

The review on the PhD dissertation thesis

Title: Knowledge Spill-Over Effects and Methods of their Measurement

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Raymond Kwame Adane Darfo-Oduro's dissertation focuses on a very relevant and important topic: how knowledge and ideas spread between people, companies, and countries – a process known as cognitive spillovers. These spillovers are essential for understanding how innovation happens, both within individual firms and across entire economies. The research reflects the growing importance of global knowledge exchange, digital and economic linkages, which, according to endogenous growth theory, which says that such knowledge-sharing is a key driver of long-term economic growth and technological advancement.

A) Theoretical and knowledge base of the thesis

The theoretical background of this study is grounded in a multidisciplinary framework that draws on the basic concepts of knowledge theory to distinguish between tacit (unspoken) and explicit (clearly stated) knowledge, and uses social exchange and social learning theories to explain the mechanisms of interaction, reciprocity, and observation at the micro-level that facilitate knowledge transfer. These micro-level foundations are then advanced to the macroeconomic level through endogenous growth theory and the knowledge spillover theory of entrepreneurship, which posit that knowledge externalities, driven by R&D and human capital, are the key internal drivers of innovation and economic growth. A key intellectual challenge arising from this literature is that knowledge spillovers as intangible externalities are unobservable, leading to the use of proxies such as technological proximity, geographic distance and trade flows. This has created a significant problem in the literature: the validity and reliability of these different measures are rarely systematically compared, and their complex, non-linear interactions with a country's own R&D and absorptive capacity are often oversimplified.

Hence, the theoretical background of the thesis is built on a solid foundation of endogenous growth theory and the theory of cognitive spillovers in a business context, while an important contribution is the review of different dimensions of proxies (geographical, cognitive) and a critical assessment of existing methods to measure these effects. The author has identified interesting gaps in the scholarly literature, such as uncertainties in complementarity or substitution between domestic R&D and foreign spillovers, complex effects, and the costs of adapting external knowledge. The theoretical framework thus provides a suitable basis for research aimed at a deeper understanding of the of the nature of the innovation process patterns and their measurement.

The ambition of the thesis is to systematically evaluate the reliability and validity of different measures of these spillovers. In addition, the thesis investigates the interactions between domestic R&D and foreign cognitive spillovers, exploring elements of the U-curve relationship, an original approach reflecting adaptation costs and synergistic processes. The complexity of the theoretical approach, as well as the attempt to integrate the concept of absorptive capacity not only as R&D intensity but also through geospatial and network parameters (e.g. centrality), represent an interesting shift in the understanding of the determinants of innovation performance of countries and firms in a globalized environment.

B) Aims and Methodology - Conceptual Strengths

The main goal of this research is to better understand knowledge spillovers—how knowledge created by one country or firm unintentionally helps others innovate and grow economically. Specifically, the study wants to check how well different methods measure knowledge spillovers; explore how knowledge spillovers and a country's own investments in research and development (R&D) work together; investigate the combined effects of own R&D and external knowledge spillovers on innovation outcomes, looking at complex, possibly nonlinear relationships; examine how a country's capacity to absorb and use external knowledge (absorptive capacity) affects innovation. This capacity depends not just on R&D but also on factors like proximity to other countries and networks.

In simple terms, this research aims to tackle four main problems in the study of how countries innovate:

The Measurement Problem: To test three standard formulas to see if they are actually valid (measure what they are supposed to) and reliable (give consistent results).

Complementarity: Does knowledge from abroad complement a country's own R&D, making its local efforts even more powerful or reduce their own R&D when they can get ideas for free.

Adjustment Cost (The U-Shaped Effect): The thesis hypothesizes that when a country first starts using foreign knowledge, it is causing a temporary dip in innovation and only after this adjustment period does the combination of local and foreign knowledge lead to a surge in innovation, creating a U-shaped curve.

Absorptive Capacity: Why are some countries better at using foreign knowledge than others? The study aims to show that a country's absorptive capacity, its ability to recognize, assimilate, and use new ideas, is the crucial factor that makes knowledge spillovers effective.

The approach applies panel regression models (both pooled OLS and fixed effects) to test relationships between spillovers, R&D, and innovation outputs. Innovation is measured by high-technology exports, which is a proxy for innovation output. Network analysis is used to examine clusters and patterns of spillovers. The decision to devote one of the main objectives to assessing the validity and reliability of spillover measures is commendable. The thesis rightly goes beyond a simple linear additive model. The complementarity hypothesis is central to innovation policy. Testing this hypothesis using an interaction term is the correct approach,

as is the hypothesis of a U-shaped relationship for the combined effect of these inputs on innovation. A worthy aspect of this thesis is the attempt to operationalize a broader concept of absorptive capacity. By moving beyond the standard proxy of R&D intensity and explicitly including spatial measures like centrality and contiguity, the author embraces the geo-economic nature of knowledge absorption.

C) Conceptual weaknesses:

Despite the conceptual strengths, however, the dissertation faces several methodological challenges that affect the interpretation and credibility of the empirical findings. These are typical risks in this field, which stem from the limitations of the data base and statistical approaches used.

- Innovation is indirectly measured using high-technology exports. This is highly debatable. While this correlates with innovation, it is not a direct measure (like patents or R&D outputs). A country could excel at exporting high-tech goods simply by being an efficient assembler or marketer of technologies developed elsewhere. This measure may capture commercial success in tech sectors rather than the actual creation of novel knowledge.

- Endogeneity: better innovation performance may attract more spillovers or encourage higher R&D spending, making it difficult to disentangle cause and effect. Some unobserved factors (e.g., institutional quality, government policy) could also affect both spillovers and innovation intensity, but are not fully controlled for, which may bias the results.

- The use of instrumental variables (IV) is mentioned in the results section (Table 22) for the complementarity analysis. While the methodology section does not detail this, the principle of using an instrument to address the endogeneity of knowledge spillovers is sound. However, a valid instrument must satisfy the exclusion restriction: it can only affect the outcome variable (innovation) through the endogenous variable (spillovers). The author's justification is almost certainly incorrect assumption.

D) Results and Synthesis

The thesis confirmed that a country's own research (R&D) and knowledge from abroad work together as a team (they are complementary). Foreign ideas make local R&D more effective. However, this effect is much stronger in countries that already invest a lot in their own R&D. The costs of adaptation have proven to be real, but not the same for all. For countries with low R&D costs, the clash with new foreign knowledge is disruptive. Their innovation dips before it gets better, following a U-shaped curve. They must go through a difficult learning curve. Countries with a high level of R&D benefit immediately from foreign knowledge. But after a certain point, they experience diminishing returns, and adding even more foreign knowledge may become less efficient, following an inverted-U-shaped curve.

Location matters for learning; a country's ability to absorb foreign ideas (absorptive capacity) is not just about how much the country spends on R&D. Its geographical location is also crucial. A central location in Europe greatly helps a country to learn from others. However, a common

border with a neighbour alone does not seem to make any difference. The most surprising and novel finding is the split result for the U-shaped curve. The common assumption is that knowledge spillovers are always good. This study shows that it is not always true.

This dissertation is a work of great intellectual ambition. The author has a clear grasp of the key theoretical debates and has formulated a set of insightful and important research questions. The narrative that emerges, particularly regarding the U-shaped innovation curve conditional on R&D capacity, is powerful and policy-relevant. The fundamental problem is that the empirical evidence presented is not strong enough to support this compelling narrative. The conclusions are built upon a foundation weakened by unresolved endogeneity. This does not necessarily mean the author's conclusions are wrong, but rather that they remain unproven by this specific analysis.

Conclusion and Recommendations

The discussion and conclusion should be rewritten to reflect the complexities and limitations of the analysis. Overly strong claims, such as having "put to rest" a major debate, should be replaced with more modest and accurate language. The discussion of results should be more critical, moving beyond the statistical significance of coefficients to explore the economic magnitude of the effects. Simply stated, the discussion lacks critical self-reflection. To publish the results in high-quality journals, further work with the models is needed to remove problematic parts in both methodology and interpretation.

This dissertation has the potential to be an excellent contribution to the macroeconomics of innovation. The author has demonstrated the ability to think deeply about complex economic problems. Although a more rigorous econometric treatment could have strengthened the empirical foundations, the work remains intellectually stimulating, empirically sound and defensible. Nevertheless, the dissertation represents a valuable contribution to the macroeconomics of innovation. The author clearly demonstrates strong analytical thinking and a deep engagement with complex economic issues

Raymond Kwame Adane Darfo-Oduro in his dissertation demonstrated his ability to process the topic, to design and implement the implemented methodology, to use multivariate econometric methods and to formulate and justify the conclusions. Therefore, I recommend the submitted dissertation for defence and propose the award of the scientific-academic degree of PhD.

Košice, August 1, 2025

Prof. RNDr. Oto Hudec, CSc.