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Information age to genetic revolution: Embodied technology transfer and assimilation — A tale of two technologies☆

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Abstract

In this paper, a fifteen regions–fifteen sectors global Computable General Equilibrium (CGE) model is calibrated. It offers quantitative enumeration of 5% exogenous biotechnological invention in USA in genetically modified crops namely, maize grains and soybean. Consequently, it results in endogenously transmitted productivity gains via traded intermediates in user sectors in donor and recipient regions. Sustained absorption and domestic usability of transgenic varieties depend on constellation of: human capital-induced absorptive capacity, governance, and structural congruence between source and recipients contingent on technology infrastructure and socio-institutional parameters. Such innovations result in higher production, welfare and global trade. Also, concomitant 4% exogenous productivity shock in information technology along with 5% productivity growth in the agro-biotech sectors further enhances such simulated impacts on global production and welfare. Regions with larger extent of technology capture aided by higher human capital, better governance, conducive institutional-structural features, and superior technological expertise perform better.

JEL classification: C68; D58; F13; O3; Q17; Q18
Keywords: Biotechnology; Information technology; Spillover; Computable General Equilibrium; Institutional factors; Absorption; Intermediate-input augmenting technical change

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1. Introduction: objectives and scope

The purpose of this paper is to offer a quantitative analysis of the joint role of information technology (IT) and biotechnology (BT) as providing the 'law of motion' of economic growth. Genomics and proteomics based on genetic algorithms, genetic engineering, gene mapping and cellular automata shows that IT and BT are 'coupled interlinked systems' with gradual convergence of boundaries between the two [1].[1] Needless to say, advances in genetic engineering techniques are built on the development of cutting-edge research in IT so that we find concomitant development in both technologies [2]. According to Linstone [1], "the convergence of information and molecular technologies may well revolutionize the innovation process and transform not only the role of forecasting, but also the process of foresight and planning." Rapid evolution of IT as a general purpose technology (GPT) gives access to rapid information network (for example, via gene bank), faster execution of experimental scientific revolution and bio-chemical synthesis. In fact, Office of Technical Assessment (OTA) of the US, identified potential areas of application of IT in agriculture such as in integrated pest management (IPM), irrigation control systems, control of application rates of fertilizers, pesticides, other agricultural chemicals, and farm management [3]. Therefore, BT developments, as aided by simultaneous maturing of IT cluster, are bound to deliver immense benefits to the society at large. The economic impacts of such inventions and their inter-cluster and inter-regional diffusions are best evaluated in a framework of 'social system agent-based simulation models' [1]. In particular, this paper focuses on exogenously specified invention of transgenic varieties in GM crops and the induced productivity escalation with the dissemination of technological improvements through multi-sectoral and multi-country interlinkages. As IT development enhances BT activities by genome mapping and programming, the information revolution facilitates gene revolution, which, in turn, induces the scope for cumulative productivity gains and cost advantages in the modern varieties of high yielding crops that are inaccessible otherwise by conventional breeding techniques. Thus, the 'gene revolution' and 'green revolution' are congruous, reinforcing one another in a complementary relationship [4]. Also, diffusion and adoption of modern plant varieties depend on constellation of technological, economic, and social factors. These factors can be represented by proxies such as absorption capacity (AC), social acceptance (SA) and structural congruence (SC). We attribute 'AC' to the human capital endowment and skills. 'SC' between the origin of technology creation and the recipients depend on governance indicator, factor proportions and technological distance between partners. Also, ' SA' based on human development index determine domestication of such genetic varieties for harnessing the benefits. We explore how these three proxies parameterize and hence, conjointly influence the extent of capture of technology embedded in traded products. A modified 15 regions–15 sectors Computable General Equilibrium (CGE) model with the global trade analysis project's (GTAP) database is calibrated for this purpose [5].

Of late, plant-biotechnology and use of genetically modified (GM) plants has grown into a $4.5 billion-a-year sector with most of the developments centered on food crops, particularly soybeans and oilseeds, maize grains, corn and canola. According to the International Society for the Acquisition of Agri-biotech Applications (ISAAA), the total extent of world coverage under GM varieties in 2003 is around 167.3 million acres, representing a 15% increase over the previous year [6]. Of this, developing regions accounted for 33% (compared to 25% in 2002) and the US tops the list with 66% of world aggregated acreage whereas EU accounts for only 0.5%. It is projected that by 2009, the acreage under GM crops and the number

[1] Growth of IT, BT and nanotechnology are studied as evolved through simulations based on computer simulation of complex, non-linear system, adaptive systems (CAS).