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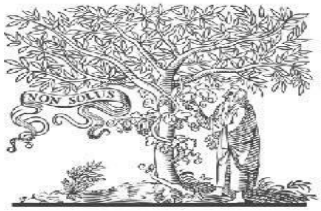

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TECHNOLOGICAL OBSOLESCENCE ANDMODERNISATION

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ABSTRACT

Many twentieth century works composed for instruments and live electronics are seldom performed due to their use of near obsolete technology. Some performing bodies avoid such works because the necessary technology is either unavailable or too expensive to hire. The use of open source software and standard protocols is proposed as a way of reducing technological obsolescence.

In this paper, an endogenous growth model is built up incorporating Schumpeterian creative destruction and embodied technological progress. Under embodiment, long run growth is affected by two opposite effects:

(i) obsolescence costs add to the user cost of capital, which have a negative effect on research efforts; and

(ii) the modernization of capital increases the demand for investment goods, raising the incentives to undertake research activities. Applied to the understanding of the growth enhancing role of both capital and R&D subsidies, we conclude that the positive effect of modernization generally more than compensates the negative effect of obsolescence.

The aim of this paper is to review current achievements relating to the theory of innovative activity and innovation including concept of 'triple helix' and its extension by adding customer. A concept of horizontal and vertical product differentiation and access to sources of knowledge has been linked to product quality and innovative activity. Access to knowledge depends on the type of research and development activity and network governance between firms

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INTRODUCTION

An important issue for growth and development theory is the role of subsidies to both capital accumulation and R&D activities. In the neoclassical growth framework, subsidizing capital has no permanent impact on the growth rate, since investment only matters in the short run while technological progress is the sole determinant of per capita growth in the long run. In contrast, facilitating and subsidizing R&D and technology adoption should foster long term growth. Moreover, in R&D based growth models, a` la Romer (1990), subsidies to research activities, which precisely drive technological progress, are effective in boosting growth. The dichotomy between capital accumulation and technological progress was at the heart of the embodiment controversy in the 1960s, as recently pointed out by Hercowitz (1998).[1] Supporters of the embodiment hypothesis argued that investment is the channel through which innovations are implemented. Since investment plays a modernization role under embodiment, it should be a decisive determinant of long run growth. In this paper, we claim that the growth enhancing role of capital subsidies needs to be analysed in an endogenous growth model with embodied technical change, and we show that the main implications of the embodiment assumption for fiscal policy cannot be captured if the modernization role of investment is neglected, which gives a theoretical support to the importance of the embodied question. Howitt and Aghion (1998) show that Romer's result is biased by the assumption that labour is the sole input in the production of research. Indeed, if the R&D sector employs capital as an input, subsidizing capital is growth enhancing. Paradoxically, Howitt and Aghion suggest that if new technologies are embodied in new machines, embodiment actually has the effect of weakening the result that a capital subsidy will affect long run growth. The reason is that replacement adds obsolescence costs to the user cost of capital, reducing the incentives to innovate. Nonetheless, the empirical literature suggests that the modernization of capital is growth enhancing. DeLong and Summers (1991) find that countries with high growth rates are precisely those with both large investment rates and fast decline rates in the relative price of equipment. These observations capture the modernization role and the embodied nature of technological progress. Wolff (1991), for a sample of seven OECD countries, finds that catch-up in total factor productivity is highly correlated with capital accumulation. He also concludes that embodiment plays a central role in this relationship as productivity growth is highly sensitive to the age of the capital stock. Bardhan and Priale (1996) notice the significant difference in the saving rate between Latin America and East Asia and invoke the modernization role of investment to explain fast economic growth in East Asia and relative stagnation in Latin America. In this paper, we introduce capital and embodied technical progress in a Schumpeterian growth model a` la Aghion and Howitt (1992). The model we propose is an endogenous growth version of Greenwood et al. (1997). As in Howitt and Aghion

[1] See Denison (1964), Phelps (1962) and Solow (1960).

(1998), the user cost of capital is increased by obsolescence costs. However, obsolescence costs are of a different nature: in Howitt and Aghion, the scrapping of machines due to the replacement of obsolete technologies increases the user cost of capital; in our framework, technologies are infinitely lived, but the investment-specific nature of technical progress permanently increases the productivity of the investment sector generating a stable decline of investment prices, which adds capital losses to the user cost of capital. More important, in our framework, research activities are exclusively addressed to the improvement of productivity in the investment sector. It is the simplest way to introduce embodied technical change. For this reason, profitability in the R&D sector depends crucially on the demand for investment goods. When technological progress is high, the demand for investment goods is high too, which raises the incentives to undertake research activities. This is the modernization role of embodiment. When applied to understanding subsidies to both capital and R&D activities, we show that the modernization effect more than compensates obsolescence costs, which contradicts the Howitt and Aghion claim that embodiment reduces the incentives to innovate and the efficacy of subsidies to capital.

IMPACT OF TECHNOLOGICAL INNOVATIONS ON ECONOMICGROWTH OF NATIONS

There is no doubt that the main strategic goals of enterprises in the future are: surviving in goodeconomic condition and satisfying the needs and requirements of customers better and faster than competition along the value chain.[2] To achieve such goals one must answer a variety of questions and find a way of solving numerous organizational and technical problems. Enterprises should consider changing dramatically market position, inventing new branches or redefining existing ones, discovering new rules of competition, new distribution channels, new value chain forms,[3] and new production systems.[4] There exist various ways to respond to the problems mentioned, however, a critical determinant of organizational performance is introduction of new products or services,[5,6] which in turn seek for new technologies and knowledge, can establish new markets and new market demands.[7] Many sources on new product or service introduction stress the enterprise's innovation ability as the result of creation, management and maintenance of knowledge.[8] The absorption of knowledge, in turn, results from R&D across industries and countries and good cooperation between researchers and practitioners.[9] The most remarkable absorption occurs in the US, Japan, Germany, France, the United Kingdom, Canada, Italy, the Netherlands and a few other countries. This absorption has been used by OECD for classification of industries into four categories, namely: high technology, medium-high-technology, medium-low technology, low-technology industries. in which relative importance of the following characteristics differs:

• intensity of R&D activity,

[2] Zalewski R.I., Skawińska E. (2004). Product quality in the process of competitive advantage formation, Foundation of Control and Management Science, 1,65-84.

[3] Hamel G., Prahalad C.K., (1999). Przewaga

konkurencyjna jutra, Business Press, Warszawa.

[4] Best, M.H., (2001). The Competitive Advantage, Oxford University Press.

[5] Dampanpour, F., (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. Academy of Management Journal, 34: 555-590.

[6] Smith K. G., Collins C.J., Clark K. D., (2005). Existing knowledge, knowledge creation capability, and the rate of new product introduction in high-technology firms. Academy of Management Journal, 48(2), 346-357.

[7] Brown, S., Eisenhardt, K., (1995). Product development: Past research, present findings, and future directions.Academy of Management Review, 20: 343-378.

[8] Drazin, R., Rao, H., (2002). Harnessing managerial knowledge to implement product-line extensions: How do mutual fund families allocate portfolio managers to old and new funds? Academy of Management Journal, 45: 609-619.

[9] Van de Ven, A. H., Johnson P.E., (2006). Knowledge for theory and practice, Academy of Management Review31 (4) 802-821.

- level of innovation,
- diffusion of innovations,
- economic risk,
- adulteration of investments and product technologies,
- product life cycle, internalization, co-operation, networking between industries, researchinstitutions in and between countries,
- competitiveness.

Innovative ability was not a subject of serious and deep studies in the theory of economy which follow early work by Joseph Schumpeter.[10] The studies by Paul Romer published in 1986 indicated that technical progress is the main driver for economic growth.[11] This growth could be measured via several indicators e.g. GDP, labour productivity, export of products etc. for a given economy. Technical progress improves transformation of resources and expenditures into products. The renaissance of interest of scholars into this subject has been revived recentlyafter OECD published a report concerning Technology Economy Programme.[12] The aim of this paper is to analyse the current state and newest achievements and developments in theoryof innovations. On this ground, the discussion of relationship between summary innovative index SII and macroeconomic indicators for several countries will be held. The place of Poland in these two dimensions will be shown among OECD and European Union countries.

[10] Schumpeter J., (1928). The instability of capitalism, The Economic Journal, 38(9). Schumpeter, J. (1939).Business Cycles. New York: McGraw-Hill.

[11] Romer P., (1986). Increasing returns and long-run growth, Journal of Political Economy, October.

[12] OECD (1992). Technology and the Economy; The Key Relationships, Paris.

SHIFTS IN THE NATURE OF R&D EFFORTS AND ITS EVALUATION

An appealing alternative explanation of the productivity paradox, which is unfortunately, not considered by Jones (1995a, 1995b), is to look at possible shifts in the nature of R&D efforts in relation to productivity growth. In discussing the productivity paradox from this perspective, three explanations arise. These explanations are:

1. R&D statistics (particularly in small firms) seem to capture only a part, and sometimes evenless than half of the total efforts attributed to technical progress, which does not show up in official statistics (OECD 1992);
2. The nature of new technologies has changed in such a way that nowadays both complementary technologies have to be developed and radical organizational changes have tobe made in order to gain a technology's full potential (David 1990);

3. R&D efforts may have become more and more devoted to product differentiation than to (product or) process innovation, thus hardly affecting economic growth but more so total consumers' welfare (Soete 1996 and Young 1998).

Testing for the applicability of these notions in a formal way is quite a challenge (and Young 1998 has already partially done so). A model that may prove very suitable is a specification à la Jones (1995b), which is enlarged by Quah and Keely (1998) and Jones and Williams (1998).[13] Here however, we will continue by pointing out which explanation of the above we find most attractive in explaining the productivity paradox, while trying to assess its importanceby means of several economic indicators.[14]

Both the investment strategies of firms and of consumers will change if the economic situation changes, as indicated by for example Kurdas (1994). A normal scenario would be that in times of economic booms, firms and customers spend large amounts of money on a similarly large variety of products. In times of recessions the reverse situation takes place: the real interest rate goes up, and people will spend their money on a rather fixed set of goods and services (although slight variations in the nature of the goods and services are possible), while firms postpone their most risky R&D efforts and invest in variations on existing products in order to fulfil consumers' demands. Besides, they might consider financing their R&D efforts more and more by themselves, instead of speculating on financial markets. If this way of reasoning is in line with economic practice, then there should be a relationship between the amount of money spenton R&D and the real interest rate. As it turns out, R&D growth and the growth of the real interest rate have moved together over the last 25 years quite closely (although the strength ofthe relationship has weakened considerably from the late 1980s onwards). Thus we may say that as an economic downswing sets in, people will invest in less risky projects. For a firm, trying to achieve maximal profits, this could imply a preference for emphasizing equivalent innovations over non-equivalent innovations. Thus, economic growth would not be increased but consumers' welfare would (Young 1998). It is very interesting that this particular role of the real interest rate has never been considered much in formal modelling (exceptions perhaps being McKinnon 1973, Morrison and Berndt 1981, Shaw 1973 and Fry 1988). Equivalent innovations as well as non-equivalent innovations utilize R&D, but the latter type of innovation is probably patented more heavily by default. This means that analysing the ratio of patents granted by the US Patent Office (USPTO) and total R&D expenditures (in constant prices) can test the aforementioned notion. The ratio is standardized so that it equals 1 in 1985. For reasons of data availability, we focus on total manufacturing (ISIC code 30) only. Figure 3.1 contains the relevant statistics. The countries considered are the G7, Japan, the Netherlands, the US, Germany, France and the UK.

IMPACT OF INFORMATION

[13] Using such a model would not only allow us to validate our explanations of the productivity paradox further,but also give us the opportunity to discuss, for example, balanced growth issues.

[14] The other explanations, including those of footnote 2, have been discussed more prominently in the recentliterature anyway.

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AND COMMUNICATION TECHNOLOGY ON ECONOMIC GROWTH

Over the last decades, the great diffusion of information and communication technology (ICT) has caused a dramatic transformation of the world into an information society. Thanks to ICT infrastructure such as fixed-line telephones, mobile phones, Internet, and broadband, people, firms, and governments now have much better access to information, knowledge, and wisdom than before in terms of scale, scope, and speed. ICT diffusion has substantially improved the efficiency of resources allocation, enormously reduced production costs, and promoted much greater demand and investment in all economic sectors.[15] While a number of empirical studies confirmed that ICT diffusion plays a positive and significant role in improving economic growth, especially in developed countries,[16] other studies found that economic growth in manycountries and regions of the world is negatively affected by ICT diffusion.[17] Focusing on developing countries, many previous studies have conducted empirical works employing different econometric models and using cross-country data to understand the relationship between ICT diffusion and economic growth.[18] These studies produced ambiguous results, andthere was a great disagreement between researchers about the question of a strong growth-enhancing effect of ICT diffusion in the context of developing countries. Therefore, this issue is still open to investigation. Among developing countries under investigation, some recent studies showed a particular interest in studying the effect of ICT diffusion on the economic growth of developing countries in the Middle East and North Africa (MENA) region,[19] and the Sub-Saharan Africa (SSA) region.[20] This interest has developed due to the fact that in recent years most MENA and SSA countries have experienced a dramatic surge in the usage of ICTs; this is measured by several indicators such as fixed-line telephone and mobile cellular subscriptions, number of Internet users, and number of broadband subscriptions (World Bank 2017; International Telecommunications Union 2017). In addition, a literature review shows that compared to developed and Asian countries, research on ICT in MENA and SSA regions is still in its infancy stage and needs further exploration and discussions to produce a clear idea on the effect of ICT diffusion on economic growth in these regions. Given this, the purpose of this paper is to investigate the effect of ICT diffusion on the economic growth of 45 developing countries in the MENA and SSA regions by employing a two-stage panel Generalized Method of Moment (GMM) growth model over the period 2007–2016. The remainder of this paper is organized as follows: Section 2 presents a brief literature review of the

[15] Jorgenson and Stiroh 1999; Vu 2011; Lee et al. 2012; Grimes et al. 2012; Pradhan et al. 2015.
[16] Roller and Waverman 2001; Inklaar et al. 2005; Koutroumpis 2009.
[17] Dewan and Kraemer 2000; Pohjola 2002; Papaioannou and Dimelis 2007; Yousefi 2011; Pradhan et al. 2015;etc.
[18] Nasab and Aghaei 2009; Andrianaivo and Kpodar 2011; Sassi and Goaied 2013; Pradhan et al. 2015, 2018;Aghaei and Rezagholizadeh 2017.
[19] Hassan 2005; Sassi and Goaied 2013.
[20] Andrianaivo and Kpodar 2011; Lee et al. 2012; Wamboye et al. 2015; Albiman and Sulong 2016.

subject. Section 3 describes the methodology applied to the MENA and SSA countries. Section 4 reports and discusses the results found. Section 5 concludes and provides policy implications and recommendations.

CONCLUSION

R&D based models relating technical change and economic growth have been unsuccessful in explaining the recent productivity paradox: R&D efforts have risen continuously in advanced countries during the post-war period whereas productivity growth has, if anything, declined. We offer three explanations of the paradox and consider one of them empirically.

The notion that R&D efforts are more and more attributed to product differentiation, thus enlarging consumers' welfare while simultaneously exhibiting only limited effects on economic growth, may very well be the most promising in explaining the productivity paradox. Besides,we find an interesting relationship between R&D growth and the growth of the real interest rate in our dataset of advanced countries, which poses great challenges for formal modelling.

Economic growth on a macro scale is approximated by several indicators e.g. GDP, GDP per capita, productivity or labour productivity, export of products etc. for a given economy. It is agreement in the literature that the engine of growth is innovation and quality. Thus, the latest outlines of innovative activity have been summarized. Innovative activity of nations is a complex, multidimensional construct exemplified by Summary Innovative Index SII for EU countries and Global Summary Innovative Index GSII. The relation between GDP per capita and SII for European and selected other countries is found to be a curvilinear semi-logarithmicplot.

In this study we investigated the effect of ICT diffusion on the economic growth of 45 developing countries from the MENA and SSA regions over the period 2007–2016. A two- step panel GMM growth model was employed to explore the nexus between economic growth and four ICT variables: fixed telephone (TEL), mobile phone (MOB), Internet usage (INT), and broadband adoption (BBA). Other policy implications related to control variables introduced in the estimations are to be considered.

Many actions should be undertaken by financial authorities in both MENA and SSA countries to improve their financial sectors. Right now, financial sectors are not well developed enough to help ICT drive economic growth, particularly in many SSA countries. Furthermore, authorities in MENA and SSA developing countries should continue their efforts to increase the openness of their economies and prioritize the allocation of resources to the development

of ICT infrastructure to benefit from the ICT revolution. In addition, they should enact policies that provide a more convenient

regulatory and institutional environment to attract foreign investors, enhance fair competition in the ICT sector, and promote Internet-enabled services and Internet presence, including e-government and e-commerce. Finally, MENA and SSA governments should adopt the necessary policies to contain government consumption and inflation rates in order to avoid their negative impact on economic growth.