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ARTICLES

INTRODUCTION TO THE *MACROECONOMIC DYNAMICS* SPECIAL ISSUE ON TECHNOLOGY ASPECTS IN THE PROCESS OF DEVELOPMENT

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We present a set of theoretical and empirical papers and briefly describe the specific contributions to the *Macroeconomic Dynamics* special issue on technology aspects in the process of development.

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The sources of economic growth have been a recurrent topic of research in economics since the writings of Adam Smith. As forcefully shown by Solow (1956, 1957), and despite Alwyn Young's (1992) claim to the contrary, input growth is not

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sufficient to explain output growth. Total factor productivity (TFP) growth, itself largely driven by technological change, plays a sizeable role. This holds for the developed as well as for the developing countries, but the individual components of TFP may differ in the two sets of countries. However, besides technology, there are also institutional, educational, and environmental aspects of growth and development. There may be complementarities but also conflicts between the different drivers of economic growth. For example, by exerting heavy pressure on natural resources, technological progress may cause side effects such as pollution and other environmental damage.

The economics literature seeks to evaluate theoretically and empirically the multiple aspects of technology in the growth and development process. This special issue of *Macroeconomic Dynamics* is a contribution to this reflection. Technology aspects covered in this issue are both theoretical and empirical, and include social capital, human capital, environment and natural resources, new technologies, public investment, innovation and productivity, and structural changes. Most of the papers of this special issue were first presented at the 6th MEIDE (Micro Evidence on Innovation and Development) conference organized by UNU-MERIT in Cape Town in late 2012.

We start with three empirical papers. The first deals with the role of public investment. Relying on a Cobb–Douglas technology, Fossu, Getachew, and Ziesemer specify a nonlinear relationship between public investment and growth to analyze the growth-maximizing levels of public investment for a panel of African countries. The paper further runs welfare-maximization simulations. The results presented contrast with previous findings. Indeed, the growth-maximizing level of public investment is estimated at about 10% of GDP. Consistently, the simulated optimal public investment share is between 8.1% and 9.6% of GDP, showing that there has been significant public underinvestment in Africa.

The role of technology in determining productivity differences between countries has been outlined by Prescott (1998), Hall and Jones (1999), Easterly and Levine (2001), and Fagerberg et al. (2010). In their study, Bresson, Etienne, and Mohnen evaluate the importance of technology, infrastructure, and institutions in explaining differences in TFP among 82 countries over the period 1990–2008. Relying on two kinds of common factors, those in the cross-sectional dimension and those in the time-series dimension, the authors propose a frequentist and a Bayesian approach to estimate a factor-augmented productivity equation. The Bayesian estimator leads to a better fit than the frequentist model. The greatest portion of the variation in TFP is explained by infrastructure, followed by technology and finally institutions.

A last dimension of technology is its societal impact as measured by the structural changes it brings about. Bluhm, de Crombrugghe, and Szirmai test whether stagnation can be predicted by institutional characteristics and external or internal political shocks and whether the effects of the included determinants on the onset of stagnation differ from their effects on the continuation of stagnation. Relying on a panel of 127 developing and developed countries, the study shows that inflation, negative regime changes, real exchange rate undervaluation, and financial and trade openness have significant effects on both the onset and the continuation of stagnation. Only in the case of trade openness is there a differential impact. Moreover, trade openness reduces the probability of falling into a stagnation spell, but does not improve the chances of exiting a spell.

The human capital aspect of technology has been studied more specifically in the papers by Brezis and Dos Santos Ferreira and Diene, Diene, and Azomahou. Brezis and Dos Santos Ferreira extend the Beckerian model of endogenous fertility to take into account net upstream intergenerational income transfers from children to parents in developing countries. The authors show that adding a negative *sibship* size effect is a sufficient condition to restore the quantity–quality Beckerian paradigm. Moreover, allowing the intensity of the effect to increase with sibship size favors the emergence of multiple equilibra with contrasting regimes of child labor, high fertility, low income, and transfers from children to parents vs. child schooling, low fertility, high income, and transfers from parents to children. The technology considered in this paper is embedded in parents' decisions, with a constant wage per efficiency that results from output production by competitive firms endowed with a linear technology.

Whereas the previous study considers deterministic environments, Diene, Diene, and Azomahou develop a framework to explain the role of uncertainty in human capital formation, in particular in finding optimal policy interventions that may improve educational outcomes. The authors posit a stochastic setting where the technology is incorporated into the school production function as well as into household decisions. Policy interventions are then linked to global performance in education. The study characterizes optimal policies and conditions of social welfare enhancement. Furthermore, the authors study the optimal growth of the economy under uncertainty and population heterogeneity when human capital is produced and used in the education sector. They show that the growth rate of the unskilled population has a direct impact on the growth of human and physical capital.

The most controversial, even philosophical, debates about technology focus on its social value. The applications of technology influence society's landmark and new technologies often raise ethical questions. These questions concern, for example, the notion of efficiency in terms of human productivity, a term originally applied to machines, and the challenge of traditional norms. The paper by Bofota, Boucekkine, and Bala discusses this topic. The authors introduce social capital into a growth model à la Lucas (1988) with sector-specific technologies. They consider human capital as a channel through which social capital affects development. The assumptions made about the cost of social capital make it possible to capture the fact that the maintenance of social networks can be costly in terms of resources that could be allocated to consumption or the accumulation of physical capital. It is primarily shown that in contrast to existing alternative specifications, the authors' specifications ensure that social capital enhances productivity gains by playing the role of a timing belt driving the transmission and propagation of all productivity shocks throughout society, whatever the sectoral origin of the shocks. However, short-term dynamics and imbalance effect properties of the model depend heavily on the elasticity of human capital to social capital. In particular, the authors show that when the substitutability of social capital for human capital increases, the economy is better equipped to surmount initial imbalances, as individuals may allocate more working time to the final goods sector without impeding economic growth.

Chan and Laffargue develop a political economy stochastic growth model to explain the main stylized facts of imperial China's dynastic cycle, in particular the evolution of taxation, public spending, and corruption over the cycle and their effects on production and income distribution. Investment in public capital by the emperor enhances the productivity of farmers. The authors clearly highlight an impulse mechanism of the dynastic cycle, which is driven by random shocks to the authority of the emperor and his central administration that change the efficiency of the institutional capital.

Van Zon and Mupela illustrate the benefits of regional connectivity and specialization to growth. The authors show how welfare increases as the number of connected regions increases. The results point to reductions in transportation and communication costs in particular as a suitable vehicle for speeding up growth. There is a strong positive effect of reductions in the cost of making new connections, which in turn impact both the steady state growth rate and transitional growth, while significantly reducing the transition period.

Nguyen and Nguyen Van study the environmental dimension of technology. The authors develop an optimal growth model with two kinds of natural resources in the final sector employing labor to accumulate knowledge. The technology used exhibits increasing returns to scale, and the two types of resources (renewable and nonrenewable) are imperfect substitutes. A direct proof of existence of the optimal solution is provided. In addition, the dynamics of transition to the steady state are used to derive empirically testable convergence relationships.

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