
in services	2996	0.215	0.249	2802	0.003	0.026
Other variables						
ln Real value added	5269	9.769	2.484	4924	0.024	0.089
ln ICT capital stock	5269	7.425	2.82	4924	0.129	0.136
ln Non-ICT capital stock	5269	10.329	2.617	4924	0.023	0.039

	Average			Annual changes				
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.		
S <sub>RD</sub>	Iaho	ir cost s	hare of the b	nucinoc	s functio	n R&D		
in manufacturing	ando	n cust s	ing	JUSITIES	Sjunctio	ΠΛαυ		
in services	unu e	nymeer	ing					
SPROD	lahou	abour cost share of the production activities						
in manufacturing	Labour cost share of the production activities							
in services								
S <sub>OTH</sub>	Labou	r cost sl	hare of other	<sup>.</sup> busine	ess funct	ions		
in manufacturing								
in services								
Narrow offshoring share								
$to \ advanced \ economies$								
to developing economies								
$in \ manufacturing$								
in services								
Broad offshoring share								
$to \ advanced \ economies$								
$to \ developing \ economies$								
$in \ manufacturing$								
in services								
Other variables								
ln Real value added								
ln ICT capital stock								
ln Non-ICT capital stock								

	Average			Annual changes			
	Obs	Obs Mean Std. Dev.		Obs	Mean	Std. Dev.	
S <sub>RD</sub>	5269	0.108	0.101	4892	0.004	0.043	
in manufacturing	2273	0.131	0.107	2107	0.005	0.052	
in services	2996	0.090	0.092	2785	0.003	0.034	
SPROD	5269	0.309	0.234	4892	-0.011	0.092	
in manufacturing	2273	0.491	0.130	2107	-0.012	0.085	
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- R&D: About 10% of labour cost; On average higher for Manufacturing and lower for Services
- About 50% of labour costs in Manufacturing due to production activities
- Majority of labour costs in services due to other activities
- Overtime, there is an increase in share of R&D and fall in production activities
- Pattern holds overall, but more pronounced in manufacturing

	Avera	ıge		Annual changes		
 Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	

- Both narrow and broad OS increase over the period
- Pattern more pronounced in manufacturing than in services
- Share of OS higher to other advanced economies
- OS to developing countries increases faster
- Decline in production activities + OS to LDC: reflective of CA role in OS?

Narrow offshoring share	5269	0.069	0.105	4924	0.001	0.015
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#### **Empirical Analysis**

• Aim:

Analyse role of OS on changes in functional structure of labour demand

- Methodology:
  - Translog cost function framework can approximate any functional form and allows for varying elasticity of substitution
  - Simultaneous estimation of a system of variable functional labour demands using panel data techniques

(more efficient estimates than single equation models when disturbances are correlated across equations)

#### **Empirical Analysis**

- Three Business Functions, adding up to total labour share in value added
  - o R&D
  - Production
  - Other activities (aggregating the remaining 7?)
  - Capital assumed to be quasi-fixed
  - Both output and capital assumed to be exogenous in the short-run
  - Q: Why exogeneity of output? To avoid reverse-causality? Is the exogeneity of output tested for?

## Methodology

• A translog cost function framework: total variable cost

$$lnC(w,x) = \alpha_0 + \sum_{i=1}^{F} \beta_i \ln w_{it} + \sum_{k=1}^{K} \beta_k \ln x_{kt} + \frac{1}{2} \sum_{i=1}^{F} \sum_{j=1}^{F} \gamma_{ij} \ln w_{it} \ln w_{jt} + \frac{1}{2} \sum_{k=1}^{K} \sum_{l=1}^{K} \gamma_{kl} \ln x_{kt} \ln x_{lt} + \frac{1}{2} \sum_{i=1}^{F} \sum_{k=1}^{K} \gamma_{ik} \ln w_{it} \ln x_{kt}$$

 $S_i = \beta_i + \sum_{j=1}^{F} \gamma_{ij} \ln w_{jt} + \sum_{k=1}^{K} \gamma_{ik} \ln x_{kt};$ 

C= total variable cost; w=prices for business functions; x=ICT/non-ICT capital stock, value added, and narrow/broad OS

Using Shephard's lemma, cost minimisation obtains labour cost share S of a business function in total labour compensation (shares add up to one)

(Constant returns to scale: cost function linear homogeneous in prices)

#### Methodology

Notation could be clearer (typos?)

$$lnC(w, x) = \alpha_{0} + \sum_{i=1}^{F} \beta_{i} lnw_{it} + \sum_{k=1}^{K} \beta_{k} lnx_{kt} + \frac{1}{2} \sum_{i=1}^{F} \sum_{j=1}^{F} \gamma_{ij} lnw_{it} lnw_{jt} + \frac{1}{2} \sum_{k=1}^{K} \sum_{l=1}^{K} \gamma_{kl} lnx_{kt} lnx_{lt} + \frac{1}{2} \sum_{i=1}^{F} \sum_{k=1}^{K} \gamma_{ik} lnw_{it} lnx_{kt}$$

 $S_i = \beta_i + \sum_{j=1}^F \gamma_{ij} \ln w_{jt} + \sum_{k=1}^K \gamma_{ik} \ln x_{kt};$ 

- Using γ for all coefficients generates confusion (e.g. when *i=j=k=1*)
- Time subscript appears on r-h-s but not on l-h-s

### Methodology

• According to Allen-Uzawa partial elasticities of substitution:

 $\sigma_{ij} = \frac{\gamma_{ij}}{s_i s_j} + 1$  (*for*  $i \neq j$ ), where  $\sigma_{ij}$  is the substitution elasticity between business function *i* and *j*.

- For σ<sub>ij</sub> > 1, net substitution between business functions *i* and *j*;
- For σ<sub>ij</sub> < 1, net complementarity between business functions *i* and *j*.
- *s* is the average cost share of a certain business function

#### **Results- all industries**

		Narrow OS		Broad	OS
		(1)	(2)	(3)	(4)
	$\gamma_{RD}$	0.016***	0.016***	0.016***	0.015***
Labour	$\gamma_{RD,Prod}$	-0.013 * * *	-0.013***	- 0. 01 2***	- 0. 01 2***
Cost share	$\gamma_{RD,Oth}$	-0.003	-0.003	-0.003	-0.003
in R&D	$\gamma_{RD,ICT}$	0.007***	0.006***	0.007***	0.006***
	$\gamma_{RD,nonICT}$	-0.005***	-0.005***	-0.005***	-0.005***
activities	$\gamma_{RD,Y}$	0.018 ***	0.017 ***	0.018 * * *	0.017 * * *
	$\gamma_{RD,Offnarrow}$	0.007			
	$\gamma_{RD,Offnarrow,toadvanced}$		-0.033**		
	$\gamma_{RD,Offnarrow,todeveloping}$		0.310 ***		
	$\gamma_{RD,Offbroad}$			-0.0003	
	$\gamma_{RD,Offbroad,toadvanced}$				-0.022***
	$\gamma_{RD,Offbroad,todeveloping}$				0.071 * * *
Labour	$\gamma_{Prod}$	0.112 ***	0.113 ***	0.113 * * *	0.114 * **
Cost share	$\gamma_{Prod,Oth}$	-0.099***	-0.100***	-0.100***	-0.102***
in Product	$\gamma_{Prod,ICT}$	-0.013 * * *	-0.012 * * *	- 0. 01 3***	-0.011***
	$\gamma_{Prod,nonICT}$	0.011 ***	0.010 ***	0.010 * * *	0.011 * **
activities	$\gamma_{Prod,Y}$	-0.001	0.001	-0.001	0.001
	$\gamma_{Prod,Offnarrow}$	-0.152 * * *			
	$\gamma_{Prod,Offnarrow,toadvanced}$		-0.065***		
	$\gamma_{Prod,Offnarrow,todeveloping}$		-0.846 * * *		
	$\gamma_{Prod,Offbroad}$			-0.031***	
	$\gamma_{Prod,Offbroad,toadvanced}$				0.027**
	$\gamma_{Prod,Offbroad,todeveloping}$				-0.169***
	Observations	5269	5269	5269	5269
	$R_{RD}^2$	0.791	0.792	0.791	0.792
•	$R^2_{Prod}$	0.894	0.896	0.893	0.894

#### Results – all industries

- For both narrow and broad OS measures:
  - OS is not related to demand for R&D activities
  - OS negatively affects demand for production activities
- Increase in ICT increases demand for R&D workers and reduces demand for production workers (opposite effect of increase in non-ICT capital stock)
- Narrow OS to both advanced and LDCs lowers demand for production activities
- Broad OS other advanced economies has positive effect on production labour demand
- Narrow and broad OS to LDCs increases demand for R&D while OS to advanced economies reduces demand for onshore R&D

## **Results-all industries**

	Implie	Implied elasticity of substitution								
	R&D	R&D Production Other activ								
R&D										
$\Pr$ oduction	$0.506^{***}$									
Other activities	$0.939^{***}$	0.479***								

Elasticity< 1: complementarity; Elasticity>1: substitutability

#### Results – all industries

- R&D complementary to HQ activities
- Very complementary with production activities
  - Firms co-locate R&D and production activities when investing abroad
    - Q: Givent the industry level analysis, can we infer firm-level behaviour? Are results at the industry level reflecting intra-industry reallocations?
  - No direct effect of OS on R&D but indirect effect via OS of production activities
    - Q: Why is this *indirect effect* not captured by the functional labour demand regression?

## **Results-manufacturing industries**



#### **Results – Manufacturing vs Services**

- OS lowers demand for production and standardized services activities in Advanced Economies
- In services, R&D is complementary to production activities
- In manufacturing, R&D substitutes for other HQ's activities

Q: Intuition

# Results-broader set of business functions

	Implied elasticity of substitution							
	R&D	Production	Back-Office	$\operatorname{Logistics}$	Marketing	Other		
R&D								
Production	$0,567^{***}$							
Back-Office	(-2,129)***	$1,531^{***}$						
Logistics	-0.62	$0,379^{***}$	3,730***					
Marketing	$5,318^{***}$	(-0,184)**	1,775***	(-0,889)***				
Other	$0,754^{***}$	$0,440^{***}$	$0,933^{***}$	-0.002	-0.069			

#### Results – Broader set of business functions

- Functions: R&D, Production, Back-office, logistics, sales and marketing, other activities
- Offshoring:
  - Unrelated to demand for R&D but significantly reduces demand for production activities
  - Lowers demand for back-office activities
  - Increases demand for logistics and sales & marketing
- Q: Intuition/implictions?

# Conclusion

 Industries in advanced economies with faster growth in offshoring lower their demand for production workers and increase their demand for R&D activities

OS reflects/enables changes in pattern of international specialisation

- Indirectly offshoring affects R&D activities as these are complementary to production
- There is further empirical research potential for a more comprehensive understanding of the relation provided the availability of new good-quality survey data

# Conclusion

- Globalisation affects national labour markets at the level of stages of production
- Typical distinction between skilled and unskilled workers is useful, but a focus on business activities yields a more nuanced picture
- Results show differences between firm-level and macro (industry) level analysis

## Comments

- Interesting paper: availability of firm level data in recent years has resulted in research being overly heavily based on firm-level analysis
  - True that aggregate adjustments result from aggregation of firm level adjustments
  - But importance of understanding 'aggregate' responses for labour market outcomes
- Analsyis however only at industry level
- Aggregate country level labour market effects would be instructive
  - Paper captures effects of OS on fuctional labour demand within industries but does not capture changes resulting from inter-industry reallocations - e.g. resulting from CA (and/or changes in CA) patterns

## Comments

- As currently written, the paper would benefit from a deeper discussion of macro and/or 'policy' implications of analysis
  - What are the implications of the results of the paper for labour markets in advanced economies?
  - Are there obvious policy implications?

## Comments

- Sound methodological work, but
  - More robustness checks desirable (e.g. simultaneity of value added as a regressor)
  - Limited analysis of variation across time, industries, countries
- Definition of OS:
  - Is it Offshoring /Outsourcing or more simply the evolving nature/depth of *specialisation* specialisation that is captured by the data used?
  - Is narrow OS encompassed into broad OS in the data? If so, why not include narrow OS and the difference between broad and narrow in the same regression?