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研究課題名（和文）Accounting for Technology Imitation in Trade-Led Growth in African Economies

研究課題名（英文）Accounting for Technology Imitation in Trade-Led Growth in African Economies

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研究成果の概要（和文）：本研究は、"easy imitation"（SITC category）や国連商品貿易統計に基づく指標を用いて、アフリカ諸国における貿易誘発型技術進歩の成長効果を定量化することを目的としている。主な結果として、技術模倣は労働力に独創的な努力を必要とするため、技術模倣率が高い国ほど、経済成長が大きくなる傾向が示された。また、一人当たりGDPが低い国ほど、他の技術関連形態に比べて技術模倣による成長効果が高いことが示された。最後に、中国との二国間貿易が強いアフリカ諸国の方が、そうでない国と比べて貿易誘発型の技術進歩は速かった。本研究から、貿易制約の軽減と貿易能力構築の重要性が示された。

研究成果の概要（英文）：The project aims at quantifying the growth-effects of trade-induced technology progress in African countries using "easy imitation" (SITC category) source of technology progress, in addition to other indicators such as those built from the UN COMTRADE Statistics. Major findings suggest that economic growth tends to be greater in countries with higher ratios of technology imitation, since technology imitation requires creative effort on the part of a countries' labor force. Another major finding is that the lower the level of GDP per capita, the higher the growth effects of technology imitation relative to other forms of technology progress such as ICT imports. Lastly, trade-induced technology progress is even faster for African countries with higher bilateral trade intensity with China compared to those with lower-intensity. Drawn implications emphasize the importance of alleviating trade constraints as well as building trade-capacity.

研究分野：　開発経済学

キーワード：　経済成長　技術進歩　技術模倣　アフリカ経済開発

１．研究開始当初の背景

The overarching goal of the research is to determine the optimal policies related to technology promotion in Africa. Specifically, it aims to quantify the growth effects of imitation across African countries. Although imitation has played the central role in development and technology progress, it has received only modest attention in explanations of economic growth (Niosi, 2012). Since the lack of research stems from the lack of tools with which to measure technology imitation, this research contributes to the literature by attempting to build proxy indicators of technology imitation using specific Standard International Trade Classification (SITC) classes. Another novel contribution of this research is the use of nonlinearity and threshold effects as a new methodological approach to empirical analysis of the relationship between technology progress and economic growth. Ultimately, understanding the effects of trade-induced technology imitation on economic growth of developing economies is important as policymakers can use this information to make decisions about which types of imports to encourage, given the constraints imposed by the balance of payments.

２．研究の目的

Although researchers are increasingly sensitive to the importance of appropriate policies in support of technological progress, views differ on what constitutes appropriate technology policy, which is particularly daunting for developing economies where research and development (R&D) is relatively scarce (Hausman and Rodrik, 2004). As an alternative to R&D, numerous studies look at spillovers from foreign-direct investment (FDI) as the instrument of technology diffusion (Keller, 1998).

The growth empirics literature further suggests that imported intermediary inputs can potentially enhance productivity of domestic firms because of their better quality as well as through imitation. In related work, Connolly (1997, 2003) shows that imitation allows for significant technological diffusion, thus improving growth in the imitating country, and that trade lowers the cost of imitation, thereby providing a dynamic boost to growth in developing countries.

To date, technology imitation has received limited attention in explanations of economic growth of developing countries. Even more worrisome, little empirical research exists on the extent to which such imitation has occurred via trade and how this affects economic growth (Datta and Mohtadi, 2005). The lack of empirical research on this critical issue stems from concerns regarding econometric model specification as well as from measurement and data constraints associated with the concept and practice of imitation. Although some of these constraints may still remain, recent progress in international trade statistics (e.g., United Nations' COMTRADE Statistics) has made it possible to mine the data and come up with acceptable proxy indicators for developing countries.

The research aims to quantify the growth effects of imitation across African countries. To do this, we explicitly posit a standard growth model that uses three alternative proxies of imitation. Particularly, the research will (1) build a comprehensive database of trade-induced imitation for African countries, (2) derive proxy indicators of imitation, and (3) use a threshold autoregressive model to test the growth effects of those proxies of imitation. The need for such research is crucial, as much of the empirical growth literature documents the existence of multiple growth regimes and parameter heterogeneity.

３．研究の方法

The datasets for our key variable (technology imitation) have been built from raw data to be extracted from the UN COMTRADE database (https://comtrade.un.org/db/default.aspx), SITC (Standard International Trade Classification, Rev. 4), of 5-digit codes for imports. Importantly, as the first proxy of technology imitation (Imitation 1), the research considers imports of goods in Standard International Trade Classes 5, 7, 86, and 89 (SITC, Rev. 1) from the Commodity Trade Statistics. These classes include machinery and transport equipment, instruments (optical, medical and photographic), watches, clocks, and miscellaneous manufactured goods (such as office equipment, which in later years has included computers). However, these commodity classes include high-technology goods, and thus are not likely to be imitable in low-income countries. Therefore, following the classification in Yilmaz (2002), we restrict the above classes of commodities to those in SITC Rev. 3: 51, 52, 54.1, 58, 59, and 75 and to build the second proxy of technology imitation (Imitation 2): reverse engineering. Moreover, for ICT imports data the study focuses on SITC Rev. 3 categories 75 (Office machines and automatic data processing machines) and 759 (Parts, accessories for machines of groups 751, 752).

The datasets comprise times series data for 44 sub-Saharan African countries. Regression-wise, the dependent variable is GDP per capita growth, defined as "the sum of the gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products" (www.worldbank.com/data). Following Barro (1997), the benchmark model will include the

following independent and control variables: physical capital investment (defined as "real gross domestic investment (private and public) as a percentage of GDP") and secondary school enrollment.

Moreover, two additional variables must be considered to control for other factors that could potentially lead to spurious correlation between the independent variables and the research proxies. For example, a finding that high-technology imports contribute positively to imitation could simply reflect an openness effect, rather than spillovers from imitation. For this reason, an openness measure will also be included in the research regressions. Similarly, since the enforcement of intellectual property rights (IPRs) affects the domestic imitation environment, an IPRs index is included in the regressions.

First, to examine the effect of technology imitation on economic growth, we use a modification of the traditional Cobb–Douglas production function. Specifically, we will follow a production function approach, *à la* Connolly (1997). Second, a major econometric issue confronting production function estimation is the possibility that some of these inputs are unobserved. This raises the endogeneity concern in most econometrics regressions.

To tackle potential endogeneity and nonlinearity, we use the threshold panel model of Hansen (2002). The basic idea underlying this model is that when some pertinent threshold is reached, the economy moves to another regime, one with a different relationship between imitation and growth. This framework also allows for trade-induced imitation to have a *differential* impact on economic growth. That is, the variables that have been identified as proxies of imitation, such as openness to international trade, the macroeconomic environment, and property rights, may have opposing effects on growth, depending on the prevailing regime. Likewise, these factors may magnify or offset the effects that imitation itself has on economic growth.

4．研究成果

The project has quantified the growth-effects of trade-induced technology progress with a focus on "easy imitation" (SITC category) source of technology progress, in addition to other indicators of trade-induced technology progress built from the UN COMTRADE Statistics. One of the studies aims at quantifying the effects of trade-induced technology imitation (proxied by the share of imports in the "easy imitation" SITC category) on economic growth in Africa. Using a production function approach in a panel system GMM estimator, it was found that, conditional on the level of the human capital index, economic growth tends to be greater in countries with higher ratios of technology imitation. One reason being that since technology imitation requires creative effort on the part of a countries' labor force. Combining these results, it can be concluded that importing of low-technology intensive items for processing purposes has the potential for enhancing technological progress by providing domestic firms in Africa with access to technologies which are embodied in foreign capital goods that are not available domestically. Hence, African policymakers would do well to foster technological progress by focusing on tax incentives designed to encourage local firms to engage in imports of technology-intensive parts and components as inputs to their production processes.

Furthermore, another major finding is that the lower the level of GDP per capita, the higher the growth effects of technology imitation relative to other forms of technology progress such as ICT imports.

Moreover, another study looks at the trade-induced technology progress in connection with the fast-growing bilateral trade partner of African economies, namely China. Using a non-linear panel threshold approach, it was found that trade-induced technology progress is even faster for African countries with higher bilateral trade intensity with China compared to those with lower-intensity. Unlike the existing empirical literature on trade-growth nexus for African economies, our findings suggest a heterogeneous trade-growth nexus with the effect of bilateral trade intensity on Africa's economic growth being higher in countries whose trade intensity with China is higher compared to those with lower-intensity.

Drawn implications emphasize the critical importance of addressing prevailing trade constraints as well as the provision of trade-capacity building. Combined with the estimated thresholds for trade intensity and concentration, these findings imply four categories of trade policies depending on the position of countries in a trade intensity-concentration matrix.

In the post-colonial Africa, technology progress should be at the core of industrial policies and development strategies. In this perspective, fostering technology progress through imitation is crucial. This crucial tool, technology imitation, of industrial catching-up has long being missing in African development policy discussions. Going forward, learning through trade should integrate schemes and incentives for imitation at the center of technology upgrading and other learning challenges.

In addition to the published papers and

presentations listed below, we have organized an international symposium entitled “Industrial upgrading through trade-induced technology imitation in Africa 2017” at Kyoto University to discuss policy implications and suggestions related to the research theme. There are also two papers currently under review: “Growth-effects of ICT Related Technology Imitation in African Economic Growth” *Contemporary Economic Policy* and “Revisiting the Growth Effects of Sino–African Bilateral Trade on African Economies” *Journal of Chinese Economic and Business Studies*.

５．主な発表論文等
（研究代表者、研究分担者及び連携研究者には下線）

〔雑誌論文〕（計 3 件）

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〔産業財産権〕

○出願状況（計 0 件）

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〔その他〕
ホームページ等

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