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The Multinational Enterprise as a Vehicle of Institutional and Technological Development in the Global Economy

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List of Abbreviations

LDCs – Least-Developed Countries

MNE – Multinational Enterprise

IB – International Business

FDI – Foreign Direct Investment

AI – Artificial Intelligence

NIE – New Institutional Economics

OLI – Ownership, Location, and Internalization

R&D – Research and Development

HOMA – Hedges-Olkin-Type Meta-Analysis

MARA – Meta-Analytical Regression Analysis

CABS – Chartered Association of Business Schools

ESG – Environmental, Social, and Corporate Governance

IEA – International Energy Agency

Orbis IP – Orbis Intellectual Property

IPC – International Patent Classification

BvDID – Bureau van Dijk Identifier

ICT – Information and Communication Technology

GUO – Global Ultimate Owner

GDP – Gross Domestic Product

IBRD – International Bank for Reconstruction and Development

IDA – International Development Association

WIPO – World Intellectual Property Organization

GPT – General-Purpose Technology

1 Introduction

"International disequilibrium may occur for innumerable reasons – from a dynastic love affair to the silting of an estuary, from a theological controversy to a technological invention. The mere growth of wealth and population, or their decrease, is bound to set political forces in motion; and the external balance will invariably reflect the internal." (Polanyi, 1944: 9)

The role of institutional and technological development in today's economy is undisputed. From the onset of the economic discipline, scholars have attached great importance to progress in these areas for economic development, exemplified through changes in productivity or the emergence of new organizational forms of society (North, 1990). Technological development increases productivity and alters societal values and norms (Schumpeter, 1939). Institutional development improves the efficiency of economic exchanges and optimizes the resource allocation necessary for sustained economic development (Williamson, 1984). Consequently, both factors have been included as exogenous variables in most models of economic development (Acemoglu, 2009). However, it is only in the last few decades that researchers have moved from taking both factors as given in their study of economic development to examining the actual processes of change, especially in the context of institutional theory and innovation studies [1].

Scholars of both fields have examined the origins of institutional improvements (North, 2005; Posner, 2005; Schneiberg, 2007) and technological upgrading (Katz, 2001; Teece, 2010; Aghion & Jaravel, 2015), which allowed for a new, more detailed understanding of change and development. Economists like Acemoglu, Johnson, and Robinson (2005) and Stiglitz (2011) have put institutions at the center of their models, while innovation scholars have examined technological advancements as a fundamental cause of economic development (Romer, 1990; Aghion & Howitt, 1997). As a result, the positive developmental impact of institutions and technologies is often unquestioned by researchers, with only a few studies indicating possible drawbacks from such improvements (Olson, 1963; Abramovitz, 1986; Freeman, 1993). We explore the validity of such an overly optimistic view on the impact of institutional and technological improvements on economic development. By reviewing and examining the interdependencies between

[1] Innovation studies refer to the group of literature that draws on Schumpeterian theory to explain technological change as an evolutionary process (see Fagerberg & Verspagen, 2009).

both theoretical spheres, we account for the complexity and scope of economic development – a task that is often not achieved in a single paper.

In an increasingly globalized and connected world, the availability of technologies and the interconnection of institutional settings have greatly increased. This has led some authors to propose a convergence of institutions across developing and least-developed countries (LDCs) based on a continuous catch-up process (Knack, 1996). By contrast, current economic realities show a picture of growing inequality between rich and poor nations and only a few countries are able to take full advantage of technological and institutional progress for development (Dicken, 2015). Findings on the resource curse (Ross, 2006) and the middle-income trap (Ozturk, 2016; Aghion & Bircan, 2017) point to the fact that many economies stagnate or decline despite access to higher-level technologies and institutional reforms. The explanations for these phenomena span from low absorptive capacity of local firms (Cohen & Levinthal, 1990) to inefficient market mechanisms that undermine any incentives for change (Arbache, Dickerson, & Greene, 2004). What is missing in these explanations is the fact that the mutual effect of institutional and technological change could affect the incentives of economic and political actors towards economic progress negatively.

This thesis addresses this gap in the literature by combining institutional theory with findings from innovation studies to develop a framework of economic development and stagnation. It provides explanations for different development scenarios through an analysis of institutional and technological change. Building on this framework, we examine the role of a special economic actor that has received too little attention in the mainstream development literature: The multinational enterprise (MNE). According to International Business (IB) theory, MNE internalizes markets in the host countries (Buckley & Casson, 1976), thereby transferring new technologies and business practices to the local environment. Thus, where incentives for economic development are absent, we argue that MNEs can provide technological and institutional stimuli that help countries to overcome barriers to change. By complementing our framework with findings from the IB literature, we evaluate the developmental impact of MNEs as a vehicle of institutional and technological change. Consequently, this thesis answers the following research question, which will be further divided into sub-questions in the next section:

How do MNEs influence institutional and technological change for economic development?

1.1 Research Questions

The main research question of this thesis focuses on MNEs as a development factor through their impact on institutions and technologies. In order to unpack different facets of the research questions, the first goal of this thesis is to review the antecedents of economic development with a special focus on the role of institutions and technologies. To this end, institutional theory, innovation studies, and development literature provide explanations on the origins of change (Purdy & Gray, 2009) and their developmental impact (Davis & North, 1971). Common among those theoretical perspectives is that change always induces uncertainty related to the future trajectory of development. These uncertainties will limit the incentives of economic actors to support further change and might even lead to the reversal of institutional and technological developments (Olson, 1963). Thus, a key interest of this research is to examine the relation between the uncertainties arising from institutional and technological change and how they jointly affect economic development. In this regard, we question the notion that institutional and technological improvements automatically lead to economic development. This complies with recent calls by leading economists arguing for a more contextual view of development factors (Acemoglu & Robinson, 2012; Stiglitz, 2019). To add to this debate and lay the foundation for an examination of the MNE's impact on both dimensions, the first sub-question of this thesis concerns the mutual effect of institutions and technologies on development:

How do institutions and technologies mutually influence economic development?

The answer to this question is provided in the framework and in *Essay 1* of this thesis, which employs an extensive meta-analysis of existing studies from various economic disciplines. The nature of the analysis allows for the summary of the direct effect of institutions and technologies on development from previous research articles as well as the identification of moderating factors. These moderators are the operationalization of institutions, a country's level of development, the time period under examination, and the complementary role of technological change. Our results illustrate the complex interaction between dimensions of institutions, technologies, and development with some combinations proving to be more effective over time. Together with an extensive summary of existing literature, this essay makes important contributions to the study of institutional and technological factors for economic development. Building

on this explorative macro study, *Essays 2* and *3* focus on the effect of MNEs on institutional and technological change.

Hitherto, most of the IB literature has focused on the effect of institutions on MNEs' investment decisions (Bailey, 2018), entry modes (Blevins, Moschieri, Pinkham, & Ragozzino, 2016), and performance (Carney, Estrin, Liang, & Shapiro, 2018), but only few studies have examined the reverse impact of MNEs on institutional development (e.g., Child & Tsai, 2005; Brandl, Darendeli, & Mudambi, 2019). More specifically, MNEs represent a unique bridge between the technological and institutional environments of home and host country that has yet to be integrated in a comprehensive framework of institutional change (Banalieva, Cuervo-Cazurra, & Sarathy, 2018). Being more innovative (Fang, Wade, Delios, & Beamish, 2013), profitable (Rugman & Oh, 2010), and politically connected (Sojli & Tham, 2017), MNEs do not compare to other institutional and economic actors usually considered in contemporary models of institutional change (Decker, Üsdiken, Engwall, & Rowlinson, 2018). Plus, MNEs are carriers of norms and practices (Regnér & Edman, 2014), fill institutional voids through institutionalized practices (Khanna & Palepu, 1997), and coevolve with national institutional environments (Cantwell, Dunning, & Lundan, 2010). Hence, theorizing MNEs as influential actors in the host country poses the question of how MNEs are different from other economic actors and under what circumstances they can stimulate institutional change:

How do multinational enterprises influence institutional change in the host country?

We answer this question in *Essay 2*. Here, we draw on existing literature of institutional theory to analyze the role of endogenous and exogenous sources of change for the introduction of new policies on the country level. By combining approaches to institutional change with the innovation and policy literature, we conceptualize technology-based sources of competitiveness and resource-dependency as facilitators of and barriers to institutional change. Since these factors lead to different incentives towards institutional change, we examine the influence of domestic and foreign actors on both dimensions to develop hypotheses on the introduction of new policies. We test those hypotheses with a dataset of green technology patents and green policies across countries worldwide. Our results allow for conclusions about the internal and external barriers as well as the opportunities for countries to change their institutional

framework. Therefore, it provides important implications for researchers and policymakers that seek to implement institutional reforms and direct the impact of MNEs in the global economy.

The technological dimension of economic development and the role of MNEs for technological change will be the focus of *Essay 3*. Existing literature in IB points to the dominance of MNEs in knowledge-intensive industries, where incentives for foreign direct investment (FDI) arise from the need to secure proprietary knowledge (Buckley & Casson, 1976). Based on the argument that internationalization as the geographical extension of firms is merely another form of technological diversification in the Penrosian sense (Buckley, 1985; Cantwell, 1989; Verbeke & Yuan, 2007), scholars have explained the relation between innovation performance (Wu, Wang, Hong, Piperopoulos, & Zhou, 2016), knowledge transfer (Osabutey, Williams, & Debrah, 2014), and entrepreneurial networks (Vasilchenko & Morrish, 2011) on FDI. The effect of such investments on the host country has largely been explored in the literature on linkages and spillovers (Javorcik, 2004; Jindra, Giroud, & Scott-Kennel, 2009; Pavlinek & Žížalová, 2016). However, innovation studies question the assumption that large firms always drive technological change, especially in the presence of uncertainty. The existence of lock-in effects and the path-dependent nature of innovation in combination with market power and strong consumer loyalty may put MNEs in the position to inhibit technological competition and hamper the adoption and diffusion of new technologies (Teece, Peteraf, & Leih, 2016). Thus, it is unclear if MNEs act as drivers of the most productive technologies – an issue that has profound consequences for the global utilization and diffusion of technological advancements for economic development:

Which factors determine the development of new technologies by multinational enterprises?

Targeting this question, *Essay 3* of this thesis draws on a combination of innovation studies and IB literature to develop hypotheses on the determinants of new technology invention by MNEs. We juxtapose the ability of MNEs to benefit from advantages of incumbency and multinationality with the negative effects of technological lock-ins and organizational inertia in order to examine how these factors affect their invention of potentially disruptive technologies. The focused technology is artificial intelligence (AI), which has been described as a key generic technology for the future of the global economy (Klinger, Mathos-Garcia, & Stathoulopoulos, 2021). Indeed, AI represents new opportunities for development as it

allows economic actors to embrace new ways of doing business and upgrade into more profitable activities (Brynjolfsson & McAfee, 2014). Analogous to the spread of technologies during the third Industrial Revolution, the adoption and transfer of AI technologies by MNEs can provide countries with broadened opportunities to transform and upgrade their economy. We build hypotheses on firm-level factors influencing the ability of MNEs to overcome organizational and technological barriers to change. To test our assumptions, we analyze a global dataset of AI patents related to MNEs. Our findings generate a comprehensive picture of the factors that stimulate MNEs' investment in new technologies. The implications of this study are not limited to the inventiveness of MNEs but also address the emergence of AI as a technological field and the measures of policymakers to stimulate technological development.

Altogether, the main research question can be broken down into three subsequent questions that are separately addressed with the three essays of this thesis. However, to establish the necessary theoretical depth of such encompassing topics, the essays will be preceded by an extensive theoretical framework, in which we conceptualize the MNE as a linking piece to explain the joint impact of institutions and technologies on economic development. To this end, we will review different perspectives on the main themes of this thesis, namely economic development, institutions, technology, and MNEs, in order to develop a unified understanding of each concept. These will be used to synthesize a theoretical framework of the MNE as a moderating factor of institutional and technological change for economic development. Before the theoretical foundations are further laid down, the key concepts will be introduced and defined.

1.2 Definitions

Definitions of economic development span from holistic views of economic and social progress to the narrow concept of growth as an increase in income (Feldman, Hadjimichael, Kemeny, & Lanahan, 2016). The latter understanding originates in the growth models of neoclassical economists that often deploy a narrow, empirical definition of development. These models explicitly refer to per capita income as the main variable for economic growth (e.g., Lewis, 1954; Solow, 1956; Lucas, 1988). Notably, these scholars rejected broader issues of development by stating that "our subject matter is growth, and not distribution" (Lewis, 1955: 9). Other models incorporated technological change as an endogenous source of development and defined growth through output per worker or income distribution (e.g., Kuznets, 1955;

Romer, 1990). A major criticism of these models is that the focus on numbers does only reflect few aspects of development but says nothing about the living realities of economic actors nor their overall economic well-being (Stiglitz, 2019).

In a broader interpretation, development scholars devote special attention to social improvements and living standards as essential features of development. In accordance with the growing attention received by LDCs since the 1970s, Seers (1979) has criticized the universal and Western views of neoclassical growth theory and focused on the reduction of poverty and inequality as the main objectives of development. Similarly, Nobel Prize winner Amartya Sen places the individual in the center of his economic theory and defines development as the ability and scope of each human to make choices (Sen, 1999). This broad view on economic development paved the way for a new wave of development research that attached greater responsibility to the firm and evolved into areas like business ethics and sustainability (Shrivastava, Jones, Selvarajah, & van Gramberg, 2016).

Other definitions of economic development originate in the specific disciplines of innovation studies or institutional theory. Schumpeter emphasized technological change in his theory of development and described real development as the disruption of the static equilibrium of an economy (Schumpeter, 1910). Institutional theorists argue that the governance of economic transactions is a major determinant of economic development (Lipset, 1959; Ostrom, 1990). Similarly, North (1984) highlights that the idiosyncrasies of institutional and technological development preclude the short-term view of many neoclassical economists and demonstrates the need for a broader, long-term view of development.

We follow the latter argumentation by adopting an inclusive view on economic development that focuses on the interdependence of institutional and technological change as a central determinant of economic development. A contextual, individualistic view as employed by Sen would not allow an international view on economic development highlighting the interdependencies of a globalized world. A neoclassical view that equates development with growth in output and income would not consider firm-level incentives for technological and institutional change. Therefore, our focus lies on the interaction of micro and macroeconomic realities determining the incentives of individuals and firms. We align with Schumpeter in extending the calculative definition of growth to an understanding of development as the

structural transformation implied in shifts in the production function, governance structures and, ultimately, the comparative advantage of an economy. In other words:

Economic development is the change in productive output and related governance structures that results in improved competitiveness of an economy. (own definition)

As a second major theme of this thesis, the concept of institutions builds on North, who has worked extensively on the relation between institutional and economic development (North, 1981; 1984; 2005). He defines institutions as the formal rules and informal norms that constitute the rules of the game in an economy (North, 1990). Adopting a broader perspective of institutional theory, we largely comply with the transaction cost perspective of new institutional economists but also emphasize concepts of the historical and sociological school of institutions that have only been addressed superficially in North's conception (Mahoney & Thelen, 2010). To advance the dynamic view emphasized in institutional research (Greif & Kingston, 2011) and to account for recent findings highlighting the role of agency (Fortwengel & Jackson, 2016), we propose a variation of his definition.

Institutions are the (formalized) manifestations of historically developed customs and habits that constrain and enable the behavior of economic actors. (own definition)

The third main concept of this thesis is technology, more specifically, technological development. As the term technology is inherently abstract and debated not only in economic but also in philosophical and sociological areas, it is difficult to grasp the core of its definition (Mokyr, 2005). Mesthene (1969: 492) provides a short definition of technology as "the organization of knowledge for practical purposes." In other words, technology is characterized through an interaction of knowledge and its practical application in tacit ideas or physical objects. Dodgson, Gann, and Salter use a broader definition, which resembles the understanding of technology throughout this thesis:

Technology is a replicable product with practical applications and the knowledge that allows it to be used and developed. Technology manifests itself in new products, processes and systems, including the knowledge and skills needed to functionally produce what is reproducible. (Dodgson et al., 2008:2)

To define the MNE as a central actor in a globalized economy, we draw on IB theory, which is the study of the "relationship between MNEs and national economies (or, sometimes, specifically defined locations in them) and how it is mediated by the wider institutional context of the global economy" (Pearce, 2018: 3). In this area, Dunning and Lundan provide a universally valid definition of the MNE:

> *A multinational […] enterprise is an enterprise that engages in foreign direct investment (FDI) and owns or, in some way, controls value-added activities in more than one country" (Dunning & Lundan, 2008a: 3).*

This definition is widely accepted in the literature, although the commonalities of MNEs have become more difficult to establish. During most of the 20th century, MNEs have been large companies from developed countries with a wide network of subsidiaries. Recent economic and technological developments, however, have leveled the playing field for smaller companies and emerging market firms making the population of MNEs very heterogenous (Dicken, 2015). The conceptualization of MNEs will be further delineated in *Chapter 2.4* as an IB perspective allows for the integration of research streams in institutional theory and innovation studies while considering the facets of a globalized economy. As the research field essentially operates at the intersection of micro and macroeconomics and focuses as much on individual firms as on nation states, this view on the economic discipline best represents the current state of the economy and enables the development of a unique research framework. Further comments on the depiction of reality and the methodological assumptions of this thesis are made in the next chapter.

1.3 Methodological Note

This thesis strongly relies on quantitative approaches to test the theoretical assumptions made. E*ssays 2* and *3* employ regression methods on the country and firm level to test the hypothesized relationships between institutional and technological change. With the country-level regression in *Essay 2*, we aim to uncover economic relationships that are reflected in aggregate data. In *Essay 3*, the meso-level focus allows a narrower investigation of firm-level factors leading to technological inventions. Both analyses rely on positivistic interpretations of data, and we acknowledge that the results are merely an observation of reality instead of an explanation of it. They are also of limited generalizability. We combat these methodological issues with theoretical and empirical rigor and discuss the limitations of the methods used within the essays. Moreover, we contribute to the methodological discourse by using a meta-analytical approach in *Essay 1*.

The idea of this method is to summarize existing literature while also accounting for methodological biases in these studies (Hunter & Schmidt, 2004). By analyzing the effect of moderator variables, which include measurement and data characteristics, we provide methodological implications for the institutional, innovation, and development literature. While the limitations of this method are also discussed in the essay, it serves as a good starting point to be complemented with the regression methods of *Essays 2* and *3*.

The choice for these approaches stems from the research objectives and the concepts discussed throughout this essay. Similar to the definitions of economic development, the literature on the topic is diverse in the sense that it focuses on the development of individuals as much as on the development of nations. Innovation studies mainly target the entrepreneurial firm as the subject of interest (Fagerberg, Martin, & Andersen, 2013). Institutional theory considers governance structure on the country level, with some streams targeting the interaction of institutions with firms and individuals (Hodgson, 2000). IB originates in the analysis of macroeconomic patterns and although the field has moved towards firm-level analysis, the core concepts focusing on a micro-macro link remain at the core of the discipline (Casson, 2016). Altogether, the research streams are characterized by methodological collectivism, which means that findings on the individual level are aggregated to the meso and macro level (Dugger & Sherman, 1994). As Kostova puts it for institutional theory:

> *"The institutional characteristics of a country reflect that country's environment in a relatively encompassing way, as they capture various aspects of the national environment, including cultural norms, social knowledge, rules, regulations, and others." (Kostova, 1997: 180)*

We believe that our methodological perspective enables the testing of the research questions related to the connection between MNEs, innovation, and institutions most effectively. It allows for the inclusion of contextual variables in a macroeconomic environment, which is also a unique feature of IB as the dominant perspective chosen (Teagarden, von Glinow, & Mellahi, 2018). To account for the limitations of quantitative methods and reduce the bias of positivistic methodologies, a critical realist perspective will be taken throughout this thesis[2]. We acknowledge the measurement imperfections of empirical data and the contextual specificities resulting from unique gathering mechanisms. We accept the existence of

[2] For a discussion of critical realism see Wicks and Freeman (1998).

methodological pluralism and do not reject findings from other methods but rather try to translate and test those findings on the meso and macro level. Thus, we see our research as one kind of research contributing to a holistic picture of the topic. Through this interdisciplinary approach, we hope to uncover aspects that cannot be addressed with one perspective only while we account for the challenges of such exhaustiveness. Most importantly, we develop a sound theoretical framework to build a strong conceptual argument for the relationships tested with empirical data. Our contribution should thus be seen as an effort to uncover aspects of a larger puzzle, both theoretically and empirically.

1.4 Structure of the Thesis

To guide the reader through this thesis, its structure will be briefly explained. The framework chapter reviews the theoretical perspectives relevant for this thesis and draws connections between them. *Chapter 2.1* provides a brief overview of the theories of economic development as a starting point for further theoretical elaboration. *Chapter 2.2* focuses on institutional theory to build a solid concept of institutions throughout this thesis and *Chapter 2.3* outlines the main theoretical approaches to technological development. They are linked in *Chapter 2.4* by reviewing their joint impact on economic development. Based on the resulting framework, *Chapter 2.5* presents the MNE as a vehicle of institutional and technological change for economic development. To do so, the concepts of institutional theory and innovation studies are discussed from an IB perspective. This leads to an explorative frame illustrating the impact of the MNE on institutional and technological development, which will serve as the basis of the three essays of this thesis. The three essays can be read as independent works, as each examines one aspect of the main research question and they do not refer to each other. In order to jointly evaluate their findings and to identify relevant conclusions and areas for future research, the thesis concludes with a chapter on theoretical and practical implications.

2 Framework Chapter

Driven by the question of what factors stimulate economic development, the economic discipline has sprawled out to a variety of sub-disciplines offering different explanations for the optimization of economic activities and their underlying actions (Hunt & Lautzenheiser, 2011). On the macro level, scholars from political science and economic history have focused on the diverse array of institutions and their influence on the developmental path of a country (Lipset, 1960; Mokyr, 2009). On the contrary, micro-level research has focused on local economic actors that build the economic foundation of countries and are crucial for their economic success (Young, 1998; Dequech, 2004). Outside of the core economic discipline, more descriptive approaches to the economy and its development emerged, namely institutional perspectives (Dollery, 2005), evolutionary economics (Nelson & Winter, 1982), and theories of the firm (Cyert & March, 1963). This has led to a diversity of factors and variables supposedly contributing to economic development, whereas the explanatory power of each singular approach diminished. As a consequence, the complexity of economic issues and theoretical explanations increased along with the variety of concepts in economics and related disciplines making simple and eclectic solutions impossible to achieve (Landreth & Colander, 2001).

As there is no single theory offering a solution for an issue as complex as economic development (De Janvry & Sadoulet, 2016), this thesis tries to combine several major economic streams to develop an integrative research framework. In this way, we avoid the criticism that our study suffers from an isolated view of economic problems and does not do justice to the complexity of the issues (Mitra, Palmer, & Vuong, 2020). However, it also bears the task of bringing together incompatible pieces of the literature and mingling them with theoretical approaches. To account for this caveat, we will explore the foundations of each theoretical concept in more detail and reintroduce the reader to the major scholars of each field. By carving out the differences and similarities in the concepts' theoretical underpinnings, we allow the reader to fully understand and retrace our way of argumentation. Consequently, this chapter will review the origins of each concept from a developmental perspective with the goal of extracting relevant features for a comprehensive theoretical framework. The topics covered in the framework chapter are illustrated in *Figure 1.1*.

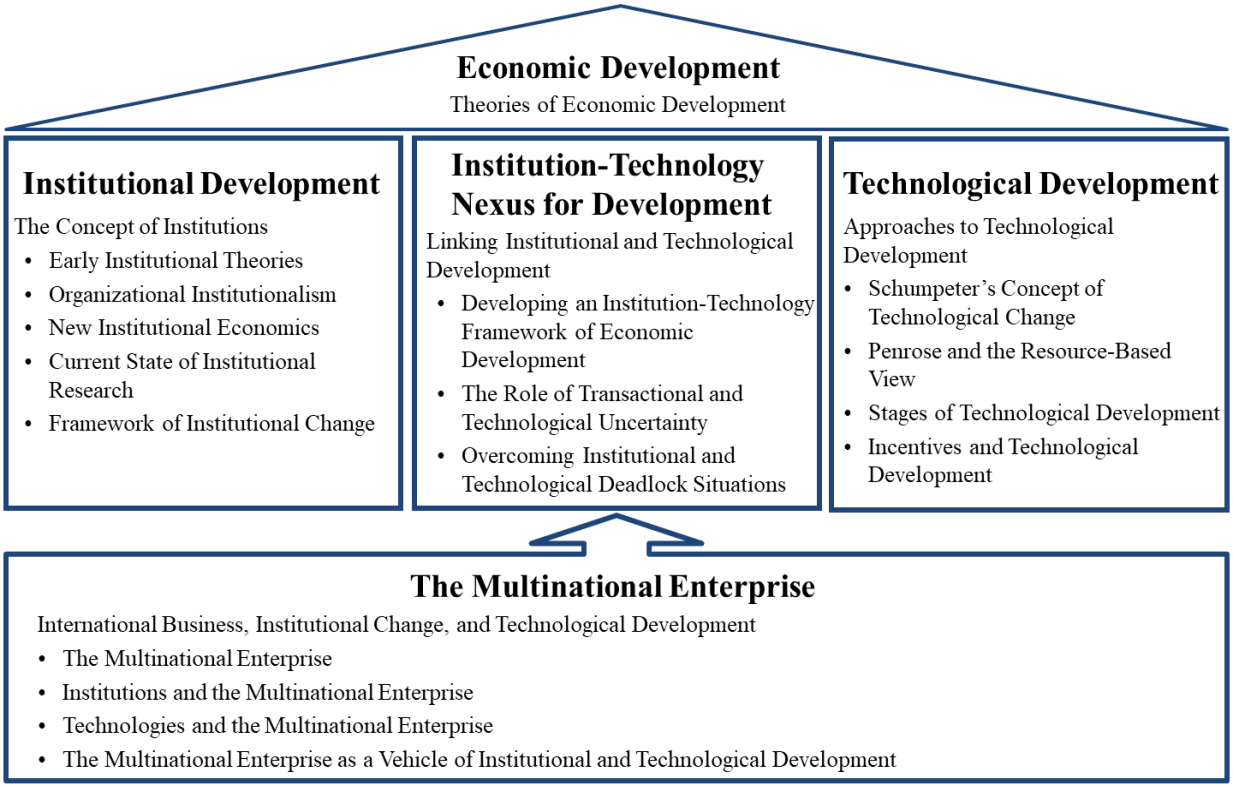

Figure 1.1: *Structure of the Framework Chapter*

2.1 Theories of Economic Development

Beginning with the big bang of modern economic theory – Adam Smith's "The Wealth of Nations" – classical growth theory assumes that the individuals' inherent pursuit of self-interest will lead to economic improvements through mechanisms of competition. While Smith already embraced historical and institutional perspectives to account for the complexity of economic well-being, it was mainly his view of the individual that sparked models and theories of the classical school of economics:

"[…] the natural effort of every individual to better his own condition, when suffered to exert itself with freedom and security, is so powerful a principle, that it is alone, and without any assistance, not only capable of carrying on the society to wealth and prosperity, but of surmounting a hundred impertinent obstructions […]" (Smith, 1776: 540)

By increasing the number of productive laborers or by increasing productivity itself, exemplified through the division of labor, individuals will increase their own profit contributing to the income of the economy as a whole. In this context, it is important to note that these assumptions were made in the realm of an agricultural-driven economy in a feudal society and the spring of the Industrial Revolution. Smith

observed that in pre-capitalist society the laborer owned all that he produced, while in the capitalist society the master and landlord deducted part of the worker's wages as their rent and profit. He saw antagonism between the interests of the worker and the master and observed that the law and magistracy were on the side of the masters. This prompted him to argue for the reduction of government intervention. Assuming a humanly inherited propensity to truck and barter that originates in unique habits, customs, and education, he proposed an economic system that optimally distributes the individual differences in talent according to a men's profession (Singh, 1959). Consequently, he postulated the machine as the liberator of a human's potential, bringing specialization and power to the working class.

Building on this definition, marginalists and utilitarians developed concepts of market capitalism – all arguing for a superiority of individual efforts over the guidance of the state. Common among these concepts is the transfer of micro-level assumptions like the "economic man" to macro-level principles of the political economy. It is assumed that individuals make rational decisions in their pursuit of individual well-being, thereby contributing to overall economic development through their influence on the division of labor (Rodríguez-Clare, 1996), the role of property (Falvey, Foster, & Greenaway, 2006) and transaction costs (Williamson, 1975). In this context, the most relevant revolution in economic theory seems to be the questioning and ultimate rejection of rational choice models by Marxian economics and old institutionalists, paving the way to more contextual theories (Ostrom, 1998).

Similar to Smith, Marx attached labor the critical role of creating value in society, but he came to quite different conclusions in terms of the societal and political orchestration of such labor. Observing the capitalist distortions of the 19th century and the increased ability of the capitalists to exploit the worker, Marx argued that the alienation of the worker from his work leads to a conflict between the capitalist bourgeoisie and the working class (Marx, 1867). Instead of believing in the self-correction of the system, he argued that the societal structures of capitalism must change so that workers can reclaim the means of production and pave the way for a socialist economy.

Underlying his theory was the division of society into a social and economic structure, where the economic system creates the foundation of social standings. The forces of production shape the relationships and ideas of a society, and any change in these forces leads to social disruptions (Huntington, 1968). Marx emphasized the role of the dynamic evolution of technology in shaping the forces of

production and, ultimately, the social structures of a country. Since his theory was strongly influenced by the experiences of the Industrial Revolution, he argued that technological change needs to be steered in such a way that it improves the well-being of a society. Marxian scholars also acknowledge the embeddedness of production forces in the wider social context, where social ideas and technology interact (Sherman, 1967). This way of mutual influence and progress allowed Marx to expand beyond the static equilibrium models of neoclassical economics and integrate dynamic concepts in his framework. In his theory, the state can actively promote economic improvements by stimulating the worker's capacities, increasing capital accumulation, and supporting technological advancements – all increasing the productivity.

In this sense, Marx reunites with Adam Smith, who also emphasized the role of technological improvements, capital supply and effectual demand under conditions of competition in his theory of development. Moreover, both thought of developmental stages, as Smith classified societies into stationary, declining, and advancing, describing his own time as "progressive" and opulent. Marx instead thought of development in phases of relative prosperity followed by phases of depression stemming from low demand and overinvestment. Still, Smith and Marx maintained a view of general growth associated with the capitalist system thriving on capital, labor, and technological improvements.

Whereas much of their work took the societal, political, and technological surroundings as exogenous to their development theory, old institutionalists like Thorstein Veblen focused on the institutional and social embeddedness of individuals, thereby further criticizing the dominant micro-level assumptions of the time (Veblen, 1899). While institutionalists acknowledge the ideas of individuals and their ability to shape their environment, they take a collectivistic view as historical path-dependency leads to the convergence of the individuals' customs and habits in a society. They also highlight the role of technology as having an important influence on social ideas and vice-versa, although it is not the only determinant. Thus, Marxism and institutionalism can be aligned in their arguments for a holistic view of ideas, structures, and the individual as well as in their dynamic, evolutionary perspective on social and economic spheres (Dugger & Sherman, 1994).

These approaches influenced more complex explanations of development related to the embeddedness of economics in the wider institutional and social environment (e.g., Polanyi, 1944; Granovetter, 1985).

One of these approaches is the innovation-based theory of economic development by Schumpeter, who grounded his theory on historical and institutional theories and criticized the lacking definition of technological change in economics (Schumpeter, 1942). By making technological advancements the core of his theoretical contribution, Schumpeter offered a complementary perspective on the interplay of institutions, ideas, and technology for economic development (Ebner, 2006). Central concepts of institutional perspectives like path-dependency and dynamism can also be found in his conception of technological and economic development, whereas his depiction of capitalism resonates with the Marxist view of society (Ebner, 2002). Moreover, Schumpeter embedded existing concepts of business cycles in his theory, thereby allowing for a dynamic interpretation of economic and social developments. In light of his theory, many scholars were attracted to the concept of the entrepreneur and innovation as driving forces of economic development.

Although far from encompassing all theoretical diversions in the history of economic thought, these deviating perspectives from neoclassical economic theory led to the degeneration of a unifying theory into a mass of multilevel theories that could not produce as simple solutions as the neoclassical theorists. As Nelson puts it,

> *"Economic development, as we have experienced it, is a very complex process. Many different kinds of activities and institutional actors are involved, and they interact in complex ways. […]. To understand economic development this complexity needs to be recognized. One of the blinders to our understanding that I associate with the rise of general neoclassical theory is that it has encouraged us to believe that the gist of what goes on in an economy can be captured in a simple theory that focuses on a very limited set of actions and actors. No theory of economic development that is focused on just a few variables and activities and institutions is, by itself, adequate to the task." (Nelson, 2015: 6)*

In sum, this short summary of the origins of current concepts of development demonstrates that a variety of disciplines needs to be reviewed to draw relevant conclusions about the myriad of factors contributing to economic development. Moreover, the concepts of institutions and technology have been at the core of the economic discipline from its start, and they have sparked major research streams focusing on different explanations for development. However, the resulting complexity of research on the topic leads to challenges in establishing a unifying framework of economic development. Rather levels of

analysis, disciplines, and economic concepts "*must be studied not in isolation but in their mutual relationship*" (Myrdal, 1968: X). To do so, we will focus on two main theoretical perspectives in the following sections with the goal of finding complementarities and interrelations among them.

2.2 Understanding the Concept of Institutions

In the context of this thesis, institutional theory is defined as the "broad study of the social provisioning process in its cultural context" (Dugger & Sherman, 1994: 106). Its theoretical development can be traced back to the so-called old institutionalists, who argued for a more contextual and historic analysis compared to the predominant neoclassical paradigm at the end of the 19th century. To allow for a complete picture and trace the origins of the concept, their ideas and contributions will be illustrated through the examples of two major scholars of the field, Thorstein Veblen and John Commons. A review of current institutional perspectives and their application will be divided into an organizational and an economic perspective. In the last two sub-chapters, an own framework of institutions will be developed based on current studies applying institutional theory.

2.2.1 Early Institutional Theories of Veblen and Commons

Although not even Smith decoupled the individual from its specific historical and institutional context, early institutionalists like Veblen put environmental conditions at the forefront of economic theorizing. Resulting from the increased pace and spread of capitalism at the end of the 19th century, Veblen eliminated the relevance of the individual by reducing its historical impact to being a carrier of habits and thoughts that are infused by past and current experiences. He defined institutions as

> *"products of the past process, [that] are adapted to the past circumstances, and therefore never in full accord with the requirements of the present. At the same time, men's present habits of thought tend to persist indefinitely, except as circumstances enforce a change. These institutions which so have been handed down, these habits of thought, points of view, mental attitudes and aptitudes, or what not, are therefore a conservative factor." (Veblen, 1899: 118)*

In this way, Veblen introduced the notion of capitalism as an evolutionary process that is shaped by historically grown institutions, which emerge through a process of natural selection (Veblen, 1899).

Accordingly, a dynamic view of institutional and economic change is embedded in his definition of economic development, both coevolving over time. Technological change takes a crucial position in his theory as an outcome of capitalist progression and driver of the institutional selection process. As Rutherfurd describes in his review of institutional theory:

> *"Veblen's [his] theory was one of new technology changing economic conditions, and new economic conditions leading to new ways of thinking and to new institutions through a (non-intentional) process habituation."*
>
> *(Rutherford, 1998: 463)*

At the core of this habituation process is the conflict of ownership and workmanship over the dominant institutional logic. This conflict determines which institutions will be maintained and which will vanish. As Veblen highlighted the class affiliation as the origin of power in a society, he predicted that the growing relevance of engineers and industrial workers will lead the future of capitalism into a more socialist direction (Papageorgiou, Kateselidis, & Michaelidis, 2013).

Inspired by this seminal work, other institutionalists took on the challenge of introducing institutional perspectives to mainstream economics, which was mainly concerned with Walrasian equilibrium analysis at that time (Rutherford, 1998). This new wave of institutionalists is best represented by John Commons, who viewed institutions as collective action by individuals, which can manifest itself in organizations "such as the family, the corporation, the trade association, the trade union, the reserve system, the state" (Commons, 1931: 649).

Being closer to neoclassical theory, he emphasized the "social" component of capitalism as well as the influence of collective habits and values on the individual's actions and economic transactions (Commons, 1931). In his conception, institutional change was driven by the expansion of markets that have changed the nature of businesses, displaced workers, and removed the barriers of social classes. Commons saw capitalism as an outcome of the institutional responses to the Industrial Revolution, which led to the conclusion that a change in institutions could change the future course of capitalism. He proposed a teleological view of institutions, where institutional change could "save capitalism by making it good" (Commons, 1934: 143).

While many scholars criticized the contributions of Veblen and Commons as ideological or descriptive at the time, their ideas remain embedded in the economic discourse to this day. They inspired the work of Coase and Penrose, which ultimately led to the emergence of the theories of the firm prevalent today. Moreover, evolutionary approaches to technological change can be found in several disciplines including evolutionary economics (Nelson & Winter, 1982) and political economy (Polanyi, 1944). Interestingly, these concepts were largely not taken up by mainstream economics, so that a new wave of institutionalists emerged towards the end of the 20th century. Out of frustration with the over-generalized explanations of economic problems, new institutionalists made another attempt at inserting the institutional environment into the economic discourse. The two main theoretical approaches resulting from these developments are organizational institutionalism[3] and new institutional economics (NIE).

2.2.2 Organizational Institutionalism

Organizational institutionalism emerged from a Weberian bureaucratization perspective on organizations (Biggart, 1991). Main issues of this theory concern the structure and change of organizations, their similarities and differences as well as their interaction with the environment. While Weber contended that bureaucratization was driven by competition and efficiency-seeking motives, which ultimately made the capitalist firm a bureaucratic organization itself (Weber, 1922), adopters of an institutional perspective outlined the role of environmental pressures constraining an organization's development (Meyer & Rowan, 1977). In this way, organizations are viewed as institutionally formed entities, which have to comply with environmental expectations to ensure their survival (Tolbert & Zucker, 1983).

In their seminal paper, DiMaggio and Powell (1983) outline the state and professions[4] as new drivers of bureaucratization and rationalization exerting coercive, normative, and mimetic pressures on organizational fields. They argue that the activity of organizations is determined by the coercive pressure of the state beyond its political boundaries (Meyer & Rowan, 1977), the normative pressure of the professions as carriers of occupational habits and values (Larson, 1977), and the mimetic pressure arising from competitive and technological uncertainty within organizational fields (March & Olsen, 1976). Within a population, organizations feel the same pressures for adaptation and barriers in their ability to

[3] Organizational institutionalism is also referred to as sociological institutionalism or new institutionalism.
[4] Professions in this case refers to managers and professional staff of large organizations.

cope with uncertainty, which ultimately leads to homogeneity in structure, culture, and output (DiMaggio & Powell, 1983). DiMaggio and Powell argue that organizational institutionalism

> *"[…] comprises a rejection of rational-actor models, an interest in institutions as independent variables, a turn toward cognitive and cultural explanations, and an interest in properties of supraindividual units of analysis that cannot be reduced to aggregations or direct consequences of individuals' attributes or motives" (DiMaggio & Powell, 1991: 8)*

Resembling Common's notion of collective action, the evolution of organizational fields is the outcome of complex response mechanisms to external pressures based on interacting interests of individuals. In this context, the ability of organizations to respond is constrained by the past decisions of organizations and the competition of interest groups within it. This can lead to lock-in mechanisms with constrained opportunities for organizations to change (McKelvey, 2002). Conversely, an organization's ability to change is facilitated by managerial willingness to take risks (van den Bosch, Volberda, & de Boer, 1999), adoption of new structures and strategies (Lewin and Volberda, 1999; Lewin, Long, & Carrol, 1999) as well as the experimentation with new practices and habits (Crouch, Streeck, Boyer, Amable, Hall, & Jackson, 2005). The development of new practices provides opportunities for change and increased performance, when productive practices gain legitimacy through their "infusion with value beyond their technical requirements" (Selznick, 1957: 17).

Pressures for change rise with increased competition or the introduction of new technologies, which create new needs for efficiency and changed practices to combat the uncertainty about future institutional logics. Embedded in this view of institutionalism is an evolutionary perspective, where organizations are competing for resources, customers, political power, and legitimacy to survive (Lewin & Volberda, 1999). McKelvey (1997) also emphasized the role of change by arguing that this process is reinforced by environmental uncertainty and causal ambiguity, so that incremental advantages resulting from variations in competencies lead to replicated success behavior. As a consequence of the same pressures in an organizational field, "organizations tend to model themselves after similar organizations in their field that they perceive to be more legitimate or successful" (DiMaggio & Powell, 1983: 152). Studies applying these concepts find patterns of adoption and imitation in the context of CSR practices (Bondy, Moon, &

Matten, 2012), investment patterns (Cui & Jiang, 2012), and emerging market MNEs (Young, Tsai, Wang, Liu, & Ahlstrom, 2014).

The learning process of organizations is viewed as crucial to adapt to new conditions by developing new and enhanced capabilities. Firms possess a different fitness for assimilating new knowledge, which is determined by their prior knowledge, organizational forms, and combinative capabilities (van den Bosch et al., 1999). Here, the theory connects with Cohen and Levinthal's (1990) definition of absorptive capacity, which is described as the ability of organizations to detect and value new information and convert it into knowledge relevant for flexibility and adaptability. Organizations with higher levels of absorptive capacity will be more adaptive to a changing environment and tend to be more proactive in enforcing change within and beyond the boundaries of their organization (Volberda, 1998). In this way, organizational institutionalism epitomizes the current economic paradigm of the knowledge economy, in which competitive advantages are quickly erased and organizations need to maximize flexibility (Acs, de Groot, & Nijkamp, 2002).

This view on institutions does not only define them as a source of constraints but also as enablers of specific organizational developments at the same time. Firms are not just passive recipients of environmental conditions but can also shape their environment proactively. Stewart (1996) points out that some organizations grow so large that they are able to dominate their environment and therefore have more chances to grow than through simple adaptation. This is reinforced if the extent of transactions between one organization and the state is high because the government often establishes rules for a whole industry resulting in less flexible and adaptive regulations for other firms. Such a process of bi-directional influencing can be conceptualized by coevolutionary theory, where organizations and institutions evolve co-deterministically (Corredoira & McDermott, 2014).

In an effort to shift the focus from organizations to the country level, Scott translated these pressures into three institutional pillars, regulative, normative, and cognitive, representing the institutional environment of a country (Scott, 1995; Scott, 2014). They determine the dominant organizational forms and business practices in a country as well as the responses of organizations to changes in the environment. For economic progress, this means that institutional and technological change are sources of uncertainty, with the developmental outcome depending on the competition of responses and the imposition of a new

institutional logic. In this way, organizational institutionalists question the ability of the government to direct institutional development because the results of such changes are hard to predict. This view resembles Veblen's description of indeterministic change of institutions. Due to the complexity of organizations and the experimental nature of adaptation, institutional change is conceptualized through the ability of economic actors to introduce new norms and values and to channel behavior in times of uncertainty.

2.2.3 New Institutional Economics

Similar to the differences between Veblen and Commons, new institutionalists also induced a research stream that is closer to neoclassical economics and rests its explanatory power on the description of transactions. This area of institutional research is called NIE. As a natural extension of transaction cost economics forwarded by Coase (1937), Williamson defined institutions as governing systems of economic transactions that determine individual behavior and reduce uncertainty (Williamson, 1975). Thus, institutions determine the form of market transactions as well as the profit functions of economic actors. The resulting stream of research in this direction has found its way into many areas of economic theory including game theory (Aoki, 1984), management theory (Mahajan, Sharma, & Bettis, 1988), and agency theory (MacLeod, 2003).

A major contributor to NIE is Douglass North, who defines institutions as the "rules of the game" consisting of formal rules and informal constraints (North, 1990: 9). More precisely, institutions are rule systems and enforcement mechanisms that reduce the uncertainty naturally embedded in human interaction. Formal rules are binding through their specification by regulators and can be enforced by legal and executing bodies. Informal constraints are codes of behavior and norms that underlie and supplement the formal rules. They derive their regulatory function from the institutionalization of social relations that reduce uncertainty within the constraints of a common heritage (North, 2005). Thereby, an important focus lies on the history of institutions, as path-dependency limits their changeability as well as the choices of institutional actors. Despite his focus on economic transactions, he deviates from rational choice conceptualizations of transactions as he emphasizes the role of motivation shaping human behavior. North's view on institutions is summarized in the following statement:

Institutions provide the structure for exchange that (together with the technology employed) determines the cost of transacting and the cost of transformation. How well institutions solve the problems of coordination and production is determined by the motivation of the players (their utility function), the complexity of the environment, and the ability of the players to decipher and order the environment (measurement and enforcement). (North, 1990: 34)

As already indicated in this statement, North highlights the role of technology complementing the governing functions of institutions. As the existence of rules and especially their enforcement is accompanied by compliance costs (e.g., to determine the violation of ownership rights or to measure performance), technology has the power to decrease them. Accordingly, it is the lack of (technological) capabilities that prevents individuals from engaging in exchanges that would otherwise improve their economic performance as expected in neoclassical zero-costs assumptions. For instance, where property rights cannot be enforced by individuals due to resource constraints, institutions can govern economic transactions to achieve optimal resource allocation for economic development. Thus, it is the interplay of institutions and technology that determines the costs of production (North, 1990).

This co-determination of institutional and technological development is also reflected in North's conception of institutional change, which is defined as change in relative prices that "alter the incentives of individuals in human interaction" (North, 1990: 84). They arise from changes in the ratio of factor prices, changes in the costs of information, or changes in tastes. All these alterations can be caused by technological developments, which represent a special dimension in North's conception of institutions and their relation to growth. Similar to the evolution of institutions, North points to the path-dependency of technological developments, which do not always favor the optimal solution. This is because institutions develop simultaneously and increase switching costs to more efficient technologies. While North uses examples of narrow-gauge rails and the survival of the gas engine over the steam engine, modern examples include difficulties in the digitalization of public administration or the adoption of renewable energies based on rigid institutionalized practices (Höffler, 2005; Carrel, 2018; Huybrechts & Haugh, 2018).

In sum, technological development is characterized by indetermination, lock-in effects, and path-dependency (Arthur, 1989; North, 1990). Notably, this resembles Veblen's conception of institutional development, especially as lock-in effects and path-dependency are outlined to be much more complicated

in the case of institutions than in the case of technology. Contributing to this complexity are the interplay of polity and economy, the involvement of many actors with varying degrees of bargaining strength, and the cultural inheritance underlying the persistence of many informal constraints. As a result, North draws the following conclusion regarding the effect of institutions and technology on economic development:

> *"Long-run economic change is the cumulative consequence of innumerable short-run decisions by political and economic entrepreneurs that both directly and indirectly (via external effects) shape performance. The choices made reflect the entrepreneurs' subjective modeling of the environment. Therefore, the degree to which outcomes are consistent with intentions will reflect the degree to which the entrepreneur's models are true models. Because the models reflect ideas, ideologies, and beliefs that are, at best, only partially refined and improved by information feedback on the actual consequences of the enacted policies, the consequences of specific policies are not only uncertain but to a substantial degree unpredictable." (North, 1990: 104)*

The main lesson from North's theory is that the analysis of institutions should be integrated into the analysis of macroeconomic developments by acknowledging the micro-level incentive structures that arise from different compositions of formal and informal institutions, especially with respect to their effect on the utilization of technology. A study of economic development is essentially a study of institutional (dys-)functionality for the effective use of the means of production and the incentive structures of economic and institutional actors to change the status quo. Studying these incentives, which vary over time and across countries, would require the systematic study of institutions as the origins of transaction and information costs in economies.

2.2.4 Current State of Institutional Research

Building on the pioneering contributions of the institutional scholars presented in the previous chapters, institutional theory has emerged as a central perspective necessary to understand economic development (Rutherford, 2001). Conversely, the inclusion of institutions into mainstream economics also led to the mingling of different institutional perspectives and a blurred definition of institutions in the economic discipline (Hall & Taylor, 1996; Jackson & Deeg, 2008). Thus, the objective of this chapter is to review recent findings of this stream of research to illustrate the current state and application of

institutional theory. By doing so, we hope to uncover common threads among the different institutional perspectives and arrive at an inclusive conception of institutions.

A large part of recent institutional research was conducted by economists like Acemoglu, Robinson, La Porta, and Djankov, among others. These scholars have examined the effect of institutions including property rights (Falvey, Foster, & Greenaway, 2006), governance structures (Maskus & Lahouel, 2000), contracting institutions (Matthews, 1986), labor market institutions (Cette, Lopez, & Mairesse, 2014; Dean, 2015), legal framework (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998; La Porta, Lopez-de-Silanes, & Shleifer, 2008) as well as democracy (Weingast, 1997; Persson & Tabellini, 2007), election systems (Schofield, 2000) or centralization (Djankov, Glaeser, La Porta, Lopez-de-Silanes, & Shleifer, 2003). More specifically, these studies mostly focus on the effect of a specific dimension of institutions on economic development (Keefer & Knack, 1998; Rodrik, Subramanian, & Trebbi, 2004). Despite significant contributions that would exceed the limits of this thesis, these applications of institutional theory have been mainly concerned with the integration of institutions into mainstream economics instead of a further development of institutional theory itself – albeit a few exceptions.

In their much-noticed contribution, Acemoglu, Johnson, and Robinson (2005) divide formal institutions into a political and an economic dimension, which both emerge endogenously from the informal structures in a society. Political institutions include the form of government and the level of democracy, which evolved historically and are very persistent. Economic institutions develop as the most efficient form of economic organization and determine the economic performance and distribution of resources. To change these institutions, key actors need to exert political power that is not only dependent on the political institutions but also on the distribution of resources according to the economic institutions. As a result of this complex interaction, hold-up situations occur where political and economic losers block any changes of the institutional status quo. This leads to inefficient institutional outcomes that hinder economic change and development (Acemoglu, Kremer, & Mian, 2008).

On the informal level, the incentives of institutional and economic actors arise from their socialization within historically developed social frameworks. For instance, Siavelis (2016) argues that the development of institutions in post-authoritarian Chile was heavily influenced by the informal institutions inherited from the authoritarian regime. Chacar, Celo, and Hesterly (2018) find evidence that informal institutions are

especially relevant for change in a highly institutionalized field, whereas emerging organizational fields are more prone to formal, top-down induction of institutional change. Other studies provide evidence for the influence of informal institutions such as egalitarianism (Siegel, Licht, & Schwartz, 2011), personal networks (Wang, 2000), and social capital (Casi & Resmini, 2017) on the incentive structures of economic actors. Helmke and Levitsky (2012) showcase the existence of interactions between informal institutions as they find that bureaucratic norms and societal values can substitute, reinforce, and compete with each other. More specifically, they argue that the Constitution of the United States is strengthened by a set of complementary social norms, while corruption in postwar Italy was fostered by the existence of diverging norms.

These findings from institutional theory indicate the existence of complementarities between institutions as they mutually influence each other (Krug & Hendrischke, 2012). This realization led to macrosystemic and configurational approaches to institutions, in which various aspects of the institutional environment are analyzed regarding their potential for development (Hall & Soskice, 2001). In these approaches, national and societal institutions reflect individual incentives and constraints that evolved into distinct configurations of the institutional environment over time (Whitley, 1999; Amable, 2003). These resulting sets of institutions can be categorized as political, financial, labor-related, educational, or cultural, which together represent an organization's environment. Due to the interrelation between these categories, their effect is dependent on the presence of supporting and sanctioning institutions (Hall & Soskice, 2001). In this way, configurational approaches have introduced the concept of institutional heterogeneity and complementarity indicating the possibility of mismatches between existing and new institutions (Krug & Hendrischke, 2012). However, the effect of such mismatches on the incentive structures of institutional actors and how powerful organizations can overcome them has remained superficially addressed in these approaches.

Here, organizational institutionalism offers more valuable concepts of how the macro-institutional structure affects the incentives of economic actors and vice versa. According to Scott (1995), institutions are every rule or pattern that exerts pressure for adherence, whereas their effect is based on competing interests negotiated and interpreted between actors. Romanelli and Tushman (1994) define the existence of a punctuated equilibrium of incentives and external forces, which is only altered when forces of change

will temporarily overcome forces of stability before reaching a new equilibrium. Such "outbursts" are triggered by performance reductions, changes in leadership and environmental challenges. The main goal of such change is to increase the fit with relevant legal or quasi-legal requirements, also called legitimacy.

However, the outcome of such change process is determined by the interaction of dominant economic and institutional actors, namely organizations, the state, and the professions. Research by Dobbin and Sutton (1998) as well as Edelman, Leachman, and McAdam (2010) provides evidence that the state cannot enforce common practices on organizations, but regulation and legal mandates are as much an endogenous force as an exogenous constraint. In other words, economic practices and structures are either reflections of or responses to rules, beliefs, and conventions built into the wider environment. Through its path-dependent nature, the current institutional framework only defines the ends and shapes the means by which interests are determined and pursued through intrinsic as well as extrinsic rewards of compliance. Greif summarizes this situation as follows:

"Given the technologically determined rules of the game, institutions – the non-technological constraints on human interactions – are composed of two interrelated elements: cultural beliefs (how individuals expect others to act in various contingencies) and organizations (the endogenous human constructs that alter the rules of the game [relevant to the decision-makers)] and, whenever applicable, [they] have to be an equilibrium [and thus self-enforcing]." (Greif, 1994:943)

The process through which such rules are created and diffused is called institutionalization. It is defined as the process "by which such patterns achieve normative and cognitive fixity, and become taken for granted" (Meyer, Boli, & Thomas, 1987:13). Institutionalized practices provide social stability by echoing reproductive processes that function as stable patterns for sequences of activities that are routinely enacted (Jepperson, 1991). Huybrechts and Haugh (2018) find that new organizational forms institutionalize through network interactions and collective actions, which help organizations to overcome the skepticism towards new forms and to gain legitimacy in an organizational field. Similarly, Briscoe and Safford (2008) find that resistance towards change can be overcome through the concession of a few key actors, which leads to a spread of previously contentious practices across an organizational field. Thus,

institutionalization is defined as the interaction of external pressures with internal legitimization processes (Colyvas & Powell, 2006).

In this way, organizational institutionalism reunites with NIE, where change is also considered to be a combination of endogenous and exogenous forces and shaped by the incentive structures of dominant actors. Endogenous change arises from the evolution of economic and institutional actors that introduce new norms and values through processes of experimentation and learning. Several studies emphasize the role of bottom-up changes triggered by individuals and interest groups in such diverse fields as accounting (Silva Guerreiro, Lima Rodrigues, & Craig, 2015), forestry (Zietsma & Lawrence, 2010), and baseball (Chacar et al., 2018). Exogenous change, on the other hand, is triggered by top-down decisions of political actors, the introduction of new technologies, or the influence of other countries. In the model by Acemoglu and Robinson (2012), endogenous change is limited due to skewed power structure so that only exogenous and stochastic events can change the power structure within the society, exemplified through the sudden alignment of interests in times of crisis.

Consequently, institutional change is mostly incremental with evolutionary processes of pressure and adaptation, but sometimes exogenous forces and the temporary alignment of interests trigger disruptive changes, which allow the overcoming of inertia and lock-in situations. Supporting this conceptualization, Streeck and Thelen (2005) analyze the change in employment regimes in industrial democracies by contemplating continuities development with breakpoint moments of institutional change. In such situations, institutions are susceptible to changes and the influence of powerful actors. This resonates with the conceptions of power and incentive structures in NIE as well as with the ability of organizations to enforce new institutions on whole organizational fields in their search for legitimacy.

Given these arguments, the major streams of institutional theory also emphasize the enabling nature of the institutional environment and the ability of actors to change institutions in their interest (Oliver, 1991). Organizations and individuals can also hinder change and strengthen the status quo where incentives for endogenous change are low. Tsebelis (1995) and Doner (2009) conceptualize such actors as vetoplayers that need to be convinced to generate significant institutional changes. Similarly, Mödlhamer (2020) describes the influence of important industries and economic stakeholders on the design of intellectual property rights in preferential trade agreements, thereby highlighting the existence of economic

vetoplayers. The power of such actors is not only dependent on the political structures but also on their resources and capabilities (Lewin & Volberda, 1999). Evidence on such influence mechanisms can be found in research adopting an agency perspective of the firm (Hall & Gingerich, 2009). To summarize these findings, we can identify three main traits that we need to incorporate in our concept of institutions: Institutionalization, complementarity, and change.

2.2.5 Framework of Institutional Change

Institutionalization can be conceptualized through the process of formalization as outlined in organizational institutionalism, where habits and customs are slowly becoming the norm in organizations and societies. Combining these micro-level definitions with North's macro concept of formal and informal institutions, the informal dimension of institutions can be explained through the degree of socialization, which means the diffusion and acceptance of habits and norms in a society.[5] In this way, we are able to define institutions through different levels of formalization and socialization as depicted in *Figure 1.2*. In this framework, institutionalization means the acceptance and adoption of norms along the dimensions of formalization and socialization, which together constrain and enable economic activity. The formal dimension of institutions includes the rules governing economic transactions and checks against expropriation by other economic actors. The informal dimension represents values that shape the economic behavior of individuals and, more importantly, the exchange between economic actors.

[5] A rule or pattern is only considered an institution if there is an unspoken sense that the rule or pattern must be followed or adhered to (Jepperson, 1991).

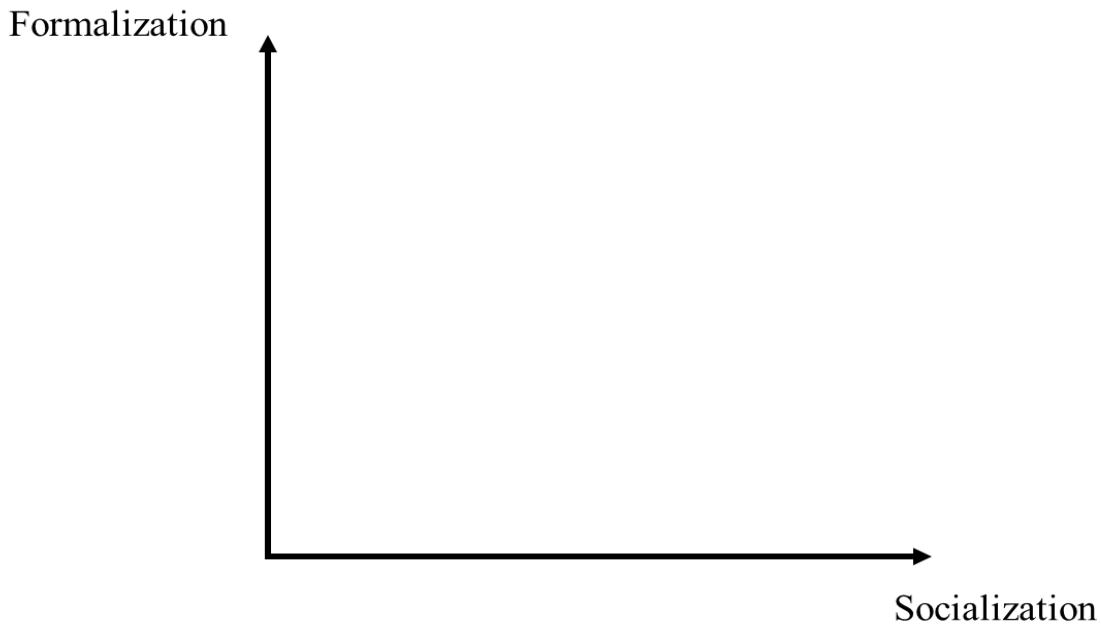

Figure 1.2: *Two Dimensions of Institutionalization*

The second major aspect of our conception of institutions is their multilevel, complementary character (Berry, Guillen, & Zhou, 2010). As reflected in configurational approaches, institutions exist on different levels and affect the constitution and effectiveness of other institutions (Scott, 2014). On the one hand, institutions can be highly formalized but not legitimized through informal norms in the society. This would foster circumvention through economic actors and make enforcement more difficult (Jeong & Peksen, 2017). On the other hand, informal values and norms might not be formalized but are still socialized within economic activity, so that they are treated as common knowledge (Helmke & Levitsky, 2012). This complementarity implies a mutual dependence of the formal and informal dimensions of institutions (Powell, 2007). If informal habits are widespread, it will be easier for policymakers to formalize and enforce related regulations. By contrast, when unwanted behavior is legitimized by informal habits, competing formal institutions will have limited effectiveness. Complementarity thus means both redundancy and amplification of institutions.

A similar understanding of institutions is now adopted by notable scholars like Stiglitz (2019), who argues that the concept of institutional complementarities needs to be accounted for together with the methodological challenges going along with it. He compares institutions to an orchestra, where it seems impossible to hear the impact of one instrument. This complies with the view of institutions as stabilizing, self-enforcing structures that coevolve and settle at an equilibrium along the bisecting angle. Despite many

economists only focusing on one specific institution, examining the interaction of institutions and incentive structures is crucial to understand their joint impact on economic realities.

In *Figure 1.3*, these complementarities are exemplified through fields of political and economic institutions as described in Acemoglu and Robinson (2005), but there are other sets of institutions including legal or social institutions. These areas are also defined as institutional fields, where different institutional artifacts interact and jointly shape the nature of the field[6]. For economic institutions, that means that a high level of property protection is not the only institution relevant to economic transactions. Instead, they interact with the rule of law, bureaucracy levels and antitrust laws jointly impacting the economic activity in a country. Moreover, informal norms and habits like corruption and the trust environment underlie such institutions and determine their effectiveness. Similarly, political institutions consist of aspects like the level of democracy, election laws, and governance system as well as democratic values or cultural heritage.

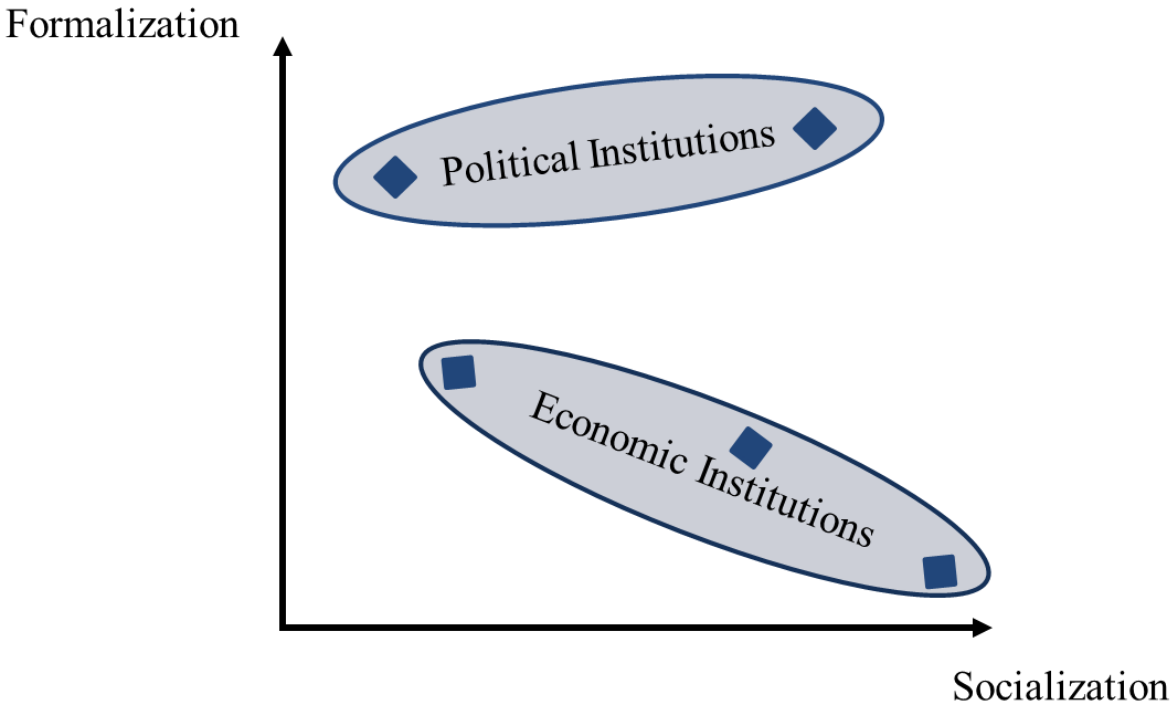

Figure 1.3: *Complementarity of Institutions*

The concept of institutional complementarities highlights the need to examine multiple institutional fields for their mutual influence on economic outcomes (Whitley, 2003). This is especially true when institutional factors within or between fields are not self-enforcing but rather work against each other.

[6] For a discussion of different institutional fields see Whitley (2003).

Here, the effect of institutions is dependent on the competing interests of institutional actors and their power to define the dominant logic of such institutions (Smets, Morris, & Greenwood, 2012; Tumbas, Berente, & vom Brocke, 2018). Most often, diverging pressures result in temporary, volatile equilibrium, which is prone to influence mechanisms before reaching a new equilibrium. Such situations induce actors to introduce new rules and norms with the goal of overcoming change barriers and shaping institutions in their way. This process reflects the common definition of institutional change, which originates in either formally imposed regulations or bottom-up processes of informal change (Culpepper, 2005). Indeed, institutional change has emerged as a key concept to understand processes of transformation and development in the economy (Peng & Su, 2014).

According to North (1990), change occurs mostly incrementally as power structures often balance the potential benefits for some with the potential costs and opposition of other economic actors. Only where such compromises cannot be reached anymore will one party ignore opposition resulting in larger disruptions and revolutions. But even if revolutions occur, new institutional frameworks will settle around what is left of the inherited norms and values in the society (Tudoroiu, 2007). Thus, path-dependency is a central feature of every theory of institutional change. In a similar vein, Roland (2004) distinguishes between fast-moving and slow-moving institutions. Mahoney and Thelen (2010) develop a theory of gradual institutional change, where incremental development of institutions can only be disrupted through formal changes in the distribution function or exogenous shocks. These would trigger responses that go beyond the simple seeking of compromises but rather lead to a war on ideas and power leading to significant changes in formal and informal institutions. To account for the relevance of institutional change, we include a time dimension in our framework (see *Figure 1.4*).

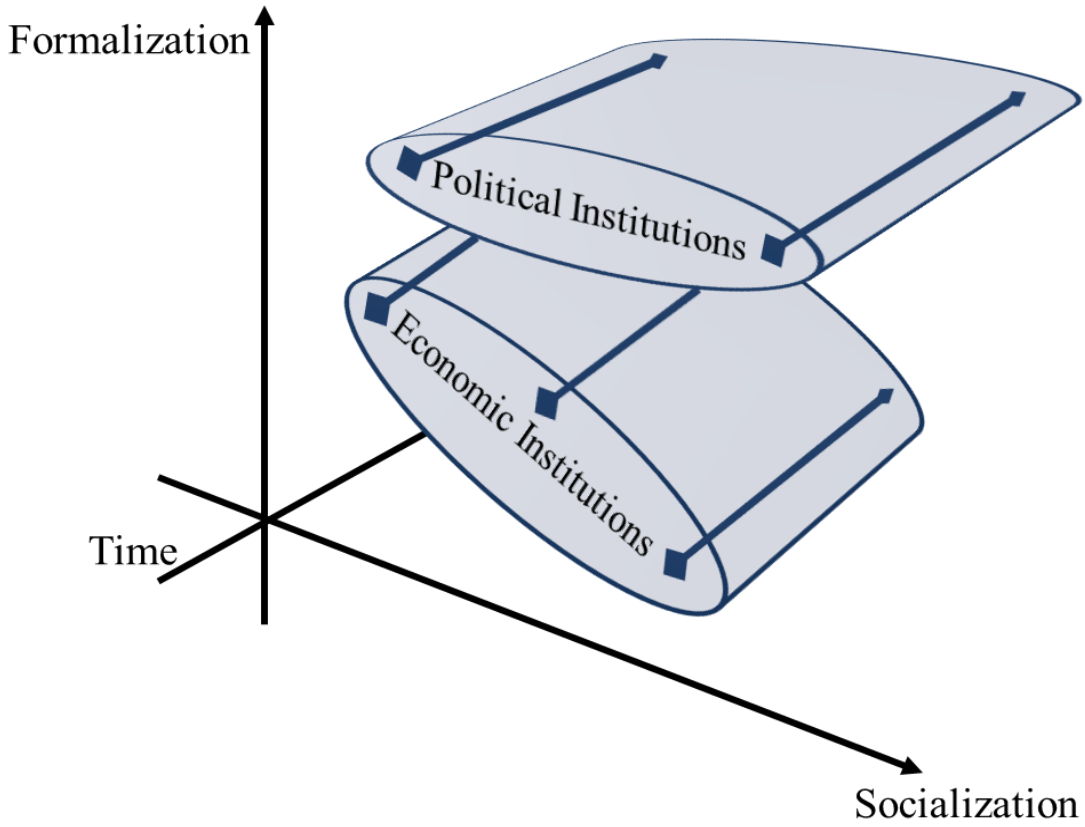

Figure 1.4: *Change of Institutional Fields over Time*

According to our framework, institutional fields evolve over time according to changes in their components. This implies two layers of safeguarding mechanisms against abrupt changes. First, institutions are generally path-dependent, so that change requires an incremental shift in their formal and informal dimension. Second, even if some components of an institutional field change quickly, their complementarity acts as a buffer against disruption resulting in relatively stable institutional mechanisms over time. Thus, institutional change is mostly incremental and disruptive change only occurs when new ideas gain momentum and support from powerful actors. Sources of such disruptive changes can be exogenous features like geography, climate, or technology (Engermann & Sokoloff, 2005).

Out of these factors, the most important trigger of such changes has been the invention of new technologies, which have also been outlined as the second major contributor to economic development. The development of technologies is synonymous with the introduction of new ideas and opportunities to a society as they require new forms and mechanisms of economic exchange (Mokyr, 2016). However, under what circumstances such advancements also increase the efficiency of institutional structures and lead to inclusive development is still unclear (Parto, 2005; Aghion, Akcigit, Bergeaud, Blundell, & Hémous,

2015). Thus, to complement our institutional framework with its relation to technological development, we will explore the literature on technologies in the next section.

2.3 Reviewing Approaches to Technological Development

Technological developments are outlined as crucial growth-stimulating factors across disciplines (Christian, 1968; Aghion, Akcigit, & Howitt, 2014). Since the Industrial Revolution, new inventions have been gateways for economic development by increasing productivity, accelerating economic transformation, and leading to social improvements (Mokyr, 2005). These transformation processes are referred to as technological development, where inventions are commercialized to achieve innovative profits and diffuse among economic actors. This process was first introduced to the economic discipline by Schumpeter and developed into a firm-level theory of entrepreneurship and innovation through the work of scholars such as Penrose. To understand how the research field evolved and relates to the study of economic development, we will review the work of these two major scholars and apply recent research findings to our concept of economic development in the following chapters.

2.3.1 Schumpeter's Concept of Technological Change

The concepts of technological change and innovation in modern economics and business studies are heavily influenced by the work of Schumpeter, who is widely regarded as the founding father of this research area (Fagerberg & Verspagen, 2009). Often considered a misfit among neoclassical scholars, he tried to open the dominant school of economics for historical approaches to economic development and cyclical movements of innovation. Thereby, he relied on evolutionary aspects derived from the German Historical School, but he also included sociological aspects of institutionalists like Veblen, Commons, and Weber and theories of production adopted from Marx (Ebner, 2002). Hodgson (1998) argues that the main contribution of Schumpeter was the integration of Darwinian ideas to the economy originating from Veblen, the idea of cyclical economic movement and countercyclical fiscal theory from Keynes and the critical approach to capitalist developments from Marx.

Based on Schmoller's concept of developmental stages and the subsequent theorization of business cycles by Kondratieff and Spiethoff, Schumpeterian theory asserts that economic history can best be explained through wave-like movements (Schumpeter, 1939). These are triggered by new innovations that

initiate phases of increasing prosperity and create new economic equilibriums. These phases are followed by economic downturns as the profitability of innovations decreases. In this context, Schumpeter highlights the role of the entrepreneur as the main agent of economic change by introducing new combinations of productive means. The resulting cost advantages provide the entrepreneur with a profit and attract other businesses into the new economic field opened up by the innovation. These innovative profits increase income, raise money supply, and drive economic development. This emphasis on the individual introducing new technologies, which subsequently leads to the erosion of monopolistic advantages of existing firms and the development of new technological paradigms [7], is referred to as creative destruction (Schumpeter, 1942). As this concept differs from his later work on economic development, it is often referred to as "Schumpeter Mark I".

His contribution deviates from neoclassical theory in that he attributes individuals not only incentives of rational choice but also extra-capitalist values like the joy of creating, an "immanent impulse" to rule, or the drive to build a family dynasty. Entrepreneurs are different from ordinary economic actors because they are motivated by habits of satisfaction arising from the social environment. In this context, Schumpeter (1935) distinguishes between spontaneous-creative and habitual-adaptive motives of economic agents. Only individuals that are driven by motives that go beyond the habitual-adaptive motives are willing to take the risk of innovation and face the threat of competition forcing them to continuously improve their forms of production. They need to be in constant search for new innovations leading to a dynamic environment, where technological competition will constantly erode temporary positions of market power. Consequently, Schumpeter views the hypothesis of perfect competition as inadequate to represent this technological dynamism.

He also acknowledges the embeddedness of economic actors in the broader institutional environment, which can be a source of constraints and opportunities. Indeed, he argues that modern capitalism is still substantially influenced by pre-capitalist institutions and social strata, thereby adapting the concept of path-dependency for his theory of economic development (Ebner, 2006). Entrepreneurs act as carriers of change mechanisms, whereas their chances to drive institutional and technological changes depends on the ability

[7] Technological paradigm refers to the dominant sources of new knowledge and new innovations in the economy, defined by certain generic technologies that can change both continuously and abruptly (Dosi, 1982).

to break inertia, find strategic partners, and gain the acceptance of customers. By all means, the manifestation of entrepreneurship depends on the historically shaped conditions of the institutional and technological environment as well as the drive and vision of economic actors. This is why Schumpeter outlines social leadership as the most important source of socio-cultural change in capitalism of the 19th and 20th century:

"Social leadership means deciding, ordering, carrying out, forging ahead. As such it is special, both within the actions of the individual, and within the social whole always a distinguishable function. It is to be considered only when confronting novel individual and social situations, and it would not exist if the life of the individual and the peoples would run steadily in the tracks of always the same routine" (Schumpeter, 1927: 64; as cited in Ebner, 2006: 505)

This dualism of institutions and technologies also resembles his conception of economic development, where the quality of entrepreneurship is the most indispensable factor of economic improvement. However, Schumpeter anticipated changes in the relevance of entrepreneurs as capitalism matures. The technological competition from new entrants will lead surviving firms to institutionalize innovation. In this way, established firms become a more effective device for learning beyond being a calculative entity balancing supply and demand. These developments are facilitated as technologies mature and production becomes more relevant for competitiveness (Schumpeter, 1954). Under those circumstances, large firms can introduce entry barriers, which provide temporary stability enabling them to introduce new products or processes in an evolutionary, path-dependent, and more effective manner.

Thus, while his early work focuses on the entrepreneur and the incentives for innovation, his later work emphasizes large established firms as the main innovators in a society, also called "Schumpeter Mark II" (Malerba & Orsenigo, 1996). While these two foci on technological change seem to be contrary at first glance, it can be argued that they merely represent different stages of capitalist development (Ebner, 2002). Indeed, Schumpeter described his period of capitalism as only a transition phase to a more socialist and "trustified capitalism"[8]. While entrepreneurs will drive the development of capitalism in the beginning,

[8] Trustified capitalism is the opposite of the competitive capitalism in Schumpeter Mark I. In Schumpeter Mark II large firms will have developed sustained innovative processes that limit the creation of new firms.

the danger of being competed down would force organizations to grow and coexist with entrepreneurial firms that are trying to replace old resource combinations (Schumpeter, 1939). This trend is magnified by the growing systematization and automatization of technological progress as well as the extinction of pre-capitalist values like family, which would render the entrepreneur obsolete. For the emerging large organizations, the prize realized within an integrated company will be lower than the competitive market price, visionary intuition will be replaced by the professional calculations of engineers, and the entrepreneur will ultimately be hired by large business units. In this way, Schumpeter also adopts explanations from transaction cost economics (Coase, 1937). As a result, the entrepreneurial function would be optimally carried out within large and bureaucratic organizations or even the state, which could be understood as a projection of the socialist state (Ebner, 2002).

While the early work of Schumpeter is often linked to the study of entrepreneurship and neoclassical conceptions of technological change, his later work evolved into a conception of innovation as the opportunities derived from internal capabilities of and factors external to the firm. Interestingly, the transition from entrepreneurial firms to large bureaucratic organizations inspired the work of succeeding innovation scholars, most prominently Edith Penrose, who studied the determinants of firm expansion and developed new perspectives on the relation between new entrants and incumbent firms as well as on the role of learning in existing firms.

2.3.2 Penrose and the Resource-Based View

Our current understanding of innovation in the economy can be traced back to the pioneering scholars, who developed the theory of the firm, especially Penrose and Coase. While Coase builds on transaction costs to explain the existence of firms, Penrose views the firm as a bundle of resources that are its source of competitiveness, profitability, and growth. Penrose (1959) builds on Schumpeter in that she asserts that the firm cannot only decide on price and output to increase profits and market power, but it can also create new social and productive capabilities through innovation, problem-solving, and cumulative learning. She argued that the pure exploitation of monopolistic advantages within an industry is not sufficient for endless growth. Instead, the growth of the firm can be attributed to innovation as the most reliable basis for long-term competitive advantages that are superior to quickly eroding monopolistic advantages of market power.

"Examples of growth over long periods which can be attributed exclusively to such protection [market power] are rare, although elements of such protection are to be found in the position of nearly every large firm." (Penrose, 1959: 113)

In opposite to neoclassical economists, who attributed the boundaries of firm growth to managerial limitations, market failure, or increasing risk premiums, Penrose merely viewed those as limits of the growth rate of firms. As the net revenue of profitable investment is unlikely to ever turn negative, firms can always grow by exploiting new opportunities and adapting new production methods (Pitelis, 2009). Their ability to do so depends on the existence of unused resources as well as the managerial capabilities and motivations to put them to work. Similar to Schumpeter's conception of entrepreneurs within a firm, these services are defined as the drive of individuals to provide the firm with new productive opportunities. By applying his concept to the large firm with a focus on its management, this approach to innovation contemplates technological change in Schumpeter's period of "trustified capitalism".

As a result of this innate drive for expansion, the question is not about whether to grow or not but rather about the direction and rate. This depends on the path-dependent accumulation of resources and exploitation of opportunities arising from the embeddedness within the broader technological environment. The ongoing search for innovative profits stimulates the diversification activities into related sectors or other markets. In this way, Penrose paved the way for the concept of technological diversification (Dosi, 1982; Pavitt, Robson, & Townsend, 1989; Teece, Dosi, Rumelt, & Winter, 1994).

Penrose also anticipated the international expansion of MNEs as technological diversification can be substituted through product or geographical diversification (Cantwell & Piscitello, 2000). She also argued that the coordination of international activities could lead to positive feedback for further innovation through the provision of additional incentives for organizing activities within the firm. While reinforcing the applicability of her theory to the global firm, she argued that the rise of the multinational organization as a new organizational form might require a "different analysis of the nature of the firm and the relation between the firm and the market" (Penrose, 1959: 239). In this way, she pre-empted the development of intra-firm networks of competence creation, which have developed through the cross-border activities of integrated MNEs from 1980 onwards (Cantwell, 1989; Cantwell & Piscitello, 2000).

Another analogy to Schumpeter concerns the existence of different dimensions of technological change. Penrose emphasized that the inventor is not necessarily the one who receives the greatest benefits from the innovation nor is it the first firm to commercialize the invention (Penrose, 1959). Instead, the most gains are received by the firm that has the optimal resource combination to adapt and further develop the invention for commercial use. Consequently, invention, innovation, and diffusion of technologies are separated phases of technological development, which also implies different cost and profit functions at the different stages. The share of profits in these stages is dependent on intellectual property rights (Teece, 1986), firm-level capabilities (Cohen & Levinthal, 1990), and competition (Scherer, Harhoff, & Kukies, 2001). Hence, both Schumpeter and Penrose acknowledged the primacy of productive and technological competence over that of exchange and selling relationships, thereby rejecting the simplistic view of firms as rational actors with incentives to optimize:

"In the long run the profitability, survival and growth of the firm does not depend so much on the efficiency with which it is able to organize the production of even a widely diversified range of products as it does on the ability of the firm to establish one or more wide and relatively 'impregnable' bases from which it can adapt and extend its operations in an uncertain, changing and competitive world." (Penrose, 1959: 137)

By highlighting the role of uncertainty as a barrier or stimulus for change, Penrose recognized the effect of economic conditions like factor prizes, competitors, or consumer tastes as relevant factors determining the opportunities for growth. However, she does not explain the concrete influence of such factors as she treats the external environment as an individual "image" in the mind of the entrepreneur. Thus, her theory is mainly explaining the internal growth mechanisms within the firm.

Addressing a potential limitation of her theory, she devotes special attention to the question of why small firms exist. In her theory, large firms have superior competitive power as they have accumulated valuable experience and size. These enable them to take advantage of many technological and organizational opportunities not possible at smaller scales of operation. For this reason, she explains the existence of smaller firms through a time dimension arguing that smaller firms might have just been founded and will grow into larger firms or that they have not yet been crowded out of the market or acquired by competitors (Penrose, 1959). Another explanation is that small firms exist because some small-scale

and niche activities are unprofitable for large firms. This is especially the case in emerging economic fields, where large firms cannot take advantage of all opportunities available to them, thereby allowing for profitable activities of smaller firms. She calls these relatively unprofitable activities “interstices” of the economy, which are also a central part of her concept of economic development.

In accordance with neoclassical assumptions, Penrose attributes technological advances and increased productivity a special role in economic development. Under conditions of rising demand, large firms with protected resources and advantages will drive such development by expanding on economies of scale and diversifying into new technological fields. In such a scenario, smaller firms will only have a minor effect on economic development as capital requirements, patents, or copyrights lower their ability to expand. However, when new technologies are accompanied by the need for new resources and shifts in consumer tastes, the opportunities for small firms to escape from the control of industry leaders and grow into dominant players will broaden (Penrose, 1959). When the dominant technological paradigm changes, the path-dependent nature of resource development in large firms will limit their adaptability and the growth opportunities for the whole economy (Cantwell, 2019). Thus, the facilitation of technological change and resource combination by small firms allows for economic growth beyond the resource boundaries of the economy. This is only true if the opportunities for profitable investment are not artificially restricted, for example through the monopoly power of large firms as this would likely lead to an incomplete use of resources, unemployment, and stagnation.

In sum, both Schumpeter and Penrose emphasized the relevance of technological development for economic development (Korres, Lionaki, & Polichronopoulos, 2003). They highlight that technological development does not equal the simple invention of a new technology nor its commercialization but rather its pervasive disruption of existing economic and social structures (Schumpeter, 1942). While inventions are defined as new ideas and scientific discoveries, innovation is the commercialization of the invention or recombination of ideas in a new product or process (Malerba & Orsenigo, 2000). However, for technological development, these innovations also need to manifest themselves not only in macro-level improvements of productivity (Jorgenson, 2001) but also in the emergence of new business models and practices (Teece, 2018). In other words, technological development is the extension and application of what is technically possible in an economically and socially transformative manner.

2.3.3 Stages of Technological Development

Schumpeter (1954) distinguished between different stages of technological development, namely the invention, innovation, and diffusion of new knowledge or technologies. Inventions are the expansion of technological boundaries either through the discovery of new knowledge or the development of new technologies (Brozen, 1951; Barnett, 1953). Innovations are "changes in production functions that cannot be decomposed into infinitesimal steps" (Schumpeter, 1935: 4). Diffusion means the spread of technologies and knowledge through commercialization, imitation, or spillovers (Brozen, 1953; Aghion & Jaravel, 2015). While a strict distinction between those stages should be avoided as inventions, innovations, and diffusion interact through feedback mechanisms (Loasby, 2007), scholars have pointed out that improvements in one dimension do not necessarily lead to improvements in another dimension.

Focusing on the interrelations of these dimensions, a large body of innovation studies provides evidence on major innovative actors (Lundvall, 2010), their incentives to drive technological change (Rodríguez-Pose & Crescenzi, 2008), and the determinants of these activities (Kotabe, Dunlap-Hinkler, Parente, & Mishra, 2007). Many of them conclude that the process of technological development is driven by Schumpeterian entrepreneurs who are risk-taking innovative actors introducing new practices and habits in an economy (Jaffe, Newell, & Stavins, 2002). By "doing new things or the doing of things that are already done, in a new way" (Schumpeter, 1947: 151), they enable the full exploitation of an economy's technological potential. Thus, they also provide the missing link between the invention of a technology and its diffusion through commercialization. Similar to the micro-macro link of institutional theory, technological developments on the micro level manifest themselves on the macro level through shifts in productivity, supply and demand patterns, and income. Indeed, it is this mutual influence between inventions, innovations, and diffusion that drives the technological development process. To understand how this process can also facilitate economic development, existing studies are reviewed with respect to the triggers of transitions between those three phases.

Invention

Innovation scholars highlight the role of two major domains relevant for the creation of new knowledge and the development of new technologies, public and private (Meusburger, Livingstone, & Jöns, 2010).

The public domain involves public research institutions such as universities or research institutes, which drive technological developments. In this context, research activities can be directed by the state to a certain extent as they are largely funded through government expenditure. A popular example of such state-led technological development is the current research efforts of China, which were strongly supported by governmental investment in specific technological areas (Fan, 2011). On the contrary, private research and development (R&D) is driven by companies that aim to explore future sources of competitiveness. As such investments are costly and risky, an estimate of more than 90% of the world's private R&D is conducted by the 2500 largest companies (European Commission, 2022). Moreover, scholars distinguish between research-intensive industries like pharmaceuticals, information and communication technology (ICT), and biotechnology, where companies are constantly searching for new sources of competitive advantages, and industries like textile, manufacturing, and agriculture, in which competitive advantages are mainly based on economies of scale and scope (Mudambi, 2008).

Together both domains are influencing the inventiveness of an economy. University spin-offs, public-private partnerships, and the establishment of private research funds for public institutions demonstrate their joint and complementary impact on the propensity for new inventions. The interplay of these actors is also crucial for the development of radical inventions, which are dependent on a diverse set of knowledge domains and existing technologies (Schoenmakers & Duysters, 2010). Such inventions are defined as novel, unique, and pathbreaking for future inventions, so that they have the potential to shape the technological base of firms and countries (Dahlin & Behrens, 2005). Nevertheless, it needs to be noted that the outcomes of R&D investments are difficult to guide and predict as inventions often evolve indeterministically (Tajaddini & Ghoulipour, 2021). Thus, the investments of public and private actors might increase the likelihood of new inventions, but there are other factors that influence the technological base of countries.

Fundamental factors of such inventiveness are the levels of human capital (Diebolt & Hippe, 2019), social capital (Barrutia & Echebarria, 2010) as well as public policy and tax incentives to promote investment in and the development of new technologies (Shah, 1994). More generally, the institutional environment has been outlined as a crucial determinant of the uncertainty associated with the investment in new knowledge and technologies (Roberts, 1998; Fan, 2011). Since they define the ability of firms to

secure and profit from their inventions, they shape the incentives of private actors. Strong institutional frameworks allow firms to secure their inventions against any similar product, so that subsequent inventors and imitators are left with a small share of profits. Such a situation is likely to lead to overinvestment of competitors and reduced breadth of subsequent patents (Scotchmer, 1991). In contrast, weak institutional frameworks disincentivize firms to invent due to the constant threat of imitation by competitors. As any competitive advantage is fading very quickly and innovative profits are evenly shared among first movers and latecomers, this will lead to underinvestment in new inventions. In that way, institutions represent a crucial mechanism to stimulate or hinder inventions.

Inventions from public and corporate R&D activities can together be conceptualized as endogenous sources of technological development in an economy (Pintea & Thompson, 2007). When such sources are not existent and actors from the private and public sector lack the capabilities and incentives to invent, countries find themselves at the low end of the developmental ladder (Brandt & Thun, 2016). However, several scholars have pointed out that the rising interconnectedness of innovative activities in recent years has increased the potential of exogenous sources introducing technologies to an economy. Therefore, the availability of technologies is not so much dependent on the location of invention but rather on their adoption. Here, similar factors of human capital and investments have been outlined as crucial for exploiting the potential of exogenous sources of technology (Lazzarini, Mesquita, Monteiro, & Musacchio, 2020).

Finally, even when there are highly inventive actors in an economy, it is sometimes challenging to translate these advances in knowledge and technologies into real technological and economic development. Mowery and Simcoe (2002) argue that countries like Switzerland, Germany, or France, which were originally involved in the invention of the internet, could not build on their early inventive success, and were ultimately surpassed by the United States, which had a more sophisticated national innovation system consisting of a large domestic market, private-public partnerships, and supportive government policies. Similarly, Gordon (2000) examined the impact of the new economy on productivity increases in the United States and found that computer technologies had no impact on 88% of the economy outside of durable manufacturing and that the productivity in the affected areas even declined. Thus, as acknowledged by

Schumpeter and Penrose, the economic impact of inventions is dependent on their translation into changes in the production function, also defined as innovation.

Innovation

The major actors adopting technological inventions in a productive way are firms that want to receive profits from innovation (Chiesa & Frattini, 2011). Here, the innovation literature as well as the theoretical discussion in the two previous chapters allows for a distinction between two main types of firms, the entrepreneurial firm and the large firm. According to Schumpeter (1954), entrepreneurs are the main drivers of creative destruction, whereas larger firms have evolved into bureaucratic organizations that institutionalized innovation to survive competition. Similarly, Penrose argued that small firms only exist in the aftermath of technological changes, so that they will not have grown into large firms yet. To understand the relation between large incumbent firms and young entrepreneurial firms, innovation studies provide additional empirical evidence.

Casson (1982: 23) defines the entrepreneur as market maker, who "specializes in taking judgmental decisions about the coordination of scarce resources." In this context, the entrepreneur is not simply a risk-taking individual (Kihlstrom & Laffront, 1979) but rather an exploiter of opportunities arising from the environment (Baumol, 1990). Shane and Venkataraman (2000: 220) follow Casson in defining entrepreneurial opportunities as “situations in which new goods, services, raw materials, markets and organizing methods can be introduced through the formation of new means, ends, or means-ends relationships.” In accordance with the concept of equilibria, these scholars argue that static environmental situations provide few incentives for new ventures as economic actors are satisfied with the current balance of output and demand (Eckhardt & Shane 2003). Similar to Schumpeter’s definition of creative destruction, entrepreneurship will only increase when disruptions open new opportunities while challenging the old ways of doing business. In other words, entrepreneurs respond to opportunities to generate innovative profits arising from technological or institutional change.

The entrepreneurial activity in a country will also rise with more positive attitudes of individuals towards uncertainty and risk (Liesch, Welch, & Buckley, 2011) as well as collaboration and exchange (Majocchi & Presutti, 2009) – aspects that are often summarized under the term entrepreneurial culture

(Hayton & Cacciotti, 2013; Uhlaner & Thurik, 2016). Moreover, the level of economic freedom (Bjørnskov & Foss, 2008), the political system (Spencer, Murtha, & Lenway, 2005), antitrust policies (Mowery & Simcoe, 2002), and property rights (Aidis, Estrin, & Mickiewicz, 2012) affect the levels and impacts of entrepreneurship. Baumol (1990) argues that the economic, political, and legal institutions do not only determine the level but also the productivity of entrepreneurship for economic growth (see also Sobel, 2008; Aparicio, Urbano, & Audretsch, 2016). Emphasizing the role of change for entrepreneurial opportunities, Young, Welter, and Conger (2018) find that institutional arrangements promoting stability and security will lead to more imitative opportunities, while institutions promoting flexibility and risk-taking behavior will foster more innovative opportunities.

Another stream of literature focuses on the innovative activities of established firms in the Penrosian sense (Teece, 1986; Cohen & Levinthal, 1990; Barney, 1991). Common to these approaches is that they explain the innovativeness of firms through their existing resources and capabilities (e.g., financial, personal, or material), which are combined in a unique way to generate an idiosyncratic competitive advantage. The main goal of those firms is not necessarily to exploit opportunities of technological change but rather to adapt to changes in the environment and retain or adopt unique advantages (Barney, 1991). Based on their resource base, which could include machine capacity, customer loyalty, production experience, or technology (Wernerfelt, 1984), firms adapt and recombine these resources in relation to specific market conditions. As some resources can be used in several product markets, they build the foundation of expansion into other economic fields. In contrast, they also posit a danger for first movers as substitutability and complementarity of resources enables competitors to close gaps in resource-based advantages. Teece (2006) explains the scope of a firm's activities through the tacit nature of knowledge, which is most efficiently exploited within the boundaries of an organization and allows firms to enter related product markets and industries.

In addition to the relevance of internal resources and capabilities, the innovativeness of firms is dependent on the competitive pressures in the technological field or industry. While in the early phases of technological development, firms often compete for a dominant design, competition in an established technological field is largely based on process innovation (Benner & Tushman, 2003). This is because young technological fields are often characterized by low competition and high, albeit uncertain, return

prospects. As more firms enter the market, a hypercompetitive environment develops where innovation is limited through unintentional spillovers or imitation, which quickly offset any technology-based advantages. As markets mature, they often become increasingly oligopolistic, so that innovation is hindered by entry barriers of large firms. However, innovation is also possible in unfavorable competitive situations as it can be substituted through a strong customer demand for new products (Wood & Williams, 2014), state intervention (Mason & Harrison, 2002), or the existence of research institutions (Rothaermel, Agung, & Jiang, 2007).

The maturation of markets can also be used to illustrate the relationship between smaller entrepreneurial and larger firms. Under conditions of technological stability and equilibrium, large firms will dominate high-demand markets and small firms will occupy niche markets or supporting industries. Indeed, the literature on entrepreneurial ecosystems highlights the cross-fertilization of entrepreneurial firms, large firms, and supporting actors like venture capitalists, government agencies, and research institutes (Bruns, Bosma, Sanders, & Schramm, 2017). However, when technologies change drastically, entrepreneurial firms will be able to disrupt the existing competitive equilibrium and overtake incumbent firms (Bower & Christensen, 1995). Although such developments have had dramatic impacts on the structure of industries, the survival of firms, and the performance of economies, the circumstances and processes under which incumbents and newcomers interact have remained unclear in most of the innovation literature (Christensen, Raynor, & McDonald, 2015). Moreover, the entrepreneurial literature often fails to recognize if and how innovations diffuse within the society and translate into integrated technological development.

Diffusion

The diffusion of technologies among actors is the last dimension of technological development. While several studies have outlined the relevance of new inventions and innovation as stimuli of the economy (Wennekers, van Wennekers, Thurik, & Reynolds, 2005; Acs, Dessai, & Hessels, 2011), the diffusion of knowledge and technology does not always follow from those two technological dimensions. Instead, the diffusion is dependent on factors like the nature of technologies and the appropriability regime (Teece, 1998).

As outlined by Teece (1986), the complexity of technologies and the requirements of highly tacit knowledge limit the adoption of technologies by other economic actors and reduces the likelihood of imitation. In the tradition of Schumpeter, Malerba and Orsenigo (2000) as well as Peneder (2010) argue that the technological regime, defined as key feature of the knowledge environment, determines the opportunity conditions of economic actors as well as the occurrence of spillovers. In this context, if innovations need the existence of co-specialized assets, the character of the technology will foster cooperation with owners of such assets. As a matter of fact, most technologies require complementary assets for an efficient usage. If this is the case, the diffusion of technologies becomes more likely, whereas some innovators will lose a share of their innovative profits to firms with such co-specialized assets.

The appropriability regime consists of legal and technology-specific protection of inventions and innovation that determines the distribution of innovative profits among first movers and latecomers (Scotchmer, 1991). In weak appropriability regimes, uncertainty about innovation rises and innovators are in danger of losing a lion's share of their profits to imitators and business partners. While such regimes are known to decrease the innovative activity, they also foster the distribution of knowledge among economic actors (Falvey & Foster, 2006). In contrast, strong property rights give the firm a maximum of power over their innovation and its future use (Winter, 2006). They encourage innovation through the provision of security about innovative profits, whereas they stifle the opportunities of other actors to use the technology and develop subsequent innovations. Thus, the appropriability regime is a crucial factor for the diffusion of knowledge within a society in that it balances the incentives for innovative investments with the opportunities for its subsequent use and diffusion.

Other factors that influence the diffusion of innovations are the willingness of actors to share knowledge (Martin, Salomon, & Wu, 2010), the degree of cooperation (Giuliani, Pietrobelli, & Rabelotti, 2005), and the proximity between economic actors (Marcon & Puech, 2017). Thus, the potential of new technologies to diffuse into and transform an economy depends on a variety of factors. Notably, the spread of knowledge and technology in the society will set up positive feedback loops as they will provide new and more opportunities for potential entrepreneurs. This is especially important for developing countries in which innovation is not yet institutionalized. As Prieger, Bamboky, Blanco, and Liu (2016) find, there is an optimal level of entrepreneurship for economic development, which is higher for developing

countries, where more new business activity is needed to develop. This implies that the impact of inventions, innovation, and diffusion is different depending on the development level of a country.

However, as all these factors play a role in the process of technological development, it is difficult to isolate the effect of one factor along the stages of invention, innovation, and diffusion. Moreover, one factor is likely to affect each dimension in different ways, thereby increasing the complexity of technological development. This also poses a unique challenge for policymakers as they cannot estimate the effect of institutional setups and policies in advance. To summarize how the three dimensions of technological development interact, we conceptualize technological development through an equilibrium approach, where invention, innovation, and diffusion depend on the incentives of economic actors.

2.3.4 Incentives and Technological Development

In line with the phases of technological development, the equilibrium finding process starts with an invention, which increases the positive private returns and attracts market entries. At some level of competition, the net social gain of new entries will vanish, and firms find themselves in a zero-profit equilibrium. In this situation, firms use their resources in different ways to establish resource and entry barriers over competitors. Thus, after a process of natural selection in the Schumpeterian sense, firms will shift their source of competitiveness to the use of slack resources and increased diversification in the Penrosian sense. When the new technological paradigm has become prevalent, these large firms with institutionalized innovative practices will dominate the competition. Moreover, the distribution of innovative profit can be anticipated with a stable appropriability regime. Schumpeter calls such an equilibrium "an unchanging economic process which flows on at constant rates in time and merely reproduces itself" (Schumpeter, 1939). This does not mean that the economy is not innovative, but rather that the innovative activity is gradually evolving based on the recombination of existing resources and capabilities. More importantly, the distribution of innovative knowledge will serve as the basis for future technological developments, which represents the path-dependent nature of technological development. Such an equilibrium is characterized by a fixed incentive structure along the three stages of technological development (see *Figure 1.5*):

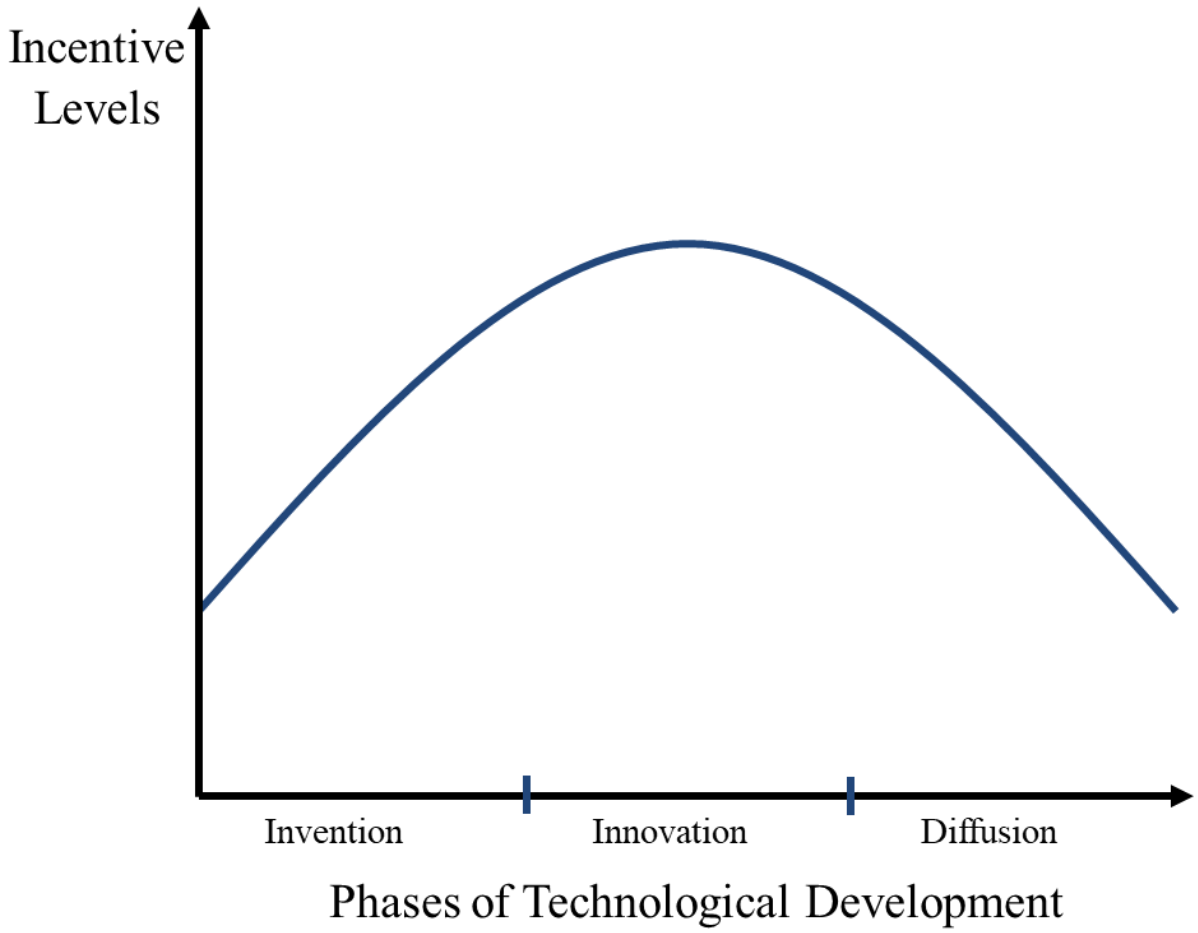

Figure 1.5: *Incentives of Technological Development*

To break such a technological equilibrium, a change in the innovative system needs to induce new entrepreneurial opportunities and a shift in the distribution of innovative profits. According to innovation studies, such changes occur through environmental shocks like the sudden emergence of a new and radical technology (Katz, 2001; Fagerberg, Srholec, & Verspagen, 2010). Endogenous sources of such changes can be R&D outputs or visionary entrepreneurs, which act as stimuli to disrupt organizational conformity and path-dependent adaptation processes. In contrast, the source of change can also be exogenous to the economy, for instance the introduction of new technologies through trade (Liu & Buck, 2007), foreign investments (Yi & Naghavi, 2017), and migration (Lin & Yang, 2017). The manifestation of these changes is dependent on the existence and formation of vetoplayers, institutional or economic barriers as well as cultural characteristics where existing norms and habits prevent idea implementation. These aspects are also influencing the market uncertainty arising from changes in the probability of investments turning into future innovative profits (Brouwer, 2000). Clarke and Weyant (2002) argue that the reaction of the

production function to such changes is dependent on the response of economic actors to the uncertainty about the technology potential and the future technological path.

Coupled with the complexity involved in the response to technological changes, institutions provide a crucial frame for economic actors through their influence on technological uncertainty. For instance, Manolova and Yan (2002) find that turbulent institutional environments lead to a short-term orientation of entrepreneurs and an increased reliance on informal networks and opportunism. Other findings relate to the importance of institutional factors for the levels of cooperation (Nooteboom, 2000). This is especially important when exogenous or endogenous changes lead to rapidly changing environments or when technologies are very complex because this makes it unlikely that one firm possesses all the resources necessary for the development and exploitation of technologies. Therefore, the importance of the institutional framework is derived from its influence on the costs of inventions and the uncertainty of profits, which together shape the incentives of actors to innovate and share their knowledge.

The most relevant institution in this regard is the protection of property, which determines the distribution of innovative profits and incentives for innovation. As already explained in the previous chapter, the degree of protection distributes innovation gains between inventors, latecomers, and imitators, thereby affecting all stages of technological development. When new economic actors, novel ideas, and business models emerge, the disruption of existing economic structures is moderated by the ability of new actors to protect their innovation against imitation and adaptation of incumbents. Low degrees of property protection would increase the likelihood of imitation and a loss of innovative profits to latecomers, while high degrees of protection would lead to the creation of monopolistic advantages, new entry barriers, and an inefficient diffusion of the new technology. Therefore, finding the most efficient level of property protection is a major task for policymakers to stimulate invention, innovation, and diffusion of technologies for economic development. In other words, if the profits and costs of research projects could be anticipated, the breadth and length of property rights protection could be organized in a socially optimal way (Scotchmer, 1991). As this information is not available, policymakers face the difficulty in stimulating incentives for technological development without impeding competition.

In conclusion, the incentives for technological development arise from the desire to generate innovative profits, whereas the outcome depends on the capabilities of the economic actors, the nature of

technology, competitive pressures, and institutional factors. Together, those factors determine the uncertainty around the future technological trajectory, the distribution of innovative profits, and degree of economic restructuring. When technology is highly tacit and requires high levels of specific investment, firms can more easily secure their innovative profits against the threats of imitation. Similarly, in established technological fields, there is little innovative competition, so that firms can estimate their return on investment with relatively high certainty. In contrast, easily imitable technologies carry the danger that profits are lost to latecomers and imitators. The same is true for technologies that require co-specialized assets, which are not freely available and need to be provided by other economic actors. Similarly, in early stages of technological development, firms cannot estimate the potential and path of a technology, which limits their commitment to a particular technology.

Altogether, innovation studies provide us not only with evidence on the incentives and capabilities necessary to innovate but also with the factors that stimulate further innovation and diffusion of technologies necessary for economic development. The findings summarized above allow us to conceptualize technological development through shifts in the incentive structures for technological change along the three dimensions invention, innovation, and diffusion. To illustrate how different factors influence the incentives for technological development, the effects of low, medium, and high levels of property rights are exemplified in *Figure 1.6*.

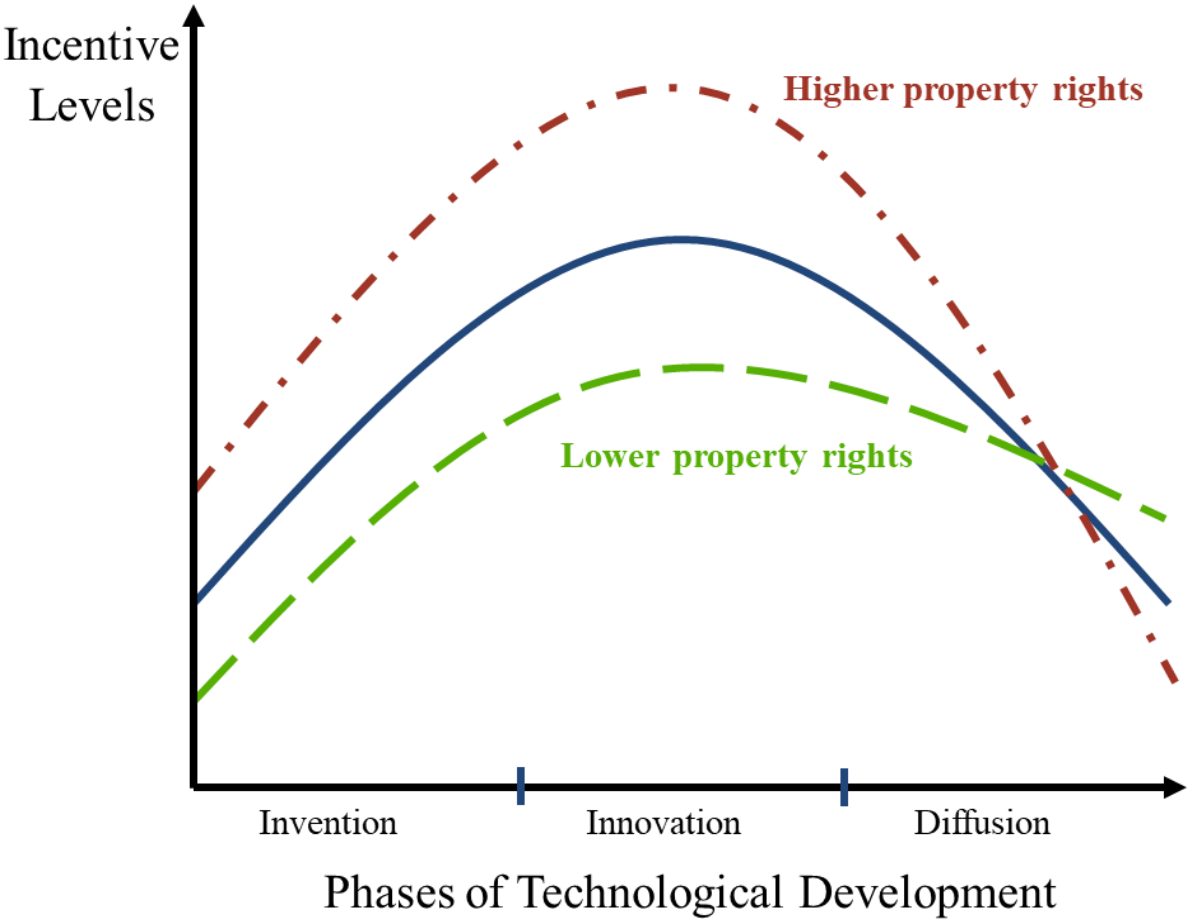

Figure 1.6: *Incentive Structures along the Technological Development Process*

The figure displays two possible alterations of the equilibrium incentive levels arising from changes in the property rights of a country. The red curve shows that stronger property rights increase incentives for invention and innovation while reducing incentives and opportunities for diffusion. In the green curve, lower property rights decrease the initial incentives for invention as well as the commercialization of these inventions due to the danger of imitation by competitors. Nevertheless, the diffusion of technologies is simplified, so that the accessibility of technology is higher than with strong property rights. A detailed discussion of the complex effect of property rights can be found in Scotchmer (1991) as well as Smeets and van de Vaal (2016). While the evaluation of every influential factor described above would go too far, this figure illustrates our conceptualization of the stages, incentives, and processes underlying technological development. As this thesis is concerned with how such technological patterns can lead to economic development, it offers promising avenues to further explore the opportunities for and barriers to

development. In addition, this concept provides several points of contact with our institutional framework, which are analyzed in the next section.

2.4 Linking Institutional and Technological Development

In the previous chapters, we have discussed how institutions and technologies change according to the incentives and abilities of economic actors on the micro level and how those translate to developmental paths on the macro level. Institutions develop along their formal and informal dimensions, which are mutually influencing each other's evolution over time. Technological development arises from changes in the incentive structures that stimulate a recombination of existing and novel resources leading to shifts in the quantity and quality of inventions, innovation, and diffusion. While it seems to be a consensus that technological improvements and institutional improvements lead to economic development (Nelson, 2015), the question is rather how those improvements can be triggered and how the two dimensions are interrelated. As this interaction has proven to be complex and vaguely conceptualized, it has not yet been fully captured by theoretical models.

In institutional theory, technologies provide new ways of doing business, which influence the informal norms in a society and exert pressure on the formalization of rules to guide the impact of these technologies. While Iyigun and Rubin (2017) argue that the mismatch between new technologies and ideologies increases the potential of institutional devolution due to high uncertainty, Perez, Cohen, and Schreiber (2019) describe the emergence of new institutions arising from the interaction between firms' choices and rule-makers' beliefs regarding the new technology. Aoki (2001) argues that technologies serve as the exogenous rules of the game that determine the strategic choices of agents in relation to the emergence of institutional arrangements. Focusing on the connection between Kondratieff cycles and international politics, Akaev and Pantin (2014) find that large technological changes are often associated with shifts in international politics as they alter established power and incentive structures and open new avenues for the influence of other economic and political actors.

Innovation studies provide evidence on the determinants of such technological changes, which can facilitate or hinder development depending on the innovation climate they establish (Aldrich & Wiedenmayer, 1993). Nooteboom (2000) claims that the innovation performance of firms is determined

by the forms of coordination between economic actors, which evolves co-deterministically with the institutional framework of a country. As institutions constrain the way of thinking in a society, they dictate ways of doing business, incentive structures and business interests (van de Ven, 1986). Indeed, the manifestation of new inventions is based on their perception by relevant stakeholders and the resulting interaction with existing idea structures (Klein & Sorra, 1996). Depending on the distribution of profits and power, the likelihood of new technologies to disrupt path-dependent adaptation processes increases as the dissatisfaction with existing institutional structures rises. This implies a rejection of neoclassical production functions and their definition of technological opportunities as being independent of entrepreneurial decisions and strategies (Nelson & Pack, 2001; Wennekers et al. 2005).

In accordance with this argumentation, we argue that institutions and innovation follow a co-determined path on the country level. Historically developed institutions determine the incentive structures of economic actors to innovate and increase their productivity. Moreover, formal institutions influence the diffusion of new technologies within the economy. Technological advancements, on the other hand, shape the socio-cultural environment of economic actors and define new habits and values. Plus, they offer new economic possibilities, which require changes in regulations to reduce the uncertainty related to innovations. In this context, it is important to note that the complexity of relations between formal and informal institutions as well as inventions, innovation, and technology diffusion on the micro level is reflected in macro-level manifestations that are relatively resistant to changes in economic interactions (Casson, 2016). Based on the discussed change processes, we can conceptualize the relation between institutional and technological development as two strands of economic development coevolving over time. To further explore this relationship, the concepts of institutions and technology introduced in the last chapters will be combined into a framework of economic development.

2.4.1 Developing an Institution-Technology Framework of Economic Development

We understand economic development not only as the increase of economic output but also as the structural transformation of the economy. For institutional development, this means the introduction of effective formal rules and regulations as well as the institutionalization of informal institutions to reduce the uncertainty related to economic transactions. In terms of technological development, the introduction of new technologies does not always provide stimulus to structural change if there are no incentives for

commercialization and diffusion. It is at this translation of changes into economic benefits, where institutional and technological development mutually determine each other's effect on economic development.

"The alteration of institutions that has led to the reduction in the uncertainties of the physical environment has created the complex human environment which has produced a whole new (and in many cases still unresolved) set of uncertainties. The revolution in technology of the past several centuries has made possible a level of human wellbeing of unimaginable proportions as compared to the past, but it also as produced a world of interdependence and universal externalities, and in consequence a whole new set of uncertainties." (North, 2005:20)

Formal institutions shape the incentives for invention and adoption of technologies in a society as they determine the distribution of innovative profits. Thereby, institutions like property rights and rule of law form institutional fields that can reduce or increase the uncertainty and responses towards new technologies (Lundvall, 2010). Informal institutions are socialized traits like ingenuity, entrepreneurial spirit, and individualism, which determine the creation of new ideas and innovativeness as well as degrees of cooperation and diffusion. For instance, informal networks and trust relationships can act as behavioral safeguarding mechanisms for inventors to secure the benefits of their innovation and in collectivistic cultures, diffusion of technologies is facilitated through high levels of collaboration and project-based work. In this way, the complementarity of institutions and their joint effect on technological developments is accounted for. The effect of institutions can be summarized through their influence on the incentives of economic actors to innovate and share their knowledge, viz. the uncertainty related to technological development.

In addition to the joint impact of formal and informal institutions on the incentives for technological development, the introduction of technologies itself will foster change of institutions and uncertainty among economic actors. New technologies bring new opportunities and ways of doing business, shape established safeguarding mechanisms and challenge the equilibrium of historically evolved norms and habits in a society. On the one hand, some innovations can decrease the effectiveness and suitability of formal institutions and pave the way to opportunism, reduced cooperation, and an erosion of basic societal values. On the other hand, some innovations increase the efficiency of markets and expand the

opportunities of economic actors to pursue their ideas. Here, institutions can be made more efficient with the help of new knowledge and technologies. Altogether, new technologies start processes of institutionalization to restore or update the efficiency of markets. As this process is influenced by the pressure of interest groups and the lack of knowledge about the technology, these changes to the formal institutional structure do not always lead to the economically optimal outcome.

Such selection processes, where old habits are filtered according to the new technological paradigm, have been described as transition periods. Here, the uncertainty related to new technologies leads to debates around the preservation of existing market mechanisms and the exploration of new ones, in which the outcome is dependent on the formation of momentum and power distribution among actors (Miles, Snow, Mathews, Miles, & Coleman, 1997). Normatively, these developments can hardly be described through "better" or "worse" but rather through the degree of efficiency in utilizing the potential of the new technology. For instance, if new technologies promote opportunities for corruption or reduce interaction between actors, they will limit the efficiency of formalized market mechanisms. In sum, the effect of technological development on institutions can be conceptualized through the transactional uncertainty that increases or decreases depending on the technological developments.

Based on this elaboration on formal and informal institutions and their interrelation with inventions, innovation, and diffusion, we developed the following framework for institutional and technological development:

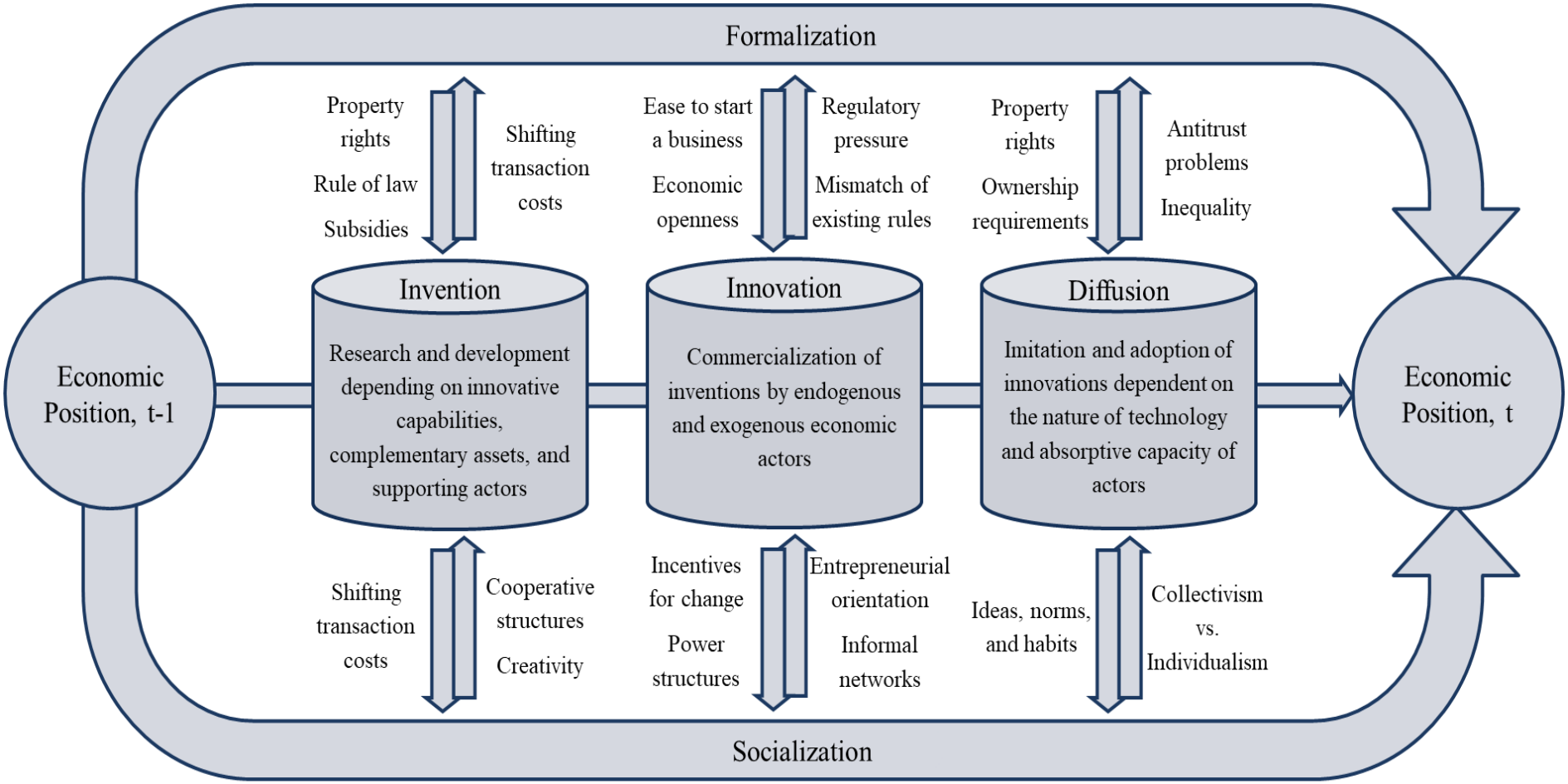

Figure 1.7: *Relationship between Institutional and Technological Development for Economic Development*

2.4.2 Defining the Role of Transactional and Technological Uncertainty

Having elaborated on these complex relationships between institutions and technologies and the various explanatory directions and interdependencies of our framework, we will further condense the implications of this institutional and technological coevolution on economic outcomes. To do so, we utilize the concept of uncertainty to explain different scenarios of economic development. As a matter of fact, uncertainty has been outlined as a crucial factor in both technological and institutional development (Dequech, 2004). Every change in both dimensions creates uncertainty for economic actors that needs to be handled in future decision-making. Such confrontation with uncertainty can lead to progressive or regressive outcomes. Thus, we argue that it is this process of dealing with uncertainty that determines the economic trajectory of countries. In the context of institutions and technologies, we call the uncertainties arising from changes in each dimension transactional and technological.

Transactional uncertainty is defined as the degree of difficulty of economic exchanges arising from the constellation of formal and informal institutions (Cannon, Achrol, & Gundlach, 2000). Where formal institutions are well-developed, transactional uncertainty is very low. However, antagonistic informal institutions like institutionalized corruption or bribery can increase the uncertainty related to economic transactions despite formal rules and regulations in place. Similarly, informal institutions can also fill formal institutional holes and provide structure and certainty. Technologies can disrupt the institutional equilibrium and increase short-term uncertainty related to economic transactions by introducing new ideas and uncovering loopholes in the formal institutional framework. To cope with the arising uncertainty, new institutions will evolve. It is at this point where institutional change is open to the influence of powerful groups so that the direction of change is dependent on the momentum developed by stakeholders and constraints of past institutional structures. Thus, we argue that technology will influence institutions through its impact on transactional uncertainty and the response of institutional and economic actors.

Technological uncertainty is defined as the ability of economic actors to anticipate the impact of new technologies on their competitiveness, originating from additional costs and new profit opportunities (Schubert, Baier, & Rammer, 2018). Costs arise from adaptation processes and profits arise from higher productivity and innovation. Institutions can influence the balance of costs and profits through their formal and informal dimension. Formal institutions can reduce uncertainty related to technological development,

while they also constrain certain opportunities and favor others. In that way, they will shape the technological paths of an economy. Examples of such intervention could be subsidies for certain technologies or funding of specific research programs. On the informal level, the technological opportunities depend on the ideas and habits available. For instance, high levels of trust are particularly useful in early stages of technology development, where specific investments and switching costs are low, transaction costs are high, and complementary assets are highly valuable. Thus, it can be argued that countries have different institutional advantages related to the overcoming of technological uncertainty and development of new technologies.

In equilibrium, the institutions-innovation nexus is characterized by low transactional and technological uncertainty. Here, economic actors, technologies, and institutions coevolved, and institutions shifted towards an effective implementation of the dominant technology paradigm. This fosters incremental technological and institutional development, in other words, the path-dependent, marginal improvements of existing market mechanisms and capabilities. It allows economic actors to anticipate the returns from innovation and the distribution of innovative profits is stable. Technological development will be based on existing technological capabilities as path-dependency means the further development of dominant technologies that have driven institutional and technological upgrading in the past. Similar to the contention of knowledge relatedness in the firm-level theory of the firm by Penrose, countries will also have mechanisms and incentive structures in place that might favor some technological areas over others. Moreover, when technologies evolve slowly, it is likely that there is a Schumpeterian shift of incentives that is caused by the institutionalization of innovation in large corporations. Since the role of the entrepreneur is often replaced by large bureaucratic organizations, the output of these organizations becomes more relevant for a country's innovative potential. Their power will further determine the balance of interests in the country and ensure economic stability.

Changes to this equilibrium are difficult due to the inertia embedded in historically evolved systems. The literature provides two main sources of change. According to neo-Schumpeterian theory, entrepreneurs can diverge from existing technologies and open new technology fields to a whole society, similar to a mutation of the otherwise homogeneous genetic pool of innovation. As already outlined, Schumpeter believed in the endogenous change driven by powerful entrepreneurs that are able to change

either the institutional framework or technological paradigm or both. Such a process can be termed endogenous technological change, where existing technologies are redeveloped to achieve higher rates of development. The emergence of new production techniques or sources of competitiveness will increase innovativeness and introduce new ideas and opportunities to economic actors. This will exert pressure on existing institutional arrangements to adapt to the new ways of doing business. Thus, institutional change is triggered when emerging actors challenge existing power mechanisms and new rules of the game need to be agreed on.

The outcome of such transition phases is dependent on the response of major economic actors and dominant institutions. On the one hand, institutional improvements provide security about property rights and enforcement mechanisms, which will foster cooperation between companies as they look for partnerships to reduce insecurity about future technological trajectories (D'Aveni, Dagnino, & Smith, 2010; Gnyawali & Charleton, 2018). Examples for this are the establishment of technology committees in the electronic industry or the amount of cross-licensing in the pharmaceutical industry. Another example of institutional support is China's five-year plan, where the state gives companies additional security about the preferred technologies of the future. Thus, an adjustment of existing institutional structures with the goal of optimizing the utilization of new technologies would lead to technological and economic development.

On the contrary, if powerful actors reject the introduction of new technologies and changing power structures, existing institutions will blight any real technological and economic improvements. When large organizations have arrived at a level of monopolistic power that gives them the ability to lead technological trajectories and customer wants, new entrepreneurs will be discouraged as it is unlikely that their investment will generate any profits. As economic actors will also look for short-term advantages instead of technologies with long-term potential, new technologies are subsequently locked-out (Arthur, 1989). Indeed, the inability to adapt to new technologies gives rise to other sources of uncertainty and prevents the efficient exploitation of new opportunities. Thus, the systemic and cumulative nature of technology makes it increasingly difficult to change a technological development path endogenously (Roehrl & Riahi, 2000). A situation like that can be called endogenous lock-in as endogenous drive is not capable of changing the inert technological and institutional equilibrium.

This is where another source of change is necessary for development, namely the shift of formal rules or informal values that induce more substantial disruptions to the institution-technology equilibrium. According to institutional theory, such changes can occur top-down, for instance through government changes, or bottom-up, for instance through social movements (Markus, 2012). Top-down change occurs when the distribution of regulatory power is significantly disrupted providing individuals with the ability to enforce new rules according to their advantages and regardless of their effect on efficiency (Scott, 1995). Bottom-up movements change the dominant norms and values in a society and create new pressures for legitimacy. Both change mechanisms create substantial transactional uncertainty that shapes the utilization of productive resources. As a result, economic actors need to reconsider alternatives in the employment of their resources and capabilities to adapt to a changing institutional environment and ultimately survive. Thus, changes in the institutional set-up induce technological change, whereas the outcome is dependent on the response of economic actors to such transactional uncertainty.

In a first possible scenario, institutional change enables the more efficient allocation and utilization of resources and stimulates new forms of market transactions. Examples of such institutional changes could be the lowering of entry barriers into economic areas, or the opening of new economic opportunities based on informal value shifts. Although these changes will increase transactional uncertainty in the first place, they enable entrepreneurs to use this opportunity to introduce new values and habits that allow for the exploration of new technologies. This would induce fruitful competitive responses and allows for a productive mobilization of resources, which is likely to improve technological outcomes. When such technological developments complement institutional changes, they can provide economic actors with novel perspectives on the future trajectory of the economy. Moreover, the disruption of informal institutions means a more fundamental shift in the institutions than a simple change of formal rules initially introduced (Mahoney & Thelen, 2010). Together with technological change, these processes will overcome institutional inertia and change institutions and technologies permanently.

Conversely, institutional changes might trigger destructive responses by powerful economic and institutional actors, who want to maintain their market position. When governments benefit from inefficient structures and economies rely on the exploitation of the existing institutional structures, the permanent change of formal institutions is unlikely. Moreover, informal institutions are even harder to change as they

are historically settled norms and traditions (Helmke & Levitsky, 2012). Thus, when transactional uncertainty increases, countries fail to mobilize the necessary resources to explore new technologies due to a lack of endogenous drive. Institutional voids hamper knowledge transfer between economic actors and existing companies prevent the growth of new ones. As Penrose argued, any restrictions against the entry of other firms increase the preservation of market power and make the production of identical products or the use of identical technology more likely. In such a scenario, entrepreneurs are hampered by a lack of incentives, investment, and capabilities. As a result, countries are unable to support and sustain any institutional and technological development.

In sum, the scenarios for technology and institution-induced change demonstrate that mutual and positive reinforcement is necessary to overcome change barriers, as depicted in *Figure 1.8*:

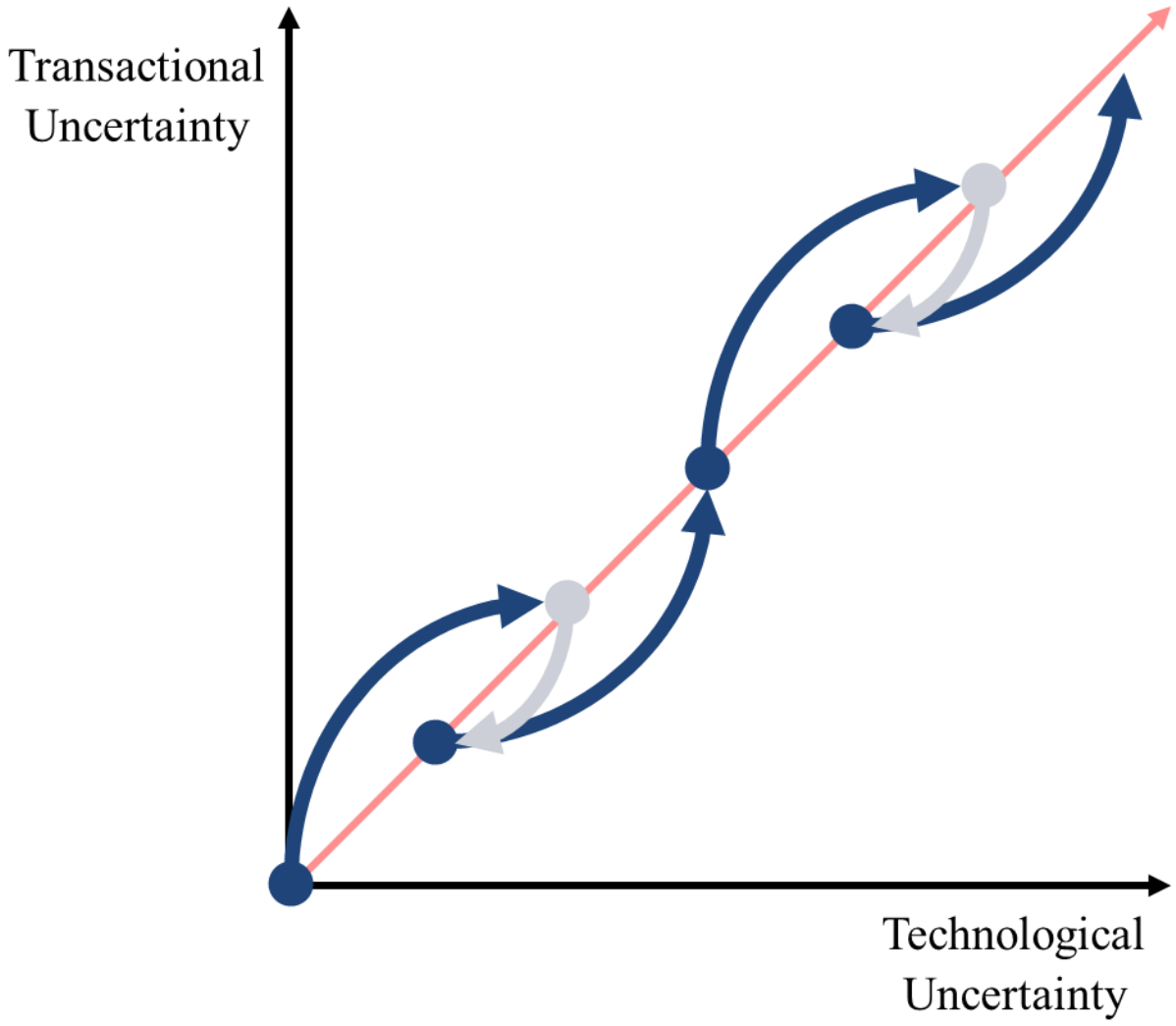

Figure 1.8: *Transactional and Technological Uncertainty*

2.4.3 Overcoming Institutional and Technological Deadlock Situations

Our discussion of transactional and technological uncertainty shows that change always goes along with uncertainty that increases the likelihood of fallbacks and negative development outcomes. The examples of endogenous change demonstrate why some countries face difficulties in upgrading through endogenous institutional and technological development when incentives for such change are lacking. Indeed, many LDCs experience high transactional uncertainty and lacking incentive structures, which prevent any technological development, and even technologies introduced by outsiders cannot be utilized efficiently. Resulting from historically shaped incentive structures that do not comply with the changed institutional framework, negative feedback loops lead to a vicious cycle where economic and political systems produce vetoplayers that stifle changes from the current system. Institutional and technological preconditions like high levels of corruption, low productivity, and high shares of resource rents further disincentivize economic actors. This raises the question of how countries can develop economically despite institutional and technological disadvantages and obstacles to change.

In an increasingly globalized world, countries might turn to exogenous sources of change, which are also highlighted in the institution and innovation literature. Exogenous sources of new technologies and institutions are diverse and manifold. First, there are linkages between domestic and international actors based on trade relationships or research collaborations. These often involve the transfer of knowledge, technologies, and innovation (Turkina & van Assche, 2018) that have the power to change the technological paths of countries. Second, there are international institutional actors like the World Trade Organization and United Nations that connect formal institutional actors across borders (Helleiner, 2009). Similarly, non-governmental organizations like Greenpeace or Amnesty International as well as the media connect civil societies across countries and enable the exchange of ideas and values. When certain ideas gain momentum and the pressure on powerful institutional and economic actors increases, existing equilibriums can be changed. However, those exogenous sources often face problems of gaining acceptance in the society and developing enough power to introduce significant disruptions (Arce, Miller, Patane, & Polizzi, 2018).

This is where we focus on an economic actor that provides both endogenous and exogenous stimuli to institutional and technological change through its unique character in the global economy: the MNE. By

building a presence in foreign countries, MNEs are influential forces in the host country that can act as catalysts for certain economic and institutional developments (Pelto & Karhu, 2019). They have been outlined as sources of new technologies (Narula & Zanfei, 2006), carriers of institutionalized practices (Fortwengel & Jackson, 2016), and advocators of formal institutional changes (Brandl et al., 2019). Moreover, MNEs embed themselves into the local institutional and technological environment, sometimes even concealing their foreignness and becoming accepted in the local community (Liou, Chao, & Yang, 2016). Saranga, Schotter, and Mudambi (2019) provide evidence on the role of linkages with MNEs for the upgrading of domestic firms in the Chinese and Indian automotive industries as this enabled learning from the takeover of R&D activities. Similarly, Hejazi, Tang, and Wang (2021) find that increases in total factor productivity can be explained through the R&D activities of foreign firms. While the influence of MNEs on economic development has been addressed numerous times (Bende-Nabende, 1998; Xu, 2000; Bajo-Rubio, Díaz-Mora, & Díaz-Roldán, 2010; Narula, 2018a), their influence through institutional and technological change has been addressed seldomly.

Despite an extensive literature on the linkages and spillovers between MNEs and host country firms positively influencing their knowledge base and business practices (e.g., Javorcik, 2004), the reflection of these effects on the macro level is often taken for granted. Indeed, estimating the developmental impact of international interactions might suffer from the fundamental misconception that advances on the firm level will translate into country-level improvements. Since international innovations can break the equilibrium in many countries and enable the development of new interests and incentives of economic actors, our framework demonstrates that the widespread diffusion and efficient adoption of new technologies is dependent on the reaction of powerful economic actors under transactional uncertainty. Similarly, new ways of doing business and new business opportunities are dependent on their fit with the dominant technological paradigm and their ability to generate innovative profits. In order to comprehensively analyze the impact of MNEs under these circumstances, we first need to gain an understanding of their character and role in the global economy. Thus, we advance our framework of institutional and technological change for economic development with a perspective on the MNE as a carrier of new institutions and technologies.

2.5 International Business, Institutional Change, and Technological Development

Since the 1950s and 60s, economists have been studying the reasons for firms to expand beyond their national borders. Stephen Hymer explained the expansion with the existence of monopolistic advantages that enable firms to seek new markets and outcompete competitors in their home market (Dunning & Rugman, 1985). His work influenced economists like John Dunning, Charles Kindleberger, and Raymond Vernon. Dunning (1958, 1980) examined the characteristics of firms from the United States internationalizing into the United Kingdom and developed the OLI[9] paradigm as a framework for explaining international production. Kindleberger (1969) used a historical economics approach to integrate Hymer's contribution into mainstream economics. Vernon (1966) developed a macroeconomic model of foreign investments and trade to explain the location of production in a stand-alone model of the international economy. As the founding scholars of the IB discipline, they filled a gap in contemporary economics and business literature and attracted more and more researchers from other areas. As Pearce puts it:

> *"What mainstream theorizing seemed reluctant to recognize was just how […] national potentials were activated by MNEs towards their internationalized competitive imperatives. The emergence of IB as a (perhaps unnecessarily) independent area of theorizing set out to address this lacuna in mainstream economics by building frameworks and analytical structures that could distinguish the nature of the MNE as a distinctive agent actively operating very much within the wider perceptions of the global economy." (Pearce, 2018: 2)*

Consequently, IB has developed into an own field of research, which predominantly focuses on the international operations of companies. It draws from and contributes to theories of management (e.g., the integration-responsiveness-framework) and strategy (e.g., the FSA-CSA matrix) as well as the study of economics (Casson, 2000), entrepreneurship (Knight & Cavusgil, 2004), and policy (Lundan, 2018). Current IB literature can be separated into micro IB, which is largely focusing on the management of international operations and the determinants of performance, and macro IB, which examines the role of FDI and trade for the economic position of countries (Casson, 2016). Although the latter has received less attention in recent years due to the competition with economic disciplines like macroeconomics or political

[9] The OLI paradigm is also referred to as Eclectic Paradigm. OLI stands for ownership, location, internalization.

economy, the relevance of understanding the impact of MNEs on the home and host country is still very much present today.

This is also true for the impact of MNEs on economic development, which is highly debated not only in the IB literature but also in areas like development studies or business ethics (Oetzel & Doh, 2009; Narula, 2018a). Contributing to this stream of the IB literature, Dunning (1981) developed an investment development path, which explains the development of countries according to their investment and trade position. In this way, Dunning extended economic models and Vernon's product life cycle with a more implicit explanation of the role of the MNE for economic development (Dunning, Kim, & Lin, 2001). Similarly, Narula has significantly contributed to the development literature by highlighting the perspective of developing countries when trying to benefit from FDI inflows (Narula & Dunning, 2000; Narula & Pineli, 2017). One example here is the development of an international growth model by extending Lewis' growth model with an IB view on location advantages and FDI (Narula, 2018b). However, these contributions tend to be an outlier from the IB literature and development studies have not received much attention in this research field. Moreover, many conceptualizations of economic development treat the MNE merely as a source of investment, whereas the concrete effects on the development process remain vague.

This lacuna is especially unsatisfying in the context of the framework developed in the previous chapter, where the limited opportunities of countries for endogenous development have been explained. Thus, this chapter will contemplate the concepts of institutional and technological development with an IB perspective to explore the MNE as a source of exogenous change. Therewith, our argument is in line with both Schumpeter and Penrose, who attached special importance to the large enterprise in having superior resources and driving innovation. More importantly, the definition of the MNE as a connector of institutions and technologies across national borders makes it a unique trigger of exogenous change, which goes beyond the conceptualization of economic development in many studies. The MNE as a global economic actor brings with it new influences for technological and transactional uncertainty that will shape the incentives of economic actors and expand the development opportunities of countries.

2.5.1 The Multinational Enterprise

Following the definition by Dunning and Lundan (2008a), firms become MNEs by investing in or gaining control over value-adding activities in another country, which involves the transfer of nonfinancial and ownership-specific assets. The reasons for MNEs to enter in such cross-border activities have been at the core of the IB discipline since its beginning. Indeed, when John Dunning (1958) explored the reasons for firms from the United States to set up subsidiaries in England, he realized that most of these firms had above-average productivity, not only among other firms in the United States but especially in comparison with British firms. He concluded that these advantages lead firms to expand beyond national borders as they want to exploit them in another country. This corresponded with the view of Stephen Hymer, who had already explained FDI as the exploitation of monopoly power through the transfer of assets.

Consequently, Dunning developed his own theory of the multinational firm, which was introduced in 1976 (Dunning, 2001). He argued that it is not only the existence of monopolistic advantages that leads firms to expand internationally but also location factors in the target country (Dunning & Rugman, 1985). He called these factors location advantages, which in combination with ownership advantages give firms the ability to successfully compete in foreign markets. They are defined as firm-specific competitive advantages, which are unique, sustainable, valuable, hard to imitate and drive MNE's international expansion (Dunning, 2000). Dunning classified O-advantages into asset-based (Oa-), transaction-based (Ot-), and institution-based (Oi-) advantages. Oa-advantages are based on the assets developed through the activities of companies in their home country and exist prior to FDI (Lundan, 2010). Ot-advantages are based on a firm's multinationality and arise through economies of common governance and scope or the existence of an internal market (Eden & Dai, 2010). Oi-advantages arise from the ability to overcome institutional differences in cross-border activities by active coevolution with the formal and informal institutions in the home and host country (Dunning & Lundan, 2008b). Overall, O-advantages determine the likelihood of FDI, while their value depends on their transferability and compatibility with location factors (Dunning, 2000; Tolentino, 2001).

These location advantages (L-advantages) enable MNEs to create synergies with their O-advantages making the foreign location attractive for their business activity. They are country-specific factors, which reflect the endowments and institutional frameworks of the respective host countries and are available to

all firms in a particular market (Dunning, 2001). These could be market potential, rule of law, bureaucratic quality, exchange rate, political systems, or cultural artifacts (Dunning, 2000; Stoian & Filippaios, 2008; Brouthers, Mukhopadhyay, Wilkinson, & Brouthers, 2009; Rugman, 2010). The relevance of these advantages depends on the motivation of firms to enter the country and a firm's ability to make use of these advantages (Dunning, 1993). Thus, immobile assets in the host country influence the MNE's investment decision and market choice depending on where it can best reinforce or exploit its O-advantages (Dunning, 2000).

Finally, the mode of a firm's international operations is dependent on the transaction costs associated with them (Nachum & Rolle, 1999). They stem from the costs of business through an external market in comparison with integrated foreign operations. Thereby, the costs of external relations arise from finding, controlling, negotiating, and enforcement costs, which are required to reduce uncertainty and opportunism of arm's length transactions. In contrast, bypassing foreign partners and setting up own subsidiaries in the host country reduce the search and negotiating costs but increase the cost of international integration and diversification. As the costs are difficult to access a priori, firms consider different ways of organizing their value-adding activities across borders. When O- and L-advantages can be combined via contractual exchanges with foreign partners, the firm is unlikely to take the risk of setting up its own foreign operation. When transaction costs of these exchanges are high and full ownership of operations allows to capture greater rents, MNEs will choose modes with higher control (Dunning & Lundan, 2008a). These advantages of cross-border investments are called internalization advantages (I-advantages).

Focusing on this type of advantages, scholars such as Alan Rugman, Peter Buckley, and Mark Casson developed their own theory about why it is more efficient for companies to organize international activities hierarchically rather than through the market. They made use of the Coasian strand of transaction cost economics to explain the creation of foreign subsidiaries with the market failure associated with doing business across borders (Buckley & Casson, 1976). As firms face costs resulting from bounded rationality and opportunism, which are often amplified in the international economy, it is sometimes beneficial to internalize certain business operations instead of relying on foreign suppliers. Indeed, while Dunning attached greater relevance to the existence of ownership advantages as a precondition for foreign investments, Buckley and Casson (1976) argue that firms do not need to possess these advantages prior to

internationalization and rather view internationalization as a means to overcome market failure. According to their so-called internalization theory, FDI is only the geographical expansion of firms, which have outgrown their domestic market or favor international diversification over other types of diversification (Buckley, 1985).

The advantages from internalization include increased control over operations, the reduction of search, contracting, and safeguarding costs, the exploitation of market power as well as avoidance of opportunism and government intervention (Buckley, 1985). Casson (1985) outlines that these advantages are especially relevant in industries that involve high capital investment and exposure to tariff and exchange rate risks. For instance, the difficulty to specify and enforce long-term future contracts in the raw material market requires purchasing companies to internalize the capital-intensive production through backward integration. Another example is the knowledge-intensive industry, where companies invest in R&D to compete on innovative products (Pla-Barber, Sanchez-Peinado, & Madhok, 2010). As firms cannot risk losing these advantages, transactions of tacit knowledge would require high training and safeguarding costs, which makes market exchanges less feasible. Moreover, differences in property rights between countries, make the protection of assets and enforcement of wrongdoing difficult. As a result, these companies will pursue geographical diversification by setting up own subsidiaries instead of using arm's length transactions.

While a discussion of differences between the OLI paradigm and internalization theory as two major IB theories can be found elsewhere (Pearce, 2018), this thesis utilizes internalization theory as a transaction cost perspective of the MNE. Accordingly, the MNE is best described as a vehicle for creating, integrating, and applying productive knowledge across its various locations to overcome market failures (Liang, Lu, & Wang, 2012; Kandogan, 2014; Maitland & Sammartino, 2015). Thereby, the motivation of the MNE and the extensiveness of operations is dependent on the institutional and technological development of the host country (Halaszovich & Lundan, 2016). Indeed, building on these characteristics of MNEs, scholars have developed concepts on the relation between the MNE and its institutional and technological environment, which will be further reviewed in the next section.

2.5.2 Institutions and the Multinational Enterprise

The institutional view of the MNE has emerged as a major perspective in IB due to the unique situation of MNEs operating in multiple institutional environments in the home and host country (Meyer & Peng, 2016). It emphasizes the MNE as an adaptor to different country contexts and, to a smaller extent, also as a vehicle of institutional transmission. Institutions are outlined as the key aspect of the MNEs' external environment because they constrain managerial choices and organizational structures. Moreover, institutional differences increase the liability of foreignness and determine the scope of operations since every institutional context requires unique adaptation processes that drive the costs of crossing borders (Peng, Lee, & Wang, 2005). To cope with the complexity of different institutional contexts, MNEs require Oi-advantages, which ensure efficient adaptation to foreign rules and regulations and even enable the exploitation of these differences (Lei & Chen, 2011).

In this context, IB researchers examined the influence of the institutional environment on the FDI decision (Lien, Piesse, Strange, & Filatotchev, 2005), general patterns of FDI (Dikova & van Witteloostuijn, 2007; Pajunen, 2008), and the location of FDI (Strange, Filatotchev, Lien, & Piesse, 2009). Cuervo-Cazurra (2008) analyzes the effect of corruption on the willingness of firms to invest, while Ghazalian and Amponsem (2019) examine the influence of economic freedom on FDI inflows. Other researchers explore the influence of government support (Lu, Liu, Wright, & Filatotchev, 2014), corruption (Godinez & Liu, 2015), institutional distance (Lindner, Muellner, & Puck, 2016), and institutional quality (Bevan & Estrin, 2004) on FDI. IB scholars also highlight the effect of institutions on internationalization patterns (Eriksson, Fjeldstad, & Jonsson, 2017), entrepreneurial firms (Muralidharan & Pathak, 2017), and emerging market MNEs (Stoian & Mohr, 2016). In this way, the institutional perspective has contributed to the further development of IB concepts like the OLI paradigm (Dunning & Lundan, 2008a; Czinkota, Grossman, Javalgi, & Nugent, 2009; Banalieva & Robertson, 2010) and the investment development path (Stoian & Mohr, 2016). In sum, there are numerous studies that analyze the influence of institutional factors on the global operations of MNEs.

A complementary stream of research focuses on the ability of MNEs to derive competitive advantages from the institutional frameworks they are operating in. The home countries of MNEs can provide them with institutional capabilities based on skills and routines that stimulate the handling of other institutional

environments (Carney et al., 2018). In the host country, MNEs can establish political ties enabling them to broaden their strategic scope and gain competitive advantages over other firms (Holtbrügge, Berg, & Puck, 2007). Jiménez, Luis-Rico, and Benito-Osorio (2014) find that the negative effect of political risk diminishes when the MNE has strong political capabilities defined as the ability to leverage political resources and obtain preferential conditions in the host country. Similarly, scholars highlight the value of political connections for earnings forecasts (Chen, Ding, & Kim, 2010), merger and acquisition performance (Brockman, Rui, & Zou, 2013), and state support (Sojli & Tham, 2017). As part of this stream of research, Liou, Chao, and Yang (2016) demonstrate that MNEs interweave with host country governments through ownership strategies as a measure to adapt to the institutional environment. Moreover, researchers have outlined political risk as a source of business opportunities in developing countries (Jiménez, 2010), the positive effect of residual state ownership (Boubakri, Guedhami, Kwok, & Saffar, 2016), and the benefits of industry-university partnerships (Fukugawa, 2005). Altogether, the institutional environment is not only a constraint for MNEs but also a trigger of adaptation processes that enable them to generate institutional advantages and political capital (Schneider, Schulze-Bentrop, & Paunescu, 2010).

Finally, researchers have also emphasized the ability of MNEs to shape their institutional environment (Cantwell et al., 2010; Fortwengel & Jackson, 2016). By positioning themselves strategically within the environment and utilizing their internal capabilities accordingly, MNEs develop strategies to influence institutions in their way. Concepts like bargaining power (Eden & Molot, 2002; King, 2015; Stevens, Xie, & Peng, 2016), institutional work (Granqvist & Gustafsson, 2016), and agency (Battilana & Casciaro, 2012; Ferner, Edwards, & Tempel, 2012; Giambona, Graham, & Harvey, 2017) are used to demonstrate how MNEs can overcome institutional barriers and influence their institutional environment. For instance, Kwok and Tadesse (2006) analyze the impact of MNEs on host country corruption and Brandl et al. (2019) find that the adoption of the Agreement on Trade-Related Aspects of Intellectual Property Rights was driven by the dependence of countries on foreign investment. More importantly, the investment of MNEs can have broader unintentional effects on the host country's institutional framework, for instance through the imitation of MNEs by local firms (Cantwell et al., 2010). These processes of institutional change

include the transmission of institutions through MNEs (Lawrence, Hardy, & Phillips, 2002) as well as institutional spillovers and signaling effects of MNEs in the host country (Kyj & Kyj, 2009).

This makes the MNE a powerful economic actor that can serve as an exogenous stimulus of institutional changes in the home and host country. The power of MNEs is increased as MNEs considering a market entry can pit host country governments against each other to receive benefits like tax breaks or preferential treatment (Vernon, 1971). The possession of scarce resources and capital relevant to a country and its government gives MNEs increased negotiating power. Plus, MNEs pioneering new technologies receive special attention when it comes to the development of regulations for this new technology (Nelson, 1995). This reflects the Penrosian description of the institutional firm, where resources and capabilities enable firms to influence the environment (Cantwell, 2002) and foreign investments involve the introduction of new rules and habits carried by economic actors with unique incentives and active agency (McGaughey, Kumaraswamy, & Liesch, 2013). The findings demonstrate that MNEs can influence the institutional environment in their host country; however, the direction of change and the potential of MNEs' influence is dependent on several factors, most importantly the technological basis and motives of MNEs in that country.

2.5.3 Technologies and the Multinational Enterprise

MNEs derive their international competitiveness from the ownership of unique resources and capabilities, which are most effectively exploited through the internalization of cross-border transactions. Similar to Penrose's theory, an excess of resources and capabilities does not only allow a technological but also geographical diversification of companies. While the possession of superior O-advantages is not necessarily a precondition for firms to internationalize successfully, these advantages determine the modes of foreign exchange (Buckley & Casson, 1976). In this context, MNEs are prevalent in many knowledge-intensive industries as the ownership of knowledge and technologies implies more risk in international transactions and requires more complex forms of market exchanges (Casson, 1985; Bhaumik & Driffield, 2011). By the same token, the multinationality of MNEs allows them to be in a better position for the development of further capabilities because they have access to various technological settings (Eden & Dai, 2010). This enables MNEs to connect home and host country not only institutionally but also to transfer technologies and capabilities between them.

Historical examples of MNEs like Siemens, General Electric, or Apple demonstrate that MNEs are deeply interwoven with the development and global diffusion of technologies. Together with the growing importance of ICTs as well as an increased technological complexity and knowledge intensity of products across industries, MNEs have significantly contributed to the advent of the knowledge-based economy as the current economic paradigm (Grübler, 1995). It is characterized by an interconnected and dynamic global business environment, which requires speedy and flexible operations as well as a continuous stream of innovations to remain competitive (Schiavone, 2011; Yeniyurt, Henke, & Cavusgil, 2013). Dunning (2001) argued already at the beginning of the 21st century that the coordination of technological assets and their innovative combination with international assets has become more relevant for MNEs. Recently, Schubert et al. (2018) argued that these pressures for innovativeness have spurred technological dynamism resulting in shorter product life cycles, increased uncertainty, and a hypercompetitive environment. As a result, MNEs have to continuously adapt to new conditions, which requires special capabilities like learning and coordination capabilities, adjusted organizational structures, and faster knowledge creation (Hutzschenreuter, Lewin, & Dresel, 2011).

Results from these new economic realities were the rising modularization and specialization of MNEs and countries, increases in intra-firm trade, dispersion of value-adding activities as well as the growing relevance of cross-border mergers and acquisitions and alliances (Dicken, 2015). In the context of the establishment of clusters and the creation of the knowledge economy, MNEs have been described as the main creator and transferor of knowledge (Nair, Demirbag, & Mellahi, 2016). Conversely, MNEs are large bureaucratic organizations that often suffer from managerial inertia. This hampers the reaction to new competition and innovations, which results in the loss of superior positions to new market entrants. There are well-documented examples of Nokia, Compaq, or Lucent, which all lost significant market share as a result of new developments in ICTs. As Luo (2020) points out, there is an organizational ambidexterity between strong routines that ensure the stability of current operations and dynamic capabilities for openness, resilience, and change.

These shifts in the global economy are also represented in IB theory with scholars having contributed to the knowledge-based theory of the MNE (Kogut & Zander, 2003), the concept of paradigm shifts (Cantwell, 1989; 2017), and the dynamic capabilities concept (Teece, 2017). As a consequence, the balance

of exploration and exploitation of competitive advantages has shifted towards a constant need for exploring and developing new assets, knowledge, and business models (Levitt & March, 1988; Luo, 2020). Notably, some contributions describe MNEs as organizations that institutionalized innovation in the Schumpeterian sense because they have unique resources that allow the generation of knowledge superior to purely domestic firms (Cantwell, 2002). These resources and capabilities arise from the combination of home and host country effects (Cantwell & Santangelo, 2000; Patel & Pavitt, 2000), the scope and degree of R&D internationalization (Cantwell & Janne, 2000), the role of subsidiaries in knowledge assimilation and transfer (Meyer, Li, & Schotter, 2020), and the network effects related to multinationality and diversification (Castellani, Montresor, Schubert, & Vezzani, 2017).

"Large firms became the key actors in combining the processes of invention and innovation, each individual firm being technologically specialised in a way that reflected the specific profile of corporate technological competence that it accumulated through cumulative path-dependent learning processes." (Cantwell, 2002: 220)

MNEs fit into our theoretical framework of institutional and technological development as exogenous triggers of change in the host country. Evidence of linkages and spillovers (Santangelo, 2009; Kubny & Voss, 2014; Pavlínek & Zízalová, 2016; Saranga et al., 2019) supports these arguments, where MNEs open up new possibilities for domestic firms (Khan, Rao-Nicholson, & Tarba, 2018). However, the effect of MNEs depends on their incentives to share technologies, the institutional conditions for knowledge transfer, and the level of absorptive capacity by local firms. Indeed, researchers also found detrimental effects of MNEs, because local firms are crowded out or exploited for low-cost advantages without any real upgrading opportunities (Meyer & Sinani, 2009). Therefore, the question is not whether MNEs act as a vehicle of technological development that triggers changes in the existing technological equilibrium but rather under what circumstances their influence can spur technological and economic development. To answer this question, we turn to our theoretical framework and analyze the influence of MNEs with regard to the mutual interdependence of institutions and technologies in the host country.

2.5.4 The Multinational Enterprise as a Vehicle of Institutional and Technological Development

This thesis has so far revealed relevant shortcomings in the conceptualization of institutional and technological development as sources of economic development as well as in the inclusion of MNEs as causes of such changes processes. While early economists ruled out the opportunity of endogenous change, scholars from institutional theory and innovation studies often focus on endogenous changes on the micro level. Moreover, only a few economists connect institutional and technological developments in their development models, among them Marx, Veblen, and Schumpeter, who focus on the emergence of technological paradigms conditioned by individual drive, societal artefacts, and institutional frameworks. Thus, institutional and technological development require a fundamental change in human behavior that goes beyond neoclassical economic models with an implicit incentive structure assuming full exploitation and availability of technologies. These preconditions for development – rational incentive structures and full utilization of available technologies - are utopian in that they are hardly achieved in countries where path-dependency and lock-in effects prevent institutional change and the diffusion of technology. Thus, these theories are bound to explain how change contributes to economic development but not how change is achieved in the first place.

"Third World countries are poor because the institutional constraints define a set of payoffs to political/economic activity that do not encourage productive activity. […]. Alterations in the path come from unanticipated consequences of choices, external effects, and sometimes forces exogenous to the analytical framework. Reversal of paths (from stagnation to growth or vice versa) may come from the above described sources of path alteration, but will typically occur through changes in the polity." (North, 1990:110)

To address this issue, we have integrated the two dimensions of change through a comprehensive framework, which acknowledges the opportunities for endogenous and exogenous change. In addition, the current economic paradigm has led to an increasingly interconnected economy and the emergence of new actors influencing this interaction. In this context, MNEs act as connectors of institutions and technologies across borders, so that they are a potential source of exogenous change in countries where incentives for change are low. They not only transfer new business practices and novel technologies through linkages and spillovers, but also actively influence policymaking through negotiation and bargaining. Thus, we

argue that MNEs should play a more prominent role in the examination of institutional and technological change for economic development.

We propose that the explicit inclusion of MNEs in development studies might be more suitable to describe institutional and technological change in today's economy through their influence on incentive structures not only within countries but also between them. Such an encompassing concept of development should not reduce the MNEs' role to a simple allocator of resources and capital, but rather view it as a vehicle of stagnation or change that affects the equilibrium in developing countries, both positively and negatively. Independent of the motive of MNEs and capabilities of local firms, they will set up a process of change as indicated by findings on institutional (Brandl et al., 2019) and technological change (Castellani, 2017). Thus, the relation of MNEs with the host country's economic development can be described through a coevolutionary interaction with local institutional and technological structures.

In our model of economic development, MNEs act as innovators in the Schumpeterian sense as they have institutionalized innovation to account for the growing importance of innovative profits in comparison with profits related to existing ownership advantages (Cantwell, 2017). They are more innovative than domestic firms as the ownership of tacit knowledge and complex technologies is a driver of internationalization in the first place (Buckley, 1985). Thereby, Lundan and Casson (1999: 32) explain that every FDI automatically brings a "package of knowledge-based assets". Thus, as connectors of technologies across borders, MNEs are influencing the technological trajectories of countries and act as exogenous sources of technological uncertainty in the host country.

Similarly, the entry of MNEs provides host country actors with stimuli for institutional change and increases transactional uncertainty. With the introduction of new and different management practices (Delmestri & Walgenbach, 2009; Cooke, Saini, & Wang, 2014), employment characteristics (Edwards & Kuruvilla, 2005; Li, Lam, Sun, & Liu, 2008), and working cultures (Harrison, McKinnon, Wu, & Chow, 2000; Harris & Carr, 2008), MNEs will influence the habits and norms of individuals and firms, thereby shifting the equilibrium of formal and informal institutions and setting up processes of institutionalization. By filling institutional voids and active influence mechanisms, MNEs have the potential to overcome the inertia of historically developed institutions.

The impact of the change in transactional and technological uncertainty brought about by MNEs depends on the existing conditions, incentives, and power structures of local actors. For technological development, institutional structures are crucial for the formation of networks (Efendic, Mickiewicz, & Rebmann, 2015), the likelihood of knowledge transfer (Corredoira & McDermott, 2014), and the ability of organizational learning (Gunawan & Rose, 2014). In an extensive meta-analysis, Meyer and Sinani (2009) find that the institutional environment plays a crucial role in determining the positive spillovers from MNEs. On the contrary, institutional development goes along with shifts in the power relationship between relevant economic and institutional actors. When existing exchange structures reflect unequal access to resources, capital, and information and, hence, produce very uneven power structures, institutional changes will be hindered or reversed. Thereby, new technologies offer opportunities for institutional and economic actors to reduce the power of vetoplayers. Under conditions of uncertainty, local firms can support changes through upgrading efforts (Chittoor, Sarkar, Ray, & Aulakh, 2009; Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012) or carrying innovative activities into unregulated fields (Giersch, 1984; D'Aveni, 1998). In other words, the change of incentive structures through an increase of productive activities brought about by MNEs provides the necessary support for successful institutional changes.

In sum, the utilization of institutions and technologies for economic development is based on the interrelation of MNEs and local institutional and technological conditions under increasing uncertainty. MNEs have the ability to improve the institutional environment not only through changing the sources of competitiveness or mechanisms of resource allocation but through their proactive transformation of the political and economic environment. Moreover, MNEs shape the dominant technological paradigm of the host countries by introducing new technologies, which require changes of formal and informal governance structures. In this way, our framework offers various points of contact for the examination of the MNE as a vehicle of institutional and technological change. To explore the viability of these influence mechanisms, the impact of MNEs on institutional and technological developments will be the main focus of the three essays of this thesis (see *Figure 1.9*).

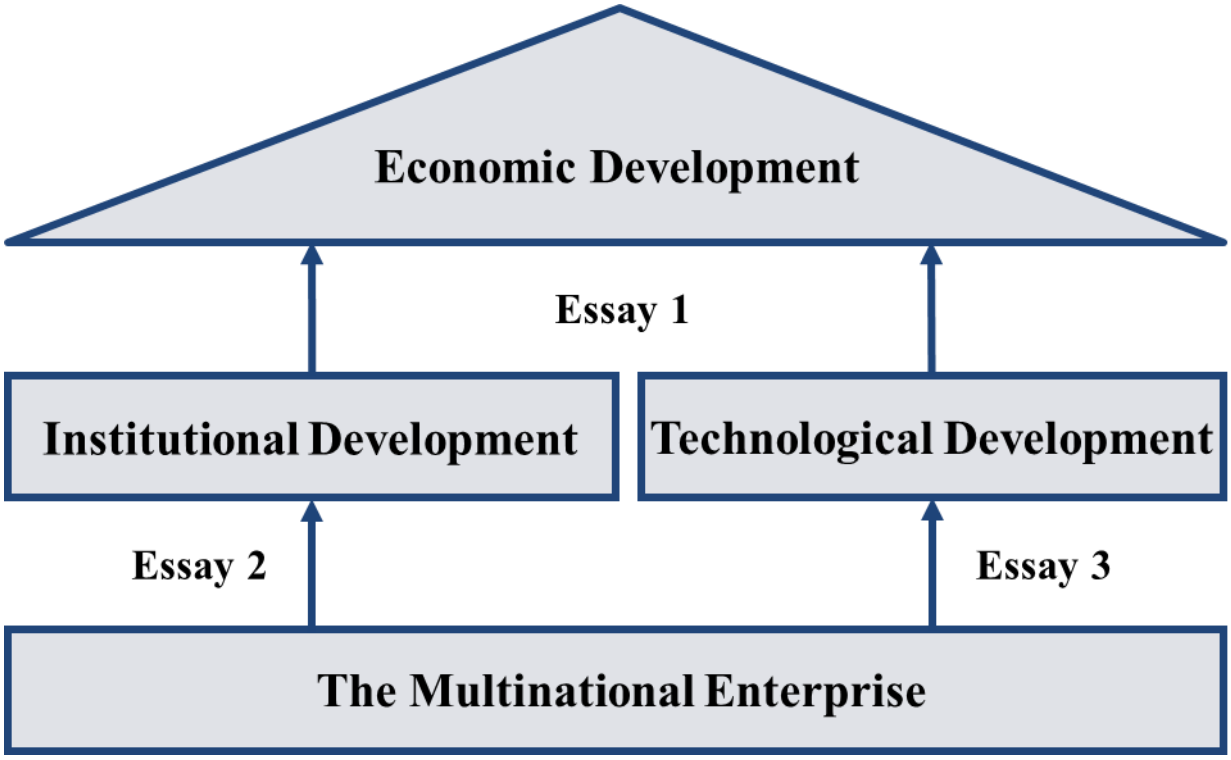

Figure 1.9: *Essays of the Thesis*

2.6 Summary of the Three Essays of this Thesis

In this chapter, the three main essays of this thesis will be summarized. To do so, their relationship with the theoretical framework established in the last sections will be explained and objectives of each essay will be briefly defined. This should help to guide the reader through the essays as they each represent a unique aspect of the connection between institutions, technology, and development as well as the role of the MNE in this triad.

2.6.1 Essay 1

Essay 1 examines the impact of institutions on economic development and how technological development moderates this relationship. In this way, we empirically test our framework with respect to the mutual influence of institutions and technologies on development. While the central focus of the essay is the explanation of country-level economic development with institutional theory, we develop hypotheses on the moderating effect of the operationalization of institutions, the level of economic development, the period of analysis and technological development. By defining dimensions of institutions, technologies, and development, we employ a more nuanced view of the theoretical concepts proposed in our framework.

We use meta-analytical methods to explore descriptive and causal relationships between these variables. First, we determine the mean correlation between institutional, technological, and economic development as well as for several subdimensions of these three categories. Second, we calculate moving averages of technological and institutional development to examine their joint effect on economic development over time and for different country groups. Finally, we use regression analysis to determine how all of our moderators affect the correlation between institutions and development. Our results demonstrate the importance to differentiate between institutional fields as well as dimensions of technological and economic development. The findings also highlight the heterogeneity of development dynamics across time and space. In this way, the essay sets the stage to further explore the MNE as a source of institutional and technological development.

2.6.2 Essay 2

Essay 2 explores the potential of MNEs to induce institutional changes with a focus on existing incentive structures in the host country. By reviewing literature on IB, sustainability, and public policy, we develop a framework of institutional change, in which we emphasize the role of domestic and foreign firms as sources of change. Therefore, the essay advances the understanding of how MNEs can facilitate change processes for economic development. Our main argument is that the introduction of new technologies by MNEs puts transformation processes in motion, whereas the outcome of such processes depends on the ability of economic actors to exploit arising business opportunities. In this way, we test the concept of exogenous change enforced by MNEs through a change of transactional uncertainty in the host country. Our assumptions are tested through the relation between green technologies and the introduction of green policies using a Probit Model. Our results show that the emergence of new technologies in the host country promotes the introduction of green policies, whereas the effect of this relation depends on the sources of new technologies and the level of development. We develop important policy implications about the opportunities of exogenous change and the necessity to attract innovative investments as a source of technological and institutional stimuli.

2.6.3 Essay 3

Essay 3 analyzes the ability of MNEs to drive the development of novel technologies given the ambidexterity between their advantages of scale and scope and their disadvantages of organizational inertia and technological lock-ins. In that way, the essay tests Schumpeter's argument on institutionalized innovation in large organizations and explores the availability of growth opportunities derived from Penrose's concept of technological change. We review the literature on innovation in IB to establish hypotheses on the influence of innovative capabilities, incumbency and multinationality on the invention of new technologies in the MNE. We extend our argument with factors that help firms to commercialize their inventions by finding functional applications for new technologies. The technology of interest is AI, which has been outlined as a potentially disruptive technology that is at the verge of defining a new technology paradigm. To test our assumptions, we gather a large dataset of 4.529 MNEs and 126.411 unique AI patents. The results from our analysis show strong advantages of innovative capabilities and incumbency, which enable MNEs to leverage their resources and experiences in an emerging technological field. We discuss the uniqueness of these results for the context of AI and highlight the need for researchers to further explore the entering into infant technologies by MNEs. This is especially relevant in the context of developing countries, where MNEs often serve as a connector between local firms and state-of-the-art technologies. Thus, this essay complements the other two essays by focusing on the initiation of technological developments by MNEs.

3 Essay 1: The Role of Institutions in Economic Development: A Meta-Analysis

Abstract

This essay explores the effect of institutions on economic development through a large-scale meta-analysis. By combining findings from institutional theory with the development literature, we develop propositions on the relationship between different types of institutions and economic development and how this relation depends on various moderating factors. A total of 237 studies with 1.349 effect sizes is examined. Our results demonstrate that the relationship between institutions and economic development depends on the type of institutions, the development level of a country, the time period under investigation, and the complementary role of technological development. We conclude that the current application of institutional theory in business and economics does not do justice to the theoretical and methodological complexity of the topic at hand.

Keywords: Institutions, Economic Development, Meta-Analysis, Technological Change

Statement of Authorship

This essay is single-authored and not yet published.

I am grateful for the support of Professor Tammo Bijmolt who held a three-day seminar on meta-analysis in business research and who gave valuable advice on how to apply the methodology. I also thank Professor Ahmet H. Kirca whose seminar on meta-analysis at the Academy of International Business Conference in Copenhagen in 2019 I attended. Their advice has set the methodological preconditions for this essay and profoundly advanced the meta-analysis and, thus, the whole essay.

3.1 Introduction

The drivers of economic development are some of the most frequently researched topics not only in economics but also in International Business (IB) and development studies (Judge, Fainshmidt, & Brown III, 2014). In the tradition of classical economics, scholars have sought to explain development with productivity increases (Gordon, 2000; Farhadi, Islam, & Moslehi, 2015), advancements of human capital (Mankiw, Romer, & Weil, 1992; Suri, Boozer, Ranis, & Stewart, 2011), and improvements of market mechanisms (Scully, 1988; Hartmann, Guevara, Jara-Figueroa, Aristaran, & Hidalgo, 2017). One set of determinants that has received much attention in the development literature concerns institutions (Afonso & Jalles, 2016). Institutions are defined as the rules of the game that provide certainty about economic transactions and institutional development relates to changes in the behavior of economic actors that allow for new and more efficient economic exchanges (North, 1990). Therefore, higher quality institutions are widely associated with successful and sustainable economic development (Cepparulo, Cuestas, & Intertaglia, 2017).

However, there are contrasting findings that associate institutional improvements with negative economic effects. Kim, Lee, Park, and Choo (2012) find that intellectual property rights do not show positive effects in developing countries as they stifle innovative activities. Similarly, the study by Dobson and Ramlogan-Dobson (2012) provides evidence that under certain conditions corruption helps to reduce income inequality in Latin American countries. More generally, a number of studies point to the dependence of institution-led development on the type of institution (Gerring, Bond, Barndt, & Moreno, 2005; Rodriduez-Pose, 2013), the income level of countries (Fabro & Aixalá, 2009; Eichengreen, Park, & Shin, 2018), and the fit of institutional and economic systems (Magnin, 2018). Methodological and empirical differences among studies further contribute to the lack of clarity about the actual impact of institutions (Sartor & Beamish, 2014). To solve the issues associated with unclear findings about the impact of institutions on economic development, we answer the following research question in this essay:

Which factors determine the effect of institutions on economic development?

To answer this question, we employ a meta-analysis of existing research papers. This approach not only summarizes the effects found in other studies but also enables the identification of the factors leading

to differing results. Indeed, meta-analyses have become more relevant and popular in the economics and business literature (Steel, Beugelsdijk, & Aguinis, 2021). Although sometimes criticized for empirical superficiality and meaningless comparisons, a rigorously conducted meta-analysis with sufficient moderators enables a critical analysis of existing research findings, thereby overcoming the limits of each individual study and the challenges of non-reproducible research (Rousseau, 2020). Thus, we believe our approach enables a detailed evaluation of the relationship between institutional factors and economic development. Furthermore, the analysis has important implications for researchers and aids policymakers in understanding how different dimensions of the institutional system can help or hinder economic development.

In order to build a solid theoretical foundation for our analysis, this paper begins with a discussion of the determinants of economic development with a special focus on institutional aspects. Furthermore, evidence of factors moderating the effect of institutions on economic development will be reviewed. By summarizing these research findings, we propose that the type of institutions, the role of technological change, the income level of countries, and the time period influence the relationship between institutions and economic development. Our final dataset consists of 237 articles with a total of 1.349 effect sizes. The analysis reveals that the effect of institutions on economic development is much more complex than often depicted in the literature with various types of institutions and development leading to significantly different results. Further, the impact is dependent on the development level of countries with developing countries demonstrating the highest correlation between institutions and economic development. Furthermore, the effect varies for different time periods and for different complementary effects of technological development. We discuss our findings in light of the growing interest in institutional theory, develop conclusions on the use of institutions in research, and translate our findings into theoretical, methodological, and political implications.

3.2 A Critical Review of the Determinants of Economic Development

Building on a variety of economic growth models on the macro level (Lewis, 1954; Kuznets, 1955; Solow, 1956; Lucas, 1988; Romer, 1990) as well as the contribution of development scholars focusing on social improvements and living standards on the micro level (Seers, 1979; Sen, 1999; Shrivastava, Jones,

Selvarajah, & van Gramberg, 2016), development-related research has spread into many academic fields, thereby increasing the number of conceptualizations and studies (Fischer, 2019). As a result, the literature provides an extensive set of development-stimulating factors, ranging from the presence of natural resources (Sachs & Warner, 1995; Dauvin & Guerreiro, 2017) to the development of local markets (Huang, 2016; Wan & Morgan, 2017). Acemoglu (2009) distinguishes between strictly economic factors and non-economic factors that can contribute to a country's development. Economic factors include capital accumulation (Vedia-Jerez & Chasco, 2016), technological progress (Chen & Puttitanun, 2005), entrepreneurship (Bjørnskov & Foss, 2013), and improvements to labor quality (Luiz, 2016); non-economic factors include aid (Islam, 2005), political systems (Magnin, 2018), institutions (Bennett, Faria, Gwartney, & Morales, 2017), and industrial policies (Paus, 2012). The IB literature extends this list with factors that go beyond individual nation states like foreign direct investment (FDI) in the manufacturing sector (Alfaro, Chanda, Kalemli-Ozcan, & Sayek, 2010; Eichengreen, Park, & Shin, 2013) as well as linkages with and spillovers of MNEs (Javorcik, 2004).

Due to the diversity of the relevant determinants of economic development and the variety of studies focusing on only a few of those factors, scholars have already embraced the advantages of large-scale qualitative and quantitative reviews to isolate the effect of specific factors. For instance, Havranek, Horvath, and Zeylanov (2016) test the resource curse hypothesis with a meta-analysis finding that there is indeed a negative effect of natural resources on a country's economic growth. Dauvin and Guerrero (2017) support these findings for developing countries by summarizing the effect of 69 articles on the same topic. Focusing on another economic driver of development, De Dominicis, Florax, and de Groot (2008) argue that the effect of inequality on growth is dependent on methodological specifications with different regression models leading to significantly different results. Benos and Zotou (2014) examine the effect of education on growth and their results indicate strong publication bias and a heterogeneous relationship dependent on factors such as estimation method and control variables. Other reviews of development factors examine the role of monetary policy (Ridhwan, de Groot, Nijkamp, & Rietveld, 2010), FDI (Iwasaki & Tokunaga, 2016), and remittances (Cazachevici, Havranek, & Horvath, 2020) using meta-analytical approaches.

Focusing on the connection between democracy and economic growth, Doucouliagos and Ulubaşoğlu (2008) analyze 84 studies with 483 estimates to find that there is no direct effect of democracy on growth but rather an indirect effect through education, inflation, and political stability. Ugur and Dasgupta (2011) conducted a meta-analysis to uncover the relationship between corruption and income, in which they find a generally negative effect of corruption that is stronger for low-income countries. In another small-scale meta-analysis of 40 articles, Efendic, Pugh, and Adnett (2011) explore the effect of institutions on economic performance measured as increases in economic output. They suggest that institutional quality generally has a positive effect on economic outcomes; however, they cannot provide conclusive evidence due to highly heterogenous study characteristics. Other meta-analytical studies that focus on institutions are concerned with their effect on FDI (Feld & Heckemeyer, 2008; Bailey, 2018), the internationalization-performance relationship (Bausch & Krist, 2007; Marano, Arregle, Hitt, Spadafora, & van Essen, 2016), entry modes (Zhao, Luo, & Suh, 2004; Magnusson, Baack, Zdravkovic, Staub & Amine, 2008), and spillovers (Meyer & Sinani, 2009).

What is common among these meta-analyses is that they often do not find a consensus of the analyzed effects but rather highlight the dependence on moderating factors. Moreover, most of these studies focus on growth as a concept of increased economic output instead of a structural change of the economic system. As economic and institutional systems consist of multiple dimensions that are complexly intertwined, we argue that a more nuanced analysis of different institutional and developmental aspects will lead to more meaningful results. By adopting an encompassing understanding of institutions and development, we are able to examine the effect of institutions as a precondition of economic development in a way that cannot be found in existing meta-analyses. Furthermore, with a few exceptions (e.g., Zhao, Luo, & Suh, 2004; Ridhwan et al., 2008), all the mentioned meta-analyses use regression coefficients as their main effect size. However, methodology experts often criticize the use of standardized regression coefficients because combining different regression models with different covariates, different outcome variables, and different units makes comparisons difficult and sometimes even meaningless (Fernández-Castilla et al., 2019). Indeed, even the use of partial correlation coefficients, which are used in many of these papers, does not solve the problems associated with various models and their generation from the regression coefficients is often not sufficiently explained (Reed, 2020). Instead, scholars argue for the use of standardized correlation

coefficients as scale-less measure for the comparison between studies (Bijmolt & Pieters, 2001; Kirca, Yaprak, 2010; Buckley, Devinney, & Tang, 2014). Therefore, a major contribution of this study is that it applies the methodological rigor of meta-analytical research as outlined in recent method papers in the field of economics (Stanley et al., 2013), management (Geyskens, Krishnan, Steenkamp, & Cunha, 2009), and IB (Steel et al., 2021).

3.3 The Facets of Institutional Theory

As institutions have become a more and more important topic in the fields of business and economics, the theoretical foundation of many studies originates in political science (Thelen, 1999), institutional economics (North, 1990), or organizational institutionalism (Scott, 1995). In political science, the focus lies on the state and its sub-components including the government, policies, and laws that are an outcome of unique historical developments, constrained choices, and unintended effects (Mahoney & Thelen, 2010). Institutional economists focus on the efficiency of market mechanisms and the existence of transaction costs by explaining institutions as governance systems as well as organizational structures and routines, which determine individual behavior and thus reduce uncertainty (Williamson, 1975; North, 1990). As a third domain of institutional theory, organizational institutionalists view institutions as socially formed entities that must comply with environmental expectations to ensure their survival (Meyer & Rowan, 1977; DiMaggio & Powell, 1983). They create coercive, normative, and mimetic pressures, which force organizations to adopt their structures and practices to gain legitimacy (Scott, 1995). While the theoretical strands have emerged from different disciplines and there are certainly different theoretical underpinnings that differentiate them, there are also common features like the concepts of path-dependency and institutional complementarity.

Accounting for the various types of institutions, institutional scholars have developed a configurational approach to a country's institutional environment (Jackson & Deeg, 2008; Judge et al., 2014). For instance, Whitley's (1999) concept of business systems explains national and societal institutions through incentives and constraints of individuals that have evolved over time into distinct configurations of the institutional environment. He distinguishes between the political, financial, labor and education as well as cultural system. In a similar vein, the varieties of capitalism approach emphasizes the presence of supporting and

sanctioning institutions to define the institutional environment on the country level (Hall & Soskice, 2001). Both views contributed to institutional theory by introducing the concept of heterogeneity based on a mismatch of existing institutions and new institutions as well as institutional complementarities (Krug & Hendrischke, 2012). Taken together, these configurational approaches to institutions emphasize the interactions between them with sets of institutions collectively constituting the institutional environment.

Despite the efforts of researchers to develop own frameworks based on institutional theory, the abstraction of institutional concepts into the disciplines of economics and IB has been criticized for employing a "thin view" of institutions (Redding, 2005; Jackson & Deeg, 2008). Indeed, scholars rather adapt their use of institutions to their specific research context while using the definition that "fits the best" (Amoako & Lyon, 2014). Such misuse of existing concepts or theory-bending might lead to a false understanding of institutions and distort the results of research in the long run (Bjørnskov & Foss, 2016). Sartor and Beamish (2014) argue that different conceptualizations of institutional theory led to contrasting results, and they call for a more nuanced theory of institutions. Moreover, most operationalizations and measurements use aggregate variables as proxies for the institutional environment and the same measures are used for different institutions, so that the subsets of institutions are not sufficiently assessed. This points to the difficulties in capturing the disparate, overlapping, and multifaceted effects of institutions (Wang, Gu, Tse, & Yim, 2013), making research results difficult to interpret. To test the actual effect of different sets of institutions, this essay summarizes and compares studies on the relationship between institutions and economic development.

3.4 Institutions and Economic Development

Most approaches to economic development have in common that they attribute to institutional development the special role of a stabilizing force that is crucial for achieving and sustaining growth (Keefer & Knack, 2007; Ramírez-Alesón & Fleta-Asín, 2016). Similarly, institutional theorists like Lipset (1959) and Ostrom (1986) highlight the role of institutions as a major determinant of economic development. This is because many development-stimulating factors like education and infrastructure also require a minimum level of institutional quality as a precondition for economic and structural changes (North, 1981; Durán & Úbeda, 2005). In these cases, institutional upgrades promote entrepreneurial

activity (Bowen & De Clercq, 2008), stimulate innovation performance (Wu, Wu, & Zhuo, 2015), enable firms to access knowledge resources (McDermott, Corredoira, & Kruse, 2009), and increase the social responsibility of foreign investment (Young & Makhija, 2014). In other words, there is a long list of papers contributing to the common wisdom that better institutions lead to some form of economic development (Efendic et al., 2011).

In their path-breaking contribution to the institution-development literature, Acemoglu, Johnson, and Robinson (2001) argue that many least-developed countries (LDCs) are characterized by "extractive" institutions and unequal access to property rights and legal accountability among social actors, which have been detrimental to economic development. Other authors find positive effects on development for property rights (Davis & Hopkins, 2011), financial development (Alfaro, Chanda, Kalemli-Ozcan, & Sayek, 2010), and democracy (Acemoglu, Naidu, Restrepo, & Robinson, 2019) but negative effects for labor market regulations (Besley & Burgess, 2004), government size (Afonso & Jalles, 2016), and restrictions on trade and investment (Greenaway, Morgan, & Wright, 2002). In that way, the development literature has cemented the notion of good and bad institutions. At the same time, there are several articles that do not reach the same conclusions and thus question the findings of a linear, unambiguous relationship between institutions and economic development.

Ram (1999) finds that the positive relation between financial institutions and development diminishes when considering the individual-country correlation between both variables and the heterogeneity of countries in the regression analysis. Similarly, Cepparulo et al. (2017) demonstrate the complementarity of institutions by providing evidence that the positive effect of financial development seen in low-income countries vanishes for high-income countries as other governance mechanisms replace financial institutions. Several papers have also raised skepticism about the positive effect of trade liberalization on economic development (Rodríguez & Rodrik, 2001; Abbott, Bentzen, & Tarp, 2009). Lin and Fu (2016) find a positive effect of trade on income inequality that is only valid for autocracies and not for democracies. Bhattacharyya (2009) uses Rodrik's (2005) four-way partition of institutions to show that market-creating and stabilizing institutions are more relevant for economic development while regulating and legitimizing institutions do not seem to matter as much.

More generally, Judge et al. (2014) use a configurational approach to find institutional settings which are beneficial and detrimental to equitable wealth creation. They identify state expenditure, regulatory quality, and trust as core conditions present in wealth-creating countries, while autocratic regimes and high levels of power distance are common among less developed countries. Accounting for the country context, Persson and Tabellini (2007) find a generally positive effect of democratic transitions on economic growth; however, they also highlight that the effect is heterogeneous across countries ranging from -5 to +5 percentage points. In a study of Asia-Pacific economies, Fu, Lin, and Molyneux (2018) find differences in the effect of financial development indicators depending on the level of economic development, while Kouame and Tapsoba (2019) find that the positive impact of structural reforms depends on the characteristics of the developing country determining the response to institutional change.

In sum, the empirical evidence suggests a positive relation between improved institutions and economic development, but there is no conclusive evidence on the exact conditions under which this effect sets in (Bhaumik & Dimova, 2014). The literature rather points to the fact that the effect of institutions is depending on aspects like the type of institutions, institutional dynamics, and the country-specific conditions under examination. These factors are examined in the next sections.

3.4.1 Institutional Types and Levels of Aggregation

The discussion above demonstrates a high diversity among the conceptualizations of institutions employed in the literature. These differences should lead to different operationalizations and measurements of institutions since they are a natural outcome of how institutions are defined and which institutional features are examined within a specific research setting (Fransen, 2013). By contrast, current institutional research often lacks a grounded institutional perspective and uses largely the same operationalizations and measurements. Since there is "no single and universally agreed definition of an ‘institution’ in the institutional school of thought" (Scott, 1995), there is also no analytical framework that covers all potentially important institutions (Chen, 2010). Moreover, scholars note an absence of databases and large-scale quantitative information on institutional features making it difficult for researchers to measure the features of institutions they focus on (Pinkse & Kolk, 2012). As different operationalizations and measurements of institutions lead to significantly different results (Sartor & Beamish, 2014), it becomes relevant to uncover which institutions matter and how they matter.

As a result of institutional complexity and a lack of specific measures, many scholars have used meta variables in an effort to account for the institutional environment not as a set of different institutions but as an aggregate outcome of structures and systems within a country (Henisz & Swaminathan, 2008). Such aggregate variables include institutional quality (Bjørnskov & Foss, 2016; Bradley & Klein, 2016), uncertainty (Smit, Pennings, & van Bekkum, 2017), trust (Aggarwal, Goodell, & Selleck, 2015), and legitimacy (Marano & Tashman, 2012). Critics suggest that the generalization of the institutional conditions overlooks previous insights on the heterogeneity of institutions even within the same geographic region (Young, Tsai, Wang, Liu, & Ahlstrom, 2014). For instance, Monaghan, Gunnigle, and Lavelle (2014) claim that subnational institutions shape the opportunities for knowledge creation and trust building, while accelerating FDI insidership, development, and innovation.

In other words, many papers adopt a variable-based approach that "views institutional diversity as variation along discrete parameters at a high level of aggregation. This approach neglects the potential for interactions among these different institutional dimensions that give rise not just to differences of degree but to fundamental differences in kind, where the impact of one institution may depend very much on the presence or absence of particular other institutions" (Jackson & Deeg, 2008: 545). For instance, Afonso and Jalles (2016) employ a study in which institutional quality has a positive effect on a country's economic performance, whereas government size negatively affects economic development. In another study on the impact of institutions on innovation, Nyström (2008) uses the sub-components of the economic freedom index and finds that government size, regulation of credit, and labor institutions decrease entrepreneurship; conversely, better legal structure and security of property rights increase it. Hüttenbrink, Oehmichen, Rapp, and Wolff (2014) showed that even institutional variables from the same institutional pillar, such as regulations on shareholder protection and disclosure requirements, can be effective in different directions. In other words, aggregate approaches to institutions ignore the fact that institutions are interrelated and complement or oppose each other (Peng & Su, 2014). As such aggregate measures will amplify an otherwise differentiated effect between institutional dimensions (Shleifer, 2000), we assume that the effects of aggregated variables overestimate the true impact of each institutional sub-component.

Proposition 1: The effect of institutions on economic development is dependent on the aggregation level.

3.4.2 Characteristics of Development

The literature also highlights the development level of the country of interest as a major factor influencing the effectiveness of institutions (Chen & Puttitanun, 2005; Nawaz, Iqbal, & Khan, 2014). In many growth regressions the possibility of diverging effects for specific countries is overshadowed by the use of growth models across income levels (Fabro & Aixalá, 2009). Therewith, authors imply similar preconditions and average out outliers with other developmental paths. In this context, researchers have outlined the special characteristics of transition economies or China (Meyer, 2001; Mutlu, Zhan, Peng, & Lin, 2015), which are often used as representatives for other emerging countries (Child & Tse, 2001; Chan, Isobe, & Makino, 2008). This might lead to an abnormally high influence of these countries on the general effect of institutions in developing countries (Du & Boateng, 2015). Another relevant contribution to explain growth differences was made by Popov (2000), who showed that over 60% of the differences in the economic performance of the transition economies can be explained by uneven initial conditions. Thus, it becomes necessary to examine the possibility of diverging effects of institutional improvements dependent on the country characteristics.

In many developed countries, indicators of institutional quality are already on a very high level, which might reduce their developmental impact. In contrast, LDCs face a variety of difficulties in stimulating economic development, which include not only underdeveloped institutions but also a lack of infrastructure, education, and investment (Reinhardt, 2000; Luiz, 2016). Thus, marginal improvements in institutions might be offset by other barriers to development. In developing countries, which have already escaped this situation, institutions have more room to improve and push further developments in the economic conditions of a country. On the other hand, these countries often lose competitiveness along their way of development, which poses unique challenges for institutional and economic development, also known as the middle-income trap (Kharas & Kohli, 2011; Agénor & Canuto, 2015). Eichengreen et al. (2018) highlight the specific nature of middle-income countries in their patterns of growth and stagnation, while Falvey, Foster, and Greenaway (2006) find that the effect of intellectual property rights on economic growth depends on a country's level of development with a positive effect for low- and high-income countries. Similarly, a more general contribution is made by Gunawan and Rose (2014), who find that measures based on samples from developed economies are not directly transferable to the examination of

the institutional challenges associated with developing economies. Consequently, we argue that the institution-development relation differs between countries at different stages of economic development.

Proposition 2: The effect of institutions on economic development is dependent on a country's level of development.

3.4.3 The Dynamics of Institutional and Economic Change

While the economics literature has often argued for a stable long-term relation between institutional and development variables (Barro, 1991) and thus used many cross-section analyses, more recent studies have employed annual data on narrower sets of countries (Medina-Moral & Motes-Gan, 2018). Since institutions are static and evolving very slowly, scholars have called for more longitudinal, dynamic datasets in order to capture changes and understand how the systems of institutions interact or coevolve over time (Veliyath & Sambharya, 2011; Ioannou & Serafeim, 2012). Indeed, North (1984) highlights that the idiosyncrasies of institutional development preclude the short-term view of many neoclassical economists and demonstrates the need for a broader, long-term view of change and development. Furthermore, the pace of institutional changes is different across countries with institutions constantly evolving in emerging markets and being rather stable in developed countries and LDCs (Peng & Su, 2014). This raises the question of how these changes affect economic variables and the relationship between institutions and development.

Shelburne (2016) finds that the effect of institutions on economic development varies periodically due to lags and inconsistencies in the relation between both variables. By dividing their sample of South American countries into two sub-periods, Vedia-Jerez and Chasco (2016) find evidence for significant structural differences between the two periods, which lead to differing effects of their institutional variables. Similar time-dependent findings related to a dynamic operationalization of institutions have been found in the context of transition economies (Shi, Sun, Yan, & Zhu, 2017) and Chinese provinces (Banalieva, Eddleston, & Zellweger, 2015). Despite those examples, Granqvist and Gustafsson (2016) argue that the role of time and temporality is still under-emphasized within institutional theory. In this way, large-sample methods and static snapshot data are likely to provide invalid insights into the role of institutions compared to cross-country studies over longer periods of time (Shinkle, Kriauciunas, &

Hundley, 2013). Based on these arguments, we propose that the effect of institutions on economic development varies between time periods.

Proposition 3: The effect of institutions on economic development is dependent on the time period under study.

3.4.4 The Moderating Role of Technological Development

One aspect that is often analyzed together with institutions and economic development is the role of technological improvements. Indeed, many notable scholars argue that the impact of institutions on development cannot be viewed in isolation but rather in conjunction with technological improvements resulting in a coevolutionary relation of both dimensions (Schumpeter, 1939; North, 1990; Nelson, 2015). As firms adapt their strategies and structures to the institutional setting, institutional changes or mismatches between institutions and technologies result in dysfunctional economic outcomes and the rejection of institutional improvements. Thus, for institutions to work effectively, they need to be supported by underlying norms and habits that enable the use of technologies in a productive manner (Basalla, 1988). However, while several studies find evidence on the impact of institutions on technological change (Katz, 2001; Cantwell & Vertova, 2004), the reverse effect has not yet been fully investigated due to the lack of studies with institutional development as an independent variable. Regardless of the reasons for this one-sided relation, the literature demonstrates that technological developments are a unique moderator of the institution-development relationship (Bjørnskov & Foss, 2016).

Institutional systems are rationally formed by individual actors emphasizing the role of power in solving collective problems to reduce uncertainty and transaction costs (Hall & Taylor, 1996). When institutions change, these power structures need to be reorganized and new competitive advantages will emerge, which leads economic actors to explore new ways of doing business. However, when powerful vetoplayers lose their superior position, short-term uncertainty will undermine the effect of institutional improvements and foster societal and economic stagnation (Olson, 1963). For instance, many business models in developing countries rely on the low-cost exploitation of resource-based advantages, which would be endangered by higher labor standards or new regulations (Arbache, Dickerson, & Greene, 2004). Thus, only when actors develop new business models and power is effectively redistributed from

incumbent economic and institutional actors to newcomers, improved institutions will evolve and foster development (Tebaldi & Elmslie, 2013). This is where technological developments can provide supporting incentives towards institutional change and trigger the development of new business models (Fan, 2011). Therefore, we propose that institutions and technologies are interdependent in their impact on economic development.

Proposition 4: The effect of institutions on economic development depends on the complementary effect of technological development.

An overview of all our propositions can be found in *Figure 2.1*.

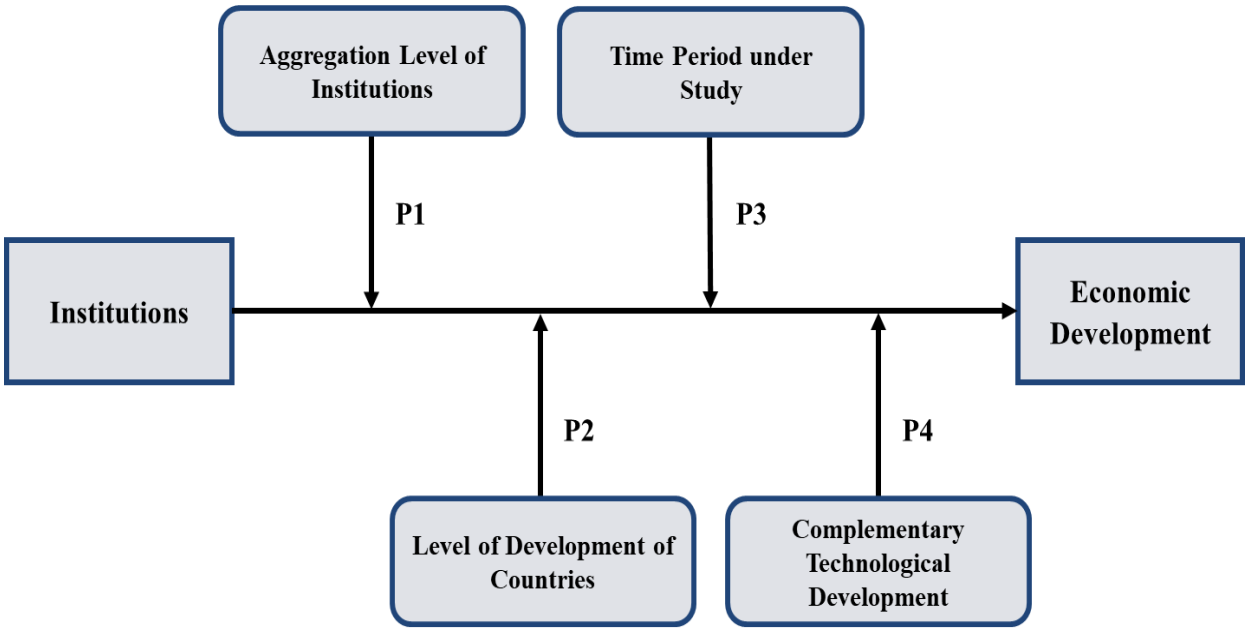

Figure 2.1: *Proposed Moderators of the Effect of Institutions on Economic Development*

3.5 Methodology

The concept of meta-analysis originated in medical and psychological research, where it helped to overcome the drawbacks of small sample sizes by aggregating the results of multiple, similar studies (Hunter & Schmidt, 2004). In economics and management research, meta-analyses have become increasingly popular since the 1990s, with a maximum of 148 studies mentioning meta-analysis in their title or abstract in the fields of economics and business and management in 2020 (see *Figure 2.2*).

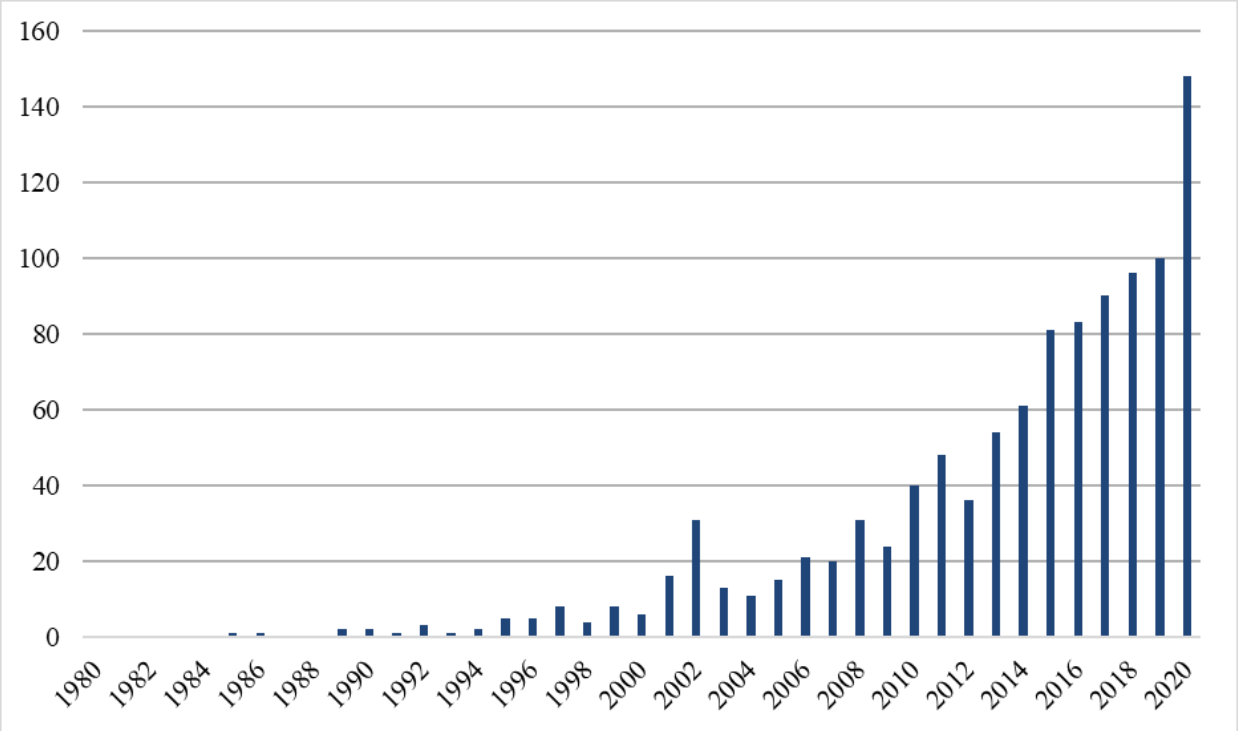

Figure 2.2: *Number of Published Meta-Analyses in Economics and Business Studies Over Time*[10]

While the main goal remains to aggregate findings from different studies, the focus has shifted from an increase of sample size to a correction of publication bias and the exploration of moderating factors in often-examined relationships (Stanley, Doucouliagos, & Jarrel, 2008). In that way, meta-analyses reveal reasons for conflicting research findings of existing studies and move beyond the limits of traditional literature reviews. Combs, Ketchen, Crook, and Roth (2011) argue that meta-analyses are more powerful in summarizing research findings and producing reliable effects than "vote counting" or other forms of human coding.

The basic tool of meta-analysis is the Hedges-Olkin-type meta-analysis (HOMA), which means the averaging of effect sizes for different variable groups. Here, the number of effect sizes and their underlying number of observations are provided. To account for publication bias, it is recommended to also create funnel plots and check for their symmetry (Dalton, Aguinis, Dalton, Bosco, & Pierce, 2012). This allows to check for the influence of sample size, as smaller sample sizes and higher standard errors are assumed to be less likely to get published. Additionally, scholars have calculated the failsafe N, also called the file-

[10] Source: https://app.dimensions.ai (Search Criteria: Meta Analysis AND Management OR Meta Analysis AND Economic OR Meta-Analysis AND Management OR Meta-Analysis AND Economic | Search Areas: Economics AND Commerce, Management, Tourism and Services).

drawer test, which considers the number of unpublished studies needed to make the effect of interest insignificant. Finally, it is recommended to regress the standard error on the effect size as the independent variable and look at the residual heterogeneity, which cannot be explained by sample size and standard error. If much of the heterogeneity does not relate to these estimation characteristics, this indicates that the differing effects of existing studies are likely the result of other moderating factors.

To test these moderating factors, which have also been established in our propositions, we employ a meta-analytical regression analysis (MARA). The common formula of the MARA is as follows (adopted from Stanley, 2008):

$$b_j = \beta + \sum_{k=1}^{K} \alpha_K Z_{jk} + e_j \qquad j = 1,2, \ldots . L.$$

b_j is the reported estimate of the existing study j. β is the "true" value of the parameter of interest and Z_{jk} is the moderator that should explain the variation in study results according to our assumptions. α is the regression coefficient indicating the influence of our moderator variable. K is the concrete effect size of which there can be multiple in each study. Finally, e_j is the error term of the MARA. Assuming that our effect sizes represent a random sample from the population of effect sizes, we use a random effects regression model to account for the variation in the population of effect sizes, so that the results also hold for the studies not observed in the dataset. Indeed, most meta-analyses today use multi-level random effects as the effect sizes are nested within studies (Fernández-Castilla, Jamshidi, Declercq, Beretvas, Onghena, & van den Noortgate, 2020). By adopting this approach, we account for the within-differences of each study as well as for the differences between them.

3.5.1 Sample

Our sample is based on an extensive, systematic literature search on the topic institutions and economic development. For a start, the Business Source Premier database by EBSCO Information Services and Google Scholar were searched using variants of the main keywords "institutions" and "economic development". Moreover, the most important journals dedicated to this topic were searched with the same keywords (see *Appendix 2.1* for a full list of keywords and journals). Finally, the reference lists of existing literature reviews were screened for additional papers to gather a comprehensive dataset of articles on the

topic. The search resulted in a sample of 3.442 papers. These were filtered according to the requirements of a meta-analysis: First, filtering for empirical papers reporting effect sizes resulted in 1.321 studies. Second, all papers that did not include at least one effect size about the relation between one institutional and one development variable were left out. Finally, many empirical papers on the topic do not present a correlation matrix and only regression coefficients, which reduced the number of studies to 237 [11].

In our analysis, we use Fisher-standardized correlation coefficients as they represent a scale-less, standardized measure of the bivariate relation between two variables (Babić Rosario, Sotgiu, de Valck, & Bijmolt, 2016). In this way, we respond to the growing criticism on the use of partial correlation coefficients and the rigor of meta-analysis in general (Steel et al., 2021). While the choice for correlation coefficients as the examined effect size is certainly debatable, our goal is also to raise awareness for the meaning of effect sizes and to encourage researchers and reviewers to gather a more in-depth understanding of the methodology. Indeed, finding a large number of correlation coefficients proved to be much more difficult than finding regression coefficients. As our search has shown, most studies in business and economics do not report correlations, which is a great deficiency also in the context of recent efforts to increase the transparency and reproducibility of research (Aguinis, Cascio, & Ramani, 2017). Nonetheless, we were able to generate a sample of 237 studies published between 1975 and 2020 with 1.349 effect sizes on the correlation between institutions and economic development. To our knowledge, this is a unique effort in the economics and business literature.

3.5.2 Institutional Variables

As explained in the development of our propositions, many authors did not use a fine-grained operationalization of institutions in their analysis but rather used aggregate measures of the institutional environment. Thus, we coded the operationalizations of overall institutional quality as our baseline category (Bevan & Estrin, 2004) and, subsequently, created more nuanced categories to account for the disaggregated nature of the institutional environment (*Institutions*). With the aggregated measure of institutional quality, we are able to compare its effect on economic development with those of specific sets of institutions.

[11] More information about the full dataset and the code for analysis is provided upon request.

More fine-grained categories were the level of democracy defined as the political system and associated characteristics like freedom of speech (Frye, 2012) as well as intellectual property rights as a frequently studied institution that is closely associated with the innovativeness of an economy (Papageorgiadis, Cross, & Alexiou, 2013). Control of corruption was used as a separate measure of institutions, which accounts for the effectiveness of the formal institutional framework (Godinez & Liu, 2015). Another aspect of the institutional environment comprises the legal system and enforcement mechanisms, which represent a unique legislative power in a country's institutional environment (Jackson, 1998). Several papers, especially in developing countries, have also used measures of economic freedom to indicate the market openness of countries (Medina-Moral & Montes-Gan, 2018). Similarly, labor rules were identified as another set of institutions, which are likely to have a distinct impact on economic development (Nickell & Layard, 1999). Following Falkenberg and Falkenberg (2009), financial institutions were used as a separate category of institutions. The last two categories were political stability, which also includes the inverse values of institutional instability (Granqvist & Gustafsson, 2016), and government size indicating the involvement of the government in the economy through consumption and tax income (Lu, Liu, Wright, & Filatotchev, 2014).

3.5.3 Economic Development Variables

Economic development can take different forms ranging from increases in economic output to the improvement of living conditions and the reduction of poverty. Although it is likely that improvements in one facet will trickle down to other development-related aspects, there are barriers to such mutual influence. Malesky, Abrami, and Zheng (2011) find that sophisticated governance structures are necessary for productive investments and increased labor output, but they do not support the distribution of new income among economic actors. Other scholars showcase that income equality and growth in economic output are mutually exclusive (Alesina & Rodrik, 1994; Tanninen, 1999), while Banerjee and Duflo (2003) find an inverted U-curve relationship between increased inequality and economic growth. Similar controversies can be found in the relation between other development variables such as growth in gross domestic product (GDP) and human development (Ranis, 2004) or inequality and competitiveness (Gründler & Scheuermeyer, 2018). To account for the character of each development dimension, we identify five distinctive categories of our dependent variable (*Development)*, namely output growth (Most

& van den Berg, 1996), size of the economy (Umer & Alam, 2015), income levels (Fabro & Aixalá, 2009), improvements of living standards (Spilerman, 2000), and income inequality (Adams & Klobodu, 2019).

This distinction allows us to further disintegrate the effect of institutions by accounting for different operationalizations of economic development (Levine & Renelt, 1992) as well as methodological considerations and the measures used in the sample. As the first category, the rate of economic growth is measured through changes in GDP and GDP per capita. This is because the growth rate describes the significance of economic improvements instead of the size of the economy or the relative wealth of countries. As most studies consider growth in absolute units of GDP and GDP per capita instead of the growth rate, this category serves as our baseline category with which we compare other measures of economic development. These include the total GDP representing the size of the economy and GDP per capita measuring the income level and relative wealth of individuals. In this context, it needs to be mentioned that many studies do not discuss the differences between those measures and seem to pick their dependent variable interchangeably. Our analysis will show that this is not a reasonable approach. The next category of economic development includes indices of human development and well-being like the human development index. Finally, income inequality is clearly separable from the other development variables as it is most often measured with the GINI coefficient or the percentage of income held by certain income groups.

To test *Proposition 2* on the level of economic development, we coded the study context of our sample papers based on the income level (*Country*) and the area of interest *(Area*). For both categories, we screened the methodology section of the original papers and extracted the countries in the sample. For income level, we used the distinction between least-developed, developing, and developed countries. The three categories were matched against the World Bank categorization of low-income (LDCs), lower and upper middle-income (developing), and high-income (developed) countries, which is available for the period 1980 to 2020. For the area variable, we coded whether a study focuses on a specific continent or on one of the frequently studied country groups, namely Sub-Saharan Africa, transition economies, Middle East and North Africa (MENA), and China. The country categories were constructed iteratively based on the data, and there are not enough articles in the dataset for more categories. The baseline category for both variables

was the analysis of mixed country samples, so that coefficients for each of the coded categories are comparisons against the set of all countries.

3.5.4 Accounting for the Dynamics of Institutions

We operationalize the time dimension by coding the time period covered by each paper in our sample. If above 80% of a study's time points were within a specific decade, we created a dummy for the respective decade. As below 10 effect sizes are attached to periods before 1960, we integrated them into a pre-1970 dummy with the remaining effect sizes covering each decade until the 2010s (*Decade*). In that way, we can account for the time-varying effect of institutions. Studies that were not categorizable and covered more than one decade were used as a baseline category. We also include dummy variables for the use of panel data instead of cross-section data (*Frame*) and for the use of yearly observations instead of multiannual averages (*Yearly*). With these measures, we hope to identify how the effect of institutions depends on whether and how the time dimension was included in the analysis. Therewith, we respond to several papers arguing for the inclusion of time-based effects into institutional research (Khoury & Peng, 2011; Banalieva et al., 2015; Luiz, 2015).

3.5.5 Technological Development Variables

To triangulate the relation between institutions and technological development as well as technological development and economic development, we employed another literature search using keywords related to technological and economic development (see *Appendix 2.1*). Of the 934 papers identified, we were able to extract an additional 110 papers and 363 effect sizes for the relation between technological variables and our development categories. By matching the search for institutional variables with our search for technology variables, we created a third sample of papers reporting on the relation between institutions and technologies as the main explanatory dimensions of economic development. This sample includes 92 studies and 267 effect sizes on the relation between institutional and technological development to provide us with additional evidence on their mutual dependence.

The variable of technological development (*Technology*) used by the majority of papers was productivity increases, which are generally accepted as the main characteristic of technological improvements. Therefore, productivity was used as our baseline category. The remaining technological

variables were split by their focus on the three main phases of technological change, namely invention, innovation, and diffusion (Schumpeter, 1954). Inventions were captured through the categories of research and development (R&D) and patents. Innovation was measured through the number of new firms, also referred to as the overall level of entrepreneurship (Bowen & De Clercq, 2008; Politis, Winborg, & Dahlstrand, 2010), entrepreneurial activity (Bruton, Ahlstrom, & Puky, 2009), or new business activity (De Clercq, Danis, & Dakhli, 2010). Finally, the diffusion category consists of variables such as the number of high-tech exports by domestic firms and indices of a country's competitiveness. These categories are used for our analysis of the institution-technology nexus of economic development.

3.5.6 Control Variables

In meta-analytical research, several control variables are commonly employed to account for the peculiarities of the research method. First, publication bias is a common problem in meta-analysis as papers are more likely to get published if they report significant results (Doucouliagios, 2005). To account for such tendencies, we develop a dummy indicating if the relation of interest is central to the paper by coding if our keywords were used in the title or abstract of the paper (*Central*). Furthermore, we construct a journal quality dummy, which indicates if the paper was published in an A or B journal according to the CABS journal ranking [12], as we expect that lower-ranked journals and working papers are less affected by the pressure to report significant results (*Journal Quality*).

A full list of our variables can be found in *Appendix 2.2*.

3.6 Results

The summary of all effect sizes on the relation between institutions and economic development shows an average correlation of 0.22. The results of the file drawer test (failsafe N = 6.910.646) demonstrate the robustness of the result to potential publication bias. Additionally, we checked for the influence of sample size by using a funnel plot (see *Figure 2.3*).

[12] CABS refers to the Chartered Association of Business Schools, which publishes its highly respected journal ranking annually.

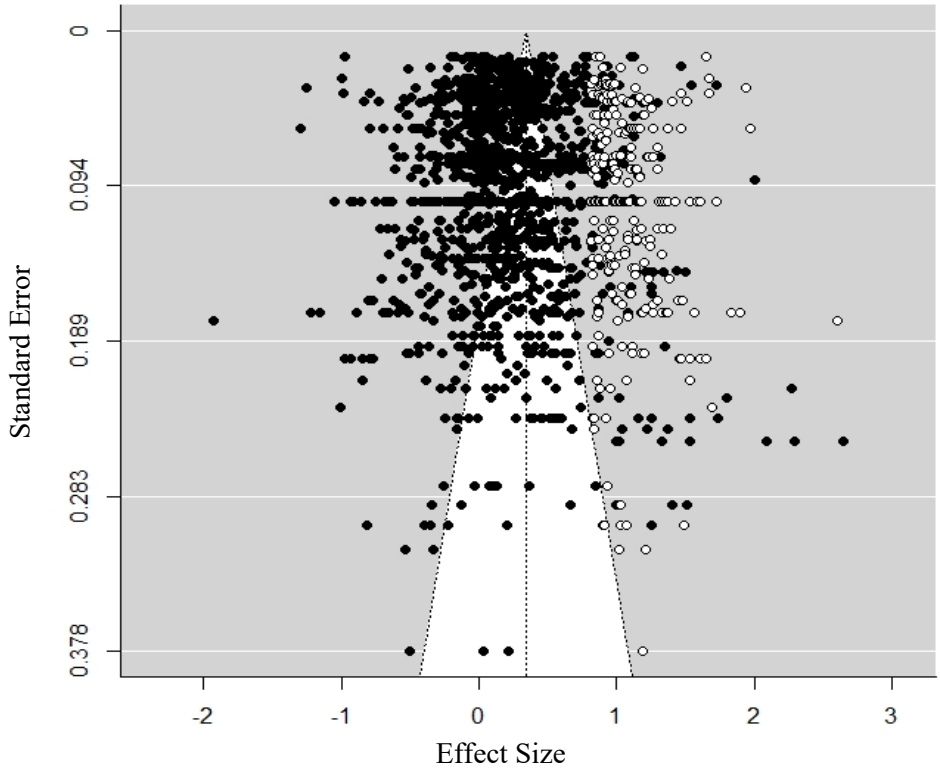

Figure 2.3: *Funnel Plot of Effect Sizes in the Sample*

The results indicate that our sample does not suffer from bias of small sample size as the effect sizes are equally distributed across studies. In a second step, we empirically test if the funnel plot is symmetric as publication bias would mean that small effect sizes with high sampling variances are missing in our sample. A ranktest shows that our sample is indeed significantly asymmetric (p-value = 0.004). By using the trimfill method indicated through the white dots in the funnel plot, we find that 263 effect sizes are missing on the right side of our mean effect size to make the plot symmetric. Thus, there are more studies on the left-hand side of the mean effect size, which means that results below the average effect size are more likely to get published in the relation between institutions and economic development. Reasons for such a distribution can be the overestimation of some effect sizes due to the use of aggregate measures and the general diversity of measures included in our sample, which further validates our distinction between institutional dimensions and search for relevant moderator variables. As a matter of fact, when regressing the standard error on the effect size, the residual heterogeneity was still above 95% (98,71) meaning that the different effects are the result of other moderating factors. Before employing the MARA to examine

these factors, *Table 2.1, 2.2,* and *2.3* show the results of our HOMA, which is based on averaging the effect sizes of different variable groups.

Predictor	**K (ESs)**	**N**	**Mean ES**	**SE**	**Lower CI**	**Upper CI**	**FsN**
Institutions:	237 (1.349)	546.668	0,223	0,099	0,193	0,254	6.848.985
Institutional Quality	87 (183)	68.957	0,306	0,109	0,212	0,407	268.299
Democracy	57 (136)	51.516	0,241	0,101	0,153	0,336	78.518
Property Rights	19 (30)	7.316	0,233	0,109	-0,013	0,541	2.323
Control of Corruption	43 (84)	22.240	0,383	0,099	0,240	0,541	39.458
Legal System	27 (45)	14.394	0,604	0,102	0,371	0,877	19.501
Trade Openness	113 (215)	127.189	0,195	0,087	0,132	0,262	201.394
Labor Rules	18 (37)	12.376	0,024	0,089	-0,101	0,164	247
Financial Development	80 (373)	138.990	0,213	0,097	0,153	0,275	457.932
Institutional Stability	43 (104)	56.236	0,182	0,088	0,107	0,263	43.726
Government Size	76 (142)	47.454	0,077	0,111	0,008	0,151	6.158

Table 2.1: *HOMA Results by Institutional Variable*[13]

Predictor	**K (ESs)**	**N**	**Mean ES**	**SE**	**Lower CI**	**Upper CI**	**FsN**
Development:	237 (1.349)	546.668	0,223	0,099	0,193	0,254	6.848.985
Growth Rate	115 (529)	140.067	0,044	0,108	0,014	0,074	47.859
Economy Size	31 (86)	29.713	0,104	0,094	-0,007	0,227	2.872
Relative Wealth	132 (496)	259.066	0,478	0,093	0,411	0,549	3.375.093
Well-Being	8 (37)	25.141	0,702	0,06	0,461	0,984	59.264
Inequality	34 (201)	92.681	0,147	0,098	0,087	0,211	68.530

Table 2.2: *HOMA Results by Development Variable*

Predictor	**K (ESs)**	**N**	**Mean ES**	**SE**	**Lower CI**	**Upper CI**	**FsN**
Development Level:	237 (1.349)	546.668	0,223	0,099	0,193	0,254	6.848.985
Mixed Sample	132 (703)	343.816	0,269	0,096	0,227	0,313	3.065.393
Developed Countries	27 (132)	32.248	0,011	0,090	-0,048	0,074	0
Developing Countries	60 (288)	92.142	0,323	0,116	0,242	0,409	287.984
LDCs	28 (226)	78.462	0,104	0,090	0,049	0,162	104.094

Table 2.3: *HOMA Results by Income Level Variable*

[13] The tables show the number of studies (K), the number of effect sizes (ESs), the combined sample of all studies (N), the mean effect size (Mean ES), the related standard error (SE), the lower and upper 95% confidence interval (Lower CI and Upper CI), and the failsafe N (fsN).

The number of studies, effect sizes, and their underlying number of observations are provided. The failsafe N for each effect size is computed to account for publication bias. While the mean effect sizes for all groups are positive, we can observe significant differences between the institutional dimensions. General institutional quality, control of corruption, and the legal system show especially high values, whereas labor rules and government size have only small effects on economic development. Similarly, the effect sizes for economic development variables such as growth rate, economy size, and inequality are much lower than for relative wealth and well-being indicators. Both results already indicate the necessity for authors to carefully choose their measures of institutional and economic development. For *Proposition 1*, we can see that the measure of aggregated institutional quality is the third highest among all categories, which indicates that aggregate measures rather overestimate the effect of institutions. For *Proposition 2*, the HOMA shows that the effect of institutions in developing countries is significantly higher than the effect in developed countries and LDCs.

To test *Proposition 3*, *Figure 2.4* shows the moving average of the effect size between 1960 and 2020. We can observe that the effect of institutional development peaked in the 1990s and has decreased in the last decades.

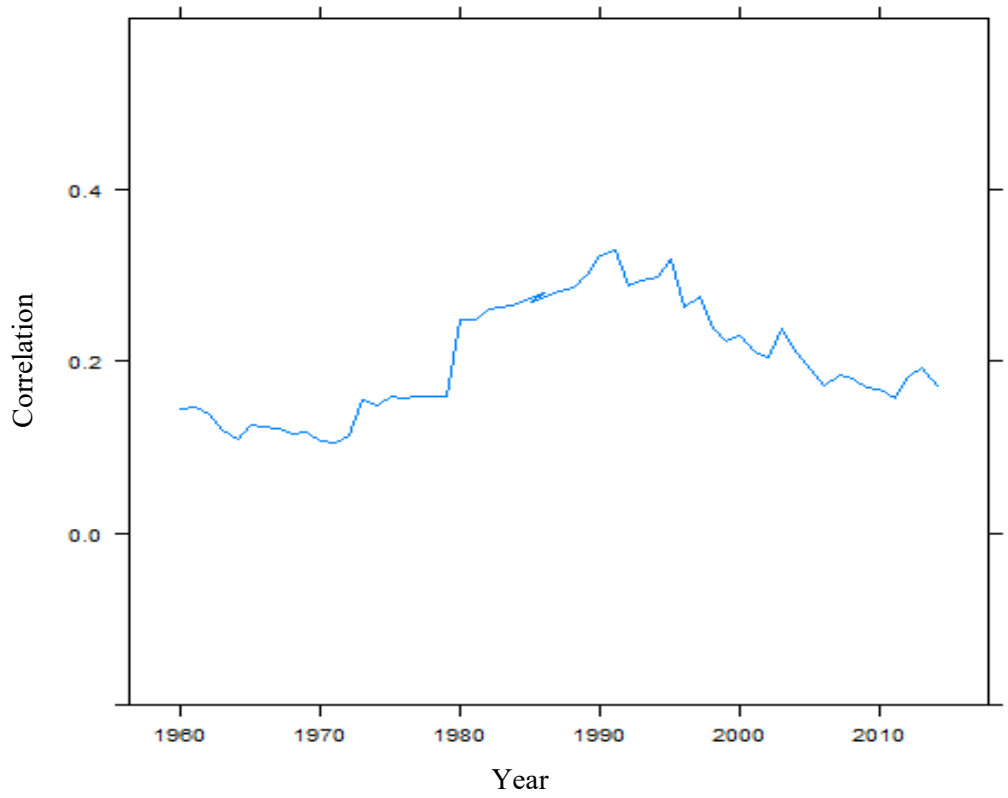

Figure 2.4: *Mean Effect of Institutions on Economic Development over Time*

However, for the moving average, we can also find diverging results for different development levels. As *Figure 2.5* illustrates, the effect of institutions on development has been the highest for developing countries, while it has remained low in developed countries. For LDCs, we can observe an upwards trend during the 1990s and a convergence with the average effect size of developing countries. As a robustness check, we removed studies that were only focusing on China (N=186) without significant changes to the curves.

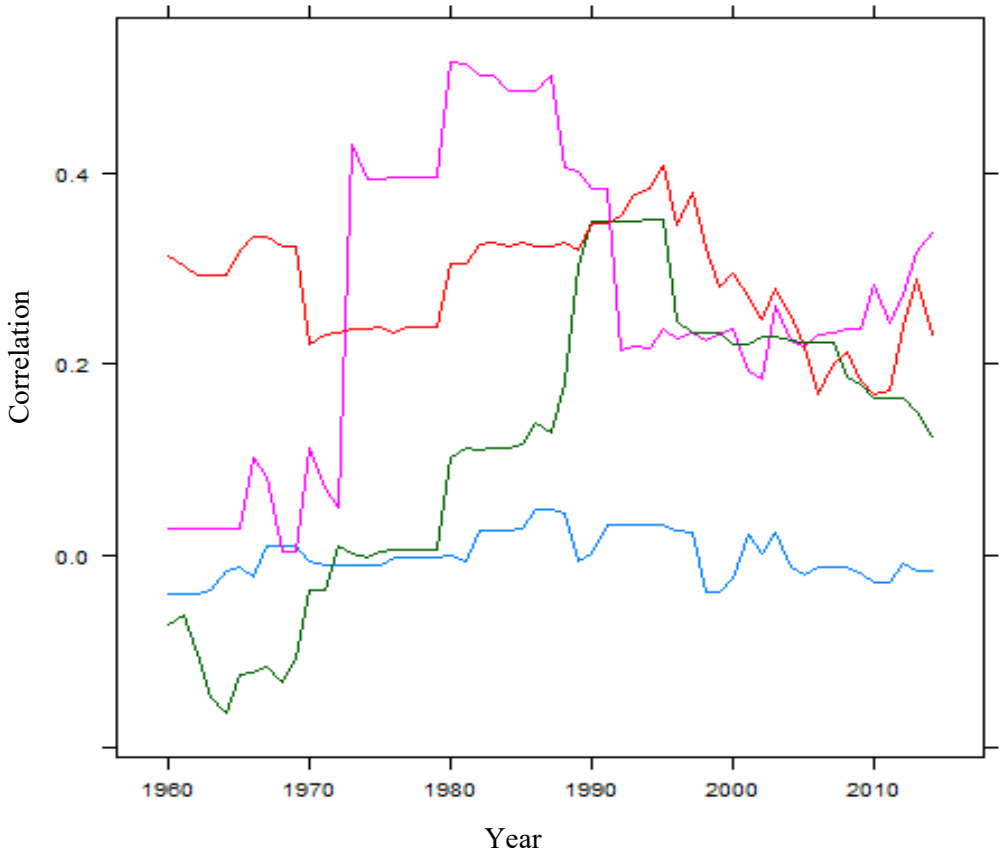

Figure 2.5: *Mean Effect of Institutions on Economic Development by Development Level*
(Orange = All Countries, Blue = Developed Countries, Pink = Developing Countries, Green = LDCs)

To verify the results of our descriptive analysis, the results of our meta-analytic regression analysis (MARA) can be found in *Table 2.4*.

	(1)	(2)
Variables	MARA	MARA
Democracy	-0,243 *(0,007)***	-0,243 *(0,070)***
Property Rights	-0,104 *(0,015)***	-0,104 *(0,145)***
Control of Corruption	-0,095 *(0,009)***	-0,095 *(0,009)***
Legal System	-0,125 *(0,010)***	-0,124 *(0,010)***
Trade Openness	-0,233 *(0,006)***	-0,233 *(0,006)***
Labor Rules	-0,252 *(0,013)***	-0,251 *(0,013)***
Financial Development	-0,066 *(0,006)***	-0,066 *(0,006)***
Institutional Stability	-0,133 *(0,007)***	-0,133 *(0,007)***
Government Size	-0,269 *(0,007)***	-0,268 *(0,007)***
Economy Size	0,052 *(0,010)***	0,052 *(0,010)***
Relative Wealth	0,160 *(0,009)***	0,160 *(0,009)***
Well-Being	0,227 *(0,014)***	0,225 *(0,014)***
Inequality	-0,227 *(0,001)***	-0,227 *(0,001)***
1960s	-0,187 *(0,152)*	-0,226 *(0,152)*
1970s	-0,019 *(0,056)*	-0,022 *(0,056)*
1980s	0,151 *(0,053)***	0,154 *(0,053)***
1990s	-0,027 *(0,060)*	-0,047 *(0,060)*
2000s	-0,200 *(0,054)***	-0,213 *(0,056)***
2010s	-0,192 *(0,105)*	-0,180 *(0,106)*
Developed Countries	0,117 *(0,022)***	
Developing Countries	0,108 *(0,021)***	
LDCs	-0,064 *(0,028)**	
Africa		-0,075 *(0,050)*
Asia		-0,112 *(0,050)**
Europe		-0,088 *(0,051)*
North America		-0,005 *(0,076)*
South America		-0,180 *(0,052)***
Sub-Saharan Africa		-0,706 *(0,097)***
Transition Economies		0,009 *(0,096)*
Middle East & North Africa		-0,648 *(0,348)*
China		-0,112 *(0,320)*
Journal Quality	-0,057 *(0,048)***	-0,093 *(0,049)*
Central	0,039 *(0,019)**	0,045 *(0,018)**
Cross-Section	0,252 *(0,257)*	0,111 *(0,257)*
Panel	0,149 *(0,256)*	0,034 *(0,257)*
Yearly	0,059 *(0,042)*	0,077 *(0,042)*
Number of Observations	1.349	1.349
R squared	0,268	0,301

Robust standard errors in parentheses
*** p<0,01; ** p<0,05; * p<0,10

Table 2.4: *MARA Results: Main Model*

The analysis shows the effect of our categorical variables on the effect size of the institution-development relation compared to our baseline categories for *Institutions* (baseline = institutional quality), *Development* (baseline = growth rate), *Decade*, *Country*, and *Area* (baseline = mixed samples). In support of *Proposition 1*, all institutional categories have a significantly smaller effect than the aggregate baseline indicator of institutional quality. Among those categories, property rights protection, control of corruption, and financial development are closer to the high average effect of institutional quality, while the effects of democracy, trade openness, labor rules, and government size are the lowest. Similar differences can be found for the development variables with relative wealth and well-being providing significantly more positive results compared to growth rate as the baseline category. In contrast, reduced inequality as a measure of economic development leads to significantly smaller effect sizes. Regarding *Proposition 2*, the effect of institutions on economic development is higher for developed and developing countries but lower for LDCs compared to the use of mixed samples. In conjunction with the positive effect of our control dummy *Cross-Section*, these findings illustrate the importance to separate research samples and further account for cross-country differences in research on economic development. The positive effect of our *Panel* dummy shows that the time dimension also needs to be included in institutional and development studies. The results for the *Decade* categories show that longitudinal studies overestimate the positive effect of institutions and that the development effect was higher between the 1970s and 1990s. In that way, they complement our moving average analysis and support *Proposition 3*. Finally, to test our *Proposition 4* about the complementary role of technological change, we employ additional tests using our technology-institution sample that contains 746 matches between the effect sizes for institutions and technologies on economic development. Based on these matches, we construct another moving average comparing the effect of institutions and technological development over time (see *Figure 2.6*).

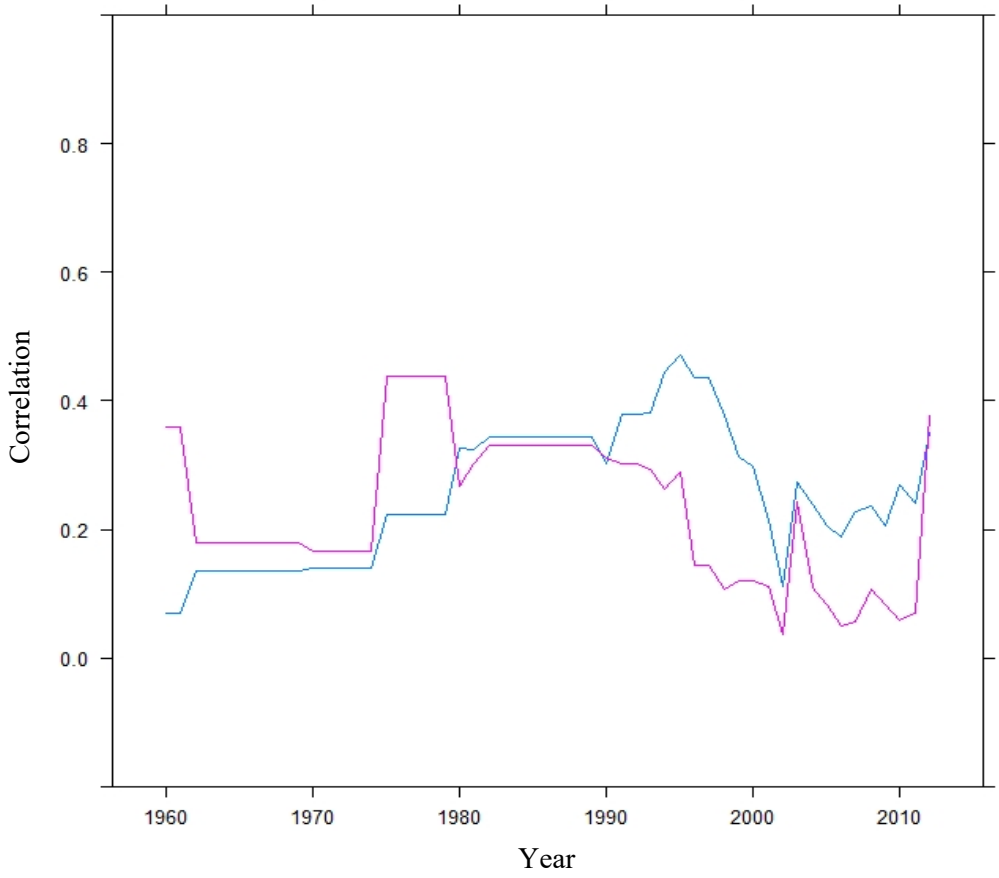

Figure 2.6: *Mean Effect of Institutions and Technologies on Economic Development over Time*
(Blue = Institutional Development; Pink = Technological Development)

The graph shows that technological development had a greater impact in the 1970s, while institutions had a greater impact in the 1990s, but overall, we can observe a very synchronous relationship between the impact of both dimensions. In a subsequent step, we averaged the effect sizes for technological development for each institutional effect size to include this variable as a moderator in our MARA on the effect of institutions on economic development. This results in a loss of effect sizes leaving 267 data points across 69 original studies. With the regressions, we analyze whether the effect of institutions on economic development is dependent on the correlation between technological and economic development during the same time period. As can be seen in *Table 2.5*, the effect of our technology variable is positive in both and significant in one model, so that our argument of a mutual dependence between institutions and technologies is partially accepted.

	(3)	(4)
Variables	MARA	MARA
Technology Variable	0,270 *(0,180)*	0,442 *(0,150)***
Economy Size	0,236 *(0,033)****	0,225 *(0,033)****
Relative Wealth	0,098 *(0,017)****	0,102 *(0,017)****
Inequality	-0,035 *(0,022)*	-0,037 *(0,022)*
1990s	0,475 *(0,250)*	0,428 *(0,208)**
2000s	-0,120 *(0,138)*	0,049 *(0,120)*
2010s	0,140 *(0,211)*	0,731 *(0,318)**
Developed Countries	-0,239 *(0,196)*	
Developing Countries	0,365 *(0,093)****	
LDCs	-0,663 *(0,114)****	
Africa		0,037 *(0,221)*
Asia		0,297 *(0,270)*
Europe		-0,008 *(0,220)*
North America		NA [14]
South America		-0,190 *(0,352)*
Sub-Saharan Africa		-0,896 *(0,130)****
Transition Economies		-0,030 *(0,157)*
Middle East & North Africa		NA
China		0,100*(0,357)*
Journal Quality	-0,162 *(0,116)*	-0,062 *(0,097)*
Central	-0,077 *(0,037)**	-0,630 *(0,037)****
Cross-Section	NA	NA
Panel	-0,005 *(0,129)*	0,145 *(0,112)*
Yearly	0,107 *(0,108)*	0,054 *(0,089)*
Number of Observations	267	267
R squared	0,406	0,354

Standard errors in parentheses
*** p<0,01, ** p<0,05, * p<0,10

Table 2.5: *MARA Results: Technology Model*

Finally, we also summarize all effect sizes for the correlation between both variables, which is illustrated in the full triangulation of effects between institutions, technological development, and economic development in *Figure 2.7*. These averages are based on all the effect sizes for each relationship in our sample.

[14] The combination of the institution and technology datasets resulted in a loss of effect sizes and independent moderators, since none of the included studies used the particular variable.

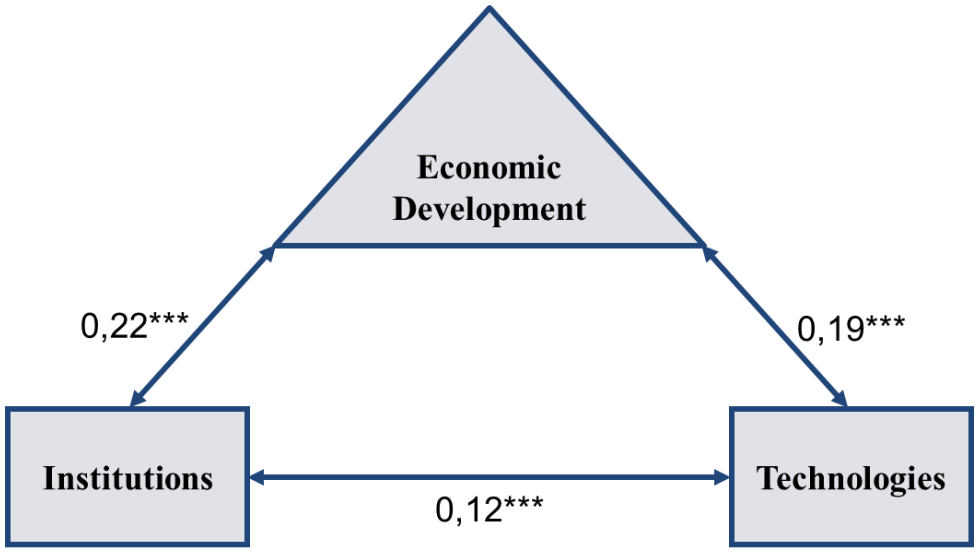

Figure 2.7: *Triangular Relation between Institutions, Technologies, and Economic Development*

The results demonstrate a significant correlation between all three dimensions. However, when further disaggregating the three dimensions, the effect is different across categories. To illuminate the relationship between institutional, technological, and development dimensions, *Appendix 2.3* provides the mean bivariate effect sizes between all sub-categories in our sample. The results demonstrate different directions and levels of effect sizes depending on the dimensions of institutional, technological, and economic development. While this data gives an overview on the diversity and complexity of relationships, we will discuss the most important results in the next section.

3.7 Discussion

Our results provide a comprehensive overview of the empirical evidence on the effect of institutions on economic development. As expected, the average effect of improved institutions on economic development is positive; however, these results are sensitive to differences in the aggregation and operationalization of the institutional variables as well as the country's development level and the time period under study. Therefore, the results indicate the difficulties in capturing the real effect of institutions and the need for researchers to account for conceptual and methodological challenges.

The differing effect between institutional dimensions corresponds with configurational views of institutions. While sociological or historic institutional approaches also emphasize that institutions operate in concert with each other (DiMaggio and Powell, 1983), concepts like varieties of capitalism (Hall & Soskice, 2001) and business systems (Whitley, 2003) have embedded institutional complementarity in their

theory. Indeed, Hall and Gingerich (2009: 450) argue that "one set of institutions is said to be complementary to another when its presence raises the returns available from the other". Therefore, we argue that configurational approaches can bring more valid results by accounting for the specific characteristics of different institutions. There are already some noticeable examples for the use of these approaches (Jackson & Deeg, 2019) and their combination with alternative research methods (Judge et al., 2014), so that we advocate for future research in this direction. Similarly, the results on aggregate indices of institutional quality suggest that the use of such measures does not generate results, which sufficiently account for the heterogeneity of institutions. Since their usage can be partly explained by a lack of institutional databases, our results demonstrate the necessity to develop better sets of measures for each institutional dimension (Estrin & Meyer, 2011).

Our findings also highlight the complexity of economic development because different definitions and measures will lead to significantly different results. This makes it important for researchers to clearly define in which facet of economic development they are interested in and how this is related to other facets and the independent variables. While some research in this direction has already been made, for instance on the relation between wealth and inequality (Loayza, Mier y Teran, & Rigolini, 2013) or output growth and well-being (Stiglitz, 2011), it still remains unclear if multiple dimensions of economic development can be achieved simultaneously. Furthermore, the findings demonstrate that the factors contributing to economic development are dependent on the development level of a country. Therefore, researchers should account for such differences in their methodological considerations and avoid using large cross-country samples. Although a vast amount of empirical evidence was aggregated in this essay, the results indicate that an in-depth examination of specific factors and concrete development phenomena can benefit from qualitative methods like case studies (Redding, 2005).

Our results on the dynamics of institutional effects show strong temporal dependence. This could be the result of country-specific differences, as we have shown that the economic take-off from LDCs to developing and even developed countries is closely associated with improvements in institutions. Nevertheless, it is important to explore which institutions help countries at which stage of development to overcome the challenges associated with reaching higher income levels. For instance, Peng and Khoury (2009) propose that in the early stages of institutional development, informal institutions fill institutional

voids, which are then subsequently replaced by formal institutions. Medina-Moral and Montes-Gan (2018) suggest that economic freedom is more important in the initial stages of economic development, whereas good governance and absence of corruption are more important for the transition from developing into developed countries. Another explanation for the time effects of institutions is the various global economic crises that have led to global recessions and phases of recovery. However, the effect of institutions does not strictly follow these dates, which implies that there are likely to be other forces at play. To further reveal the existence of such moderating factors, researchers need to move their attention to the dynamics of change and development, for instance by advancing a dynamic theory of institutions (Banalieva et al., 2015).

Finally, our essay contributes to the development literature by incorporating the role of technological development as a complementary dimension to institutions. While many theoretical models have outlined the importance of both dimensions, the empirical literature seems to search for the factor that trumps other factors in its impact on economic development. Instead, our results show that there is not one factor but that it is rather the complementarity of institutions and technologies that drives development. Although the complementary effect of technologies is only significant in one regression, the moving average demonstrates that institutions and technologies develop in a mutually dependent manner across countries. These results highlight the need to further illuminate the link between sub-categories of institutions and technologies. The bivariate correlations show that institutional categories like institutional quality, democracy, and control of corruption have a positive effect on most technology categories but have a negative average effect on entrepreneurship. Government size has a positive effect on R&D and competitiveness but a negative effect on three of the other technology dimensions. Thus, we argue that institutions and technologies should not be seen as separated concepts but rather as inherently intertwined and researchers as well as policymakers need to understand under what circumstances both dimensions reinforce or contradict each other.

3.8 Conclusion

The main goal of our article has been to address the inconclusive evidence on the effect of institutions on economic development and advance the institutional approaches in business and economics. Therefore,

we conducted a meta-analysis on institutional quality and economic development, which helped to identify the influencing factors of development models in economics, development studies, and IB. By gathering a dataset of correlation coefficients, which is unique in its extensiveness, we were able to summarize the mean effects of different categories of institutions and economic development. Moreover, we find a moderating influence of a country's income level, the time dimension, and technological development. These results allow for a more detailed examination of the effects of institutions on different aspects of economic development.

First, we show that institutional research needs to account for differences between institutional dimensions. Therefore, scholars should further work on developing appropriate indices capturing institutions instead of using highly aggregated measures. This would not only help to advance methodological aspects but also the inductive abstraction of empirical results into institutional theories (Fransen, 2013). Second, scholars seeking to develop solutions for economic development need to clearly state their definition of development and make use of appropriate measures. Our results should increase awareness about the fact that one facet of economic development does not automatically bring about improvement in other facets. In this context, we argue for a broad approach to examining economic development that goes beyond the often-used equalization with economic growth. Third, scholars need to advance research on the interrelations between institutions, technologies, and economic development and, more specifically, translate single-study findings into a broader framework of this triangular relationship. This means that the factors influencing this triplex like education, trade, or FDI should be examined not only for their bivariate relationship but also for their subsequent effects (Yi, Wang, & Kafouros, 2013; Bjørnskov & Foss, 2016).

Despite these contributions, our essay also has several limitations, mainly related to the meta-analysis as the chosen statistical method. First, scholars often criticize meta-analyses for unreasonable comparisons and a lack of empirical evidence as it mainly provides the mean of the effect sizes. This is true in the sense that our analysis relies on existing studies, which are not always comparable. However, we tried to combat such criticism by using correlation coefficients as a standardized effect size. As expressed in the book of Smith, Glass, and Miller (1980: 47): "Indeed the approach does mix apples and oranges, as one necessarily would do in studying fruits." Regarding the reliability of our comparisons, problems mainly arise from a

lack of empirical rigor and reporting in the original studies, which we account for through appropriate moderator variables and robustness checks. Thus, we encourage scholars to engage more with the concept of meta-analysis to extract implications for the reporting and testing of their own methodology (e.g., using within-study meta-analysis).

Another limitation stems from the potential endogeneity problems between institutions and economic development (Millar, Choi, & Cheng, 2009). Such endogeneity is not only likely to exist between our independent and dependent variable but also within our variable groups. For instance, it is plausible that income inequality is jointly determined with the rate of economic growth. If the independent variables are endogenous and thus correlated with the error term, the OLS estimators are biased and inconsistent. This chicken-or-egg problem has not been adequately dealt with in many growth models as lagged variables are not always a sufficient solution. Since our analysis is based on correlation coefficients to avoid the drawbacks of regression coefficients, such problems cannot be fully addressed with our analysis. However, regression coefficients suffer from incomparability and high sensitivity to model specifications, which are often not known to the researcher conducting the meta-analysis. Thus, future research needs to account for this general problem of measurement in empirical research.

Finally, while our results have important implications for the future theoretical development of institutional concepts in economics and business, we were not able to provide more than research stimuli and outline possible directions of future research. For instance, while we find temporal effects for the relation between institutions and development, we were not able to further delineate this effect, for instance by investigating certain periods of economic development, due to the eclectic focus in our analysis and the lack of short-frame studies in the original data. Therefore, we encourage researchers to think more carefully about the research setting and theoretical underpinnings of their institutional research. It is important to clearly define the dimension of institutions addressed as well as the relationship between cause and effect in the empirical functions.

In sum, we believe our essay brings important results and displays a comprehensive overview of the role of institutions for economic development, which allows for theoretical implications and the mapping of unresolved problems in this relationship.

3.9 References

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[15] The upper case numbers indicate the relationship under examination:
[1] Institutions-Development
[2] Technology-Development
[3] Institutions-Technology
[4] Institutions-Development & Institutions-Technology
[5] Technology-Development & Institutions-Technology
[6] Institutions-Development & Technology-Development & Institutions-Technology

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3.10 Appendix

Appendix 2.1: Keywords Used to Identify Existing Studies

Institutions-Development Relation	
Institutions	**Economic Development**
institutions, *institutional quality*, *democracy*, *property rights*, *corruption*, *legal system*, *regulations*, *policies*, *tax*, *law*, *economic freedom*, *financial institution*, *institutional change*, *political stability*, *government*	*economic development*, *economic growth*, *inequality*, *living standards*, *income growth*, *income level*, *GDP growth*, *economic performance*, *wealth*
Data Sources: Business Source Premier, Google Scholar, Journal of International Development, Oxford Development Studies, Review of Development Economics, Journal of Business Ethics, Development and Change, Journal of Development Studies, World Development, Journal of Development Economics, Growth and Change, Journal of Economic Growth, Journal of International Business Studies, International Business Review, Journal of World Business, Journal of International Business Policy, Journal of Evolutionary Economics, Entrepreneurship Theory & Practice, Small Business Economics	

Technology-Development Relation	
Technology	**Economic Development**
technologies, *technological change*, *technological development*, *invent*, *research and development*, *R&D*, *patent*, *innovation*, *technology diffusion*	*economic development*, *economic growth*, *inequality*, *living standards*, *income growth*, *income level*, *GDP growth*, *economic performance*, *wealth*
Data Sources: Business Source Premier, Google Scholar, Journal of International Development, Oxford Development Studies, Review of Development Economics, Journal of Business Ethics, Development and Change, Journal of Development Studies, World Development, Journal of Development Economics, Growth and Change, Journal of Economic Growth, Journal of International Business Studies, International Business Review, Journal of World Business, Journal of International Business Policy, Journal of Evolutionary Economics, Entrepreneurship Theory & Practice, Small Business Economics	

Appendix 2.2: Description of Variables and Data Sources (Essay 1)

Variable	Description	Source
Dependent Variable		
Correlation	Standardized correlation between institutions and economic development	Study Sample
Independent Variables		
Growth	0 = Growth rate (baseline), 1 = Economy size, 2 = Relative Wealth, 3 = Well-Being, 4 = Inequality	Study Sample
Institutions	0 = Institutional quality (baseline), 1 = Democracy, 2 = Property rights protection, 3 = Control of corruption, 4 = Legal system, 5 = Economic openness, 6 = Labor rules, 7 = Financial development, 8 = Institutional stability, 9 = Government size	Study Sample
Technology	0 = Productivity (baseline), 1 = Research and development, 2 = Patents, 3 = Entrepreneurship, 4 = Competitiveness	Study Sample
Country	0 = Mixed sample (baseline), 1 = Developed country, 2 = Developing country, 3 = Least-developed country	Study Sample
Area	0 = Mixed sample (baseline), 1 = Africa, 2 = Asia, 3 = Europe, 4 = North America, 5 = South America, 6 = Oceania, 7 = Sub-Saharan Africa, 8 = Transition economies, 9 = MENA, 10 = China	Study Sample
Decade	0 = Not categorizable (baseline), 1 = Pre-1970s, 2 = 1970s, 3 = 1980s, 4 = 1990s, 5 = 2000s, 6 = 2010s)	Study Sample
Control and Robustness Variables		
Frame	1 = Time-series (baseline), 2 = Cross-section, 3 = Panel	Study Sample
Journal Quality	Dummy for publication quality (0 if the publication is ranked C or lower, 1 if otherwise)	Study Sample
Central	Dummy for topic of the research article (0 if the relation between institutions and growth was not central to the paper, 1 if otherwise)	Study Sample
Yearly	Dummy if the papers used yearly data (1 if yes, 0 if they used averages)	Study Sample

Appendix 2.3: Mean Effect Sizes between the Institution-Technology-Development Variables

Variables	*Growth Rate*	*Economy Size*	*Relative Wealth*	*Well-Being*	*Inequality*
Institutional Quality	0,025	0,159	0,385	0,596	-0,076
Democracy	0,058	0,146	0,292	0,269	0,213
Property Rights	-0,254	0,301	0,392	NA	NA
Control of Corruption	0,150	0,204	0,360	0,243	0,160
Legal System	0,204	0,340	0,466	0,533	0,111
Trade Openness	0,123	-0,068	0,246	0,446	0,029
Labor Rules	0,022	-0,196	0,044	NA	0,020
Financial Development	0,018	-0,026	0,361	0,411	0,222
Institutional Stability	0,069	0,477	0,256	0,365	0,042
Government Size	-0,007	0,402	0,089	0,140	0,135

Variables	*Growth Rate*	*Economy Size*	*Relative Wealth*	*Well-Being*	*Inequality*
Productivity	0,197	0,056	0,450	NA	-0,083
Research & Development	0,061	0,211	0,224	NA	0,464
Patents	0,321	-0,760	0,175	NA	-0,006
Entrepreneurship	0,146	-0,090	-0,065	-0,06	0,156
Competitiveness	0,163	0,405	0,203	NA	0,328

Variables	*Productivity*	*Research and Development*	*Patents*	*Entrepreneur-ship*	*Competitive-ness*
Institutional Quality	0,017	0,091	0,104	-0,006	0,388
Democracy	0,292	0,530	0,253	-0,071	0,529
Property Rights	0,214	0,219	0,267	0,018	0,316
Control of Corruption	0,842	-0,005	0,198	-0,062	-0,06
Legal System	NA	0,010	0,079	0,271	NA
Trade Openness	0,083	0,139	-0,118	0,193	0,191
Labor Rules	0,252	0,055	NA	-0,093	-0,024
Financial Development	0,328	0,112	-0,078	0,029	0,152
Institutional Stability	0,117	0,05	0,350	NA	0,017
Government Size	-0,088	0,330	-0,045	-0,027	0,190

4 Essay 2: Understanding the Relationship between Patenting Activity and Green Policy Initiatives: Multinational Enterprises as Drivers of Change

Abstract

This essay examines exogenous and endogenous triggers of institutional change in the form of green policy introduction for 113 countries over the period from 2001 to 2020. By combining institutional literature with findings from International Business as well as sustainability and policy studies, we discuss how new technologies that shape the incentives of economic actors determine the support or opposition towards the introduction of green policies. We develop hypotheses on the overall impact of green technologies, the resource-dependency of countries as well as domestic and foreign actors as sources of green technologies. Testing these assumptions with a Probit model, our findings demonstrate that green policy introduction is more likely when local and foreign firms indicate their ability to use new policies in a productive way, whereas high resource-dependency leads to low economic incentives for change.

Keywords: Institutional Change, Green Policies, Green Technologies, Resource-Dependency

Statement of Authorship

This essay is single-authored and not yet published.

The essay emerged from a paper on the sources of competitiveness and institutional change in developing countries. This original version was based on the following perspective paper of Tilo Halaszovich and Arijit Ghosh:

> *Halaszovich, T., & Ghosh, A. (2018). Who wants to change the rules? Sources of competitive advantage and incentives for and against institutional evolution. EIBAzine - International Business Perspective, 22, 13–16.*

Based on the idea presented in this perspective paper, a joint essay was developed and presented together with the two colleagues at the Academy of International Business Conference in Copenhagen 2019. The feedback received on this version led to a complete revision of the essay with a shift in perspective from the relationship between competitiveness and institutional change to an application of this idea to green technologies and green policies. The revision included a change of the underlying literature as well as a methodological shift using novel patent data at the firm level and green policies at

the country level. The scope of the research was expanded from developing countries to a mixed country dataset. The resulting change, which took five years to complete, was done individually. Therefore, no co-authorship is indicated.

I am deeply grateful to Tilo Halaszovich and Arijit Ghosh for their support in preparing the conference paper and for sparking the original idea on the link between competitiveness and institutional change.

4.1 Introduction

The ability of countries to adapt their institutional framework in accordance with changing economic realities is a key factor of their economic development. When comparative advantages shift, new technologies are introduced, or in the event of crisis, policymakers need to adjust their political strategies to account for the arising contingencies (Jaffe, Newell, & Stavins, 2002). The resulting change processes are best described through theories of institutional change and concepts from the policy literature (Orihuela, 2013; Aissaoui & Fabian, 2022). Ritchie (2016) explains institutional change through micro-level interactions between economic actors, where institutions change through agency and demonstration effects. Hamilton-Hart (2017) finds that the introduction of property rights is dependent on the incentives and capabilities of influential actors and that the legal environment moderates these incentives. Other scholars focus on macro-level changes in the policy environment, where governments induce changes through state policies (De Marchi & Alford, 2022), tax incentives (Shah, 1994), or structural reforms (Andersson, 2016; Kouame & Tapsoba, 2019). A central takeaway from these studies is that endogenous triggers lead to adaptation processes by local economic actors that can ultimately change the institutions of a country (Shen & Tsai, 2016).

However, the outcomes of such changes are dependent on the path-dependent nature of institutions, the process of compromise finding as well as the incentives and power of economic actors (Mohan, 2016). Helmke (2010) explains that effective institutional change is hindered by diverging interests of powerful actors. Similarly, the existence of contradicting informal institutions provides mistrust in formal structures and resistance towards institutional reforms (Chari & Gupta, 2008; Danquah & Sen, 2022). Jandhyala (2015) also finds that the introduction of property rights is depending on the existence of interest groups and public concerns leading to differences in the sensitivity towards external pressure. Thus, where internal conditions for change are missing, political and economic actors have limited opportunities to respond to economic challenges and successfully change the institutional framework.

Such a situation, where existing incentive and power structures collide over the future direction of a country, is currently observed in many countries that transition to a more sustainable economy (MacFeely, 2019). Several authors have already examined the relation between environmental regulations and private standards (Di Ubaldo, McGuire, & Shirodkar, 2022), the change towards sustainable business practices

among economic actors (Bryngemark, Söderholm, & Thörn, 2023), and macroeconomic factors facilitating green policy[16] adoption (Knill, Shikano, & Tosun, 2014). Despite the evidence on the increased adoption of green policies worldwide (Coria & Kyriakopoulou, 2018), Roelfsema et al. (2020) find that the implementation of current policies leaves a median emission gap of 22.4 to 28.2 gigatons of global CO2 emissions compared to the necessary reductions needed to achieve the Paris goals[17]. Thus, the question is how countries can achieve the transition towards a green economy, when the collision of economic, social, and environmental interests limits incentives for change among economic and political actors.

This is where several scholars have pointed to the opportunity of external sources of change that can provide stimuli to overcome internal barriers to change (Chakraborty & Nunnenkamp, 2008; Mahoney & Thelen, 2010; Koning, Mertens, & Roosenboom, 2018). Indeed, several studies provide examples where external influences including novel technologies (Mödlhamer, 2020) and the presence of foreign actors (Brandl, Darendeli, & Mudambi, 2019) have changed the institutional framework of countries. We build on these findings by employing the concept of institutional change to examine the influence of domestic and foreign actors on policy introduction. More specifically, we explore how green technologies[18] introduced by these actors affect the introduction of green policies on the country level. Thus, this essay answers the following research question:

How do endogenous and exogenous sources of green technologies influence the introduction of green policies?

To answer this question, we combine institutional theory with findings from the International Business (IB), sustainability, and policy literature to develop a theoretical framework of institutional change. Our framework explains policy introduction through changes in the institutional equilibrium triggered by endogenous and exogenous sources of change. We apply this framework to analyze the effect of green technologies introduced by domestic and foreign actors on policy introduction and how resource-

[16] Green Policy means any policy and measure to reduce greenhouse gas emissions, improve energy efficiency and support the development and deployment of renewables and other clean energy technologies (IEA, 2023).
[17] The Paris Agreement entered into force on November 4 2016 and is a global agreement ratified between 196 international parties with the goal to limit global warming to below 2°C and pursue efforts to limit it to 1,5°C.
[18] Green Technologies means climate technologies that facilitate the reduction of greenhouse gas emissions and include renewable energies such as wind energy, solar power, and hydropower among others.

dependency influences this effect. Our hypotheses are tested on a dataset of 5.040 unique green policy initiatives between 2001 and 2020 across 113 countries. The results demonstrate that firm-level patents of green technologies as indicator of changing incentive structures enable policymakers to implement green policies. The effect diverges depending on the resource-dependency and development level of a country.

4.2 Institutional Change and the Introduction of New Policies

Institutional theory has emerged as a core approach in the social sciences and has been widely used to explain policy change (Jensen, 2003), organizational change (Yeung, Lo, & Cheng, 2011), and economic development (Acemoglu, Naidu, Restrepo, & Robinson, 2019). More specifically, the three main streams of institutional theory – historical institutionalism, organizational institutionalism, and new institutional economics (NIE) – attach great importance to the role of persistence and exogenous shocks as triggers of change (Mahoney & Thelen, 2010).

Historical institutionalists emphasize the role of path-dependency and political power, where the emergence and persistence of institutions result from efforts to maintain power and distribution systems (Steinmo, 2008; Weyland, 2008). Change only occurs in phases where the usual constraints on actions are lifted or eased, and the relative weight of agency increases to overcome this structural persistence (Becker, Boeckh, Hainz, & Woessmann, 2016). Organizational institutionalism explains the continuity of institutions through slowly changing cognitive beliefs and values underlying the regulatory rules of a society (DiMaggio & Powell, 1983; Scott, 2014). Resulting from the inertia of cultural change, the possibility of endogenous change is limited, and change is often triggered by exogenous forces that bring new interpretive frames imported or imposed from the outside (Dacin, Goodstein, & Scott, 2002). These exogenous forces can be changes in the regulatory, normative, and cognitive dimension of institutions, which lead to new pressures for legitimacy and diverging institutional logics, ultimately resulting in a change of action. According to NIE, institutions emerge from an equilibrium of interests and the self-enforcement of institutions, which often results in similar behaviors and processes across economic actors (North, 1990; Kranton, 1996). This equilibrium changes when exogenous events lead to new incentive structures of the actors involved (Greif & Kingston, 2011). To disrupt the reproducing mechanisms and

trigger the renegotiation of a new equilibrium, a shift of transaction costs among economic actors – arising from changing internal structures or external factors – is required (Greif & Laitin, 2004).

Deducting from historical institutionalism and NIE, change seems to occur when existing political and economic equilibria are challenged, and the power is redistributed among actors. This might be a result of exogenous influence, but it can also be due to the development and maturation of incentives of powerful groups (van der Heijden & Kuhlmann, 2017). For instance, the development of new technologies within a firm might lead to changed incentives regarding the introduction of property rights to secure their invention and increase competitiveness (Markus, 2012). Such examples of change agents are common to all three approaches as these agents can lobby for new rules and regulations according to their interests and power in society. Therefore, the direction of change also depends on the incentives of actors and which groups can enforce their interests within the specific institutional environments. Scott (1995) highlights the role of professionals who control formal knowledge and belief systems, giving them the ability to define reality and employ power to protect their valued interests. Similarly, North (2005) emphasizes the role of the entrepreneur, or in other words, the firm, as the main agent of change, where the sources of change are his or her perceived opportunities.

Organizational institutionalism also highlights the role of legitimacy and acceptance of new rules to be effective and enforceable. The effectiveness of institutional reforms depends on the social and economic realities of a country and if they are receptive to changes. In that way, powerful actors and their relationships play a crucial role because "whether a regulative structure will in fact develop depends on the nature of the social relationships among those whose interests are affected" (Scott, 1995: 68). This relevance of informal change preceding formal change can also be found in newer approaches of historical institutionalism, where institutional change results from evolving mismatches with the underlying informal structures (Koning, 2016). Thus, feedback loops are crucial for the success of institutional reforms as actors negatively affected by the change will try to block new institutions to maintain their position in society (Tsebelis, 1995). This is similar to economic explanations of change, where institutional change is dependent on shifts in the transaction cost structures between economic actors (Williamson, 2000).

Altogether, the combination of institutional approaches allows us to conceptualize institutional change as a result of incentive changes and agency of powerful actors, whereas the actual form and size of change

are shaped by the inertia of and compatibility with the existing institutional framework. To evaluate how the concepts of institutional change translate to the introduction of new policies, we focus on the emergence and diffusion of environmental regulations and how they relate to the incentive structures of economic actors.

4.3 Technological Development and Green Policies

Environmental regulation has emerged as one of the most powerful tools to address the issues of climate change and induce the sustainable transition of a country's economy (Kivimaa & Mickwitz, 2006; Ma & Xu, 2022). In the wake of an ongoing academic, political, and economic discourse about the impact of climate change and the measures to combat it, supranational institutions like the United Nations Conference on Trade and Development (MacFeely, 2019), the World Bank (Monasterolo et al., 2022) and the Organisation for Economic Co-operation and Development (Koźluk & Zipperer, 2014) have developed sustainability initiatives and outlined the need for policy change to reduce the negative impact of economic actions on the environment. As a result, the number of countries trying to facilitate a sustainable economic transition through new regulations, so-called green policies, has significantly increased in the past years (Aklin & Urpelainen, 2014; Söderholm, 2020). Similarly, more and more private companies are adopting environmental standards, ESG [19] reporting, and separate environmental strategies (Xing, Liu, Wang, Shen, & Zhu, 2019). However, evidence suggests that the sustainable development goals cannot be reached with the current state of global green policies, either due to the low effectiveness of environmental regulation (Burgeon, 2022) or a lack of policies (Roelfsema et al., 2020).

Consequently, the introduction of green policies has been an extensively researched topic in the sustainability literature. More specifically, scholars have focused on the relation between policy initiatives and the technological paradigm as one of the most important levers for political influence (Mealy & Teytelboym, 2022). Since green policies often aim at facilitating the invention or diffusion of novel technologies, they often restrict the use of other, sometimes widely used, technologies (Auerswald & Stefanotti, 2012). In this context, scholars have analyzed the effect of environmental taxation on the

[19] ESG (environmental, social, and corporate governance) means the integration of these three topics into the corporate decision-making and investment strategies.

investment in green technologies (Tchorzewska, Garcia-Quevedo, & Martinez-Ros, 2022), the role of public procurement for environmental innovation (Krieger & Zipperer, 2022) as well as the interaction of technology-push and demand-pull policies (Nuñez-Jimenez, Knoeri, Hoppmann, & Hoffmann, 2022). In contrast, technological inventions broaden the opportunities of public and private actors to develop new, more sustainable business models. For instance, Kivimaa and Mickwitz (2006) outline that the increased interest in research and technology policies stems from an interest of policymakers to achieve broader environmental goals through innovation. Fusillo (2023) highlights that the technological diversity of green technologies is increasing during the innovation process, which enables firms to expand their knowledge base and prepare them for the green transition. However, the relation between policies and technologies is not linear and dependent on several moderating factors.

In their seminal paper about the influence of environmental regulation on the competitiveness of firms, Dechezleprêtre and Sato (2017) argue that green policies bring short-term changes in relative costs and the need for firms to adapt their business models, whereas their response can vary drastically. Depending on the resulting changes in investment and production behavior, the response of firms in the affected population will influence the economic, technological, international, and environmental outcomes of any environmental regulation. Similarly, other studies have found that the effectiveness of environmental regulation is dependent on the willingness and ability of firms to generate positive outcomes that outweigh the costs (Constantini & Mazzanti, 2012; Stucki, 2019). Fabrizi, Guarini, and Meliciani (2018) conclude that regulatory policies need to be complemented with the existence of research networks and complementary regulations to generate a positive effect on sustainable innovation.

Mulligan, Mollaoglu-Korkmaz, Cotner, and Domas Goldberry (2018) analyze the effectiveness of green policies in the United States construction industry and their results show that the impact of policies was reduced through increasing costs and a low awareness of construction companies. Nahm (2017) finds that the response of firms towards similar industrial policy goals in China, Germany, and the United States significantly differed as a result of different industrial specializations, domestic institutional frameworks, and power distribution among firms. Such underlying factors determining the response towards policy change seem to be a common theme among studies on the effect of green policies. While one study finds

that firms voluntarily adopted the ISO 14001 standard[20] to increase formal compliance with other regulations and use the standard adoption as a reputational asset (Potoski & Prakash, 2005), another study finds that formal environmental institutions were necessary to translate informal stakeholder pressure into green innovation initiatives in MNEs' subsidiaries (Kawai, Strange, & Zucchella, 2018). In other words, the effectiveness of green policies depends on the social and economic realities of a country and if they are receptive for changes.

These factors not only influence the effectiveness of environmental regulation but also the introduction of such policies in the first place. As Horner (2022) argues, due to the existence of diverse incentive structures and the difficulty to predict outcomes of institutional processes, policymakers need to find a balance between local actors' interests, the interest of customers, and the interest of the country. This complexity is amplified by the tension between short-term interest and long-term goals, which require time sensitivity from policymakers (Rašković, 2022). In his commentary to the Journal of International Business Policy, Rašković (2022) defines the term policy entrepreneurship as the ability to develop an inclusive momentum for specific projects and generate acceptance of relevant stakeholders. Other factors that support the enactment and effectiveness of such policies are the ability of governments to build trust in their initiatives (Noda, 2018), the attitude of economic and other political actors towards their policies (Tsebelis, 1995), and the existing institutional and industrial conditions (Jaffe, Newell, & Stavins, 2002). When these supporting factors are absent and policymakers face opposition towards new initiatives, countries will fail to implement necessary changes in their institutional framework for sustainable development. Thus, while the effect of policy initiatives on economic, social, and technological outcomes has been extensively examined, we make use of the institutional change literature to analyze the effect of exogenous and endogenous factors on the introduction of green policies, a topic that has been addressed rarely in the literature (Brandl et al., 2019).

[20] The ISO 14001 standard defines requirements for an environmental management system needed to improve the environmental performance of a company and is published by the International Organization for Standardization.

4.4 Hypotheses Development

4.4.1 Green Technologies as a Source of Institutional Change

The three main strands of institutional theory provide evidence that institutional change is the result of endogenous and exogenous triggers, whereas the outcome depends on complex forming processes shaped by the power and incentive structures of affected actors. In the case of green policies, institutional structures in many countries are based on the dominant technological paradigms of the past, where economic actors base their competitiveness on existing technologies and supporting institutions (Beck, Demirgüç-Kunt, & Maksimovic, 2006; Chacar, Newburry, & Vissa, 2010). The emergence of new technologies will change the foundation of this equilibrium resulting in a diminishing raison d'être of existing institutions and the need for new institutions. In other words, as complementary institutional changes are essential for economic actors to develop new competitive strengths and seek opportunities within new technological fields (Luo & Tung, 2007), the introduction of technologies will increase the need for policies to regulate emerging economic sectors.

The move towards new technologies can be explained through entrepreneurial action (McMullen, Bagby, & Palich, 2008), anticipation of future business opportunities (Andersson, Dasi, Mudambi, & Pedersen, 2016) as well as normative pressures (Kostova & Roth, 2002). Similar to the example of firm-level sustainability initiatives, companies will start to develop and use new technologies when they anticipate changes in the formal environmental framework (Klooster & Mercado-Celis, 2016). Cojoianu, Clark, Hoepner, Veneri, and Wójcik (2020) argue that environmental policy plays an important role for the financing of green start-ups but that the decision of entrepreneurs to enter the sector is not dependent on the existence of supporting policies. In conjunction with the sensemaking of policymakers, which is defined as the ability to scan the environment for the future trajectory of the economy and to cope with future challenges (Rašković, 2022), such individual upgrading processes of economic actors will facilitate the action of governments towards the introduction of new policies.

Regarding green policies, this means that the development of green technologies by economic actors will indicate shifting incentive structures and broaden the opportunities of governments to enforce new environmental regulations for a sustainable economic transition. Indeed, firms are more likely to support green policies if they are able to leverage new regulations through emerging business opportunities and

sources of competitive advantage (Araújo, & Salerno, 2015; Söderholm, 2020). As the development of green technologies means the explorative expansion into previously unregulated fields (De Marchi, 2012; Fusillo et al., 2020), firms with high-potential innovation in the technological field will exert pressure on policymakers to secure their advantage and exclude competition. Indeed, several studies find that complementary policies are needed for the full exploitation of green technologies (Orsatti, Quatraro, & Pezzoni, 2020; Wu, Xu, Niu, & Tao, 2021). Similarly, Corradini (2019) provides evidence that entry into green technologies is based on geographical proximity, which implies a snowball effect once a critical mass of firms enters a new technological field. Thus, we argue that the development of green technologies will reduce opposition towards and exert pressure on the enactment of green policies.

Hypothesis 1: Green technological development will facilitate the introduction of green policies.

4.4.2 MNEs as an Exogenous Source of Institutional Change

Our framework of institutional change further highlights that the absence of endogenous sources of change can be compensated through exogenous sources. In terms of exogenous triggers of technological and institutional change, MNEs represent an influential force in their host countries as they are not only adapting to the institutional environment but also actively affect the institutions in the host country (Cantwell, Dunning, & Lundan, 2010; Fortwengel & Jackson, 2016). MNEs that are looking for efficiency increases or new assets in the host country are interested in the establishment of sufficient regulations and reliable enforcement mechanisms, since they enable them to trust local partners and access complementary assets (Hennart, 2009). Child and Tsai (2005) argue that firms which can offer significant inducements to an economy by ways of investment and technology are able to influence institutions through relational frameworks. This impact is facilitated through more valuable assets, increased legitimacy, and expertise brought in by the MNEs (Bucheli & Kim, 2012; Osabutey, Williams, & Debrah, 2014). In that way, they provide exogenous triggers of institutional change as their presence facilitates technology diffusion, capital accumulation, intellectual property transfer as well as the acquisition of know-how and managerial experience by domestic firms (Temiz & Gokmen, 2014).

Indeed, Castellani, Marin, Montresor, and Zanfei (2020) demonstrate that MNEs positively influence the local specialization in green technologies, whereas their impact is facilitated through research and

development (R&D) investments and reduced through the existence of competing technological paradigms. Other studies also support a long-run positive relationship between the presence of MNEs and structural transformation (Amighini & Sanfilippo, 2014; Owusu-Nantwi & Erickson, 2019). As most countries need to develop institutions in the realm of sustainability, foreign firms will seize the opportunity to influence this process (Regnér & Edman, 2014; Zhang, Zhao, & Ge, 2016). Supporting this argument, studies found that foreign firms are the main beneficiaries of structural reform in the host countries (Cuervo-Cazurra & Dau, 2009). Therefore, MNEs bringing in green technologies will have strong incentives and bargaining power to support the introduction of green policies.

Hypothesis 2: Green technologies by multinational enterprises provide an exogenous stimulus for the introduction of green policies.

4.4.3 Resource-Dependency as a Moderator of Institutional Change

To further delineate the factors influencing the introduction of green policies, we will discuss resource-dependency as a factor affecting not only the introduction of green technologies but also the incentives of economic actors in a country (Ross, 2015). In terms of institutional change, any deviations from the dominant institutional logic will develop within the constraints of the existing institutional framework (Shen & Tsai, 2016). This means that firms bringing in green technologies will initiate deviations of existing cost-benefit assessments and a discourse on the introduction of green policies (Rennings & Rexhäuser, 2010; Lipscy, 2015; Della Posta, Nee, Opper, 2017). Acknowledging that the current institutional framework determines the optimal use of new sources of competitiveness like technological capabilities, the response of other firms, and related power structures determine the support or opposition towards institutional changes (Papyrakis, 2017). To conceptualize the determining factors of such a policy discourse, the concept of resource-dependency helps to explain differing incentive structures leading to different policy outcomes.

In resource-dependent countries, existing institutional frameworks are likely to foster business models based on the exploitation of natural endowments (Brunnschweiler & Bulte, 2008) and any improvements in the institutional system, for example, by introducing higher environmental standards, would jeopardize their business success. For these firms, competitive advantages are predominantly based on cost advantages

(Bulte, Damania, & Deacon, 2005), so that they have no incentives to advocate for strict environmental regulations (Arbache, Dickerson, & Green, 2004). In other words, firms, which have based their competitiveness on natural resources and their low-cost processing, are indeed dependent on a system with low levels of environmental regulation (Kolstad & Wiig, 2009). These assumptions are in line with the concept of the resource curse, where the existing incentive structures prevent any institutional progress (Sovacool, Walter, van de Graaf, & Andrews, 2016). In such situations, powerful economic actors will act as vetoplayers or "continuity agents" and try to prevent or reverse reforms in order to maintain their advantages (Grillitsch, 2015; Mandelkern & Koreh, 2018). Having high incentives for weak environmental regulation, firms in resource-dependent countries will oppose any introduction of green policies.

In countries, which are not dependent on natural resources, more firms will pursue technology-based sources of competitiveness and use new inventions as a differentiating factor towards competitors (Lepoutre, Justo, Terjesen, & Bosma, 2013). These firms need an appropriate institutional structure that ensures access to complementary assets and promotes the creation of local demand (Li, Li, Liu, & Yang, 2010; Khoury, Cuervo-Cazurra, & Dau, 2014). Hence, firms recognizing the potential of environmental protection will have more incentives to lobby for the introduction of green policies to provide guidance for future technological developments, raise the entry barriers for competition, and further enable the formation of capabilities over time (Jackson & Deeg, 2019). As the main source of competitiveness for these firms is based on the productive introduction of green technologies through advancing human capital or technological capacities (Kedia & Bilgili, 2016), they require supporting policies for the integration of different and heterogeneous technologies and knowledge sources (Petruzzelli et al., 2011; Shi, Sun, Yan, & Zhu, 2017). As the growth of new technologies, industries, or clusters is often related to the emergence of new institutions (Tang & Koveos, 2008; Menzel & Fornahl, 2009; Ter Wal & Boschma, 2011), the effect of green technologies on the introduction of green policies will be facilitated in those economies.

Hypothesis 3a: In resource-rich countries, the effect of green technologies on the introduction of green policies will be lower.

Hypothesis 3b: In resource-short countries, the effect of green technologies on the introduction of green policies will be higher.

An overview of our theoretical framework and hypotheses can be found in *Figure 3.1*.

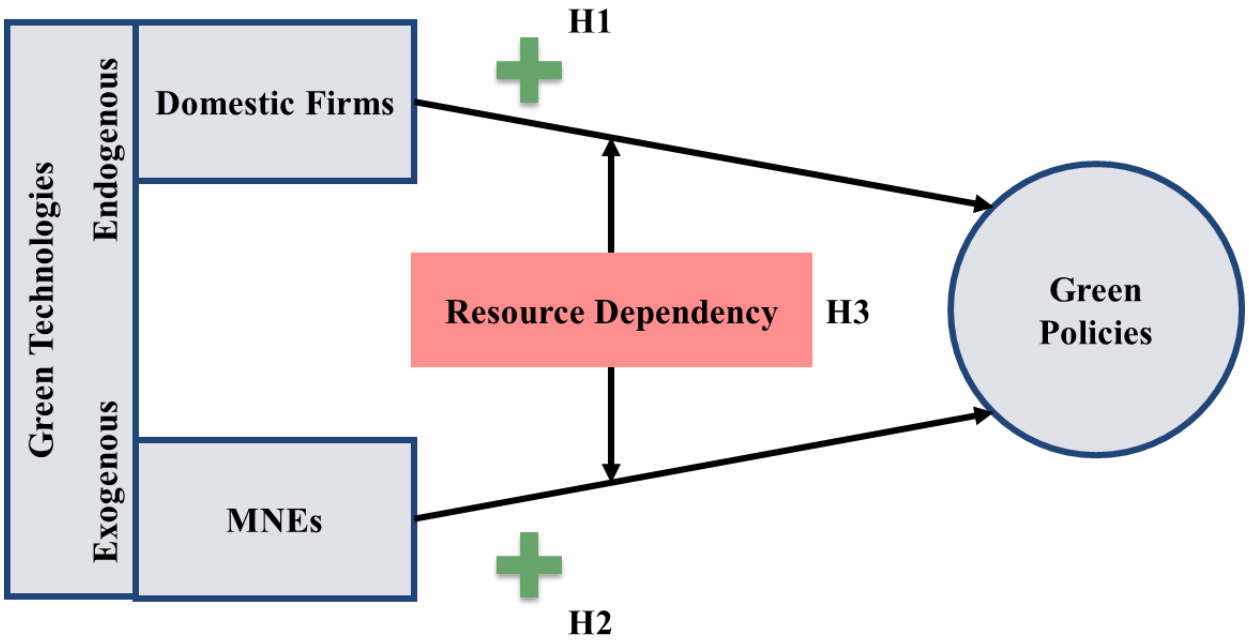

Figure 3.1: *Theoretical Framework and Hypotheses (Essay 2)*

4.5 Methodology

4.5.1 Sample

To test the above hypotheses, we collected annual data on 113 countries from the World Bank Open Database and International Energy Agency (IEA) as well as firm-level patent data from the Orbis IP database. Our models have a temporal coverage that extends from 2001 to 2020. Countries with a population of less than two million are left out because small nations are constrained in their ability to pursue resource-based strategies of competitiveness (Pitelis, 2009), which would bias the result. [21]

4.5.2 Dependent Variable

Our dependent variable is drawn from the IEA's Policies and Measures Database, which provides "information on past, existing or planned government policies and measures to reduce greenhouse gas emissions, improve energy efficiency and support the development and deployment of renewables and other clean energy technologies" (IEA, 2023). We only included policies with the status "in force" in our analysis and used the year of enaction to count the number of green policy initiatives for each country in a

[21] More information about the full dataset and the code for analysis is provided upon request.

given year. While the database also distinguishes between types of green policies like regulation, strategic plans, or grants[22], we used the aggregate value of all policy initiatives as all of them fall under our conception of institutional change. However, we downloaded the policies by type and removed duplicate policies for our analysis because some fall into several categories. Finally, the database distinguishes between different types of jurisdictions like regional, national, and international. In this case, when a policy was clearly assigned to one country, we counted that policy as one initiative. As all international policies in the database fall under the jurisdiction of the European Union, we assigned those policies to all member states. The final dataset consists of 5.040 unique policy initiatives across 113 countries. As we are only interested in the introduction of green policies and not the extensiveness of policy initiatives, we coded a dummy variable for each year in which the country introduced a new green policy (*Green Policies)*. With an average number of 2,25 policies among non-zero observations and a maximum of 35 policies for one country in one year, this approach accounts for the realities of the data as well as the distinction between introduction and extent of new policies.

4.5.3 Independent Variable

Technological Development

The measure of technological development was taken from the Orbis IP database, which connects patent applications to companies over time. The database currently provides information of up to 110 million patents (Bureau van Dijk, 2023). From this data, we identified green technologies by matching the International Patent Classification (IPC) Codes of the patents with the World Intellectual Property Organization (WIPO) Green Inventory, which provides the IPC Codes for green technologies in the areas of alternative energy production, transportation, energy conservation, waste management, agriculture/forestry, administrative, regulatory or design aspects, and nuclear power generation (WIPO, 2023). The inventory was developed by the IPC Committee of Experts to facilitate searches for patent information relating to environmentally sound technologies, as listed by the United Nations Framework

[22] Types of policies are “Payments, Finance and Taxation”, “Regulation”, “Payments and Transfers”, “Targets, Plans and Framework Legislation”, “Grants”, “Strategic Plans”, “Information and Education”, “Codes and Standards”, “Taxes, Fees and Charges”, “Performance-based policies”.

Convention on Climate Change. By searching for those patents, we were able to identify all firms with patent applications in these areas worldwide (*Green Patents*).

In a subsequent step, we created a dummy of affiliation to MNEs by matching the patent owners to a dataset of MNEs and their subsidiaries via the Bureau van Dijk identifier (BvDID). The longitudinal data on MNEs was developed by recreating the ownership structure via the Orbis and Zephyr database (Lüders, 2023)[23]. By further accounting for the country of origin of these firms, we were able to identify three main types of firms and their related patents: local firms, domestic MNEs, and foreign MNEs. Based on this unique match of patent data, we can aggregate the number of patents for these types of firms on the country level. Together with the policy data, we observe that all indicators of sustainability have experienced growth demonstrated through a continuous increase of green patents, green patent applications, and green policies for the years in our dataset. The descriptive statistics of the number of patents by these firm types and the number of green policies over time are shown in *Table 3.1*.

Year	Green Patents	Green MNE Patents	Green Domestic MNE Patents	Green Foreign MNE Patents	Green Local Firm Patents	Green Policies
2001	8.607	4.989	4.316	673	3.618	150
2002	8.634	5.073	4.464	609	3.561	81
2003	9.611	5.665	4.829	836	3.946	111
2004	9.965	5.930	5.051	879	4.035	83
2005	11.217	6.530	5.526	1.004	4.687	161
2006	11.902	6.843	5.763	1.080	5.059	226
2007	12.956	7.412	6.206	1.206	5.544	202
2008	12.713	7.428	6.128	1.300	5.285	269
2009	15.507	8.699	7.215	1.484	6.808	302
2010	16.479	9.238	7.611	1.627	7.241	220
2011	14.084	6.932	5.327	1.605	7.152	265
2012	19.947	11.279	9.310	1.969	8.668	281
2013	21.909	12.432	10.297	2.135	9.477	523
2014	21.667	12.740	10.510	2.230	8.927	338
2015	22.512	11.703	9.520	2.183	10.809	235
2016	29.169	16.447	14.052	2.395	12.722	283
2017	32.116	17.910	15.344	2.566	14.206	224
2018	33.834	18.604	15.987	2.617	15.230	198
2019	34.342	18.608	16.120	2.488	15.734	275
2020	35.381	18.934	16.386	2.548	16.447	749

Table 3.1: *Descriptive Statistics of Green Patents and Green Policies*

[23] For a full description, see the referenced working paper, where the code for constructing the data is also provided.

Resource-Dependency

The data to test our hypothesis on the effect of resource-dependency on green policies is drawn from the World Bank Open Database. The variable *Resource Rents* measures the total resource rents as a percentage of gross domestic product (GDP). Indeed, countries relying on natural resources will seldom invest in green technologies as they are characterized by economic and political instability, which increases the threat for actors to lose their position in the economy and reduces the incentives for institutional change (Parlee, 2015). While we use this measure as an explanatory variable in our main model, we also use different models for different levels of resource-dependency. To split the dataset, we use the threshold of 20% of resource rents as a share of GDP, which is commonly employed in the literature (Peres-Cajías, Torregrosa-Hetland, & Docoing, 2022). The underlying reasoning is that a country's incentive structures are different for various levels of resource-dependency, which also changes the ability of policymakers to introduce green policies.

4.5.4 Control Variables

We control for other factors influencing the incentives of economic and political actors towards the introduction of green policies. First, we include the share of manufacturing value-added as a percentage of GDP to measure the size of the productive sector in the economy (*Manufacturing Value-Added*). While manufacturing goes along with the energy-intensive use of resources, efficiency-increases through the use of new green technologies can increase incentives towards green policies (Rogge & Schleich, 2018). Therefore, we believe that the different incentive structures of the manufacturing sector can be effective in both directions with regard to the introduction of green policies. To measure the effect of foreign firms that do not innovate in the field of green technologies and rather pursue other motives in the host country, we measure the presence of these firms through net inflows of foreign direct investment (*FDI*) as a percentage of GDP. We also include the variable *Trade*, which measures exports and imports as a percentage of GDP, as we assume that a county's insertion into global value chains affects the diffusion of international institutions, which might change incentives towards green policies (Andersson et al., 2016). We also control for influential institutional actors, namely the government and international organizations. The influence of the government towards change is proxied through our government size variable, *Government*, which is general government final consumption expenditure as a percentage of GDP. The

reasoning is that governments supporting green policies will spend more to fulfill their role as facilitators and buyers to secure the support of local actors and execute necessary changes (Rašković, 2022). On the contrary, a government that is against institutional changes will not make the required investments. Besides the national government, international organizations such as the United Nations and World Bank have recently strengthened their position in shaping the global economic landscape (Oetzel & Doh, 2009; Hartmann, Lindner, Müllner, & Puck, 2022). To capture the effect of international organizations, we use the values of International Bank for Reconstruction and Development (IBRD) loans and International Development Association (IDA) credits provided to the country (*Development Assistance*). These organizations are generally in favor of green policies and can raise pressure on countries seeking financial stability (Helleiner, 2009). As a further robustness check, we employ different models for different income stages using the World Bank country classification: High-income, middle-income (upper-middle and lower-middle-income stage) and low-income.

4.5.5 Estimation Approach

As our dependent variable is a dummy variable indicating the introduction of green policies and more than 57% of all values are "0", we applied a Probit Model to capture the effect of our independent variables on the probability of policy introduction. To correct for potential heteroscedasticity, we use robust and country-clustered standard errors for our regression. Additionally, we addressed the potential endogeneity between independent and dependent variables by lagging our dependent variable for one year. As we assume that policymakers will screen the environment for changes and try to anticipate future trajectories based on past developments, this accounts for time lags in their decision-making process. A full list of our variables can be found in *Appendix 3.1*.

4.6 Results

In *Table 3.2*, the correlations between our continuous variables are summarized.

	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	*Green Policies*	1									
(2)	*Green Patents*	0.315	1								
(3)	*Green Patents (Domestic MNEs)*	0.310	0.999	1							
(4)	*Green Patents (Local Firms)*	0.316	0.999	0.996	1						
(5)	*Green Patents (Foreign MNEs)*	0.352	0.977	0.969	0.982	1					
(6)	*Resource Rents*	-0.075	-0.042	-0.041	-0.043	-0.044	1				
(7)	*Manufacturing Value-Added*	0.200	0.173	0.164	0.178	0.211	-0.017	1			
(8)	*FDI*	-0.066	-0.036	-0.036	-0.036	-0.040	0.017	-0.229	1		
(9)	*Trade*	-0.128	-0.083	-0.079	-0.086	-0.098	-0.040	0.047	0.374	1	
(10)	*Government Consumption*	-0.030	0.039	0.036	0.041	0.044	-0.108	-0.128	0.162	0.371	1
(11)	*Development Assistance*	0.095	-0.105	-0.105	-0.105	-0.100	0.026	0.000	-0.115	-0.294	-0.316

Table 3.2: *Correlation Matrix (Essay 2)*

Figure 3.2 illustrates the descriptive statistics of our green patent and policy data with darker green indicating more green policies and the pie charts indicating the amount and breakdown of green patents among local firms, domestic MNEs and foreign MNEs.

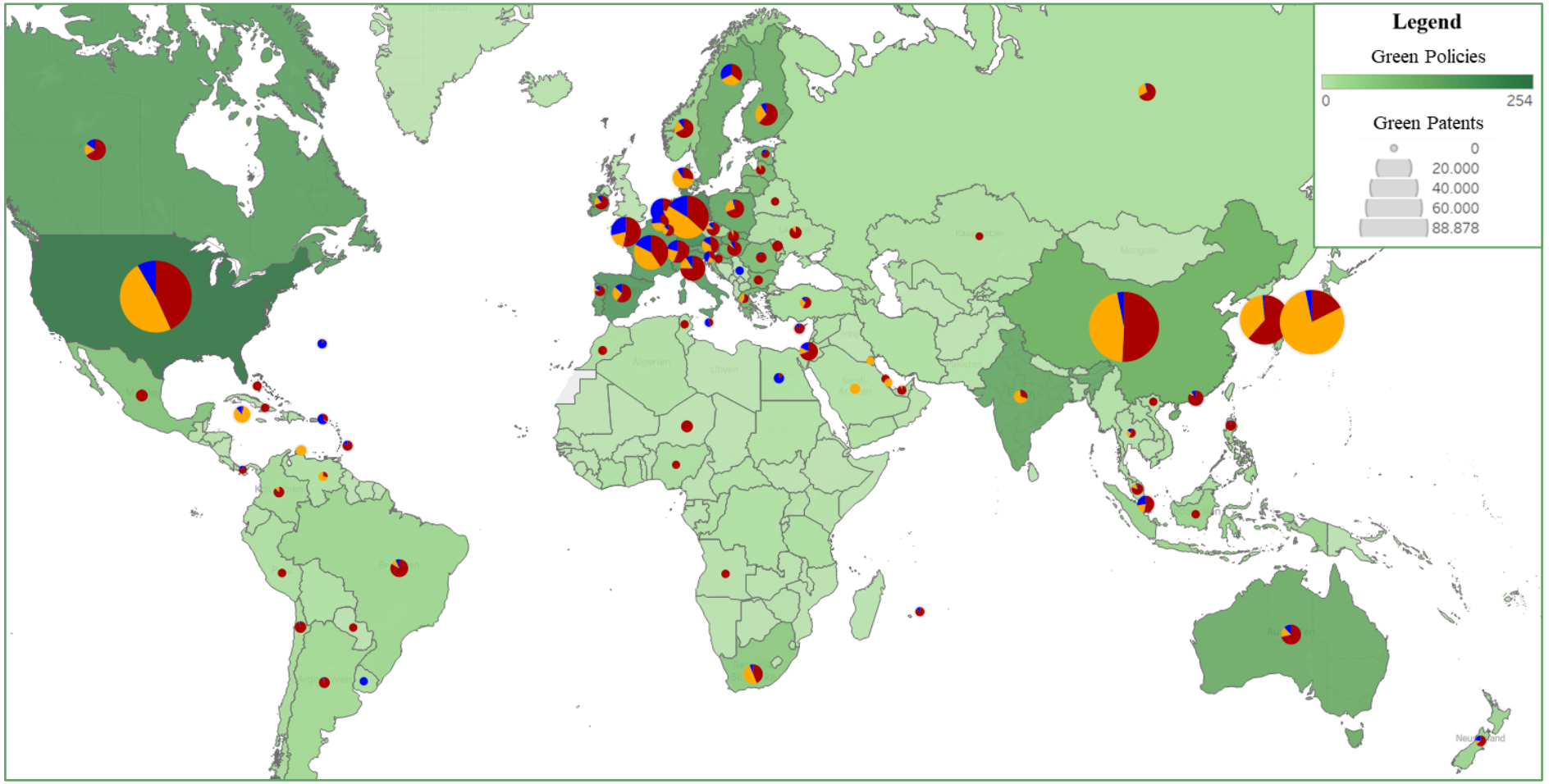

Figure 3.2: *Global Dispersion of Green Technologies and Policies*
(Red = Local Firm Patents, Orange = Domestic MNE Patents; Blue = Foreign MNE Patents)

The results of our main model are summarized in *Table 3.3*.

	(1)	(2)	(3)	(4)	(5)
Variables	Green Patents	Green Patents (All MNEs)	Green Patents (Domestic MNEs)	Green Patents (Foreign MNEs)	Green Patents (Local Firms)
Manufacturing Value-Added	1,251** *(0,517)*	1,325** *(0,519)*	1,341** *(0,521)*	1,344*** *(0,508)*	1,176** *(0,510)*
FDI	0,295 *(0,753)*	0,317 *(0,754)*	0,356 *(0,762)*	-0,157 *(0,901)*	0,255 *(0,772)*
Trade	-1,283** *(0,551)*	-1,373** *(0,552)*	-1,417** *(0,556)*	-1,286 *(0,523)*	-1,190** *(0,569)*
Government Consumption	1,113 *(0,726)*	1,120 *(0,727)*	1,139 *(0,732)*	0,867 *(0,711)*	1,101 *(0,735)*
Development Assistance	-4,130*** *(1,365)*	-4,349 *(1,363)*	-4,453*** *(1,362)*	-3,668*** *(1,259)*	-3,826*** *(1,386)*
Resource Rents	-1,326*** *(0,229)*	-1,371*** *(0,291)*	-1,397*** *(0,289)*	-1,167*** *(0,220)*	-1,261*** *(0,304)*
Green Patents	0,001 *(0,001)*	0,001 *(0,001)*	0,001 *(0,001)*	0,014** *(0,006)*	0,002 *(0,002)*
Constant	-0,141 *(0,450)*	-0,111 *(0,455)*	-0,105 (0,459)	-0,051 (0,484)	-0,186 (0,448)
Number of Observations	1.968	1.968	1.968	1.968	1.968
Log Likelihood	-1.155,174	-1.161,358	-1.164,610	-1.130,353	-1,145,515
AIC	2.326,347	2.338,717	2.345,221	2.276,706	2.307,030
McFadden's Pseudo R^2	0,223	0,219	0,217	0,240	0,229

Robust standard errors in parentheses
*** p<0,01; ** p<0,05; * p<0,10

Table 3.3: *Probit Regression: Main Model*

Model 1 contains the overall effect of *Green Patents*, where Model 2-5 include the effects of green patents by all MNEs, domestic MNEs, foreign MNEs, and local firms. The results provide inconclusive evidence on the effect of green technological development on the introduction of green policies, while *Resource Rents* have a significantly negative impact on *Green Policies* across all models. As the effect of technology and institutional variables might significantly differ between countries, we further distinguish between the separate levels of resource-dependency. The results are shown in *Table 3.4*:

	Resource-Short Countries			Resource-Rich Countries		
Variables	(6)	(7)	(8)	(9)	(10)	(11)
Manufacturing Value-Added	1,658*** *(0,625)*	1,877*** *(0,613)*	1,901*** *(0,593)*	0,419 *(0,302)*	0,443 *(0,305)*	0,443 *(0,320)*
FDI	0,873 *(0,760)*	0,979 *(0,767)*	0,533 *(0,873)*	-3,995** *(1,758)*	-3,664** *(1,821)*	-3,636** *(1,756)*
Trade	-1,414** *(0,567)*	-1,666*** *(0,568)*	-1,543*** *(0,517)*	-0,585 *(1,426)*	0,415 *(1,495)*	0,197 *(1,497)*
Government Consumption	1,440* *(0,849)*	1,496* *(0,840)*	1,187 *(0,812)*	-0,608 *(0,870)*	-0,747 *(0,813)*	-0,640 (0,843)
Development Assistance	-3,896*** *(1,536)*	-4,569*** *(1,491)*	-3,655*** *(1,376)*	-3,185‘ *(1,728)*	-3,514* *(1,822)*	-3,783** *(1,851)*
Green Patents (Local Firms)	0,002 *(0,002)*			0,009** *(0,004)*		
Green Patents (Domestic MNEs)		0,005 *(0,005)*			0,014** *(0,005)*	
Green Patents (Foreign MNEs)			0,013** *(0,080)*			0,047 *(0,080)*
Constant	-0,633 *(0,472)*	-0,574 *(0,483)*	-0,532 *(0,500)*	0,857 *(0,913)*	0,871 *(0,904)*	0,910 *(0,910)*
Number of Observations	1.673	1.673	1.673	295	295	295
Log Likelihood	-984,515	-1.026,078	-1.000,472	-165,209	-165,593	-166,600
AIC	213,923	212.493	215.557	344.419	345.187	347.120
McFadden’s Pseudo R^2	0,214	0,200	0,227	0,137	0,135	0,130

Table 3.4: *Probit Regression: Resource Model*

The related robustness models, where we distinguish between different levels of development, can be found in *Appendix 3.2*.

According to *Hypothesis 1*, the invention of green technologies provides a trigger for green policy introduction because more firms entering green technologies indicate changing incentive structures and increasing support for more environmental regulation. For the full sample (*Models 1-5*), we do not find support for the overall influence of *Green Patents*, but there is a significantly positive effect for *Green Patents* by foreign MNEs. Moreover, when accounting for income levels, we find significant effects for all three types of firms. For local firms, this effect is only positive for upper middle-income countries and negative for low-income countries, which demonstrates the difficulty of local firms to endogenously change institutions and generate policy support for their innovation activities (Brandt & Thun, 2016). Indeed, scholars have argued that the optimal policy outcome regarding intellectual property rights

(Mödlhamer, 2020), FDI policies (Bende-Nabende & Ford, 1998), or subsidies (Cherif, Hasanov, Grimpe, & Sofka, 2022) is often prevented by powerful economic actors. The effect of *Green Patents* by domestic MNEs is positive and significant for all income levels except for high-income countries. This supports our framework of institutional change as large companies and specifically MNEs possess more bargaining power (Ciabuschi, Dellestrand, & Kappen, 2012) and engage in institutional entrepreneurship (Fortwengel & Jackson, 2016), which enables domestic MNEs to exert more pressure on home country policymakers in comparison with smaller local firms. This effect is facilitated by the increased geographical diversification of MNEs since it allows them to explore more diverse institutional contexts and equip themselves with institutional advantages to transfer business practices and regulations to the home country.

Regarding *Hypothesis 2*, we find a significantly positive effect for *Green Patents* by foreign MNEs on the introduction of green policies. This supports our main hypothesis that exogenous sources of change can substitute for endogenous sources when these are absent due to diverging incentives. Regarding our robustness checks, we observe no patenting activity of foreign MNEs in low-income countries. This lack of asset-augmenting investment already demonstrates the interaction of country determinants and MNEs' motivations because most MNEs in these countries only exploit them for cost- and resource-advantages and neither have the capacities nor the willingness to shape the policymaking process (Narula, 2018). While the effect of foreign MNEs is insignificant for lower-middle-income countries, the results show significantly positive effects for high-income and especially upper middle-income countries. This complies with our assumption that MNEs can stimulate institutional change towards more sustainability, but only when countries already have a moderate level of development. Pinkse and Kolk (2012) and Regnér and Edman (2014) have referred to the dependency of MNEs' influence on their embeddedness in the host country and the susceptibility of institutional environments, which is generally higher in more developed countries. This is further validated by the ambiguous effect of FDI indicating that the presence of MNEs per se is not sufficient for the introduction of new policies.

In *Hypothesis 3A* and *3B*, we argued that a country's resource-dependency will provide incentives for economic and political actors to lobby against green policies. Therefore, we expected the effect of *Green Patents* to be lower in resource-rich countries than in resource-short countries. The results in *Table 3.4* demonstrate full support for this hypothesis. While the effect of *Green Patents* by foreign MNEs,

Government Consumption, and *Manufacturing Value-Added* on *Green Policies* is positive in resource-short countries, only *Green Patents* by domestic MNEs and local firms show marginally positive effects on green policies in resource-rich countries. Similarly, we find a negative effect of *Resource Rents* across all models, which is even more detrimental to the introduction of green policies in low- and high-income countries. These findings resemble the literature on the resource curse, where a lack of incentives hinders institutional upgrading in countries with high resource rents, although it is important to notice that the negative effect diminishes for countries that have already experienced some economic and institutional development (Williams, 2011).

For the other control variables, we find a positive effect for *Manufacturing Value-Added*, but the effect is insignificant for low-income countries and increases with higher levels of economic development. This demonstrates that efficiency increases can already promote institutional change in terms of green policy introduction, but their effect depends on the circumstances in the respective country. Interestingly, the effect of *Trade* on green policies is significantly positive for low-income countries, diminishes for middle-income countries, and turns negative for high-income countries. This demonstrates that the participation in global value chains can be a substantial trigger of green policies not only for economic actors but also for policymakers, when other sources of change are missing. The decrease for higher developed countries can be explained by a growing relevance of FDI, as the presence of foreign firms enables the development of more direct linkages and spillovers than trade relations. The effect of *Government Consumption* is negative for low- and middle-income countries but turns positive for high-income countries. As lower-developed countries are often associated with less regulatory quality and also corruption (Kolstad & Wiig, 2009), this indicates the inefficient support of policy initiatives through state action. The effect of *Development Assistance* is significantly negative in our main model but turns positive for low-income and lower middle-income countries, demonstrating the ability of international organizations to influence policymakers in these countries via financial incentives.

4.7 Discussion

Taken together, the results support our central argument that endogenous and exogenous sources of technological development influence policy introduction due to diverging institutional and technological

pressures based on the incentives of economic actors. Countries dominantly relying on an abundance of natural resources will face more opposition against green policy initiatives. This relates to previous findings on the negative effects of resource-dependency (Brunnschweiler & Bulte, 2008), although the juxtaposition of incentives depending on the technological development of economic actors offers additional explanations for this relation. It can be assumed that countries in which many firms depend on resources for their success face serious difficulties in introducing green policies.

By contrast, countries with firms building their competitive advantages on green innovation will find support for green policies. This is in line with existing results on the correlation between policy change and firm-level adoption of new standards (Arbache et al., 2004; Clougherty & Grajek, 2015). What is novel in our results is that technological development, used as a measure for the willingness of domestic and foreign firms to support policy initiatives, indeed influences future institutional change. Moreover, we assert that the positive effect of technological development increases along with a country's economic development. More specifically, the positive effect of local firms and domestic MNEs in resource-rich countries can be explained with the active agency of local firms or through signaling theory, where those firms "signal" governments that green policies are beneficial for them (Connelly, Certo, Ireland, & Reutzel, 2011). This demonstrates that domestic support towards a sustainable transition is pivotal and that policymakers should promote efficiency-seeking and asset-augmenting investments to stimulate institutional change.

An interesting finding in this respect are the differing effects for local firms and domestic MNEs in low and lower middle-income countries. As these countries are often characterized by weak institutions, sources of competitiveness are based on the exploitation of low wage levels (Lin & Fu, 2016), underdeveloped labor standards (Schmitz, 2006), and dependency of local communities (Loayza, Mier y Teran, & Rigolini, 2013). The negative results for local firms show that there will be strong resistance towards any green policies as this would undermine the main sources of competitiveness. However, our findings demonstrate that domestic MNEs can play a unique role in these countries as they are not reliant on such institutional deficiencies and can transfer new practices and technologies from other countries to their home country. Moreover, they have the power to influence policymakers and overcome change barriers towards a green transition.

The missing effect of foreign MNEs in low-income and lower middle-income as well as resource-rich countries demonstrates that FDI does not automatically lead to institutional change but that the effect rather depends on the activities of MNEs. MNEs looking for simple cost advantages will likely invest in countries where institutional voids foster unskilled labor or ease the exploitation of resources (Mosley, 2017; Shapiro, Hobdari, & Oh, 2018). Therefore, these MNEs have no incentives to bear the costs of green policies as they will undermine their main motive for investment. Instead, MNEs will try to maintain the status quo or rather move their production to other less developed countries (Kojima, 2000), signaling their opposition towards institutional change. Furthermore, the extraction of natural resources is characterized by the exploitation of local communities with the main goal of extracting the resources at minimum costs (United Nations, 2012). Thus, MNEs that are motivated by resource exploitation will have no incentives to support changes in the institutional environment (Narula, 2018).

Contrary to the effect of foreign MNEs in low-income countries, their patenting activity seems crucial for resource-short as well as middle- and high-income countries to generate support for green policy initiatives. MNEs with innovation motives have an interest in supporting institutions that help to increase the capabilities of local actors, improve the infrastructure, and protect intellectual property (Globerman & Shapiro, 2003; Khoury et al., 2014). The results also indicate that especially upper middle-income countries are more prone to institutional changes brought in by foreign as well as domestic firms, as they have certain basic institutional framework elements in place, but the institutional environment is still susceptible to influence (Krug & Hendrischke, 2008). This is in line with other findings indicating that economic actors in middle-income countries can generate more momentum when institutions are already in flux, whereas institutions in low- and high-income countries are generally more stable (Acemoglu & Robinson, 2012; Banalieva, Cuervo-Cazurra, & Sarathy, 2018). In other words, the effect of foreign MNEs differs according to the development of financial markets, market structures, and the human capital of a country (Alfaro, Chanda, Kalemli-Ozcan, & Sayek, 2010). This supports concepts of observation and imitation as well as those of coevolution and institutional entrepreneurship (Fortwengel & Jackson, 2016). Taken together, the diverging results for different income levels demonstrate that the ability of foreign MNEs to become involved in processes of institutional change is dependent on a diverse array of local actors and their power to change incentive structures among them (Faulconbridge & Muzio, 2015).

Concerning the other variables in our models, the results on trade demonstrate that low-income countries can support green policies by inserting themselves into global value chains (García, Avella, & Fernández, 2012). Indeed, producing for the global market enables firms to increase their capabilities (Kumaraswamy, Mudambi, Saranga, & Tripathy, 2012), absorb novel technologies and knowledge (Wei & Liu, 2006), and adapt to international standards (Clougherty & Grajek, 2008). In contrast, the negative effect of trade in middle- and high-income countries supports the argument that trade and FDI can be substitutes for each other (Dunning & Lundan, 2008) and that the actual presence of foreign companies is more influential for institutional change than cross-border transactions. The introduction of green policies is mostly negatively influenced by government spending for low- and middle-income countries, which is in line with other findings on the barriers to institutional reforms in developing countries including corruption (Kolstad & Wiig, 2009; Shi et al., 2017), selfish behavior (Mudambi, Navarra, & Paul, 2002), and general political instability (Allard, Martinez, & Williams, 2012). Conversely, international organizations are able to provide incentives for the introduction of green policies in low- and middle-income countries. One reason for these results could be the financial dependence of these countries on development assistance. However, our discussion on institutional change shows that the introduction of green policies to meet the requirements of international organizations needs to be complemented by other measures to increase their enforceability (Helleiner, 2009). Even when countries ratify or adopt such rules in response to international pressure, the literature provides evidence of the difficulties in implementing them due to a lack of control mechanisms, empty-shell adoption, or the general incompatibility of international rules with national institutions (Buntaine, Parks, & Buch, 2017; Moore, Brandl, & Dau, 2020).

A more general result from our analysis is that the opportunities for countries to induce institutional changes become broader along their path of economic development. While low-income countries can mostly rely on trade and powerful domestic MNEs to induce economic incentives towards green policies, countries at the middle-income stage can rely on the positive effects of domestic and foreign MNEs as well as local firms and their technology-based sources of competitiveness. For high-income countries, only the patenting activity of foreign MNEs is significantly facilitating the introduction of green policies; however, the positive signs of other variables indicate a more complex interrelation between variables where it is

difficult to extract one factor that trumps the other in supporting policy introduction. Thus, the results demonstrate the necessity for low-income countries to become part of global value chains and increase their capabilities through learning and knowledge acquisition. Additionally, spillovers from assembly activities for the world market (Gereffi & Lee, 2016), training from international organizations (Liu & Lu, 2016), and the inclusion of returnees (Liu, Lu, Filatotchev, Buck, & Wright, 2010) can support sustainability initiatives. More advanced countries, on the other hand, should focus on attracting asset-seeking FDI to increase the benefits of technological development and successfully introduce new policies. All in all, the results reflect the changing incentive structures of economic actors leading to different effects on institutional change and support the assumption that the incentives are determined by the economic status and resource-dependency of a country. This provides novel insights on why nations fail to implement the necessary structural reforms for sustainable development.

4.8 Conclusion

This essay synthesized the literature on institutional change, IB, and environmental regulations to identify the economic determinants of the introduction of green policies and explain how local and foreign economic actors alter a country's capacity for green institutional change. Although the connection between institutions and policies has been made several times in the literature, our contribution is to use policy introduction as the dependent variable and examine the influence of patenting activity of domestic and foreign firms on the outcome of policymaking. Therefore, we add to the policy and sustainability literature by bringing in micro-level attitudes towards institutional change.

Our results show strong support for the dependence of green policies on resources and new technologies as the main sources of competitiveness resulting in countervailing incentives of relevant actors. We find that resource-rich and low-income countries have few options to kickstart green policy initiatives and that the existence of political resistance is the result of an absence of exportable production and green technologies. Our results also imply that the role of local firms and especially domestic MNEs in promoting institutional change has been underrepresented in the literature. Indeed, using the dependence on resources and technologies as a proxy for the different attitudes towards institutional change is novel

and provides new stimuli for institutional and policy research in IB. Thus, our findings support the concepts of institutional agency and coevolution.

Our results also have important implications for policymakers at the different levels of the institutional environment. The inability of governments to trigger institutional changes by themselves is demonstrated, emphasizing the idea that rent-seeking behavior and illegal influence must be reduced for institutional development (Mudambi et al., 2002). Moreover, the findings show that international organizations have an impact on country-level institutions in low-income countries but that they cannot help to overcome the change barriers of resource-dependency. The results indicate that international organizations need to focus on the micro level by supporting the invention and diffusion of new technologies, encouraging entrepreneurship, guiding local firms to adopt new technologies, and supporting the structural transformation of industries. In this way, they can help to buffer the negative effects of the transition to green technologies.

This essay has several limitations, which should be addressed in future research. First, the link between incentive structures and institutional change is only implicitly addressed in our analysis. We tried to combat this issue by matching a specific set of technologies with a concrete set of policies, where the link between both dimensions is theoretically and logically derived. Although the relationship between incentives and institutional change is evident in the literature (Bjørnskov & Foss, 2016), an examination of the actors' influence on green policies based on case study research could further validate our results. In this context, the distinction between different policy types in the IEA Policies and Measures Database as well as the areas of green technologies in the WIPO Green Inventory offer fruitful extensions of our contribution to further delineate the idiosyncrasies of different technologies and policy initiatives. Second, the importance of institutional change has gained significant importance in the last decades, but the existence of economic and political barriers to change have received less attention (Nunn & Trefler, 2014). Thus, a further examination of the incentives of economic and political actors towards institutional change will help to open the black box of institutional change and the related influence mechanisms. Coming up with more specific evaluations of the incentive structures of institutional and economic actors and how they jointly influence institutional change is needed in future research. Finally, our analysis utilizes the patenting activity of MNEs as a proxy for their influence on green policies but does not provide evidence on the

origins of such patents and the motivations to conduct asset augmentation in the host country. While we assume that there is a mutual influence between already favorable policy conditions and the investment motivations of MNEs, we hope our findings might intrigue IB researchers to further explore the role of MNEs in the context of technological and institutional change.

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4.10 Appendix

Appendix 3.1: Description of Variables and Data Sources (Essay 2)

Variable	Description	Source
Dependent Variable		
Green Policies	Dummy if green policies were introduced in a given year (t+1)	International Energy Agency
Independent Variables		
Green Patents	Number of green patents according to the WIPO Green Inventory	Orbis IP
Green Patents (Domestic MNEs)	Number of green patents by domestic MNEs according to the WIPO Green Inventory	Orbis IP
Green Patents (Local Firms)	Number of green patents by local firms (non MNEs) according to the WIPO Green Inventory	Orbis IP
Green Patents (Foreign MNEs)	Number of green patents by foreign MNEs according to the WIPO Green Inventory	Orbis IP
Resource Rents	Total natural resource rents (% of GDP)	World Bank
Control and Robustness Variables		
Manufacturing Value-Added	Manufacturing, value added (% of GDP)	World Bank
FDI	Foreign direct investment, net inflows (% of GDP)	World Bank
Trade	Sum of Exports and Imports (% of GDP)	World Bank
Government Consumption	General government final consumption (% of GDP)	World Bank
Development Assistance	Log of IBRD loan and IDA credits (DOD, current US$)	World Bank
Income level	High, middle-income, and low-income	World Bank

Appendix 3.2: Probit Regression: Robustness Check for Different Income Levels

	Low-Income Countries			Lower Middle-Income Countries			Upper Middle-Income Countries			High-Income Countries		
Variables	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Manufacturing Value-Added	1,144 *(0,888)*	0,764 *(0,752)*	1,168 *(0,878)*	1,163* *(0,706)*	1,145 *(0,726)*	1,416* *(0,780)*	1,520** *(0,615)*	1,779*** *(0,669)*	1,480** *(0,599)*	0,812 *(-1,226)*	0,899 *(-1,189)*	0,933 *(-1,162)*
FDI	0,9392 *(-6,060)*	0,888 *(-5,810)*	0,666 *(-6,058)*	0,805 *(-1,949)*	0,702 *(-1,916)*	1,077 *(-1,999)*	-5,416 *(-3,924)*	-3,884 *(4,152)*	-6,072 *(4,097)*	0,740 *(0,747)*	0,774 *(0,754)*	0,555 *(0,776)*
Trade	4,071** *(-1,897)*	4,720*** *(-1,808)*	4,264** *(-1,830)*	-1,181 *(-1,253)*	-0,9313 *(-1,253)*	-1,453 *(-1,340)*	-0,871 *(-1,027)*	-2,103* *(-1,114)*	-1,142 *(0,961)*	-2,526*** *(0,816)*	-2,687*** *(0,829)*	-2,449*** *(0,752)*
Government Consumption	-0,704 *(-1,357)*	-0,918 *(-1,450)*	-0,848 *(-1,389)*	-0,176 *(-1,017)*	-0,164 *(-1,001)*	0,093 *(0,997)*	-1,692* *(0,873)*	-1,191 *(0,975)*	-1,831** *(0,903)*	0,869 *(-1,310)*	0,704 *(-1,307)*	0,716 *(-1,398)*
Development Assistance	1,715 *(-1,434)*	1,770 *(-1,476)*	1,780 *(-1,454)*	3,611*** *(-1,375)*	3,277*** *(-1,267)*	3,734*** *(-1,421)*	-2,039 *(-2,283)*	-2,922 *(-2,245)*	-2,984* *(-2,254)*	-8,346* *(-4,499)*	-8,923** *(-4,551)*	-7,583* *(-4,371)*
Resource Rents	-3,453** *(-1,430)*	-3,355** *(-1,423)*	-3,516** *(-1,414)*	-0,203 *(0,532)*	-0,174 *(0,524)*	-0,217 *(0,598)*	-1,297** *(0,535)*	-1,394** *(0,543)*	-1,262** *(0,521)*	-2,187*** *(0,411)*	-2,230*** *(0,407)*	-2,037*** *(0,423)*
Green Patents (Local Firms)	-0,016 *(0,023)*			0,007 *(0,012)*			0,017** *(0,006)*			0,000 *(0,000)*		
Green Patents (Domestic MNEs)		0,223*** *(0,027)*			0,0247* *(0,014)*			0,0166** *(0,008)*			-0,000 *(0,000)*	
Green Patents (Foreign MNEs)			NA			0,0140 *(0,015)*			0,1974*** *(0,044)*			0,003* *(0,002)*
Constant	-1,693 *(-1,533)*	-1,691 *(-1,440)*	-1,625 *(-1,514)*	-1,401* *(0,716)*	-1,369* *(0,719)*	-1,588** *(0,747)*	2,056 *(-1,402)*	1,760 *(-1,502)*	2,472* *(-1,496)*	0,941 *(0,750)*	1,059 *(0,740)*	0,939 *(0,770)*
Number of Observations	231	231	231	525	525	525	543	543	543	669	669	669
Log Likelihood	-99,962	-98,247	-99,778	-303,452	-297,228	-299,584	-327,336	-339,700	-323,755	-245,647	-248,452	-247,979
AIC	213,923	212,493	215,557	622,905	610,456	615,169	670,672	695,400	663,511	507,293	512,904	511,958
McFadden's Pseudo R^2	0,178	0,192	0,178	0,145	0,152	0,134	0,195	0,161	0,192	0,263	0,262	0,272

5 Essay 3: The AI Advantage of MNEs: Leveraging Incumbency and Multinationality for Technological Development

Abstract

This essay analyzes the role of incumbency and multinationality for the development of patents in the area of artificial intelligence. Based on the innovation and international business literature, we develop hypotheses on how different dimensions of incumbency and multinationality affect the ability of multinational enterprises to tap into new technological fields. Furthermore, we analyze how these factors relate to the commercialization of new technologies as we distinguish between fundamental AI techniques and functional applications as categories of innovative output. We develop a longitudinal dataset of 126.411 AI patents attached to 4.529 corporate groups for the period from 2001 to 2020. We find that incumbency is a valuable asset for AI inventions, whereas multinationality is less important for entering this new technological field. These findings are in contrast with existing findings on the emergence of new technologies in entrepreneurial firms and born globals, which we explain with the idiosyncrasies of AI technologies that equip established MNEs with unique advantages over smaller rivals.

Keywords: Multinational Enterprises, Artificial Intelligence, Technological Change

Statement of Authorship

This essay is single-authored and not yet published.

The essay resulted from a joint research project between PhD students from the University of Bremen and Copenhagen Business School. The project was led by Björn Jindra, who was a constant supporter throughout the development of this essay. Moreover, the data was originally gathered jointly with Matheus Leusin, who was part of the research project. After leaving the research group, the dataset was newly set up for the purpose of the essay, so that only own code was used. The resulting essay was presented at the International Schumpeter Society Conference 2021, where additional feedback was provided by the attendants. I am grateful to the participants of the joint research group, especially Björn Jindra and Matheus Leusin, as well as the other researchers who provided feedback throughout the development of the essay.

5.1 Introduction

Multinational enterprises (MNEs) possess ownership advantages that allow them to expand beyond national borders and outcompete domestic firms in the host countries (Dunning & Lundan, 2008). These advantages are based on higher productivity (Kafouros, Buckley, & Clegg, 2012), superior know-how (Cantwell, 1989), and managerial experience (Wu, Wood, Chen, Meyer, & Liu, 2020). Moreover, there are advantages of scale and scope that arise from international expansion, which relate to industry leadership and multinationality (Hutzschenreuter, Lewin, & Dresel, 2011; Añón Higón & Manjón Antolín, 2012; Castellani, Montresor, Schubert, & Vezzani, 2017)[24]. Despite extensive literature on organizational renewal and dynamic capabilities in the MNE (Kim & Pennings, 2009; Blomkvist, Kappen, & Zander, 2014), the emergence of new technologies is still often associated with small, dynamic start-ups that drive technological change. Examples from the field of biotechnology (Birkinshaw, Visnjic, & Best, 2018) or solar energy (Lagerstedt Wadin, Ahlgren, & Bengtsson, 2017) highlight the role of newcomers challenging incumbent firms defined by organizational complexity, inertia, and technological lock-ins (Teece, 1998; Hill, Brandeau, Truelove, & Lineback, 2014). However, we argue that such competitive developments are not transferable to generic technologies defined by pervasiveness and industry-wide applications as these technological features equip incumbents with unique advantages that allow them to overcome barriers to innovation and quickly respond to technological change.

An example of such a change is the spread of artificial intelligence (AI) as a technology, which is defined as "the ability of a machine to perform cognitive functions that we associate with human minds, such as perceiving, reasoning, learning, interacting with the environment, problem-solving, decision-making, and even demonstrating creativity" (Rai, Constantinides, & Sarker, 2019: III). Although its definition implies the recreation of human intelligence, common examples of AI technologies are concerned with so-called weak AI, which is the development of self-optimizing systems that can solve specific problems without figuring out how human reasoning works. These systems have become increasingly sophisticated through rapid improvements in the underlying algorithms (Franceschetti, 2018),

[24] These advantages are also called Ot-advantages, which refer to a firm's ability to coordinate multiple and geographically dispersed value-adding activities and to capture the gains of risk diversification (Dunning & Lundan, 2008).

exponential increases in computing capacity with novel processors and calculation systems (Kreutzer & Sirrenberg, 2019), and the growing amount of data considered to be the new oil fueling AI techniques (Klinger, Mateos-Garcia, & Stathoulopoulos, 2021). These advances have led to the emergence of productive and ready-to-use applications with the capability to self-improve and support technological advancements in other sectors (Trajtenberg, 2018).

Although the technology is still in an early developmental stage and the full potential is yet to be determined, AI has the power to initialize a new technological paradigm by amplifying the already diminishing productivity effects of the information and communication technology (ICT) revolution (Brynolfsson & McAffee, 2014; Cockburn, Stern, & Henderson, 2018). Indeed, use cases demonstrate positive effects on the efficiency of internal and external corporate processes, for instance through compressed response times (Davenport, 2018). In contrast, the emergence of AI technologies also poses a threat to established firms by enabling new competition for dominance in the digital economy. Similar to the ICT revolution, where incumbents that could not adapt to the new paradigm lost their superior market position (Ojala, Evers, & Rialp, 2018; Li, Lee, & Kong, 2019), early adopters of AI are able to influence the technological trajectory, increase their market power, and secure long-term competitiveness (Frattini, Bianchi, De Massis, & Sikimic, 2014). Many studies have focused on the emergence of such major technological shifts from an entrepreneurial and innovation perspective but only a few analyze the circumstances driving MNEs to enter new technological fields (Teece, 2018). In the context of these potentially disruptive developments and the lack of evidence on MNEs' prerequisites to respond to such disruptions, we examine the following research question in our essay:

Do MNEs possess advantages from incumbency and multinationality in the development of AI technologies?

We answer this question by combining findings from International Business (IB) and innovation studies to develop hypotheses on firm-level factors influencing the development of AI in MNEs. As AI technologies are characterized by a technical and a functional dimension, which also relate to differences in productive usability (Chiesa & Frattini, 2011), we discuss the link between the nature of AI technologies, types of inventions, and capabilities of MNEs. To test our hypotheses, we use a novel dataset of 126.411

AI patent applications granted to a sample of 4.529 multinational parent companies and their subsidiaries between 2001 and 2020. We extract our data from the Orbis Intellectual Property (Orbis IP) database to identify AI patents using a keyword-based search adapted from the World Intellectual Property Organization (WIPO, 2019a). Our findings contradict the popular view that MNEs utilize diverse sources of knowledge for innovation but rather highlight the role of size and experience as well as previous technological diversification. Our essay concludes with implications for future research.

5.2 The Determinants of Innovation in MNEs

The innovation stream of the IB literature analyzes innovativeness as the main source of competitive advantage enabling MNEs to compete successfully with other firms across borders (Cano-Kollmann, Cantwell, Hannigan, Mudambi, & Song, 2016; Meyer, Li, & Schotter, 2020). These advantages arise from a novel combination of resources and capabilities in the home (Cantwell & Santangelo, 2000) and host country (Patel & Pavitt, 2000). Scholars such as Castellani et al. (2017) find positive effects from multinationality and diversification on the innovative output of MNEs. Other studies show that innovation is dependent on the scope and degree of research and development (R&D) internationalization (Cantwell & Janne, 2000), the role of subsidiaries in knowledge assimilation (Cantwell & Piscitello, 2000), and the relevance of linkages and spillovers to other firms (Hsu, Iriyana, & Prescott, 2016). Thus, access to diverse sources of knowledge and advantages of size and scope will often enable MNE to maintain a superior competitive position over time.

To preserve their market position, Luo (2020) argues that MNEs need a combination of strong routines and dynamic capabilities providing resilience and adaptability. This duality is especially important in times of technological change. Schubert, Baier, and Rammer (2018) provide evidence that risk-assertiveness is needed to overcome inertia and explore new technologies efficiently. In the context of MNEs, several scholars also point to the relevance of multinational diversification determining their ability to utilize foreign knowledge sources for innovation (Kafouros et al., 2012; Li, Qian, & Qian, 2013). Similarly, multinational depth, defined as the intensity of operations in the host countries, provides more opportunities for linking with local knowledge sources and utilizing foreign technologies for innovation.

For instance, Blomkvist et al. (2014) find that a lion's share of international innovation in MNEs comes from a few "superstar" subsidiaries that are characterized by high embeddedness in the host country.

In contrast, the innovation literature also points to the difficulties arising from large and complex organizational structures that result from MNEs' expansion into other countries. Ahmad and Barner-Rasmussen (2019) explain that the exploitation of existing assets is often efficiently managed in MNEs, while staying competitive through learning and entering new fields of knowledge requires significant changes to the organization. This limits the innovativeness of large firms that are characterized by an attachment to the status quo (Williamson, 1975; Teece, 1998). Halme, Lindemann, and Linna (2012) find that multiple strategies including a short-term orientation, diverging incentive structures, or uncertainty avoidance limit the innovativeness of MNEs. In a similar vein, Petricevic and Teece (2019) highlight the changing global environment, which increases the difficulties of incumbent MNEs to react to new competitors and might result in the loss of their superior position to new market entrants.

Overcoming such inertia is especially relevant when new technologies are not developing incrementally but abruptly, so that competitors challenge the dominant market position of MNEs (Gao, Gerst, & Sun, 2014). Similar to Schumpeter's (1942) depiction of creative destruction, scholars suggest that the introduction of new technologies is accompanied by the emergence of new products, business models, and entrants that threaten existing competitive advantages of incumbent firms (Christensen, 1997; Kostoff, Boylan, & Simons, 2004). Economists argue that especially general-purpose technologies (GPTs), defined as technologies that are pervasive, improving over time, and able to spawn innovations, have a far-reaching impact on industries and, most often, the whole economy (Jovanovic & Rousseau, 2005). Since they are not bound to a specific purpose but rather have the potential to disrupt business models across industries, companies need to learn how to apply these technologies as quickly as possible in order to remain competitive (Qiu & Cantwell, 2018).

To explore the circumstances under which MNEs are able to embrace new technologies at an early stage and gain a leading position in a technological field (Fu, Emes, & Hou, 2021), we review evidence on the determinants of innovation in the MNE (Verbeke, Chrisman, & Yuan, 2007; Cantwell, 2017). There are examples of such efforts for technologies like ICTs (Brouthers, Geisser, & Rothlauf, 2016; Hennart, 2019), additive manufacturing (Hannibal & Knight, 2018), and GPTs (Qiu & Cantwell, 2018), which

explain the emergence of new competitors and the adoption of new technologies by MNEs (Parente, Geleilate, & Rong, 2018; Ojala et al., 2018). However, these studies only focus on the adoption of new technologies, whereas the distinguishing feature that enables some MNEs to become producers of a new technology remains unclear. By exploring the competitive dynamics in the emerging field of AI, we move beyond these limitations and analyze the ability of MNEs to become inventors of a novel, disruptive technology.

5.3 Artificial Intelligence and Technological Paradigms

As an example of a disruptive technological change, many scholars use the example of ICTs, which have led to a paradigm shift in the global economy (Brouthers et al., 2016; Hennart, 2019). They have been the source of new market entrants (Kostoff, Boylan, & Simons, 2004), facilitated internationalization of firms (Vasilchenko & Morrish, 2011), and led to new organizational forms (Buckley, 2009). Due to their pervasiveness, ICTs contributed to an increasingly interconnected and dynamic global business environment across economic sectors (Petersen & Welch, 2003; Yeniyurt, Henke, & Cavusgil, 2013) as well as a continuous stream of innovations (Schiavone, 2011; Vecchi & Brennan, 2022). Based on these significant shifts in the global economy, scholars have extensively examined the emergence and effect of ICTs (Antonelli, 1998; Islamoglu & Liebenau, 2007). However, to apply these findings to other technologies, it is necessary to analyze if such technologies share similar characteristics with respect to their disruptiveness and pervasiveness.

In the case of AI technologies, while their inception goes back to the 1950s, we have been witnessing an all-time high of publications and inventions related to AI during the last decade (WIPO, 2019a). This "boom" was facilitated by a shift from mathematical models (like fuzzy logic and expert systems) to biological and machine learning models (like neural networks and deep learning) as well as the generation of high-performance parallel computing chips and large datasets that extended the applicability of AI (Leusin, Günther, Jindra, & Moehrle, 2020; Klinger, Mateos-Garcia, & Stathoulopoulos, 2021). While some authors view AI as a GPT (Brynjolfsson, Mitchell, & Rock, 2018; Trajtenberg, 2018), which is characterized by its capability of ongoing technological improvement and innovative applications across industries, other authors argue that AI technologies are still immature and have not yet gained enough

pervasiveness for having measurable economy-wide impacts (Teece, 2018). However, there is consensus in the literature that AI is a generic "enabling technology", which could yield benefits for a wide range of sectors through the integration within a network of products and systems (Martin, 1993; Teece, 2018).

Recent trends in patent data indicate that AI is developed across all application fields and industries with telecommunications, transportation as well as life and medical sciences being most prominent (WIPO, 2019a). Other important and fast-growing sectors include affective computing, smart cities, agriculture, computing in government as well as banking and finance. According to data from the WIPO (2019a), the development of AI is concentrated in developed countries and China. Of the top 20 companies filing AI-related patents, 12 are based in Japan, three are from the United States, and two are from China. The report further highlights the role of incumbent firms leveraging their industry expertise and access to specialized data to invent AI technologies. Based on these numbers, Bughin, Seong, Manyika, Chui, and Joshi (2018) estimated that by 2030 around 70% of all companies will adopt at least one type of AI technologies and that AI could potentially deliver additional economic output of around $13 trillion by 2030, boosting global GDP by about 1,2% a year. However, recent research demonstrates that most firms are merely using existing AI technologies instead of developing own AI solutions to solve complex and unique business problems and fully embracing the potential of the technology (Zolas et al., 2020; Rammer, Fernandez, & Czarnitzki, 2022). Indeed, moving from the adoption to the creation of internal and external solutions has been outlined as crucial to generate profits from the use of AI technologies (Rosenberg, 1976; Hienerth, 2006; Baldwin & von Hippel, 2011).

This finding also highlights the need for companies to shift their focus towards more commercial applications of AI as the largest share of patents in the field still relates to fundamental techniques optimizing digital processes (WIPO, 2019a). In this context, experts distinguish between fundamental AI techniques like machine learning, logic programming, and fuzzy logic and functional applications like computer vision, natural language processing, and speech processing. The data demonstrates a clear link between certain AI techniques, functional applications, and industries as most inventions related to AI mention an AI technique, application, or field in combination with another. In sum, AI technologies have the ability to influence the nature of a firm's competitive advantages through the provision of cost-

effective, easy-to-use solutions (Teece, 2018), which explains why firms are increasingly trying to use them to their advantage.

5.4 Determinants of AI Inventions

As the example of AI illustrates, changing technologies shape the sources of competitiveness of MNEs (Chen & Kamal, 2016) and require new configurations of global production (Laplume, Petersen, & Pearce, 2016; Coviello, Kano, & Liesch, 2017). In this context, overcoming organizational barriers to innovation becomes the main task to secure market position and future profits (Kogut & Zander, 2003). The success of such a transformation process is not only indicated by organizational or technological adoption but rather by shaping the technology in their way to achieve innovative profits (Cantwell, 2002; Andersson, Dasi, Mudambi, & Pedersen, 2016). In other words, MNEs recognizing the potential of AI as a source of future competitiveness will mobilize resources and capabilities and leverage network advantages in different technological environments to become producers of the technology themselves. The propensity to invent AI technologies is dependent on several key determinants outlined in the IB and innovation literature.

5.4.1 Incumbency and Innovative Capabilities

A majority of the innovation literature focuses on smaller firms that are equipped with flexibility and entrepreneurial spirit to commit to novel technologies and challenge the position of dominant firms (Schumpeter, 1942; Christensen, 1997; Schiavone, 2011). According to the concept of business cycles and technology paradigms, large firms will dominate the technological developments and competition in an established market, whereas smaller firms will focus on highly competitive niche markets to reduce direct competition with market leaders. When new technologies emerge, incumbents are often hesitant to invest and respond to potential competitors and imitators as these technologies do not promise relevant profits at an early stage (Teece, Peteraf, & Leih, 2016). Instead, smaller firms will embrace the new technology as they are more risk-assertive (Birkinshaw et al., 2018) and employ higher learning outcomes (Aw, Chung, & Roberts, 2000; Jha, Dhanaraj, & Krishnan, 2018). In contrast to this argumentation, we argue that the unique nature of AI technologies makes them not comparable to this theoretical concept of technological

change, because they entail stronger entry barriers for smaller firms than other technologies (Balakrishnan & Das, 2020).

As AI technologies require extensive amounts of data to develop, train, and apply the algorithms (Kim, 2020), small firms are at a disadvantage in gathering the necessary data. Large incumbent firms often possess a plethora of unutilized data that can be used for the development of AI techniques (Shamim, Zeng, Choksy, & Shariq, 2020). Cumulative learning processes and operations in many technological areas help to create specialized knowledge in different industries and to recognize the market and technological opportunities (Singh & Schoenbachler, 2001; Liu, Wang, & Wei, 2009). Therefore, the problem-specific nature of many AI solutions will help experienced, diversified firms to leverage their capabilities for successful inventions in the field. Indeed, the example of ICTs showed that large industry leaders did not change their underlying business model but rather utilized the technology to strengthen existing advantages and create new entry barriers over competitors (Cantwell & Santangelo, 2003). While the ICT revolution certainly produced new opportunities for entrepreneurs and smaller firms, MNEs responded quickly by adopting the new technologies and facilitating their transfer of across countries, making them the primary vehicle of technology diffusion (Kogut & Zander, 2003). We expect similar advantages of incumbent MNEs in the context of AI technologies.

Hypothesis 1: Incumbency facilitates the development of AI technologies in MNEs.

Another main factor of MNEs' innovativeness is their ability to develop, integrate, and deploy internal and external resources to create new sources of revenue and respond to environmental changes (Verbeke et al., 2007; Teece et al., 2016). Similar to the dynamic capabilities in Teece's seminal work (Teece, 1986), this ability is significantly different from the resources and capabilities used to reproduce a certain performance and can rather be described as innovative capability (Schubert et al., 2018). Since these capabilities are determining the range of growth opportunities for large firms (Penrose, 1959; Young, Smith, & Grimm, 1996), MNEs with strong innovative capabilities are able to develop new valuable assets and take strategic action in response to technological change (Wernerfelt, 1984). Such firms are characterized by constant adjustments to their business models (Hill et al., 2014), dynamic and responsive

organizational structures (Azar & Ciabuschi, 2017; Da Silva Lopes, Casson, & Jones, 2019), and a rich and historically evolved knowledge base (Lewin, Massini, & Peeters, 2020).

In the context of AI, such innovative capabilities are especially relevant for MNEs to cope with the uncertainty surrounding the future applications of the technology. Schubert et al. (2018) developed a behavioral model of risk tolerance under technological uncertainty, where they find that high-capability firms are more risk-assertive than low-capability firms. Arikan, Koparan, Arikan, and Shenkar (2019) find that the long-lasting competitiveness of MNEs is dependent on their ability to redefine existing resources and adapt their signature processes. More generally, studies find a positive relationship between successful innovation history, knowledge diversity, and future innovativeness (Bolli, Seliger, & Woerter, 2020). As the real potential of AI is still unclear, past experiences with novel technologies will strengthen the ability of MNEs to tap into this new technological field. Thus, only MNEs with strong innovative capabilities will be able to leverage their resources effectively and invent AI technologies on their own.

Hypothesis 2: Innovative capabilities facilitate the development of AI technologies in MNEs.

5.4.2 Multinationality

The IB literature provides evidence that MNEs possess advantages arising from their multinationality positively affecting innovativeness (Castellani et al., 2017; Turkina & van Assche, 2017). A foreign presence through subsidiaries widens access to new technologies, which enhances the MNEs' knowledge base through autonomous research units and reverse knowledge transfer (Birkinshaw & Hood, 1998; Beugelsdijk & Jindra, 2018). Even if the MNE is not doing research in these countries, learning from up- and downstream activities in multiple locations is beneficial for innovative output (Castellani & Fassio, 2017). These advantages are also related to the growing relevance of global networks as a source of knowledge (Cantwell, 1989; Beugelsdijk & Jindra, 2018; Mees-Buss, Welch, & Westney, 2019), which are especially important in times of rapid technological change (Schubert et al., 2018). Access to diverse knowledge through multinationality is usually conceptualized with multinational breadth, understood as the dispersion of international activities (Contractor, Kumar, Kundu, & Pedersen, 2010; Hsu, Lien, & Chen, 2015). Scholars using this concept assume that MNEs operating in more countries will have more opportunities to learn about new technologies via their network of subsidiaries (Kafouros et al., 2012).

Thus, the variety of knowledge sources available to the firm should have a positive effect on inventions in new technological fields like AI (Cantwell & Mudambi, 2005; Cantwell, 2017; Nuruzzaman, Gaur, & Sambharya, 2017). However, we argue that the digital nature of AI makes the dispersion of physical activities irrelevant for innovative output as the necessary data can be gathered through other non-equity entry modes. Moreover, the dispersion of international operations does not measure the intensity of operations in each country, which would increase the amount of data and knowledge about the host country to help developing data-driven solutions. Indeed, Cockburn et al. (2018) argue that AI requires specific technological capabilities that are highly concentrated in specialized locations contributing to the development of AI technologies. Moreover, geographically diversified operations increase organizational complexity and bureaucracy, which decreases flexibility to respond to new technologies (Schubert et al., 2018). On a technological level, data gathering and integration become more complex across borders (Liu, 2021). Thus, we argue that the multinational diversity of foreign operations will make AI inventions more difficult for MNEs.

Hypothesis 3: Multinational breadth hinders the development of AI technologies in MNEs.

In addition to the diversity of country contexts, researchers emphasize the intensity of MNE activities in the host country, also referred to as embeddedness (Halaszovich & Lundan, 2016) or multinational depth (Li et al., 2013). The main argument here is that more connections to local economic and institutional actors will increase spillovers and knowledge transfer (Castellani et al., 2017). Jha et al. (2018) find that an increased depth of R&D activities enlarges the opportunities to develop long-lasting relations with international partners. Indeed, subsidiaries with more stable relationships can learn more from partners (Castellani & Zanfei, 2004) and enable MNEs to leverage the unique capabilities available in the host country (Blomkvist, Kappen, & Zander, 2017). Thus, the engagement of MNEs with local actors will improve knowledge-sourcing activities and enable the effective utilization of foreign resources and capabilities, ultimately increasing the productive output (Castellani et al., 2017).

For AI technologies, higher technology levels in the host country allow the sourcing of more high-quality knowledge as the availability of complementary assets will enhance the ability of innovation development and foreign learning (Song & Shin, 2008; Cantwell, 2009; Hennart, 2011). Phene and

Almeida (2008) show that knowledge absorption patterns are particularly strong in regions that demonstrate significant knowledge creation. In a similar vein, Castellani (2017) argues that "local buzz" is crucial for the development of knowledge and persistence of innovation activities leading to the fact that a large share of new inventions is concentrated in the same regions. As outlined in the WIPO (2019a) report, the regions with a high propensity for AI inventions are the developed countries and China. This pattern suggests that more subsidiaries in these technologically advanced regions will help MNEs to assimilate more high-quality knowledge for their AI inventions (Ciabuschi, Dellestrand, & Kappen, 2012). Thus, adjusting for the technological capabilities of the host countries, the ability of MNEs to benefit from multinational depth is beneficial for becoming producers of AI.

Hypothesis 4: Multinational depth in high-technology locations facilitates the development of AI technologies in MNEs.

5.4.3 Technical and Functional AI Applications

Teece (2017) argues that innovation is not only the simple creation of new assets but also the positioning and recombination of those in a competitive fashion. This means that new technologies need to be used to create value for the customer. The innovation literature supports the relevance of commercialization of inventions through their embedding in product innovation (Beugelsdijk & Jindra, 2018) and the creation of new markets (O'Connor & Rice, 2013). In their study on breakthrough innovation, Silva, Styles, and Lages (2017) find that market orientation increases the positive performance effects of inventions, which indicates the relevance of understanding how to deploy them in marketable products. Indeed, the translation of inventions into commercialized products or processes has been outlined as one of the most important skills in the innovation literature (Schumpeter, 1939; Barney, 1991; Kim & Pennings, 2009). Thus, MNEs with high innovative capabilities will try to focus on readily applicable technologies and their commercialization, while MNEs with lower innovative capabilities will be limited to explorative activities.

In the context of AI, the distinction between fundamental AI techniques and functional applications resembles this difference between the development of generic assets and their value-adding deployment (Baruffaldi et al., 2020). Opposing the notion that AI techniques like learning algorithms or computational

methods will automatically lead to innovation, Kim (2020) states that the functional applications of AI are dependent on understanding the interaction of techniques with humans and their problem-solving potential. The output of such functional applications will increase when MNEs have skilled employees and embrace the use of AI technologies in their organization (Makarius, Mukherjee, Fox, & Fox, 2020; Rampersad, 2020). In line with our previous assumptions about factors contributing to AI inventions, we infer that these factors will also help to translate AI technologies into functional applications.

Hypothesis 5: Incumbency, innovative capabilities, and multinational depth in high-technology locations facilitate the development of functional AI technologies in MNEs.

An overview of our hypotheses is shown in *Figure 4.1*.

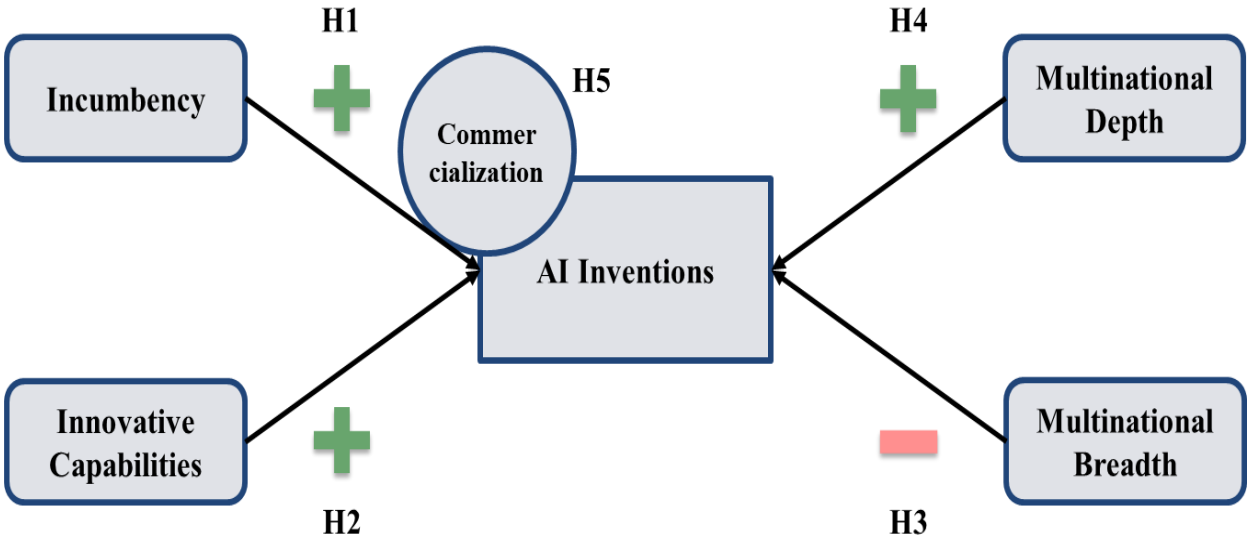

Figure 4.1: *Theoretical Framework and Hypotheses (Essay 3)*

5.5 Methodology

5.5.1 Sample

To test our hypotheses, we use a novel dataset of priority patents [25] on the firm level extracted from the Orbis IP database. It consists of all 126.411 AI patents granted to a sample of 4.529 MNE parent companies and their subsidiaries between 2001 and 2020. MNEs were identified in the Orbis database by Bureau van Dijk following a bottom-up principle moving from foreign subsidiaries to their immediate parents and the

[25] Priority patent means the first filing of a patent for a particular invention to which complementary inventions and patent filings in other country will refer to. In that way, priority patents build the foundation of a patent family.

global ultimate owners (GUOs). The goal was to identify all companies within the network of a GUO, which indicates the top node in an ownership hierarchy. The data was matched and cross-checked with a data search of shareholders with foreign subsidiaries to find the home country subsidiaries and maximize the number of subsidiaries attached to the GUO. However, a financial entity or a person can be the GUO within the Orbis database. In those cases, the hierarchically highest corporate enterprise (using Orbis classification) was defined as the GUO. To retrace the ownership structure of these MNEs over time, we used past mergers and acquisitions from the Zephyr database to account for changes in the ownership structure during the period of interest. This resulted in a panel of 256.000 GUOs that own around two million subsidiaries (Lüders, 2023)[26].

We used a keyword-based search in the novel Orbis IP database to identify patents related to AI, thereby distinguishing between techniques and functional applications. The choice of keywords is based on the framework proposed by the WIPO (2019a), which includes the analysis of AI experts on both the applied and the research side on this topic. The full list of keywords and synonyms searched for in the title and abstract of all patents in the database can be found in *Appendix 4.1*. The search resulted in a total of 614.856 priority patents of which 435.930 are classified as functional applications. Together with the patents, the International Patent Classification (IPC) codes, previous and current owners as well as transaction dates were extracted. By accounting for the transaction year and expiration year, we were able to assign each patent to an owner for each year of the time period.

The patent data was matched to the GUOs by linking the Bureau van Dijk identifier (BvDID) of patent owners and the corporate entities of the GUOs. As firm-level data from the Orbis database was only available from 2001 onwards, the patent sample was restricted to inventions made after 2000. Moreover, the years 2021 and 2022 were excluded to account for the lengthy application process of patents. After matching both datasets, we complemented the data with country-level variables on the technology profile of the host countries using data from the Global Competitiveness Index published by the World Economic Forum. We added company-specific data from the Orbis database to complete our dataset. To increase the comparability of the companies, we restricted the sample to MNEs with more than 500 employees and a

[26] For a full description, see the referenced working paper, where the code for constructing the data is also provided.

revenue of more than $50 million. In addition, only companies that already patented in other areas were included, so that only MNEs already engaged in inventive activities are examined. These steps resulted in a significant loss of AI patents, but our sample still covers 20% of all AI-related patent applications made within our sample period[27].

5.5.2 Dependent Variables

Our dependent variable is the invention of AI technologies measured through the number of priority patent applications related to AI that are added to an MNE and its subsidiaries in a given year (*AI Inventions)*. Moreover, a second dependent variable only focuses on the inventions of functional AI applications (*AI Functional Inventions*). These variables include the own development of AI technologies as well as the purchase or sale of existing patents. Throughout the construction of the dataset, these transactions were also captured with acquisitions of companies and patents termed "*Brownfield"*-patents and the generation of patents in the first year of existence referred to as "*Greenfield"*-patents. However, patent transactions only account for 1% of patents in our dataset. To refine our analysis for *Hypothesis 5*, we count the number of new patents related to functional AI applications based on the keywords explained above.

Patents have been commonly used as a proxy to study the underlying patterns of technological change, given the cumulative, incremental, and path-dependent character of technological evolution they represent (Nelson & Winter, 1982; Rosenberg, 1982). They allow us to reveal the scale and scope of technological inventions across regions, industries, and over time (Trajtenberg, 1990). Although there are established limitations highlighted in the literature including the ignoring of other tacit knowledge or differences in patenting propensity across industries and countries (Sichelmann & Graham, 2010), we use proper control variables to overcome these problems (Griliches, 1990; Salomon & Jin, 2008). Therefore, we argue that patents can accurately capture the intellectual property of MNEs and serve as a direct and observable outcome of the innovation process (Archibugi & Pianta, 1996).

[27] More information about the full dataset and the code for analysis is provided upon request.

5.5.3 Independent Variables

Incumbency

To test *Hypothesis 1*, we operationalize incumbency with two variables. First, we use age measured as the number of years between the founding of the MNE and the respective year in our panel (*Age)*. Age of is a common indicator of experience distinguishing incumbent and entrepreneurial firms (Perra, Sidhu, & Volberda, 2017). Second, we follow Giovanetti, Ricchiuti, and Velucchi (2011) in using operating revenue to measure the firm size of the corporate group (*Revenue*). In our dataset, both measures are not correlated, which indicates that they indeed reflect two dimensions of incumbency, namely the experience of firms as well as scale and scope. As discussed in our hypotheses development, we expect both dimensions to be positively related to *AI Inventions*.

Innovative Capabilities

To test *Hypothesis 2*, we operationalize innovative capabilities as the technological diversification of the MNE's patent portfolio (*Innovative Capabilities*). This measure differs from commonly used measures of prior patent stock (Song & Shin, 2008) or R&D expenditure (Banalieva, Cuervo-Cazurra, & Sarathy, 2018) in two important ways. First, prior patent stock as an indicator of technological capabilities has a highly endogenous relationship with other count-based patent variables (Hagedoorn & Cloodt, 2003). Second, the number of patents does not automatically reflect the firm's ability to invent new technologies as the firm can also be highly specialized in one specific technological area (Breschi, Lissoni, & Malerba, 2003). This would not comply with our assumptions of AI as a novel disruptive technology that requires entrepreneurial incentives to move into other technological fields. Similarly, R&D expenditure captures the investments of MNEs into the development of new technologies; however, the intention and previous knowledge stock are not accounted for with this measure.

Thus, we follow other papers (Leten, Belderbos, & van Looy, 2007; Rahko, 2016) to construct a measure of technological diversification that captures the variety of the MNE's existing patent stock in different technology classes:

$$Innovative\ Capabilities = (1 - \sum(\frac{N_k}{N})^2) \cdot (\frac{N}{N+1})$$

N is the number of IPC codes in an MNE's patent portfolio, and N_k is the number of patents assigned to technology class k. The index takes values between 0 and 1, where high values indicate a high degree of technological diversification. Except for the missing values (e.g., patents not assigned to a technology class), which are replaced by zeros, the measure is based on all patents of the MNE in the home and host country as we expect that the whole knowledge base is being used for future innovativeness (Henderson & Cockburn 1996; Ahuja, 2000). Hence, this index measures the ability of MNEs to enter new technological fields, while also accounting for the path-dependent nature of innovation within MNEs (Cohen & Levinthal, 1990).

Multinationality

The concept of multinationality has often been measured through the number of foreign countries in which the MNE is operating (Morck & Yeung, 1991; Castellani & Zanfei, 2004; Thomas & Eden, 2004; Kafouros et al., 2012). However, this concept has been criticized since it considers neither the size of the activities in the different countries (Hennart, 2011) nor the real diversity of host countries (Hsu et al., 2015). For instance, MNEs that have subsidiaries only in European countries will experience less diversity of knowledge than multinationals with fewer subsidiaries across the Triad regions (Kim, Lampert, & Roy, 2020). In other words, the advantages arising from multinationality are not simply arising from the number of host countries but are based on the ability to acquire complementary location advantages and specialized knowledge in the host countries (Asakawa, 2001; Papanastassiou, Pearce, & Zanfei, 2020). We respond to this criticism (Li et al., 2013) by extending the multinationality measure with a technological dimension. Indeed, several authors find that the technological differences between home and host country will define the knowledge sourcing of MNEs (Cantwell & Janne, 2000; Song & Shin, 2008). Thus, we use the Technological Readiness Index from the Global Competitiveness Index to categorize countries into five quantiles. By calculating the distribution of host countries within these groups, we develop a measure of technological diversification in different host countries (*Multinational Breadth*). Moreover, we account for the total number of technological contexts, which leads to the following formula:

$$Multinational\ Breadth = \sum(\frac{N_k}{N+1})^2) \cdot (\frac{K}{K+1})$$

N_k is the number of host countries in a technology group and N is the total number of countries the MNE is operating in. The resulting value of technological distribution of subsidiaries is multiplied by a fractional value of K, which is the total number of technology contexts the MNE is operating in. The resulting index takes values between 0 and 1, where high values indicate an equal distribution of subsidiaries in a high number of technologically different host countries.

To measure multinational depth, we follow Castellani et al. (2017) in using the average number of subsidiaries per host country. However, like the conception of multinational breadth the simple operationalization of multinational depth through the number of subsidiaries per country (Kafouros et al., 2012) or the concentration of investment (Li et al., 2013) would fail to recognize the technological dimension and its influence on the invention of AI. As Collinson and Wang (2012) argue, the embeddedness of subsidiaries increases the innovative output and makes the subunits within MNEs more specialized in the technological fields the host country is offering location advantages. Thus, it is not only the number of subsidiaries but also the context of the host country that influences the ability of MNEs to benefit from the embeddedness in a specialized location. To account for this relation, we develop a measure of depth accounting for the number of subsidiaries per country as well as for the expected effect of the host country context on AI inventions (*Multinational Depth*):

$$Multinational\ Depth = \sum\left(\frac{S_k}{(S_n + 1)} \cdot \left(\frac{1}{\frac{N}{N_k}}\right)\right)^2 \cdot w_k)$$

S_k is the number of subsidiaries in a particular technology class, S_n is the total number of subsidiaries, N is the number of countries the MNE is operating in, and N_k is the number of countries in the technology class. Based on this formula, a higher number of subsidiaries in a small set of countries serving one technology class will increase the technological concentration value. Moreover, a greater number of subsidiaries in fewer countries will also lead to higher values. w_k is the weight of the respective technology quantile based on the Technological Readiness Index of the host country. The weights are 0.1, 0.3, 0.5, 0.7, and 0.9 with higher weights indicating higher technological readiness and innovative capabilities of the host countries. The resulting index takes values between 0 and 1, where high values indicate a

concentration of subsidiaries within a few countries of a technology group that should be beneficial for the development of AI technologies.

5.5.4 Control Variables

To account for other factors influencing the ability to invent AI technologies, we employ several control variables. We construct a measure of the relative competitive position of MNEs to account for industry leadership as a potential influencing factor (*Industry Position*). Therefore, we categorize firms within an industry into leaders and laggards according to their return on equity with 50% as the threshold. We also include a measure of intangible non-current assets as a share of total fixed assets (*Share of Intangibles*), which is used in the literature to indicate the knowledge intensity of firm's operations (Kramer, Marinelli, Iammarino, & Diez, 2011). As several authors argue that the availability of short-term cash reserves influences the decision to invest in new technologies (Kotha, Rindova, & Rothaermel, 2001; Chang & Rhee, 2011; Lin, 2014), we use slack as another control variable measured by the current ratio (*Slack*). *Slack* reflects the short-term improvements in operating efficiency allowing firms to spend time and money on new inventions. Finally, we also include a cluster variable in our analysis (*Cluster*), which measures the number of subsidiaries in cities considered as hubs for AI technologies (Chakravorti, Bhalla, Chaturvedi, & Filipovic, 2021). We include this measure as a control and not as a variable of technological depth as there is a limited amount of data on clusters specializing on AI technologies and the cited study mainly considers large cities in the developed countries and China as AI hubs. The use of independent data on the city level reduces problems of endogeneity, which an own calculation of AI hubs based on patent data would have caused. *Appendix 4.2* provides an overview of all variables used.

5.5.5 Estimation Approach

Our selection for a statistical model is primarily driven by the nature of our dependent variable, which is a count measure that can take only non-negative integer values and many of the observations are bunched at or close to zero. These characteristics require the use of non-linear models building on Poisson or negative binomial distributions to avoid heteroskedastic, non-normal residuals (Hausmann, Hall, & Griliches, 1984: Borror, 2008). As negative binomial regression suffers from misspecification of predictors under strict assumptions (Allison & Waterman, 2002), we use a fixed-effects Poisson model for our main

estimation. Concerns about overdispersion and zero-inflation are accounted for through the use of robust standards errors, which satisfies the conditional mean assumption (Wooldridge, 1999). Moreover, Cameron and Trivedi (2013) outline that Poisson fixed-effects models provide consistent estimators for short panels when overdispersion is controlled for with the inclusion of individual effects. The decision for a fixed effect regression was made as we assume arbitrary dependence between the unobserved effect and the observed explanatory variables.

Although the fixed-effects Poisson regression provides consistent estimators, we add additional robustness checks to the analysis (see *Appendix 4.3)*. We exchange our variables of multinationality (*Multinational Breadth* and *Depth)* to compare our calculated measures with the commonly used indicators of the literature (*Number of Countries* and *Average Number of Subsidiaries*). Additional robustness is provided by the split of our sample period into the periods 2001-2010 and 2011-2020. Indeed, the division into these periods is validated through our empirical data, which shows that the exponential growth of global AI patents started after 2011 (see *Figure 4.2)*.

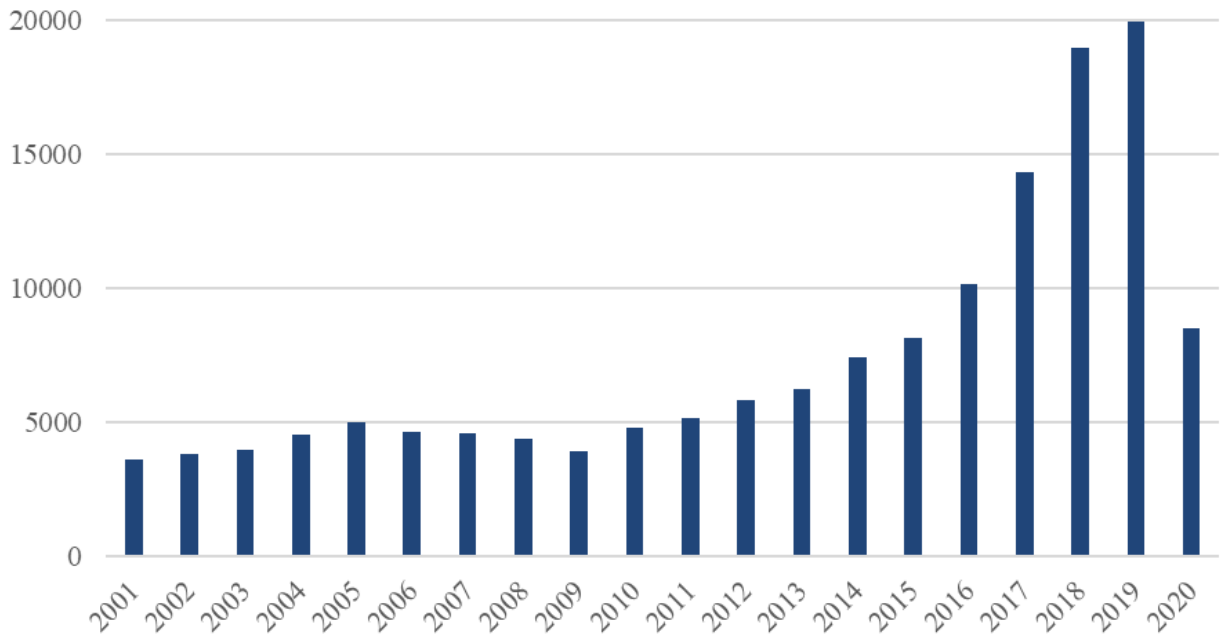

Figure 4.2: *Total Number of AI Inventions over Time*

The results of our main model and robustness checks will be further discussed in the next section.

5.6 Results

In *Table 4.1*, the correlations between our continuous variables are provided.

	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1)	*AI Inventions*	1										
(2)	*AI Functional Inventions*	0,951	1									
(3)	*Age*	0,022	0,023	1								
(4)	*Revenue*	0,213	0,197	0,092	1							
(5)	*Innovative Capabilities*	0,022	0,013	-0,103	-0,037	1						
(6)	*Multinational Breadth*	0,030	0,029	0,199	0,052	-0,033	1					
(7)	*Multinational Depth*	-0,042	-0,040	-0,106	-0,067	0,077	-0,476	1				
(8)	*Number of Countries*	0,172	0,160	0,174	0,371	-0,116	0,233	-0,320	1			
(9)	*Average Number of Countries*	0,081	0,078	0,034	0,230	-0,025	-0,001	-0,152	0,358	1		
(10)	*Share of Intangibles*	0,002	-0,007	-0,071	0,056	0,030	0,019	-0,088	0,315	0,157	1	
(11)	*Slack*	-0,009	-0,009	-0,126	-0,100	0,001	-0,031	0,025	-0,102	-0,105	-0,092	1

Table 4.1: *Correlation Matrix (Essay 3*)

Before illustrating the regression results, additional descriptive statistics are used to illustrate the geographical and industrial dispersion of AI inventions.

Figure 4.3 shows a scatter plot of *Innovative Capabilities* as a measure of technological diversification and average *AI inventions* per industry. For clarity purposes, we use logarithmic axes. The size of the circles relates to the age of the companies. The data demonstrates that especially firms in ICTs, electronics, automotive as well as machinery and equipment are patenting in the field of AI. However, these companies do not demonstrate significantly higher levels of technological diversification compared to other industries. Industries with moderate levels of *Innovative Capabilities* and average AI patents are chemicals and pharmaceuticals, wholesale and retail as well as mining and quarrying. Industries with the lowest average of AI patents are real estate, accommodation and food services as well as agriculture, forestry, and fishing. These findings largely comply with levels of digitalization and automation in each industry, thereby demonstrating that firms that benefitted from the ICT revolution are also among the firms that tap into AI

technologies. A plausible explanation for this is the superior access to relevant data. With respect to the average *Age*, only firms in ICTs and electronics are significantly younger than firms in the other industries. As these industries also demonstrate the highest average of *AI Inventions*, this might indicate some advantages of newness. However, as the figure shows the values for all firms within an industry, it does not provide information about which MNEs are patenting in the field of Ai in an industry.

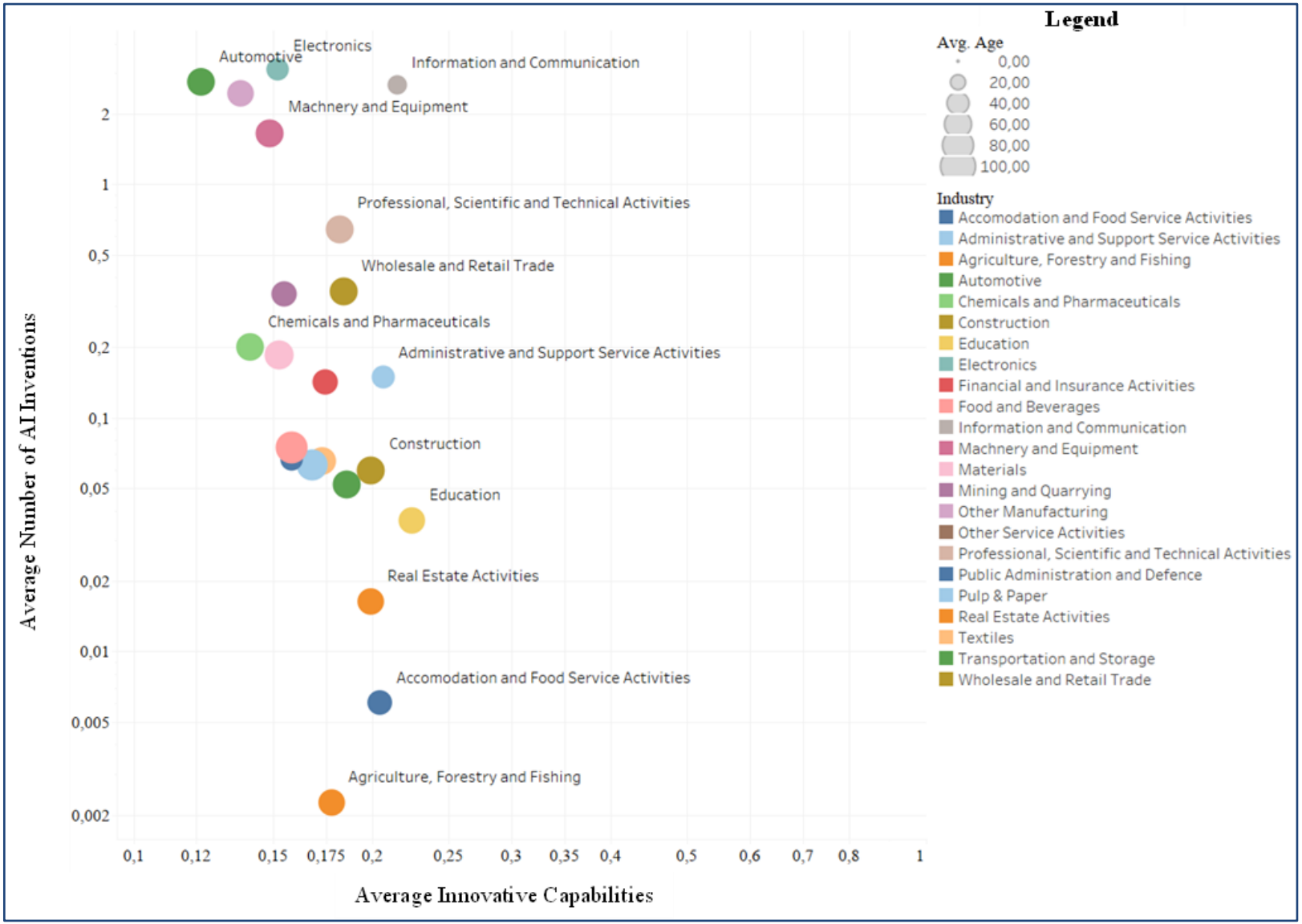

Figure 4.3: *Scatterplot of AI Inventions and Technological Diversity by Industry and Age*

To give some insights into the firms dominating their industries in terms of AI inventions, we provide a list of the top 10 companies per industry in *Appendix 4.4*. The findings of the top companies are similar to those in the WIPO (2019a) report in that the list is dominated by US tech companies like IBM, Microsoft, or General Electric. Nevertheless, there are also some differences, especially regarding the dominance of Asian firms in our findings, which can be explained through several factors. First, the WIPO used the FAMPAT database provided by Questel (WIPO, 2019b), whereas we used the Orbis IP database by Bureau van Dijk. Second, the reporting time ends at the beginning of 2018 and the report displays the portfolio of existing patents rather than the number of new inventions per year. Third, our analysis also considers the purchase and sale of patents by accounting for past transactions of companies and patents. Altogether, our descriptive statistics on the industry level demonstrate the dominance of large MNEs in digital industries in terms of AI patenting.

Focusing on the country level, *Figure 4.4* depicts the geographic location of firm headquarters, where the size of the circles indicates the number of *AI Inventions* made by MNEs in that city. The color of the states indicates the number of *AI Inventions* with darker blue meaning more patents in the technological field. The chart on the bottom left shows the top 30 cities where the headquarter of MNEs with the most AI patents in our dataset are located. The figure shows that nearly all MNEs producing AI technologies are located in the USA, Europe, Japan, Korea, and China. More specifically, the Asian countries are ahead of Western developed countries in terms of *AI Inventions* with Tokyo, Suwon-Si, and Seoul hosting more MNEs patenting in AI than Armonk, Boston, and Stuttgart. This finding further emphasizes that firms from these countries are fully embracing the technology and leveraging home and host country advantages to their full potential.

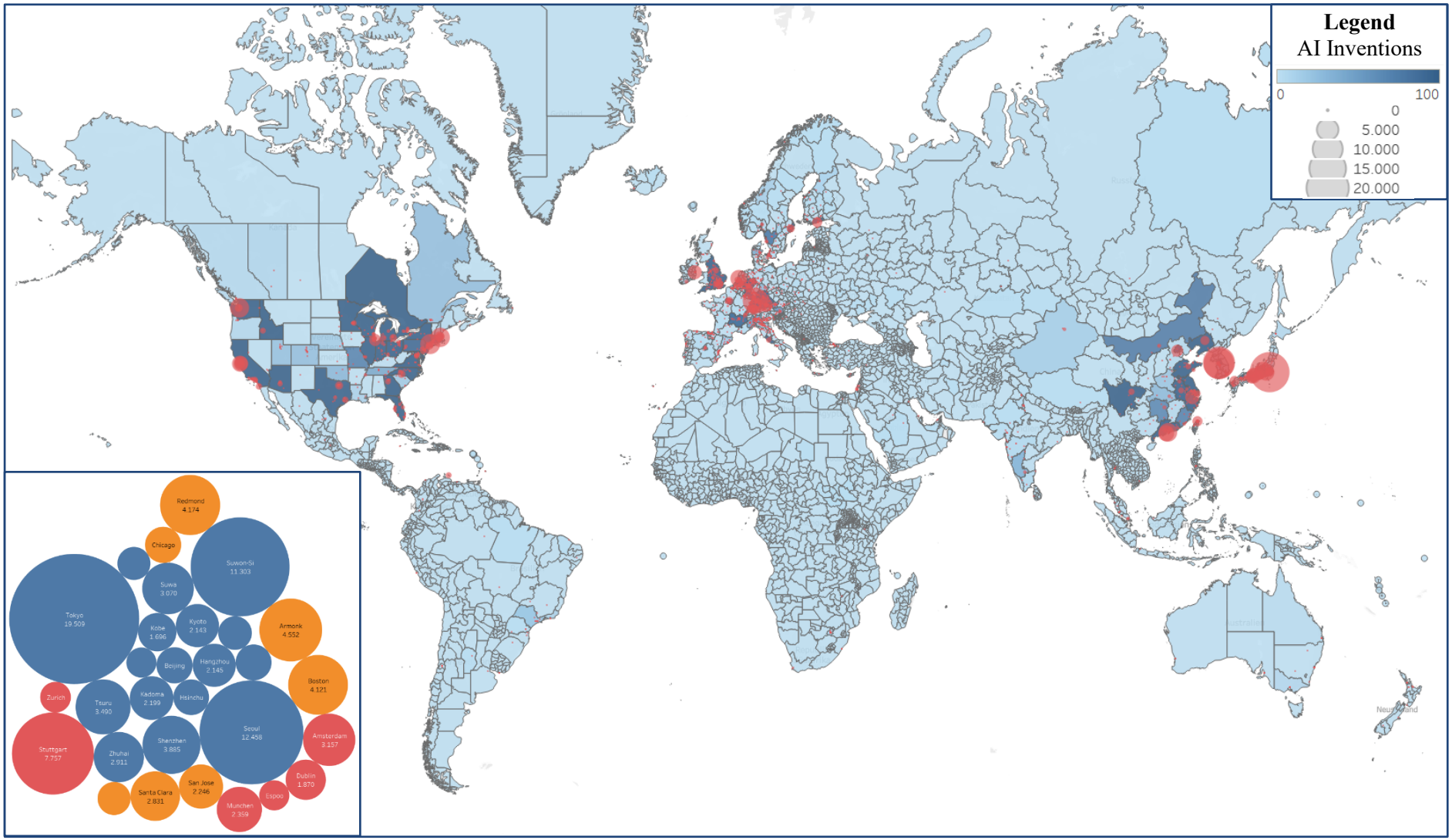

Figure 4.4: *Global Dispersion of AI Patents*

Our regression results are summarized in *Table 4.2*. Due to high multicollinearity between the AI inventions and functional inventions, we used different models to test the related hypotheses.

Variables	(1) Poisson AI Inventions	(2) Poisson AI Functional Inventions
Innovative Capabilities	5,837*** *(0,639)*	4,793*** *(0,788)*
Age	2,504*** *(0,806)*	2,156*** *(0,867)*
Revenue	0,333*** *(0,655)*	0,253*** *(0,809)*
Multinational Breadth	-0,306*** *(0,279)*	-0,450*** *(0,325)*
Multinational Depth	-0,127** *(0,249)*	0,350*** *(0,294)*
Industry Position	-0,013 *(0,052)*	-0,032** *(0,064)*
Share of Intangibles	1,329*** *(0,563)*	0,323*** *(0,619)*
Slack	-3,703*** *(3,328)*	-5,877*** *(4,217)*
Cluster	0,009*** *(0,007)*	-0,001* *(0,006)*
Lok-Like	-47,754	-39,974
Free Parameters	9	9
Number of Observations	69.864	69.864
Number of MNEs	4.529	4.529
Number of Iterations	73	70

Robust standard errors in parentheses
*** p<0,01; ** p<0,05; * p<0,10

Table 4.2: *Poisson Regression: Main Model*

The results show that our main independent variables *Age, Revenue* and *Innovative Capabilities* have a significantly positive effect on technical and functional AI inventions with *Innovative Capabilities* and *Age* demonstrating the highest coefficients. In this way, we can support *Hypothesis 1* and *2.* Conversely, the results for *Multinational Breadth* are significantly negative in both models. This is in line with *Hypothesis 3*, where we argued that the diversity of knowledge in different locations is not as important as access to specialized knowledge in a few locations. Regarding *Hypothesis 4*, the effect of *Multinational Depth* is also negative for all *AI Inventions* but turns significantly positive for functional applications. Thus,

Hypothesis 4 can only be partly confirmed. Despite this sign change for *Multinational Depth*, the results show only marginal differences between the effect sizes for technical and functional AI patents, suggesting that both dimensions are largely influenced by the same variables. To further validate these findings, the results of our robustness checks demonstrate the differences between multinationality variables (*Models 3* and *4*) as well as the differences between the two time periods under analysis. They will be discussed together with the results from our main model in the next section (*Models 5* to *8*).

5.7 Discussion

In all models, incumbency measured as the experience and size of MNEs is positively related to our main dependent variables. The estimations underline the assumption that AI inventions are driven by established firms that leverage their access to data and specialized knowledge. In this way, AI is different from other emerging technologies since it is not only applied in niche markets but rather used as a generic technology to increase overall efficiency (Teece, 2018). Regarding *Hypothesis 2*, the results for *Innovative Capabilities* indicate a positive relationship between previous expansion into other technological areas and the invention of AI technologies. Thus, MNEs with already diverse patent portfolios have benefits from past experiences with new technologies and higher diversity of their existing resources. This allows the conclusion that the development of AI technologies benefits from a wide range of potential use cases in MNEs, as diversified companies offer more applications for AI solutions.

The results also suggest that established, diversified companies are investing equally in basic AI techniques and functional applications. Nevertheless, the lower coefficient for *Innovative Capabilities*, *Age*, *Revenue*, and *Share of Intangibles* in *Model 2* indicates a more complex relationship between those factors and the commercialization of AI technologies. This finding can be explained by the relatively early stage of technological development as well as the current use of AI technologies for economic success. As the development of AI is still dominated by the improvement of AI techniques, fundamental techniques and functional applications are closely connected, so that the generation of innovative profits could directly emerge from the invention of a new, more powerful technique. Indeed, 70% of functional AI applications can be directly linked to one specific AI technique exemplified by the connection between improvements in image recognition and Apple's Face ID (WIPO, 2019a). Similarly, the high share of single-user

applications among AI inventions (Rammer et al., 2022) emphasizes the difficulties in commercializing the technology. Moreover, as the development is dominated by big tech firms, they generate innovative profits through the sale of fundamental AI solutions as well as specific functional applications. Thus, only highly specialized firms are developing readily applicable AI solutions.

Our findings regarding multinationality highlight the role of *Multinational Depth* for functional applications, but both dimensions are insignificant and even negative in their effect on fundamental AI techniques. The positive effect of *Multinational Depth* on functional AI applications, which is further highlighted in our robustness checks, demonstrates that access to knowledge in specialized, innovative locations seems crucial to commercialize AI technologies. Moreover, the difference between our and conventional measures is highlighted in our robustness checks, where the *Average Number of Subsidiaries* has a significantly negative effect on both dependent variables. This reinforces our assumption that these conventional measures of multinationality are rather referring to the size of the firm than to the real access to different resources. A comparison of the two sub-periods reveals that the effect of *Multinational Depth* and *Multinational Breadth* becomes positive for the time period from 2011 to 2020. This could indicate that the expansion into other countries becomes more prevalent as technologies mature but that multinationality is no precondition for the entry into new technologies. We conclude that multinationality is not as important to the development of new technologies for MNEs as their incumbency. Furthermore, the development of AI technologies is dependent on the density of operations in high-capability locations like Japan, China, and the United States.

Other interesting findings from our robustness checks are that the relevance of *Innovative Capabilities* diminishes over time, which indicates that firms with innovation experience are entering new technological fields at an early stage. Moreover, our measure of intangible assets often has significantly different effects compared to *Innovative Capabilities*. A possible explanation is that the *Share of Intangibles* does not refer to the technological diversification used in our main measure but could also represent a highly specialized portfolio of patents, copyrights, and other intangible assets. Thus, the effects do not necessarily oppose our original findings but rather highlight the contrast between MNEs' ability to develop inventions in related technologies and the capabilities needed to enter unrelated technological fields (Breschi et al., 2003). Finally, our *Cluster* variable, which indicates the city-level presence of subsidiaries in global AI hubs, does

show a marginally positive but significant effect throughout *Models 1-7*. This confirms our conclusion about the importance of specialized knowledge and clusters. A reason for the relatively low effect could be that the focus on the top 50 hubs might be too broad as AI is even more densely located in very few locations globally. This is supported by the descriptive results displayed in *Figure 4.4*. The implications of our findings are summarized in the next section.

5.8 Conclusion

The descriptive and inferential statistical analyses demonstrate that MNEs benefit from incumbency with respect to the development of AI technologies. This can be explained with the technological nature of AI, which requires extensive amounts of data to develop and test algorithms. Our dimensions of incumbency, namely experience and size, equip large multinational firms with the ability to apply their knowledge in the context of AI. This is facilitated by past entries into unrelated technological fields, as it helps MNEs to overcome inertia and risk associated with novel technologies. Access to diverse sources of knowledge measured through multinational breadth seems to play a minor role for successful inventions in the field of AI. Instead, MNEs benefit from their presence in a few high-technology locations that are specialized in the development of new technologies. Therefore, our findings show that geographical proximity and technological specialization still represent important factors for technological development (Harmancioglu & Tellis, 2018), because they allow the full exploitation of agglomeration effects (Alfaro & Chen, 2014) and the benefits of greater embeddedness (Halaszovich & Lundan, 2016).

Despite those findings, our essay also suffers from several limitations. First, our data provides evidence on the headquarter level of the MNE and although some measures involve subsidiary characteristics, our results remain on the macro level. Future research must therefore conduct country-, industry-, and company-specific analyses to investigate the determinants of inventions in generic technologies. Second, our regression analysis offers inconclusive results and can be extended through the collection of additional primary or secondary data and the use of other analytical methods. For instance, we could not include dummy variables as time-invariant effects are already accounted for with our fixed effects estimation. Thus, more sophisticated techniques could add additional value to the analysis. Finally, despite our efforts to account for the transaction of patents and companies, limitations in the original data sources will have

an impact on the value of our dependent and independent variables. While we have attempted to improve data quality through manual controls, the size of the dataset does not allow for an in-depth control of all data points. However, as our main findings are mostly consistent with reports on AI patenting (WIPO, 2019), we believe we have sufficiently approached the actual data and made a theoretical and data-driven contribution to the further development of the research topic.

Our essay offers several implications for future research. First, the literature on innovation in the MNE could benefit from research on young, emerging technologies as they provide evidence on the ability of MNEs to respond to and drive technological development. While some technologies might suit the advantages of smaller firms (Gassmann & Keupp, 2007), the development of AI technologies is facilitated by advantages of age and size. Similar to the findings on the location of innovation in ICTs (Forman & Goldfarb, 2022), there might be a tendency of generic technologies to be driven by large organizations instead of entrepreneurial firms. Another implication is that the positive view on multinationality as a source of knowledge might require more detailed analysis as the dimensions of multinationality play an important role. For instance, geographical, cultural, and institutional differences have also been outlined to affect the location and effectiveness of R&D activity (Schneider, Schulze-Bentrop, & Paunescu, 2010; Cano-Kollmann et al., 2016). Thus, these dimensions should be accounted for in future research. With our development of new measures of multinational breadth and depth, we hope to inspire thoughts in this direction. More generally, we hope to stimulate further research on the role of infant technologies in MNEs as they are the main vehicles of innovation and technology transfer across borders.

5.9 References

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5.10 Appendix

Appendix 4.1: Keywords Used for the Patent Search

AI Techniques

*ADABoost*OR*artific intelligen*OR*augmented reality*OR*bayes network*OR*bayesian network*OR*bio-inspired comput*OR*biologically inspired comput*OR*character recognition*OR*classification tree*OR*computation intelligen*OR*computational motion*OR*computer reason*OR*computer vision*OR*data mining*OR*decision model*OR*decision tree learn*OR*declarative programming*OR*deep learn*OR*deep_learn*OR*deep-learn*OR*deep structured learn*OR*description logistic*OR*distributed artificial intellig*OR*expert system*OR*fuzzy logic*OR*fuzzyfication*OR*game tree search*OR*genetic algorithm*OR*gradient tree boosting*OR*graphical model*OR*hidden markov model*OR*hierarchical learn*OR*hyperspectral imag*OR*image classific*OR*image detec*OR*image recognition*OR*image segment*OR*information extraction*OR*inductive logic*OR*inductive logic program*OR*instance-based learn*OR*intelligent agents*OR*intelligent personal assis*OR*latent dirichlet allocation*OR*latent represent*OR*latent semantic analysis*OR*learning algorithm*OR*learning model*OR*logic programming*OR*logical learn*OR*machine control method*OR*machine dial*OR*machine intelligen*OR*machine learn*OR*machine_learn*OR*machine-learn*OR*machine optimizat*OR*machine optimization*OR*machine phonology*OR*machine planning*OR*machine sentiment anal*OR*machine transl*OR*memory-based learn*OR*micro-operators sear*OR*mobile agents*OR*multilayer perception*OR*multi-agent system*OR*multi-task-lean*OR*natural language process*OR*natural language generat*OR*neural network*OR*neural_network*OR*neural-network*OR*object match*OR*object recognition*OR*object tracking*OR*ontology engineer*OR*pervised learn*OR*phonological anal*OR*predictive anal*OR*probabilistic reason*OR*probability logic*OR*probabilistic logic*OR*question answering syst*OR*random forest*OR*rankboost*OR*recommender syst*OR*regression tree*OR*reinforced learn*OR*reinforcement learn*OR*relational learn*OR*robotic vision*OR*robotic*OR*rule induction*OR*rule learn*OR*scene understand*OR*semantic anal*OR*search partial observ*OR*semi-supervised connect*OR*semi-supervised learn*OR*semi-supervised_learn*OR*semi-supervised-learn*OR*signal detect*OR*speaker recogn*OR*speech gener*OR*speech process*OR*speech recognition*OR*speech synthesis*OR*speech-to-speech*OR*stochastic gradient descent*OR*structured probabilistic model*OR*supervised learn*OR*supervised_learn*OR*supervised-learn*OR*support vector machin*OR*support vector network*OR*swarm intelligen*OR*task learn*OR*text mining*OR*text-to-speech*OR*transfer learn*OR*transfer_learn*OR*transfer-learn*OR*unsupervised learn*OR*unsupervised_learn*OR*unsupervised-learn*OR*XGBoost*OR*3D imag*OR*video analysis*OR*video segment*OR*video summariz*OR*virtual reality*OR*visual biometrics*OR*visual inspect*

AI Functional Applications

*3D imag*OR*augmented reality*OR*character recogn*OR*chatbot*OR*computational motion*OR*computer reason*OR*computer vision*OR*dictation system*OR*distributed artificial intelligen*OR*hyperspectral imag*OR*image classific*OR*image detec*OR*image recognition*OR*image segment*OR*information extraction*OR*intelligent agents*OR*intelligent personal assis*OR*machine control method*OR*machine dial*OR*machine optimizat*OR*machine phonology*OR*machine planning*OR*machine sentiment anal*OR*machine transl*OR*mobile agents*OR*multi-agent system*OR*natural language process*OR*natural language generat*OR *object match*OR*object recognition*OR*object tracking*OR*phonological anal*OR*predictive anal*OR*question answering syst*OR*recommender syst*OR*robotic vision*OR*robotic*OR*scene understand*OR*semantic anal*OR*signal detect*OR*speaker recognition*OR*speech gener*OR*speech process*OR*speech recognition*OR*speech synthesis*OR*speech-to-speech*OR*text-to-speech*OR*video analysis*OR*video segment*OR*video summariz*OR*virtual reality*OR*visual biometrics*OR*visual inspect*

Appendix 4.2: Description of Variables and Data Sources (Essay 3)

Variable	Description	Source
Dependent Variable		
AI Inventions	Number of AI patent applications per year	Orbis IP
AI Functional Inventions	Number of functional AI Patent applications per year	Orbis IP
Independent Variables		
Innovative Capabilities	Past inventions in different technological areas	Orbis IP
Age	Number of years since foundation	Orbis
Revenue	Operating revenue in thousand US$	Orbis
Multinational Breadth	Multinational technological breadth	GCI
Multinational Depth	Multinational technological depth	GCI
Number of Countries	Number of countries operating in	Orbis
Average Number of Subsidiaries	Average number of subsidiaries per country	Orbis
Control and Robustness Variables		
Industry Position	Industry position (Dummy for leader and laggard, based on return on equity with 50% as the threshold)	Orbis
Share of Intangibles	Share of intangible non-current assets	Orbis
Slack	Current ratio	Orbis
Cluster	Number of subsidiaries in cities considered as AI hubs (based on Chakravorti, Bhalla, Chaturvedi, & Filipovic, 2021)	Orbis

Appendix 4.3: Poisson Model: Robustness Checks

Variables	(3) Poisson AI Inventions Full Period	(4) Poisson AI Functional Inventions Full Period	(5) Poisson AI Inventions 2001-2010	(6) Poisson AI Inventions 2011-2020	(7) Poisson AI Functional Inventions 2001-2010	(8) Poisson AI Functional Inventions 2011-2020
Innovative Capabilities	5,871*** *(0,574)*	4,888*** *(0,833)*	1,446*** *(1,478)*	5,506*** *(0,655)*	1,414*** *(1,586)*	4,741*** *(0,843)*
Age	2,712*** *(0,811)*	2,318*** *(0,907)*	1,640*** *(1,533)*	2,287*** *(1,477)*	1,680*** *(1,642)*	-0,076 *(1,861)*
Revenue	0,118 *(0,677)*	0,190* *(0,864)*	2,102*** *(1,487)*	0,179 *(0,970)*	1,926*** *(1,584)*	0,679*** *(1,216)*
Multinational Breadth			-1,045*** *(0,469)*	0,669*** *(0,283)*	-1,000*** *(0,502)*	0,524*** *(0,339)*
Multinational Depth			-0,191 *(0,289)*	0,480*** *(0,250)*	-0,090 *(0,303)*	0,939*** *(0,302)*
Number of Countries	0,575*** *(0,733)*	-0,381** *(1,196)*				
Average Number of Subsidiaries	-18,062*** *(9,812)*	-15,077*** *(9,405)*				
Industry Position	-0,025** *(0,053)*	-0,041*** *(0,062)*	0,035* *(0,062)*	-0,014 *(0,067)*	0,038* *(0,068)*	-0,047** *(0,065)*
Share of Intangibles	1,201*** *(0,549)*	-0,237*** *(0,627)*	-1,371*** *(0,411)*	2,352*** *(0,474)*	-1,385*** *(0,418)*	1,003*** *(0,598)*
Slack	-4,098*** *(3,376)*	-5,258*** *(4,231)*	-3,036** *(2,975)*	0,735 *(3,325)*	-3,597** *(3,206)*	-4,434*** *(4,118)*
Cluster	0,017*** *(0,158)*	0,008*** *(0,841)*	0,008*** *(0,127)*	0,017*** *(0,008)*	0,014*** *(0,136)*	0,001 *(0,006)*
Lok-Like	-47,754	-40,008	-10,137	-27,689	-9,367	-21,763
Free Parameters	9	9	9	9	9	9
Number of Observations	69.864	69.864	30.037	39.827	30.037	39.827
Number of MNEs	4.529	4.529	3.960	4.451	3.960	4.451
Number of Iterations	61	59	58	66	53	69

Robust standard errors in parentheses
*** p<0,01; ** p<0,05; * p<0,10

Appendix 4.4: List of Top AI Patentors by Industry

Industry	Company	Country	*AI Inventions (Average)*	*Age (Average)*	*Revenue (Average)*	*Subsidiaries per Country*	*Number of Countries*
Electronics	SAMSUNG ELECTRONICS CO.,LTD.	KR	11.096	73	138.975.555	6	61
	LG CORP.	KR	8.458	64	29.143.595	5	54
	SONY GROUP CORPORATION	JP	3.090	65	53.058.688	13	51
	SEIKO EPSON CORPORATION	JP	3.070	69	10.829.080	3	30
	KONINKLIJKE PHILIPS N.V.	NL	2.774	120	32.613.534	9	89
	PANASONIC HOLDINGS CORP	JP	2.199	93	75.196.136	10	55
	NEC CORPORATION	JP	2.122	112	34.834.631	5	40
	MITSUBISHI ELECTRIC CORP	JP	2.016	90	36.916.462	5	40
	INTEL CORP	US	1.998	43	48.031.600	2	40
	FUJITSU LIMITED	JP	1.452	76	43.490.495	6	52
Information and Communication	INTERNATIONAL BUSINESS MACHINES CORP	US	4.552	100	88.225.600	4	86
	MICROSOFT CORPORATION	US	4.174	36	70.404.350	3	76
	TENCENT HOLDINGS LIMITED	CN	3.212	13	15.114.602	6	22
	SIEMENS AG	DE	2.359	164	93.465.358	12	105
	IROBOT CORPORATION	US	1.026	21	479.782	1	6
	ADOBE INC	US	620	29	4.561.204	2	30
	NUANCE COMMUNICATIONS, INC.	US	581	19	1.053.807	2	26
	KT CORPORATION	KR	569	30	9.393.641	1	10
	SK INC.	KR	532	58	36.837.087	7	28
	SAP SE	DE	390	39	18.581.411	5	69
Machinery and Equipment	FANUC CORPORATION	JP	3.490	39	4.137.189	1	27
	GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI	CN	2.887	20	12.277.565	1	5
	CANON INCORPORATED	JP	2.819	74	34.480.346	5	55
	APPLIED MATERIALS INC	US	802	44	9.649.756	2	20
	GRENZEBACH MASCHINENBAU	DE	755	51	67.007	2	30
	SIASUN ROBOT & AUTOMATION CO.,LTD.	CN	602	11	163.863	0	2
	RICOH CO LTD	JP	429	75	18.807.941	5	51
	MITSUBISHI HEAVY INDUSTRIES LTD	JP	361	77	31.002.600	6	42
	KOMATSU LTD.	JP	258	90	17.764.547	7	38
	FUJI CORPORATION	JP	221	77	817.097	2	6
Other Manufacturing	GENERAL ELECTRIC COMPANY	US	4.053	119	128.084.550	14	94
	KAWASAKI HEAVY INDUSTRIES LTD	JP	1.535	115	13.073.361	4	21
	HONDA MOTOR CO., LTD.	JP	1.223	63	105.679.973	10	37
	INTUITIVE SURGICAL INC	US	977	16	1.700.910	1	19
	BOEING COMPANY (THE)	US	931	95	72.237.650	3	35
	SAMSUNG HEAVY INDUSTRIES CO.,LTD.	KR	501	37	8.006.779	2	11
	RAYTHEON TECHNOLOGIES CORPORATION	US	454	77	48.622.750	7	83
	BAE SYSTEMS PLC	GB	324	12	23.621.413	9	50
	STRYKER CORPORATION	US	280	70	8.088.125	3	43
	AIRBUS SE	NL	234	11	60.100.053	8	51
Automotive	ROBERT BOSCH GESELLSCHAFT MIT BESCHRAENKTER HAFTUNG	DE	3.515	125	35.295.866	5	18
	HYUNDAI MOTOR COMPANY	KR	1.941	44	71.502.548	8	41
	TOYOTA MOTOR CORPORATION	JP	1.262	74	218.897.909	11	67
	DENSO CORPORATION	JP	672	62	35.467.432	5	36
	MERCEDES-BENZ GROUP AG	DE	529	13	167.132.999	11	54
	GENERAL MOTORS COMPANY	US	495	103	101.015.000	3	42
	HONEYWELL INTERNATIONAL INC	US	484	12	33.510.350	8	63
	STELLANTIS N.V.	NL	364	112	90.392.719	16	57
	HYUNDAI MOBIS CO.,LTD.	KR	218	44	20.247.521	3	5
	VALEO	FR	137	88	14.965.006	6	38

Industry	Company	Country	*AI Inventions (Average)*	*Age (Average)*	*Revenue (Average)*	*Subsidiaries per Country*	*Number of Countries*
Professional, Scientific and Technical Activities	ROBERT BOSCH INDUSTRIETREUHAND KOMMANDITGESELLSCHAFT	DE	3.697	125	207	8	78
	ACCENTURE PUBLIC LIMITED	IE	524	22	26.821.576	8	70
	JMV SE & CO. KG	DE	305	12	267.726	4	53
	XEROX HOLDINGS CORPORATION	US	298	105	15.025.350	3	53
	VORWERK SE & CO. KG	DE	148	128	1.413.105	2	23
	TELEDYNE TECHNOLOGIES INCORPORATED	US	47	51	1.882.990	4	27
	FESTO BETEILIGUNGEN GMBH & CO. KG	DE	42	86	1.667.200	2	61
	FAIR ISAAC CORPORATION	US	42	55	766.989	1	18
	NIELSEN HOLDINGS LIMITED	GB	41	88	3.330.850	5	57
	EXPERIAN PLC	IE	40	15	3.392.900	4	44
Wholesale and Retail Trade	ALIBABA GROUP HOLDING LIMITED	CN	2.102	12	17.269.116	17	16
	AMAZON.COM, INC.	US	583	17	86.204.860	4	27
	OCADO GROUP PLC	GB	366	11	987.949	2	6
	EBAY INC	US	336	16	7.439.317	3	42
	TE CONNECTIVITY LIMITED	CH	190	70	9.774.300	5	60
	SHENZHEN GOODIX TECHNOLOGY CO.,LTD.	CN	114	9	202.544	0	2
	RAKUTEN GROUP INC.	JP	93	14	4.610.632	5	13
	DENTSPLY SIRONA INC.	US	82	112	2.546.527	3	40
	MITAC HOLDINGS CORPORATION	TW	73	-3	505.423	7	11
	LAUNCH TECH COMPANY LIMITED	CN	44	19	88.749	1	3
Chemicals and Pharmaceuticals	FUJIFILM CORPORATION	JP	601	77	1.886.983	1	3
	HANWHA CORPORATION	KR	342	59	27.731.780	11	30
	NOVARTIS AG	CH	161	41	45.098.186	6	86
	BASF SE	DE	107	146	72.672.952	7	85
	PROCTER & GAMBLE CO	US	100	174	66.186.200	3	81
	ABBOTT LABORATORIES	US	86	123	24.040.574	5	84
	BAYER AG	DE	78	148	46.100.324	8	94
	ASAHI KASEI CORPORATION	JP	75	80	16.060.524	5	30
	SANOFI	FR	68	38	36.676.268	5	75
	PERRIGO COMPANY PLC	IE	67	124	2.723.059	5	36
Materials	POSCO HOLDINGS INC.	KR	324	43	41.006.159	5	21
	SUMITOMO ELECTRIC INDUSTRIES, LTD.	JP	264	114	22.167.394	9	45
	3M COMPANY	US	192	109	26.278.350	2	68
	HIWIN TECHNOLOGIES CORPORATION	TW	138	22	352.911	1	11
	LS CORP.	KR	118	75	8.303.013	4	13
	NIPPON STEEL CORPORATION	JP	80	61	40.711.766	9	31
	KOBE STEEL LIMITED	JP	60	106	16.592.282	5	20
	COMMSCOPE HOLDING COMPANY	US	39	35	2.938.948	3	37
	FUJIKURA LTD	JP	37	126	5.279.245	3	22
	VESUVIUS PLC	GB	33	307	2.427.943	3	42
Financial and Insurance Activities	JPMORGAN CHASE & CO	US	335	140	80.908.150	15	97
	THE CAPITAL GROUP COMPANIES, INC.	US	223	80	0	3	26
	ADVENT INTERNATIONAL CORP	US	60	27	0	8	82
	DELFIN S.A R.L.	LU	59	58	-1.526	16	69
	B&D HOLDING S.P.A.	IT	41	-2	2.493.172	5	57
	KKR & CO. INC.	US	36	35	1.188.789	5	52
	YANMAR HOLDINGS CO., LTD.	JP	25	99	2.314.300	2	30
	WORLDLINE	FR	24	38	919.785	3	44
	CHINA RESOURCES NATIONAL CORPORATION	CN	17	73	12.934.718	0	2
	DONGHEE HOLDINGS CO.,LTD	KR	15	39	537.639	1	4

Industry	Company	Country	*AI Inventions (Average)*	*Age (Average)*	*Revenue (Average)*	*Subsidiaries per Country*	*Number of Countries*
Water Supply, Sewerage, Waste Management and Remediation Activities	VEOLIA ENVIRONNEMENT	FR	16	158	26.202.850	18	93
	RENTOKIL INITIAL PLC	GB	4	87	3.650.173	5	67
	HARSCO CORPORATION	US	2	158	2.380.410	3	57
	CLEAN HARBORS INC	US	1	31	1.904.763	13	6
Transportation and Storage	UNITED PARCEL SERVICE INC	US	32	104	52.792.550	3	42
	EAST JAPAN RAILWAY COMPANY	JP	19	24	23.787.596	1	3
	AVIC INTERNATIONAL HOLDING	CN	18	32	6.766.324	0	2
	FEDEX CORP	US	14	40	41.341.152	3	54
	DSV A/S	DK	8	35	7.807.727	6	111
	DEUTSCHE LUFTHANSA AG	DE	8	85	32.431.634	6	52
	CENTRAL JAPAN RAILWAY	JP	7	24	14.679.861	1	4
	SHAWCOR LTD	CA	6	81	1.028.908	4	19
	NORWEGIAN CRUISE LINE HOLDINGS	US	5	45	1.819.270	4	28
	UNITED AIRLINES HOLDINGS, INC	US	4	43	27.178.000	2	5
Textiles	NITTA CORPORATION	JP	56	126	560.030	1	13
	HYOSUNG CORPORATION	KR	53	45	6.755.349	3	33
	POU CHEN CORPORATION	TW	23	42	6.648.856	11	16
	WINGTECH TECHNOLOGY CO.,LTD	CN	16	18	1.115.761	1	3
	K3 BUSINESS TECHNOLOGY GROUP	GB	15	20	72.254	3	16
	BANDO CHEMICAL INDUSTRIES LTD	JP	12	105	811.658	2	14
	KURABO INDUSTRIES LIMITED	JP	10	123	1.441.814	2	8
	TEX-RAY INDUSTRIAL CO.,LTD.	TW	8	33	206.747	4	10
	LEVI STRAUSS & CO.	US	8	158	4.545.460	2	37
	ASICS CORPORATION	JP	7	62	2.522.248	1	25
Real Estate Activities	LIFULL CO LTD	JP	6	16	131.741	1	6
	W. P. CAREY INC.	US	5	38	508.797	5	21
	SINYI REALTY INC.	TW	4	24	266.102	6	6
	WEWORK INC	US	3	1	434.810	3	16
	NORDSTJERNAN AKTIEBOLAG	SE	2	121	2.552.643	2	21
	MOVE, INC.	US	2	18	148.787	0	1
	SHANGHAIZHANGJIANG(GROUP)	CN	1	19	227.682	0	1
	KOREA LAND & HOUSING CONSTRUCTION	KR	1	2	8.570.129	0	1
Pulp & Paper	KIMBERLY CLARK CORP	US	53	139	17.786.005	2	60
	MAXELL, LTD.	JP	22	51	1.327.177	1	11
	DE LA RUE PLC	GB	18	190	721.781	2	25
	TOPPAN INC.	JP	16	111	14.093.390	4	28
	UNICHARM CORPORATION	JP	12	50	4.292.798	2	17
	TWENTY-FIRST CENTURY FOX, INC.	US	12	96	23.472.961	2	11
	SEALED AIR CORP	US	8	51	4.811.019	2	53
	DAIO PAPER CORPORATION	JP	6	68	4.239.412	1	7
	DS SMITH PLC	GB	5	71	3.947.607	4	48
	AVERY DENNISON CORPORATION	US	5	76	5.764.360	4	72
Public Administration and Defence	TECHNIP ENERGIES N.V	NL	4	53	1.418.749	3	13
Mining and Quarrying	SCHLUMBERGER N.V.	CW	288	85	27.272.493	11	57
	HALLIBURTON CO	US	221	92	19.380.250	3	21
	PGS ASA	NO	59	20	1.181.191	3	15
	SHELL PLC	GB	39	111	319.882.250	13	84
	TOTALENERGIES SE	FR	28	87	167.814.264	8	121
	NABORS INDUSTRIES LTD.	US	25	57	3.844.074	4	28
	DEVON ENERGY CORP	US	23	40	9.300.150	3	13
	GLENCORE PLC	CH	20	37	119.326.500	12	66
	CGG	FR	18	80	2.051.730	5	24
	OCEANEERING INTERNATIONAL INC	US	12	47	1.859.660	2	19

Industry	Company	Country	*AI Inventions (Average)*	*Age (Average)*	*Revenue (Average)*	*Subsidiaries per Country*	*Number of Countries*
Human Health and Social Work	LABORATORY CORP OF AMERICA HOLDINGS	US	22	33	6.218.170	7	34
	TELADOC HEALTH, INC.	US	18	9	128.122	1	13
	LAURITZEN FONDEN	DK	4	66	585.758	3	28
	HCA HEALTHCARE, INC.	US	2	43	32.718.300	6	8
	BML INC	JP	2	56	858.969	2	2
	I'ROM GROUP CO LTD	JP	1	14	83.695	0	2
	COMMUNITY HEALTH SYSTEMS INC	US	1	26	10.516.852	6	5
Food and Beverages	DOOSAN CORP.	KR	100	115	13.297.368	4	25
	INNER MONGOLIA YILI INDUSTRIAL GROUP CO.,LTD.	CN	77	18	5.853.390	5	24
	PALDO CO.,LTD	KR	39	28	243.170	1	3
	PHILIP MORRIS INTERNATIONAL INC.	US	19	164	23.410.850	2	69
	LIEN HWA INDUSTRIAL HOLDINGS CORPORATION	TW	19	60	183.732	6	9
	EGING PHOTOVOLTAIC TECHNOLOGY CO.,LTD	CN	17	11	332.456	0	2
	UNILEVER PLC	GB	14	121	42.377.374	7	107
	COCA-COLA COMPANY (THE)	US	13	119	33.408.500	3	60
	KOPPARBERGS BRYGGERI AB	SE	10	129	121.764	1	12
	BEAM SUNTORY INC.	US	8	76	3.217.745	3	36
Electricity, Gas, Steam and Air Conditioning Supply	THE CHUGOKU ELECTRIC POWER COMPANY, INCORPORATED	JP	47	60	11.045.537	1	6
	RWE AKTIENGESELLSCHAFT	DE	43	113	54.749.157	11	58
	VESTAS WIND SYSTEMS A/S	DK	37	66	8.045.731	3	57
	CHINA GUODIAN CORPORATION	CN	22	9	7.818.568	0	5
	THE KANSAI ELECTRIC POWER COMPANY INCORPORATED	JP	19	60	27.426.816	2	11
	BEIJING SIFANG AUTOMATION CO., LTD.	CN	18	17	272.038	1	3
	ENEL SPA	IT	15	49	74.526.655	21	51
	NATIONAL GRID PLC	GB	14	21	17.479.211	26	15
	TAIWAN POWER COMPANY	TW	7	65	15.694.887	1	2
	AES CORPORATION (THE)	US	4	30	11.864.350	7	43
Education	HELSINGIN YLIOPISTO	FI	4	371	383.637	1	3
	HEALTHSTREAM INC	US	4	21	109.036	1	3
	BENESSE HOLDINGS INC.	JP	2	56	3.737.582	4	14
	YDUQS PARTICIPACOES S.A.	BR	1	41	512.952	1	3
Construction	TAIKISHA LTD.	JP	68	98	1.806.638	2	23
	QUANTA SERVICES INC	US	35	14	5.390.998	8	15
	HYUNDAI ENGINEERING & CONSTRUCTION CO.,LTD.	KR	18	64	10.277.655	1	7
	OBAYASHI CORPORATION	JP	17	119	15.023.091	4	11
	ECOLAB INC	US	15	88	8.738.385	4	90
	VINCI	FR	8	112	41.499.884	14	119
	SEKISUI CHEMICAL CO LTD	JP	7	64	9.310.892	5	19
	CHINA RAILWAY GROUP LIMITED	CN	7	61	61.046.269	0	1
	KAWADA TECHNOLOGIES INC	JP	5	89	664.387	1	3
	IIDA GROUP HOLDINGS CO., LTD.	JP	5	44	4.455.419	1	4
Arts, Entertainment and Recreation	INTERNATIONAL GAMES SYSTEM CO.,LTD	TW	9	20	79.683	2	2
	MULTICHOICE GROUP LIMITED	ZA	4	16	1.036.054	2	19
	FUSHENG PRECISION CO., LTD.	TW	3	58	151.402	4	3
	SIX FLAGS ENTERTAINMENT CORPORATION	US	1	50	1.078.987	2	4
	GAMANIA DIGITAL ENTERTAINMENT CO.,LTD.	TW	1	16	196.834	5	5
Agriculture, Forestry and Fishing	LIVESTOCK IMPROVEMENT CORPORATION LIMITED	NZ	1	102	113.778	1	5
	HOKUTO CORPORATION	JP	1	47	446.486	1	4

Industry	**Company**	**Country**	***AI Inventions (Average)***	***Age (Average)***	***Revenue (Average)***	***Subsidiaries per Country***	***Number of Countries***
Administrative and Support Service Activities	INTERDIGITAL, INC.	US	202	39	324.425	1	4
	QINETIQ GROUP PLC	GB	56	10	1.644.751	5	10
	NETFLIX, INC.	US	29	14	5.701.216	1	8
	SECOM CO LTD	JP	24	49	7.119.227	4	21
	TAIWAN SHIN KONG SECURITY COMPANY LIMITED	TW	10	31	197.429	3	3
	SG HOLDINGS CO LTD	JP	6	54	2.543.615	4	36
	ALLEGION PLC	IE	4	140	1.066.150	4	26
	ROESLER HOLDING GMBH	DE	3	78	132.544	1	9
	NICE HOLDINGS CO.,LTD	KR	3	25	630.155	2	4
	EUROPCAR MOBILITY GROUP	FR	3	62	1.209.573	3	28
Accomodation and Food Service Activities	HOTEL LOTTE CO.,LTD	KR	2	38	2.135.310	2	12
	PAPA JOHNS INTERNATIONAL INC	US	1	27	1.296.970	2	5
	MARRIOTT INTERNATIONAL INC	US	1	84	13.012.250	6	77
	GOURMET MASTER CO. LTD.	TW	1	6	340.349	6	8

6 Thesis Conclusion

This thesis sought to explain how institutional and technological developments interact in the context of economic development and how the MNE as an exogenous source of institutions and technologies can shape the development process. We extensively reviewed the theoretical foundations and the current research findings on economic development as well as institutional and technological change to establish a guiding framework for the three essays of this thesis. Moreover, we introduced the MNE as an actor that can stimulate changes in the host country, thereby affecting the equilibrium of transactional and technological uncertainty. Based on this framework, the three essays focused on the relation between institutions, technology, and MNEs to exploratively analyze the existence and magnitude of such interrelations in the context of development and change. *Essay 1* reviewed empirical findings on the institution-technology nexus of economic development and enabled a deeper understanding of the role and dimensions of institutions and technologies for economic development. *Essay 2* examined the potential of green technologies introduced by local and foreign firms to trigger institutional changes in the form of green policy introduction. *Essay 3* explored the ability of MNEs to drive technological development, more specifically, the invention of AI technologies, by focusing on advantages of incumbency and multinationality. Altogether, our essays complement the broad framework established in the first chapters with additional theoretical depth, topic-specific examples, and empirical evidence. To summarize our research findings and extract the overall implications from our essays, we will review them against our initial framework and derive theoretical and practical implications.

6.1 Theoretical Implications

This thesis built strongly on institutional theory as a core perspective across economic disciplines to explain micro- and macro-level interactions between non-economic and economic actors. By defining formal and informal dimensions, complementarity, and dynamism as the core principles of institutions, we were able to build a framework of transactional and technological uncertainty to explain outcomes of economic changes. In *Essay 1*, we tested those assumptions by summarizing the results from a total of 439 studies on the relation between institutions, technologies, and development. We found evidence of the differential impact of institutional, technological, and development dimensions and the time period under

study, and further demonstrated the mutual dependence between institutional and technological development. *Essay 2* added to our understanding of this relationship as we examined the effect of technological development on institutional change and the origins of such development. Our findings demonstrate that the introduction of new technologies provides a significant trigger of institutional changes. However, in accordance with our theoretical framework, the sources of such changes can be endogenous and exogenous depending on the incentive structures in the country. Plus, rising transactional uncertainty among economic actors and the uncertainties stemming from the introduction of new technologies make the outcome of such changes difficult to predict. In *Essay 2*, we used resource-dependency and new technologies to approach the concept of uncertainty through changes in the sources of competitiveness – however, future studies need to examine how precisely the interaction of actors and their incentives influence such change processes. *Essay 3* provides evidence on the ability of MNEs to overcome technological uncertainty and drive the development of novel technologies. In that way, they are able to help countries in overcoming endogenous barriers, whereas future studies should target these transition processes in LDCs and developing countries.

More generally, our results highlight the need for studies adopting institutional theory to account for the theoretical complexities outlined by institutionalists. While scholars like North (1990), Scott (1995), and Hall and Soskice (2001) have long established the role of institutional complementarities and the existence of different institutional fields, other economic disciplines have addressed these issues only seldomly. Notable exceptions are the innovative approach by Judge, Fainshmidt, and Brown III (2014) or the explorative studies by Bailey (2018) and Steel, Beugelsdijk, and Aguinis (2021) who combined the use of institutional approaches with the necessary theoretical depth and novel methods. Future studies should pay more attention to the different facets of institutional development and address topics like the joint impacts of different dimensions as well as their substitutability. Furthermore, these studies should avoid using aggregated measures and instead focus on sub-components of the institutional environment. This would not only help researchers to achieve more detailed results about the impact of institutions but also guide policymakers in understanding the effects of different measures. In this way, a major contribution of this thesis is to showcase how the underlying theoretical and empirical principles of institutional theory can be addressed in an empirical study.

As a second major theoretical perspective, our thesis focused on the innovation literature to develop a framework of technological development and the related uncertainty. As the process of development can be divided into the stages of invention, innovation, and diffusion, we argued that institutions can support or hinder each of these phases differently as well as the transition between those phases. In this way, institutions reduce or increase the uncertainty that accompanies technological development. In *Essay 1*, we examined the correlation of these three stages with economic and institutional variables, thereby identifying different effects for each dimension. Since a positive effect of technological factors on economic development facilitated the positive effect of institutions on economic development, this essay provides support for the framework established in *Chapter 2.4*. *Essays 2* and *3* further explore the dynamics and effects of technological development. In our study on the relation between green technologies and green policy introduction, we find that new technologies can indeed facilitate the green transition of countries. To do so, there needs to be a shift in the incentive structures of powerful actors, indicated through the patenting activity of local and foreign firms. A key takeaway from this study is that the technologies introduced by domestic and foreign MNEs can be especially vital for policymakers to generate support for green policies. These findings support our assumptions on the MNE as an actor influencing institutions and technologies on a global scale. *Essay 3* complements this finding by demonstrating that these firms can be innovators not only in their respective technological field but that they can also drive the development from one to another technological paradigm.

These findings indicate the need to further explore the role of different types of firms as drivers of technological and institutional change and the circumstances under which they can bring about such changes. Moreover, the distinction between three stages of technological development allows researchers to explore the determinants of development in each as well as the relation between those phases. Thus, we argue that more scholars should focus on the origins of technological development and the co-determination with institutions to examine how countries can overcome institutional deadlocks and technological lock-ins. Contrary to other studies on infant technologies (Lagerstedt Wadin, Ahlgren, & Bengtsson, 2017; Birkinshaw, Visnjic, & Best, 2018), we explore the roles of incumbents characterized by different levels of organizational complexity and inertia and how these factors are linked to shifts in the macroeconomic environment.

As the third main theoretical perspective, we introduced the MNE as a core actor in the global economy and integrated findings from the IB literature into our framework. While several scholars have already utilized concepts from IB in the development literature (Durán & Úbeda, 2005), those studies have mainly treated the MNE as a source of investment. Instead, we follow concepts of coevolution (Cantwell et al., 2010) to combine micro-level approaches from the institutional and innovation literature to portray the MNE as a driver of changes on the country level. This relation is the main focus of *Essay 2*, where the effect of MNEs on the introduction of green policies is examined. While we operationalize the influence of MNEs through patenting activity, future studies could focus on other effect types and explore the influence mechanisms of MNEs through qualitative research methods. *Essay* 3 complements these results with factors that enable MNEs to dominate a new technological paradigm across countries, which brings relevant implications to the study of ownership and location factors in the global economy. In that way, our approach relates to the original definition of MNEs as an entity with superior productivity over actors in the home and host country.

We believe that the conceptualization of MNEs as actors of change in the IB literature remains superficial, with a few exceptions (Kwok & Tadesse, 2006; Regnér & Edman, 2014; Fortwengel & Jackson, 2016). In this context, our research demonstrates that existing models are not fully equipped to explain the active influence of MNEs, but that IB researchers need to draw on other economic theories to fill this gap in the literature. Therefore, IB can serve as a linking piece between micro-level theories of institutional or technological change and macroeconomic models of development (Gereffi & Lee, 2016; Jeong & Peksen, 2017). In that sense, *Essays 2* and *3* demonstrate the power of IB research in explaining the economic realities of a global economy. Therefore, our essays should be seen as explorative endeavors to attract more scholars to study economic development from an IB perspective.

Finally, the original aim of this thesis was to investigate the effect of the concepts of institutions and technology on economic development. While the definitions of economic development were largely taken for granted throughout this thesis, we were able to derive theoretical implications for the study of economic development, especially in our first essay. As one of the most-researched topics in the economic discipline, *Essay 1* demonstrates that scholars need to clarify their understanding of development at the beginning of their study. As different dimensions of institutions and technologies lead to significantly different results,

this would contribute to a more nuanced picture of the determinants of economic development. Moreover, we presented the meta-analysis to reveal the true effect of institutions as a main development determinant, thereby overcoming the complexity and blurred relations resulting from a wide variety of different studies. As empirical relations are sensitive to changes in theoretical and methodological underpinnings (Levine & Renelt, 1992; Orr & Scott, 2008), this method can help researchers and policymakers to draw more well-founded conclusions on the factors contributing to economic development.

In sum, we were able to explore two of the most important factors of economic development by connecting micro-level change processes to developments on the meso and macro level. Indeed, what is missing in many development studies is the transfer of the results to a broader picture. While change and development can safely be regarded as micro processes, it is the developments that are visible on the macro level that concern many economists and policymakers. Although this might be a flaw of the economic literature per se, development studies need to reconcile generic theories of development with their findings on the micro level. While the contributions made in this thesis can only be seen as an initial attempt, they reflect on many of these micro-macro links and highlight the importance of change agents and incentive structures for macroeconomic development. In this way, we were able to explain the emergence of existing phenomena like the resource curse or the middle-income trap through a lack of productive opportunities, the existence of vetoplayers, and paralyzing uncertainty. Therefore, future studies on economic development should further emphasize the relation of institutional and technological changes, agency, and opportunities and translate those to developments on the macro level.

6.2 Practical Implications

Besides the theoretical implications derived from *Essays 1*, *2*, and *3*, this thesis also offers several implications for practitioners, namely policymakers and managers. A central takeaway from our discussion of institutional theories is that institutional changes cannot simply be achieved through the introduction of new rules. Instead, it is the interaction of formal and informal institutions as well as the influence of technologies that determine the effectiveness of governance structures. This also relates to the issue of complementarity, where different institutions affect each other positively or negatively. Therefore, policymakers must understand their own institutional environment and how new rules and regulations

might affect existing incentive structures and institutional frameworks. This is especially true for emerging economies, which are characterized by a permanent reuse of past institutions even after policy changes and economic transformations. As can be seen with the liberalization movements of Asian economies in the 1980s or the transition of former Soviet countries in the 1990s, some countries were more successful with similar institutional changes than others (Meyer & Peng, 2005). Our theoretical framework of transactional uncertainty offers explanations for these differences as existing power structures and the ineffectiveness of policymakers limited the support for new policies, while economic actors in other countries were more open to changing their incentives towards a productive transition. Thus, we believe that our understanding of institutions offers an important perspective for policymakers to understand their impact on institutional change.

In terms of technological change, it is important to acknowledge that the global economy has drastically changed in the last decades and that growth recipes of the past are no longer viable today. While the East-Asian countries were able to catch up in the 1980s by negotiating access to necessary resources, the global economy has become an integrated platform for the exploration and exploitation of resources and capabilities (Dicken, 2015). Increasing competition and decreasing costs of internationalization make it more difficult for latecomer countries to establish a sustainable development track. For this reason, it is the simultaneous invention, application, and distribution of resources and, more importantly, technologies that drives economic development (Stiglitz & Greenwald, 2014). Indeed, *Essay 2* demonstrates how the introduction of green technologies has the potential to support structural transformation processes. Fu, Emes, and Hou (2021) find that AI has similar effects on the transformation of China and *Essay 3* provides evidence that MNEs play an integral part in the development and diffusion of this technology. Therefore, governments need to invest in the necessary infrastructure and capabilities to enable an effective utilization of technologies for economic development. Moreover, property rights and antitrust laws need to be organized in a way to allow for the diffusion of these technologies.

Our thesis also offers a new perspective on the role of MNEs for the invention and diffusion of technologies in the global economy. While MNEs have been mainly portrayed as exploiters of local resources or as valuable sources of investment and development (D'Amelio, Garrone, & Piscitello, 2016; Wu, Ma, & Zhuo, 2017), the focus on micro-level incentives allows for a more realistic picture of the

advantages and disadvantages from MNE investments. Where local conditions facilitate the exploitation of local resources, MNEs are less likely to engage in linkages and upgrading since a flawed institutional environment is a source or constraint to the MNE's competitiveness. Policymakers need to create additional incentives for MNEs to share their technologies, utilize the country for additional value-adding activities, and contribute to the local economy in more productive ways. In contrast, when local actors are susceptible to change, policymakers could make use of locally embedded and powerful domestic and foreign MNEs as potential triggers of successful economic transitions. In sum, as MNEs operate at the technological frontier and are constantly seeking to invest in areas where novel capabilities help them to explore new sources of competitive advantage, the main task of developing countries is to establish such capabilities and replace exploitative with explorative investments. As institutions play a key role here, policymakers need to balance the attraction of productive investment with the distribution of the generated profits and technologies to broaden the opportunities of local firms and achieve comprehensive sustainable development.

In addition to the generalized findings on technologies, institutions, and MNEs, *Essays 2* and *3* provide evidence on the global technological and institutional dynamics in the area of AI and sustainability. Both are among the most important topics of our time that bring unique challenges and opportunities to the future of the global economy. However, while AI technologies are constantly making drastic improvements, recent survey evidence indicates that only 1-3% of all firms in the United States use a specific AI-related technology in the production of goods and services (Zolas et al., 2020). Similarly, only 5,8% of German firms use AI-related technologies, whereby 3,5% use externally produced AI, 0,9% were single-users, and 1,4% used internally and externally developed AI (Rammer, Fernandez, & Czarnitzki, 2022). Our essay confirms these survey findings, namely that AI technologies are clustered in a few leading firms and that the development of productive business models is dependent on access to highly specialized knowledge. Nevertheless, we conclude that the diffusion of AI technologies and enablement of smaller firms in other countries helps the translation of fundamental technologies into functional applications and might spark a transition into a new technological paradigm.

In terms of the green transition, evidence suggests that the global economy is lagging behind the climate goals and that the contributions of corporate efforts are not understood by researchers and

policymakers (van Tulder, Rodrigues, Mirza, & Sexsmith, 2021). Despite an increasing number of firm-level sustainability initiatives, for instance through sustainability reports and self-audits, those initiatives are often not integrated into the business models, therewith increasing the likelihood of greenwashing or bluewashing[28] (van Zanten & van Tulder, 2018). Thus, our study uses green patents as an indicator of a firm's investment in sustainability and their goal to transform new technologies into competitive advantages. Although policies regarding the sustainable utilization of existing technologies are necessary to reduce CO2 emissions in the short run, the development of new technologies should also be targeted by economic policies. As the International Energy Agency (IEA, 2021) points out, most of the global reductions in CO2 emissions until 2030 will come from technologies existing today; however, until 2050, nearly half of the CO2 reductions will come from technologies that are currently in the prototype stage. Thus, our study displays the current state of patenting activity and the global dispersion of policies in this field. Together with our findings on institutional change, we believe that technological developments can lay the foundations for the change of incentives among economic and political actors, which allows policymakers to introduce the necessary policies.

Finally, policymakers must understand the dynamics of development and which factors might contribute to successful economic improvements at which time. As our meta-analysis in *Essay 1* showed, the effect of technological improvements on development has decreased since the 1990s, whereas the effect of institutional development has remained on a high level. This reflects the findings of several authors about declining innovativeness and growth potential of ideas (Bloom, Jones, van Reenen, & Webb, 2020) and general productivity decreases (Gordon, 2000). As a result, policymakers should move the focus of their attention from the support of existing power structures and the protection of the status quo to the enablement of people and the embracement of change. This could mean the unleashing of market forces in the neoclassical sense; however, *Essay 2* has shown the relevance of incentives for the outcome of such changes. Therefore, policymakers should not necessarily limit the market power of economic actors as they can drive technological development as depicted in *Essay 3*, but they need to reduce their bargaining power and the reliance on such actors in order to induce incentives for continuous improvements. This

[28] Greenwashing refers to forms of advertising that overstate firms' commitment to sustainability in order to persuade the public. Bluewashing expands this definition with a focus on responsible social practices.

would also mean a more holistic approach to economic development, where the interplay of institutions and technologies is facilitated by accounting for the productive interaction between those, a finding that is very much in line with other recent contributions to the development literature (Mazzucato, 2021). Only when the underlying incentives of local and foreign actors towards institutional and technological development are integrated into new policy initiatives will the current political and economic system provide solutions to the challenges of our time.

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