Endogenous Skill Choice as Source of Productivity Dispersion, and Export Margins

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Abstract

Technical progress has differential impacts on productivities across sectors contingent on skilled labor shares. At the macro level, given the overall human capital stock of a region and structural congruence with the trading partners, apart from the motives of comparative advantage, the regions participate in trade to reap **the technological bonus** out of trade flows. A theoretical model formalizing the nexus between embodied technology transfer, human capital and TFP Growth is developed. **Capturing** these benefits requires an appropriate mix of skilled and unskilled labor, which is recognized by the firm in its production decisions. Assuming skilled labor as the harvester of new technology, the ratio of skilled and unskilled wage bills, as a measure of skill intensity, proxies absorption capacity. Sectors with higher skilled labor intensity will have an advantage in extracting the trade-mediated technology spillovers. The "optimal" level of skilled labor makes the best use of the technological bonus reflected in higher productivity. The model is designed for numerical simulation to explore the impact of a technology shock on productivity. Thus, skill heterogeneity explains the sources of heterogeneity in productivities.
JEL:O3, O4. Keywords: Productivity, Skill, Trade, Firm, Absorptive Capacity, Structural Congruence.

Introduction

Globalization and technological innovations changing the nature of the economy: changing the modes of production in other sectors and triggering a chain reaction of complementary inventions, access to foreign markets, technology, and aid. –World Bank's World Development Report (WDR 2002, 2005, 2008/09) and Global Economic Prospect (2005, 2008, 2009), etc. Digitization (WDR 2017)

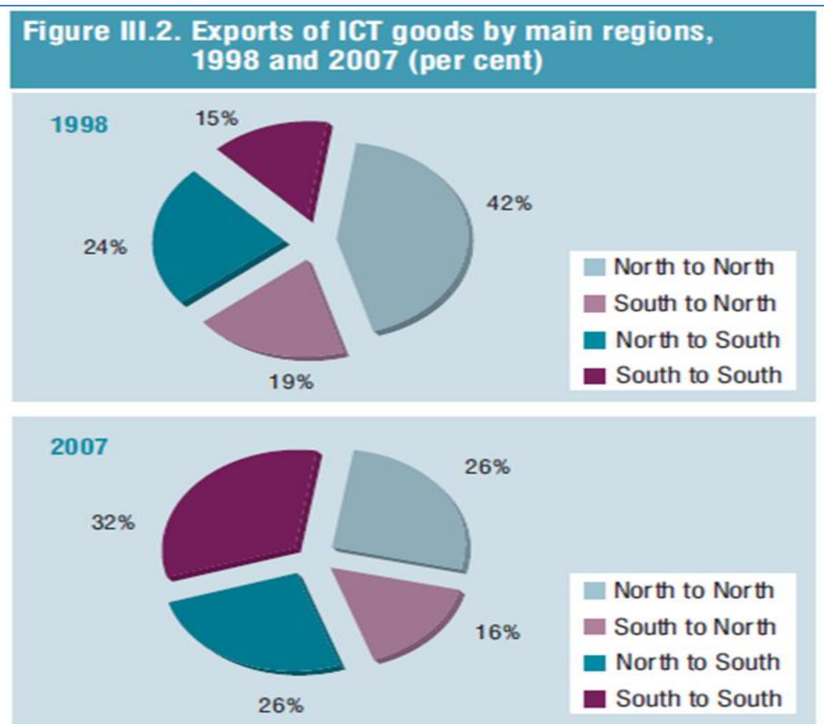
The success stories of emerging Asian and some Latin American countries show that combination of technological competence, upgrading skills via human capital to undertake complex capital, and skill- and technology-intensive activities breaks the barriers of industrial growth, and has profound impact on sustained growth. Comparatively disadvantaged groups, like the other underdeveloped regions, lag behind these early leaders because of inability to create enabling 'systems of learning and diffusion' encompassing human capital base, institutions, technological infrastructure.
Recent Studies: Keller (2004); Schiff and Wang (2006, 2007), Lucas 2009, Jones and Romer 2009. Coe, Helpman and Hoffmaister 2008. Lucas 2014 (NBER), Hausmann (2014), Nour (2013, 2014), Jones and Romer (June 2009, NBER): six stylized facts Cross-country variation in GDP growth attributed to increasing distance from the technology frontier, and large TFP differences. Role of ideas, human capital, institutions. Emphasis on unraveling linkages and gains from trade. Lucas 2009 (AER, Economica, NBER): Diffusion of industrial revolution and human capital. Coe, Helpman, Hoffmaister (2008): Caselli and Coleman, 2006, Spence (2011).

Table 3: Regional growth rates for global trade in technology clusters, 1992-2006

Technology Clusters	Average annual growth (%) in trade from		
Source Region:	G7	Other EU	Other OECD
Information and communication technology	5.3	6.9	4.9
Consumer goods	3.8	3.8	4.0
Biotechnology Cluster	2.4	4.1	4.9
Nanotechnology Cluster	8.3	10.2	8.9
Transport Equipment	6.4	6.8	7.7
Fabrication	5.8	5.9	7.2

Source: Calculated from the time-series trade data for the aggregated GTAP V7 Database

Figure III.2. Exports of ICT goods by main regions, 1998 and 2007 (per cent)



Source: UNCTAD, based on COMTRADE data.
Note. Economies in transition are included in the "South".

Theoretical Premise

Absorption is a costly learning activity that a firm can employ to integrate and commercialize knowledge and technology that is new to the firm, but not new to the world. .. In other words, ***innovation shifts a notional technological frontier outward, while absorption moves the firm closer to the frontier***. Examples of absorption include: **adopting** new products and manufacturing processes developed elsewhere, **upgrading** old products and processes, **licensing** technology, **improving** organizational efficiency, and **achieving** quality certification. **Embodied technology transmission via traded *intermediates***—*World Bank (2008, 2017)*; ***Assimilation***—role of *professionals* with technical competence -Schiff and Wang (2004), Lederman et al. (2003), *Javorcik (2006); Keller (2004); Eaton et al. (2001); Tang and Koveos (2008).* ***Digitization and inclusiveness.***
***Main Focus*: Absorptive Capacity (AC)**, Tech via **Trade intensi**ty (TI), **and Structural Congruence** (SC).—Cohen et al. (1990), Das (2015/17), Lucas (2009), Romer (2007), Chen et al 2017, etc.

Core Variables

We define a binary, scalar index of capture-parameter (θ_{ijrs}) for sector j in s' involving AC (X^A_{js}), SC (X^C_{jrs}) and TI (X^T_{ijs}) so that the production function for θ_{ijrs} is *Constant Ratios of Elasticities of Substitution, Homothetic* (CRESH) (Hanoch 1975): $\theta_{ijrs} = Z(X^A_{js}, X^C_{jrs}, X^T_{ijs})$
Second stage transforms θ_{ijrs} into a variable Ω_{ijrs} that is bounded in the *unit* interval:

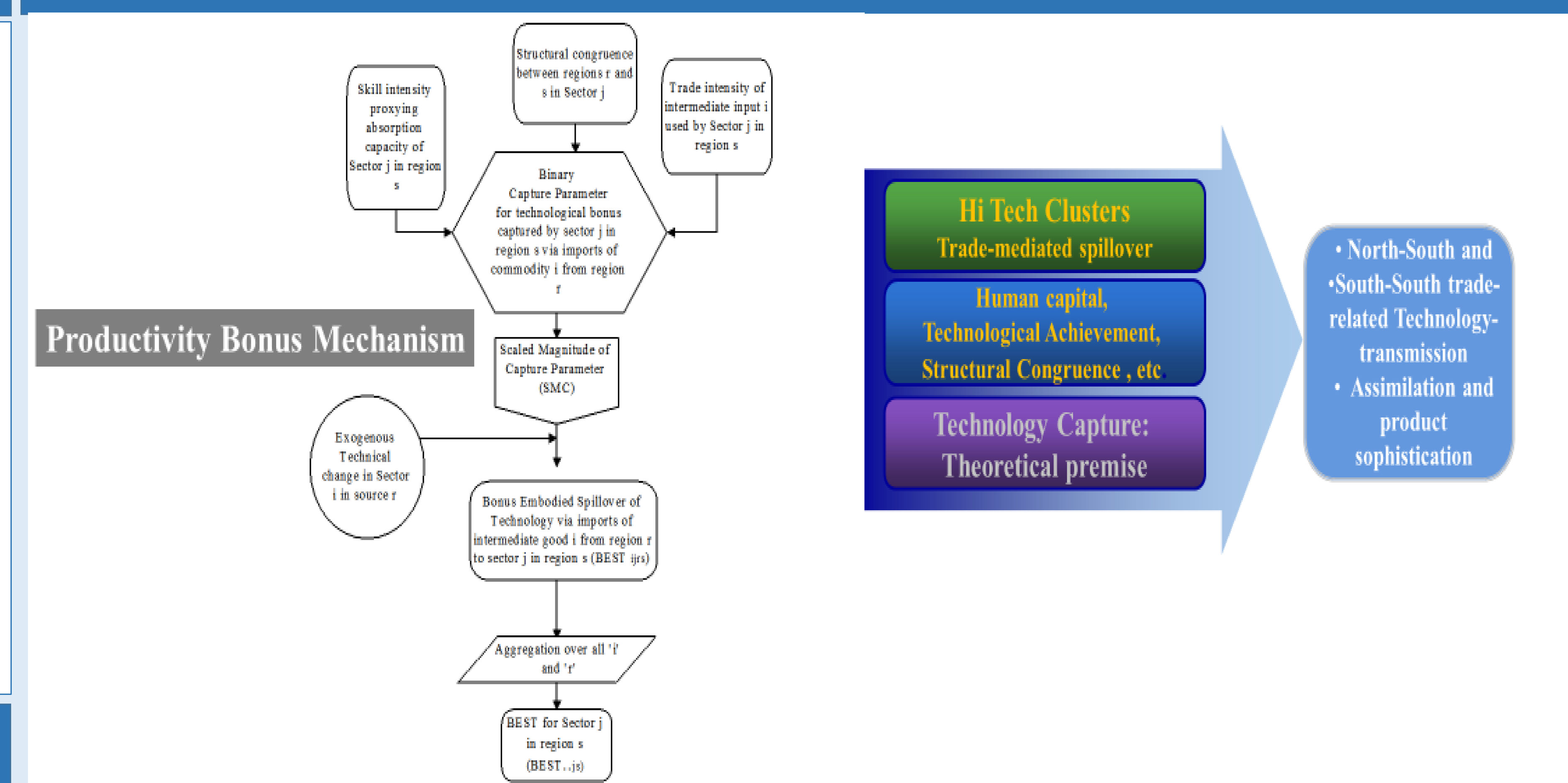
$$\Omega_{ijrs} = G(\theta_{ijrs}) = \frac{a\theta^{\kappa}_{ijrs}}{a\theta^{\kappa}_{ijrs} + 1}; \quad \theta_{ijrs} > 0,\ a > 0 \text{ and } \kappa > 0$$

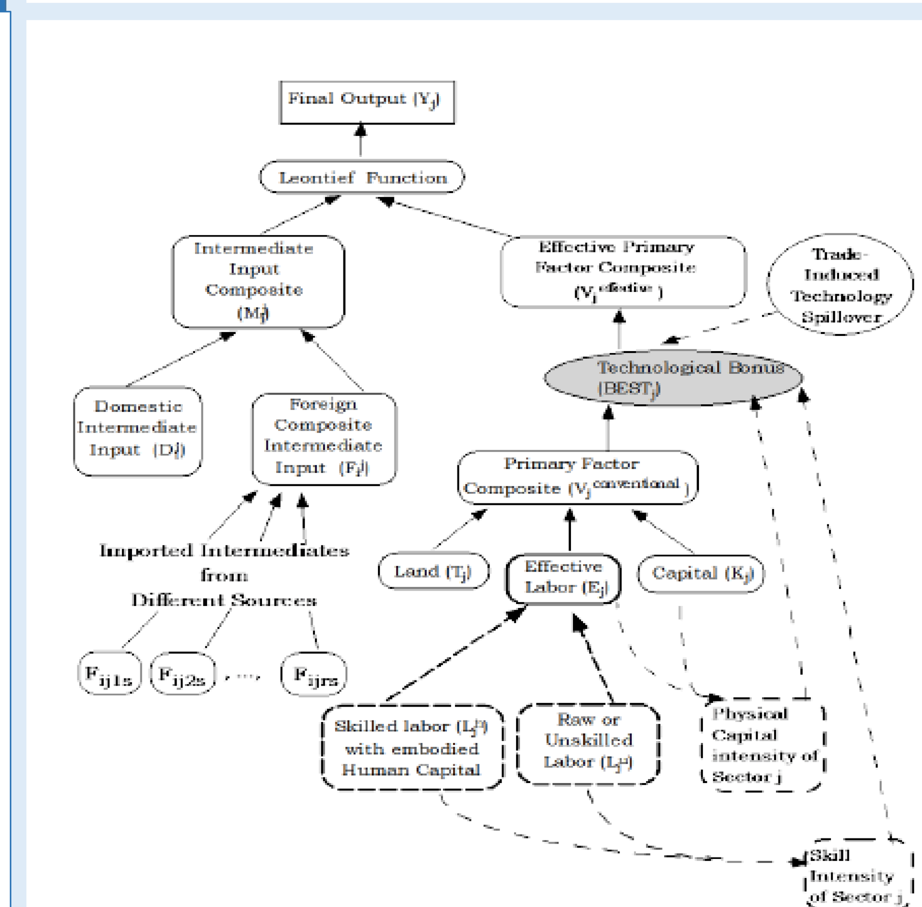
with $\frac{\partial G}{\partial \theta} > 0$, *globally*, and $\frac{\partial^2 G}{\partial \theta^2} > 0$ for low values of θ, then $\frac{\partial^2 G}{\partial \theta^2} = 0$; while finally $\frac{\partial^2 G}{\partial \theta^2} < 0$ for high values of θ_{ijrs}. When $\theta_{ijrs} \to \infty$, $\Omega_{ijrs} \to 1$ implying fully realised technological bonus; when $\theta_{ijrs} \to 0$, $\Omega_{ijrs} \to 0$. Given *a* and θ, the higher is κ, the higher is the firm's efficiency in harnessing the productivity '*bonus (TB)*. Equation for technology transmission from i in source r to recipient j in s as

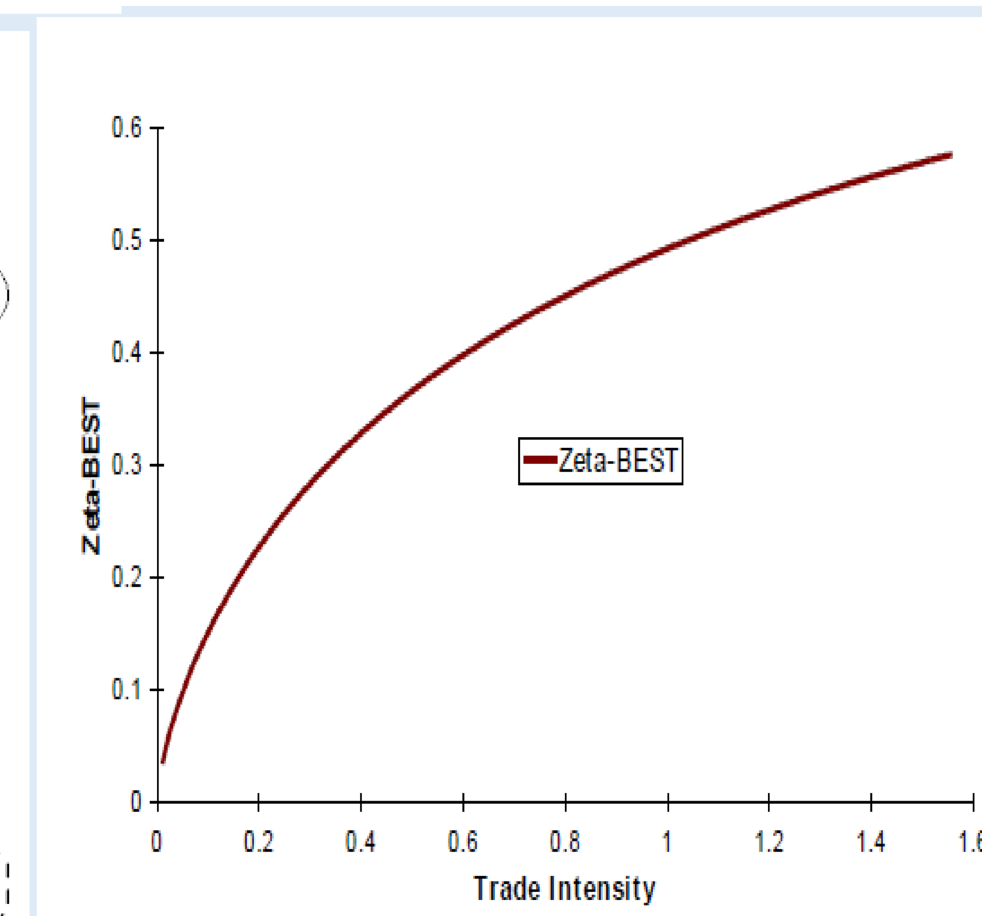
$$\Xi_{ijrs} = \Omega_{ijrs} \times A_{ir} \quad , 0 \le \Omega_{ijrs} \le 1$$

Production of final output Y_j is a product of the productivity bonus ($BEST_j$) and input of conventional primary factor composite (V^c_j): $V^{effective}_j = V^c_j \times TB_j$. Leontief combination of inputs of composite materials (M_j) and effective primary factors composite ($V^{effective}_j$), is : $Y_j = A_j \min [A^M_j M_j, V^{effective}_j]$

Method and Models

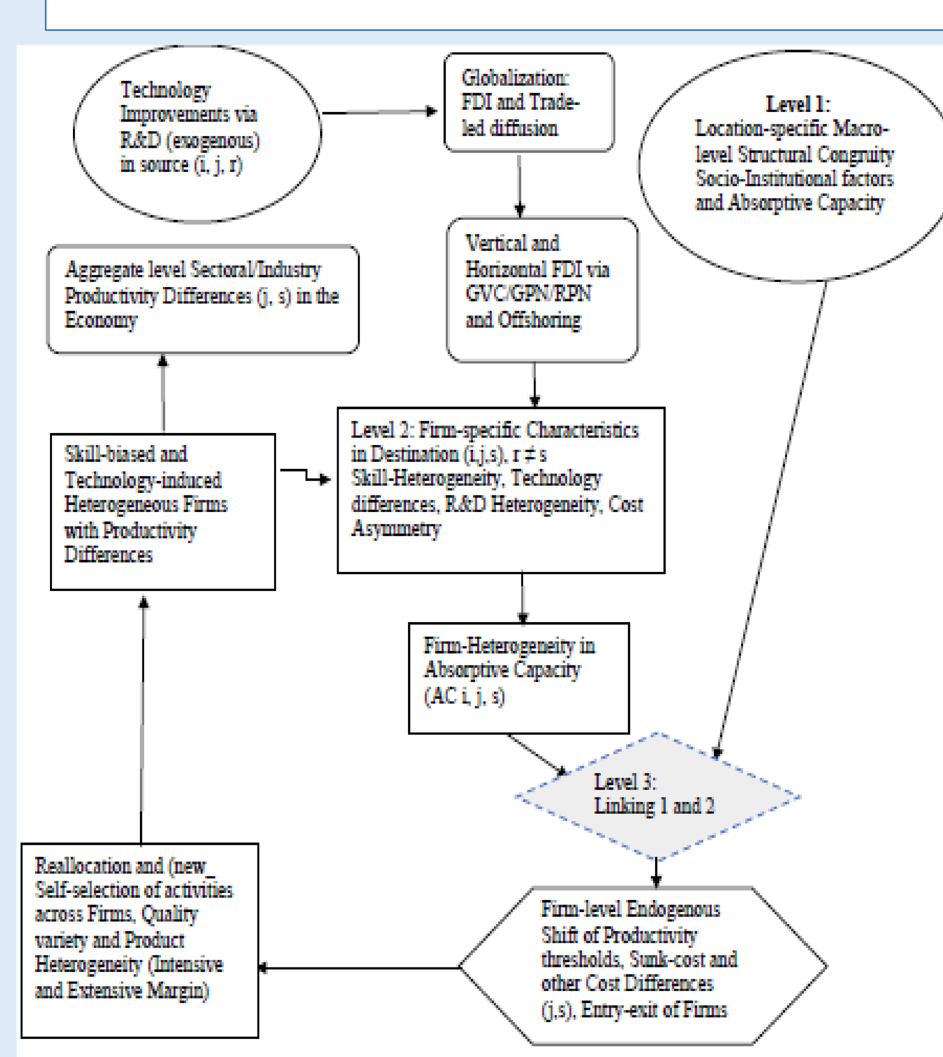






Analytical Results

Proposition I: *With the foreign-composite input held fixed, a unit increment of domestically sourced intermediate input reduces the captured productivity bonus (Ξj); on the other hand, with a fixed level of domestic intermediate inputs, Ξj is augmented by an increment of foreign-sourced intermediates due to a higher capture of the foreign-sourced technological improvement.*
Proposition II: *For positive values of the parameters ΓΞ, δh and with MPXAj>0 (and even if MPXCj = 0) 'TB' per unit of increment of composite labour input Ej will go up when skill-intensity increases. Thus, higher AC proxied by skill-intensity augments the technological bonus via effective assimilation of fruits of transmitted technology.*
Proposition III: *Since MPXCj>0, a higher dose of physical capital will stimulate accrual of higher productivity bonus. Thus, higher capital intensity translates into higher appropriation of technological bonus in any region. As long as the destination's capital intensity is lower than that in the source (i.e., if capital intensity increases in the destination but not as rapidly as that of the source so that the client's capital-intensity does not overshoot the source's), then higher dose of physical capital in the recipient translates into larger value of structural congruence resulting in amplification of productivity bonus.*
Proposition IV: *An increment of unskilled labor, (keeping skilled labor fixed) reduces Ξ owing to lower absorption of technology. An increment in skilled labour inflates the value of Ξj.*



Conclusions

A theory which allows for the endogenous capture of foreign technical change has been offered. Transmitted technology shock via imported inputs becomes endogenous. Workers differ in their skill contents to achieve a productivity level with a particular vintage of technology. It is postulated that: (i) *AC* increases with the skill intensity; (ii) amount of technology potentially captured increases with import intensity; and (iii) *SC* increases with higher capital intensities. The capacity of traded inputs to carry technological improvements changes the factor-mix problem of representative firms, taking into account not only the conventional marginal rate of substitution between domestic and foreign inputs of same generic type, but also the 'bonus' of the superior technology embedded in inputs. The model embeds a mechanics of technology adoption in a global input-output structure based on differences in skill, trade-intensity and capital-intensity.

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