



On optimal long-term relationship between TFP, institutions, and income inequality under embodied technical progress



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ABSTRACT

We develop a simple optimal catch-up model under embodiment to study the potential long term dynamic relationship between total factor productivity (TFP), institutional quality, and income inequality in the context of a developing economy. Assuming a proactive role of institution in the persistence of TFP and minimum inequality spread for social optimum, we quantify the extent to which embodiment characteristics determine the long-term dynamics among these factors. It is shown that the amelioration (deterioration) of institutional quality influences skilled labour mobility across sectors (in developing economies) thereby decreasing (increasing) long term income inequality. Long run scenarios are built using our model in which the production sophistication of the economy under embodiment is shown to be compatible with both better institutions and less income inequality. Quantile regression results for a sample of 27 developing countries over 1990–2010 provide broad support to the theoretical predictions. In particular, it is found that – along the distribution path of embodied technical progress – there is heterogeneous response of productivity growth to the inequality spread and innovation intensity. Our results have interesting policy implications.

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“If machines are indivisible, a vintage capital model must give rise to income inequality. If new machines are always better than old ones and if society cannot provide everyone with a new machine all of the time, inequality will result”.
Jovanovic (1999).

1. Introduction

In a number of recent research – both theoretical and empirical – it has been established that embodied technical

progress (ETP)¹ is an important source of total factor productivity (TFP) growth in both developed and developing countries. The extant literature on this subject identifies two main paradigms. The first one concerns the literature that evolves around trivial/insignificant effect of ETP. This begins with the work of Phelps (1962) and latter qualified by empirical research by Denison (1964) and Matthews (1964), and recently, by Baily and Gordon (1988). In this stream of research, it was emphasized that embodiment hypothesis was largely ‘unimportant’ because changes in the age distribution of capital stock exerted only a small

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¹ Broadly defined as technological improvements in the design of investment goods.

impact on output growth and that ETP could not be adduced as an explanation of the productivity slowdown (especially for the US in the 1970s). The second paradigm centers around the literature that establishes nontrivial role of ETP in productivity growth and development. Notable examples from this camp are [Gordon \(1990\)](#), [Hulten \(1992\)](#) and [Jovanovic \(1999\)](#), and more recently, [Boucekkine et al. \(2006\)](#), who demonstrated that ETP plays pivotal role in productivity growth and economic development.

While the existing research have invariably focused on developed economic context (with the exception of [Boucekkine et al., 2006](#)), the question on 'to what extent ETP can shape the development trajectories of developing economies – has yet to be convincingly understood. However, this is quite important especially in light of the fact that many leading developing economies in recent years have been persistently evincing astounding growth in information and communication technologies (ICT). Like ICT, embodied technical change has also been steadily introduced in a large number of consumer and producers' goods in both developed and developing economies. In conjunction with conducive institutional environment, this technological dynamics is said to have contributed to a large improvement in economic growth over time. However, better things always come with a price that may be detrimental to the development of the masses. Consequently, it has been demonstrated by recent research that ETP may invariably lead to persistent inequality.

Indeed, research both in the tradition of [Jovanovic \(1999\)](#) and its subsequent extensions have demonstrated that vintage capital models are well suited to explain income inequality across economies over time. Assuming that there exists certain degree of complementarity between machine quality and skill, persistence of inequality germinates itself as a natural outcome of the process – thus challenging the conventional exogenous mechanism (viz., policy or initial endowment discrepancies² of inequality persistence). In line with the vintage capital theory income inequality would be the result of different investment choices made by economies. [Boucekkine et al. \(2006\)](#) were the first since [Jovanovic \(1999\)](#) to theoretically assess the development problem under embodied technological progress. While the authors provided broad conclusions of the effect of ETP on macroeconomic process and economic development, they did not undertake a rigorous study of the impact of ETP on inequality on the one hand, and the veritable influence of institutional quality on TFP change under embodiment on the other. This paper aims to fill the void in the growing literature by establishing an optimal relationship between TFP, inequality, and institutional quality under embodied technical progress in a developing economic context. The choice of these countries is led by the fact that developing economies often display observed persistence in income inequality and poor infrastructure and institutional quality.

A number of important reasons also contribute to our objectives. First, several empirical studies conducted

for developed country context (particularly the USA and Europe) have spelled out the relevance of embodied technological progress on (labor) productivity growth of these economies, especially in the aftermath of World War II (see for instance, [Greenwood et al. \(1997\)](#), [Sakellaris and Wilson \(2004\)](#) and [Ströbel \(2013\)](#)). Roughly speaking, almost two third (2/3) of this growth were attributable to investment in embodied equipment. Second, since many Latin American and Asian countries have undertaken huge efforts in ICT,³ it is likely that the same impact (at least in qualitative terms) which is observed in developed countries could also be replicated – at least to a partial extent – for developing economies. Despite its veritable significance, there is sparse literature except [Boucekkine et al. \(2006\)](#) who were the first to extend embodiment theory to the developing economic context. In this research, the distributive aspects were not considered because agents were assumed to be homogeneous. Moreover, the potential role of institutions in economic development under ETP was also limited because the authors assumed the same as an exogenous variable and was not connected to changes in TFP.

While the existing research on embodiment discuss about various consequences, such as, domestic equity ownership and outsourcing in the presence of embodiment, the 'missing institution' may play a significant role in producing heterogeneous effect of embodiment on economic development. For instance, [Helene \(2013\)](#) developed framework in the environment proposed by [Boucekkine et al. \(2006\)](#) and determine under which conditions domestic equity ownership constraints imposed on multinational corporations turn out to be beneficial for a country aiming at narrowing its technology gap with the world frontier while facing a limited supply of skilled labor resources. Similarly, [Herbert et al. \(2010\)](#) present a dynamic model of a firm in deciding whether to outsource parts of its production to a less developed economy where wages and the level of technology are lower. The authors find, among others, that there is variable effect of the speed of technology adoption and of the wage differential on total labor income in the home country.

In the current research, we introduce an analytical setting by considering both distributive and endogenous role for institution to influence economic development under embodiment. There is branch of literature that concentrates on the influence of labor market institutions as another source of wage inequality. In this setting, the impact of trade unions, collective bargaining systems and minimum wages are identified as important institutions that influencing the distribution of wages. In this paper, however, we do not explore the distributive effects of all these types of institutions under embodiment. Rather we focus our study on how changes in endogenous institutional quality impact changes in TFP and whether such changes are compatible with the sophistication of the economy with less income inequality.

The rest of the paper is organized as follows. In Section 2, we present and discuss the properties of our model.

² See [García-Peñalosa and Turnovsky \(2006\)](#); and [Galar and Zeira \(1993\)](#) for details.

³ By definition, it includes both sophisticated and specific (i.e., embodied) technological change

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