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Vertical Foreign Direct Investment, Knowledge Spillovers and the Global Growth: A Q-theory Approach

Yin He
Department of Economics, University of Colorado at Boulder
Boulder, Colorado

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Center for Economic Analysis
Department of Economics

University of Colorado at Boulder
Boulder, Colorado 80309

Vertical Foreign Direct Investment, Knowledge Spillovers and the Global Growth: A Q-theory Approach

1. Introduction

2. Literature review

3. The Static Model

3.1 Consumers

$$U = \left(C_X^{\phi} C_Y^{-\phi}\right)$$

$$C_X \equiv \left\{ \int^{n+m+s} [c_i]^{-\ \varepsilon} di \right\}^{\overline{-\ \varepsilon}}$$

ε

ε

$$p = w \quad \alpha$$

$$< \alpha = \quad - \quad \varepsilon <$$

3.3 FDI

$$S^{M} = K^{M} \quad K^{N} + K^{M}$$

$$S^{N} = K^{N} \quad K^{N} + K^{M} \quad = \quad - S^{M}$$

$$S^{S} = K^{S} \quad K^{N} + K^{M}$$

$$S^{M} \quad - S^{M} \left[\frac{\pi^{N}}{F} - \frac{\pi^{M}}{F \quad + \Gamma} \right] =$$

$$\Rightarrow \quad \leq \Gamma \leq w^{\varepsilon-} \; -$$

$$C_X \equiv \left\{ \int^{n+m+s} [c_i]^{- \quad \varepsilon} di \right\}^{\overline{- \quad \varepsilon}} \qquad \varepsilon > \qquad\qquad \rho$$

$$E \;\; E = r - \rho$$

4.2 Knowledge Capital

a_I a_I

$$a_I = \frac{}{K^N + K^M \quad + \lambda K^S + \mu n}$$

$$\geq \lambda \geq \qquad \mu \geq$$

$$K = K^N + K^M + K^S$$

λ

S^S

4.3 FDI

$$S^M \quad - S^M \left[\frac{\Pi^N}{F} - \frac{\Pi^M}{F \quad + \Gamma} \right] =$$

$$\Pi^i \equiv \int_{s=}^{\infty} e^{-rs} \pi_s^i ds \qquad i = N \;\; M \qquad \pi^i$$

$$\pi^M = \pi^S = \frac{-\alpha \;\; \phi \cdot E}{w^{-\varepsilon} n + m + s} = \frac{-\alpha \;\; \phi \cdot E}{K^N + K^M \quad w^{-\varepsilon} \quad - S^M \quad + S^M + S^S}$$

$$\pi^N = \frac{-\alpha \;\; \cdot w^{-\varepsilon} \cdot \phi \cdot E}{w^{-\varepsilon} n + m + s} = \frac{-\alpha \;\; \cdot w^{-\varepsilon} \cdot \phi \cdot E}{K^N + K^M \quad w^{-\varepsilon} \quad - S^M \quad + S^M + S^S}$$

$K^N + K^M$

$K^N + K^M$ $g^N = L_I A$ π^i

$$E = \frac{L^S + wL^N - wL_I}{-\phi \quad -\alpha}$$

L_I

$L_I =$

$E =$ $r = \rho$

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$$q \equiv V \quad F =$$

$$q^N \equiv V^N \quad F = q^M \equiv V^M \quad\quad + \Gamma \;\; F =$$

$$V_t \equiv \int_{s=t}^{\infty} e^{-r \;\; s-t} \;\; \pi_s^i ds = \pi \quad \rho + g^N \quad\quad i = N \;\; M$$

$$L_I \quad = \frac{L^S + wL^N \quad\quad -\alpha \;\; \phi A - w[\;\; -\phi \quad -\alpha \;\;]\rho\left[S^M + \quad\quad +\Gamma \;\; S^S + \quad\quad +\Gamma \;\; w^{-\varepsilon} S^N\right]}{w[\;\; -\phi \quad -\alpha \;\;]A\left[S^M + \quad\quad +\Gamma \;\; S^S + \quad\quad +\Gamma \;\; w^{-\varepsilon} S^N\right] + w\phi A \quad -\alpha}$$

$$g^N \quad = \frac{L^S + wL^N \quad\quad -\alpha \;\; \phi\left[\;\; +\mu \quad -S^M \;\;\right] - w[\;\; -\phi \quad -\alpha \;\;]\rho}{w}$$

$$\frac{\partial g}{\partial S^M} = \frac{L^S + wL^N \quad -\alpha \quad -\phi\mu}{w} \leq$$

$$g = K \quad K = g^{N} \qquad + S^{S}$$

$$g^{S} = \frac{K^{S}}{K^{S}} = \frac{\frac{j}{+\Gamma} K^{M}}{K^{S} + \frac{j}{+\Gamma} K^{M}}$$

$$= g^{N} = g = L_{I} A$$

5.2 Production of X

$$w \quad \alpha \qquad\qquad\qquad\qquad \alpha$$

$$P_{X} = \left[\left(\frac{}{\alpha} \right)^{-\varepsilon} s + \left(\frac{}{\alpha} \right)^{-\varepsilon} m - j \cdot m + {}^{-\varepsilon} \cdot j \cdot m + \left(\frac{w}{\alpha} \right)^{-\varepsilon} n \right]^{\overline{-\varepsilon}}$$

g^N g^N

$\Pi^N = \pi^N \quad \rho + g^N$

$\Pi^M = \pi^M \quad \rho + j + g^N$

—

Result 1: A lower imitation rate leads to a higher rate of multinationalization and a lower level of investment in innovation. As a result, knowledge capital grows more slowly in the long run.

5.3.3 Disadvantage cost, MNCs share and long-run growth rate

$$\Gamma$$

Γ

ε

Result 3: Increases in the wage gap or elasticity of substitution between varieties increases the rate of multinationalization, decreases the investment level, and decreases the long-run growth rate.

5.4 Solving for long-run GDP growth rate

$E =$

$L_I =$

$real\ GDP$

$$g_{GDP} = -\frac{P}{P} = -\left[-\phi \cdot \frac{P_Y}{P_Y} + \phi \cdot \frac{P_X}{P_X} \right] = -\phi \cdot \frac{P_X}{P_X}$$

$$\frac{P_X}{P_X} == \frac{}{-\varepsilon} g$$

$$g_{GDP} = \frac{\phi}{\varepsilon -} g$$

5. Conclusions

Appendix1 The Static Model

Consumer's problem:

$$U = \left(C_X^{\phi} C_Y^{-\phi}\right) \qquad C_X \equiv \left\{ \int^{n+m+s} [c_i]^{-\ \ \varepsilon} di \right\}^{\overline{-\ \ \varepsilon}}$$

$$P_X C_X + C_Y = E$$

$$U = C_X^{\phi} C_Y^{-\phi} + \lambda\left[E - P_X C_X + C_Y\right]$$

1 $\dfrac{\partial U}{\partial C_X} = \quad \Rightarrow \quad \dfrac{\phi C_X^{\phi-} C_Y^{-\phi}}{C_X^{\phi} C_Y^{-\phi}} = -\lambda P_X$

2 $\dfrac{\partial U}{\partial C_Y} = \quad \Rightarrow \quad \dfrac{-\phi\ C_X^{\phi} C_Y^{-\phi}}{C_X^{\phi} C_Y^{-\phi}} = -\lambda$

3 $\overline{}$

5 $\frac{\partial U}{\partial c_b} = \quad \Rightarrow \quad \frac{\phi C_X^{\phi-}\ C_Y^{-\phi}}{C_X^{\phi} C_Y^{-\phi}} \cdot \frac{\quad}{-\frac{}{\varepsilon}} \cdot \left(\int^{n+m+s} c_i^{\,-\frac{}{\varepsilon}} di \right)^{\frac{}{-\frac{}{\varepsilon}}} \cdot \quad -\frac{}{\varepsilon} = -\lambda P_b$

b tfs$– @e r #›„ PsL ÌÌÊFäjÚ jF-

$$M \qquad S \qquad \frac{\qquad}{\qquad} \quad \frac{\left. \frac{}{} \right)}{\left(\frac{w}{}\right) n + \left(\frac{}{}\right) m + \left(\frac{}{}\right) s} \cdot \quad \cdot E = \frac{- \qquad \cdot E}{w \quad n + m + s}$$

1.4 FDI or not?

$$\frac{\pi^{M}}{+\Gamma\ F} \geq \frac{\pi^{N}}{F}$$

$$\frac{\qquad\qquad E}{w \quad n \quad m \quad s} \qquad \frac{w \qquad E}{w \quad n \quad m+s}$$

2 $\Leftrightarrow$

$$\Rightarrow C_Y^N \cdot \frac{}{w} = L_Y^N$$

3 $\Leftrightarrow$

$$\Rightarrow n \cdot c_i^N = n \cdot \frac{\left(\frac{w}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s}$$

4 $\Leftrightarrow$

$$\Rightarrow m \cdot c_i^M = n \cdot \frac{\left(\frac{}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s}$$

5 $\Leftrightarrow$

$$\Rightarrow s \cdot c_i^S = n \cdot \frac{\left(\frac{}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s}$$

$$L = C_Y^S + C_Y^N \cdot \frac{}{w} + n \cdot \frac{\left(\frac{w}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s} + m \cdot \frac{\left(\frac{}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s}$$
$$+ s \cdot \frac{\left(\frac{}{\alpha}\right)^{-\varepsilon} \phi \cdot E}{\left(\frac{w}{\alpha}\right)^{-\varepsilon} n + \left(\frac{}{\alpha}\right)^{-\varepsilon} m + \left(\frac{}{\alpha}\right)^{-\varepsilon} s}$$

$$L = C_Y^S + C_Y^N \cdot \frac{\quad}{w} + n \cdot \frac{\alpha w^{-\varepsilon} \phi \cdot E}{w^{-\varepsilon} n + m + s} + m \cdot \frac{\alpha \phi \cdot E}{w^{-\varepsilon} n + m + s} + s \cdot \frac{\alpha \phi \cdot E}{w^{-\varepsilon} n + m + s}$$

$$L^S = C_Y^S + m \cdot \frac{\alpha \phi \cdot E}{w^{-\varepsilon} n + m + s} + s \cdot \frac{\alpha \phi \cdot E}{w^{-\varepsilon} n + m + s}$$

Appendix2 The Benchmark Model

2.1 Growth rate of knowledge capital held by the North.

$$N \qquad \frac{\qquad}{N \qquad M} \qquad \frac{I \left[\quad N \quad M \quad S \quad N \right]}{N \quad M}$$

$$F = wa_I \qquad a_I = \frac{L_I}{g^N} \cdot \frac{}{K^N + K^M} = \frac{L_I}{L_I A \; K^N + K^M} = \frac{}{A \; K^N + K^M}$$

$$= \frac{+\Gamma \; w}{A \; K^N + K^M}$$

$$Numerator = \frac{-\alpha \; \phi \cdot E}{w^{-\varepsilon} n + m + s \quad \rho + g^N}$$

$$\frac{wL}{}$$

$$g^N \quad L_I A \qquad \frac{}{L \;\; A}$$

Appendix3 Math calculation and derivation for the imitation model

3.1 Growth rate of southern knowledge capital.

$$g^S = \frac{K^S}{K^S} = \frac{\frac{j}{+\Gamma} K^M}{K^S + \frac{j}{+\Gamma} K^M}$$

$$K^N + K^M$$

$$g^S = \frac{\frac{j}{+\Gamma} \cdot \frac{K^M}{K^N + K^M}}{S^S + \frac{j}{+\Gamma} \cdot \frac{K^M}{K^N + K^M}}$$

S^S

$$E = \frac{L^S + wL^N - wL_I \;\; \cdot \left(w^{-\varepsilon} S^N + \frac{S^M}{+\Gamma} - j \cdot \frac{S^M}{+\Gamma} + S^S + \alpha^{-\varepsilon} j \cdot \frac{S^M}{+\Gamma} \right)}{w^{-\varepsilon} S^N + \frac{S^M}{+\Gamma} - j \cdot \frac{S^M}{+\Gamma} + S^S \;\; \cdot [\; - \quad -\alpha\;\phi] + \alpha^{-\varepsilon} j \cdot \frac{S^M}{+\Gamma}}$$

3.3 Solve for equilibrium investment level in R&D with imitation:

$$q^M \equiv \frac{V^M}{+\Gamma\;\; F} = \frac{\frac{\pi^M}{\rho + j + g}}{+\Gamma\;\; F} =$$

$$= \frac{+\Gamma\;\; w}{A\;\; K^N + K^M}$$

$$Numerator = \frac{-\alpha\;\; \phi \cdot E}{w^{-\varepsilon} n + m - \; jm + \alpha^{-\varepsilon} \cdot \; jm + s \quad \cdot \;\; \rho + \; j + g}$$

$$g \quad L_I A$$

$$Numerator = \frac{-\alpha\;\; \phi \cdot \frac{L^S + wL^N - wL_I \;\; \cdot \left(w^{-\varepsilon} n + m - \; jm + s \;\; + \alpha^{-\varepsilon} jm \right)}{w^{-\varepsilon} n + m - \; jm + s \quad \cdot [\; - \quad -\alpha\;\phi] + \alpha^{-\varepsilon} jm}}{\rho + L_I A + \; j \quad w^{-\varepsilon} n + m - \; jm + s \;\; + \alpha^{-\varepsilon} jm}$$

$$= \frac{L^S + wL^N - wL_I \qquad -\alpha\;\; \phi}{\rho + L_I A + \; j \;\left\{ w^{-\varepsilon} n + m - \; jm + s \quad \cdot [\; - \quad -\alpha\;\phi] + \alpha^{-\varepsilon} jm \right\}}$$

$$K^N + K^M$$

$$L^S + wL^N - wL_I \qquad -\alpha\;\; \phi A =$$

$$\rho + L_I A + \; j\;\; w \left\{ \left[w^{-\varepsilon} \quad +\Gamma\;\; S^N + S^M - jS^M + \quad +\Gamma\;\; S^S \right] \cdot [\; - \quad -\alpha\;\phi] + \alpha^{-\varepsilon} jS^M \right\}$$

$$L_I$$

$$L_I =$$

$$\frac{L^S + wL^N \quad - \alpha\ \phi\left[\ + \mu \quad - S^M\ \right] - \ \rho + j\ w\left\{\left[w^{-\varepsilon} \quad + \Gamma \quad - S^M \quad + S^M - jS^M\right] \cdot \left[\ - \quad - \alpha\ \phi\right] + \alpha^{-\varepsilon} jS^M\right\}}{w\left[\ + \mu \quad - S^M\ \right]\left\{\left[w^{-\varepsilon} \quad + \Gamma \quad - S^M \quad + S^M - jS^M\right] \cdot \left[\ - \quad - \alpha\ \phi\right] + \alpha^{-\varepsilon} jS^M + \quad - \alpha\ \phi\right\}}$$

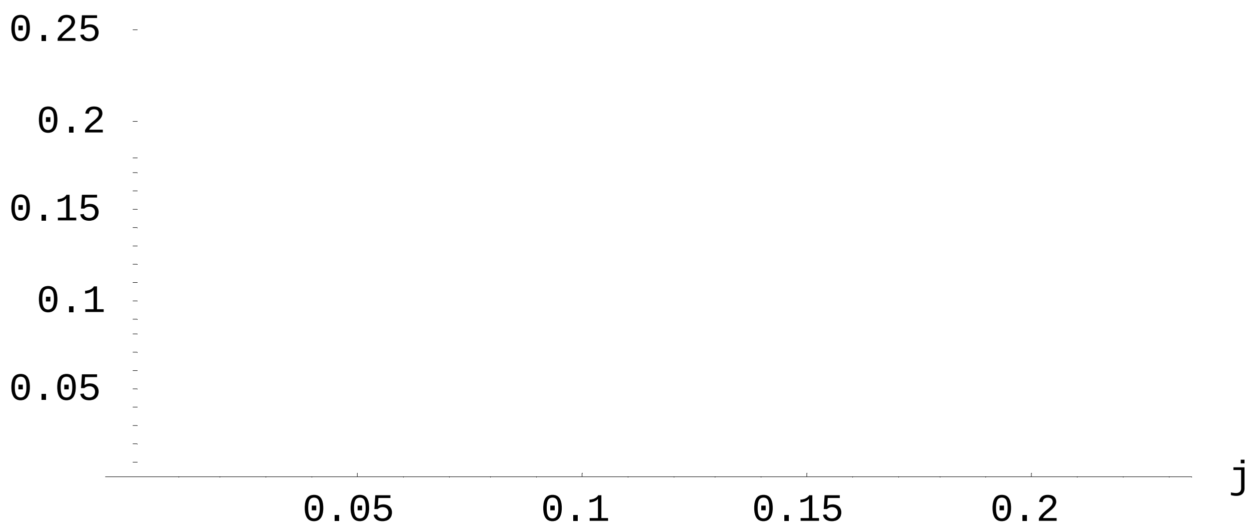
3.4 Solution of share of MNCs (from Mathematica)

$$= \quad {}^{\varepsilon} \cdot \Big[\quad + \Gamma\ + \quad - \quad - \quad {}^{\varepsilon-} + \Gamma\ + \quad + \quad - \quad + \quad - \quad {}^{\varepsilon-} + \Gamma\ \Big] \cdot$$

$$- \quad {}^{\varepsilon} \ + \quad {}^{\varepsilon} \ + \Gamma - \quad {}^{\varepsilon-} + \quad {}^{\varepsilon-} \ - \quad - \quad {}^{\varepsilon-} + \quad {}^{\varepsilon-} - \quad - \quad {}^{\varepsilon} \quad {}^{+\varepsilon}\phi \ -$$

$$- \quad \alpha^{\varepsilon}\Gamma\phi \quad - \alpha\ + \quad + \quad \alpha^{\varepsilon}\mu\phi \quad - \alpha \quad + \Gamma - \quad {}^{\varepsilon-} \quad {}^{-}$$

$$g_{GDP} = -\left[\quad -\phi \quad \cdot \frac{P_Y}{P_Y} + \phi \cdot \frac{P_X}{P_X} \right] = -\phi \cdot \frac{P_X}{P_X} = \frac{\phi}{\varepsilon -} g$$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References:

Journal of International Economics,

"Multinationals, Endogenous Growth and Technological Spillovers: Theory and Evidence". 2001.

Journal of Economic Surveys, .

The University of Michigan Press, .

The American Economic Review,

he American Economic Review,

European Economic Review 39,

The World Bank Economic Review

International Economic Review,

". Journal of International Economics 40,

European Economic Review 35,

Handbook of International Economics

Econometrica,

Canadian Journal of Economics,

The Journal of Political Economy,

Quarterly Journal of Economics .

The World Bank Economic Review, .

“International Intellectual Property Rights Protection and the Rate of Product Innovation”. Journal of Development Economics,

Journal of International Economics 55, 2001,

Journal of
Money, Credit and Banking,