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QUARTERLY REVIEW OF ACADEMIC LITERATURE ON THE ECONOMICS OF RESEARCH AND INNOVATION

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1. The Middle Productivity trap: Dynamics of Productivity Dispersion

Bahar, D. (2017). *The Middle Productivity trap: Dynamics of Productivity Dispersion*. *Global Economy & Development*, Brookings, Working Paper 107, September 2017.

- The paper aims to investigate the reasons behind the recent growing dispersion of productivity in narrowly defined sectors.
- It links convergence-divergence dynamics of firm-level productivity growth to within-industry dispersion.
- The paper confirms that (i) median Total Factor Productivity (TFP) has decreased across sectors since 2006 and (ii) the dispersion of productivity levels has increased across all the observed sectors, and shows that (iii) the distribution in TFP productivity growth follows a U-shaped pattern: the fastest growing rates are found at both extremes of the distribution, i.e. in high and low productive companies, across the examined industries.

The analysis makes use of firm-level data from the Orbis database from Bureau Van Dijk and from COMPUSTAT (for US data). The sample used is an unbalanced panel of a bit less than 4 million firms in 127 countries between 2006 and 2014, totalling over 16 million observations. The firms are sorted into 5 industry categories, at the one-digit NAICS level: agriculture and fishing; mining, utilities and construction (MUC); manufacturing; commerce (retail and wholesale); and; finance, insurance and real estate. Summary statistics show that between 2006 and 2014, (i) the median TFP rate has declined across sectors and that (ii) the dispersion of productivity rates has increased in the observed sample (measured by the standard variation of log TFP).

It shows that while convergence is indeed taking place – growth rates decrease with increasing initial productivity levels – the relation is non-linear. This signifies that both, firms at the lower and at the upper end of the distribution tend to have higher growth rates, leading to a "*middle productivity trap*". While at first the relationship is negative: firms with a low initial level of productivity show higher growth rates, which decrease progressively with increasing initial levels, a turning point occurs for all observed industries at the end of the distribution. Hence growth rates start to increase again with higher initial productivity levels – around the 98th percentile, except for MUC for which it occurs earlier. These results support results of previous studies on the divergence of productivity levels between frontier and laggard firms, the rise of superstar firms and the slowdown in aggregate productivity levels.

2. Aggregate multi-factor productivity: measurement issues in OECD countries

Égert, B. (2017). *Aggregate multi-factor productivity: Measurement issues in OECD countries*. OECD Economics Department Working Papers; No. 1441; OECD publishing; Paris.

- Values of Multi-Factor Productivity (MFP) are linked to measurement issues, being by definition a measure of the unknown, "residual" of output once all inputs are accounted for.
- The paper aims at making a sensitivity analysis of MFP measurements, to show the implications of using alternative measures.
- The results show that the treatment of Human Capital (and whether it is used at all) and Purchasing Power Parity (PPP) have an impact on the results, while using the different measures for labour and capital stock does not alter the results.

The paper sets out to perform an extensive sensitivity analysis on the different ways of measuring the levels and dynamics of MFP. It uses 2005 PPP adjusted labour force survey data for 34 countries. At first, a reference measure for MFP is calculated and subsequently alternative measures are constructed to assess which inputs have an impact on the results. The impact of the following variables is tested: (i) Human Capital; (ii) the way labour is measured, i.e. hours worked or number of employees; (iii) how the capital stock is measured; and (iv) which measure of PPP is used for comparison between different countries. The results show that including Human Capital as a variable is crucial and provides more intuitive productivity results. For PPP exchange rates, using constant or varying PPP has an important impact on the resulting MFP. Here investment PPP appears to deliver the most plausible results, whilst using constant or varying PPPs also seems to have advantages. For labour input, using employment or total hours worked, only a small influence on the results is observed. Finally, it is found that the measures used for physical capital can also have an influence on results, as well as the initial level used and the depreciation rate.

3. Global value chains, national innovation systems and economic development

Fagerberg, J.; Lundvall, B-Å; Srholec, M. (2017). *Global value chains, national innovation systems and economic development*. *Papers in Innovation Studies*, No. 2017/15. Circle, Lund University.

- The paper looks into "openness" and Global Value Chains (GVC) for economic development
- Taking advantage of relatively recent data on trade in intermediate products by UNCTAD, the analysis allows to test not only different forms of openness, but also the impact of technological, absorptive, and social capacities.
- The results show that growth levels depend on the national innovation system and that the participation to GVC is not as important as often assumed.

Economic development depends on a large set of factors that go beyond capital, labour and the access to natural resources, such as the ability of an economy to absorb and use knowledge. Given that the foreign knowledge-base is usually larger than domestic ones, the role of "openness" and international knowledge flows has gained increasing interest, especially the participation of economies in GVCs. This paper aims to investigate the role of openness for economic development, with a particular look at the participation in GVCs using import data from value added input-output tables provided by UNCTAD and the OECD. These data allow also testing the impact of other channels of knowledge flow, such as capital goods imports; Foreign Direct Investments; and the outbound mobility of tertiary students. Additionally, it uses different indicators to capture the role of innovation systems – via technological and social capabilities of the observed economies (via a composite indicator) as well as several control variables (size, access to natural resources etc). The analysis is performed via a conditional growth regression, using the log of the indicators, for 125 countries and two periods: 1997 and 2013. It shows that while capabilities always have a significantly positive effect on economic development, the participation in GVCs is negatively associated to economic growth, especially for low income countries, with at best a zero contribution for rich countries. It underlines the need for economies to develop their national innovation systems, while the effects of openness might not be as positive for growth as often put forward.

4. What does it take to implement open innovation? Towards an integrated capability framework.

Hosseini, S.; Kees, A.; Manderscheid, J.; Röglinger, M.; Rossemann, M. (2017). What does it take to implement open innovation? Towards an integrated capability framework. *Business Process Management Journal*, 23(1), 87-107.

- The study discusses which capabilities companies should develop to be able to implement Open Innovation (OI)
- It builds on a two-step process: a literature review in a first, and discussions with experts from academia and industry in a second step
- It proposes an Open Innovation Capability Framework (OICF), that can be seen as a guide for what companies should consider when switching to an open form of innovation

In recent years, much attention has been devoted to the use of external knowledge for innovation within companies. In a context of shorter product-life cycles, advances in ICT, social networks and global knowledge flows, the advantages of open forms of innovation for the competitiveness of companies are being widely discussed. While many large companies are using OI, many companies are failing to move from a closed to an open form of innovation. Research on this issue is fragmented. This paper tries to collect the different work streams to develop a holistic approach on what type of abilities companies need to allow for a successful implementation of an open form of innovation.

The study was conducted in a two-step process: a literature review was performed in AISel, EBSCOhost and ScienceDirect using keyword search, which resulted in a more detailed analysis of 127 studies that were sorted using heatmaps. This was followed by a discussion with experts from academia and subsequently industry to refine and endorse the suggested findings. The result is an Open Innovation Capability Framework (OICF) encompassing 23 capability areas, divided into 6 factors: strategic alignment (the alignment of the OI strategy with the business and the IT strategy of the company), governance, methods, IT, people and culture. The work also reveals that the contextual factors have not yet been researched enough, as well as factors related to the human side: people and cultural implications, but also strategic alignment.

5. The nature of industrial development and the speed of structural change

Romano, L., Trau, F. (2017). The nature of industrial development and the speed of structural change. *Structural Change and Economic Dynamics*, 42, 26-37.

- The paper studies the links between globalisation, industrial development and *intra* and *inter* sectoral structural change for a panel of developed and developing countries.
- The emergence of Global Value Chains in the age of globalisation has affected industrial development in late industrialising countries, stimulating a narrower specialisation in manufacturing and a faster take up and slowing down of the industrialisation process.
- While previously accumulated industrial competences and global value chains affect countries' specialisation, investing in new capabilities is fundamental to expand each country production frontier.

The Age of Globalisation has dramatically changed the world division of production since the 1980s. Technological change and the progress in communication and transportation have reduced the associated cost breaking the boundaries of production possibilities. Production has been increasingly organised world-wide to exploit both wage differentials and the availability of knowledge networks. The paper analyses how the distribution of production across global value chains has affected countries' specialisation in industrial activities, focusing on two main aspects. First, on the consequences in terms of *intra*-manufacturing structural change, i.e. how international competition has led new industrialising countries to focus on a narrower set of manufacturing activities to exploit comparative advantages. Second, on the *inter*-sectoral structural change, i.e. how fast these countries have been deindustrialising away from manufacturing.

Exploiting a sample of 44 countries in the period 1980-2011, the authors find that indeed new industrialising countries have been concentrating their activities on a narrower range of activities compared to countries which first entered the industrialisation process. In particular, the later industrialisation kicked off, the faster the sectoral concentration of manufacturing value added was. Furthermore, the correlation between specialisation and globalisation is positive and significant. Similarly, these countries experience a rapid deindustrialisation process compared to the already developed economies, with a shift of economic activity away from manufacturing sectors. The authors suggest that this process can be due to the limited set of manufacturing capabilities developed by these economies together with the saturation of the original comparative advantage. Investing in new capabilities and knowledge would be therefore fundamental to expand the production frontier not to halt the convergence process observed in the developing world.

6. Digital Innovation and the Distribution of Income

Guellec D. and C. Paunov (2017). Digital Innovation and the Distribution of Income. *NBER Working Paper Series*. Working paper 23987

- This research paper provides an overview of the relationship between digital innovation and changes in income inequality in recent years.
- Digital innovations have the properties of non-rival goods and can hence be scaled-up at low or even no additional cost other than the cost of the invention.
- Digital non-rivalry (DNR) leads to a concentration of market shares, sometimes even natural monopolies, so-called winner-takes-most market structures.
- A panel model using ExecuComp data is estimated showing that in markets with higher concentration and higher risks, pay of top executives is also high at the industry level.

The authors cite numerous examples of how digital innovation is one of the factors which can be attributed to growing inequality. An empirical link to the rise in top executives' pay is established on one hand and on the other, the stagnation of average and low pay. Intangible goods such as software or companies operating platforms such as Google or Facebook, for example, have grown increased their market share in the past decade thanks to the DNR nature of their products and their large returns to scale. For policy makers the challenge lies in finding policy tools to counterbalance the observed rise in income inequality which do not stifle innovation activity. So far, policies as well as the measurement and documentation issues of the deep changes caused by digital innovation are not taking into account the increasing role of intangible capital and its rents. Just as ICT patents show a strong upward trend, other traditional sectors such as automotive, pharma and aerospace and defence also thrive on embedded IT assets and inflate the intangible capital stock. The evolution of profits in global knowledge-intensive markets displays a winner-takes-most market structure. The top percentile of firms ranked by return on invested capital grew the most over the last three decades. While digital innovation contributed to these developments, it also increased the risks that firms operating in these markets have to bear. This contributes to the declining return to labour as well as higher returns to executive pay. Policy makers have yet to come up with an adequate response to tackle growing inequalities – be it through fiscal policy, innovation support policies, IPRs and standards or competition policy.

7. Optimization in R&D intensity and tax on corporate profits for supporting labor productivity of nations

Coccia, M. (2017). Optimization in R&D intensity and tax on corporate profits for supporting labor productivity of nations. *The Journal of Technology Transfer*, 1-23.

- The present study investigates the optimal level of R&D intensity and taxes on corporate profits so as to reach a higher path in terms of labour productivity.
- Two working hypotheses are tested: first, R&D expenditure enhances economic growth and labour productivity and second, R&D investment opportunities can be reduced by high taxes on corporate profits.
- These hypotheses are tested on a sample of thirty-five OECD countries for which aggregate level data is available over the period from 1992-2014.

The research aim of this paper is to determine an optimal rate of R&D investment as well as a tax rate on corporate profits which fosters labour productivity. To do so, the authors investigate the functional forms of these relationships separately. Namely the link between R&D intensity and labour productivity as well as between labour productivity and the tax rate on corporate profits at the country-level. Via optimisation of the estimated relationships, it is found that the ideal level of R&D intensity lies at about 2.5% of GDP, whereas the optimal tax on corporate profits is 3.1%. The relationship between these two variables and labour productivity is characterized by an inverted U-shape: both low and high rates affect labour productivity negatively. The findings also confirm the hypothesis that optimal levels exist which can maximize labour productivity in a given country. Possible explanations to this are diminishing returns to R&D investment at the country level. Furthermore, high tax rates have the potential to restrain a firms' ability to invest in R&D due to reduced liquidity. Hence one conclusion which can be drawn from this analysis is that an average level of R&D intensity in combination with elevated rates of taxation on corporate profits are likely not to have a positive impact on national labour productivity levels.

8. The role of state ownership and institutions in the innovation performance of emerging market enterprises: Evidence from China

Yi, J., Hong, J., chung Hsu, W., & Wang, C. (2017). The role of state ownership and institutions in the innovation performance of emerging market enterprises: Evidence from China. *Technovation*.

- Institutional factors are analysed in view of an enhancement of innovation performance in China using a balanced panel of 193 506 firms from the Annual Census of Chinese Industrial Firms between 2005 and 2007.
- State ownership is found to be an important force of an innovation business model for emerging market enterprises (EME).
- The innovation augmenting role of state ownership in China is complemented by region-specific marketisation and industry-specific institutional policy.

In recent years the Chinese economy managed to improve its position with regards to technological capability, particularly in the high-tech sector. As opposed to private firms in market economies, EMEs cannot rely on internal capabilities to generate innovations as the ecosystem does not allow for the protection of intellectual property rights and the appropriation of R&D as they cannot be enforced by an ecosystem with a functioning legal framework. In this non-market environment the Chinese state granted liberties to local governments to adopt industrial policy which protects local firms and establishes a national technology catch-up model implemented at the industry-level. In this context, state ownership plays a twofold role: first the state as shareholder exerts pressure on firms to innovate and secondly, the state can positively influence R&D activity appropriation. The latter is achieved through preferential treatment and protection of knowledge. The Chinese government also applies its science and technology policy in specific sectors, such as the high tech sector, granting preferential support and access to complementary resources. Hence, while it was found that state ownership exerts a significantly positive effect of R&D intensity on innovation performance, the effect is not homogenous across regions and sectors due to state intervention.

9. Financial dependence and innovation: The case of public versus private firms

Acharya, V., & Xu, Z. (2017). Financial dependence and innovation: The case of public versus private firms. *Journal of Financial Economics*, 124(2), 223-243.

- Lack of capital is often cited for firms not to engage in innovation activity; the authors isolate the effects of stock markets access and the need for external capital on innovation.
- The analysis makes use of patent citation data from the National Bureau of Economic Research (NBER)'s patent citation database and financial data from Standard & Poor's Capital IQ from 1994-2004.
- It is shown that public firms which are dependent on external finance (EFD) invest on average more in R&D and produce higher quality patents than private firms.

Theoretical models do not provide clear guidance on how public listing or staying a private company influences innovation activity. Opponents of public listings theorise that the firm can be restrained in its innovation activity because of short-sighted conflicts between managers and investors. Others highlight the benefits of easier access to equity capital and better responsiveness to investment opportunities, including risky innovation activity. Panel data estimates as well as an estimation based on matched industry-pairs and a quasi-experimental estimation strategy confirm the finding that public firms in industries with more external financing needs are more innovative than their private counterparts. The same result does not hold for public firms which operate in internal finance dependent (IFD) industries. The measure which determines the external finance need of a company is constructed as the fraction of capital expenditures which is not financed through internal cash flows. Hence the empirical findings show a clear distinction in the appropriateness of public listing for enterprises. For instance, the results signify that a listing on the stock exchange is not suited to finance innovation activities in firms which are situated in industries with sufficient liquidity. The resulting loss in innovation efficiency and short-termism outweighs any benefits from additional access to external capital.

10. Technological Innovation, Resource allocation, and Growth

Kogan, L., Papanikolaou, D., Seru, A., & Stoffman, N. (2017). Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics*, 132(2), 665-712.

- This paper contributes to the literature which aims to capture the effects of technological innovation on economic growth.
- The authors construct a novel measure of innovation which is based on Google Patent entries and estimates of their economic value; it is subsequently used to demonstrate their impact on firm growth.
- At the aggregate level, an index is constructed from the individual patent entries. The underlying assumption is that firm monopoly profits resulting from patents are related to an increase in output and total factor productivity (TFP).

A novel measure approximating the economic value of patents is proposed. This makes use of the stock price reaction after the patent issuance. The empirical estimate is carefully constructed and tested in terms of distributional assumptions. The private value of the patent is then compared to its scientific value by correlating it with forward patent citations. The positive relationship adds validity to the attributed economic meaning of the constructed measure. It is subsequently employed to show effects on firm growth and productivity. It is found that firm growth is strongly associated with innovation output, also inducing creative destruction in the economy. A competitor of an innovative firm experiences a decline in profits, output and capital investment as well as employment in a five year period. The differences in firm growth and productivity are aggregated to form an index which captures the macroeconomic impact of innovation activity. The index is compared to three major waves of technological innovation in the United States: the 1930s, 1960s and 1970s and the 1990s and 2000s. The last wave can be characterized by advances in telecommunications and computer networks. The comparison shows that the constructed aggregate measure for innovation activity can explain most of the medium-run fluctuations in growth and TFP at the macroeconomic level.