

ESRC Grant ‘Knowledge Accumulation and Diffusion’ (2013-6, ES/K008919/1)

Introduction Following the recent global recession ‘industrial policy’ and selective government support for specific industrial sectors are “creeping back into fashion” (*Financial Times*, 8/4/2012). Policymakers and think tanks alike seem keen to “[b]ring back manufacturing” (OECD, 2012), the sector where according to Barack Obama’s 2012 *State of the Union Address* the “blueprint for an economy that’s built to last” begins and for which his 2013 budget incorporates an annual US\$1bn over the next decade (CRS, 2012). In the UK Nesta, an innovation think tank, recently reported a collapse in innovation investments within manufacturing and called for a new plan to boost long-term, innovation-led growth. Such arguments view manufacturing as a driver for innovation through high levels of R&D, and as a crucial source of knowledge spillovers, leading to recommendations to safeguard manufacturing for the benefit of the wider economy (Helper *et al*, 2012).

This debate about industrial policy or a lack thereof is not limited to OECD countries. Former World Bank Chief Economist Justin Lin (2012:27) has argued for a ‘New Structural Economics’ where governments in less developed countries assist “firms in the process of industrial upgrading by addressing externality and coordination issues.” Nobel Laureate Joe Stiglitz comments that this is strong support for the view that “accumulation, absorption, adaptation, production, and transfer of knowledge are at the center of successful development” (*ibid.* 59). Concerns over knowledge spillovers also occupy agricultural economists, who call for renewed public investment in agricultural R&D, especially in LDCs (Pardey *et al*, 2010, 2012), warning that the international spillovers “that contributed significant past gains in food production throughout poorer countries” are not well understood, their importance underappreciated and their patterns likely to shift to the detriment of LDCs (Alston *et al*, 2006: 2).

A summary of the above arguments for public policy could be “to encourage the accumulation of knowledge-based capital at home, and to be able to capture as much value from the investment as possible” (OECD, 2012). But how to achieve this feat given that the diffusion of knowledge is neither inevitable nor automatic (Keller, 2010)? Which sectors in which countries are important sources/recipients of spillovers, do spillover patterns differ between agriculture and manufacturing, and what roles do FDI, trade and geographic location play in this process? The renewed interest in the patterns of knowledge accumulation and diffusion, and the means and ways to ‘capture value’ from domestic and international knowledge investments for economies at different stages of development is the prime motivation for this research.

Research Projects and Their Relevance Projects are under two headlines: (1) ‘Knowledge Production and Diffusion in the OECD,’ and (2) ‘Innovation, Knowledge and Spillovers in Developing Economies.’ The overarching research question is *to what extent countries at different stages of development can capture appropriate knowledge and safeguard long-term growth through (i) international knowledge spillovers, and/or (ii) increasing R&D expenditure in their own country or sector*. Building on a theoretical foundation which links a standard model for technology spillovers (Keller, 2010) with ‘appropriate technology’ models (Diwan & Rodrik, 1991; Basu & Weil, 1998) this question will be addressed with macro panel data using novel empirical methods from the panel time series and spatial econometric literatures. The identification of causal relations and of the commonality and heterogeneity of technology and spillovers across countries and sectors will be central concerns for the modelling process.

This research is important because it recognises that production technology and the nature and role of knowledge creation differ across countries and sectors (‘heterogeneity’), but that all countries in the world are subject to common shocks, albeit to a different extent (e.g. recession in Greece vs UK vs China), in addition to various more localised malign or benign spillover effects (‘interconnected world’). Existing (macro) studies offer broad conclusions (‘trade is important’ or ‘distance matters’) which are rarely policy-relevant for individual countries, especially in the heterogeneous group of LDCs. Focusing on OECD sectors, and the agriculture and manufacturing sectors in LDCs, this research contributes to the academic literature on innovation and spillovers and will enable policymakers and institutions such as the OECD, UNIDO and the Consultative Group on International Agricultural Research (CGIAR) – all of which are supporting the projects – to draw policy conclusions *in a specific country context*, rather than learning about *average* effects across heterogeneous groups of countries.

Research Agenda The *first part* of the agenda is focused on the world's 'technology creators', a handful of rich countries which account for the vast share of R&D and innovation (Keller, 2010), and for which data availability extends to all sectors of production. The project builds on the PI's previous work on R&D spillovers in OECD manufacturing (Eberhardt *et al*, 2013), which suggests the argument that R&D spillover regressions (Coe & Helpman, 1995; Keller, 2002; Griffith *et al*, 2004; Acharya & Keller, 2009) cannot distinguish between 'true' knowledge spillovers and other unobserved heterogeneities (e.g. differential reaction to global shocks, spillovers unrelated to R&D activities, heterogeneity arising from empirical misspecification). Imposing a rigid structure on 'transmission channels' for knowledge diffusion based on somewhat *ad hoc* assumptions (e.g. distance, bilateral trade, FDI), the results from these regressions are at best not capturing *all* of the knowledge spillovers and at worst do not capture *any at all*. Focusing on the empirical identification of private returns to R&D, we find that if we account for spillovers and common shocks in a flexible way that is agnostic about transmission channels, then private returns drop significantly compared with results in the literature. The natural extension of this work is to investigate *how knowledge spillovers can be analysed in an empirical model that can distinguish them from other shocks and heterogeneity, whilst at the same time addressing concerns over endogeneity and nonstationarity*, as outlined above. This project will benefit from the input and advice given by Prof. Peter Egger during study visits to ETH Zurich as well as from knowledge exchange with researchers in the OECD Directorate for Science, Technology & Industry. It is anticipated that two research papers will result from this project, including one on methodology.

The *second part* of the research agenda is concerned with knowledge creation and diffusion in/to LDCs. Many LDCs have low aggregate R&D expenditure, limited FDI and virtually no patents. As Fagerberg *et al* (2010: 835) emphasize, the analysis of innovation in LDCs needs to move away from the 'high-tech' OECD country image, redefining innovation as "the attempt to try out new or improved products, processes or ways to do things". While existing studies investigate knowledge diffusion to LDCs via imports of capital goods (Coe *et al*, 1997, 2009; Madsen *et al*, 2010), there is little work attempting to quantify innovation in LDCs over a long time horizon or going beyond the use of aggregate economy data. These studies furthermore neglect the potential that "the North and South have different technological needs and tastes" (Diwan & Rodrik, 1991: 28) as emphasized by the appropriate technology literature. Data availability for agricultural production and innovation (ASTI) enables an investigation closer to the model outlined above for 40-50 LDCs, while for the measurement of innovation in LDC manufacturing high-quality data on exports (in the spirit of Bahar *et al*, 2012 and Hausmann *et al*, 2006) and knowledge stock (proxies from CHAT – Comin and Hobijn, 2004 – and human capital data – Timmer, 2002; Barro and Lee, 2012) will be considered among alternative strategies. This project aims to *investigate innovation and knowledge spillovers in sectoral data for LDCs* (manufacturing, agriculture), allowing for alternative measures for innovation and a maximum of flexibility in the empirical model as developed above.¹ The agriculture project will benefit from the input and advice of Prof. Doug Gollin and Prof. Steven Block during study visits to Oxford CSAE and Tufts University, respectively; the manufacturing project will benefit from the input and advice of Prof. Pierre Mohnen during study visits to UNU-MERIT and will pursue knowledge exchange with researchers at UNIDO. It is anticipated that three research papers on agriculture ($\times 2$) and manufacturing sectors will result from this project.

References

- [1] Acharya, R., and W. Keller. 2009. 'Technology transfer through imports.' *Canadian Journal of Economics*, Vol. 42, No. 4, pp. 1411-1448.
- [2] Alston, J., P.G. Pardey and R.R. Piggott. 2006. 'Introduction and Overview,' in: P.G. Pardey, J.M. Alston and R.R. Piggott (eds) *Agricultural R&D in the Developing World: Too Little, Too Late?*, Chapter 1. Washington D.C.: International Food Policy Research Institute (IFPRI).

¹Again there are close links to the PI's previous research: as shown in Eberhardt & Teal (2013a), aggregate data hide important structural differences across LDCs and can lead to significant bias in empirical results; Eberhardt & Teal (2013b) suggest that agricultural technology is closely related to agro-climatic environment, thus empirically confirming the location-specificity of agricultural technology and spillover potential (Gollin, 2011; Pardey *et al*, 2010).

- [3] **Bahar, D., R. Hausmann, and C. A. Hidalgo. 2014.** 'Neighbors and the evolution of the comparative advantage of nations: Evidence of international knowledge diffusion?' *Journal of International Economics* Vol. 92, No. 1, pp. 111-123.
- [4] **Barro, R., and J.-W. Lee. 2012.** 'A New Data Set of Educational Attainment in the World, 1950-2010.' Unpublished update of National Bureau of Economic Research Working Paper No. 15902.
- [5] **Basu, S., and D.N. Weil. 1998.** 'Appropriate Technology And Growth.' *The Quarterly Journal of Economics*, Vol. 113, No. 44, pp.1025-1054
- [6] **Coe, D.T., and E. Helpman. 1995.** 'International R&D Spillovers.' *European Economic Review*, Vol. 39, No. 5, pp.859-887.
- [7] **Coe, D.T., E. Helpman and A. Hoffmaister. 2009.** 'International R&D spillovers and institutions.' *European Economic Review*, Vol. 53, No. 7, pp. 723-741.
- [8] **Comin, D., and B. Hobijn. 2004.** 'Cross-Country Technology Adoption: Making the Theories Face the Facts.' *Journal of Monetary Economics* Vol. 51, pp. 39-83.
- [9] **CRS [Congressional Research Service]. 2012.** *Federal Research and Development Funding: FY2013*, June 14, 2012. Available online at <http://www.crs.gov/>.
- [10] **Diwan, I., and D. Rodrik. 1991.** 'Patents, Appropriate Technology and North-South Trade.' *Journal of International Economics* Vol. 30, No. 1-2, pp.27-47.
- [11] **Eberhardt, M., C. Helmers, and H. Strauss. 2013.** 'Do Spillovers Matter When Estimating the Returns to R&D?' *Review of Economics and Statistics* Vol.95, No. 2, pp.936-948.
- [12] **Eberhardt, M., and F. Teal. 2013a.** 'Structural Change and Cross-Country Growth Empirics.' *World Bank Economic Review* Vol. 27, No. 2, pp.229-271.
- [13] **Eberhardt, M., and F. Teal. 2013b.** 'No Mangoes in the Tundra: Spatial Heterogeneity in Agricultural Productivity Analysis.' *Oxford Bulletin of Economics and Statistics* Vol. 75, No. 6, pp. 914-939.
- [14] **Gollin, D. 2011.** 'Climate Change and Technological Innovation in Agriculture: Adaptation through Science,' in: A. Dinar and R. Mendelsohn (eds) *Handbook On Climate Change And Agriculture*, Chapter 17, Cheltenham: Edward Elgar.
- [15] **Hausmann, R., J. Hwang and D. Rodrik. 2007.** 'What you Export Matter.' *Journal of Economic Growth* Vol. 12, No. 1, pp. 1-25.
- [16] **Helper, S., T. Krueger, and H. Wial. 2012.** 'Why Does Manufacturing Matter? Which Manufacturing Matters? A Policy Framework.' Metropolitan Policy Program at Brookings, research paper, 22nd February. Washington, D.C.: The Brookings Institution.
- [17] **Keller, W. 2002.** 'Trade and the Transmission of Technology.' *Journal of Economic Growth*, Vol. 7, No. 1, pp.5-24.
- [18] **Keller, W. 2010.** 'International Trade, Foreign Direct Investment and Technology Spillovers.' in: B. H. Hall and N. Rosenberg (eds) *Handbook of the Economics of Innovation*, North-Holland, Volume 2, pp.793-829.
- [19] **Lin, Justin Yifu. 2012.** *New Structural Economics: A Framework for Rethinking Development and Policy*. Washington D.C.: The World Bank.
- [20] **Madsen, J., R. Islam, and J B. Ang. 2010.** 'Catching up to the technology frontier: the dichotomy between innovation and imitation.' *Canadian Journal of Economics*, Vol. 43, No. 4, pp.1389-1411.
- [21] **OECD. 2012.** 'How manufacturing can create value and jobs.' *OECD Observer*, Vol. 292, Q3.
- [22] **Pardey, P.G., J.M. Alston and V.W. Ruttan. 2010.** 'The Economics of Innovation and Technical Change in Agriculture,' in: B.H. Hall and N. Rosenberg (eds) *Handbook of the Economics of Innovation*, Volume 2, Chapter 22, pp.939-984.

- [23] **Pardey, P. G., J. M. Alston and C. Chan Kang. 2012.** 'Agricultural Production, Productivity and R&D over the Past Half Century: An Emerging New World Order,' unpublished mime.
- [24] **Timmer, C. P 2002.** 'Agriculture and economic development.' In: B. L. Gardner and G. C. Rausser (eds) *Handbook of Agricultural Economics*, Vol. 2, Part 1, Chapter 29, pp. 1487-1546.
- [25] **UNIDO-UNCTAD. 2011.** *Economic Development in Africa Report 2011: Fostering industrial development in Africa in the new global environment*. Vienna: UN Industrial Development Organization (UNIDO).