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**DETERMINANTS OF PRODUCTIVITY GROWTH IN DEVELOPING COUNTRIES:
WHAT REALLY MATTERS?**

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Abstract

We argue that value of productivity determinants supposedly may greatly differ not only between developed and developing countries but also within the developing countries. The research question is what really matters for productivity growth of developing countries and how productivity determinants contribute for certain groups of developing countries. The study investigates the causal impact of the key determinants on productivity growth in the developing countries, capturing the effects for groups of developing countries depending on their development level. We especially focus on the channels of international technology diffusion in developing countries. To this respect we rely on the *new growth theory* as well as empirical studies on *causal explanations of productivity growth*. We substantiate a set of key productivity determinants applicable for the developing countries. For empirical testing we use panel data methods with fixed effects in combination with instrumental variable analysis. Our total sample includes about 80 developing countries for the period of 22 years (1991-2012). *Our hypotheses* are that technology intensive trade openness and R&D spillovers stay main channels of technology diffusion affecting productivity growth. Secondly, the human capital, domestic R&D activity, use of foreign intellectual property rights, and institutional improvement may more ambiguously impact on total factor productivity of developing countries. These effects need to be tested explicitly for groups of developing countries depending on development level. Thirdly, there may be the interactions between some determinants that positively cause the productivity growth of certain groups of developing countries. *The policy impact* of the study may occur on national and multinational levels. A developing country can focus especially on fostering particular determinant greatly effecting its productivity growth. The world community responsibly may implement the instruments related to trade, investments, R&D, intellectual property rights in multinational realm.

Keywords: productivity growth, developing countries, international technology diffusion, total factor productivity, technologically intensive trade openness, research and development.

JEL Classification: O47, O30, F43

OBJECTIVES

Both classic and new growth theories support the idea that productivity growth is the driving force of economic growth of a country. One of the current hot topics in economic literature is the role of different factors of productivity growth. A set of studies claims that productivity growth determinants differ among the developed and developing countries. Besides we argue that the value of productivity determinants may greatly differ also within the group of developing countries depending on their development levels. The divergence among the developing countries has only continued within the last decade. Therefore on a multinational level any universal policy approach for developing countries as a group does not likely meet the productivity growth challenges for these countries. **The research question** is what really matters for productivity growth of the developing countries and how productivity determinants are important for certain groups of developing countries.

Our goal is to determine the key factors of productivity growth in the developing countries. We especially focus on the ways the technologies and knowledge diffuse in the developing countries from abroad. These are trade openness, R&D spillovers, domestic R&D activity, human capital, use of foreign intellectual property rights, and institutional improvement. We plan to investigate the causal impact of the key determinants on total factor productivity in our sample of 80 developing countries for the period of 1991-2012. For empirical testing we use panel data methods with fixed effects in combination with instrumental variable analysis for trade openness. Also we try to tackle endogenous problem for the other explanatory variables as R&D. We especially test the importance of the productivity growth determinants for particular group of developing countries. We disaggregate the broad countries sample into the groups/clusters depending on development level. We plan to find out the key interactions between some variables that positively cause the productivity growth of developing countries. We intend to find new proofs for the new growth theory and make causal explanations of productivity growth in developing countries paying attention on specific importance of productivity determinants in developing countries depending on their development level.

PRACTICAL CONTRIBUTION OF RESEARCH

We attempt to look for new empirical evidence of economic significance of productivity growth determinants that might be applicable for policy making in the developing countries.

The policy challenge is how the developing countries and responsible world community can contribute to foster productivity growth of these developing countries.

The policy impact of the study may occur on national and multinational levels. On a national level a developing country can focus especially on a policy fostering particular determinant(s) greatly effecting its productivity growth. On a multinational level, the international organizations and developed countries as responsible actors may implement the particular instruments related to trade, investments, R&D, intellectual property rights, for instance, in the framework of the WTO special and deferential regime or UNCTAD supporting programs etc. The instruments shall be more specific to meet the productivity growth challenges of certain groups of developing countries depending on their development level.

HYPOTHESES

Our main hypothesis is that the main determinants of productivity growth in the developing countries are technologically intensive trade openness and R&D spillovers from highly innovative countries. Both determinants stay main channels of international technology diffusion affecting productivity growth as predicted by the new growth theory. At the same time low technology oriented trade can even negatively cause the productivity growth in the developing countries. It can mean that raw material trading or cheap energy supplies can prevent the developing countries from moves towards productivity growth.

Our second hypothesis is that human capital, domestic R&D activity, use of foreign intellectual property rights, and institutional improvement may more ambiguously impact on total factor productivity of developing countries. These effects need to be tested explicitly for certain groups of developing countries depending on development level. We may argue that lower developed countries cannot largely benefit from technologies due to insufficient local R&D infrastructure and human capital. Therefore the effect of internal R&D activity on total factor

productivity of the country can be not clear or endogenous. We intend to test this hypothesis in case of certain groups of developing countries.

Thirdly, there may be the interactions between some determinants that positively cause the productivity of developing countries. Following the literature (among others Engelbrecht, 2002; Falvey et al., 2007) we suppose the technologically intensive trade might have larger effect on total factor productivity when a developing country has more educated labor. Also we suppose that technology intensity trade together with human capital may have greater effect on productivity growth. It is even more challenging to test these interactions for certain groups of developing countries.

LITERATURE REVIEW

Theoretical growth studies suggest complex and different relationships between productivity growth and its determinants. The new growth theory supposes that “a country’s openness to world trade improves domestic technology, and hence an open economy grows faster than a closed economy through its impact on technological enhancement” (Jin, 2006, p. 229). The theoretical foundations of the new growth theory are discussed in Romer (1986) and Lucas (1988), and further developed by Grossman and Helpman (1990-1991), Levine and Renelt (1992) and others. As Harrison (1996, p. 419-420) states “trade provides access to imported inputs, which embody new technology, increases the size of the market faced by the domestic producers, which raises the returns to innovation, and facilitates a country’s specialization in research-intensive production”. Taking into consideration the above approach we can substantiate the following sources of productivity growth.

Sources of productivity growth. *Trade, R&D, and R&D spillovers* are generally considered to be the important determinants for productivity growth according to the new growth theory. Danquah et al (2011) empirically finds that the most robust TFP growth determinants are trade openness and technological progress (i.e. innovation). Santacreu (2011) finds that the trade channel is of particular importance in developing countries, accounting for about three-fourths of their growth. Azomahou, Bity and Mbaye (2013) using country *panel* data over 1998-2008 for both developed and developing countries prove that R&D expenditure internally and from abroad impact positively the productivity growth. Coe and Helpman (1995) initiated and other studies continued reporting the

importance of *domestic R&D capital stock*, *North-South R&D spillovers* on the overall productivity growth of the South. The literature summarizes that international technology can be transferred by market transactions and externalities. Keller (2004) stresses that most of them occur namely through externalities (spillovers) but good data on them do not exist. In our research we try to capture at least some components of the externalities by employing North-South R&D spillovers implementing the approach of Coe and Helpman (1995), as well as FDI in R&D, and international licensing/patenting by non-residents.

The theory suggests that the next source of productivity growth is *internal innovations* in a country. But the existing influential studies on the issue tend to employ this variable only for a sample of developed countries, arguing that the R&D expenditures are negligible in the majority of developing countries and their domestic R&D capital is assumed to be constant (Coe, Helpman and Hoffmaister, 1997). Moskalyk (2008) provides some empirical evidence that the domestic R&D tend to be more important for developing countries' productivity recently, however the issue seems to be studied more explicitly. We argue that the country's level of economic development might be the crucial point for the country to be able to use complicated technology successfully. The economic literature recognizes *human capital* as an important determinant of productivity growth. Human capital indicates the quality of the country's labor force that is to use the intermediate products, technology and other intellectual inputs effectively obtained through foreign trade and other channels of international technology diffusion. Falvey et al (2007) find that countries with higher levels of human capital benefit more from international R&D spillovers. The higher quality of *institutions* can cause the growth of a country. However, the important challenge is to determine the proper institution indicator most directly influencing the productivity growth. We may suppose that different kinds of institutions may contribute better on a country's different levels of economic development. The recent studies and an opinion of the EERC experts might be valuable in this case.

The empirical evidence is not unambiguous. A number of empirical studies were undertaken to examine the relationship between growth and trade, R&D activity, R&D spillovers, and other channels of international technology diffusion, but they often show controversial or not explicit results. Even if growth and trade are

correlated across countries, but the mechanisms underlying this relationship are not well understood (Santacreu, 2011).

Reasons of the mixed results and outline for our research In our opinion the *first* fundamental reason of the mixed empirics is not focusing on the central link between these the channels of international technology diffusion and economic growth. As the new growth theory suggests total factor productivity becomes endogenous mainly to trade and R&D investments. They affect output directly through TFP and indirectly through induced capital accumulation (Aghion and Howitt 1992). Therefore we are focusing on the central link between productivity and trade, R&D as well as other channels of international technology diffusion.

The *second* reason might be a difficulty of measuring productivity determinants. Many studies use various approaches to measure openness, human capital, R&D, R&D spillovers, intellectual property rights, and institutions examining their effects on economic growth. We argue that some of the measures can suffer from measurement bias. We explicitly check the appropriate measurement approaches and apply those that identify technology intensive components. For example, we may rely on the indicator of *technologically intensive trade openness*. The other determinants shall be checked in terms of their contribution to technology increase as well. The *third* reason is that some econometric models did not explicitly test causality and endogeneity. In our study we use panel data analysis with fixed effects transformation to eliminate country heterogeneity and apply instrumental variable methods to tackle with other econometrics problems, notably endogeneity, e.g. due to the omission of time-varying explanatory variable or simultaneity problem. We primarily look for proper time-varying instruments for our trade openness and R&D variables. Some findings of consistent instrumental variables for trade openness are reported in Moskalyk (2008).

The *fourth* reason is possible specification bias. The economic literature arguments that different channels of international technology diffusion (including trade, FDI in R&D, R&D spillovers, international licensing) as well as a set of domestic factors (internal innovations, human capital, and institutions) are important factors of productivity growth in a country. However some earlier studies tended to omit some of the factors because of data limitations at that time or other considerations. We argue that these determinants are key factors for the

developing countries and time-varying statistical data are more available now. Moreover a particular group of developing countries depending on development level can benefit from a particular factor(s). The challenge is to adjust these specific factors and identify the role of each for productivity growth.

The *fifth* reason is too broad sample of countries with different levels of economic and technological development. We argue about significant distinction in technological level between developed and developing countries as well as among the group of developing countries, even more evidently in the recent decades. Not counting these differences in the broad samples can result unclear picture of what determinants really matter for the productivity of the sample. We may try to capture the effects of the productivity growth determinants for the certain groups of developing countries.

METHODOLOGY

Data

In our study we plan to examine the causality of relationship between total factor productivity (TFP) and its key determinants for all developing countries for whom statistical data are available for the period of 1991-2012 (about 80 countries and 22 years). To tackle with possible endogeneity problems in estimating equations we use panel data methods with fixed effects in combination with instrumental variable analysis.

Data sources:

- GDP, capital, labor, education completion rate, royalty and license fees payments abroad, domestic R&D expenditures to GDP can be taken from World Bank's World Development Indicators 2013 (WDI),
- Bilateral imports volumes are from IMF Direction of Trade Statistics (DOTS) and MAcMAPS (Trade Map),
- Nominal R&D expenditure data are from the OECD's Main Science and Technology Indicators,
- The implicit deflator for business sector output and average business sector wages for calculation of domestic R&D capital stock can be taken from OECD Analytical Data Base, IMF National Account Statistics,

- Institution variables as Index of Economic Freedom (IEF) can be taken from the web-site of Heritage Foundation, or Corruption Perception Index can be found from the web-site of Transparency International.

Theoretical Model. Estimation

Our theoretical model is based on the new growth theory and in particular the approach of Coe, Helpman, and Hoffmaister (1997), Keller (2004), Lumenga-Neso, Olarreaga and Schiff (2005)¹ with some extensions. In particular we focus on the technological intensity of sources of productivity growth. We add into analysis those indicators that can causally explain productivity growth in developing countries. We also may focus on different groups of developing countries to capture the effect for them. The basic and/or extended log-linear specifications may be reflected in the equations that relate TFP of developing countries to the key determinants, in particular:

- (1) trade openness disaggregated into technologically intensive trade openness, *TITO*, and technologically non-intensive trade openness, *TNITO*,
- (2) R&D spillovers from North, *RDN* (as in Coe and Helpman, 1995, with possible extensions),
- (3) human capital proxied as educational attainment, *E*,
- (4) use of foreign intellectual property rights, *IPR*,
- (5) domestic R&D activity, *RDD*,
- (6) quality of institutions, *I*,
- (7) possible interactions between some determinants influencing TFP.

$$\log TFP_{it} = a_1 \log TITO_{it} + a_2 \log TNITO_{it} + a_3 \log RDN_{it} + a_4 \log E_{it} + a_5 \log IPR_{it} + a_6 \log RDD_{it} + a_7 \log I_{it} + a_8 \log TITO_{it} \log E_{it} + a_9 \log TITO_{it} \log IPR_{it} + a_{10} \log TITO_{it} \log RDD_{it} + c_i + u_{it} \quad (1)$$

¹ Lumenga-Neso, Olivier; Olarreaga, Marcelo and Schiff, Maurice. "On 'Indirect' Trade-Related R&D Spillovers." *European Economic Review*, Elsevier, 2005, 49(7), pp. 1785-98.

Besides, we include in the estimating equation the dummy variables of different groups of developing countries depending on development level using classification approaches of World Bank's income level, as well we can use other clusterization approaches. We may add dummy variables of periods to track the role of factors over the particular time spans.

We may check the alternative models estimators to check the robustness of our basic models, first, consistent for heteroscedasticity and weak instruments; second, we may test the severity of reverse causality problem between some determinants and TFP; and third, we can discuss possible endogeneity in the case of particular groups of developing countries.

Expected Research Outputs

We expect to receive the empirical evidence of the causal impact of the key determinants on productivity growth in the developing countries. The most important is to capture the specific value of productivity determinants in certain groups depending on the particular developmental level, region, and some other clusterization criterion. *First*, we may predict that technology intensive trade openness and R&D spillovers from highly innovative countries stay the major channel of international technology diffusion affecting productivity growth in all groups of developing countries. The economic importance and statistical significance of the estimated parameters may differ for certain groups of developing countries. It might be interesting to interpret. *Secondly*, the human capital, domestic R&D activity, use of foreign intellectual property rights, and institutional improvement may have more ambiguous impact on productivity growth among groups of developing countries and need to be tested explicitly using our models robustness checks. Also the alternative measures in case of institutions, and human capital variables may be applied. We can also look at some extra specific, systemic, and time-varying factors that may influence productivity growth in a particular group of countries, for example, infrastructure. *Thirdly*, there may be a set of important interactions between some determinants influencing productivity growth of a certain group of developing countries. Possible interactions can be between trade openness and human capital, human capital and R&D stock, R&D stock and foreign R&D spillovers. Such synergy seems to be even more important than a single determinant.

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PARTICIPANTS

Roman Moskalyk

The role: modern literature review, model adjustment, data collection and analysis, empirical testing and formulating the conclusions and policy recommendations.

ALTERNATIVE/ADDITIONAL SOURCES OF FUNDING

None

PROJECT TIMETABLE

The study is planned to be completed within 1 year.

In the first part of the research I plan to study modern literature with focus on recent empirical evidence on the issue, to adjust the model specification, collect the data and make econometric testing. I plan to present interim report in the EERC workshop within 5-6 months.

For the final report I plan to do final econometric testing, interpretation of the results, conclusions and relevant policy recommendations. Final report is to be presented in the end of research year.