

# Productivity and outbound FDI in software services: A reversal of the HMY model

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# Part I

## New insights into multinationals

- Which firms export? Which firms become MNCs? These are not a mere random sample out of firms present.
- Some firms *choose* to serve foreign customers.  
Some firms *choose* to serve foreign customers by producing overseas.
- Firms maximise profit; certain kinds of firms choose to export and certain kinds of firms choose to become MNCs.
- Firm heterogeneity is at the heart of understanding exports and multinationals.

# The HMY model

- Helpman, Melitz and Yeaple, 2004
- Exporting incurs transportation cost. More productive firms find that exporting is profitable despite this cost.
- Building an MNC is serving foreign customers by other means.
- Building an MNC incurs a fixed cost. The most productive firms find that building an MNC is profitable: the transportation cost is avoided thereafter.
- Key prediction: More productive firms export; the most productive firms do outward FDI.

# The puzzle of software services exports

How to think about FDI by companies exporting software services?

Near-zero transport costs

*Discourages outbound FDI*

Non-commoditised nature of software services

*Encourages outbound FDI*

Need a more general model.

# A model

- Consumer's perceived risk about quality of service exported is higher than for service bought from foreign firm situated at home (Lee and Tan, 2003)
- Demand faced by firm:

$$q(i) = \begin{cases} 0, & \text{with prob } \gamma_j \\ Dp(i)^{-\sigma}, & \text{with prob } 1 - \gamma_j \end{cases} \quad j = X, I \quad (1)$$

- $\sigma = \frac{1}{1-\epsilon} > 1$
- $\gamma_X > \gamma_I$
- No transport cost
- Demand realized after production
- $F_X < F_I$  as in HMY

# The firms' optimisation

- Risk neutral firm maximises expected profit
- Cut-off productivity level such that export and FDI firms just break even

$$A_X^{*\sigma-1} = \frac{F_X(\sigma-1)\left(\frac{\sigma}{\sigma-1}\right)^\sigma}{D(1-\gamma_X)^\sigma}, \quad A_I^{*\sigma-1} = \frac{F_I(\sigma-1)\left(\frac{\sigma}{\sigma-1}\right)^\sigma}{D(1-\gamma_I)^\sigma}$$

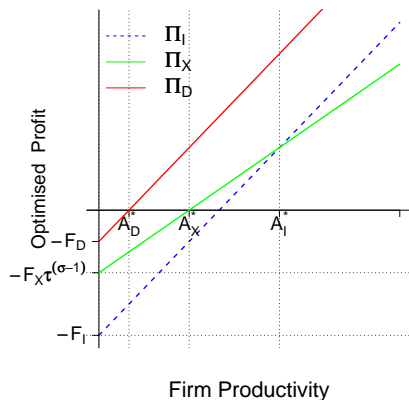
- Since exporters face greater risk compared to FDI firms, threshold productivity of exporters to break even is higher than FDI firms

# A generalisation of HMY

$\tau > 0$ and $\gamma = 0$	$\tau = 0$ and $0 < \gamma < 1$
Standard assumptions	Necessitated for the software setting
Collapses into standard HMY	A new environment
Most productive firms do FDI	Least productive firms do FDI

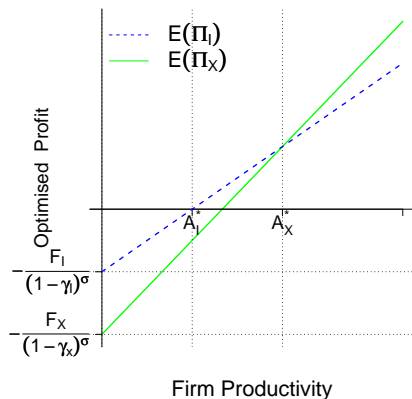


# To take you back to the standard HMY



- More productive firms export; the most productive firms do FDI
- Substantial empirical success: Head and Ries (2003, 2004) Kimura and Kiyota (2006) Girma et al (2004, 2004) Tomiura (2007)

# But in the software services setting



- The least productive firms do FDI
- What does the data say?

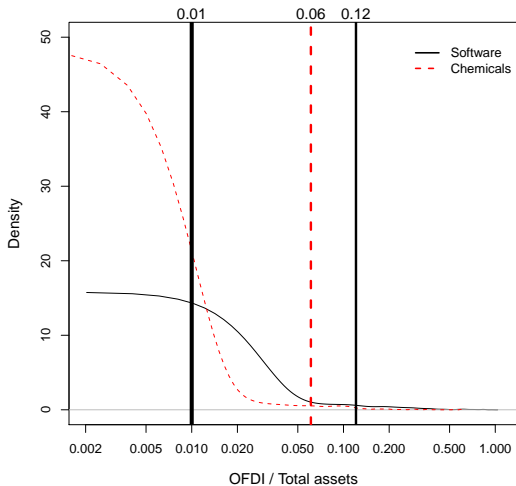
## Part II

# Testing

- CMIE Prowess database, 2000-2008 (9 years of data).
- Productivity estimation is best done within one narrow industry
- No one estimation procedure for productivity dominates  
So we work with four different methods.
- As a check about our dataset and estimation strategy: apply this in the one two-digit manufacturing industry with the most FDI (Chemicals) – does a traditional HMY style result obtain?

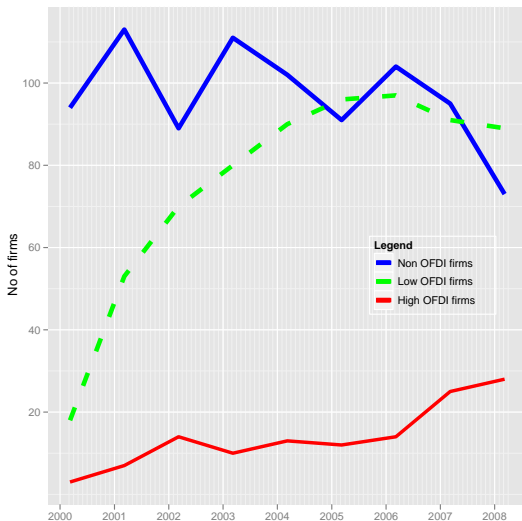
# Density plot of OFDI to Total Assets (2000-2008)

Software Services vs. Chemicals



# Firms engaging in outbound FDI over time

Software Services

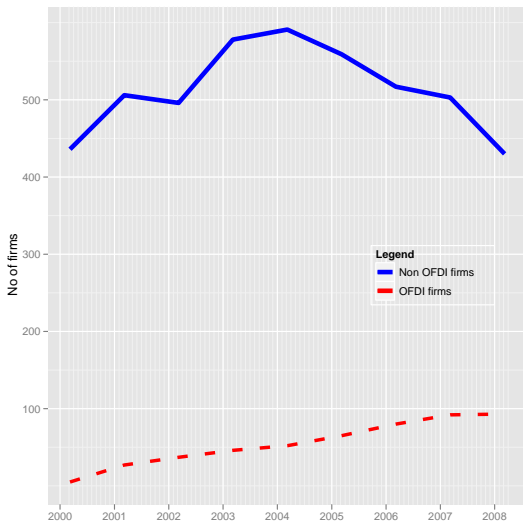


# Summary statistics about Software Services companies: 2000-2008

	Units	Extent of FDI		
		None	Low	High
Sales	Bln. Rs.	1.003	4.517	0.859
Total assets	Bln. Rs.	1.089	5.373	3.205
Gross fixed assets	Bln. Rs.	0.474	1.779	1.779
Exports to sales	Percent	65.33	70.72	72.32
OFDI to total assets	Percent		14.44	68.69

# Firms engaging in outbound FDI overtime

Chemicals





# Summary statistics about Chemicals companies: 2000-2008

	Units	Extent of FDI	
		Non OFDI	OFDI
Sales	Bln. Rs	8.803	7.068
Total Assets	Bln. Rs	5.883	10.81
Gross Fixed Assets	Bln. Rs	4.105	5.87
Exports to sales ratio	Percent	28.1	34.02
OFDI to total assets ratio	Percent		9.116

# Efficiency effects Stochastic Frontier Analysis

- Efficiency effect stochastic frontier (Battese and Coelli, 1995)

$$y_{it} = \exp(x'_{it}\beta - u_{it} + v_{it}), \quad u_{it} \geq 0 \quad (2)$$

where  $v_{it}$  is i.i.d.  $N(0, \sigma_v^2)$

- component  $u_{it}$  accounts for the firms failure to produce maximum output given the set of inputs used
- $u_{it}$  follows a truncated normal distribution  $N^+(z_{it}\delta, \sigma_u^2)$  where  $u_{it}$  can be explained by firm-specific characteristics,

$$u_{it} = z_{it}\delta + w_{it}, \quad w_{it} \geq -z_{it} \quad (3)$$

- Technical efficiency of production for the  $i$ -th firm at the  $t$ -th observation is defined by

$$TE_{it} = \frac{\exp(x'_{it}\beta - u_{it} + v_{it})}{\exp(x'_{it}\beta + v_{it})} = \exp(-u_{it}) \quad (4)$$

# Model explaining inefficiency with stochastic frontier analysis

Software Services

Variable	Model 1		Model 2	
	Estimate	S. E.	Estimate	S. E.
Intercept	2.0460***	0.08	2.2382***	0.08
Log wages	0.4821***	0.01	0.5046***	0.01
Log capital	0.3850***	0.02	0.3210***	0.02
Age	0.0423***	0.01	0.0086**	0.003
Log total assets	-0.3578***	0.07	-0.1287***	0.02
Ratio of investment to capital	-1.9993**	0.75	-0.1640**	0.06
OFDI dummy	1.0966***	0.23		
High OFDI dummy			0.5337***	0.09
Low OFDI dummy			0.4570***	0.07
Listed dummy	0.7914***	0.17	0.5364***	0.04
Market share	0.0297**	0.01	0.0123**	0.01
$\frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$	0.4724***	0.09	0.0012***	6.36e-06
No. of firms	375		375	
No. of observations	1677		1677	

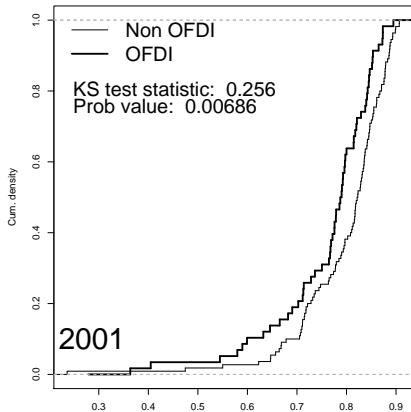
# Model explaining inefficiency with stochastic frontier analysis

Chemicals

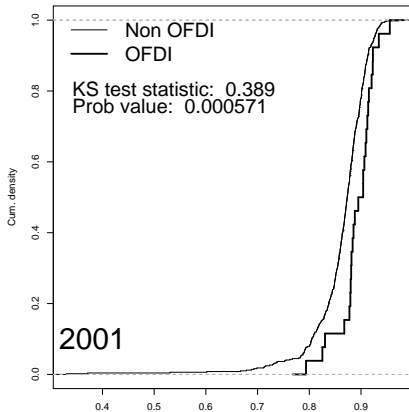
Variable	Estimate	S.E.
Intercept	1.6289***	0.02
Log wages	0.3516***	0.01
Log capital	0.0319***	0.01
Log of raw material expense	0.6362***	0.01
Age	23.5980*	10.29
Size (Log Total Assets)	-782.4200*	340.65
Ratio of investment to capital	-2260.0000*	263.76
OFDI dummy	-603.5900*	263.76
Listed dummy	-1268.0000*	552.47
Market share	-44.5010*	19.36
$\frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$	0.9999***	5.7106e-05
No. of firms	976	
No. of observations	5098	

# Comparing cumulative distribution of productivity: 2001

## Software Services

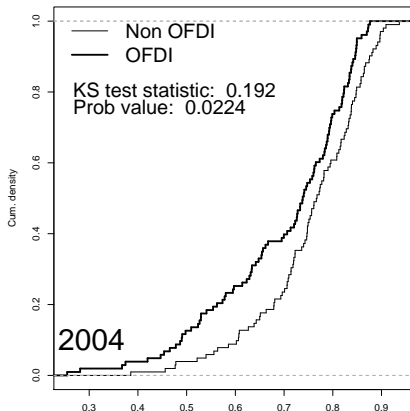


## Chemicals

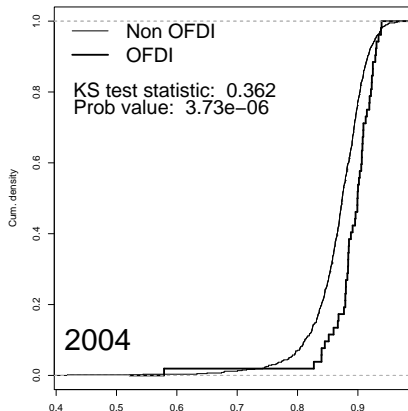


# Comparing cumulative distribution of productivity: 2004

## Software Services

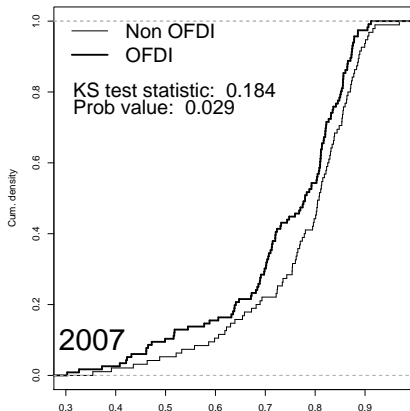


## Chemicals

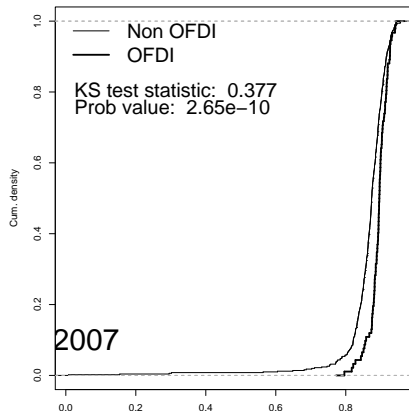


# Comparing cumulative distribution of productivity: 2007

## Software Services

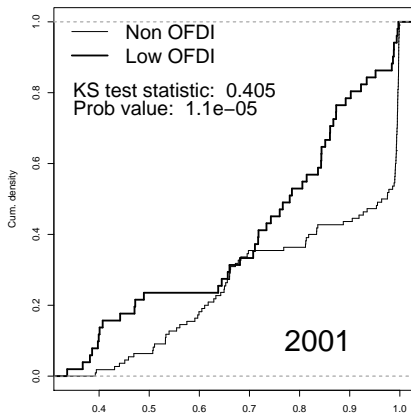


## Chemicals

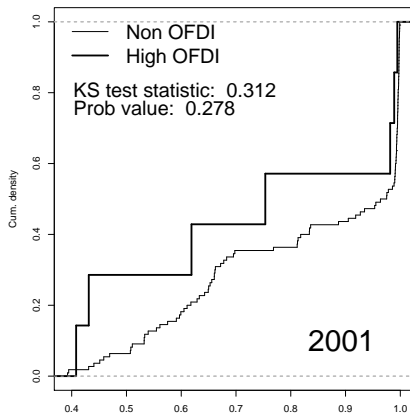


# Ranking of cumulative distribution of productivity: low and high OFDI firms in Software Services in 2001

## Non OFDI vs. low OFDI



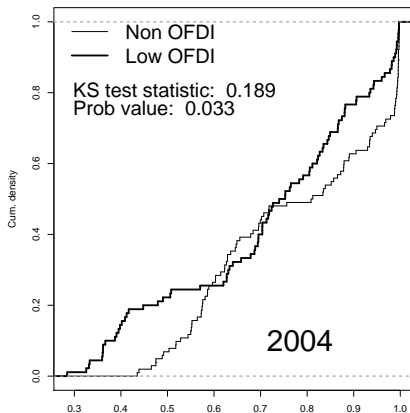
## Non OFDI vs. high OFDI



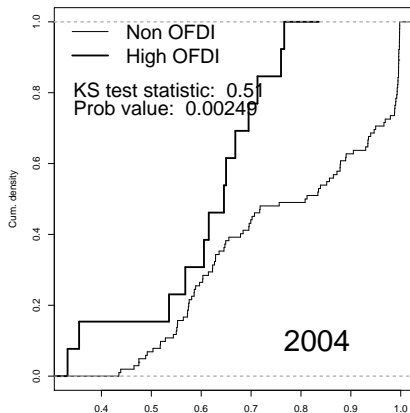


# Ranking of cumulative distribution of productivity: low and high OFDI firms in Software Services in 2004

## Non OFDI vs. low OFDI

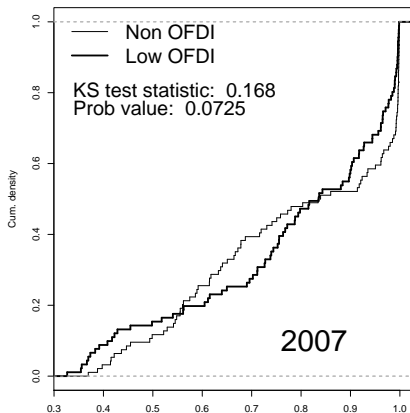


## Non OFDI vs. high OFDI

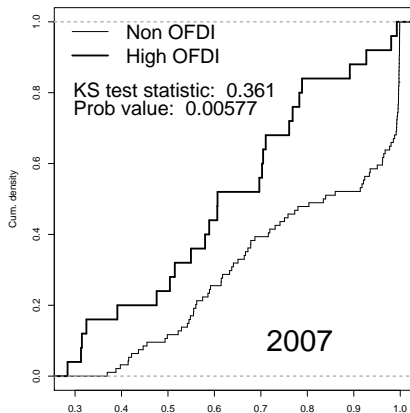


# Ranking of cumulative distribution of productivity: low and high OFDI firms in Software Services in 2007

## Non OFDI vs. low OFDI



## Non OFDI vs. high OFDI



# Software Services: HMY reversal with alternative methods of productivity measurement

Variable	Fixed Effect		Olley & Pakes (1996)	
	Estimate	S. E.	Estimate	S. E.
Intercept	-4.2058***	0.08	0.0222*	0.01
Age	-0.0016	0.003	0.0004	0.0003
Size (Log Total Assets)	0.2190***	0.01	0.0068***	0.001
Ratio of investment to capital	0.1507**	0.05	0.0120*	0.01
OFDI dummy	-0.3148***	0.04	-0.0263***	0.004
Listed dummy	-0.1847***	0.04	-0.0137**	0.005
Market share	-0.0079	0.01	-0.0006	0.0006
No. of firms	375		289	
No. of observations	1677		1269	

# Chemicals: HMY with alternative methods of productivity measurement

Variable	Fixed Effect	Olley & Pakes (1996)	Levinsohn & Petrin (2004)
Intercept	-4.3081***	1.6037***	-3.9782***
Age	0.0017***	3.7358e-06***	0.0001
Size (Log Total Assets)	0.1204***	-0.0002***	0.0214***
Ratio of investment to capital	0.1406***	0.0003***	0.1004**
OFDI dummy	0.2805**	0.0001 .	0.2071*
Listed dummy	0.09765***	0.0001*	0.0585***
Market share	6.3499e-05	-5.5508e-07	-4.2777e-06
Size interacted with OFDI dummy	-0.0433***		-0.0347**
No. of firms	965	733	965
No. of observations	5042	3809	5042

# Conclusion

- Transportation cost is of essence in the decision of a firm to do outbound FDI in the immensely influential HMY model
- But this compulsion is not in the picture for Software Services companies
- We propose an alternative model, where zero transportation cost goes along with a greater risk when buying software services from a foreign provider
- The HMY predictions prove to be reversed: the *least* productive Software Services companies do outbound FDI
- With Chemicals, standard HMY results are obtained
- With Software Services, our predictions are upheld
- Robust across four different methods for productivity estimation.

Thank you