

# Industrial Transformation with Heterogeneous Foreign Multinationals and Human Capital

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**Imitation to Innovation** - some successful, some not...

**East Asia:** *Singapore-South Korea-Taiwan* (success);  
*Malaysia-Thailand* (MI Trap: 5.2% -> 3.8% [MYS], 5.3% -> 3/4% [THA]);

**Common factors:** Human Capital (HC) & Foreign multinationals (MNCs) (Nelson & Pack 1999);

Agénor & Canuto (2012), Eeckhout & Jovanovic (2012) —> **HC heterogeneity & allocations** key in influencing imitation-innovation tradeoffs.

**Typical FDI pattern** (Dunning & Lundan 2008): Mere exploratory type first, followed by *market-seeking Horizontal* type, then *efficiency-seeking Vertical* MNC —> Studies exploring **dynamics of entry strategies & relative importance** to host economy remain scarce (Saggi 2002).

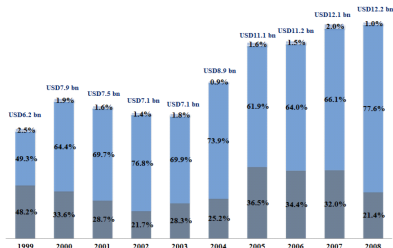
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A **hierarchy of internalisation decision-making** wrt foreign subsidiary mode, and the order of **Nonmandatory-Horizontal-Vertical** matches respective importance in host economy's spillover: **Sequential entry dynamics**;

# Preliminary estimation based on HMT: FDI compositions

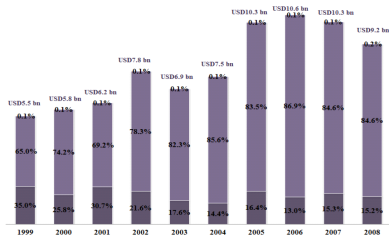
Estimated FDI Composition from U.S. to Malaysia, 1999-2008  
[FDI Position, Historical-Cost Basis]

■ Non-mandated FDI ■ Horizontal FDI ■ Vertical FDI



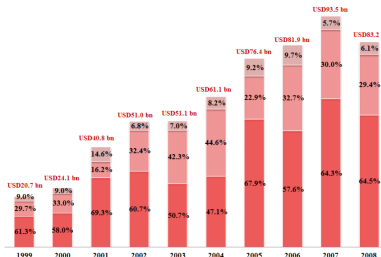
Estimated FDI Composition from U.S. to Thailand, 1999-2008  
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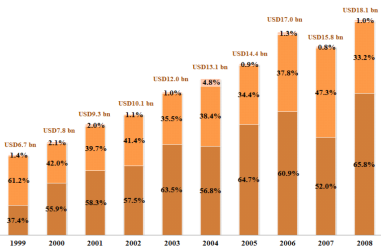
Estimated FDI Composition from U.S. to Singapore, 1999-2008  
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■ Non-mandated FDI ■ Horizontal FDI ■ Vertical FDI



Estimated FDI Composition from U.S. to Taiwan, 1999-2008  
[FDI Position, Historical-Cost Basis]

■ Non-mandated FDI ■ Horizontal FDI ■ Vertical FDI



# Evolving characteristics of Modern Foreign Enterprise

Markusen & Trofimenko (2009) —> model **FDI at more disaggregated level** [foreign experts themselves];

- In 2009, 22 host locations for assignees (PWC 2012);
- In 2009, an average of 250 assignees per global organisation (PWC 2012)



Drawing primarily Agénor & Dinh (2013) (*domestic*) and extend using specification of Brambilla et al. (2009) (*foreign*), this paper:

1. fills a vacuum in growth literature by developing an industrial transformation model with FDI examined at the disaggregated level of *foreign experts*;
2. formalises a framework to explain '*internalisation advantage*' (Dunning's *OLI/Eclectic Paradigm*) for heterogeneous MNCs and determination of their compositions;
3. generates transitional dynamics consistent with stylized facts in FDI literature & uncovers policy complementarities.

# Representative Households

- ▶ Identical ability ( $a$ , Pareto) within household, though different abilities at household level;
- ▶ Inter-temporal training decision gives:

$$\hat{a}_t = [w_t^U / (1 - \Gamma)w_t^S]^{1/\xi}.$$

- ▶ Unskilled LS (productivity assumed unity), & Effective Skilled LS:

$$\theta_{U,t} = \frac{L_{U,t}}{L_t} = \int_{a_m}^{\hat{a}_t} f(a) da = [1 - (a_m/\hat{a}_t)^\chi],$$

$$\theta_{S,t} = \frac{L_{S,t}}{L_t} = \int_{\hat{a}_t}^{\infty} a f(a) da = \frac{\chi a_m^\chi}{\chi - 1} (\hat{a}_t)^{1-\chi}.$$



# Production in Host Economy

**Imitation:** (i) Jones's (2005) ( $M_t^I$ ); (ii) Horizontal MNCs ( $n_{FH,t}$ , Markusen & Maskus 2002); (iii) spillover ( $n_{FV,t}M_t^R$ ) (Saggi 2002).

$$\dot{M}_t^I = (n_{FH,t})^{\psi_1} [M_t^I + \psi_2^I n_{FV,t} M_t^R] (\theta_{U,I,t}),$$

used to derive f.o.c,  $w_t^U = f(n_{FH,t}, \theta_{U,I,t}, n_{FV,t}M_t^R/M_t^I, R_t^I)$ .

**Innovation:** (i) Jones (2005); (ii) Vertical MNCs ( $n_{FV,t}$ , Braconier et al. 2005); (iii) *stepping-stone* effect ( $M_t^I$ ) (Glass 2010).

$$\dot{M}_t^R = (n_{FV,t})^{\psi_1^R} [M_t^R + \psi_2^R M_t^I] (\theta_{S,R,t}),$$

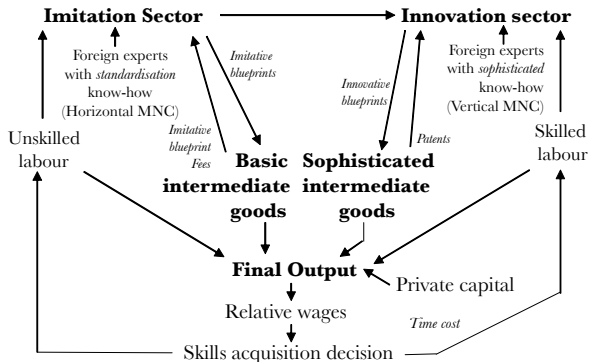
used to derive  $w_t^S = f(n_{FV,t}, \theta_{S,R,t}, M_t^I/M_t^R, Q_t^R)$ .

# Production in Host Economy

Also, **IG & Final Output** sector (fairly standard). With endogenous growth, we yield **aggregate**

$$Y_t = \mathbf{F}(\theta_{S,Y,t}, \theta_{U,Y,t}, m_t^I, m_t^R) K_t, \quad m_t^I = M_t^I / K_t, \quad m_t^R = M_t^R / K_t.$$

Production and Labour Allocations in Host Economy



3 types of MNC mode: (i) *Nonmandated*; (ii) *Horizontal*; (iii) *Vertical*. Focus on the latter 2;

- ▶ Each foreign firm consists of 1 expert bringing either *standardisation* (Horizontal MNC) or *sophisticated* (Vertical MNC) know-how;

3 types of MNC mode: (i) *Nonmandated*; (ii) *Horizontal*; (iii) *Vertical*. Focus on the latter 2;

- ▶ Each foreign firm consists of 1 expert bringing either *standardisation* (Horizontal MNC) or *sophisticated* (Vertical MNC) know-how;
- ▶ A partial equilibrium model on its own using a 3-staged, nested Dixit-Stiglitz CES specification (Brambilla et al. 2009);
- ▶ Dichotomous relationship between (i) domestic & foreign firms; (ii) Vertical MNC & other MNCs.

A **Variable info cost component** ( $1/\varpi$ ) due to perceived productivity difference, & **Fixed** DWL components ( $F_0, F_1, F_2$ )

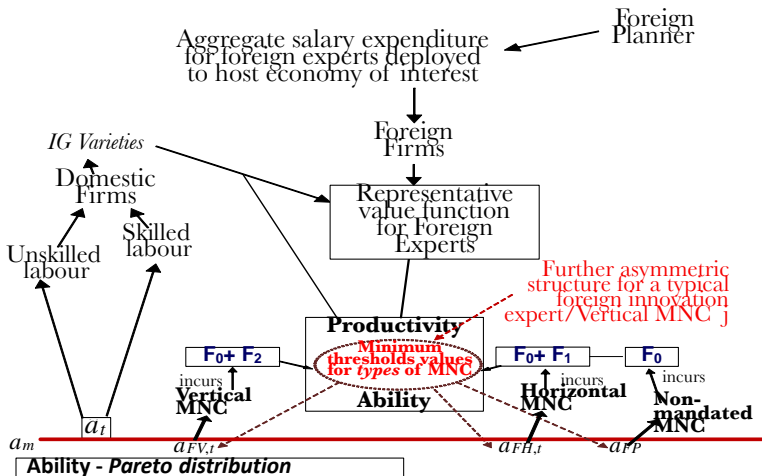
1. Nonmandated MNC -  $F_0$
2. Horizontal MNC -  $F_0 + F_1$
3. Vertical MNC -  $F_0 + F_2$

B. Productivity is a transformation of ability ( $\varpi = a/\tilde{a}$ ) due to *persistence*, resulting in Melitz (2003) type of sorting.

C. Assymetry for Vertical MNCs - growing difficulties to separate best among brightest [ $1/\varpi$  subject to  $\phi$ ] (Blomström-Kokko 2003)

# Foreign Sector

MNCs' thresholds values  $\Leftrightarrow a_{FV,t} < a_{FH,t} < a_{FP,t}$ .



**Setting**  $a_{FP,t} = a_{FP} \forall t$ , at any time  $t$ , we have:

$$n_{FP,t} = \frac{N_{FP,t}}{N_{F,t}} = [F(1/\varpi_{FH,t}) - F(1/\varpi_{FP,t})] = [1 - (\frac{a_{FH,t}}{a_{FP}})^\chi] ,$$

$$n_{FH,t} = \frac{N_{FH,t}}{N_{F,t}} = [F(1/\varpi_{FV,t}) - F(1/\varpi_{FH,t})] = [(\frac{a_{FH,t}}{a_{FP}})^\chi - (\frac{a_{FV,t}}{a_{FP}})^\chi],$$

$$n_{FV,t} = \frac{N_{FV,t}}{N_{F,t}} = [1 - F(1/\varpi_{FV,t})] = (\frac{a_{FV,t}}{a_{FP}})^\chi,$$

**with threshold value of entry ( $a_{FH,t}$ ,  $a_{FV,t}$ ) determined by:**

$$a_{FH,t} = \left[ \frac{F_0}{F_1} ((LI)^{\sigma^F - \theta^F} (\gamma_{1,t})^{\sigma^F} - 1) \right]^{-1/(1-\sigma^F)} a_{FP}, \text{ and}$$

$$a_{FV,t} = \left[ \frac{F_2 - F_1}{F_0} \frac{1}{(LI)^{\sigma^F - \theta^F} [\gamma_{2,t}^{\sigma^F} - \gamma_{1,t}^{\sigma^F}]} \right]^{1/[\phi(1-\sigma^F)]} a_{FP}^{1/\phi} \tilde{a}^{(\phi-1)/\phi}.$$

# Key Policy Parameters

System of 4 first-order Differential Equations & 7 static equations (include  $n_{FH,t}$ ,  $n_{FV,t}$ );

**A. Industrial Composition Ratio** — index measuring progress of transformation:

$$m_t = \frac{M_t^I}{M_t^R} = \frac{m_t^I}{m_t^R},$$

**B. Foreign-to-domestic innovation expertise ratio** — a normalised index measuring relative innovation expertise:

$$\psi_t = \frac{N_{FV,t}}{N_{S,R,t}} = \frac{N_{FV,t}/N_{F,t}}{N_{S,R,t}/\bar{N}} = \frac{n_{FV,t}}{\theta_{S,R,t}},$$

where  $\bar{N} = 1$ ,  $N_{F,t} = 1$  are normalisation assumptions.



# Parameterisation: Benchmark [Malaysia as host economy]

Parameter	Ref.	Description
<i>Households</i>		
$\rho = 0.04$	<i>AM,08</i>	Annual discount rate
$\sigma = 0.27$	<i>Stats</i>	Elasticity, intertemporal substitution
$n = 0.0173$	<i>Stats</i>	Population growth rate
$\xi = 0.9$	<i>Text</i>	Efficiency of skills acquisition
$\Gamma = 0.25$	<i>SH,12</i>	Skills acquisition cost
$\chi = 2.001$	<i>AA,14</i>	Pareto index, ability distribution
<i>Imitation</i>		
$\psi_1^I = 0.35$	<i>Lim,15</i>	Elasticity wrt foreign experts, $n_{FH,t}$
$\psi_2^I = -0.3$	<i>YN,09</i>	Externality, $n_{FV,t} M_t^R$
$\Lambda^I = 0.1$	<i>AK; SH,12</i>	Cost markup-labour mkt distortion
<i>Innovation</i>		
$\psi_1^R = 0.4$	<i>Rasiah, 12</i>	Elasticity wrt foreign experts, $n_{FV,t}$
$\psi_2^R = 9.5$	<i>KZM,10</i>	Stepping stone effect, imitative stock
$\Lambda^R = 0.2$	<i>HW,01</i>	Cost markup-labour mkt distortion

# Parameterisation - Domestic Production [continue]

Parameter	Ref.	Description
<i>Final Output</i>		
$\alpha = 0.3$	<i>Ag,11</i>	Elasticity wrt private capital
$\beta^U = 0.15$	<i>Text</i>	Elasticity wrt unskilled labour
$\beta^S = 0.25$	<i>AD,13</i>	Elasticity wrt skilled labour
$\gamma = 0.3$	<i>Text</i>	Elasticity wrt composite IG
$\nu = 0.57$	<i>Text</i>	Basic input share, composite IG
$\Lambda^Y = 0.05$	<i>AK; SH,12</i>	Cost markup-labour mkt distortion
$\delta = 0.068$	<i>AD,13</i>	Depreciation rate, private capital
<i>Intermediate goods</i>		
$\eta = 0.39$	<i>Seq,11</i>	Substitution parameter, IG
<i>Government</i>		
$\tau = 0.25$	<i>Stats</i>	Effective tax rate, final output

# Parameterisation - Foreign Sector

Parameter	Ref.	Description
$\sigma^F = 2.0$	<i>BHL,09</i>	Elasticity, between varieties
$\theta^F = 1.64$	<i>Iac,10</i>	Elasticity, across varieties
$LI = 0.7456$	<i>ZL,13</i>	Lerner Index
$F_0 = 0.2733$	<i>WB Stats</i>	Basic doing-business cost
$F_1 = 0.33$	<i>Text</i>	Additional cost, Horizontal MNC
$F_2 = 0.40$	<i>Text</i>	Additional cost, Vertical MNC
$\phi = -1.0$	<i>Text</i>	Asymmetry, Vertical MNC-specific
$\omega_k = 1.0$	<i>BEJK,03</i>	Shape parameter, Weibull function
$\omega_\lambda = 2.0$	<i>BEJK,03</i>	Slope parameter, Weibull spread

There are values that are set arbitrarily for stability reasons, and to derive initial values that matched to *National Statistics*.

Broadly, human capital and FDI-promoting policies:

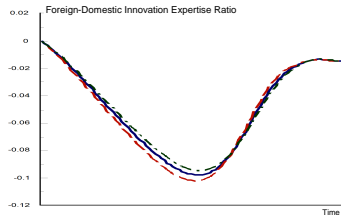
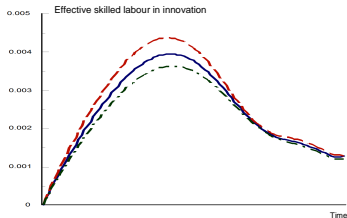
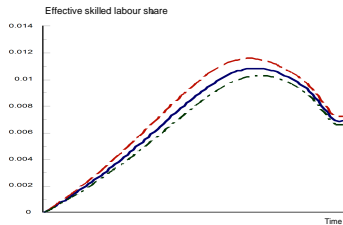
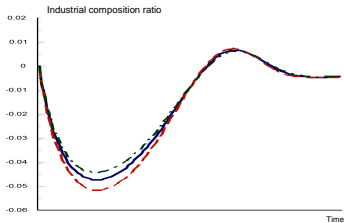
- ▶ Skills acquisition cost cut [ $\Gamma = 0.25$  to  $0.18$ ];
- ▶ Hiring cost cut for Innovation Sector [ $\Lambda^R = 0.2$  to  $0.0$ ];
- ▶ Foreign Investment Liberalisation Measures:
  1. Cut of  $F_2 = 0.40$  to  $0.37$ ;
  2. Cut of  $F_1 = 0.33$  to  $0.30$ ;
  3. Cut of  $F_0 = 0.2733$  to  $0.2433$ .

In addition to  $m_t$  and  $\Psi_t, \geq 0$  ss growth for  $\dot{C}_t/C_t$ , skilled labour ( $\theta_S$ ), skilled labour in innovation ( $\theta_{S,R}$ ), Vertical FDI ( $n_{F,V}$ ) required for best policy package.

# Skills acquisition cost cut

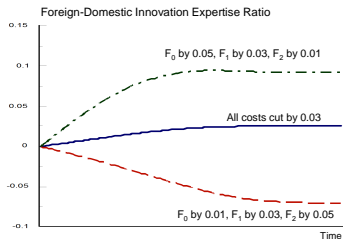
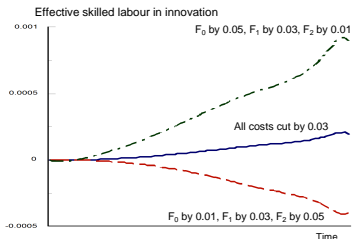
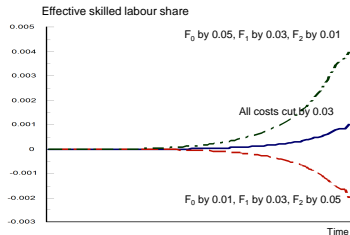
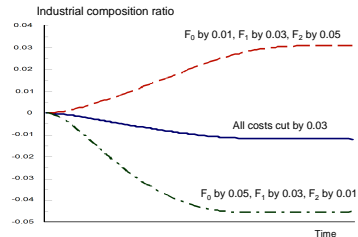
## Permanent Cut in Skills Acquisition Cost from 0.25 to 0.18 (Absolute deviations from baseline)

— Baseline  $\xi = 0.9$     - - -  $\xi = 0.8$     - - -  $\xi = 0.99$



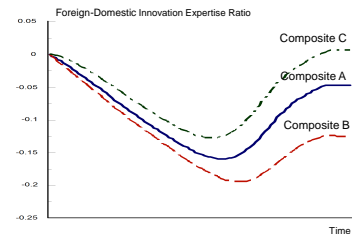
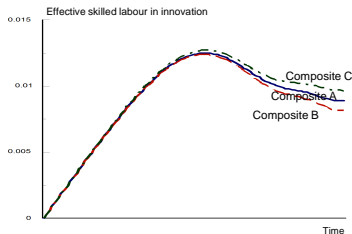
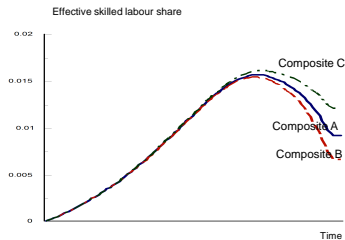
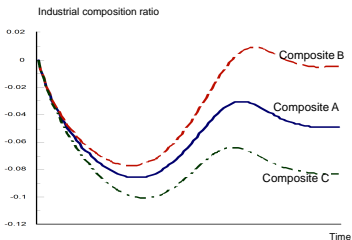
# Different combination of foreign cost cut

Benchmark Calibration (Absolute deviations from baseline)



# Composite Reform Experiments

## Composite Policy Reform Packages, (Absolute deviations from baseline)



## Simulation Results (benchmark, steady-state effects)

Indiv. Policies	Initial values	$\Gamma$ cut	$\Lambda^R$ cut	$F_0$ cut	$F_1$ cut	$F_2$ cut
$m$	0.5836	-0.0043	-0.0325	-0.0134	-0.0333	0.0560
$\theta_S$	0.2400	0.0069	0.0014	0.0003	0.0038	-0.0036
$\theta_{SR}$	0.0446	0.0013	0.0072	0.0001	0.0009	-0.0009
$\dot{C}/C$	0.0430	0.0003	0.0009	-0.0002	-0.0022	0.0022
$n_{FV}$	0.0164	-0.0002	-0.0002	0.0020	0.0023	-0.0052
$\Psi$	0.3672	-0.0145	-0.0553	0.0439	0.0431	-0.1109

Composite	Initial values	Composite A	Composite B	Composite C
$m$	0.5836	-0.0489	-0.0048	-0.0830
$\theta_S$	0.2400	0.0092	0.0067	0.0121
$\theta_{SR}$	0.0446	0.0089	0.0082	0.0097
$\dot{C}/C$	0.0430	0.0007	0.0022	-0.0010
$n_{FV}$	0.0164	0.0007	-0.0036	0.0039
$\Psi$	0.3672	-0.0477	-0.1256	0.0063



# Further sensitivity - Endogenous technological change

Endogenising production parameter,  $\nu_t$ , to  $m_t$  using standard S-curve [generalized logistic function]:

$$\nu_t = f(m_t) = \nu_m + \frac{(\nu_M - \nu_m)}{[1 + \exp\{-\zeta(m_t - m_I)\}]^{1/\nu}}, \quad \nu_t \geq \nu_m,$$

Parameter	Value	Description
$\nu_M$	0.9	Upper bound for $\nu$ (asymptotes)
$\nu_m$	0.1	Lower bound for $\nu$ (asymptotes)
$\nu$	1.272	Corresponding asymptote value for diffusion
$\zeta$	1.0	Diffusion rate
$m_I$	0.55	Inflection point for industrial composition ratio

# Is there Policy Complementarity to gain?

## Comparison across the balanced Composite Program A:

	$m$	$\theta_S$	$\theta_{SR}$	$\dot{C}/C$	$\Psi$
<i>Sum of Parts:</i>					
$\Gamma$ cut	-0.0043	0.0069	0.0013	0.0003	-0.0145
$\Lambda^R$ cut	-0.0325	0.0014	0.0072	0.0009	-0.0553
$F_0$ cut	-0.0134	0.0003	0.0001	-0.0002	0.0439
$F_1$ cut	-0.0333	0.0038	0.0009	-0.0022	0.0431
$F_2$ cut	0.0560	-0.0036	-0.0009	0.0022	-0.1109
<b>Aggregate effects</b>	<b>-0.0275</b>	<b>0.0087</b>	<b>0.0086</b>	<b>0.0011</b>	<b>-0.0937</b>
<b>Composite A (fixed <math>\nu</math>)</b>	<b>-0.0489</b>	<b>0.0092</b>	<b>0.0089</b>	<b>0.0007</b>	<b>-0.0477</b>
<b>Composite A (endogenous <math>\nu</math>)</b>					
- $\zeta = 1.0$	-0.0535	0.0105	0.0101	0.0009	-0.0566
- $\zeta = 2.0$	-0.0585	0.0121	0.0116	0.0011	-0.0670
- $\zeta = 3.0$	-0.0643	0.0141	0.0134	0.0013	-0.0791
- $\zeta = 4.0$	-0.0709	0.0165	0.0155	0.0017	-0.0931
- $\zeta = 5.0$	-0.0780	0.0195	0.0182	0.0021	-0.1090

- Significance of endogenous technological diffusion in generating policy complementarity between labour & FDI-promoting policies

**Policy Implications** - Derivation of potential insight on industrial transformation dynamics when there are heterogeneous foreign MNCs:

1. In presence of perceived productivity difference, skills acquisition choice and foreign subsidiaries' operational mode choice can be determined along a same distribution. This generates policy complementarity between human capital and FDI-promoting policies.
2. In presence of asymmetry between Vertical and other MNCs, a balanced investment liberalisation measure (targeting all foreign firm types) is more innovation-promoting than targeted policy biased towards leading foreign firms only.
3. In context of MI trap, policies that improve absorption capacity & technological diffusion would enhance the overall gains from industrial transformation.

**Thank you!**