# Unveiling the determinants of scientific productivity in middle-income countries

# Summary

Science is an important contributor to innovation and economic growth. While the production of scientific knowledge is a complex process, there is a lack of economic research concerning the organization of scientific activities and a need to expand the empirical evidence in the economics of science field to better understand the different forces at play in the production of scientific knowledge as well as its impact.

This thesis aims to understand the role of scientists and scientific communities in the process of knowledge creation by looking at scientific productivity, its determinants and effects at the individual level, and the macro level, in the context of Middle-Income Countries (MICs). It uses a quantitative econometric approach anchored in the economics of science literature and is conceptually largely informed by social network theory.

The thesis investigates the role and effects of different determinants on scientific productivity: cognitive proximity – notably gender and ethnicity, status homophily, organizational proximity, social and community structure, and access to foreign knowledge and international collaboration networks. We use four empirical chapters to understand the role and effect of these determinants on scientific productivity in-depth. For doing so, we use two-novel datasets of researchers of the National Research Foundation (NRF) of South Africa and the National System of Researchers (SNI) of Mexico and their scientific production.

Chapter 2 investigates the determinants of scientific productivity using a network theory perspective and focuses on South Africa as a particular case. The chapter looks at the different factors associated with tie formation (the first collaboration between co-authors) and tie persistence (second and subsequent collaborations) affecting collaborative scientific research. Four different sets of factors are analyzed in detail: cognitive proximity (1); status homophily (2); organizational proximity (3); and social and community structure (4). The results show that different factors are associated with each type of collaboration. Collaborations happen for the first time among researchers that are well connected and close to each other, have high cognitive and organizational proximity, and are part of the same social communities. In contrast, little seems to matter apart from social structure and organizational proximity to make a collaboration persist over time. We also find that researchers are more likely to collaborate for the first time with others of the same ethnicity and are more likely to make the collaboration persist over time with others of the same gender.

Chapters 3 and 4 aim to understand the role that gender plays on researchers' scientific productivity and shed light on the reasons and consequences of existing inequalities in scientific

performance at the individual and aggregate academic system levels in Mexico (Chapter 3) and South Africa (Chapter 4). We show that collaboration characteristics, probabilities of promotion, selectivity, and initial productivity account for differences in scientific productivity. Other factors, such as the quality of the research and institutional affiliation (Chapter 3), also explain the different magnitudes of gender productivity gaps. Chapter 4 shows that race plays a more important role than gender in explaining productivity gaps in South Africa and suggests the existence of a race productivity gap.

The results of both empirical applications in Mexico and South Africa show that women are marginally less productive than men or as productive as men, particularly when the research output is weighted by the quality of the outputs (Chapter 3). Moreover, female researchers are under-represented in the highest seniority levels and have fewer chances than men to be promoted in their academic careers. However, once we control for other factors, notably promotion, we find that the gender productivity gap favors women. We also show that significant individual and system-wide productivity increases for both females and males (but notably females) could be achieved by controlling for selectivity and promotion. Eliminating promotion biases would result in the largest increase in aggregate scientific productivity.

Chapter 5 analyzes how access to foreign/international knowledge through education and training affects scientific productivity. Firstly, we look at how foreign training affects the career of the researcher itself (impact-on-self). Secondly, we look at the 'outward' effects of foreign training by analyzing how it influences the researchers' position in international collaboration networks and facilitates the diffusion of knowledge nationally and internationally (impact-on-others). We find that foreign-educated researchers play an important role as conduits of knowledge to the scientific community at large and have a central role in the domestic upgrading of their academic fields. However, we also find that the degree's origin becomes irrelevant at higher seniority levels as locally-trained researchers are equally well connected internationally. Moreover, this increased connectedness comes with a cost. We find that foreign-educated researchers have fewer probabilities of promotion to higher academic ranks relative to their nationally-trained peers when controlling for endogenous sample selection.