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Variety Expansion Redux: A Cross-Country Estimation of the Spillover Effects of Innovation and Imitation

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Variety Expansion Redux: A Cross-Country Estimation of the Spillover Effects of Innovation and Imitation

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Abstract

The complex interactions between imitation and innovation are frequently examined in endogenous growth models: imitation serves as a *stepping stone* to innovation; innovation exhibits spillover to imitation; for both, the accumulative stock provides a *standing-on-shoulders* effect to further growth. However, empirical estimation of these concepts in true Romerian product variety interpretation is scarce. This is due to variety expansion often being treated only as imitative activities in the relatively popular Schumpeterian interpretation to innovation. Using an overlapping generations framework that models innovation and imitation as semi-symmetric ideas production functions, this paper estimates these spillover effects using cross-country data by treating each 4-digit ISIC industries as a separate industrial variety. We find robust and significant estimates for all three spillover effects, with both imitation and innovation being complementary to each other. In addition, the growth regressions also reaffirm the significance of product variety expansion as a source of innovation-driven growth.

JEL Classification Numbers: O11, O40, O47
Keywords: Growth, Ideas Production, Imitation, Innovation, Product Variety Expansion.

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1 Introduction

The dynamics of imitation and innovation, together with their interactions, are fundamental to the industrial transformation of many developing economies. Broadly, there are two main interpretations. First, theories in the Nelson-Phelps, Aghion-Howitt tradition interpret innovation as a leap at the edge of the knowledge frontier while other firms jostle along the quality ladder where imitative activities take place. Conversely, industrial transformation theories in the Romerian tradition view both as sectors with semi-symmetric ideas production functions, where gains in innovation arise horizontally in the form of product variety expansion as a result of spillovers from the imitation sector. Existing empirical studies analyzing the tradeoff between imitation and innovation are predominantly based on the former, largely due to difficulties in empirically examining the industrial transformation thesis in Romerian product variety interpretation. As such, the learning and spillover effects between the two sectors and to others in an economy remain underexplored. We contribute to the empirical literature on growth regressions by estimating the elasticities to well-known theoretical concepts such as "*standing-on-shoulder*" (Caballero and Jaffe 1993; Jones 2005) and "*stepping-stone*" effects (Glass 1999; Collins 2015). Using highly disaggregated industrial data, to our knowledge, this paper is the first to empirically establish the presence of a positive *stepping-stone* effect across countries. Further, by estimating a positive effect of innovative variety on the expansion of imitative varieties, we also find empirical evidence in support of a complementary relationship between innovative and imitative industrial varieties.

In terms of theoretical contributions, studies such as Davidson and Segerstrom (1998) and Aghion et al. (2000) find that too much imitation hinders economic growth, whereas studies such as Glass (1999), Agénor and Dinh (2013), and Collins (2015) argue that imitation is a key stepping stone for innovation. Though, Mukoyama (2003) and Benhabib et al. (2014) are examples of studies that show that imitation is neither good nor bad, as it is merely the optimal choice of firms or economies in their production.

The theories discussed are non-exhaustive, and the many studies concerning imitation and innovation adopt various interpretations to the two ideas production activities. Most existing empirical contributions on ideas production-based endogenous growth models mainly follow the tradition of Nelson and Phelps (1966), Aghion and Howitt (1992, 1998), Vandenbussche et al. (2006), and therefore rest on a Schumpeterian and distance-to-frontier interpretation to innovation ("vertical innovation"). Comparisons between Schumpeterian and semi-endogenous growth models, such as Ha and Howitt (2007) and Madsen (2008) find the former to have superior empirical validity. However, the theoretical framework underpinning their empirical analysis is premised on adopting the distance-to-frontier interpretation to innovation, while product variety is generally specified as imitation by firms playing catching-up along the quality ladder. Such an interpretation, in essence, already imposes a prior association of variety expansion to imitation as a source of growth. As argued in studies such as Gustafsson and Segerstrom (2010), Puga and Trefler (2010), and Ang et al. (2015), horizontal innovation in the form of expanding new varieties is as important a source of innovation as the jumps along the frontier, especially for emerging industrial economies.

Moreover, the lack of empirical support for what are known as semi-endogenous growth models in the aforementioned empirical studies (compared to Schumpeterian models) is also largely due to the use of aggregate R&D expenditure data—and its lack of correlation with TFP growth—which in itself does not capture the essence of the original interpretation of Romerian expanding variety models. R&D expenditure is an input measure, whereas in a Romerian horizontal innovation-driven growth model, productivity in the final goods sector depends directly on the expansion of intermediate varieties, which are inherently output based.

As pointed out in Ang and Madsen (2015a), existing studies do not test for the returns to ideas stock in the ideas production function. As such, they will not be able to provide any empirical insight for the sign and magnitude of the spillover/externality effects that are inherent in Romerian models.[1] Ang and Madsen (2015a) test for this channel, commonly dubbed the *standing-on-shoulder* effect, in a single ideas production function using data from selected economies from 1870-2010. While they control for international knowledge spillover, the study by design, does not reveal much about the dynamics between innovation and imitation. In a separate study, Ang and Madsen (2015b) partly address this by examining the productivity growth effects of education across different age cohorts through the channels of innovation and imitation; but their interpretations of the two sectors are based heavily on models with vertical innovation. Innovation is interpreted as gains along the frontier while imitation as product variety in the lower rung of the ladder, often proxied by employment or population (inherently flawed measures). If both imitation and innovation are modelled as product varieties driven by interacting ideas production functions, as in Rustichini and Schmilz (1991), Walz (1996), and more recently, Agénor and Dinh (2013) and Lim (2015), an appropriate empirical strategy is one that is based on a horizontal innovation interpretation.

In terms of measurement, in the existing literature, innovation is mainly measured by patent applications while imitation by trademarks or employment. While patent data is a good measure for innovation, the proxies used for imitation and product variety are often flawed.[2] Conceptually, the use of measures such as employment or R&D

[1]Indeed, the significance of the spillover mechanism of a Romerian ideas production function-based, horizontal innovation model can often be seen in multisectorial growth models examining developmental issues such as industrial transformation and stages of development, such as Funke and Strulik (2000), Sequiera (2011), and Agenor and Dinh (2013).

[2]See Bottazzi and Peri (2003) and Ang and Madsen (2013) for examples. Their justification is often that the number of products tend to grow at the same rate of population in the steady state, but this assumption (i) is primarily Schumpeterian-based, and (ii) the steady-state assumption is ill-suited when estimating coefficients of a dynamic system.

researchers as a proxy for product variety is no longer valid once the scale effect is adjusted for. For another popular measure, the input measure of R&D expenditure, it is well-documented in the empirical literature to have failed in explaining innovation-driven productivity growth. The direct use of a product space-based measure is therefore essential.

Recent releases of the INDSTAT 4 by the United Nations Industrial Development Organization (UNIDO) provide us with sufficiently long disaggregated industrial data across countries. This, coupled with the progression in product sophistication studies such as Hausmann et al. (2007), allows us to examine empirically the interactions of imitation and innovation—as semi-symmetric ideas production functions—directly in the industrial output variety dimension, which is fully consistent with the Romerian interpretation of product variety expansion. Specifically, we present a simple version of an industrial transformation model that is based on Agénor and Dinh (2013) in Section 2. This allows us to derive a 2x2 linear difference equation system characterizing the solutions,

$$\begin{bmatrix} \hat{m}_{t+1}^{R} \\ \hat{m}_{t+1}^{I} \end{bmatrix} = \begin{bmatrix} \Omega_R^1 & \Omega_I^1 \\ \Omega_R^2 & \Omega_I^2 \end{bmatrix} \begin{bmatrix} \hat{m}_{t}^{R} \\ \hat{m}_{t}^{I} \end{bmatrix}, \tag{1}$$

where $\hat{m}_t^R = \ln m_t^R$ denotes innovative and $\hat{m}_t^I = \ln m_t^I$ denotes imitative varieties. Given the log-deviations from steady-state form, the model to be tested empirically is therefore not bounded by the steady-state assumption. By also introducing public capital and skilled labor (though the model specification is such that a reduced form 2x2 dynamics system with only imitation and innovation can be derived), we also test and control for their role in influencing the imitation-innovation dynamics. Section 3 derives an empirical structure for the theoretical model. This is followed by Section 4, which discusses the empirical strategy and the estimation results. Section 5 concludes the paper.

2 The Model

The model belongs to a group of Romerian (1990) expanding variety models on industrial transformation developed in the tradition of Rustichini and Schmilz (1991). Based primarily on the overlapping generations model of Agénor and Dinh (2013), the economy is populated by individuals with identical preferences but different innate abilities, who live for two periods. Population is constant at $\bar{N}$. Each individual is endowed with one unit of time in the first period of life, and zero unit in old age. Abilities are instantly observable by all and follow a continuous distribution with density function $f(a_t)$ and cumulative distribution function $F(a_t)$, with support $(0, 1)$. For tractability and critical to the subsequent derivation of the 2x2 reduced form, ability is assumed to be uniformly distributed on its support[3]. At the beginning of adulthood, individuals choose whether to spend a fraction $\varepsilon \in (0, 1)$ and training cost, tc_t, to undergo training. This decision determines the proportion of skilled and unskilled workers in the economy.

Let $c_{t+j}^{h,t}$ denote consumption at period $t + j$ of an individual of skill level $h = U, S$, born at the beginning of period t, with $j = 0, 1$. The individual's discounted utility function is given by

$$V_t^h = \ln c_t^{h,t} + \frac{\ln c_{t+1}^{h,t}}{1+\rho}, \ \ h = U, S, \quad j = 0, 1 \tag{2}$$

where $\rho > 0$ is the discount rate, while the period-specific budget constraints are given by

$$c_t^{U,t} + s_t^U = (1-\tau)w_t^U, \tag{3}$$

$$c_t^{S,t} + s_t^S = (1-\tau)[(1-\varepsilon)w_t^S - tc_t], \tag{4}$$

[3] An alternative distribution that can be used is the Pareto distribution, which will also give a tractable expression for the average value of ability.

$$c_{t+1}^{h,t} = (1 + r_{t+1})s_t^h, \quad h = U, S, \tag{5}$$

where w_t^h is the wages, s_t^h the savings, $1 + r_{t+1}$ the gross rate of return on holding assets, and $\tau \in (0, 1)$ the tax rate.

It is optimal for an individual with ability $a_t \in (a_m, 1)$ to train and become skilled if and only if

$$V_t^S \geq V_t^U, \tag{6}$$

where, the training cost, tc_t, is proportional to the wage that skilled workers earn (after accounted for training time, ε)[4],

$$tc_t = \mu(1 - \varepsilon)w_t^S / a_t, \text{ where } \mu \in (0, 1). \tag{7}$$

As shown in Appendix A, holding equation (6) as an equality, together with (7), we can derive the threshold level of ability a_t^C such that all individuals with ability lower than a_t^C choose to remain unskilled as a function of the relative wage ratio:

$$a_t^C = 2\mu \left(1 - \frac{w_t^U}{(1 - \varepsilon)w_t^S}\right)^{-1} - 1. \tag{8}$$

The productivity of unskilled workers, independently of abilities, is constant and normalized to unity. Given (8), the proportion of unskilled labor, θ_t^U, is given by

$$\theta_t^U = \frac{N_t^U}{\bar{N}} = \int_0^{a_t^C} f(a_t)da = F(a_t^C) = a_t^C. \tag{9}$$

The raw supply of skilled labor, at any time t, is $N_t \int_{a_t^C}^1 f(a_t)da = (1 - a_t^C)N_t$. However, the average skill level of workers with ability $a \in (a_t^C, 1)$ who have undergone training equals $0.5(1 + a_t^C)$; thus, the proportion of *effective* supply of skilled labor at

[4] For papers with similar specification, see Galor and Moav (2000), Tanaka and Iwaisako (2009), and Agénor and Canuto (2017).

time t, is

$$\theta_t^S = \frac{N_t^S}{\bar{N}} = \frac{1-(a_t^C)^2}{2}. \quad (10)$$

2.1 Final Good

The final good is produced by a continuum of unit mass competitive firms, indexed by $i \in (0,1)$, employing χN_t^U of unskilled labor in the economy. For each firm, production of Y_t^i uses untrained labor, $N_{i,t}^U$, private capital, $K_{i,t}^P$, and the combination of intermediate inputs, $x_{i,s,t}$, with $s \in (0, M_t)$, with the production function given by

$$Y_t^i = [\frac{K_t^G}{(K_t^P)^{\zeta_K}(N_t)^{\zeta_N}}]^{\omega}(\chi N_{i,t}^U)^{\beta}(K_{i,t}^P)^{\alpha}(X_t^i)^{\gamma}, \quad (11)$$

where $\beta, \alpha, \gamma \in (0,1)$, $\omega > 0$, $\zeta_K, \zeta_N > 0$, $\gamma = 1-\beta-\alpha$, K_t^P the aggregate private capital, and $X_t^i = [\int_0^{M_t^I}(x_{s,t}^{i,I})^{\eta}ds]^{\nu/\eta} \cdot [\int_0^{M_t^R}(x_{s,t}^{i,R})^{\eta}ds]^{(1-\nu)/\eta}$ the composite intermediate input for firm i, where $\eta \in (0,1)$ and $1/(1-\eta) > 1$ is the price elasticity of demand for each intermediate good, and $\nu \in (0,1)$. Thus, the composite intermediate input exhibits constant returns to scale with respect to innovation- and imitation-based inputs.

Assuming full depreciation, firm i's profits are defined as

$$\Pi_{i,t}^Y = Y_t^i - \int_0^{M_t^I} P_t^{I,s}x_{s,t}^I ds - \int_0^{M_t^R} P_t^{R,s}x_{s,t}^R ds - w_t^U \chi N_{i,t}^U - (1+r_t)K_{i,t}^P,$$

where standard profits maximization by each firm yields the first-order conditions: for unskilled wage, $w_t^U = \beta\frac{Y_{i,t}}{\chi N_{i,t}^U}$, interest rate, $1+r_t = \alpha(\frac{Y_{i,t}}{K_{i,t}^P})$, and the demand for intermediate inputs as follows:

$$x_{s,t}^j = (\frac{\gamma\nu^j Z_t^j}{P_t^{j,s}})^{1/(1-\eta)}, \; s = 1, ...M_t^j, \; j = I, R, \; \nu^I = \nu, \nu^R = 1-\nu, \quad (12)$$

$$Z_t^j = Y_t / \int_0^{M_t^j} (x_{s,t}^j)^\eta ds. \tag{13}$$

In a symmetric equilibrium, $\int_0^{M_t^I} (x_{s,t}^I)^\eta ds = M_t^I (x_t^I)^\eta$ and $\int_0^{M_t^R} (x_{s,t}^R)^\eta ds = M_t^R (x_t^R)^\eta$. The composite intermediate input can then be written as

$$X_t = [(M_t^I)^{1/\eta} x_t^I]^\nu [(M_t^R)^{1/\eta} x_t^R]^{1-\nu}.$$

The number of firms is normalized to unity, which gives the aggregate final output Y_t as:

$$Y_t = [\frac{K_t^G}{(K_t^P)^{\zeta_K} (N_t)^{\zeta_N}}]^\omega (\chi N_t^U)^\beta (X_t)^\gamma (K_t^P)^\alpha. \tag{14}$$

2.2 Intermediate Inputs

There are two sets of intermediate goods producers: those producing imitation-based inputs (index I) using blueprints from the imitation sector, and those producing innovation-based inputs (index R), based on blueprints from the innovation sector. Using one unit of final good, each firm produces one horizontally-differentiated intermediate input.

The two sectors are treated symmetrically, modelled in similar fashion to Romer (1990) and Gustafsson and Segerstrom (2010). Each producer in sector $j = I, R$ pays the relevant blueprint fee Q_t^j. Then, each producer sets its price to maximize profits, given the perceived demand function for its good (12), which determines marginal revenue. Under a symmetric equilibrium, profits are given by $\Pi_t^j = (P_t^j - 1)x_t^j$ or using (12) and (13), $\Pi_t^j = (P_t^j - 1)[\gamma \nu^j Y_t / P_t^j M_t^j (x_t^j)^\eta]^{1/(1-\eta)}$, $j = I, R$. The solution yields the optimal price,

$$P_t^{j,s} = \eta^{-1}. \ \ \forall s = 1, ...M_t^I, \quad j = I, R \tag{15}$$

Using (12), the quantity demanded at this price is $x_{s,t}^j = (\gamma \eta \nu^j Z_t^j)^{1/(1-\eta)}$, $\forall s$, that is, noting that under symmetry $\int_0^{M_t^j}(x_{s,t}^j)^\eta ds = M_t^j(x_t^j)^\eta$,

$$x_t^j = \gamma\eta\nu^j(\frac{Y_t}{M_t^j}), \quad j = I, R \tag{16}$$

with maximum profit given by

$$\Pi_t^j = (1-\eta)\gamma\nu^j(\frac{Y_t}{M_t^j}), \quad j = I, R \tag{17}$$

For simplicity, intermediate-input producing firms in both sub-sectors are assumed to last only one period, and that the blueprints are auctioned off randomly to a new group of firms in each period. Thus, each producer of a new intermediate good holds the blueprint only for the period during which it is bought, implying monopoly profits during that period only; yet the blueprints would last forever.[5] By arbitrage, therefore,

$$Q_t^j = \Pi_t^j. \quad j = I, R \tag{18}$$

2.3 Ideas Production Sectors: *Imitatio*n and *Innovation*

Blueprints are produced in two sectors: an innovative sector, which employs skilled labor, in quantity N_t^S, to produce variety, M_t^R, and an imitation sector, which employs a constant share of unskilled labor, $(1-\chi)N_t^U$ to produce variety, M_t^I. First, consider the imitation sector. The aggregate technology is defined as

$$M_{t+1}^I - M_t^I = A_t^I(\frac{(1-\chi)N_t^U}{N_t}), \tag{19}$$

[5] See Agénor and Canuto (2012) for a more detailed discussion of this assumption.

where A_t^I is a productivity factor,

$$A_t^I = (\frac{M_t^R}{K_t^P})^{\phi_1^I}(k_t^G)^{\phi_2^I} M_t^I. \tag{20}$$

Consistent with the literature in the tradition of Romer (1990), this specification includes the direct learning effect from stock of imitation (M_t^I), with a constant return specification following the empirical estimate of Ang and Madsen (2015), and the spillover effect from innovation (which can be either positive or negative, as in Lim (2015)). In addition, as in Agénor and Neanidis (2015), and subject to congestion measured by private capital stock, a positive productivity effect from access to public capital (k_t^G) is specified. To eliminate scale effects, it is the *ratio* of employed workers to total population that is taken to affect activity in that sector.[6]

Firms in the imitation sector choose labor so as to maximize profits, $\Pi_t^I = Q_t^I(M_{t+1}^I - M_t^I) - w_t^U(1-\chi)N_t^U$, subject to (19), and taking the wage rate, the patent price, Q_t^I, and productivity A_t^I, as given. The first-order condition with strictly positive employment is given by

$$w_t^U = \frac{Q_t^I A_t^I}{N_t}, \tag{21}$$

Consider now the innovation sector. The aggregate technology is defined as

$$M_{t+1}^R - M_t^R = A_t^R[\frac{(1-\varepsilon)N_t^S}{N_t}], \tag{22}$$

where A_t^R is a productivity factor,

$$A_t^R = (\frac{M_t^I}{K_t^P})^{\phi_1^R}(k_t^G)^{\phi_2^R} M_t^R. \tag{23}$$

[6] See Dinopoulos and Thompson (1998), Dinopoulos and Segerstrom (1999), and Perez-Sebastian (2007).

Again, the direct learning effect is modelled, and ϕ_1^R is known as the *stepping-stone effect* in the literature (Glass 1999; Collins 2015).

Standard profit maximization based on $\Pi_t^R = Q_t^R(M_{t+1}^R - M_t^R) - w_t^S(1-\varepsilon)N_t^{S,R}$, subject to (22), taking the wage rate, the patent price, Q_t^R, and productivity as given, gives

$$w_t^S = \frac{Q_t^R A_t^R}{N_t}. \tag{24}$$

2.4 Government & Market-clearing Conditions

The government taxes only wages. A constant fraction of government revenue is spent on public capital investment, G_t^I, and the remaining on all other non-productive spending, G_t^O. It is assumed that the government cannot borrow.

$$G_t = \sum G_t^h = \upsilon_h \tau \{w_t^U N_t^U + [(1-\varepsilon)w_t^S - tc_t]N_t^S\},\ h = I, O, \tag{25}$$

where $\upsilon_h \in (0,1)$, $\sum_i \upsilon_i = 1$.

Assuming full depreciation, public capital stock evolves according to

$$K_{t+1}^G = G_t^I. \tag{26}$$

Both the skilled and unskilled labor markets clear. The supply of the unskilled and the effective skilled labor can be expressed in the shares of population, as follows:

$$\theta_t^U = \frac{N_t^U}{N_t},\quad \theta_t^S = \frac{N_t^S}{N_t}. \tag{27}$$

Assuming full depreciation ($\delta_P = 1$), the saving-investment balance requires the private capital stock in $t+1$ to be equal to savings in period t by individuals born in

$t-1$:

$$K_{t+1}^{P} = s_t^U N_t^U + s_t^S N_t^S. \tag{28}$$

3 From Dynamic System to Empirical Form

The *dynamic* and *balanced growth equilibriums* of the model economy are defined as follows:

Definition: The *dynamic equilibrium* is a sequence of consumption and saving allocations $\{c_t^{h,t}, c_{t+1}^{h,t}, s_t^h\}_{t=0}^{\infty}$, for $h = U, S$, private capital stock $\{K_t^P\}_{t=0}^{\infty}$, public capital stocks $\{K_t^G\}_{t=0}^{\infty}$, prices of production inputs $\{w_t^U, w_t^S, r_{t+1}\}_{t=0}^{\infty}$, prices and quantities of intermediate inputs $\{P_t^{s,j}, x_{s,t}^j\}_{t=0}^{\infty}$, $\forall s \in (0, M_t)$ and $j = I, R$, existing varieties, $\{M_t^I, M_t^R\}_{t=0}^{\infty}$, such that, given initial stocks $K_0 > 0$, $K_0^G > 0$, M_0^I, $M_0^R > 0$, (a) all individuals maximize utility by choosing consumption subject to their intertemporal budget constraint, taking prices and tax rate as given, (b) final good firms maximize profits by choosing inputs taking the respective prices as given, (c) intermediate input producers set prices so as to maximize profits while internalizing the effect of their decisions on the perceived aggregate demand curve for their product, (d) knowledge sector firms maximize profits by choosing labor, taking wages, blueprint prices, productivity, and population as given, (e) each equilibrium blueprint price extracts all profits made by the corresponding intermediate producer, and (f) all markets clear.

Definition: A *balanced growth equilibrium* is an equilibrium with imperfect competition in which (a) $\{c_t^{h,t}, c_{t+1}^{h,t}, s_t^h\}_{t=0}^{\infty}$, for $h = U, S$, and K_t^P, K_t^G, Y_t, M_t^I, M_t^R, w_t^U, w_t^S, grow at the constant, endogenous rate $1+\gamma$, implying that the knowledge-capital ratios, and public-private capital ratios, are constant; (b) the rate of return on capital $1 + r_{t+1}$ is constant; (c) the price of intermediate goods P_t^j and the blueprint prices Q_t^j, $j = I, R$, are constant; (d) the threshold level of individuals who choose to remain unskilled, a_t^C, is constant; (e) the skilled and unskilled labor share, θ_t^S and θ_t^U are constant.

As shown in Appendix A, when we solve the model, the share of skilled labor, θ_t^S, can be substituted out fully from the system while public capital is independent of t. These then allow us to condense the dynamic form of the solution into a first-order linear difference equation system in log-deviations from the steady state, $\hat{m}_t^R = \ln m_t^R$ and $\hat{m}_t^I = \ln m_t^I$, where

$$\begin{bmatrix} \hat{m}_{t+1}^R \\ \hat{m}_{t+1}^I \end{bmatrix} = \begin{bmatrix} \Omega_R^1 & \Omega_I^1 \\ \Omega_R^2 & \Omega_I^2 \end{bmatrix} \begin{bmatrix} \hat{m}_t^R \\ \hat{m}_t^I \end{bmatrix}. \tag{29}$$

Ω_R^1 and Ω_I^2 are interpretable as the respective aggregate *standing-on-shoulder* effects, Ω_1^I the *stepping-stone effect*, and Ω_R^2 the spillover effect from innovation to imitation. As also shown in Appendix A, upon imposing certain restrictions on the congestion parameters, we can write (14) in standard AK-form of $Y_t = f(m_t^R, m_t^I; \tilde{k}^G)K_t^P$.[7] With Y_t and K_t^P growing at the same rate along the balanced growth path, we can then write the long-run growth rate as depending on the imitative varieties, the innovation varieties, and public capital.

Modifying the theoretical dynamic system into an empirically testable form for dynamic panel estimation, the benchmark empirical setup is represented by:

$$\begin{aligned} innov_{jt} \;=\; & \alpha_0 + \alpha_1 innov_{jt-1} + \alpha_2 imit_{jt} + \alpha_3 imit_{jt-1} + \alpha_4 pubcap_{jt} \\ & + \alpha_5 initGDP_{jt} + \sum_{l=1}^{L} \psi_l X_{l,jt} + \sum_{m=1}^{n-1} \lambda_m Z_{m,jt} + \mu_{jt} + u_{jt}, \end{aligned} \tag{30}$$

[7]As shown in the derivations in Appendix A, $f(m_t^R, m_t^I; \tilde{k}^G) = \frac{(k_t^G)^{\omega/(1-\gamma)}}{(\Psi_1)^{-\beta/(1-\gamma)}}(m_t^I)^{\xi_2}(m_t^R)^{\xi_1}$, with $\Psi_1 = (\beta/\chi)(1-\eta)^{-1}(\gamma\nu)^{-1}[\sigma(1-\tau)/(\upsilon_I\tau)]^{\phi_2^I}$, $\xi_1 = [\gamma(1-\nu)(1-\eta) - \phi_1^I\beta\eta]/[\eta(1-\gamma)]$, and $\xi_2 = [\gamma\nu(1-\eta)]/[\eta(1-\gamma)]$. Further, given that $\tilde{k}^G = k_t^G = k_{t+1}^G = \frac{K_{t+1}^G}{K_{t+1}^P} = \frac{\upsilon_I\tau}{\sigma(1-\tau)}, \forall t$, public capital can be treated as exogenous from the system in the empirical specification.

$$
\begin{aligned}
imit_{jt} \quad = \quad & \beta_0 + \beta_1 innov_{jt} + \beta_2 innov_{jt-1} + \beta_3 imit_{jt-1} + \beta_4 pubcap_{jt} + \\
& + \beta_5 initGDP_{jt} + \sum_{l=1}^{L} \psi_l X_{l,jt} + \sum_{m=1}^{n-1} \lambda_m Z_{m,jt} + \mu_{jt} + v_{jt},
\end{aligned} \tag{31}
$$

$$
pubcap_{j,t} = \gamma_0 + \gamma_1 urban_{jt} + \gamma_2 popdens_{jt} + \sum_{m=1}^{n-1} \lambda_m Z_{m,jt} + \mu_{jt} + z_{jt}, \tag{32}
$$

$$
\begin{aligned}
g_{j,t} \quad = \quad & \delta_0 + \delta_1 initGDP_{jt} + \delta_2 innov_{jt} + \delta_3 imit_{jt} + \delta_4 pubcap_{jt} \\
& + \delta_5 \Delta innov_{jt} + \delta_6 \Delta imit_{jt} + \sum_{k=1}^{K} \xi_k \Upsilon_{k,jt} + \mu_{jt} + \varepsilon_{jt},
\end{aligned} \tag{33}
$$

where $j(t)$ is a country (time) index; $innov_{jt}$ and $imit_{jt}$ are innovative and imitative varieties; $pubcap_{j,t}$ is public capital stock; $g_{j,t}$ is growth rate of per capita real GDP; $initGDP_{jt}$ is the logarithm of initial per capita GDP (introduced to capture the conditional convergence effects). In line with Agénor and Neanidis (2015), we also examine the contemporaneous effects between the two main endogenous variables, introduce urban shares and population density in the equation for public capital stock, as well as use $\{Z_{m,jt}\}_{m=1}^{n-1}$, a set of fiscal variables in levels (measured as fractions of GDP) for exclusion restriction, with the excluded factor being tax revenue. $\{X_{l,jt}\}_{l=1}^{L}$ and $\{\Upsilon_{k,jt}\}_{k=1}^{K}$ denote the set of control variables for the ideas production functions and economic growth. Lastly, μ_{jt} captures time-invariant country-specific effects, while u_{jt}, v_{jt}, z_{jt}, and ε_{jt} are the error terms.

The coefficients of interest are α_1, α_2, α_3, β_1, β_2, β_3, δ_2, δ_3, δ_5, δ_6. α_1 and β_3 give the aggregate *standing-on-shoulder* effects for innovative and imitative varieties respectively. α_2 and α_3 are coefficients for the *stepping-stone* effect, with the former depicts a contemporaneous effect and a combination of the two (adjusted by the lagged dependent variable) would allow for a quick calculation of the *stepping-stone* effects; β_1 and β_2 give the corresponding spillover effects from innovation to imitation, for which firm-level empirical studies have found conflicting results.[8] The δ's allow us to compare the stock and flow effects of ideas-driven growth. Though the public capital equation is estimated as in Agénor (2012) and related models, the coefficients associated with public capital are not of main interest, though they allow for an empirical validation of the effects of public capital stocks on industrial transformation.

4 Empirical Analysis

4.1 Data and Empirical Measurement

The key challenge in this study is in constructing the measures for imitative and innovative varieties. We employ a bottom-up approach by constructing the measures using disaggregated industrial data from the UNIDO database of INDSTAT-4 2016 Revision 3, down to the 4-digit level of ISIC. The validity of the measures therefore depends heavily on what ISICs constitute imitation and what are defined as innovative varieties. To minimize arbitrariness and to ensure robustness, six different pairs of imitative and innovative varieties are constructed. Two of these (*Innov1-Imit1* and *Innov2-Imit2*) are based on OECD's technology intensity classification of manufacturing industries, where the first pairing considers only the high-tech ISICs as innovative varieties while the second pairing includes both high- and medium-high tech ISICs as innovative varieties. One pair, *Innov3-Imit3*, is based on the primary industrial baskets of leading innovative economies as defined by the country ranking of *Global Innovation Index* (INSEAD 2017).[9] Finally, three pairs are based on an income-based

[8] See empirical studies in the area of international production networks, such as Athukorala and Hill (2010), for positive evidence, and studies such as Djankov and Hoekman (2000) for negative effects.

[9] This imitation-innovation pairing, *Innov3-Imit3*, is constructed by first identifying the top five ISICs (in terms of output value) respectively for the five most innovative economies in the world, as defined by the average rankings of the countries over 2013-17. These five economies are Singapore, Switzerland, Ireland, Slovakia, and Germany. These ISICs (down to 4-digit level) identified constitute innovative varieties, while the rest constitutes imitative varieties.

product sophistication index constructed based on a similar approach to the PRODY measure of Hausmann et al. (2007). Contrary to PRODY, our index is a production-based, weighted-average of the per capita GNIs of countries producing a given product variety, and so it represents the income level associated with said ISICs[10].

The constructed index ranks all the 4-digit ISICs along a continuum of income-based sophistication values, which then allows us to classify these ISICs using World Bank's 2013 income-level cut-off values in grouping countries by income level. Specifically, given that the per capita GNI numbers used in constructing the index are based on the Atlas method, we categorize the 4-digit ISICs to four groups: high-, upper-middle-, lower-middle, and low-income. After that, three innovation-imitation pairings are constructed: (i) *Innov4-Imit4*: only ISICs with high-income values are considered innovative, while only the ISICs with upper-middle-income values are considered imitation (dropping the rest); (ii) *Innov5-Imit5*: only ISICs with high-income values are considered innovative, but ISICS with both upper- and lower-middle-income values constitute imitation; and (iii) *Innov6-Imit6*: innovation includes ISICs with high- and upper-middle income values, and imitation constitutes the rest. Further descriptions of the six pairs of innovative-imitative variety measures, as well as the income-based industrial production sophistication index, are summarized in Appendix B.

For the benchmark analysis, the innovative and imitative varieties are proxied by the total value added of the ISIC at 4-digit level. In other words, we measure innovation and imitation using a bottom-up aggregate measure, assuming each 4-digit ISIC as a different type of product variety, with the respective values being the values of the variety types. For further robustness, for each of these six pairs, we repeat the same

[10] Specifically, for the index, the product sophistication level associated with an ISIC k is given by $\sum_j \frac{z_{jk}/Z_j}{\Sigma_j (z_{jk}/Z_j)} Y_j$, where z_{jk}/Z_j is the share of value-added of the product variety in a country j's overall production basket. The denominator aggregates these value shares across all the economies. As such, the weights correspond to a revealed comparative production strength of a country in variety k.

estimation exercise using two additional measures, which include the logarithm of output per employee and the logarithm of value added per employee. Strictly speaking, the two per worker measures are more productivity based measures than raw varieties. However, given the stationary nature of the variables, m_t^R and m_t^I in the dynamic system, the variety per worker measures do allow for some additional robustness checks to our benchmark estimation.

On the other variables, recall from (32) that public capital is a key explanatory variable whose determination is independent of the imitative and innovative varieties. To measure public capital, we use two indicators: (i) a direct use of the recently published public capital stock data from the International Monetary Fund (IMF), and (ii) all telephone (including cellular) lines. The former is by definition the stock of public capital, while the latter is a telecommunication based public infrastructure measure that is commonly used as a proxy for advanced infrastruture (see Röller and Waverman 2001; Esfahani and Ramírez 2003).[11]

In line with Ang and Madsen (2013, 2015a, 2015b) and related studies, we use the gross tertiary enrolment rate as a proxy for the skilled workforce in the two ideas production equations. While they capture knowledge spillovers through imports, given that our specification focuses on domestic industrial transformation, we use FDI inflows instead as a controlling variables. In the growth equation, in addition to the stock effects, we also model the flows effects for both innovation and imitation. The remaining controls are standard variables employed in cross-country growth regressions, drawn from sources such as the World Bank World Development Indicators, the various statistical databases of the International Monetary Fund, and the UNESCO database for

[11] There are also other indicators of public infrastructure that can be used as alternative measures, as discussed in Romp and de Haan (2007) and Straub (2008). However, the main coefficients of interest in this paper are not associated with the public capital measure. Moreoever, existing empirical studies show that the different measures tend to give similar elasticities. Extra robustness analysis for infrastructure is therefore not explored.

educational statistics. Further details on these variables are also presented in Appendix B.

Our data is an unbalanced panel, spanning 91 countries for the period 1990-2013, with a total of 1070 observations. However, for some countries, there are missing observations in between the years. The chosen time period is largely restricted by data availability in the INDSTAT-4 database. Following standard approach of growth regressions, we construct 3-year period averages (1990-92, 1993-95, ... , 2011-13) to minimize business cycle effects. While this leaves us with $T = 8$, the reasonably large N means we have a maximum sample size of 495 observations. However, in actual implementation, when the use of lags as instruments and the differencing in (33) are accounted for, this drops significantly to a range of 205-332 observations. We prioritize estimating equations (30)-(33) as a system. Given the disparity of INDSTAT-4 data across countries, the system-GMM approach of Blundell and Bond (1998) is applied in favour of the difference-GMM estimator, since the latter is susceptible to weak-instruments problem and is less efficient for data with many panels and few periods. In addition, given the importance of joint-estimation of a general equilibrium system, we also apply the three-stage-least-squares (3SLS) estimator, controlling for country and time fixed effects.

4.2 Empirical Implementation and Results

Benchmark: We start off by using total value added in the benchmark regressions, with the empirical results (for the six combination of variety and two public capital measures) presented in Table 1-3. For the system-GMM estimation, we treat the non-public capital control variables in the two ideas production equations as exogenous. This is mainly to address the "too many instruments" problem highlighted by Roodman (2009), where an excessive number of instruments can result in overfitting of the instrumented variables, therefore biasing the results. While the choice of the Blundell-Bond estimator does partly mitigate the weak-instruments problem associated with difference-GMM, we restrict the lagged variable used as instruments to one period. Further, we also apply the rule of thumb of Agénor and Neanidis (2015), where the number of instruments is less than the number of countries and subject the empirical model to various robustness tests. Since we use one-period lagged terms, the validity of the instruments can be verified indirectly by applying the Arellano and Bond (1991) test for serial correlation up to two lags. Further, the Hansen (1982) J-test of overidentifying restrictions is applied to check for the exogeneity of the instruments. A two-step estimator is applied, hence necessitating the use of the Windmeijer robust standard errors (Windmeijer 2005).

While the outlined strategy with respect to system-GMM estimation allows us to reduce the risk of potential over-identification causing biased estimates, the flip side is that the relatively restrictive criterion, coupled with the nature of an instrumented approach, means we have an increasing chance of poorly-fitting a model, hence obtaining statistically insignificant estimates. Indeed, this is the case when estimating the growth equation: Given the unit horizon of three-year averages, finding appropriate instruments is challenging as even the one-period lagged growth rate is unlikely to be an excellent choice. This is reflected in the relatively low p-values associated with the Hansen J-statistics calculated for some of the estimated growth equations. The use of 3SLS estimation therefore partly mitigates this problem by providing a complementary approach to the estimation (at a cost of not controlling for the lagged variables' endogeneity over time; which is not as much of a problem here given the objective is to estimate spillover effects that are inherently dynamic in nature).

Out of the 24 sets of results in the benchmark estimation, we observe statistically significant positive estimates for *standing-on-shoulder* effects in 21 of the estimated coefficients: average elasticity values of 0.725 and 0.744 for innovative and imitative varieties respectively (0.661 and 0.714 if we included the non-significant estimates). These are lower compared to the 0.99 estimated by Ang and Madsen (2015a) for single ideas production function. It is also worth noting that the estimated *standing-on-shoulder* effects based on the system-GMM approach are generally lower, which gives an average of 0.579 and 0.668 for innovation and imitation respectively.

In terms of the *stepping-stone* effect, all the estimates for the contemporaneous coefficient, α_2, are positive and statistically significant, at an average of 0.872. All but five estimates of the lagged term, α_3, are significant too, which together with the contemporaneous term, gives an estimated average *stepping-stone* effect of 0.255. However, if we were to consider only the statistically significant estimates, the average drops to 0.153. In addition, for a more dynamic context to the *stepping-stone* effect, the associated multiplier effect is also calculated, which yields an average of 0.948.[12] This shows that the long-run impact of imitative industrial expansion on the innovative industries is positive, with a one-percent increase in imitative variety believed to translate to just slightly below a one-percent increase in innovative variety over the long-run.

Next, for the spillover from innovation to imitation, dubbed as the "*creative-imitation*" effect, the contemporaneous effect is about 0.845; though after accounting for the lagged terms, we have an average *creative-imitation* effect of 0.210. This value is lower too if we included only the statistically significant estimates, which then yields an average of 0.139. A relatively smaller dynamic multiplier associated with the *creative-imitation* effect is also calculated at 0.650. The positive value indicates that

[12] This is calculated using the standard time series approach, where the estimated dynamic *stepping-stone* effect equals $(\hat{\alpha}_2 + \hat{\alpha}_3)/(1 - \hat{\alpha}_1)$. The value quoted is the average of the 12 values. Given the three-year averaging, this estimate is therefore valid in the context of a six-year period, covering the usual five-year horizon of most medium-term development plans in developing countries. Also, given that the estimated results are mostly free from second-order autocorrelations, the long-term elasticity should be close to the estimated figure too.

innovative variety expansion does have both short- and long-term positive externalities to the development of imitative industries.

For the other coefficients of interest, in the growth equation, the estimated coefficients for the stocks of imitative and innovative varieties are mostly negative. Nevertheless, the growth effects associated with the idea flows from innovative variety expansion ($\hat{\delta}_5$) are significantly positive. This corroborates the finding suggested in studies such as Dinopoulos and Thompson (1998) and Perez-Sebastian (2007) that it is the flow of knowledge that drives growth, not the stocks. Given that the overfitting risk of "too many instruments" is low with the estimated growth equation (as evidenced by the Hansen J-statistics being on the low side), this suggests that industrial variety expansion is a valid alternative source of innovation-driven growth. Lastly, in terms of the role of public capital on innovation and imitation, the empirical evidence associated with the relevant coefficients is mixed. Most benchmark estimates are insignificant, if not negative. This suggests that the strength of public capital stock in simultaneously driving both imitative and innovative industrial development, as implied in Agénor and Dinh (2013), may be overstated and will require further empirical investigation.

Robustness analysis: As mentioned, by design, the use of the six pairs of innovative-imitative variety measures is partly for robustness purposes. By construction, the OECD-based *Innov1-Imit1* measure, the income content-based *Innov4-Imit4* and *Innov5-Imit5* measures have a relatively strict interpretation as to what product variety constitutes innovation. On the other hand, the other OECD-based measure, *Innov2-Imit2*, and the income content-based pair of *Innov6-Imit6* have a broader definition to innovation, where products in the medium-high-tech industries (or industries with the sophistication content of upper-middle-income economies) are also classified as innovative varieties. Lastly, the *Innov3-Imit3* pair classifies industries solely based on their significance in the overall industrial production of the top five most innovative economies in the world. Overall, these different measures therefore implicitly allow for robustness checks of the estimated elasticities, regardless of how strictly innovation ought to be interpreted.

In this respect, we estimate the system again by using output per employee (Tables 4-6) and value added per employee as product variety measures (Tables 7-9), therefore also giving a conventional productivity interpretation to the variables. Adding the additional 48 sets of estimates to the benchmark and repeating the same calculation exercises yield overall average *standing-on-shoulder* effects of 0.587 and 0.606 for the innovative and imitative varieties respectively. While the benchmark results mostly hold for the different variations of the estimated system, it is important to note that the estimated standing-on-shoulder effects have much lower statistical significance when the per employee numbers are used with system-GMM approach. For instance, half of the estimated $\hat{\alpha}_1$ (12 out of the 24 estimated coefficients using system-GMM) are not significant at the ten-percent level. Moreover, when value added per employee is used as a proxy measure for the *Innov6-Imit6* combination in a system-GMM estimation, we get a contradicting result with respect to the estimated coefficients for the $\hat{\alpha}_1$ (see Table 9). The former reaffirms that Jones' (2005) *standing-on-shoulder* effect is a much weaker concept when the scale effect of ideas production is controlled for using per worker numbers. The latter indicates an inherent weakness in the definition of the *Innov6-Imit6* pairing, which classifies industrial varieties with both high- and upper-middle-income as innovation. This suggests a need to distinguish between the truly high-income content industrial varieties and the upper-middle income content varieties, given that the latter, as often suggested in the middle-income traps literature, is likely to consist of industries with imitation in nature.[13] Taking the insignificance into

[13] See Gill and Kharas (2007), Eichengreen et al. (2014), and Agénor (2017) for studies specifically on the middle-income traps.

consideration, we re-calculate the overall average with only the significant estimates (57 out of 72), which yields *standing-on-shoulder* effects of 0.681 and 0.700 for the innovative and imitative varieties respectively.

For the *stepping-stone* effect, the estimated average is now 0.340 while the dynamic multiplier effect associated with it is 0.921. While all the estimates for the contemporaneous term are significant, about one-third of the estimates for the lagged term are not. While this is good news for the validity of our approach in calculating the dynamic multiplier, this requires us to re-calculate and present the *stepping-stone* effect with the two-thirds of the estimated coefficients that are statistically significant: 0.187, which is within the range of our benchmark estimate earlier. Similarly, the dynamic multiplier effect with only significant estimates is 0.963, which is close to the benchmark averages. These suggest that, unlike the *standing-on-shoulder* effects, the *stepping-stone* effects are independent of the scale effect.

We face similar issues with the robustness analysis for β_1 and β_2, though we still have a representative set to support the empirical validity of the positive *creative-imitation* effects from innovative varieties to imitation. Overall, based on two-thirds of the estimated coefficients that are statistically significant (both $\hat{\beta}_1$and $\hat{\beta}_2$ need to be significant), the *creative-imitation* effect has an average value of 0.137, with the associated dynamic multiplier being 0.762, much lower than the corresponding value associated with the *stepping-stone* effect. Nevertheless, the obtained estimates reinforce the benchmark finding that innovative and imitative varieties are complements in an industrial development context.

On the other estimates, the estimated positive coefficient for the ideas flow of innovation remains robust in the growth equation with per worker numbers, though not for imitation flows. While we still do not find a conclusive result for the impact of public capital, it is worth pointing out that, when the advanced infrastructure measure of phone lines is used, the positive effects of public capital on innovative variety and growth per capita become a lot more significant. This is especially when the system-GMM approach is applied, suggesting that the positive productivity effect of public capital depends on the specific type of public infrastructure.

In addition to the two public capital measures considered, we also repeat the same estimation exercises using the infrastructure quality-measure of non-hydropower, renewable energy-generated electricity. This measure is akin to public infrastructure stocks with codified knowledge, believed to correlate well with the progression of ideas in an economy (Agénor and Neanidis 2015). To save space, the full set of estimation results with this measure can be referred to Tables B3-B8 in Appendix B. Overall, the estimated spillover effects between imitative and innovative varieties remain robust. For example, the averages of the *standing-on-shoulder* effects for innovative and imitative varieties remain in the 0.6 range. Some of the limitations in the preceding analysis, namely the lower statistical significance associated with system-GMM estimation and the shortcoming of the *Innov6-Imit6* pairing, are observed too. Indeed, in terms of the coefficients associated with public capital, the strength of the infrastructure effect on innovative varieties is much weaker compared to when telecommunication variable is used as proxy. Overall, the additional analysis here reinforces the robustness of the estimated results obtained in the previous sections.

Comparing across different stages of development: Lastly, a common practice in growth regression is to repeat the same estimation exercises using annual intervals, mainly to extend the number of observations at the cost of not controlling for business cycle effects. We implement this strategy in order to estimate the model across three different samples: high-income, upper-middle-income, and low-and-lower-middle-income economies. The estimation by different country groupings is meaningful and in consistent with studies such as Perez-Sebastian (2007), who documents that imitation tends to play a more important role in emerging economies before it is gradually phased out by innovation as an economy develops. For this particular exercise, the sample size of the low-and-lower-middle-income economies is particularly restrictive. The econometric estimation implemented therefore uses only the total value added data and public capital stock as proxies in estimating all six variants of the product variety specification. Moreover, given the annual interval, the dynamic multiplier becomes a meaningless measure without implementing a full time-series analysis, and is therefore omitted from this exercise.

Given the two different estimation procedures employed, for all three country-groups, we obtain 12 sets of estimates. The averages for the key estimated coefficients of interest are summarized in Table 10. As we have relatively few observations to estimate the model for the low-and-lower-middle-income group, an interpretation of estimates for this particular group requires caution. For all three groups, all the estimated *standing-on-shoulder* effects are statistically significant. However, the lower income group has much smaller estimated *standing-on-shoulder* effects compared to the other two groups, and there is no positive knowledge spillover mechanism between the two variety types. In comparing the upper-middle-income economy and the high-income economy, the former has a much significant *stepping-stone* effect, though the latter registers a slightly higher elasticity value of within-variety spillover from the existing knowledge stock for both imitative and innovative varieties.

Overall, these results are largely consistent with the present state of understanding of industrial policy in developing economies. For less-developed economies with inadequate industrial structures, the focus of industrial policy ought to be one that promotes development within-industry, and when necessary, protectionist measures may be warranted due to the negative spillover effects–albeit with limited statistical significance–

observed across product varieties. On the other hand, for an upper-middle-income economy, growth policies need to be designed in maximizing the inter-knowledge spillover among product varieties in the economy, as the development of imitative varieties remains significant in promoting the eventual expansion of innovative varieties. For a high-income economy, interestingly, the *stepping-stone* effect of imitative varieties is positive, and the *standing-on-shoulder* effect for imitative varieties remains robust. This suggests that an across-the-board industrial development strategy remains significant as the relationship between imitation and innovation is largely complementary.

5 Conclusion

The main purpose of this paper is to fill a gap in the economic growth literature where empirical estimation of commonly used theoretical concepts associated with Romerian and Jones type of ideas-based growth models, such as the "*standing-on-shoulder*" and "*stepping-stone*" effects, is scarce. The present empirical literature is predominantly based on a Schumpeterian interpretation to innovation, with an existing bias in relegating expanding variety to merely being imitation activities. Using highly disaggregated industrial data as measures for product varieties, we test for the relationship between imitation and innovation in a dynamic general equilibrium setup. Consistent with the single ideas production function-based findings of Ang and Madsen (2015a), we document robust and statistically significant *standing-on-shoulder* effects for both innovation and imitation, albeit at lower elasticities. We also document a significant *stepping-stone* effect of imitation on innovation, a key finding that has provided empirical validity to the implicit assumptions made in the many theoretical studies such as Glass and Saggi (1998) and Collins (2015). Based on our knowledge, our study is the first to empirically estimate the *stepping-stone* effect, as well as its associated dynamic multiplier effect over a medium-term horizon of 5-6 years. This has significant implication for the industrial plans, which typically cover about 5 years, in many developing countries.

The corresponding spillover from innovation to imitation, dubbed as the *creative-imitation* effect, is found to be positive too, though at a slightly lower magnitude than the *stepping-stone* effect. In the growth regression, we also find significant positive effects of the change in innovative varieties on per capita GDP growth. This reaffirms the need to treat product variety expansion as an alternative source of innovation-driven growth. These findings have important implications for industrial policies designed to foster innovation-driven growth, especially in middle-income and developing economies.

Given that the empirical implementation in this paper is largely conditioned by data availability, there are obvious improvements that can be implemented as more cross-country disaggregated industrial data becomes available in future. In terms of the theoretical specification, the model setup here neither explicitly accounts for the different types of foreign investment in a host economy, nor the effects of inter-industrial trade within an economy. Prior to this study, most of these elements are modelled in the niche area of computational general equilibrium (CGE) studies. The rich information on highly disaggregated industrial production—hence the different product varieties—often contained in input-output tables and specialized manufacturing surveys, could allow for a more elaborate empirical examinations based on rigorous theoretical growth models of variety expansion-based growth, such as one that includes intra- and inter-industry trades, at cross-country level are potential venues for future research. In terms of empirical setup, the use of a threshold model, such as Caner and Hansen (2004), to examine for any potential threshold associated with the spillover effects is also a worthy exercise to pursue in the future.

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Table 1: Benchmark Results, where total value added are used as product variety measures

	Innov1 & Imit1, with IMF public capital stock measure								*Innov1 & Imit1, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.078	0.908	1.127	-4.128	-0.632	0.542	1.037	-0.106	-0.271	0.040	1.072	2.629	-2.421	1.952	0.913	1.782
	(0.915)	(0.573)	(0.000)	(0.585)	(0.001)	(0.002)	(0.000)	(0.874)	(0.584)	(0.955)	(0.000)	(0.444)	(0.000)	(0.000)	(0.000)	(0.202)
Innovation, t (log)		0.959		-3.360		0.886		-0.405		0.913		-2.319		0.959		-0.397
		(0.000)		(0.079)		(0.000)		(0.000)		(0.000)		(0.157)		(0.000)		(0.000)
Innovation, t-1 (log)	0.539	-0.402			0.865	-0.767			0.780	-0.697			0.941	-0.905		
	(0.000)	(0.001)			(0.000)	(0.000)			(0.000)	(0.002)			(0.000)	(0.000)		
Imitation, t (log)	0.477			1.682	0.943			-0.195	0.684			-0.370	0.959			-0.170
	(0.014)			(0.403)	(0.000)			(0.160)	(0.000)			(0.852)	(0.000)			(0.209)
Imitation, t-1 (log)	-0.389	0.348			-0.819	0.854			-0.569	0.614			-0.785	0.823		
	(0.032)	(0.001)			(0.000)	(0.000)			(0.029)	(0.051)			(0.000)	(0.000)		
Public capital (log)	0.304	-0.874		6.391	0.601	-0.484		0.721	0.655	-0.405		1.954	2.534	-2.010		-1.294
	(0.581)	(0.474)		(0.186)	(0.002)	(0.008)		(0.294)	(0.042)	(0.364)		(0.184)	(0.000)	(0.000)		(0.380)
FDI	0.020	0.004			0.000	0.001			0.001	0.013			-0.002	0.002		
	(0.104)	(0.839)			(0.903)	(0.675)			(0.964)	(0.239)			(0.188)	(0.104)		
Skilled workforce	0.020	0.002			0.003	-0.002			-0.003	0.023			0.001	0.000		
	(0.424)	(0.928)			(0.184)	(0.329)			(0.806)	(0.261)			(0.612)	(0.870)		
Gov. expenditure	0.040	-0.059	-0.016		0.028	-0.025	-0.006		0.069	-0.122	0.053		0.036	-0.035	-0.001	
	(0.562)	(0.263)	(0.479)		(0.009)	(0.012)	(0.484)		(0.149)	(0.002)	(0.494)		(0.008)	(0.002)	(0.889)	
Non-tax revenue	0.078	-0.086	0.012		-0.010	0.009	0.007		0.118	-0.086	-0.040		-0.009	0.009	0.001	
	(0.459)	(0.279)	(0.216)		(0.087)	(0.117)	(0.140)		(0.207)	(0.132)	(0.424)		(0.208)	(0.146)	(0.780)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.788)	
Urban			-0.004				-0.002				0.000				-0.003	
			(0.708)				(0.275)				(0.978)				(0.031)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.398)				(0.490)				(0.287)	
Current account balance			-0.002				0.003				0.029				-0.003	
			(0.845)				(0.518)				(0.324)				(0.407)	
Trade				0.098				0.006				0.108				0.007
				(0.014)				(0.134)				(0.021)				(0.082)
Investment				0.060				0.204				-0.203				0.184
				(0.717)				(0.000)				(0.114)				(0.000)
Inflation				-0.047				-0.004				0.033				-0.001
				(0.398)				(0.828)				(0.350)				(0.952)
D.Innovation [t - t-1]				3.553				0.751				2.368				0.576
				(0.034)				(0.003)				(0.149)				(0.082)
D.Imitation [t - t-1]				0.031				1.136				1.908				1.281
				(0.982)				(0.000)				(0.139)				(0.000)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	68/235	68/235	94/403	80/309	69/236	69/236	69/236	69/236	66/220	66/220	88/369	73/282	67/221	67/221	67/221	67/221
R^2					0.963	0.944	0.943	0.412					0.871	0.843	0.939	0.280
Number of Instruments	37	37	46	42					32	32	39	34				
Hansen J-statistics (p-value)	0.779	0.394	0.859	0.690					0.832	0.760	0.185	0.192				
AR(2) test (p-value)	0.210	0.407	0.149	0.122					0.703	0.511	0.105	0.211				

	Innov2 & Imit2, with IMF public capital stock measure								*Innov2 & Imit2, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.980	0.546	1.127	-3.984	-0.754	0.660	1.020	0.143	0.365	0.310	1.072	-2.501	1.803	-1.546	0.920	2.731
	(0.666)	(0.682)	(0.000)	(0.423)	(0.003)	(0.000)	(0.000)	(0.841)	(0.666)	(0.528)	(0.000)	(0.570)	(0.000)	(0.000)	(0.000)	(0.060)
Innovation, t (log)		0.567		0.995		0.619		-0.143		0.577		-0.384		0.678		-0.140
		(0.001)		(0.449)		(0.000)		(0.211)		(0.004)		(0.840)		(0.000)		(0.228)
Innovation, t-1 (log)	0.197	-0.302			0.789	-0.483			0.850	-0.599			0.861	-0.581		
	(0.478)	(0.099)			(0.000)	(0.000)			(0.011)	(0.062)			(0.000)	(0.000)		
Imitation, t (log)	1.054			-3.527	1.319			-0.497	1.066			-1.858	1.335			-0.440
	(0.000)			(0.005)	(0.000)			(0.016)	(0.000)			(0.563)	(0.000)			(0.060)
Imitation, t-1 (log)	-0.114	0.383			-0.905	0.679			-0.872	0.589			-1.090	0.811		
	(0.855)	(0.036)			(0.000)	(0.000)			(0.034)	(0.104)			(0.000)	(0.000)		
Public capital (log)	1.021	-0.319		4.360	0.574	-0.486		0.411	-0.660	-0.026		3.940	-2.052	1.767		-2.433
	(0.523)	(0.803)		(0.357)	(0.027)	(0.008)		(0.544)	(0.182)	(0.930)		(0.136)	(0.000)	(0.000)		(0.106)
FDI	0.041	-0.002			0.001	0.001			0.026	0.006			0.001	0.000		
	(0.408)	(0.852)			(0.454)	(0.282)			(0.181)	(0.570)			(0.701)	(0.915)		
Skilled workforce	0.007	0.010			0.001	0.000			0.018	0.017			0.000	0.000		
	(0.766)	(0.284)			(0.640)	(0.851)			(0.509)	(0.176)			(0.961)	(0.830)		
Gov. expenditure	0.066	-0.065	-0.016		0.002	-0.002	-0.005		0.007	-0.071	0.053		-0.007	0.004	0.000	
	(0.621)	(0.136)	(0.479)		(0.869)	(0.855)	(0.546)		(0.956)	(0.132)	(0.494)		(0.609)	(0.703)	(0.966)	
Non-tax revenue	0.037	-0.008	0.012		-0.002	0.002	0.005		0.065	-0.007	-0.040		-0.002	0.002	0.000	
	(0.845)	(0.920)	(0.216)		(0.772)	(0.690)	(0.265)		(0.301)	(0.926)	(0.424)		(0.775)	(0.742)	(0.921)	
Gov. debt			0.006				0.004				-0.020				-0.001	
			(0.016)				(0.000)				(0.059)				(0.294)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.369)				(0.978)				(0.464)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.563)				(0.490)				(0.659)	
Current account balance			-0.002				0.008				0.029				-0.005	
			(0.845)				(0.099)				(0.324)				(0.167)	
Trade				0.038				0.002				0.050				0.002
				(0.171)				(0.600)				(0.455)				(0.668)
Investment				0.221				0.205				-0.068				0.194
				(0.521)				(0.000)				(0.807)				(0.000)
Inflation				-0.063				-0.008				0.027				0.001
				(0.273)				(0.574)				(0.490)				(0.957)
D.Innovation [t - t-1]				1.046				0.316				6.039				0.059
				(0.281)				(0.126)				(0.070)				(0.822)
D.Imitation [t - t-1]				2.553				1.905				-2.472				2.307
				(0.106)				(0.000)				(0.469)				(0.000)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/243	72/243	94/403	85/329	72/243	72/243	72/243	72/243	68/225	68/225	88/369	78/295	68/226	68/226	68/226	68/226
R^2					0.943	0.953	0.941	0.419					0.877	0.874	0.939	0.140
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.555	0.697	0.859	0.434					0.356	0.676	0.185	0.167				
AR(2) test (p-value)	0.165	0.223	0.149	0.106					0.701	0.528	0.105	0.754				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 2: Benchmark Results, where total value added are used as product variety measures (cont.)

	Innov3 & Imit3, with IMF public capital stock measure								*Innov3 & Imit3, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.025	0.210	1.127	-2.663	0.846	-0.772	1.023	0.188	-0.572	0.083	1.072	-0.903	-1.850	1.555	0.917	2.149
	(0.981)	(0.834)	(0.000)	(0.192)	(0.000)	(0.000)	(0.000)	(0.787)	(0.613)	(0.844)	(0.000)	(0.867)	(0.000)	(0.000)	(0.000)	(0.112)
Innovation, t (log)		0.967		0.164		1.015		-0.467		0.720		-1.946		1.130		-0.293
		(0.000)		(0.854)		(0.000)		(0.002)		(0.000)		(0.579)		(0.000)		(0.045)
Innovation, t-1 (log)	0.371	-0.237			0.833	-0.871			0.796	-0.733			0.864	-0.984		
	(0.090)	(0.262)			(0.000)	(0.000)			(0.001)	(0.024)			(0.000)	(0.000)		
Imitation, t (log)	0.487			1.264	0.789			-0.149	0.649			0.053	0.791			-0.185
	(0.013)			(0.158)	(0.000)			(0.296)	(0.000)			(0.990)	(0.000)			(0.161)
Imitation, t-1 (log)	-0.164	0.384			-0.640	0.816			-0.572	0.978			-0.670	0.849		
	(0.375)	(0.101)			(0.000)	(0.000)			(0.006)	(0.000)			(0.000)	(0.000)		
Public capital (log)	0.349	-0.540		2.746	-0.762	0.746		0.371	0.197	-0.381		3.280	2.060	-1.718		-1.874
	(0.680)	(0.609)		(0.663)	(0.000)	(0.001)		(0.584)	(0.467)	(0.348)		(0.255)	(0.000)	(0.000)		(0.204)
FDI	0.015	0.001			0.000	0.000			0.007	0.014			-0.001	0.001		
	(0.180)	(0.908)			(0.715)	(0.975)			(0.614)	(0.422)			(0.367)	(0.231)		
Skilled workforce	0.032	-0.016			-0.001	0.002			0.010	0.026			0.001	-0.001		
	(0.009)	(0.517)			(0.598)	(0.417)			(0.543)	(0.249)			(0.538)	(0.790)		
Gov. expenditure	0.004	-0.081	-0.016		0.019	-0.022	-0.005		-0.031	-0.095	0.053		0.014	-0.018	0.001	
	(0.946)	(0.522)	(0.479)		(0.041)	(0.033)	(0.582)		(0.715)	(0.265)	(0.494)		(0.199)	(0.088)	(0.934)	
Non-tax revenue	-0.030	0.055	0.012		-0.007	0.008	0.004		-0.003	0.026	-0.040		-0.007	0.009	0.000	
	(0.508)	(0.279)	(0.216)		(0.208)	(0.173)	(0.338)		(0.931)	(0.550)	(0.424)		(0.226)	(0.098)	(0.987)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.651)	
Urban			-0.004				-0.001				0.000				-0.002	
			(0.708)				(0.521)				(0.978)				(0.214)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.159)				(0.490)				(0.226)	
Current account balance			-0.002				0.005				0.029				-0.001	
			(0.845)				(0.273)				(0.324)				(0.682)	
Trade				0.067				0.002				0.086				0.003
				(0.256)				(0.555)				(0.170)				(0.430)
Investment				0.220				0.204				-0.026				0.177
				(0.335)				(0.000)				(0.926)				(0.000)
Inflation				-0.017				-0.007				0.008				0.004
				(0.798)				(0.653)				(0.917)				(0.779)
D.Innovation [t - t-1]				0.186				1.335				0.536				2.063
				(0.746)				(0.000)				(0.878)				(0.000)
D.Imitation [t - t-1]				0.657				0.784				2.945				0.269
				(0.150)				(0.002)				(0.401)				(0.328)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/245	72/245	94/403	87/333	73/246	73/246	73/246	73/246	68/227	68/227	88/369	79/298	69/228	69/228	69/228	69/228
R^2					0.952	0.925	0.942	0.416					0.879	0.870	0.939	0.233
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.703	0.625	0.859	0.508					0.631	0.176	0.185	0.196				
AR(2) test (p-value)	0.427	0.359	0.149	0.158					0.156	0.258	0.105	0.173				

	Innov4 & Imit4, with IMF public capital stock measure								*Innov4 & Imit4, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.442	-0.181	1.127	7.149	0.545	-0.266	1.019	0.256	0.366	-0.330	1.072	-1.994	-1.679	1.153	0.920	1.620
	(0.645)	(0.883)	(0.000)	(0.130)	(0.016)	(0.197)	(0.000)	(0.716)	(0.107)	(0.518)	(0.000)	(0.593)	(0.000)	(0.000)	(0.000)	(0.242)
Innovation, t (log)		0.651		-4.102		0.781		-0.452		0.687		-5.278		0.921		-0.251
		(0.000)		(0.065)		(0.000)		(0.010)		(0.000)		(0.130)		(0.000)		(0.151)
Innovation, t-1 (log)	0.424	-0.309			0.731	-0.604			0.592	-0.718			0.822	-0.771		
	(0.072)	(0.141)			(0.000)	(0.000)			(0.002)	(0.000)			(0.000)	(0.000)		
Imitation, t (log)	0.870			0.797	0.914			-0.198	0.902			3.956	0.947			-0.250
	(0.000)			(0.733)	(0.000)			(0.198)	(0.000)			(0.228)	(0.000)			(0.081)
Imitation, t-1 (log)	-0.550	0.582			-0.699	0.782			-0.844	1.086			-0.772	0.823		
	(0.071)	(0.039)			(0.000)	(0.000)			(0.000)	(0.000)			(0.000)	(0.000)		
Public capital (log)	-0.073	-0.019		-3.573	-0.407	0.243		0.314	0.131	0.042		4.939	1.883	-1.273		-1.319
	(0.928)	(0.984)		(0.262)	(0.091)	(0.264)		(0.641)	(0.491)	(0.904)		(0.054)	(0.000)	(0.000)		(0.374)
FDI	0.002	0.009			0.000	0.001			0.006	0.004			-0.001	0.001		
	(0.895)	(0.542)			(0.881)	(0.492)			(0.623)	(0.809)			(0.331)	(0.168)		
Skilled workforce	0.004	0.005			0.000	0.001			0.008	0.005			0.000	0.001		
	(0.665)	(0.720)			(0.865)	(0.737)			(0.426)	(0.729)			(0.963)	(0.674)		
Gov. expenditure	0.010	-0.059	-0.016		0.010	-0.011	-0.004		0.007	-0.102	0.053		0.002	-0.003	-0.001	
	(0.898)	(0.327)	(0.479)		(0.343)	(0.251)	(0.612)		(0.890)	(0.422)	(0.494)		(0.862)	(0.732)	(0.887)	
Non-tax revenue	0.005	0.008	0.012		-0.001	0.002	0.005		0.001	0.037	-0.040		0.003	-0.002	0.001	
	(0.940)	(0.916)	(0.216)		(0.841)	(0.734)	(0.334)		(0.976)	(0.497)	(0.424)		(0.625)	(0.640)	(0.884)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.465)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.381)				(0.978)				(0.296)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.270)				(0.490)				(0.488)	
Current account balance			-0.002				0.007				0.029				-0.005	
			(0.845)				(0.123)				(0.324)				(0.137)	
Trade				0.048				0.002				0.094				0.003
				(0.269)				(0.642)				(0.082)				(0.515)
Investment				0.117				0.208				-0.112				0.178
				(0.531)				(0.000)				(0.652)				(0.000)
Inflation				0.009				-0.005				0.064				0.005
				(0.883)				(0.748)				(0.324)				(0.735)
D.Innovation [t - t-1]				2.890				0.980				1.315				1.645
				(0.016)				(0.000)				(0.704)				(0.000)
D.Imitation [t - t-1]				1.495				1.147				1.510				0.560
				(0.000)				(0.000)				(0.689)				(0.056)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/245	72/245	94/403	86/330	73/246	73/246	73/246	73/246	68/227	68/227	88/369	78/297	69/228	69/228	69/228	69/228
R^2					0.946	0.944	0.942	0.422					0.884	0.909	0.940	0.309
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.220	0.669	0.859	0.234					0.558	0.474	0.185	0.179				
AR(2) test (p-value)	0.377	0.126	0.149	0.130					0.597	0.284	0.105	0.537				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 3: Benchmark Results, where total value added are used as product variety measures (cont.)

	Innov5 & Imit5, with IMF public capital stock measure								*Innov5 & Imit5, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.334	-0.405	1.127	6.512	0.938	-0.772	1.024	0.136	0.133	0.137	1.072	-2.411	-1.611	1.121	0.920	2.119
	(0.779)	(0.723)	(0.000)	(0.021)	(0.000)	(0.000)	(0.000)	(0.848)	(0.521)	(0.785)	(0.000)	(0.489)	(0.000)	(0.000)	(0.000)	(0.131)
Innovation, t (log)		0.663		-3.577		0.822		-0.465		0.720		-4.400		0.947		-0.275
		(0.000)		(0.049)		(0.000)		(0.007)		(0.000)		(0.220)		(0.000)		(0.112)
Innovation, t-1 (log)	0.325	-0.313			0.767	-0.655			0.537	-0.685			0.826	-0.794		
	(0.096)	(0.201)			(0.000)	(0.000)			(0.021)	(0.013)			(0.000)	(0.000)		
Imitation, t (log)	0.626			0.225	0.943			-0.204	0.840			3.119	0.938			-0.242
	(0.004)			(0.905)	(0.000)			(0.209)	(0.000)			(0.407)	(0.000)			(0.108)
Imitation, t-1 (log)	-0.376	0.627			-0.718	0.771			-0.656	0.918			-0.767	0.824		
	(0.137)	(0.035)			(0.000)	(0.000)			(0.000)	(0.000)			(0.000)	(0.000)		
Public capital (log)	0.149	0.163		-2.892	-0.841	0.729		0.453	0.288	-0.415		4.701	1.801	-1.235		-1.846
	(0.874)	(0.852)		(0.286)	(0.001)	(0.001)		(0.510)	(0.272)	(0.279)		(0.056)	(0.000)	(0.000)		(0.219)
FDI	0.005	0.011			0.000	0.000			0.002	0.013			-0.001	0.001		
	(0.728)	(0.437)			(0.887)	(0.724)			(0.881)	(0.339)			(0.389)	(0.212)		
Skilled workforce	0.010	0.003			-0.002	0.002			0.006	0.019			0.000	0.001		
	(0.329)	(0.859)			(0.535)	(0.309)			(0.581)	(0.327)			(0.959)	(0.719)		
Gov. expenditure	-0.022	-0.050	-0.016		0.009	-0.009	-0.005		0.012	-0.102	0.053		0.001	-0.002	-0.001	
	(0.644)	(0.464)	(0.479)		(0.390)	(0.342)	(0.594)		(0.861)	(0.292)	(0.494)		(0.938)	(0.814)	(0.927)	
Non-tax revenue	0.033	0.039	0.012		0.001	-0.001	0.005		-0.014	0.044	-0.040		0.002	-0.002	0.001	
	(0.361)	(0.485)	(0.216)		(0.845)	(0.888)	(0.291)		(0.725)	(0.456)	(0.424)		(0.695)	(0.721)	(0.875)	
Gov. debt			0.006				0.003				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.499)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.373)				(0.978)				(0.403)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.546)				(0.490)				(0.583)	
Current account balance			-0.002				0.005				0.029				-0.005	
			(0.845)				(0.232)				(0.324)				(0.119)	
Trade				0.050				0.001				0.092				0.002
				(0236)				(0.715)				(0.090)				(0.634)
Investment				0.127				0.208				-0.079				0.185
				(0.487)				(0.000)				(0.778)				(0.000)
Inflation				0.010				-0.005				0.063				0.004
				(0.880)				(0.737)				(0.391)				(0.775)
D.Innovation [t - t-1]				2.772				1.036				0.954				1.758
				(0.011)				(0.000)				(0.803)				(0.000)
D.Imitation [t - t-1]				1.441				1.043				1.676				0.441
				(0.003)				(0.002)				(0.698)				(0.136)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/245	72/245	94/403	86/330	73/246	73/246	73/246	73/246	68/227	68/227	88/369	78/297	69/228	69/228	69/228	69/228
R^2					0.934	0.930	0.942	0.411					0.893	0.915	0.940	0.236
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.302	0.297	0.859	0.226					0.363	0.390	0.185	0.148				
AR(2) test (p-value)	0.261	0.175	0.149	0.108					0.960	0.348	0.105	0.356				

	Innov6 & Imit6, with IMF public capital stock measure								*Innov6 & Imit6, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.324	0.368	1.127	-2.448	1.648	-2.055	1.048	-1.293	-0.132	-0.134	1.072	-6.400	0.636	-0.995	0.927	0.124
	(0.700)	(0.820)	(0.000)	(0.694)	(0.000)	(0.000)	(0.000)	(0.064)	(0.755)	(0.898)	(0.000)	(0.140)	(0.000)	(0.000)	(0.000)	(0.933)
Innovation, t (log)		0.983		0.313		1.077		-0.103		0.956		-0.607		1.089		-0.186
		(0.000)		(0.887)		(0.000)		(0.517)		(0.000)		(0..866)		(0.000)		(0.247)
Innovation, t-1 (log)	0.364	-0.606			0.867	-0.942			0.065	-0.356			0.853	-0.925		
	(0.215)	(0.117)			(0.000)	(0.000)			(0.844)	(0.540)			(0.000)	(0.000)		
Imitation, t (log)	0.807			-1.657	0.861			-0.495	0.890			0.607	0.833			-0.266
	(0.000)			(0.372)	(0.000)			(0.002)	(0.000)			(0.767)	(0.000)			(0.163)
Imitation, t-1 (log)	-0.338	0.556			-0.620	0.719			-0.157	0.476			-0.724	0.855		
	(0.173)	(0.130)			(0.000)	(0.000)			(0.590)	(0.055)			(0.000)	(0.000)		
Public capital (log)	-0.322	-0.048		2.452	-1.713	2.141		1.689	0.168	0.056		5.460	-0.674	1.089		0.234
	(0.663)	(0.964)		(0.541)	(0.000)	(0.000)		(0.016)	(0.472)	(0.900)		(0.007)	(0.000)	(0.000)		(0.878)
FDI	0.012	-0.001			0.002	-0.003			0.009	-0.003			0.001	-0.001		
	(0.655)	(0.965)			(0.030)	(0.052)			(0.675)	(0.878)			(0.241)	(0.456)		
Skilled workforce	0.028	-0.022			-0.006	0.008			0.009	-0.007			0.002	-0.001		
	(0.204)	(0.540)			(0.002)	(0.001)			(0.608)	(0.797)			(0.296)	(0.478)		
Gov. expenditure	-0.109	0.091	-0.016		-0.032	0.039	-0.006		-0.067	0.051	0.053		-0.017	0.020	-0.002	
	(0.372)	(0.470)	(0.479)		(0.002)	(0.002)	(0.488)		(0.567)	(0.409)	(0.494)		(0.040)	(0.068)	(0.803)	
Non-tax revenue	-0.071	0.089	0.012		0.014	-0.018	0.009		-0.062	0.057	-0.040		-0.007	0.008	0.001	
	(0.285)	(0.421)	(0.216)		(0.024)	(0.019)	(0.073)		(0.343)	(0.709)	(0.424)		(0.143)	(0.163)	(0.828)	
Gov. debt			0.006				0.001				-0.020				0.000	
			(0.016)				(0.233)				(0.059)				(0.903)	
Urban			-0.004				-0.002				0.000				-0.003	
			(0.708)				(0.129)				(0.978)				(0.082)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.282)				(0.490)				(0.162)	
Current account balance			-0.002				0.001				0.029				-0.012	
			(0.845)				(0.800)				(0.324)				(0.002)	
Trade				0.026				0.001				0.981				0.004
				(0.351)				(0.740)				(0.111)				(0.373)
Investment				0.272				0.212				-0.118				0.173
				(0.163)				(0.000)				(0.592)				(0.000)
Inflation				-0.031				-0.006				0.063				0.004
				(0.623)				(0.716)				(0.461)				(0.790)
D.Innovation [t - t-1]				2.866				2.129				5.091				1.886
				(0.102)				(0.000)				(0.183)				(0.000)
D.Imitation [t - t-1]				0.454				-0.038				-3.824				0.091
				(0.817)				(0.889)				(0.169)				(0.795)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	68/236	68/236	94/403	83/316	69/237	69/237	69/237	69/237	65/220	65/220	88/369	76/284	66/221	66/221	66/221	66/221
R^2					0.866	0.848	0.940	0.307					0.951	0.939	0.941	0.418
Number of Instruments	37	37	46	42					32	32	39	34				
Hansen J-statistics (p-value)	0.434	0.149	0.859	0.130					0.628	0.600	0.185	0.308				
AR(2) test (p-value)	0.885	0.382	0.149	0.272					0.291	0.482	0.105	0.306				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 4: Benchmark Results, where output per employee are used as product variety measures

	Innov1 & Imit1, with IMF public capital stock measure								*Innov1 & Imit1, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.076	0.025	1.127	2.902	2.086	-1.806	1.050	-0.906	-0.392	0.475	1.072	-2.742	-0.261	-0.509	0.924	2.570
	(0.938)	(0.962)	(0.000)	(0.536)	(0.000)	(0.388)	(0.000)	(0.243)	(0.254)	(0.302)	(0.000)	(0.108)	(0.246)	(0.032)	(0.000)	(0.151)
Innovation, t (log)		0.779		-0.763		0.934		-0.321		0.987		-1.055		0.978		-0.394
		(0.000)		(0.570)		(0.000)		(0.144)		(0.000)		(0.621)		(0.000)		(0.159)
Innovation, t-1 (log)	0.722	-0.546			0.718	-0.668			0.397	-0.478			0.783	-0.758		
	(0.042)	(0.000)			(0.000)	(0.000)			(0.303)	(0.118)			(0.000)	(0.000)		
Imitation, t (log)	1.041			-1.477	1.025			-0.475	0.786			-1.536	0.911			-0.398
	(0.000)			(0.398)	(0.000)			(0.062)	(0.000)			(0.484)	(0.000)			(0.162)
Imitation, t-1 (log)	-0.447	0.427			-0.656	0.662			-0.225	0.329			-0.749	0.803		
	(0.234)	(0.065)			(0.000)	(0.000)			(0.498)	(0.289)			(0.000)	(0.000)		
Public capital (log)	-0.082	0.159		-4.018	-2.013	1.751		1.013	0.323	-0.317		2.610	0.295	0.560		-2.645
	(0.921)	(0.694)		(0.251)	(0.000)	(0.000)		(0.169)	(0.358)	(0.509)		(0.137)	(0.236)	(0.033)		(0.178)
FDI	0.005	-0.004			0.002	-0.002			0.010	-0.013			0.000	0.000		
	(0.768)	(0.722)			(0.054)	(0.042)			(0.388)	(0.390)			(0.747)	(0.716)		
Skilled workforce	-0.004	0.004			-0.008	0.008			0.004	0.002			-0.001	0.001		
	(0.751)	(0.648)			(0.000)	(0.000)			(0.776)	(0.908)			(0.552)	(0.463)		
Gov. expenditure	-0.003	0.016	-0.016		0.019	-0.017	-0.004		0.070	-0.070	0.053		0.017	-0.019	0.003	
	(0.980)	(0.837)	(0.479)		(0.129)	(0.124)	(0.651)		(0.194)	(0.334)	(0.494)		(0.069)	(0.064)	(0.699)	
Non-tax revenue	0.009	-0.014	0.012		0.019	-0.018	0.006		0.023	-0.025	-0.040		0.005	-0.001	-0.002	
	(0.854)	(0.366)	(0.216)		(0.006)	(0.005)	(0.212)		(0.281)	(0.328)	(0.424)		(0.330)	(0.823)	(0.656)	
Gov. debt			0.006				0.001				-0.020				0.000	
			(0.016)				(0.146)				(0.059)				(0.896)	
Urban			-0.004				0.000				0.000				-0.001	
			(0.708)				(0.923)				(0.978)				(0.650)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.635)				(0.490)				(0.357)	
Current account balance			-0.002				0.002				0.029				-0.009	
			(0.845)				(0.634)				(0.324)				(0.011)	
Trade				0.031				0.005				0.100				0.004
				(0.342)				(0.258)				(0.038)				(0.376)
Investment				0.111				0.185				-0.078				0.172
				(0.432)				(0.000)				(0.663)				(0.001)
Inflation				-0.002				-0.026				-0.013				-0.030
				(0.974)				(0.200)				(0.855)				(0.138)
D.Innovation [t - t-1]				-0.536				0.136				-1.162				0.063
				(0.776)				(0.664)				(0.635)				(0.874)
D.Imitation [t - t-1]				3.421				0.969				3.658				1.171
				(0.097)				(0.003)				(0.070)				(0.001)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	71/248	71/248	94/403	84/331	71/248	71/248	71/248	71/248	69/233	69/233	88/369	78/302	69/233	69/233	69/233	69/233
R^2					0.667	0.659	0.939	0.280					0.915	0.869	0.936	0.076
Number of Instruments	39	39	46	44					33	33	39	35				
Hansen J-statistics (p-value)	0.314	0.473	0.859	0.297					0.608	0.387	0.185	0.524				
AR(2) test (p-value)	0.511	0.614	0.149	0.175					0.115	0.272	0.105	0.240				

	Innov2 & Imit2, with IMF public capital stock measure								*Innov2 & Imit2, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.070	0.227	1.127	0.025	1.255	-1.076	1.039	-1.664	-0.226	0.272	1.072	-6.415	1.046	-1.075	0.913	6.852
	(0.927)	(0.503)	(0.000)	(0.996)	(0.000)	(0.000)	(0.000)	(0.035)	(0.585)	(0.206)	(0.000)	(0.042)	(0.000)	(0.000)	(0.000)	(0.000)
Innovation, t (log)		0.535		0.665		0.767		0.074		0.752		2.206		0.769		-0.397
		(0.000)		(0.725)		(0.000)		(0.726)		(0.000)		(0.457)		(0.000)		(0.205)
Innovation, t-1 (log)	0.208	0.055			0.740	-0.561			0.291	-0.203			0.736	-0.562		
	(0.269)	(0.758)			(0.000)	(0.000)			(0.210)	(0.280)			(0.000)	(0.000)		
Imitation, t (log)	1.099			-3.003	1.232			-0.936	1.048			-4.164	1.241			-0.417
	(0.000)			(0.151)	(0.000)			(0.001)	(0.000)			(0.257)	(0.000)			(0.221)
Imitation, t-1 (log)	-0.041	-0.021			-0.869	0.692			-0.257	0.266			-0.979	0.781		
	(0.888)	(0.944)			(0.000)	(0.000)			(0.415)	(0.319)			(0.000)	(0.000)		
Public capital (log)	-0.185	0.083		-1.693	-1.207	1.040		1.703	0.228	-0.247		4.867	-1.124	1.166		-7.475
	(0.788)	(0.790)		(0.645)	(0.000)	(0.000)		(0.024)	(0.712)	(0.446)		(0.049)	(0.000)	(0.000)		(0.000)
FDI	0.021	-0.012			0.001	-0.001			-0.026	0.009			0.000	0.000		
	(0.056)	(0.350)			(0.362)	(0.349)			(0274)	(0.54)			(0.934)	(0.954)		
Skilled workforce	0.017	-0.009			-0.006	0.005			0.016	-0.006			0.001	-0.001		
	(0.196)	(0.448)			(0.013)	(0.011)			(0.546)	(0.708)			(0.536)	(0.549)		
Gov. expenditure	-0.020	-0.002	-0.016		0.013	-0.007	-0.004		-0.013	-0.004	0.053		0.018	-0.015	0.003	
	(0.759)	(0.979)	(0.479)		(0.256)	(0.424)	(0.615)		(0.849)	(0.393)	(0.494)		.(0.081)	(0.083)	(0.653)	
Non-tax revenue	0.026	-0.010	0.012		0.016	-0.013	0.003		-0.023	0.005	-0.040		0.001	0.001	0.000	
	(0.412)	(0.763)	(0.216)		(0.013)	(0.019)	(0.433)		(0.572)	(0.842)	(0.424)		(0.899)	(0.907)	(0.994)	
Gov. debt			0.006				0.002				-0.020				0.000	
			(0.016)				(0.007)				(0.059)				(0.674)	
Urban			-0.004				-0.001				0.000				0.000	
			(0.708)				(0.538)				(0.978)				(0.878)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.279)				(0.490)				(0.633)	
Current account balance			-0.002				0.006				0.029				-0.011	
			(0.845)				(0.136)				(0.324)				(0.001)	
Trade								0.002				0.124				-0.004
								(0.692)				(0.061)				(0.443)
Investment								0.211				-0.228				0.222
								(0.000)				(0.354)				(0.000)
Inflation								-0.034				0.068				-0.035
								(0.070)				(0.313)				(0.097)
D.Innovation [t - t-1]				-0.357				-0.018				-2.211				-0.454
				(0.724)				(0.949)				(0.351)				(0.214)
D.Imitation [t - t-1]				2.671				1.022				4.861				1.901
				(0.131)				(0.004)				(0.053)				(0.000)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	76/263	76/263	94/403	91/365	76/263	76/263	76/263	76/263	72/244	72/244	88/369	72/244	72/244	72/244	72/244	72/244
R^2					0.838	0.800	0.943	0.179					0.873	0.813	0.936	0.472
Number of Instruments	41	41	46	44							39	35				
Hansen J-statistics (p-value)	0.394	0.639	0.859	0.399					0.807	0.689	0.185	0.489				
AR(2) test (p-value)	0.383	0.192	0.149	0.175					0.468	0.548	0.105	0.276				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 5: Benchmark Results, where output per employee are used as product variety measures (cont.)

	Innov3 & Imit3, with IMF public capital stock measure								*Innov3 & Imit3, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	1.408	-0.480	1.127	9.617	1.680	-1.640	1.048	-1.574	-0.045	0.010	1.072	-4.836	0.034	-0.592	0.918	6.176
	(0.285)	(0.266)	(0.000)	(0.022)	(0.000)	(0.000)	(0.000)	(0.058)	(0.896)	(0979)	(0.000)	(0.074)	(0.883)	(0.010)	(0.000)	(0.002)
Innovation, t (log)		0.677		-4.539		0.933		-0.591		0.815		-3.716		0.896		-0.624
		(0.003)		(0.000)		(0.000)		(0.001)		(0.000)		(0.487)		(0.000)		(0.002)
Innovation, t-1 (log)	0.384	-0.135			0.791	-0.747			0.583	-0.574			0.768	-0.691		
	(0.071)	(0.681)			(0.000)	(0.000)			(0.007)	(0.021)			(0.000)	(0.000)		
Imitation, t (log)	0.668			1.880	0.925			-0.291	0.878			1.616	0.937			-0.231
	(0.023)			(0.367)	(0.000)			(0.079)	(0.000)			(0.744)	(0.000)			(0.215)
Imitation, t-1 (log)	-0.282	0.423			-0.703	0.753			-0.472	0.655			-0.742	0.784		
	(0.203)	(0.038)			(0.000)	(0.000)			(0.068)	(0.000)			(0.000)	(0.000)		
Public capital (log)	-1.132	0.130		-9.206	-1.544	1.525		1.647	0.028	0.065		5.469	0.018	0.614		-6.693
	(0.427)	(0.841)		(0.006)	(0.000)	(0.000)		(0.037)	(0.953)	(0.866)		(0.114)	(0.943)	(0.014)		(0.002)
FDI	0.002	0.001			0.001	-0.001			0.007	-0.007			0.000	0.001		
	(0.942)	(0.956)			(0.626)	(0.560)			(0.787)	(0.758)			(0.694)	(0.549)		
Skilled workforce	0.029	-0.011			-0.002	0.002			0.034	-0.026			0.003	-0.002		
	(0.199)	(0.434)			(0.416)	(0.359)			(0.145)	(0.110)			(0.141)	(0.224)		
Gov. expenditure	-0.054	0.026	-0.016		0.008	-0.003	-0.001		-0.062	0.036	0.053		0.004	-0.007	0.006	
	(0.496)	(0.419)	(0.479)		(0.506)	(0.784)	(0.921)		(0.461)	(0.681)	(0.494)		(0.679)	(0.493)	(0.378)	
Non-tax revenue	-0.030	0.053	0.012		-0.011	0.011	0.003		-0.040	0.059	-0.040		-0.022	0.023	0.001	
	(0.244)	(0.130)	(0.216)		(0.130)	(0.110)	(0.457)		(0.133)	(0.051)	(0.424)		(0.000)	(0.000)	(0.718)	
Gov. debt			0.006				0.002				-0.020				0.000	
			(0.016)				(0.033)				(0.059)				(0.777)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.179)				(0.978)				(0.406)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.377)				(0.490)				(0.612)	
Current account balance			-0.002				0.003				0.029				-0.012	
			(0.845)				(0.388)				(0.324)				(0.000)	
Trade				0.004				0.001				0.102				-0.003
				(0.901)				(0.762)				(0.082)				(0.543)
Investment				0.213				0.183				-0.112				0.219
				(0.191)				(0.000)				(0.669)				(0.000)
Inflation				-0.013				-0.039				0.012				-0.033
				(0.885)				(0.036)				(0.897)				(0.112)
D.Innovation [t - t-1]				5.035				1.164				2.929				1.244
				(0.000)				(0.000)				(0.349)				(0.000)
D.Imitation [t - t-1]				-1.747				-0.168				-0.343				0.076
				(0.181)				(0.507)				(0.903)				(0.796)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	77/266	77/266	94/403	94/373	77/266	77/266	77/266	77/266	73/247	73/247	88/369	86/333	73/247	73/247	73/247	73/247
R^2					0.690	0.720	0.943	0.202					0.864	0.862	0.937	0.804
Number of Instruments	41	41	46	44					33	33	39	35				
Hansen J-statistics (p-value)	0.385	0.261	0.859	0.222					0.845	0.834	0.185	0.280				
AR(2) test (p-value)	0.137	0.516	0.149	0.491					0.382	0.119	0.105	0.401				

	Innov4 & Imit4, with IMF public capital stock measure								*Innov4 & Imit4, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.607	0.894	1.127	5.178	-0.227	0.243	1.023	-0.836	-0.044	-0.013	1.072	-3.844	-0.902	0.343	0.925	4.571
	(0.562)	(0.372)	(0.000)	(0.308)	(0.330)	(0.258)	(0.000)	(0.301)	(0.911)	(0.974)	(0.000)	(0.141)	(0.000)	(0.072)	(0.000)	(0.013)
Innovation, t (log)		0.826		-1.345		0.871		-0.554		0.728		-1.141		0.856		-0.403
		(0.000)		(0.509)		(0.000)		(0.005)		(0.000)		(0.693)		(0.000)		(0.101)
Innovation, t-1 (log)	0.310	-0.298			0.773	-0.683			0.297	-0.175			0.761	-0.655		
	(0.086)	(0.348)			(0.000)	(0.000)			(0.164)	(0.357)			(0.000)	(0.000)		
Imitation, t (log)	0.763			-1.105	1.038			-0.384	0.934			-0.758	1.062			-0.484
	(0.000)			(0.548)	(0.000)			(0.055)	(0.000)			(0.778)	(0.000)			(0.094)
Imitation, t-1 (log)	-0.270	0.370			-0.794	0.761			-0.369	0.243			-0.757	0.711		
	(0.286)	(0.329)			(0.000)	(0.000)			(0.117)	(0.217)			(0.000)	(0.000)		
Public capital (log)	0.807	-1.200		-5.417	0.274	-0.270		0.970	0.262	-0.049		3.559	1.018	-0.398		-4.848
	(0.460)	(0.258)		(0.135)	(0.228)	(0.197)		(0.203)	(0.571)	(0.910)		(0.093)	(0.000)	(0.058)		(0.018)
FDI	0.003	0.015			-0.001	0.001			0.011	-0.014			-0.001	0.001		
	(0.876)	(0.234)			(0.321)	(0.403)			(0.543)	(0.317)			(0.491)	(0.368)		
Skilled workforce	0.005	-0.002			0.003	-0.003			0.014	-0.015			0.000	0.000		
	(0.728)	(0.925)			(0.159)	(0.217)			(0.486)	(0.444)			(0.945)	(0.843)		
Gov. expenditure	-0.029	0.077	-0.016		-0.016	0.018	-0.001		-0.014	0.018	0.053		-0.019	0.015	0.003	
	(0.630)	(0.172)	(0.479)		(0.113)	(0.057)	(0.929)		(0.777)	(0.715)	(0.494)		(0.084)	(0.090)	(0.673)	
Non-tax revenue	-0.027	0.039	0.012		-0.014	0.013	0.004		-0.043	0.065	-0.040		-0.011	0.011	0.000	
	(0.435)	(0.176)	(0.216)		(0.014)	(0.016)	(0.419)		(0.222)	(0.006)	(0.424)		(0.058)	(0.014)	(0.954)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.637)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.166)				(0.978)				(0.645)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.378)				(0.490)				(0.418)	
Current account balance			-0.002				0.012				0.029				-0.010	
			(0.845)				(0.009)				(0.324)				(0.004)	
Trade				0.021				0.002				0.086				0.000
				(0.492)				(0.639)				(0.061)				(0.950)
Investment				0.223				0.186				-0.114				0.191
				(0.167)				(0.000)				(0.602)				(0.000)
Inflation				-0.023				-0.039				0.014				-0.033
				(0.768)				(0.037)				(0.810)				(0.115)
D.Innovation [t - t-1]				2.501				0.816				2.205				1.113
				(0.100)				(0.004)				(0.287)				(0.000)
D.Imitation [t - t-1]				0.166				0.212				0.422				0.115
				(0.922)				(0.477)				(0.840)				(0.738)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	76/261	76/261	94/403	92/364	76/261	76/261	76/261	76/261	72/243	72/243	88/369	84/328	72/243	72/243	72/243	72/243
R^2					0.873	0.881	0.942	0.277					0.817	0.887	0.938	0.328
Number of Instruments	40	40	46	44					33	33	39	35				
Hansen J-statistics (p-value)	0.432	0.732	0.859	0.194					0.741	0.817	0.185	0.414				
AR(2) test (p-value)	0.332	0.501	0.149	0.280					0.692	0.350	0.105	0.251				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 6: Benchmark Results, where output per employee are used as product variety measures (cont.)

	Innov5 & Imit5, with IMF public capital stock measure								*Innov5 & Imit5, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.641	1.155	1.127	5.378	0.405	0.243	1.027	-1.229	-0.205	0.016	1.072	-3.894	-0.564	-0.044	0.927	4.730
	(0.479)	(0.201)	(0.000)	(0.303)	(0.089)	(0.258)	(0.000)	(0.133)	(0.643)	(0.968)	(0.000)	(0.124)	(0.013)	(0.822)	(0.000)	(0.012)
Innovation, t (log)		0.917		-1.469		0.865		-0.559		0.736		-0.843		0.840		-0.456
		(0.000)		(0.468)		(0.000)		(0.003)		(0.000)		(0.721)		(0.000)		(0.051)
Innovation, t-1 (log)	0.314	-0.250			0.786	-0.692			0.306	-0.173			0.774	-0.653		
	(0.077)	(0.343)			(0.000)	(0.000)			(0.148)	(0.377)			(0.000)	(0.000)		
Imitation, t (log)	0.603			-1.020	1.032			-0.394	0.873			-1.141	1.061			-0.437
	(0.000)			(0.547)	(0.000)			(0.040)	(0.000)			(0.607)	(0.000)			(0.113)
Imitation, t-1 (log)	-0.323	0.445			-0.794	0.767			-0.462	0.383			-0.795	0.745		
	(0.133)	(0.074)			(0.000)	(0.000)			(0.037)	(0.070)			(0.000)	(0.000)		
Public capital (log)	0.822	-1.412		-5.469	-0.332	0.354		1.356	0.432	-0.141		3.627	0.652	0.024		-5.003
	(0.392)	(0.147)		(0.144)	(0.154)	(0.099)		(0.080)	(0.409)	(0.737)		(0.097)	(0.008)	(0.911)		(0.017)
FDI	0.015	0.000			-0.001	0.001			0.007	-0.008			-0.001	0.001		
	(0.515)	(0.971)			(0.611)	(0.624)			(0.702)	(0.530)			(0.623)	(0.449)		
Skilled workforce	0.027	-0.021			0.001	-0.001			0.013	-0.009			0.001	0.000		
	(0.096)	(0.400)			(0.582)	(0.706)			(0.565)	(0.519)			(0.612)	(0.807)		
Gov. expenditure	-0.001	0.066	-0.016		-0.013	0.016	0.000		0.021	-0.010	0.053		-0.016	0.012	0.003	
	(0.991)	(0.128)	(0.479)		(0.212)	(0.099)	(0.995)		(0.757)	(0.865)	(0.494)		(0.124)	(0.182)	(0.648)	
Non-tax revenue	-0.038	0.024	0.012		-0.011	0.010	0.004		-0.034	0.053	-0.040		-0.013	0.014	0.000	
	(0.156)	(0.319)	(0.216)		(0.050)	(0.055)	(0.400)		(0.199)	(0.057)	(0.424)		(0.020)	(0.004)	(0.972)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.717)	
Urban			-0.004				-0.003				0.000				-0.001	
			(0.708)				(0.076)				(0.978)				(0.625)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.336)				(0.490)				(0.392)	
Current account balance			-0.002				0.010				0.029				-0.011	
			(0.845)				(0.023)				(0.324)				(0.002)	
Trade				0.021				0.002				0.090				-0.001
				(0.504)				(0.601)				(0.062)				(0.920)
Investment				0.223				0.185				-0.131				0.197
				(0.171)				(0.000)				(0.552)				(0.000)
Inflation				-0.019				-0.038				0.018				-0.031
				(0.783)				(0.038)				(0.736)				(0.125)
D.Innovation [t - t-1]				2.474				1.016				1.735				1.204
				(0.100)				(0.000)				(0.360)				(0.000)
D.Imitation [t - t-1]				0.235				-0.023				1.019				0.001
				(0.880)				(0.937)				(0.607)				(0.998)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	76/261	76/261	94/403	92/364	76/261	76/261	76/261	76/261	72/243	72/243	88/369	84/328	72/243	72/243	72/243	72/243
R^2					0.864	0.877	0.942	0.244					0.850	0.898	0.938	0.363
Number of Instruments	40	40	46	44					33	33	39	35				
Hansen J-statistics (p-value)	0.326	0.812	0.859	0.194					0.573	0.762	0.185	0.451				
AR(2) test (p-value)	0.568	0.720	0.149	0.276					0.647	0.138	0.105	0.276				

	Innov6 & Imit6, with IMF public capital stock measure								*Innov6 & Imit6, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.468	-0.329	1.127	0.866	2.548	-3.354	1.068	-2.772	-0.011	0.028	1.072	-5.291	-0.169	-0.172	0.922	4.521
	(0.450)	(0.724)	(0.000)	(0.839)	(0.000)	(0.000)	(0.000)	(0.001)	(0.978)	(0.952)	(0.000)	(0.015)	(0.363)	(0.470)	(0.000)	(0.005)
Innovation, t (log)		0.673		-1.096		1.260		-0.220		0.886		-0.574		1.225		-0.606
		(0.000)		(0.631)		(0.000)		(0.449)		(0.000)		(0.863)		(0.000)		(0.036)
Innovation, t-1 (log)	0.455	-0.298			0.539	-0.677			0.263	-0.546			0.678	-0.828		
	(0.082)	(0.315)			(0.000)	(0.000)			(0.213)	(0.089)			(0.000)	(0.000)		
Imitation, t (log)	0.604			-1.180	0.764			-0.612	0.653			-1.298	0.730			-0.231
	(0.008)			(0.545)	(0.000)			(0.021)	(0.003)			(0.697)	(0.000)			(0.414)
Imitation, t-1 (log)	-0.278	0.447			-0.291	0.386			-0.278	0.756			-0.491	0.675		
	(0.183)	(0.107)			(0.000)	(0.000)			(0.289)	(0.000)			(0.000)	(0.000)		
Public capital (log)	-0.366	0.056		-2.165	-2.401	3.168		2.720	0.105	-0.352		4.273	0.233	0.139		-4.894
	(0.490)	(0.949)		(0.594)	(0.000)	(0.000)		(0.001)	(0.795)	(0.471)		(0.018)	(0.247)	(0.589)		(0.006)
FDI	-0.005	0.024			0.002	-0.003			-0.002	0.019			-0.001	0.001		
	(0.552)	(0.150)			(0.051)	(0.046)			(0.902)	(0.526)			(0.446)	(0.325)		
Skilled workforce	0.003	0.015			-0.010	0.013			0.027	-0.004			0.001	-0.002		
	(0.836)	(0.445)			(0.000)	(0.000)			(0.074)	(0.881)			(0.420)	(0.494)		
Gov. expenditure	0.000	0.019	-0.016		-0.007	0.011	0.000		0.025	0.002	0.053		-0.008	0.008	0.006	
	(0.994)	(0.726)	(0.479)		(0.575)	(0.474)	(0.959)		(0.752)	(0.976)	(0.494)		(0.410)	(0.486)	(0.431)	
Non-tax revenue	0.013	0.013	0.012		0.010	-0.014	0.008		-0.033	0.008	-0.040		-0.008	0.013	-0.001	
	(0.697)	(0.575)	(0.216)		(0.128)	(0.123)	(0.084)		(0.239)	(0.769)	(0.424)		(0.129)	(0.049)	(0.847)	
Gov. debt			0.006				0.001				-0.020				0.000	
			(0.016)				(0.430)				(0.059)				(0.701)	
Urban			-0.004				-0.005				0.000				-0.001	
			(0.708)				(0.002)				(0.978)				(0.394)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.198)				(0.490)				(0.439)	
Current account balance			-0.002				-0.001				0.029				-0.014	
			(0.845)				(0.674)				(0.324)				(0.000)	
Trade				0.019				0.002				0.098				-0.001
				(0.569)				(0.565)				(0.122)				(0.892)
Investment				0.248				0.192				-0.052				0.213
				(0.240)				(0.000)				(0.813)				(0.000)
Inflation				-0.083				-0.038				-0.023				-0.035
				(0.384)				(0.056)				(0.806)				(0.091)
D.Innovation [t - t-1]				3.264				1.714				2.940				1.901
				(0.151)				(0.000)				(0.353)				(0.000)
D.Imitation [t - t-1]				-0.932				-0.500				-1.077				-0.512
				(0.518)				(0.075)				(0.759)				(0.120)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	73/256	73/256	94/403	90/354	73/256	73/256	73/256	73/256	70/239	70/239	88/369	83/316	70/239	70/239	70/239	70/239
R^2					0.467	0.322	0.940	0.126					0.885	0.865	0.936	0.293
Number of Instruments	40	40	46	44					33	33	39	35				
Hansen J-statistics (p-value)	0.319	0.555	0.859	0.174					0.335	0.508	0.185	0.257				
AR(2) test (p-value)	0.221	0.146	0.149	0.171					0.100	0.585	0.105	0.194				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 7: Benchmark Results, where value-added per employee are used as product variety measures

	Innov1 & Imit1, with IMF public capital stock measure								*Innov1 & Imit1, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.277	0.468	1.127	-4.581	-0.075	-1.313	1.033	1.004	-0.306	0.493	1.072	-3.954	-0.302	-0.120	0.932	1.846
	(0.538)	(0.440)	(0.000)	(0.335)	(0.710)	(0.000)	(0.000)	(0.184)	(0.453)	(0.362)	(0.000)	(0.005)	(0.211)	(0.658)	(0.000)	(0.232)
Innovation, t (log)		0.852		-2.792		1.226		-0.812		0.835		-2.651		1.064		-0.750
		(0.000)		(0.013)		(0.000)		(0.000)		(0.983)		(0.262)		(0.000)		(0.000)
Innovation, t-1 (log)	0.568	-0.113			0.730	-0.906			0.403	-0.037			0.747	-0.798		
	(0.036)	(0.619)			(0.000)	(0.000)			(0.109)	(0.917)			(0.000)	(0.000)		
Imitation, t (log)	0.696			2.276	0.872			0.438	0.773			1.233	0.831			0.396
	(0.000)			(0.191)	(0.000)			(0.003)	(0.000)			(0.646)	(0.000)			(0.006)
Imitation, t-1 (log)	-0.327	0.026			-0.628	0.753			-0.177	-0.006			-0.633	0.758		
	(0.096)	(0.908)			(0.000)	(0.000)			(0.351)	(0.983)			(0.000)	(0.000)		
Public capital (log)	-0.342	-0.079		3.067	-1.264	1.236		-0.419	0.339	-0.504		4.305	0.357	0.107		-2.011
	(0.444)	(0.930)		(0.431)	(0.595)	(0.530)		(0.540)	(0.350	(0.344)		(0.001)	(0.170)	(0.714)		(0.226)
FDI	0.007	-0.006			0.000	0.000			0.003	0.000			0.000	0.001		
	(0.464)	(0.675)			(0.885)	(0.841)			(0.810)	(0.998)			(0.714)	(0.555)		
Skilled workforce	0.008	0.001			-0.002	0.003			-0.007	0.019			0.002	-0.001		
	(0.539)	(0.959)			(0.284)	(0.239)			(0.715)	(0.618)			(0.418)	(0.551)		
Gov. expenditure	0.046	-0.032	-0.016		0.021	-0.029	-0.004		0.068	-0.068	0.053		0.022	-0.023	-0.004	
	(0.386)	(0.710)	(0.479)		(0.072)	(0.021)	(0.642)		(0.281)	(0.521)	(0.494)		(0.034)	(0.051)	(0.548)	
Non-tax revenue	-0.006	-0.024	0.012		0.014	-0.014	0.007		0.033	-0.039	-0.040		0.002	-0.001	0.001	
	(0.876)	(0.781)	(0.216)		(0.039)	(0.041)	(0.119)		(0.503)	(0.539)	(0.424)		(0.706)	(0.850)	(0.701)	
Gov. debt			0.006				0.003				-0.020				0.000	
			(0.016)				(0.002)				(0.059)				(0.978)	
Urban			-0.004				-0.001				0.000				0.000	
			(0.708)				(0.546)				(0.978)				(0.745)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.203)				(0.490)				(0.199)	
Current account balance			-0.002				0.002				0.029				-0.012	
			(0.845)				(0.708)				(0.324)				(0.002)	
Trade				0.029				0.002				0.108				0.003
				(0.469)				(0.593)				(0.016)				(0.598)
Investment				0.290				0.227				-0.116				0.218
				(0.039)				(0.000)				(0.410)				(0.000)
Inflation				-0.036				-0.012				-0.009				-0.017
				(0.509)				(0.498)				(0.893)				(0.339)
D.Innovation [t - t-1]				0.455				0.406				0.073				0.497
				(0.569)				(0.114)				(0.954)				(0.078)
D.Imitation [t - t-1]				0.860				0.520				1.343				0.555
				(0.464)				(0.022)				(0.298)				(0.013)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	67/230	67/230	94/403	79/302	68/231	68/231	68/231	68/231	65/216	65/216	88/369	73/276	66/217	66/217	66/217	66/217
R^2					0.800	0.752	0.940	0.399					0.892	0.848	0.942	0.129
Number of Instruments	37	37	46	42					32	32	39	34				
Hansen J-statistics (p-value)	0.750	0.338	0.859	0.283					0.787	0.664	0.185	0.195				
AR(2) test (p-value)	0.102	0.279	0.149	0.535					0.116	0.328	0.105	0.415				

	Innov2 & Imit2, with IMF public capital stock measure								*Innov2 & Imit2, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.796	0.244	1.127	-6.608	2.617	-1.663	1.035	-0.550	-0.588	0.265	1.072	-4.197	1.379	-1.292	0.918	7.028
	(0.551)	(0.733)	(0.000)	(0.226)	(0.000)	(0.000)	(0.000)	(0.482)	(0.570)	(0.695)	(0.000)	(0.028)	(0.000)	(0.000)	(0.000)	(0.000)
Innovation, t (log)		0.424		-1.158		0.647		-0.046		0.579		-0.134		0.735		-0.232
		(0.000)		(0.441)		(0.000)		(0.736)		(0.000)		(0.951)		(0.000)		(0.154)
Innovation, t-1 (log)	0.722	-0.329			0.750	-0.482			0.399	-0.301			0.729	-0.531		
	(0.214)	(0.307)			(0.000)	(0.000)			(0.461)	(0.605)			(0.000)	(0.000)		
Imitation, t (log)	0.953			-0.595	1.397			-0.349	0.628			-1.861	1.253			-0.368
	(0.001)			(0.716)	(0.000)			(0.061)	(0.005)			(0.293)	(0.000)			(0.079)
Imitation, t-1 (log)	-0.575	0.443			-1.011	0.717			-0.301	0.374			-1.075	0.849		
	(0.362)	(0.115)			(0.000)	(0.000)			(0.641)	(0.497)			(0.000)	(0.000)		
Public capital (log)	-0.611	-0.327		4.663	-2.496	1.593		0.473	0.370	-0.164		4.046	-1.438	1.365		-7.750
	(0.585)	(0.621)		(0.326)	(0.000)	(0.000)		(0.528)	(0.693)	(0.766)		(0.021)	(0.000)	(0.000)		(0.000)
FDI	0.013	-0.008			0.001	-0.001			0.013	-0.017			-0.001	0.001		
	(0.804)	(0.733)			(0.589)	(0.571)			(0.697)	(0.497)			(0.500)	(0.426)		
Skilled workforce	-0.020	0.020			-0.009	0.007			0.037	0.019			0.002	-0.001		
	(0.588)	(0.343)			(0.012)	(0.008)			(0.162)	(0.163)			(0.426)	(0.465)		
Gov. expenditure	0.150	-0.212	-0.016		0.019	-0.011	-0.008		-0.043	-0.176	0.053		0.023	-0.019	0.002	
	(0.158)	(0.073)	(0.479)		(0.309)	(0.347)	(0.346)		(0.719)	(0.217)	(0.494)		(0.077)	(0.077)	(0.738)	
Non-tax revenue	-0.041	0.116	0.012		0.015	-0.009	0.005		0.019	0.055	-0.040		-0.002	0.002	0.001	
	(0.660)	(0.097)	(0.216)		(0.165)	(0.175)	(0.290)		(0.818)	(0.493)	(0.424)		(0.788)	(0.694)	(0.809)	
Gov. debt			0.006				0.001				-0.020				0.000	
			(0.016)				(0.095)				(0.059)				(0.867)	
Urban			-0.004				0.001				0.000				0.000	
			(0.708)				(0.501)				(0.978)				(0.891)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.189)				(0.490)				(0.420)	
Current account balance			-0.002				-0.002				0.029				-0.010	
			(0.845)				(0.602)				(0.324)				(0.004)	
Trade				0.074				-0.001				0.079				-0.006
				(0.210)				(0.712)				(0.077)				(0.198)
Investment				0.147				0.194				-0.001				0.244
				(0.496)				(0.000)				(0.996)				(0.000)
Inflation				-0.110				-0.010				-0.005				-0.015
				(0.211)				(0.549)				(0.954)				(0.469)
D.Innovation [t - t-1]				0.441				-0.414				0.294				-0.884
				(0.662)				(0.038)				(0.876)				(0.000)
D.Imitation [t - t-1]				1.723				1.444				2.291				2.513
				(0.182)				(0.000)				(0.233)				(0.000)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/243	72/243	94/403	85/327	72/243	72/243	72/243	72/243	68/225	68/225	88/369	78/294	69/226	69/226	69/226	69/226
R^2					0.562	0.668	0.938	0.316					0.816	0.789	0.939	0.486
Number of Instruments	38	38	46	43					32	32	39	34				
Hansen J-statistics (p-value)	0.465	0.66	0.859	0.415					0.403	0.525	0.185	0.159				
AR(2) test (p-value)	0.199	0.109	0.149	0.353					0.670	0.510	0.105	0.498				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 8: Benchmark Results, where value-added per employee are used as product variety measures (cont.)

	Innov3 & Imit3, with IMF public capital stock measure								*Innov3 & Imit3, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.822	-0.355	1.127	0.765	1.684	-1.710	1.034	-0.814	-0.355	0.151	1.072	-3.543	-0.589	0.013	0.925	4.151
	(0.440)	(0.200)	(0.000)	(0.902)	(0.000)	(0.000)	(0.000)	(0.335)	(0.302)	(0.781)	(0.000)	(0.134)	(0.039)	(0.963)	(0.000)	(0.029)
Innovation, t (log)		0.443		-3.117		0.913		-0.329		0.439		-1.763		0.907		-0.241
		(0.002)		(0.205)		(0.000)		(0.037)		(0.087)		(0.342)		(0.000)		(0.146)
Innovation, t-1 (log)	0.432	-0.295			0.773	-0.727			0.607	-0.316			0.762	-0.710		
	(0.067)	(0.117)			(0.000)	(0.000)			(0.003)	(0.201)			(0.000)	(0.000)		
Imitation, t (log)	0.485			0.068	0.871			-0.063	0.658			-0.742	0.838			-0.052
	(0.005)			(0.978)	(0.000)			(0.624)	(0.000)			(0.760)	(0.000)			(0.736)
Imitation, t-1 (log)	-0.249	0.722			-0.702	0.806			-0.578	0.798			-0.674	0.812		
	(0.302)	(0.001)			(0.000)	(0.000)			(0.001)	(0.001)			(0.000)	(0.000)		
Public capital (log)	-0.715	0.174		-1.339	-1.566	1.611		0.675	0.672	-0.593		4.013	0.675	-0.028		-4.666
	(0.543)	(0.590)		(0.763)	(0.000)	(0.000)		(0.405)	(0.062)	(0.069)		(0.046)	(0.026)	(0.927)		(0.024)
FDI	0.004	0.022			0.000	0.000			-0.005	0.024			0.000	0.001		
	(0.812)	(0.404)			(0.785)	(0.798)			(0.773)	(0.417)			(0.842)	(0.584)		
Skilled workforce	0.034	-0.008			-0.002	0.003			0.006	0.020			0.003	-0.002		
	(0.088)	(0.620)			(0.516)	(0.390)			(0.672)	(0.363)			(0.188)	(0.357)		
Gov. expenditure	-0.122	0.044	-0.016		0.006	-0.001	-0.004		-0.029	-0.065	0.053		-0.004	-0.001	0.002	
	(0.230)	(0.517)	(0.479)		(0.669)	(0.916)	(0.667)		(0.725)	(0.343)	(0.494)		(0.764)	(0.939)	(0.699)	
Non-tax revenue	-0.044	-0.028	0.012		-0.005	0.005	0.005		-0.026	0.007	-0.040		-0.017	0.018	0.003	
	(0.425)	(0.575)	(0.216)		(0.547)	(0.532)	(0.317)		(0.617)	(0.895)	(0.424)		(0.014)	(0.009)	(0.333)	
Gov. debt			0.006				0.002				-0.020				0.000	
			(0.016)				(0.008)				(0.059)				(0.763)	
Urban			-0.004				-0.002				0.000				-0.001	
			(0.708)				(0.213)				(0.978)				(0.562)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.330)				(0.490)				(0.196)	
Current account balance			-0.002				0.002				0.029				-0.013	
			(0.845)				(0.699)				(0.324)				(0.000)	
Trade				0.034				-0.002				0.100				-0.002
				(0.462)				(0.512)				(0.080)				(0.691)
Investment				0.185				0.208				-0.145				0.215
				(0.475)				(0.000)				(0.493)				(0.000)
Inflation				-0.068				-0.007				-0.029				0.004
				(0.499)				(0.674)				(0.717)				(0.837)
D.Innovation [t - t-1]				2.044				1.002				0.732				1.305
				(0.113)				(0.000)				(0.561)				(0.000)
D.Imitation [t - t-1]				1.059				-0.101				1.988				-0.144
				(0.386)				(0.651)				(0.282)				(0.540)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	72/245	72/245	94/403	87/332	73/246	73/246	73/246	73/246	68/227	68/227	88/369	79/297	69/228	69/228	69/228	69/228
R^2					0.628	0.727	0.941	0.272					0.795	0.868	0.940	0.493
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.298	0.686	0.859	0.520					0.142	0.227	0.185	0.107				
AR(2) test (p-value)	0.296	0.386	0.149	0.192					0.242	0.134	0.105	0.772				

	Innov4 & Imit4, with IMF public capital stock measure								*Innov4 & Imit4, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	0.853	-0.059	1.127	1.202	0.410	-0.384	1.014	0.030	-0.336	-0.164	1.072	-4.025	-0.681	0.273	0.937	2.252
	(0.561)	(0.973)	(0.000)	(0.744)	(0.132)	(0.139)	(0.000)	(0.972)	(0.336)	(0.798)	(0.000)	(0.118)	(0.011)	(0.275)	(0.000)	(0.174)
Innovation, t (log)		0.570		-0.916		0.886		-0.314		0.507		-1.349		0.887		-0.276
		(0.001)		(0.651)		(0.000)		(0.061)		(0.032)		(0.579)		(0.000)		(0.087)
Innovation, t-1 (log)	0.524	-0.160			0.750	-0.676			0.515	-0.281			0.784	-0.708		
	(0.054)	(0.681)			(0.000)	(0.000)			(0.016)	(0.375)			(0.000)	(0.000)		
Imitation, t (log)	0.672			-1.691	0.971			-0.171	0.802			-1.721	0.973			-0.116
	(0.000)			(0.288)	(0.000)			(0.250)	(0.000)			(0.531)	(0.000)			(0.510)
Imitation, t-1 (log)	-0.288	0.342			-0.708	0.730			-0.359	0.444			-0.713	0.735		
	(0.326)	(0.289)			(0.000)	(0.000)			(0.282)	(0.010)			(0.000)	(0.000)		
Public capital (log)	-0.828	-0.139		-1.705	-0.354	0.345		-0.113	0.382	0.115		4.241	0.756	-0.303		-2.512
	(0.616)	(0.926)		(0.603)	(0.181)	(0.171)		(0.886)	(0.283)	(0.822)		(0.055)	(0.008)	(0.259)		(0.169)
FDI	0.016	0.022			0.000	0.000			-0.001	0.007			0.000	0.000		
	(0.685)	(0.535)			(0.825)	(0.818)			(0.960)	(0.796)			(0.922)	(0.763)		
Skilled workforce	0.035	-0.009			0.000	0.001			0.016	-0.006			-0.001	0.001		
	(0.153)	(0.610)			(0.974)	(0.804)			(0.290)	(0.628)			(0.728)	(0.505)		
Gov. expenditure	-0.117	0.042	-0.016		-0.017	0.019	-0.002		-0.124	-0.014	0.053		-0.019	0.017	-0.002	
	(0.341)	(0.628)	(0.479)		(0.150)	(0.085)	(0.851)		(0.333)	(0.844)	(0.494)		(0.135)	(0.131)	(0.776)	
Non-tax revenue	-0.007	0.008	0.012		-0.004	0.004	0.005		0.041	0.012	-0.040		-0.006	0.006	0.002	
	(0.929)	(0.916)	(0.216)		(0.507)	(0.536)	(0.273)		(0.600)	(0.909)	(0.424)		(0.383)	(0.310)	(0.515)	
Gov. debt			0.006				0.004				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.987)	
Urban			-0.004				-0.003				0.000				-0.001	
			(0.708)				(0.160)				(0.978)				(0.718)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.175)				(0.490)				(0.111)	
Current account balance			-0.002				0.006				0.029				-0.013	
			(0.845)				(0.177)				(0.324)				(0.000)	
Trade				0.040				-0.001				0.088				0.000
				(0.276)				(0.753)				(0.055)				(0.993)
Investment				0.128				0.206				-0.109				0.199
				(0.386)				(0.000)				(0.588)				(0.000)
Inflation				-0.090				-0.010				-0.053				0.007
				(0.285)				(0.557)				(0.542)				(0.730)
D.Innovation [t - t-1]				1.165				1.043				0.966				1.411
				(0.348)				(0.000)				(0.538)				(0.000)
D.Imitation [t - t-1]				1.648				-0.049				2.244				-0.281
				(0.089)				(0.833)				(0.225)				(0.224)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	71/241	71/241	94/403	85/325	72/242	72/242	72/242	72/242	67/224	67/224	88/369	77/293	68/225	68/225	68/225	68/225
R^2					0.822	0.853	0.940	0.323					0.786	0.854	0.943	0.220
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.431	0.683	0.859	0.431					0.341	0.585	0.185	0.200				
AR(2) test (p-value)	0.486	0.259	0.149	0.558					0.483	0.142	0.105	0.908				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 9: Benchmark Results, where value-added per employee are used as product variety measures (cont.)

	Innov5 & Imit5, with IMF public capital stock measure								*Innov5 & Imit5, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	-0.090	-0.166	1.127	0.811	1.004	-1.024	1.022	-0.507	-0.427	-0.065	1.072	-4.131	-0.524	0.062	0.936	2.350
	(0.946)	(0.922)	(0.000)	(0.808)	(0.001)	(0.000)	(0.000)	(0.557)	(0.302)	(0.887)	(0.000)	(0.158)	(0.055)	(0.806)	(0.000)	(0.169)
Innovation, t (log)		0.536		-0.904		0.875		-0.274		0.536		-1.279		0.864		-0.249
		(0.001)		(0.658)		(0.000)		(0.101)		(0.003)		(0.584)		(0.000)		(0.121)
Innovation, t-1 (log)	0.441	-0.208			0.739	-0.656			0.516	-0.307			0.767	-0.673		
	(0.114)	(0.405)			(0.000)	(0.000)			(0.014)	(0.219)			(0.000)	(0.000)		
Imitation, t (log)	0.544			-2.158	0.978			-0.219	0.645			-2.208	0.980			-0.144
	(0.000)			(0.186)	(0.000)			(0.151)	(0.000)			(0.407)	(0.000)			(0.425)
Imitation, t-1 (log)	-0.196	0.510			-0.722	0.738			-0.430	0.628			-0.737	0.753		
	(0.493)	(0.008)			(0.000)	(0.000)			(0.100)	(0.001)			(0.000)	(0.000)		
Public capital (log)	0.120	-0.023		-1.148	-0.916	0.951		0.400	0.606	-0.229		4.509	0.598	-0.085		-2.621
	(0.935)	(0.988)		(0.701)	(0.001)	(0.001)		(0.625)	(0.096)	(0.640)		(0.066)	(0.041)	(0.752)		(0.163)
FDI	0.022	0.021			0.000	0.000			0.003	0.019			0.000	0.001		
	(0.234)	(0.496)			(0.977)	(0.939)			(0.888)	(0.473)			(0.904)	(0.711)		
Skilled workforce	0.038	-0.010			-0.001	0.002			0.015	0.000			0.000	0.001		
	(0.272)	(0.633)			(0.615)	(0.440)			(0.399)	(0.981)			(0.999)	(0.748)		
Gov. expenditure	-0.091	0.047	-0.016		-0.016	0.019	-0.001		-0.099	-0.003	0.053		-0.018	0.017	-0.002	
	(0.405)	(0.332)	(0.479)		(0.187)	(0.114)	(0.869)		(0.374)	(0.957)	(0.494)		(0.140)	(0.144)	(0.780)	
Non-tax revenue	-0.014	-0.024	0.012		-0.001	0.000	0.005		0.024	0.025	-0.040		-0.007	0.007	0.002	
	(0.857)	(0.694)	(0.216)		(0.913)	(0.980)	(0.246)		(0.727)	(0.761)	(0.424)		(0.290)	(0.223)	(0.509)	
Gov. debt			0.006				0.003				-0.020				0.000	
			(0.016)				(0.000)				(0.059)				(0.933)	
Urban			-0.004				-0.003				0.000				0.000	
			(0.708)				(0.067)				(0.978)				(0.753)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.214)				(0.490)				(0.113)	
Current account balance			-0.002				0.003				0.029				-0.013	
			(0.845)				(0.479)				(0.324)				(0.000)	
Trade				0.047				-0.001				0.101				0.000
				(0.196)				(0.752)				(0.052)				(0.971)
Investment				0.124				0.207				-0.141				0.201
				(0.436)				(0.000)				(0.558)				(0.000)
Inflation				-0.095				-0.012				-0.040				0.006
				(0.258)				(0.504)				(0.627)				(0.758)
D.Innovation [t - t-1]				1.059				1.150				0.738				1.432
				(0.427)				(0.000)				(0.638)				(0.000)
D.Imitation [t - t-1]				2.053				-0.201				2.893				1.432
				(0.098)				(0.402)				(0.132)				(0.148)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	71/241	71/241	94/403	85/325	72/242	72/242	72/242	72/242	67/224	67/224	88/369	77/293	68/225	68/225	68/225	68/225
R^2					0.758	0.796	0.940	0.300					0.793	0.859	0.943	0.196
Number of Instruments	38	38	46	44					32	32	39	34				
Hansen J-statistics (p-value)	0.297	0.880	0.859	0.462					0.363	0.620	0.185	0.274				
AR(2) test (p-value)	0.627	0.301	0.149	0.527					0.244	0.843	0.105	0.977				

	Innov6 & Imit6, with IMF public capital stock measure								*Innov6 & Imit6, with public infrastructure stock (proxied by telephone measure)*							
	System GMM				**3SLS, with FE**				**System GMM**				**3SLS, with FE**			
	Innovation	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**	**Innovation**	**Imitation**	**P.capital**	**Growth**
Initial GDP per capita (log)	2.098	-0.935	1.127	-0.336	2.261	-3.035	1.051	-1.136	0.283	-0.183	1.072	-5.338	-0.085	-0.287	0.924	4.846
	(0.034)	(0.326)	(0.000)	(0.955)	(0.000)	(0.000)	(0.000)	(0.136)	(0.522)	(0.699)	(0.000)	(0.014)	(0.736)	(0.339)	(0.000)	(0.013)
Innovation, t (log)		0.673		-2.130		1.096		0.574		0.752		-2.636		1.087		0.572
		(0.002)		(0.211)		(0.000)		(0.001)		(0.008)		(0.212)		(0.000)		(0.001)
Innovation, t-1 (log)	-0.583	0.219			0.595	-0.638			-0.335	0.264			0.678	-0.727		
	(0.397)	(0.668)			(0.000)	(0.000)			(0.370)	(0.544)			(0.000)	(0.000)		
Imitation, t (log)	0.873			0.261	0.794			-0.938	0.997			1.402	0.761			-0.941
	(0.035)			(0.873)	(0.000)			(0.000)	(0.000)			(0.424)	(0.000)			(0.001)
Imitation, t-1 (log)	0.361	0.102			-0.406	0.518			0.204	0.008			-0.534	0.704		
	(0.603)	(0.786)			(0.000)	(0.000)			(0.537)	(0.981)			(0.000)	(0.000)		
Public capital (log)	-1.122	0.337		-1.282	-2.154	2.902		0.998	0.586	-0.657		4.430	0.117	0.295		-5.411
	(0.413)	(0.671)		(0.800)	(0.000)	(0.000)		(0.173)	(0.329)	(0.077)		(0.038)	(0.662)	(0.354)		(0.010)
FDI	-0.057	0.040			0.002	-0.002			-0.075	0.071			0.000	0.001		
	(0.266)	(0.216)			(0.262)	(0.270)			(0.231)	(0.069)			(0.990)	(0.727)		
Skilled workforce	0.007	0.009			-0.010	0.013			0.001	0.012			0.001	-0.001		
	(0.878)	(0.639)			(0.001)	(0.000)			(0.962)	(0.657)			(0.683)	(0.829)		
Gov. expenditure	-0.148	0.078	-0.016		-0.015	0.024	-0.005		-0.083	0.075	0.053		-0.014	0.016	0.002	
	(0.343)	(0.375)	(0.479)		(0.299)	(0.181)	(0.550)		(0.466)	(0.468)	(0.494)		(0.231)	(0.260)	(0.795)	
Non-tax revenue	-0.008	-0.008	0.012		0.018	-0.025	0.009		-0.071	0.027	-0.040		-0.006	0.009	0.001	
	(0.947)	(0.889)	(0.216)		(0.031)	(0.024)	(0.051)		(0.391)	(0.646)	(0.424)		(0.401)	(0.260)	(0.820)	
Gov. debt			0.006				0.001				-0.020				0.001	
			(0.016)				(0.115)				(0.059)				(0.814)	
Urban			-0.004				-0.003				0.000				0.000	
			(0.708)				(0.037)				(0.978)				(0.737)	
Population density			0.000				0.000				0.001				0.000	
			(0.169)				(0.760)				(0.490)				(0.399)	
Current account balance			-0.002				-0.002				0.029				-0.014	
			(0.845)				(0.681)				(0.324)				(0.000)	
Trade				0.042				-0.001				0.090				-0.003
				(0.566)				(0.730)				(0.172)				(0.546)
Investment				0.121				0.242				-0.022				0.261
				(0.600)				(0.000)				(0.919)				(0.000)
Inflation				-0.120				-0.014				-0.028				-0.016
				(0.149)				(0.445)				(0.702)				(0.479)
D.Innovation [t - t-1]				3.806				0.671				3.909				0.804
				(0.001)				(0.002)				(0.028)				(0.001)
D.Imitation [t - t-1]				-1.652				0.177				-2.312				0.300
				(0.216)				(0.425)				(0.312)				(0.319)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries/Observations	68/236	68/236	94/403	83/316	69/237	69/237	69/237	69/237	65/220	65/220	88/369	76/284	66/221	66/221	66/221	66/221
R^2					0.575	0.401	0.940	0.302					0.859	0.828	0.940	0.588
Number of Instruments	37	37	46	42					32	32	39	34				
Hansen J-statistics (p-value)	0.429	0.690	0.859	0.248					0.633	0.689	0.185	0.185				
AR(2) test (p-value)	0.215	0.235	0.149	0.791					0.237	0.109	0.105	0.797				

Parantheses denote p-values. For System-GMM, the test statistics are calculated based on the Windmeijer robust standard errors. The AR(2) test refers to the Arellano-Bond test for autocorrelations.

Table 10: Annual Regressions - Estimated elasticities, by stage of development/income grouping (averages, using total value added as product variety measures)

Country groups (observations)	*Standing-on-shoulder* effects		*Stepping-stone* effect	*Creative-imitation* effect
	Innovation	Imitation		
Low-and-lower-middle-income economies n= 67	0.542	0.513	-0.924	-0.464
Upper-middle-income economies n=217	0.798	0.845	0.158	0.093
High-income economies n=334	0.858	0.861	0.054	0.100

The averages are calculated based on the 12 sets of estimates for the respective groups.

Given only regressions with annual intervals are implemented, the dynamic multipliers for the *stepping-stone* and *creative-imitation* effects are not calculated.