# ESSAYS ON THE INSTITUTIONAL AND FINANCIAL FOUNDATIONS OF LOCAL ECONOMIC DEVELOPMENT, MOBILITY, AND GROWTH

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A Thesis Submitted for the Degree of PhD
at the
University of St Andrews

2019



Identifiers to use to cite or link to this thesis:

DOI: https://doi.org/10.17630/10023-19102
http://hdl.handle.net/10023/19102

# Essays on the Institutional and Financial Foundations of Local Economic Development, Mobility, and Growth.

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This thesis is submitted in partial fulfilment for the degree of

Doctor of Philosophy (PhD)

at the University of St Andrews

January 2019

## Acknowledgements

I have written this thesis as a Ph.D. student at the University of Saint Andrews. I am indebted to my advisors Daniel Oto-Peralías, Dimitris Chronopoulos, and John Wilson for helpful comments and advices during my Ph.D. process.

I would also like to thank Professor Stelios Kotsios, Professor Nikolaos Milonas, Dr. George Dotsis, Professor Nikolina Kosteletou, Dr. Violetta Dalla, Dr. Nick Drydakis and Professor Yianis Varoufakis for their motivation, support, and encouragement during my first steps of academic career.

Moreover, this thesis would not have being possible without the generous financial support of School of Management of the University of St Andrews.

Last but not least, I would like to thank my family and friends for their unwavering support during the difficult years of my M.Phil. and Ph.D.

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# ABSTRACT

This thesis consists of three independent chapters. Chapter 1 describes briefly several schools of thoughts and recent interest regarding economic development. Moreover, it explains the role of historical shocks on economic development and provides an outline of this thesis. The second chapter examines whether there is any long-term effect arising from ancient colonialism on current economic development along the Mediterranean Sea at the local level. More specifically, it is argued that ancient Greek, Phoenician, or Etruscan colonies that were established after the 8$^{th}$ century BC, left their institutional, technological, and cultural legacy perennially. Therefore, in places where there is at least one ancient colony from the above-mentioned civilizations, there is higher development at the beginning of the 21st century. The main variables consist of the coordinates of ancient colonies as well as light density at night from the space as an index of development at the local level. The findings suggest that, indeed, in places that we observe at least one Greek, Phoenician and/or Etruscan ancient colony there is higher recent economic development. Several robustness checks validate the initial hypothesis. In the third chapter, it is assumed that the Australian localities which were colonised earlier by Europeans after 1788, experienced higher economic development nowadays. Due to the limitation of technology, the size of Australia and the dissimilar relationships between Europeans and Aboriginals along the Australian coasts, cities were established almost in a random way and time. It is suggested that cities follow a dynamic process of development based on several forces such as technology adoption, institutional development etc. Thus, time is a significant parameter in explaining the development of urban cities. Chapter 4 examines the role of financial environment on intergenerational mobility. In 1994, the United States adopted a reform which permitted the interstate banking. As a consequence, banking competition at the local level increased and impacted on the real economy via changes in household incomes, entrepreneurship, innovation and state-level GDP. While prior literature has provided insights as to the interconnections between these banking reforms and banking, household, firm and macroeconomic outcomes, to date there is no evidence regarding the implications of banking sector deregulation for the economic mobility of individuals. In Chapter 4, the results of an extensive empirical analysis suggest that banking reforms affected the local financial environment and influenced the rates of intergenerational mobility for children.

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# CHAPTER 1: INTRODUCTION

## 1.1 Economic Development: Back to the Origins

Economic theories of economic development date back to the 18th century. Smith (1776) suggests that economic development could be achieved on the basis of the division of labour and the 'invisible hand'. The former, according to Smith, would lead to a specialised work force, which would maximise overall productivity and ensure social welfare. The latter, as an unseen force, would regulate markets through the power of personal incentives. He assumes that governments are inefficient in supervising economic activity, and therefore argues that free trade, private property, and competition should be the main engines for economic development. A century later, Marx (1867) suggests a radically different model of development based on social or public ownership of property. His theory claims that capitalism is inextricably linked with labour exploitation, wealth accumulation by a minority of people, poverty, and inequality. His position is that socialism would be the ideal model for sustainable and equitable growth and development.

Models forwarded by Rostow (1960), Harrod (1948) and Domar (1947) suggest that capital investment is the major force driving rapid economic growth. These models state that development is a multi-stage process. Every country needs to follow a specific pattern in order to move from an underdeveloped to developed status. Nevertheless, later theories acknowledge that each country follows a distinct development path. A significant contribution comes from Solow (1956), who points out the importance of population growth, education, savings, and investment, as well as exogenous technological innovations. Moreover, he claims that in a world with open economies, technology transfers and frictionless foreign investment, developing countries' income levels might eventually converge with those of the developed world. More recent theories by Romer (1986), Lucas (1988), and Aghion and Howitt (1992) consider the positive role of government intervention in promoting human capital formation, private investment, and the growth of technology-intensive industries. Although traditional theories examine a multitude of potential forces that can influence growth, recent research has moved the focus onto geographical, institutional, and cultural determinants of economic development. Sections 1.2 and 1.3 explain the role of environmental and individual factors, as well as historical shocks that can change the development trajectories of countries and regions.

## 1.2 Determinants of Economic Development

One of the most crucial questions in economic literature concerns the forces that drive economic development. A plethora of research shows that geographical conditions can have a substantial impact on economic development across countries and regions. Gallup et al. (1999) investigates differences in economic development on a global level, and finds that tropical and landlocked areas face significant disadvantages in terms of creating wealth over the long-run. On the other hand, coastal countries with access to open seas tend to experience higher levels of economic development. Moreover, they argue that population density is positively related to development in coastal regions, but negatively related in inland areas. Other studies, meanwhile, try to identify specific environmental conditions that drive economic development. Dell et al. (2009) emphasise the role of temperature, arguing that 23 per cent of the variance in incomes across countries can be explained by differences in temperature. Furthermore their reasearch at the local (county) level in the United States show that a temperature decrease of one degree Celsius is associated with up to two per cent increase in income per capita.

Other significant geographical/environmental factors driving economic development include average precipitation, terrain slope and the suitability (quality) of soil for agriculture. Barrios et al. (2010) examine the effects of rainfall on development across the world using climate data. They find that precipitation levels have a significant impact on Africa, but not other developing countries. More specifically, they claim that the decline in rainfall that Africa has witnessed in recent decades increased its GDP per capita gap with the rest of the developing world by up to 40 per cent. Regarding the terrain slope, Nunn and Puga (2012) argue that although it is negatively associated with development in the huge majority of countries, this is not the case for Africa. They find that rugged terrain within Africa was a natural protection against slave traders from the 15th until the 20th century. Therefore, the more rugged areas experienced lower slavery and higher long-term economic development. Galor and Ozak (2015) highlight the role of soil quality and land productivity in long-term development. Their findings show that the suitability of land for the production of high-calory foods is associated with comparatively higher growth in certain countries, especially during the pre-industrial era. Overall, geographic and climatic factors have played a significant role, at both a national and a regional level in long-term economic development.

Apart from geographical conditions, recent theories also associate human genetic characteristics with economic progress. For instance, Comin, Spolaore and Wacziarg (2013) posit that the ‘genetic distance’ between two nations matters in terms of their divergent economic development. Genetic distance is an index of different local traditions, cultural characteristics, habits, norms and human traits that influence long-term economic development. In the same vein, Ashraf and Galor (2013) argue that recent economic development is associated with genetic diversity. They measure the distance from East Africa (specifically Addis Ababa) as a proxy for human genetic characteristcs, and their findings suggest that civilisations with very high or very low degrees of genetic diversity, such as African and Native American populations, experience lower levels of development. Besides, populations with intermediate levels of genetic diversity, such as Europeans and Asians, enjoy higher rates of development.

## 1.3 The role of historical shocks

Although a huge body of research associate recent economic activities with environmental conditions and individual human characteristics, economic literature also highlights the influence of historical events on long-term economic development. Significant historical events act can determine the path of development at the state and local level. Akçomak et al. (2016) find that a religious community (Brethren of the Common Life) in Netherlands during the 14th century, which increased the level of book production at the local level, was a significant positive local shock for human capital accumulation and long-term economic development.

One of the most important historical shocks for many countries was the experience of colonisation. During the 16$^{th}$ century, European countries established colonies across the world, transferring with them their institutions (such as legal systems), human capital, culture, and technology. These colonisations were an exogenous shock, which affected the development of many regions. A pioneering study by Engerman and Sokolof (2000) investigates the effects of early colonial institutions on economic development. The authors' principal argument is that places with either an abundance of mineral resources (such as gold) or fertile regions producing cash crops (such as rice, sugar and tobacco) adopted institutions benefited the transfer of slaves for harvesting purposes. Moreover, the rise of concentrated political hierarchies (typically oligarchies), and the unequal distribution of land ownership led to extreme social inequality. This affected negatively the chances for the majority to improve their financial status, human capital, and political power. Since colonial elites had the political power to establish permanent rules, laws, and institutions that favoured their respective class, inequality acquired a persistent character. Thus, persistency acted as a significant link between early oligarchic institutions and long-term economic development. Nevertheless, the authors do acknowledge that colonised nations, which initially had more egalitarian societies and less centralised political hierarchies experienced higher rates of economic development in the long run than those with authoritarian traditions and concentrated hierarchical structures.

Acemoglu et al. (2001) revisit the theory of the persistent effects of colonial institutions and their impact on long-term economic development. It is argued that European colonisers treated countries whose climate and tropical environment caused diseases such as malaria (and thus high rates of mortality) differently from places where such hazards were less prevalent. Therefore, tropical, and disease-prone regions were typically exploited for their resources through ‘extractive’ institutions, whereas other regions benefited from ‘inclusive’ institutions. Inclusive institutions such as the rule of law and property rights, promoted a more egalitarian environment, and higher levels of development. Overall, Acemoglu et al. (2001) argue that these early institutions persist to the present day , thus determining institutional frameworks and current economic development.

Alongside the above seminal papers on colonial institutions and economic development, there is a substantial literature that examines the effects that European colonisation had from the 16$^{th}$ century onwards. Recent research investigates the persistent effects of colonial institutions by examining various sub-national regions. For instance, Bruhn and Gallego (2012) examine the principal economic activities during the early colonial period in 345 sub-national areas of the United States, and the current economic development in those areas. Regions with early institutions based on the exploitation of labour experience lower rates of development in the present day, thus supporting earlier state-level findings by Engerman and Sokolof (2000) and Acemoglu et al. (2001).

Another recent study on the role of early institutions at the local level is provided by Michalopoulos and Papaioannou (2013). Their unit of observation is either the pre-colonial ethnic groups in Africa (from George Peter Murdock’s Ethnographic Atlas; Murdock, 1967) or random pixels of $0.125*0.125$ decimal degrees. They use light density at night as seen from space, as a proxy for economic development at the local level. Their findings suggest that pre-colonial political institutions correlate significantly with current regional development. Based on this the authors argue that early institutions and traditions that existed amongst the African population before the era of colonisation matter in terms of long-term economic development.

Although historical events, such as colonialism, are important economic development determinants in themselves, they are not easily distinguishable from other factors that can affect long-term growth. It seems that history is closely interwoven with human experience and knowledge, which are strong determinants of growth and development. Atkinson and Stiglitz (1969), and Dasgupta and Stiglitz (1988) associate learning-by-doing with innovative and more advanced industrial production, as well as higher technical knowledge. Meanwhile, Lucas. (1988) highlights the role of experience on human capital formation, while Bockstette et al. (2002) stress the importance of state-level experience for the development of progressive public administration. Akçomak et al. (2015) argue that societies with greater experience of educational establishments as a source of human capital tend to experience higher development rates. In addition, North (1994) points out that time allows humans and societies to learn from their previous experience, thus creating a "stock of knowledge."

Overall, history (and more specifically historical shocks such as colonialism) appear to have had a significant impact on long-term development. This thesis contributes to research on historical events as determinants of economic development in three ways. The second chapter shows how ancient historical events such as ancient colonialism may have influenced current economic development. This is a significant contribution, since the huge literature on the long-term effects of colonialism is limited to the most recent European colonial activity.

The third chapter of this thesis reveals that not just historical shocks, but also their duration (e.g., the period of time over which a colonial power exploits resources) can play a role in determining long-term economic development. The fourth chapter shows that economic growth at the local level can also be influenced by more- recent historical events. In that sense, one can argue that the current level of development of a country or region is a function of the aggregate shocks that occurred in their ancient as well as recent history. These shocks include changes of institutions, the adoption of high technology, and political and/or financial reforms.

The aforementioned arguments that link historical shocks with current economic development are consistent with early growth models, which show that each country has a steady (equilibrium) level of development expressed in terms of specific output per capita. If each region of the world is working under a specific steady equilibrium, a historical shock may disturb the equilibrium point and cause temporary or permanent change. The degree of persistency might depend on the type of the shock, and the period that it occurs in. Historical events can have permanent effects when the steady rate of development within a country or locality changes either upwards or downwards. However, prior research suggests that historical shocks may in fact only have short-term effects. For example, Davis and Weinstein (2002) use a sample of 114 Japanese towns and cities that were destroyed through bombing during World War II, and show that this historical shock only had temporary effects. The population as well as the sizes of those towns remained mostly unchanged despite the catastrophic attacks. These findings appear to contradict research that associates economic development with early colonial institutions. Nevertheless, the type and timing of shocks appear to play an important role in determining the degree of persistency.

## 1.4 Outline of the thesis

This thesis examines whether historical events influence contemporary economic development and growth. Recent research investigates the effects of several historical shocks on the real economy. These shocks include colonisation, natural catastrophes, wars and the transfer of institutions and culture due to migration. As regards colonisation, a substantive body of prior research examines the effects of recent European colonialism (after the 16th century) on contemporary economic development. More specifically, it has been examined whether there are persistent effects of colonial institutions during the pre-industrial revolution era on current economic development (Acemoglu et al. 2001). All previous evidence shows that the institutions which were applied in several parts of the world by colonizers before 500 years have persistent effects on development in the long term. However, to date, no study has investigated whether ancient colonialization has similar effects. Chapter 2 addresses this question by examining ancient colonialism around the Mediterranean Sea.

From approximately the $8^{th}$ century BC, Greeks, Phoenicians, and Etruscans spread around the Mediterranean, establishing colonies and settlements. For the Greeks, there were several factors that motivated them to search for new places to settle, including political disturbances, an increasing birth rate, limited arable land, finite natural resources, climatic disruptions, and natural disasters. The Phoenicians, meanwhile, established colonies principally in order to expand trade. The Etruscans were a commercially-oriented city-state civilisation whose institutions were relatively similar to those of the Greeks, while their prosperity was mainly based on trade and mineral deposits. Along with human capital, institutions, technology, and culture were transferred to new places, thus changing the local populations’ way of living. These ancient civilisations introduced the concept of *polis*, a city within fortified walls whose residents were not only part of the production process (as workers or slaves) but also political entities. The (male) residents had certain political rights and were encouraged to participate in votes and decision making. Thus, for the first time in human history, a jurisdictional hierarchy emerged, with even citizens with no property enjoying political rights. In order to examine whether these early civilisations and colonies left an institutional legacy, it is necessary to test whether the areas where *poleis* were founded have a higher level of economic development. Development at the local level is measured using light density at night-time as seen from space. To identify the locations of ancient colonies, several historical maps, including the Historical Atlas of the Ancient World, are used. Each colony falls into one of 864 cells (in a 50×50 kilometre grid) of the territory around the Mediterranean Sea and the Black Sea. The results of this investigation suggest that there is indeed a higher level of development in places where there was at least one ancient Greek, Phoenician, or Etruscan colony. Since the territory sample is restricted to a distance of only 50km from the coast, it is geographically homogeneous. That means that the results are not driven by heterogeneity effects or any bias related to unique environmental conditions. In order to reassure that current comparative development is driven by the "superior" institutions of the aforementioned three ancient civilisations, it is examined whether grids with settlements of other ethnicities or clans in the same era are associated with the same level of current light density at night. The results find a positive and significant correlation, but of a much lower degree than in the case of settlements that had been founded by Greeks, Phoenicians, or Etruscans.

The results outlined in Chapter 2 suggest that areas around the Mediterranean Sea and the Black Sea that hosted ancient colonies with relatively advanced civilisations (in terms of institutions, culture, technology, and human capital) are still experiencing higher levels of economic development today. This finding is a significant contribution to the literature on economic development, because existing research on the topic focuses on later-era colonialism and the effects which the major empires had on the rest of the world from the 16$^{th}$ century onwards.

Chapter 3 examines the long-term effects of European colonialism over the last five centuries. Specifically, it investigates whether regions which adopt the institutions and technology of their colonisers earlier than others achieve higher economic development in the long-term. Although this question has already been examined at the state or national level in previous research, there is limited evidence at the local level. In Chapter 3, I examine the role that the duration of colonial institutions and technology had on colonised regions. Previous research suggests that modern economic development at the state level is related to the length of time that a state has functioned as a political and economic entity. The contention that the earlier a state starts its economic and political development, the higher its long-term development will be is called the 'early start' hypothesis. Borcan et al. (2018) show that accumulated state experience (both economic and political) increases aggregate productivity until a specific point, when the relationship becomes inverted. Although there is a certain amount of research on this hypothesis at a country/state level, there is limited evidence to support it at the local level. Chapter 3 therefore contributes to the existing literature by analysing whether regions within a country that adopted 'inclusive' colonial institutions earlier than other areas currently enjoy higher economic development.

The 'early start' hypothesis is examined in the context of Australia's colonisation by Europeans. The westernisation of Australia started in 1778 when the British government decided to relieve overcrowded prisons in Great Britain by deporting prisoners to the region of Australia that is now Sydney. Although these new inhabitants of Australia were mostly convicts, they were relatively educated and skilled compared to the Aboriginal population and other Europeans of the same era. Therefore, their mass transfer to Australia constituted a significant and positive economic shock at the local level. Assuming that their superior institutions affected positively each place that they were colonising, it is examined whether localities with earlier European presence enjoy higher current economic development. Data on the first European arrivals at the local level are collected from several historical sources, including Encyclopaedia Britannica. Current economic development is measured in three ways — median income per capita, the proportion of residents who have college or university-level qualifications, and the proportion of residents who have post-graduate degrees. The third development index differs from the second in the sense that it can reflect the proportion of the population that may be engaged in research and development. The results indicate that the localities of Australia that came earlier under early European administration experience higher current economic development. This is a significant contribution because previous research provided evidence for such a relationship only at a state level.

Apart from exogenous forces for change (such as colonialism), domestic drivers, such as financial and institutional reforms, can affect development and growth at the local level. Chapter 4 examines the argument that financial reforms can affect real economic outcomes, such as personal incomes. Although previous research has examined the effects of financial reforms on several macroeconomic indicators, no study has examined whether such reforms can influence rates of intergenerational mobility at the local level. This is somewhat surprising, since the issue of economic mobility has attracted huge academic interest over the last few decades. Therefore, Chapter 4 examines whether the major US banking reforms that took place in the 1990s have influenced current rates of local economic mobility.

Chapter 4 specifically examines whether the financial environment can influence children's economic mobility through their parents. Economic or Intergenerational mobility refers to the persistence of income level between two or more consecutive generations. If the young generation succeeds in having a higher income level than the older one, it enjoys an upward rate of economic mobility. Moreover, parents' income and credit constraints are related to the financial environment. If credit becomes more accessible to poorer families then they could have more opportunities to invest in the offspring's education. Thus, banking policies that alleviate parents' credit constraints may benefit children's economic outputs when they grow up through their access to education. Although previous research associate financial environment with several real-world macroeconomic indicators such as inequality, no one until now has examined whether it influences intergenerational mobility rates at the local level. Chapter 4 examines this relationship by looking at a financial reform that took place in the United States during the 1990s.

From 1994 onwards, the United States implemented a banking reform aimed at permitting banks to establish local branches in other states. This interstate banking reform was a shock for the banking sector, since competition might have increased. Moreover, poor households may have become more prosperous due to the lower credit constraints at the local level. Thus, poor children could have been benefited by the reform through their parents' economic status. In that case, in places with a better financial environment in terms of competition and credit constraints, intergenerational mobility rates should be higher. In order to examine this hypothesis, we construct an index, thus representing the financial environment at the local level. Then we associate this index with local rates of intergenerational mobility rates of poor children. All econometric results suggest that a financial environment with higher banking competition is associated with higher rates of poor children's intergenerational mobility. A potential explanation is that parents from the lower percentiles in the national income distribution may be less credit constrained after the interstate banking reform. Thus, their children may have access to education with less economic difficulties. This is supported by our results which show that banking reform is associated with expected signs with a series of education variables such as college attendance in early adulthood, school dropout rates, and percentage of people with high school or more diploma. The main contribution of Chapter 4 is that it reveals the effects of the financial environment on economic mobility at the local level. Moreover, it gives preliminary evidence for the links between finance and intergenerational mobility.

Overall, this thesis examines the effects of old as well as recent historical shocks on economic development and growth. In states and localities that are working under a steady equilibrium of development, shocks can disturb that equilibrium, forcing the economy to follow a different trajectory. If the shock is significant, such as colonisation, the effects can be persistent. Instead, economies re-stabilize in their previous equilibrium point in the long term.

# CHAPTER 2: Spreading civilisations: Ancient colonialism and economic development along the Mediterranean

This chapter investigates the long-term effects of ancient colonialism on economic development. In an early form of colonisation, the Phoenicians, Greeks and Etruscans spread around the Mediterranean from the 11th to the 6th centuries BCE transferring their superior technologies and institutions to new geographic areas. We find that geographic areas colonised by these civilisations are more developed in the present day. Our results hold after controlling for country fixed effects and splitting the sample by continent. Moreover, our findings are robust to the use of alternative measures and different historical data sources on ancient colonies. Overall, the results suggest that ancient colonialism along the Mediterranean left a positive economic legacy which persists today despite two millennia of historical turbulence.

## 2.1 Introduction

This chapter investigates the long-term economic legacy of ancient colonialism (c. 11th–6th centuries BCE). As the advanced Phoenician, Greek and Etruscan civilisations spread around the Mediterranean, they transferred their respective institutions, culture, technology and human capital to new locations. This early form of colonialism which occurred more than two millennia ago was confined to the territory surrounding a city, and as such did not lead to vast overseas dominions. We find robust evidence indicating that areas that had Phoenician, Greek or Etruscan colonies are today more developed in terms of higher light density at night. This suggests that having an early exposure to a more advanced civilisation has a positive long-term influence on economic development.

This current study is framed within the vibrant literature on the historical origins of comparative development, and more specifically, within the body of research that evaluates the economic consequences of colonialism (Spolaore and Wacziarg, 2013; Nunn, 2014; Michalopoulos and Papaioannou, 2017).[1] While research on modern European colonialism is extensive, this is to our knowledge the first study to assess the economic impact of ancient colonialism. This early form of colonialism has several attractive features that differentiate it from its modern counterpart. First, ancient colonialism took place more than two millennia ago

[1] For literature investigating the economic consequences of colonialism, see among others: Engerman and Sokoloff (2000), Acemoglu et al. (2001, 2002), Banerjee and Iyer (2005), Angeles (2007), Feyrer and Sacerdote (2009), Dell (2010), Iyer (2010), Bruhn and Gallego (2012), Easterly and Levine (2016), Oto-Peralías and Romero-Ávila (2014a, b, 2016), Michalopoulos and Papaioannou (2016), Dell and Olken (2017), and Droller (2017).

and the metropolitan political dominion over the colonies was brief or non-existent. These two characteristics are consistent with the fact that former ancient colonies have been part of several empires and kingdoms during the past two and a half thousand years. If despite all this historical turbulence there is still an economic legacy, it would imply a remarkable persistence of the influence of ancient civilisations. Second, this form of colonialism was concentrated geographically along the Mediterranean (which is a relatively homogeneous territory) thereby facilitating its empirical study. Third, ancient colonialism was local in nature, generally confined to the area surrounding a town, which implies that, if there has been persistence, it has been working at the local level. All these features make ancient colonialism a particularly interesting historical setting to analyse the influence of more advanced civilisations on economic development.

Our work also contributes to the literature on the economic and social legacy of the classical world, which has attracted a renewed interest among economists and other social scientists (e.g., Scheidel et al., 2008; Ober, 2015; Dalgaard et al. 2015; Michaels and Rauch, 2018; Maurer et al., 2017; Wahl, 2017). While it is widely acknowledged that the influence of classical Greece is pervasive in Western culture, we document a direct and local impact of the Phoenician, Greek and Etruscan civilisations on economic development. The positive effect found for ancient colonialism suggests that the benefit of having contact with these advanced cultures was in the long-run greater than the potential short-term costs (for instance, due to conflicts).[2] In addition, this chapter improves our understanding of the historical causes of regional economic development along the Mediterranean. Remarkably, despite the very divergent historical paths of countries within this broad region, the legacy of ancient colonies survives at the local level.

To test whether areas with ancient colonies are more developed today, we collect data on the location of Phoenician, Greek, and Etruscan colonies as well as on geographic and climatic characteristics for all Mediterranean and Black sea countries. Our main unit of analysis are 50×50 kilometres grid cells. We use fine spatial resolution light density data as a proxy for economic development at the sub-national level, which prior literature shows has a high correlation with GDP per capita (Henderson et al., 2011, 2012; Pinkovskiy, 2016). The main independent variable in our empirical analysis is a binary indicator capturing whether there is

[2] An interesting feature of ancient colonialism is that even if civilisations were very different across the Mediterranean, the natural environment was relatively similar, including the disease environment. Therefore, the native population was not decimated as a consequence of diseases brought by colonisers.

at least one ancient colony in a 50x50 grid cell. Our baseline regression model includes country fixed effects and restricts the sample to grid cells located within 50 kilometres of the Mediterranean coast, thus allowing us to compare a relatively homogeneous geographical coastal area.

The results of our empirical analysis indicate that places with ancient colonies have higher levels of light density. This finding is robust to a large battery of robustness checks which include: i) the use of an alternative indicator of ancient colonies (distance from the colony); ii) the division of the sample by continents to test whether the results are consistent across Europe, Asia and Africa; iii) the use of alternative data sources for the indicators of ancient colonies; iv) the exclusion of grid cells with a zero value in luminosity; v) the restriction of the sample to coastal grid cells; vi) the differentiation of the effect by coloniser identity; and vi) the use of a bigger cell size of 100×100 kilometres. Reassuringly, the results from these robustness checks provide support to our baseline finding that ancient colonialism has a positive and persistent impact on long-term economic development.

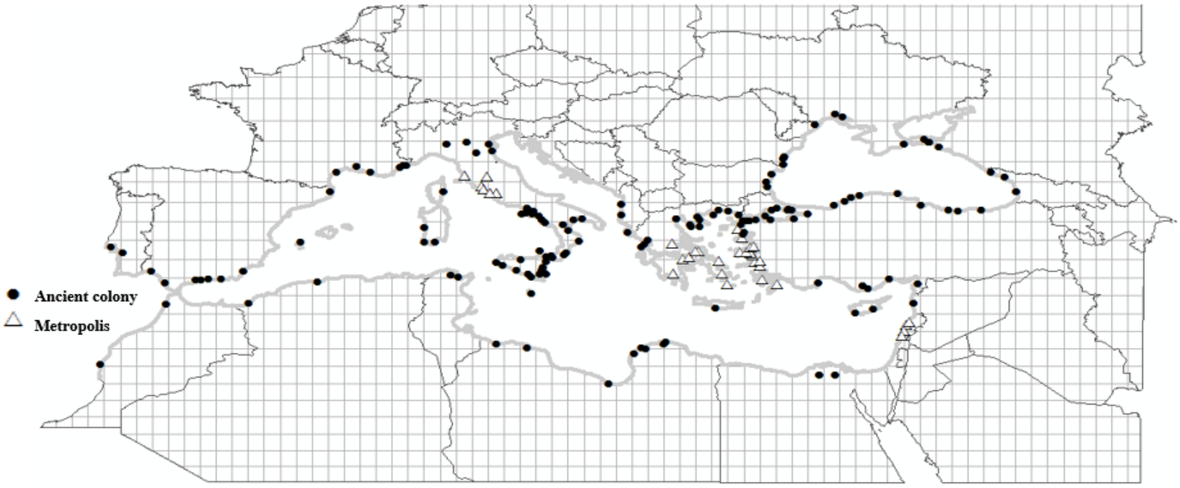
Two complementary mechanisms can explain our results. On the one hand, the institutional-cultural view, typical in the colonialism literature (Acemoglu et al. 2001, Easterly and Levine, 2016), whereby our results reflect the persistent effect of the exposure to a more advanced civilisation, including culture, human capital, institutions and technology. On the other hand, according to the "early start" view (Bockstette et al., 2002) the results may also reflect the advantages of an early start (such as an early establishment of a settlement) and be partially the consequence of agglomeration economies accruing over the long-run. To analyse the relative importance of each mechanism we compare ancient colonies with settlements of other cultures from the same era. Our findings suggest that both channels play an important role.

The rest of the chapter is organised as follows. Section 2.2 outlines the historical period concerning ancient colonialism and the main characteristics of the Greek, Phoenician and Etruscan civilisations. Section 2.3 discusses the empirical strategy and provides a preliminary discussion of the data. Section 2.4 presents our main results and a battery of robustness checks. Section 2.5 discusses the results and sheds some light on the mechanisms. Finally, Section 6 concludes.

## 2.2 Historical background

Etruscans, Greeks and Phoenicians developed and settled around the Mediterranean and the Black sea coasts from the 11th to the 6th century BCE. These civilisations exhibited outstanding economic and cultural progress which has often been attributed to common characteristics such as advanced institutions, high levels of social capital and technological innovation (including naval engineering). Focusing on the Greeks (but largely applicable also to Etruscans and Phoenicians as well), Ober (2015) argues that "citizen-centred" institutions and competitiveness were the drivers of this classical prosperity.[3] In this section, we discuss the main characteristics of each of these civilisations and their respective expansion overseas. Figure 2.1 represents the geographical distribution of ancient colonies along the Mediterranean area.

Figure 2.1 Map of Ancient Colonies in the Mediterranean area




Notes: This map shows the geographic distribution of ancient colonies along with their metropolis (c. 11th-6th cents. BCE). The countries in the figure are overlapped with a 50x50 km grid. Source: Wittke (2011b).

### 2.2.1 The Greek Colonisation

The Greek colonisation took place between the 11th and the 5th century BCE. During this period, the Greeks were the most active colonisers, establishing settlements mainly in the southern European coastline and around the Black sea. At the beginning of the archaic period (8th century BCE), aristocracies based their socioeconomic power on the prestige of birth and wealth. However, the lack of primogeniture rights resulted in a wide division of land among siblings, undermining their previous predominant power and generating political instability

[3] More specifically, to explain the classical Greek prosperity, Ober (2015, p.103) argues that "[f]air rules and competition within a marketlike ecology of states promoted capital investment, innovation, and rational cooperation in a context of low transaction costs."

(White, 1961). Moreover, early evidence from ancient grave sites around Attica and Argolid illustrates a shift in the adult to child ratio from approximately 9:1 before 750 BCE to 1:1 afterwards (Scheidel et al., 2008). Higher life expectancy at birth, overpopulation, limited arable land, finite natural resources, climatic disasters in the Greek plains, and political instability were factors that led to the search for new territories to settle, mitigating at the same time emerging risks for civil-war (White, 1961; Austin and Vidal-Naquet, 1980; Cawkwell, 1992).[4]

The first wave of Greek colonisation spanned the period from the 11th until the 8th century BCE, and the second wave from the 8th to the end of the 6th century BCE. By the end of the second wave, it is estimated that about 400,000 Greeks (a third of the total population) lived outside the Aegean Sea (Morris, 2005). Religious beliefs of the ancient poleis (city-states) as well as their institutional arrangements had a significant influence on the way that new colonies were founded. The new area to be colonised was chosen following a specific ritual related to religious customs, taking a guidance from several oracles within the Greek territory. Evidence from the locations of Greek poleis reflect a preference for the coast, which is well reflected in Plato's analogy "[Greeks live] like ants or frogs around a pond" (Plato's dialogue *Phaedo*, in Ober, 2015, p. 21). Most areas along the Mediterranean coast shared similar characteristics such as natural harbours, mild climate and fertile soil. The colonial enterprise was organised by the mother city or metropolis, which maintained strong cultural ties with the new colonised area.

The Greek colonies, in line with established standards of the mother city, developed their own laws, cults, foreign relations and arts. In doing so, they disseminated the Greek culture to neighbouring indigenous communities (White, 1961). Progressively, an increasing number of towns and small settlements which were embedded within larger regions, adopted social norms and formal rules influenced by the Greeks becoming similar to poleis (Ober, 2015). The Greek alphabet (a conversion of Phoenician primitive symbols) and Greek coins (the primary means of transacting at least in Western colonies until the end of 5th century) had great influence along the Mediterranean (Culican, 1992). More often than not neighbouring indigenous societies

[4] Naval technology played an important role in the foundation of new colonies. The design and construction of a new type of ship, the trireme, permitted safer and more efficient transportation along the Mediterranean coast (Davison, 1947).

adopted elements of the Greek civilisation which, according to our hypothesis, could stimulate their subsequent economic development.

### 2.2.2 The Phoenician Colonisation

The Phoenicians played a major role in establishing settlements on the Mediterranean coast from the end of the second millennium until the $7^{th}$ century BCE. Among the most important Phoenician cities were Byblos, Sidon, Tyrus, Citium, Utica, Gades and Lixus (Bryce, 2012). The overall expansion around the Mediterranean took place mainly in North Africa and Western Europe. Phoenicians were also a prosperous civilisation of small-states, with a salient commercial orientation and relatively open political institutions (Ober, 2015). The Phoenician colonisation was similar (but not identical) to the Greek one. However, the colonisation process was organised in a different way. Apart from Carthage (which was founded as a colony in 814/3 BCE by Tyrians), every other Phoenician settlement was initially a trading post (Whittaker, 1974). Promontories and small islands close to the mainland were preferred. The Phoenician's expansion and economic development was based on their large trade network. Luxurious and prestigious goods enhanced their reputation as good traders. The search for purple shells (whose surface was rich in an expensive colour, and a key input in their cloth dyeing trade) led the Phoenicians to expand in many places such as Cyprus, Rhodes and Crete. Since their dye factories were a significant source of their wealth, they had to establish treatment plants and settlements not only in places with profitable trading with the natives, but also in regions with rich coral deposits (Jensen, 1963).

There is evidence that significant (and bidirectional) relationships existed with their neighbouring civilisations. Phoenician temples devoted to Asherah goddess indicate religious influence on the indigenous population in modern day Israel. Egyptian talismans, medallions and scarabs were founded in the surrounding area of Phoenicia suggesting an exchange of cults and norms between the two civilisations. Black-on-red vessels which are related predominantly to the Phoenician style of pottery appear at Tarsus in Cecilia around 1000 BCE (Culican, 1992). In summary, the Phoenicians had a pervasive influence and close relationships with indigenous populations in North Africa and Western Europe. The colonies they established soon became vibrant trading posts. Given the importance of trading by that time, Phoenicians as a naval nation were able to disseminate their civilisation in coastal regions around the Mediterranean Sea.

### 2.2.3 The Etruscan Colonisation

In common with the Greeks and Phoenicians, the Etruscans were a prosperous commercially-oriented city-state civilisation with a citizen-centred political regime. In contrast to the Greeks and Phoenicians, the Etruscans settled in a limited geographic area confined to modern-day northern Italy, which had an abundance of natural and agricultural resources. The fertile land combined with large forests provided them with a wide range of agricultural products and wood which was important for the construction of ships (Haynes, 2005). Mineral deposits including iron, copper, zinc, tin, and lead were plentiful, and enabled the Etruscans to form profitable trading relationships with the Greeks and Phoenicians. Moreover, salt mines in Volterra, salt works along the Tyrrhenian, and wool processing stations boosted their economy (Wittke, 2011b). In the first half of the sixth century, the Etruscan trading network extended to northern Europe, Phoenicia, Sardinia, and Euboea, exchanging not only goods but also foreign institutions and culture. Trade relationships with Euboeans inspired Etruscans to adopt new drinking practices, new ceremonies, and the Greek alphabet. Imports of amber from northern Europe, perfume and ornamental objects and other luxurious products from Corinth indicate a high standard of living among the Etruscans (Bernardini and Camporeale, 2004).

Economic development led to political and cultural development for Etruscan regions. The improvement in living standards and the formation of a new class of specialised artisans and small business owners contributed to the creation of more inclusive institutions. This economic and cultural change was reflected in the physical infrastructure of Etruscan cities. Straight-running roads, squares, sewerage system, paved sites and walls resembled the Greek polis (Wittke, 2011a). Iconographic, thematic, and stylistic proximity with the Greek painting style in graves and vases suggest a high cultural influence from Greeks (Spivey, 2006). Despite their relatively limited territorial expansion, by the end of the 6$^{th}$ century, Etruscans had established a distinguished cultural stamp in many places around the Mediterranean Sea.

### 2.2.4 Ancient colonialism and long-term development

The Greeks, Phoenicians and Etruscans achieved remarkable prosperity by the pre-modern standards. Focusing on the Greeks, the most active coloniser, Morris (2004) estimates an annual rate of aggregate consumption growth of 0.6 to 0.9% over the period 800 to 300 BCE. This growth rate is certainly smaller than that of Britain after the Industrial Revolution, but higher than a very successful pre-industrial economy such as Holland between 1580 and 1820 (which grew at 0.5%). These advanced civilisations had more participatory and open political institutions than their neighbours. Moreover, they were more commercially oriented and used money as a medium of exchange. All these factors contributed to prosperity. Our main hypothesis is that ancient colonialism, by geographically spreading these more advanced civilisations has had a positive legacy on long-term economic development. Colonisers brought human capital, culture, technologies, and institutions to the settlements that they founded. This was a positive shock for the territory affected directly by the foundation of the colonies, but also for the surrounding area, given the influence exerted on the indigenous population.[5] As culture and institutions become very persistent over time, the existence of a link between ancient colonialism and modern economic development is plausible. Recent research has indeed emphasised the tendency of prosperity to perpetuate over time (Comin et al., 2010; Chanda, et al., 2014; Maloney and Calcedo, 2016). We thus expect that places with ancient colonies to be relatively more developed today.

## 2.3 Data and empirical strategy

### 2.3.1 Data

To investigate whether there is a link between ancient colonialism and current economic development, we compare geographic areas with and without ancient colonies. For that purpose, we divide the territory surrounding the Mediterranean and Black Sea with a 50×50 kilometres grid. The geographic sample covers the areas affected by ancient colonialism, as shown in Figure 2.1. For brevity we refer to this area as Mediterranean Sea or simply Mediterranean. The main analysis is conducted restricting the sample to grid cells located within 50 kilometres of the coast (a total of 864 cells).[6]

Regarding our measure of ancient colonies, we collect data on the locations of ancient Etruscan, Greek and Phoenician colonies. To this end, we use the *Historical Atlas of the Ancient World* (Brill's New Pauly Supplements I - Volume 3 –Wittke, 2011b). Figure 2.1

[5] Evidence for the colonial period shows that indigenous populations in the western Mediterranean area were far from living under political and cultural institutions, which were prominent in Greek and Phoenician poleis. Pounds (1969) argues that until the 5th century B.C., Greeks had spread their cities-poleis throughout the western Mediterranean, highlighting their organisation under progressive political and cultural institutions. Furthermore, Bairoch (1988) discusses the case of Alexandria in Egypt. He argues that influence of transferred Greek institutions was the most prominent reason for Egypt becoming such a great city after the 5th century B.C. In the same vein, Scott (2018) contends that the Phoenician influence was the dominant reason for the formation of Iberian culture, and its first cities, while indigenous societies evolved as a result of "foreign contact". Overall, urban institutions (which were highly correlated with significant local economic development around the Mediterranean Sea from 8th century B.C. onwards), were mainly a Greek and Phoenician innovation (Osborne and Cunliffe, 2005).

[6] The intersection of the countries' shapefile with the 50×50 kilometres grid renders 922 observations. We delete polygons with a very small surface area (lower than 10 km$^2$) and those with missing values in our dependent variable.

illustrates the colonies of these three ancient civilisations circa $11^{th}$ to $6^{th}$ centuries BCE. There are 145 colonies in coastal areas around the Mediterranean along with 32 metropolis.[7] From these 177 settlements, 14 were Etruscan (8 colonies and 6 metropolis), 133 were Greek (111 colonies and 22 metropolis), and 30 were Phoenician (26 colonies and 4 metropolis). Our main independent variable is a binary indicator which takes the value of 1 if there is at least one ancient colony in the grid cell and 0 otherwise. For the sake of robustness, we also use different historical sources regarding the location of ancient colonies. First, we take the location of Greek colonies from Osborn (1996), whereas for Etruscans and Phoenicians we exploit a number of electronic sources (see Table 2. A1 in the Appendix A for more details). Second, we use the extensive dataset on Greek *poleis* provided by Ober (2015), which has the advantage of being very rich and comprehensive (although with the downside of only covering Greek colonies).

For our measure of economic development, we follow Michalopoulos and Papaioannou (2013) and Alesina, Michalopoulos and Papaioannou (2016) in using luminosity at night from satellite data. It has been found that a high correlation exists between light density at night and GDP per capita, access to electricity and the provision of public goods (Pinkovskiy, 2016). Moreover, Chen and Nordhaus (2011) argue that light density is likely to add value as a proxy for output for national sub-divisions with low-quality data collection systems. For these reasons, given the lack of available data at the sub-national level in some countries included in our sample (particularly in Africa and Asia), light density is a suitable measure of economic development for the purposes of our study. Data are obtained from the Defense Meteorological Satellite Program's Operational Linescan System (NOAA) that reports images from the earth at night between 20:30 and 22:00 local time. The satellite detects lights from any human and natural activity including ephemeral lights, sunlight, glares, moonlight, aurora, blooming areas (e.g., areas that reflect light due to snow) and cloud observations. Light density is then purged from all the non-permanent luminosity sources and translated into an index that takes values ranging between 0 and 63 for approximately each square kilometre of surface. We use this index to calculate the average light density for each grid cell over six years (from 2000 to 2005).

We also collect data on a wide array of geographic and climatic variables, including temperature, rainfall, altitude, ruggedness, agricultural suitability and marine wealth. In order

[7] Metropolis refer to settlements in the homeland of these civilisations. Grid cells containing metropolis are excluded from the analysis.

to conserve space, we refer to Table 2. A1 in the Appendix A for the definitions and sources of the variables employed in the analysis. Descriptive statistics are provided in Table 2. A2 in the Supplementary Material.

## 2.3.2 Preliminary data analysis and methodological issues

Table 2.1 compares the level of luminosity of grid cells with and without ancient colonies. Column 1 restricts the sample to grid cells located within 200 kilometres of the coast. Places with ancient colonies are much more developed in terms of light density. The difference of 1.71 (in logs) is large and highly statistically significant. Naturally, it can be argued that this comparison is not valid as colonisers founded their colonies in areas close to the sea, which tend to be more developed than inland regions. Consequently columns 2 and 3 restrict the sample to the territory located within 100 and 50 kilometres of the coast, respectively. The difference remains large and highly statistically significant. According to column 3, light density is 180% higher ($e^{1.032}$–1) in grid cells with ancient colonies. Note that when restricting the sample to areas within 50 kilometres of the coast we are comparing territories that are relatively similar, particularly in terms of access to the sea. For instance, for this sample almost 75% of the observations are coastal (72.69%).

Table 2.1 Ancient colonialism and economic development: A first look at the data

| | Log night light density | | |
|---|---|---|---|
| | Within 200 km of the Mediterranean coast (1) | Within 100 km of the Mediterranean coast (2) | Within 50 km of the Mediterranean coast (3) |
| Ancient colonies | 1.865074<br>*116* | 1.865074<br>*116* | 1.823839<br>*112* |
| No ancient colonies | 0.1544367<br>*1,808* | 0.5837332<br>*1,106* | 0.7920832<br>*726* |
| Difference | 1.711***<br>(0.318) | 1.281***<br>(0.226) | 1.032***<br>(0.153) |

Notes: The units of analysis are 50x50 km grid-cells. Variables descriptions are provided in Table 2. A1. The number of observations is in italics. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that differences are statistically significant at 10%, 5%, and 1%, respectively.

Even if a 50 kilometre bandwidth renders a relatively homogeneous coastal sample, observations may differ along other geographic and climatic dimensions. Greeks, Phoenicians, and Etruscan might have selected places with some specific (attractive) features to establish their colonies. If so, then the higher development of ancient colonies reported in Table 2.1 could be due to superior geographic endowments. To address this concern, first, we point out that the process of colony foundation was not purely driven by economic considerations. Religious and political factors played very often a major role (Rutter, 1986). [8] Second, and more crucially, there were many equally attractive areas available along the Mediterranean and ancient colonisers only occupied a few of them. That is, even assuming that colonisers had good information and selected attractive areas, we can still compare them with many other equally good areas that were not colonised. One interesting case in point is the presence of natural harbours, which can be thought of as a major determinant for the location of colonies. This fact does not actually create major problems for the analysis because the Mediterranean is full of natural harbours.[9]

Notwithstanding the previous comments, we control in our baseline model for a large set of geographic and climatic variables. Moreover, in order to evaluate empirically whether ancient colonisers selected places with specific geographic and climatic features, we next present a balancedness table showing the relationship between our colony dummy indicator and several geographic and climatic variables. Columns 1 to 7 of Table 2.2 show that there are no statistically significant differences between grid cells with and without colonies in terms of temperature, rainfall, elevation, ruggedness, soil quality, water quality and being an island or not. Columns 9 and 10 also reveal the absence of significant differences in latitude and

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[8] The religious ritual undertaken to decide the location of colonies introduces an element of randomness in the process. According to Greek beliefs, the god Apollo gave instructions for the new exploration via Pythia, a priestess who was in contact with him while she was inhaling emitted vapours from a chasm in the ground (Crouch, 2004). This process would suggest that Pythia selected the place for the new colony randomly. Regarding the role of political factors, an example is the colony of Himera founded in current Cecilia by a group of exiles from Syracuse (a Greek Dorian metropolis) along with Chalcidinians. Note that for Greeks, the causes and the effects of exiles had always political character (Forsdyke, 2008).

[9] de Graauw (2017) provides a list of ancient harbours and ports based on documents from 79 ancient and many modern authors, incorporating information from the Barrington Atlas (Bagnall and Talbert, 2000). They provide a list of around 4,400 ancient ports. de Graauw (2017) identifies as a port or harbour “a place where ships can seek shelter. In the concept of ‘shelter’ must be included anchorages, landing places on beaches and ports”. Shelters of interest in de Graauw’s (2017) catalogue include “all places which may have been used by seafarers sailing over long distances”. Figure 2. A1 in the Supplementary Material A shows the geographic distribution of ancient ports. It is apparent that these are widespread along the Mediterranean, which mitigates any concern about the potential heterogeneity of our sample in this regard. In other words, even assuming that colonies were established in places with natural harbours, the latter were so widespread that this is unlikely to bias the results of our analysis.

longitude. There are only differences regarding the coastal dummy variable (column 8), with the positive coefficient suggesting that ancient colonisers tended to select coastal places. Arguably, this significant correlation does not create a major problem for the analysis. First, the coastal dummy variable is included in the control set of the baseline model. Second, most of the 50 kilometre bandwidth sample is coastal (about 75% of the observations), and omitting observations that are landlocked does not change the main results (see Section 2.4.2).

Table 2.2 Balancedness table

| | The dependent variable is: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Temperature | Rainfall | Elevation | Ruggedness | Soil quality | Water quality | Island | Coastal | Latitude | Longitude |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Ancient colonies | -0.337 | 43.567 | -59.128 | 1.938 | 0.218 | -2.765 | 0.029 | 0.284*** | 0.699 | 0.934 |
| | (0.384) | (36.138) | (36.487) | (20.549) | (0.131) | (2.996) | (0.069) | (0.04) | (0.668) | (1.729) |
| R-sq | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 |
| Observations | 838 | 838 | 838 | 838 | 838 | 837 | 838 | 838 | 838 | 838 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Another concern with the empirical strategy might be the presence of survivorship bias in our measure of ancient colonies. There exists the possibility that we only observe (or are more likely to observe) colonies that have historically succeeded and have survived over time to become cities. In contrast, information about failed colonies is perhaps more scarce and has often not reached us. This would inflate the effect of ancient colonialism on economic development. We address this concern through several avenues. First, we argue that there are several sources of information from which historians can reliably collect evidence on former colonies. The available data is not only based on archaeological evidence *in situ* (the source arguably most affected by the survivorship bias), but also on historical writings and testimonies left in the metropolis and other places, which help identify and locate ancient colonies. Second, we include country fixed effects to control for the fact that some (richer) countries may afford more archaeological exploration than others, which could also bias our coefficient of interest upwards. Third, we use several alternative data sources to measure ancient colonialism. In particular, we use the very rich dataset provided by Ober (2015) that contains a comprehensive list of Greek poleis for which survivorship bias should not be a concern.

## 2.4 Regression results

To investigate the possible link between ancient colonialism and current economic development we estimate the following equation via Ordinary Least Squares (OLS), with standard errors clustered at the country level.

$$\boldsymbol{Y_{ic} = \alpha \times Colony\ dummy_{ic} + \beta \times X_{ic} + \eta_c + \varepsilon_{ic}} \qquad (2.1)$$

where $i$ denotes grid cells and $c$ denotes countries. $Y_{ic}$ represents the logarithm of mean light density. $\boldsymbol{Colony\ dummy_{ic}}$ is a binary variable taking the value 1 if there is at least one ancient colony in grid cell $i$ of country $c$ established by either Etruscans, Greeks or Phoenicians, and 0 otherwise. $\boldsymbol{X_{ic}}$ is a vector of geographic, topographic and climatic characteristics that includes temperature, precipitation, elevation, ruggedness, agricultural suitability, water quality, island dummy, coast dummy, latitude, and longitude. The model also includes country fixed effects, $\boldsymbol{\eta_c}$, to capture any unobserved country-wide characteristics (such as national institutions or common historical shocks). $\boldsymbol{\varepsilon_{ic}}$ is a stochastic error term. The coefficient of interest here is $\boldsymbol{\alpha}$, which represents the effect of ancient colonies on current economic development. Among several possible econometric methods, we choose Ordinary Least Squares (OLS) for two reasons. First, OLS is used typically by throughout an extensive literature which examines the role of: natural resource endowments (Barrios et al., 2010); historical legacy (Acemoglu et al., 2001); environmental conditions (Galor and Ozak, 2015); fiscal conditions (Bockstette et al., 2002); ideas (Glaeser and Gottlieb, 2009); state capacity (Borcan et al., 2018); and older institutions (Acemoglu and Robinson, 2012; Michalopoulos and Papaioannou, 2013; Michalopoulos and Papaioannou, 2017) on current economic development. The control variables used in the present study relate to this aforementioned literature. Second, the structure of data (and indeed that of prior studies in the field) is suited to using OLS to investigate the effects of ancient colonies on current economic development. This is because there are no widely available time series of local level institutional and economic development (such as GDP, education etc) from ancient times to the current period.

### 2.4.1 Baseline results

Table 2.3 presents the baseline results of the chapter. Column 1 shows the effect of ancient colonies on light density conditional on country fixed effects. The coefficient on the colony dummy is positive and highly statistically significant, confirming the previous evidence about the positive legacy of ancient colonialism on development. Columns 2 to 7 add the geographic and climatic control variables, which do not affect the coefficient of interest.[10] Column 8 reports a more saturated model which includes a full set of control variables along with country fixed effects. The coefficient on the colony dummy is both statistically and economically significant.[11] Grid cells with ancient colonies have a level of light density 140% higher than counterparts without colonies (i.e., $e^{0.882}-1$). In other words, the existence of at least one colony within each cell produces, on average, a 0.3905 standard deviation increase in luminosity density. Since Henderson and Weil (2011) and Michalopoulos and Papaioannou (2013) find that luminosity has a strong within-country correlation with GDP (exceeding 0.95) and wealth (exceeding 0.75), respectively, the effect of ancient colonies on current level of luminosity may

[10] In contrast to prior expectations, the sign of the ruggedness control variable is positive. This is because hills enhanced the visibility of potential enemies. Thus, many ancient cities were built in hilltops near the sea for defensive reasons (Gates, 2011).

[11] In Table 2. A9 of Appendix A, we present the variance inflation factor (VIF) for all our control variables. The VIF shows how much the variance of an estimated regression coefficient increases when predictors are correlated. If predictors are not correlated, the VIF value is equal to 1. As a rule of thumb, if the VIF exceeds 10, it is assumed that the regression coefficients are poorly estimated due to multicollinearity (Akinwande et al., 2015). In order to address possible multicollinearity concerns, we replicate our regression excluding the temperature and latitude. The main variable of interest remains positive and significant ($t_{stat}$= 6.59). Thus, our results are robust after taking into consideration multicollinearity concerns.

also suggest a strong effect on more traditional economic development indexes at the local level.

Table 2.3 Ancient colonialism and economic development: Baseline results

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Ancient colonies | 0.959*** | 0.981*** | 0.855*** | 0.929*** | 0.976*** | 0.886*** | 0.974*** | 0.882*** |
| | (0.196) | (0.178) | (0.23) | (0.195) | (0.195) | (0.157) | (0.123) | (0.149) |
| Temperature | | -0.021 | | | | | | 0.142 |
| | | (0.07) | | | | | | (0.155) |
| Rainfall | | 0.002*** | | | | | | 0.001 |
| | | (0.001) | | | | | | (0.001) |
| Elevation | | | -0.002*** | | | | | -0.001 |
| | | | (0.00) | | | | | (0.001) |
| Ruggedness | | | 0.005*** | | | | | 0.004*** |
| | | | (0.002) | | | | | (0.001) |
| Soil quality | | | | 0.18 | | | | 0.159 |
| | | | | (0.167) | | | | (0.14) |
| Water quality | | | | | 0.011*** | | | 0.012*** |
| | | | | | (0.003) | | | (0.003) |
| Island | | | | | | -1.455*** | | -1.031*** |
| | | | | | | (0.249) | | (0.24) |
| Coastal | | | | | | 0.253 | | 0.157 |
| | | | | | | (0.255) | | (0.299) |
| Latitude | | | | | | | 0.214*** | 0.178 |
| | | | | | | | (0.047) | (0.15) |
| Longitude | | | | | | | -0.003 | -0.001 |
| | | | | | | | (0.053) | (0.052) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.23 | 0.23 | 0.22 | 0.22 | 0.24 | 0.23 | 0.29 |
| Observations | 838 | 838 | 838 | 838 | 837 | 838 | 838 | 837 |

*Notes:* The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2.4 uses an alternative indicator to measure the influence of ancient colonialism, namely, distance from the nearest colony. This variable is the linear distance from the centroid of each cell to its nearest ancient colony. Thus, even within the cells where an ancient colony exists, the variable never takes a value of 0. While the variable *ancient colonies* assumes a discrete and discontinuous effect of ancient colonialism, the variable *distance to the nearest colony* assumes a linear relationship between the geographic distance to an ancient colony and economic development. We expect that the positive influence of ancient colonies diminishes as distance from the colony increases. In other words, the closer an area is to a colony, the higher its luminosity should be. In order to test this hypothesis, we replace the binary colony indicator used in Table 2.3 with a variable measuring the distance between the centroid of each grid cell and its nearest ancient colony. This variable enters in all regressions with a negative and statistically significant coefficient. According to the coefficient reported in column 8, each kilometre of distance from an ancient colony decreases light density on average by 0.6% ($e^{-0.006}–1$).

In column 9, we perform our baseline analysis by including both ancient colonialism variables. The coefficients retain statistical significance as well as expected sign. However, the coefficient on the dummy variable *ancient colonies* is almost 30% lower than in table 2.3. This suggests that ancient colonies did not only influence the place where they were located, but also spread (advanced cultural and technological knowledge) to contiguous areas. In other words, ancient colonies generated spillovers that affected populations and economies in nearby locations. Since trade of goods and people between colonies and other settlements was the principal economic activity during this era, it is likely colonies created positive externalities.[12]

Table 2.4 Ancient colonialism and economic development: Distance to the nearest colony

| | The dependent variable is Log night light density | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Distance to the nearest colony | -0.006*** | -0.005*** | -0.005** | -0.006*** | -0.007*** | -0.005*** | -0.006*** | -0.006*** | -0.005*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Ancient colonies | | | | | | | | | 0.591*** |
| | | | | | | | | | (0.169) |
| Temperature | | -0.019 | | | | | | 0.121 | 0.168 |
| | | (0.061) | | | | | | (0.142) | (0.15) |
| Rainfall | | 0.002*** | | | | | | 0.001 | 0.001 |
| | | (0.001) | | | | | | (0.001) | (0.0007) |
| Elevation | | | -0.002*** | | | | | -0.001 | -0.001 |
| | | | (0.00) | | | | | (0.001) | (0.001) |
| Ruggedness | | | 0.005*** | | | | | 0.004*** | 0.004*** |
| | | | (0.001) | | | | | (0.001) | (0.001) |
| Soil quality | | | | 0.206 | | | | 0.173 | 0.167 |
| | | | | (0.159) | | | | (0.127) | (0.126) |
| Water quality | | | | | 0.017*** | | | 0.016*** | 0.016*** |
| | | | | | (0.003) | | | (0.004) | (0.004) |
| Island | | | | | | -1.399*** | | -0.929*** | -0.911*** |
| | | | | | | (0.215) | | (0.236) | (0.249) |
| Coastal | | | | | | 0.311 | | 0.205 | 0.118 |
| | | | | | | (0.232) | | (0.289) | (0.294) |
| Latitude | | | | | | | 0.227*** | 0.18 | 0.2 |
| | | | | | | | (0.045) | (0.145) | (0.146) |
| Longitude | | | | | | | -0.002 | 0.005 | 0.007 |
| | | | | | | | (0.048) | (0.046) | (0.046) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.23 | 0.23 | 0.22 | 0.23 | 0.24 | 0.24 | 0.29 | 0.3 |
| Observations | 864 | 864 | 864 | 864 | 863 | 864 | 864 | 863 | 837 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

The evidence presented thus far suggests that ancient colonies have a positive impact on regional economic development in the long-run. The culture, institutions, technologies and human capital that the more advanced Greek, Phoenician and Etruscan civilisations distributed around the Mediterranean via the establishment of colonies influenced the economic

[12] The observations in column 9 become 837 which are the same as in Table 2.3. This is because the variable *ancient colonies* exclude all cells which include mother cities.

development of the areas where they settled. This effect appears to have persisted over more than two millennia. Given that the models include country fixed effects, the legacy of ancient colonialism documented here is working at the regional (local) level. The rest of this section shows that this result is robust to a large battery of robustness checks.

## 2.4.2 Robustness checks

### 2.4.2.1 Splitting the sample by continents

Our analysis is based on data drawn from countries located in three continents. It could be possible that one of these continents is driving our results. To alleviate this concern, we create three different subsamples by classifying observations on the basis of the continent they belong to, and then regress light density on ancient colonies for Europe, Asia, and Africa separately. Columns 1 and 2 in Table 2.5 focus on the European subsample, and present the results for the most parsimonious and most saturated models. Columns 3 and 4, and 5 and 6 repeat this for the Asian and African subsamples respectively. In all cases the coefficient on ancient colonies is positive and statistically significant (albeit the coefficient in the European subsample is slightly smaller).

Table 2.5 Robustness checks (I): Splitting the sample by continents

| | The dependent variable is Log night light density | | | | | |
|---|---|---|---|---|---|---|
| | Europe | | Asia | | Africa | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Ancient colonies | 0.776** | 0.64*** | 1.09*** | 0.906*** | 1.505*** | 0.977* |
| | (0.269) | (0.199) | (0.139) | (0.203) | (0.256) | (0.42) |
| Temperature | | -0.004 | | 0.236 | | 0.299** |
| | | (0.16) | | (0.206) | | (0.095) |
| Rainfall | | 0.003*** | | 0.00 | | -0.002 |
| | | (0.00) | | (0.001) | | (0.002) |
| Elevation | | -0.003** | | 0.00 | | -0.001 |
| | | (0.001) | | (0.001) | | (0.002) |
| Ruggedness | | 0.005** | | 0.003 | | 0.008 |
| | | (0.002) | | (0.002) | | (0.006) |
| Soil quality | | 0.563*** | | 0.06 | | -0.022 |
| | | (0.175) | | (0.416) | | (0.039) |
| Water quality | | 0.009** | | 0.032*** | | 0.037 |
| | | (0.003) | | (0.005) | | (0.026) |
| Island | | -0.844*** | | -7.243*** | | -2.776*** |
| | | (0.257) | | (0.678) | | (0.396) |
| Coastal | | -0.1 | | -0.435* | | 0.885 |
| | | (0.202) | | (0.185) | | (0.601) |
| Latitude | | -0.004 | | 0.262 | | 0.759 |
| | | (0.122) | | (0.211) | | (0.358) |
| Longitude | | 0.016 | | 0.009 | | -0.077 |
| | | (0.076) | | (0.029) | | (0.078) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.24 | 0.38 | 0.26 | 0.45 | 0.07 | 0.19 |
| Observations | 470 | 470 | 159 | 158 | 209 | 209 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

### 2.4.2.2 Alternative data sources

In addressing concerns that our results hinge on a singular source of information regarding the location of ancient colonies, we repeat the analysis using an indicator of ancient colonies based on alternative sources. The results are reported in columns 1 and 2 of Table 2.6. In both specifications, the alternative colony dummy variable enters into the regression with a statistically significant positive coefficient, indicating that our findings are robust to alternative data sources regarding the location of ancient colonies. As an additional exercise, we use Ober's (2015) dataset on Greek poleis. This source contains a comprehensive list of all Greek poleis known to have existed in the Antiquity, from 800 BCE up to 323 BCE, covering the archaic as well as the classical period of ancient Greece. We consider as colonies all those Greek poleis outside the Greek homeland. Thus, the cells with non-Greek (Phoenician, Etruscan and other civilisations) settlements are assigned a value of 0 and 1 otherwise. While this source has the obvious disadvantage of covering Greek colonies only, it has the important advantage of being very comprehensive, and thus mitigates the possible survivorship bias discussed in Section 2.3.2.[13] The results, reported in columns 3 and 4, show a positive and statistically significant effect of Greek colonies on regional economic development. The magnitude of the effect is lower to that reported in the baseline specification. However, this is possibly anticipated given that our sample of colonies is similar, but not identical to that used in the baseline estimation.

Table 2.6 Robustness checks (II): Alternative sources for Ancient colonies

| | The dependent variable is Log night light density | | | |
|---|---|---|---|---|
| | Alternative sources for Greek, Phoenicians and Etruscan colonies | | Ober (2015)'s poleis dataset | |
| | (1) | (2) | (3) | (4) |
| Ancient colonies (alternative sources) | 0.92*** | 0.774*** | 0.492** | 0.543** |
| | (0.197) | (0.192) | (0.183) | (0.228) |
| Temperature | | 0.128 | | 0.29** |
| | | (0.162) | | (0.114) |
| Rainfall | | 0.001 | | 0.001 |
| | | (0.001) | | (0.001) |
| Elevation | | -0.001 | | 0.000 |
| | | (0.001) | | (0.001) |
| Ruggedness | | 0.004*** | | 0.003** |
| | | (0.001) | | (0.001) |
| Soil quality | | 0.151 | | 0.088 |

[13] Ober's (2015) dataset is based largely on the *Inventory of Archaic and Classical Poleis* (Hansen and Nielsen, 2004). The *Inventory* is a monumental work by the Copenhagen Polis Centre that contains information on more than 1,000 Greek city-states known to have existed during the period c. 800-323 BCE.

| | | | | |
|---|---|---|---|---|
| | | (0.131) | | (0.092) |
| Water quality | | 0.012*** | | 0.011*** |
| | | (0.004) | | (0.004) |
| Island | | -1.043*** | | -0.978*** |
| | | (0.257) | | (0.323) |
| Coastal | | 0.19 | | 0.255 |
| | | (0.286) | | (0.304) |
| Latitude | | 0.164 | | 0.282* |
| | | (0.156) | | (0.137) |
| Longitude | | -0.003 | | 0.006 |
| | | (0.052) | | (0.045) |
| Country fixed effects | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.29 | 0.23 | 0.31 |
| Observations | 839 | 838 | 770 | 769 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

#### 2.4.2.3 Distinguishing among colonisers

Historians observe several differences in culture and institutions among the Etruscans, Greeks and Phoenicians. In this section we investigate whether the effect of ancient colonialism depends on the identity of the coloniser. We create three dummy variables to distinguish colonies based on coloniser identity. There are 81 grid cells with Greek colonies, 25 with Phoenician colonies, and only 5 with Etruscan colonies. In addition, there are 3 observations containing colonies from two colonisers, which have been grouped into a residual category called “mixed”. Table 2.7 shows that the positive relationship between ancient colonies and light density holds across the three colonisers. It indicates that our findings are not driven by a subgroup of colonisers, although it seems that the coefficient for Greek colonies is larger, while the coefficient for the Phoenician colonies is only marginally significant. The larger size of the coefficient on Greek colonies may suggest that the influence of the classical Greek civilisation was more pervasive, or that some elements of this civilisation such as the strong civic capital and inclusive political institutions have been more decisive for local economic development than other features more salient in the other civilisations. However, this evidence has to be interpreted carefully given the lower number of observations for the Phoenician and Etruscan colonies. Overall, the findings provide support to our hypothesis of the positive legacy of ancient colonialism by which more advanced civilisations transferred their institutions, culture and technologies to distant places in the Mediterranean.

#### 2.4.2.4 Other checks

This subsection conducts further robustness checks. First, we restrict the sample to only coastal grid cells. These are the majority in our 50 kilometre sample, but in doing so we assure that we are comparing only observations with access to the sea. Second, we exclude dark grid cells, that is, with an average value of light density equal to zero. Third, we check whether the results survive the inclusion of a variable measuring the connectedness of the coast (Maurer et al., 2017). Fourth, we run our baseline specification deleting countries one by one, which allows us to check whether some country is exerting an undue influence on the coefficient of interest. Fifth, we replicate the main analysis using a 100×100 kilometre grid (rather than the 50×50 kilometre grid used so far), which renders grid cells of 10,000 km$^2$. Finally, we check whether the statistical significance of the results remains unchanged when using Conley's (1999) standard errors to correct for spatial dependence of unknown form. Reassuringly, the positive coefficient on the colony dummy remains robust and statistically significant in all cases.[14]

Table 2.7 Differentiating among colonisers

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Greek colony | 1.041*** | 1.056*** | 0.975*** | 0.998*** | 1.059*** | 0.933*** | 0.998*** | 0.929*** |
| | (0.196) | (0.162) | (0.224) | (0.201) | (0.196) | (0.118) | (0.123) | (0.137) |
| Phoenician colony | 0.64 | 0.688* | 0.498 | 0.639 | 0.644 | 0.708 | 0.797** | 0.718* |
| | (0.385) | (0.352) | (0.417) | (0.391) | (0.389) | (0.428) | (0.313) | (0.378) |
| Etruscan colony | 1.439*** | 1.204*** | 0.824*** | 1.522*** | 1.467*** | 1.04*** | 1.453*** | 0.553*** |
| | (0.033) | (0.079) | (0.204) | (0.081) | (0.033) | (0.098) | (0.08) | (0.171) |
| Mixed (more than one coloniser) | 0.947*** | 0.953*** | 0.64*** | 0.934*** | 0.977*** | 0.912*** | 1.198*** | 0.813*** |
| | (0.033) | (0.072) | (0.074) | (0.035) | (0.033) | (0.058) | (0.095) | (0.127) |
| Temperature | | -0.029 | | | | | | 0.107 |
| | | (0.067) | | | | | | (0.148) |
| Rainfall | | 0.002*** | | | | | | 0.001 |
| | | (0.001) | | | | | | (0.001) |
| Elevation | | | -0.002*** | | | | | -0.001 |
| | | | (0) | | | | | (0.001) |
| Ruggedness | | | 0.005*** | | | | | 0.004*** |
| | | | (0.002) | | | | | (0.001) |
| Soil quality | | | | 0.181 | | | | 0.155 |
| | | | | (0.167) | | | | (0.138) |
| Water quality | | | | | 0.011*** | | | 0.011*** |
| | | | | | (0.003) | | | (0.003) |
| Island | | | | | | -1.478*** | | -1.032*** |
| | | | | | | (0.259) | | (0.234) |
| Coastal | | | | | | 0.258 | | 0.164 |
| | | | | | | (0.254) | | (0.302) |
| Latitude | | | | | | | 0.222*** | 0.166 |
| | | | | | | | (0.047) | (0.145) |
| Longitude | | | | | | | -0.008 | -0.002 |
| | | | | | | | (0.053) | (0.053) |

[14] Detailed results from these robustness checks are presented in the Supplementary Material A.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.23 | 0.23 | 0.21 | 0.22 | 0.24 | 0.23 | 0.29 |
| Observations | 864 | 864 | 864 | 864 | 863 | 864 | 864 | 863 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

## 2.5 Mechanisms: Institutional-cultural transfer or urban persistence?

There are two complementary explanations for the positive effect of ancient colonialism. Our first hypothesis is couched in terms of institutions and culture. Ancient colonialism was a major positive shock in terms of institutions, culture, human capital and technology. The Phoenicians, Greeks, and Etruscans enjoyed a much higher standard of living than the rest of their Mediterranean neighbours. They had more inclusive institutions, a high level of civic capital and more diversified and sophisticated economies. All these elements were transferred to the new locations, with positive consequences for economic development. Another related explanation is the "early start" hypothesis, which contends that geographic areas where politically organised societies were established earlier have shaped a more homogenous economic and social environment with higher linguistic unity, social cohesion, political stability and better public management (Bockstette et al., 2002). Relatedly, once a town or settlement is founded, the forces of agglomeration economies can reinforce the dynamics of the concentration of economic activity and promote economic development over the long-run. In this sense, there is evidence that cities are very persistent, even after major shocks (Davis and Weinstein, 2002; Bleakley and Lin, 2012).

We investigate the relative importance of each mechanism by comparing settlements of Phoenician, Greek and Etruscan origin to all ancient settlements including other cultures of similar age. We use the gazetteer of ancient places to collect information on settlements existing before 500 BCE (Pleiades, 2017). A dummy variable "other ancient settlements" is created, which takes the value of 1 if the grid cell contains at least one ancient place classified either as Greek, Phoenician, Etruscan colony or as settlement, city, urban, town or village, and 0 otherwise. In other words, this new variable controls for agglomeration effects. If the coefficient on the colony dummy (without settlements from other cultures) is larger than the coefficient on "other ancient settlements", this would imply that the mechanism explaining our result is not only city persistence, but also the transfer of institutions and culture. Columns 1 and 2 in Table 2.8 include these two indicators together with and without additional control variables. Both indicators have positive and statistically significant coefficients. The magnitude of the colony dummy is larger, with the difference being statistically significant at the 5% level. This suggests that both the "early start-urban persistence" and the "institutions-culture" mechanisms help explain the positive effect of ancient colonies on economic development. [15][16]

Table 2.8 Mechanisms: Institutional-cultural transfer vs. urban persistence

| | The dependent variable is Log night light density | |
|---|---|---|
| | (1) | (2) |
| Ancient colonies | 1.387*** | 1.309*** |
| | (0.29) | (0.237) |
| Other ancient settlements | 0.854** | 0.792** |
| | (0.355) | (0.355) |
| Temperature | | 0.113 |
| | | (0.162) |
| Rainfall | | 0.001 |
| | | (0.001) |
| Elevation | | -0.001 |
| | | (0.001) |
| Ruggedness | | 0.004*** |
| | | (0.001) |
| Soil quality | | 0.159 |
| | | (0.142) |
| Water quality | | 0.012*** |
| | | (0.004) |
| Island | | -0.9*** |
| | | (0.272) |
| Coastal | | 0.089 |
| | | (0.286) |
| Latitude | | 0.178 |
| | | (0.146) |
| Longitude | | 0.004 |
| | | (0.049) |
| Country fixed effects | Yes | Yes |
| R-sq | 0.23 | 0.31 |
| Observations | 838 | 837 |

*Notes:* The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

[15] The evidence shown in Table 2.7 is also consistent with the importance of the institutions-culture channel. If the "early start" hypothesis predominates, the Phoenician colonies, which predate the Greek and Etruscan counterparts, should be the most developed today. We find the opposite. Relatedly, the differences in the magnitude of the coefficients when disaggregating the colony dummy by the identity of the coloniser suggest that there is something else than the mere fact of establishing a settlement to account for our results. The specific elements of each civilisation that were exported are likely to matter. Moreover, urban persistence arguably cannot explain *per se* the legacy of ancient colonialism. Cities to persist over time require a certain level of economic development to exchange manufactured goods and services for agricultural products. In the absence of any institutional-cultural transfer, it is very difficult to explain how places with ancient colonies managed to maintain a higher level of urbanisation. Indeed, there is no guarantee that the urban system survives a major shock, as witnessed by Britain after the collapse of the Roman Empire (Michaels and Rauch, 2018).

[16] The difference between the coefficient in column 2, and the corresponding in Table 2.3 could be attributed to the institutional effect of ancient poleis on current economic development .

## 2.6 Conclusion

This chapter investigates the long-term effect of ancient colonialism on economic development. By collecting data on the location of Phoenician, Greek and Etruscan colonies and using light density at night as a proxy for economic development at the sub-national level, we find that areas colonised by these civilisations are today more developed. The results hold across continents (Africa, Asia, and Europe), when controlling for country fixed effects, and are robust to using alternative measures and historical sources of ancient colonies. Our findings suggest that the more advanced civilisations that ancient colonialism spread along the Mediterranean have left a positive economic legacy, which persists today despite two millennia of historical turbulence.

This study contributes to the literature on the economic legacy of colonialism by focusing, for the first time, on the very early experience of colonialism undertaken by the Phoenicians, Greeks and Etruscans. In doing so, we also contribute to improving our understanding of the causes of economic development in the large region of the Mediterranean. In contrast to its modern counterpart, ancient colonialism was much more local in nature, confined merely to the territory surrounding a city, and as a consequence did not lead to vast overseas dominions (with the exception of Carthage). Regions in which ancient colonisers established their colonies have belonged to different empires and countries, and have been subjected to very different historical paths during the ensuing period exceeding two millennia. It is remarkable that we consistently observe even across continents (Europe, Asia, and Africa) that areas with ancient colonies are relatively more developed today. Given that we control for country fixed effects, the positive legacy of ancient colonialism documented here has been working at the local level.

We argue that two complementary mechanisms are behind our chapter results. On the one hand, the colonisers transferred to the new locations their more advanced institutions, culture, human capital and technologies. On the other hand, they also founded towns, which implies an early urban start in a context of rural predominance, with the advantages of agglomeration economies reinforcing the concentration of economic activity in existing places. We attempt to evaluate the relative importance of each channel by comparing ancient colonies with settlements of other cultures but of similar age. The results suggest that both mechanisms are relevant in explaining the positive effect of ancient colonialism.

The evidence presented in this chapter is appealing, but our analysis has some limitations. One is the use of light density at night as a proxy for economic development. While it is the best alternative at hand to measure economic development at the subnational level for the wide and diverse Mediterranean area, there has been some criticism on this measure. Importantly, it is correlated not just with income, but also with the level of urbanisation and the concentration of economic activity on particular locations (Henderson et al., 2012; Mellander et al., 2015). Even accounting for this criticism, the results of this chapter are nevertheless valuable since we document that ancient colonialism has been a major factor in shaping the economic geography of Mediterranean countries. Another limitation of our analysis has to do with a potential problem of endogeneity in the location of ancient colonies. Although we conduct a large battery of robustness checks to address this concern and we interpret our coefficient as *causal*, we acknowledge that it is impossible to completely dispel all doubts.

To conclude, our chapter emphasises the idea that historical shocks play a significant role for regional and local economies. The impact of a change in institutions, culture, technology and human capital appears to influence the long-term economic path of societies, even after thousands of years. The Greeks, Phoenicians and Etruscans have not only influenced modern Western culture in general, these civilisations have also left an economic legacy at the local level. This chapter has thus shed additional light on the legacy of the classical world and revealed that the contact and interaction between civilisations has positive implications for economic development.

## 2.7 Appendix A

Table 2. A1 Description of variables

| Variable | Description | Source |
|---|---|---|
| *Dependent and main independent variables:* | | |
| Log night light density | Natural logarithm of 0.001 plus the average night light density from 2000 until 2005. | NOOA/National Centers for Environmental information, https://ngdc.noaa.gov/eog/dmsp/download V4composites.html |
| Ancient colonies | Dummy variable indicating whether there is at least one ancient Phoenician, Greek or Etruscan colony in the grid cell. Observations with metropolies (mother cities in the civilisations' homeland) are excluded from the analysis. | Authors' elaboration using data from Wittke (2011b). |
| Distance to the nearest colony | Linear distance in kilometers between each cell's centroid and the nearest ancient colony. | Authors' elaboration using data from Wittke (2011b). |
| Ancient colonies (alternative sources) | Dummy variable indicating whether there is at least one ancient Phoenician, Greek or Etruscan colony in the grid cell. Observations with metropolies (mother cities in the civilisations' homeland) are excluded from the analysis. | Etruscan colonies: http://www.historyfiles.co.uk/KingListsEurope/ItalyEtruscans.htm Greek colonies: Greece in the Making, 1200-479 BC, Robin Osborne Phoenician colonies: https://www.lib.utexas.edu/maps/historical/shepherd/greek_phoenician_550.jpg |
| Poleis outside the Greek homeland | Dummy variable indicating whether there is at least one ancient Greek polis in the | Authors' elaboration using data from Ober (2015). |

| | | |
|---|---|---|
| | grid cell. Observations with poleis located in modern day Greece are excluded from the analysis. | |
| Greek colony | Dummy variable indicating whether there is at least one ancient Greek colony in the grid cell. Observations with metropolies (mother cities in the civilisation's homeland) are excluded from the analysis. | Authors' elaboration using data from Wittke (2011b). |
| Phoenician colony | Dummy variable indicating whether there is at least one ancient Phoenician colony in the grid cell. Observations with metropolies (mother cities in the civilisation's homeland) are excluded from the analysis. | Authors' elaboration using data from Wittke (2011b). |
| Etruscan colony | Dummy variable indicating whether there is at least one ancient Etruscan colony in the grid cell. Observations with metropolies (mother cities in the civilisation's homeland) are excluded from the analysis. | Authors' elaboration using data from Wittke (2011b). |
| Mixed (more than one coloniser) | Dummy variable indicating whether in the same grid cell there are at least two colonies from different colonisers. Observations with metropolies (mother cities in the civilisations' homeland) are excluded from the analysis. | Authors' elaboration using data from Wittke (2011b). |
| Other ancient settlements | Binary indicator measuring whether in the grid cell there is at least one ancient place classified as settlement, city, urban, town or village. Only places with attested time period before 500 BCE are selected. | Authors' elaboration using data from Pleiades (2017). |

**Table 2. A1**
**Description of variables** (*Continued*)

| Variable | Description | Source |
|---|---|---|
| Other ancient settlements (only precise location) | Binary indicator measuring whether in the grid cell there is at least one ancient place classified as settlement, city, urban, town or village. Only places with precise location and attested time period before 500 BCE are selected. | Authors' elaboration using data from Pleiades (2017). |
| Other ancient settlements (only town, city or urban) | Binary indicator measuring whether in the grid cell there is at least one ancient place classified as city, urban or town. Only places with attested time period before 500 BCE are selected. | Authors' elaboration using data from Pleiades (2017). |
| *Geographic and climatic controls:* | | |
| Altitude | Average altitude of the surface area of the grid cell. | Author's elaboration using data from GTOPO30 (Data available from the U.S. Geological Survey). |
| Distance to the Mediterranean coast | Linear distance between the grid cell's centroid and the nearest point of the Mediterranean coast (in km). | Author's elaboration. |
| Coastal | Dummy variable indicating whether the grid cell borders the Mediterranean coast. | Author's elaboration. |
| Connectedness of the coast | Number of 10x10 km coastal grid cells that are within a distance of 500 km moving only through water. We follow the methodology developed by Maurer et al. (2017).* | Author's elaboration. |
| Island dummy | Dummy variable indicating whether the grid cell is within an island. | Author's elaboration. |

| | | |
|---|---|---|
| Latitude/ Longitude | The geographic coordinates of the grid cell centroids, in decimal degrees. | Author’s elaboration. |
| Precipitation | Annual precipitation, in hundreds of mililiters. It corresponds to the average value of the surface area of the grid cell.* | Author’s elaboration using data from WorldClim (Hijmans et al., 2005). |
| Ruggedness | Standard deviation of the altitude of the territory corresponding to the grid cell. | Author’s elaboration using data from GTOPO30 (Data available from the U.S. Geological Survey.). |
| Soil quality | Average of seven key soil dimensions important for crop production: nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability to roots, excess salts, toxicities, and workability. The average value for each component is calculated for the surface area corresponding to the grid cell .* | Author’s elaboration using data from Fischer et al. (2008). |
| Temperature | Annual average temperature. It corresponds to the average value of the surface area of the grid cell.* | Author’s elaboration using data from WorldClim (Hijmans et al., 2005). |
| Water quality | Mean chlorophyll of the sea water around the grid cell using a buffer of 50 kilometres.* | http://sedac.ciesin.columbia.edu/data/set/icwq-annual-chlorophyll-a-concentration-1998-2007 |

Notes: The units of analysis are 50x50 km grid-cells. The basic layer of countries surrounding the Mediterranean Sea comes from EUROSTAT (Countries, 2010 - European Commission, Eurostat/GISCO). * Values of the (up to 5) nearest neighbour have been imputed to grid cells with missing values in some of these variables. This imputation is relevant to the variable water quality and connectedness, since all grid cells farther than 50 kilometres from the coast have missing values given the way the variable is constructed. For the other three variables, the imputation only affects about 5% of the observations.

## 2.8 Supplementary Material A

Table 2. A2 Descriptive statistics

| *Panel A: Within 200 km of the Mediterranean coast* | | | | | |
|---|---|---|---|---|---|
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| Log night light density | 1,951 | 0.27 | 2.58 | -6.91 | 4.14 |
| Ancient colonies | 1,924 | 0.06 | 0.24 | 0.00 | 1.00 |
| Distance to the nearest colony | 1,951 | 136.00 | 85.49 | 0.53 | 460.83 |
| Ancient colonies (alternative source) | 1,923 | 0.06 | 0.24 | 0.00 | 1.00 |
| Poleis outside Greek homeland | 1,853 | 0.06 | 0.25 | 0.00 | 1.00 |
| Greek colony | 1,951 | 0.04 | 0.20 | 0.00 | 1.00 |
| Phoenician colony | 1,951 | 0.01 | 0.11 | 0.00 | 1.00 |
| Etruscan colony | 1,951 | 0.00 | 0.05 | 0.00 | 1.00 |
| Mixed (more than one coloniser) | 1,951 | 0.00 | 0.04 | 0.00 | 1.00 |
| Other ancient settlements | 1,924 | 0.25 | 0.43 | 0.00 | 1.00 |
| Other ancient settlements (only precise location) | 1,924 | 0.24 | 0.43 | 0.00 | 1.00 |
| Other ancient settlements (only town, city or urban) | 1,924 | 0.01 | 0.11 | 0.00 | 1.00 |
| Connectedness | 864 | 565.94 | 307.42 | 190 | 1373 |
| Altitude | 1,951 | 519.84 | 493.59 | -77.60 | 2637.68 |
| Distance to the Mediterranean coast | 1,951 | 76.72 | 62.77 | 0.57 | 199.97 |
| Coastal | 1,951 | 0.32 | 0.47 | 0.00 | 1.00 |
| Island dummy | 1,951 | 0.07 | 0.26 | 0.00 | 1.00 |
| Latitude | 1,951 | 38.51 | 5.33 | 28.55 | 48.83 |

| | | | | | |
|---|---|---|---|---|---|
| Longitude | 1,951 | 19.37 | 15.06 | -10.63 | 45.00 |
| Precipitation | 1,951 | 539.61 | 315.72 | 10.93 | 1796.39 |
| Ruggedness | 1,951 | 192.19 | 169.02 | 0.46 | 934.44 |
| Soil quality | 1,951 | 8.78 | 1.32 | 0.00 | 10.00 |
| Temperature | 1,951 | 14.09 | 4.42 | 0.03 | 23.06 |
| Water quality | 913 | 10.90 | 24.70 | 0.99 | 263.11 |

*Panel B: Within 50 km of the Mediterranean coast*

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Log night light density | 864 | 0.93 | 2.27 | -6.91 | 4.14 |
| Ancient colonies | 838 | 0.13 | 0.34 | 0.00 | 1.00 |
| Distance to the nearest colony | 864 | 86.22 | 67.48 | 0.53 | 294.83 |
| Ancient colonies (alternative source) | 839 | 0.14 | 0.34 | 0.00 | 1.00 |
| Poleis outside Greek homeland | 770 | 0.15 | 0.36 | 0.00 | 1.00 |
| Greek colony | 864 | 0.09 | 0.29 | 0.00 | 1.00 |
| Phoenician colony | 864 | 0.03 | 0.17 | 0.00 | 1.00 |
| Etruscan colony | 864 | 0.00 | 0.05 | 0.00 | 1.00 |
| Mixed (more than one coloniser) | 864 | 0.00 | 0.06 | 0.00 | 1.00 |
| Other ancient settlements | 838 | 0.370 | 0.48 | 0.00 | 1.00 |
| Other ancient settlements (only precise location) | 838 | 0.369 | 0.48 | 0.00 | 1.00 |
| Other ancient settlements (only town, city or urban) | 838 | 0.021 | 0.15 | 0.00 | 1.00 |
| Connectedness | 864 | 565.94 | 307.42 | 190 | 1373 |
| Altitude | 864 | 323.33 | 319.60 | 1.83 | 2051.87 |
| Distance to the Mediterranean coast | 864 | 17.50 | 13.97 | 0.57 | 49.96 |
| Coastal | 864 | 0.73 | 0.45 | 0.00 | 1.00 |
| Island dummy | 864 | 0.17 | 0.37 | 0.00 | 1.00 |
| Latitude | 864 | 38.75 | 4.41 | 30.08 | 47.52 |
| Longitude | 864 | 18.95 | 13.50 | -9.70 | 42.30 |
| Precipitation | 864 | 618.18 | 291.91 | 41.20 | 1796.39 |
| Ruggedness | 864 | 191.33 | 160.03 | 0.46 | 896.86 |
| Soil quality | 864 | 8.82 | 1.08 | 0.00 | 10.00 |
| Temperature | 864 | 15.03 | 3.20 | 4.81 | 21.63 |
| Water quality | 863 | 10.02 | 22.39 | 0.99 | 199.87 |

Notes: The units of analysis are 50x50 km grid-cells. Variables descriptions are provided in Table 2. A1.

Table 2. A3 Robustness checks: Only coastal observations

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Ancient | 0.997*** | 1.017*** | 0.921*** | 0.962*** | 1*** | 0.962*** | 1.002*** | 0.936*** |
| colonies | (0.22) | (0.206) | (0.237) | (0.209) | (0.218) | (0.179) | (0.148) | (0.175) |
| Temperature | | -0.093 | | | | | | 0.101 |
| | | (0.103) | | | | | | (0.168) |
| Rainfall | | 0.002** | | | | | | 0.002 |
| | | (0.001) | | | | | | (0.001) |
| Elevation | | | -0.003*** | | | | | -0.002* |
| | | | (0.001) | | | | | (0.001) |
| Ruggedness | | | 0.007*** | | | | | 0.006*** |
| | | | (0.002) | | | | | (0.002) |
| Soil quality | | | | 0.168 | | | | 0.158 |
| | | | | (0.19) | | | | (0.17) |
| Water quality | | | | | 0.009* | | | 0.011** |
| | | | | | (0.005) | | | (0.005) |
| Island | | | | | | -1.501*** | | -1.084*** |
| | | | | | | (0.267) | | (0.321) |
| Coastal | | | | | | - | | - |
| | | | | | | - | | - |
| Latitude | | | | | | | 0.185*** | 0.133 |
| | | | | | | | (0.03) | (0.142) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Longitude | | | | | | | 0.023 | 0.009 |
| | | | | | | | (0.065) | (0.058) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.2 | 0.23 | 0.22 | 0.21 | 0.21 | 0.24 | 0.22 | 0.28 |
| Observations | 602 | 602 | 602 | 602 | 602 | 602 | 602 | 602 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to Mediterranean coastal observations. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A4 Robustness checks: Excluding dark places

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Ancient colonies | 0.486*** | 0.456*** | 0.338*** | 0.472*** | 0.494*** | 0.351*** | 0.5*** | 0.387*** |
| | (0.132) | (0.134) | (0.116) | (0.133) | (0.129) | (0.118) | (0.084) | (0.113) |
| Temperature | | 0.13*** | | | | | | 0.259*** |
| | | (0.025) | | | | | | (0.082) |
| Rainfall | | 0.001** | | | | | | 0.000 |
| | | (0.00) | | | | | | (0.00) |
| Elevation | | | -0.002*** | | | | | 0.000 |
| | | | (0.00) | | | | | (0.001) |
| Ruggedness | | | 0.002** | | | | | 0.001* |
| | | | (0.001) | | | | | (0.001) |
| Soil quality | | | | 0.088 | | | | 0.061 |
| | | | | (0.063) | | | | (0.045) |
| Water quality | | | | | 0.005*** | | | 0.005*** |
| | | | | | (0.002) | | | (0.001) |
| Island | | | | | | -0.509*** | | -0.284* |
| | | | | | | (0.12) | | (0.153) |
| Coastal | | | | | | 0.478*** | | 0.24 |
| | | | | | | (0.138) | | (0.171) |
| Latitude | | | | | | | 0.123*** | 0.233** |
| | | | | | | | (0.029) | (0.084) |
| Longitude | | | | | | | 0.001 | 0.013 |
| | | | | | | | (0.026) | (0.024) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.35 | 0.38 | 0.41 | 0.35 | 0.35 | 0.38 | 0.37 | 0.46 |
| Observations | 794 | 794 | 794 | 794 | 793 | 794 | 794 | 793 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast and with values of night light density higher than zero. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A5 Robustness checks: Excluding countries one by one (I)

| | The dependent variable is Log night light density | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALBANIA | | BOSNIA AND HERZEGOVINA | | BULGARIA | | CYPRUS | | ALGERIA | | EGYPT | | GREECE | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
| Ancient colonies | 0.941*** | 0.859*** | 0.959*** | 0.881*** | 0.972*** | 0.894*** | 0.948*** | 0.875*** | 0.965*** | 0.871*** | 0.942*** | 0.83*** | 0.889*** | 0.925*** |
| | (0.196) | (0.147) | (0.196) | (0.15) | (0.202) | (0.152) | (0.198) | (0.15) | (0.201) | (0.148) | (0.195) | (0.153) | (0.194) | (0.158) |
| Temperature | | 0.14 | | 0.129 | | 0.144 | | 0.154 | | 0.091 | | 0.146 | | 0.295** |
| | | (0.157) | | (0.16) | | (0.156) | | (0.157) | | (0.15) | | (0.159) | | (0.119) |
| Rainfall | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.002** | | 0.001 | | 0 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Elevation | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | 0 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Ruggedness | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004** | | 0.004*** | | 0.004*** |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Soil quality | | 0.143 | | 0.16 | | 0.158 | | 0.152 | | 0.143 | | 0.389* | | 0.092 |
| | | (0.134) | | (0.141) | | (0.139) | | (0.136) | | (0.134) | | (0.2) | | (0.092) |
| Water quality | | 0.012*** | | 0.011*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.01** | | 0.011*** |
| | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.004) | | (0.003) |
| Island | | -1.048*** | | -1.023*** | | -1.035*** | | -1.031*** | | -1.007*** | | -0.966*** | | -0.998*** |
| | | (0.241) | | (0.238) | | (0.24) | | (0.239) | | (0.262) | | (0.235) | | (0.348) |
| Coastal | | 0.211 | | 0.146 | | 0.168 | | 0.156 | | 0.162 | | 0.213 | | 0.158 |
| | | (0.301) | | (0.304) | | (0.303) | | (0.3) | | (0.321) | | (0.303) | | (0.323) |
| Latitude | | 0.175 | | 0.172 | | 0.179 | | 0.189 | | 0.143 | | 0.189 | | 0.3** |
| | | (0.15) | | (0.152) | | (0.15) | | (0.151) | | (0.143) | | (0.158) | | (0.136) |
| Longitude | | -0.004 | | -0.002 | | -0.001 | | 0 | | 0.021 | | -0.028 | | 0.024 |
| | | (0.052) | | (0.053) | | (0.052) | | (0.052) | | (0.048) | | (0.057) | | (0.047) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.22 | 0.3 | 0.22 | 0.31 | 0.24 | 0.31 |
| Observations | 826 | 825 | 831 | 830 | 828 | 827 | 827 | 826 | 801 | 800 | 802 | 801 | 743 | 742 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A5

Robustness checks: Excluding countries one by one (II)

| | The dependent variable is Log night light density | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPAIN | | FRANCE | | GEORGIA | | CROATIA | | ISRAEL | | ITALY | | LEBANON | |
| | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) | (23) | (24) | (25) | (26) | (27) | (28) |
| Ancient colonies | 1.057*** | 0.986*** | 0.967*** | 0.899*** | 0.936*** | 0.86*** | 0.959*** | 0.885*** | 0.959*** | 0.883*** | 1.122*** | 0.882*** | 0.959*** | 0.879*** |
| | (0.203) | (0.137) | (0.206) | (0.159) | (0.196) | (0.149) | (0.196) | (0.149) | (0.196) | (0.149) | (0.191) | (0.192) | (0.196) | (0.149) |
| Temperature | | 0.126 | | 0.14 | | 0.14 | | 0.141 | | 0.144 | | 0.15 | | 0.146 |
| | | (0.163) | | (0.157) | | (0.16) | | (0.163) | | (0.156) | | (0.184) | | (0.155) |
| Rainfall | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Elevation | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Ruggedness | | 0.004*** | | 0.004*** | | 0.004** | | 0.004*** | | 0.004*** | | 0.005*** | | 0.004*** |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.002) | | (0.001) |
| Soil quality | | 0.174 | | 0.167 | | 0.168 | | 0.151 | | 0.159 | | 0.129 | | 0.162 |
| | | (0.156) | | (0.146) | | (0.143) | | (0.137) | | (0.139) | | (0.135) | | (0.14) |
| Water quality | | 0.013*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** |
| | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) |
| Island | | -1.226*** | | -0.958*** | | -1.041*** | | -0.958*** | | -1.029*** | | -1.205** | | -1.029*** |
| | | (0.234) | | (0.241) | | (0.244) | | (0.229) | | (0.24) | | (0.434) | | (0.24) |
| Coastal | | 0.161 | | 0.142 | | 0.148 | | 0.147 | | 0.153 | | 0.159 | | 0.163 |
| | | (0.318) | | (0.307) | | (0.305) | | (0.303) | | (0.301) | | (0.326) | | (0.301) |
| Latitude | | 0.14 | | 0.18 | | 0.169 | | 0.179 | | 0.18 | | 0.256 | | 0.181 |
| | | (0.164) | | (0.15) | | (0.153) | | (0.154) | | (0.151) | | (0.187) | | (0.15) |
| Longitude | | -0.018 | | 0 | | 0.001 | | 0 | | -0.001 | | -0.031 | | -0.002 |
| | | (0.056) | | (0.053) | | (0.053) | | (0.053) | | (0.052) | | (0.062) | | (0.052) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.19 | 0.27 | 0.2 | 0.28 | 0.21 | 0.28 | 0.21 | 0.29 | 0.21 | 0.28 | 0.18 | 0.26 | 0.21 | 0.29 |
| Observations | 774 | 773 | 813 | 812 | 827 | 826 | 822 | 821 | 833 | 832 | 710 | 709 | 834 | 833 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A5
Robustness checks: Excluding countries one by one (III)

| | LIBYA | | MOROCCO | | MONTENEGRO | | MALTA | | PALESTINIAN AUTHORITY | | PORTUGAL | | ROMANIA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | The dependent variable is Log night light density | | | | | | | | | | | | | |
| | (29) | (30) | (31) | (32) | (33) | (34) | (35) | (36) | (37) | (38) | (39) | (40) | (41) | (42) |
| Ancient colonies | 0.904*** | 0.851*** | 0.965*** | 0.894*** | 0.959*** | 0.882*** | 0.909*** | 0.829*** | 0.959*** | 0.879*** | 0.968*** | 0.896*** | 0.944*** | 0.862*** |
| | (0.194) | (0.171) | (0.201) | (0.154) | (0.196) | (0.149) | (0.184) | (0.135) | (0.196) | (0.149) | (0.201) | (0.153) | (0.195) | (0.145) |
| Temperature | | 0.056 | | 0.153 | | 0.142 | | 0.141 | | 0.14 | | 0.146 | | 0.143 |
| | | (0.127) | | (0.173) | | (0.155) | | (0.155) | | (0.156) | | (0.157) | | (0.156) |
| Rainfall | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Elevation | | -0.002** | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Ruggedness | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Soil quality | | 0.218 | | 0.161 | | 0.16 | | 0.16 | | 0.161 | | 0.16 | | 0.133 |
| | | (0.157) | | (0.139) | | (0.14) | | (0.14) | | (0.141) | | (0.14) | | (0.134) |
| Water quality | | 0.01*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** |
| | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.003) |
| Island | | -1.092*** | | -1.005*** | | -1.03*** | | -1.034*** | | -1.032*** | | -1.037*** | | -1.04*** |
| | | (0.255) | | (0.24) | | (0.24) | | (0.241) | | (0.24) | | (0.24) | | (0.239) |
| Coastal | | -0.115 | | 0.158 | | 0.153 | | 0.167 | | 0.158 | | 0.15 | | 0.186 |
| | | (0.163) | | (0.32) | | (0.301) | | (0.3) | | (0.3) | | (0.307) | | (0.303) |
| Latitude | | 0.076 | | 0.188 | | 0.178 | | 0.178 | | 0.177 | | 0.178 | | 0.182 |
| | | (0.107) | | (0.167) | | (0.15) | | (0.15) | | (0.15) | | (0.151) | | (0.151) |
| Longitude | | 0.031 | | -0.003 | | -0.001 | | -0.002 | | -0.001 | | -0.001 | | -0.001 |
| | | (0.048) | | (0.053) | | (0.052) | | (0.052) | | (0.052) | | (0.052) | | (0.052) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.3 | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 |
| Observations | 779 | 778 | 796 | 795 | 835 | 834 | 836 | 835 | 834 | 833 | 823 | 822 | 830 | 829 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A5

Robustness checks: Excluding countries one by one (IV)

| | The dependent variable is Log night light density | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RUSSIAN FEDERATION | | SLOVENIA | | SYRIAN ARAB REPUBLIC | | TUNISIA | | TURKEY | | UKRAINE | |
| | (43) | (44) | (45) | (46) | (47) | (48) | (49) | (50) | (51) | (52) | (53) | (54) |
| Ancient colonies | 0.979*** | 0.875*** | 0.959*** | 0.882*** | 0.962*** | 0.899*** | 0.941*** | 0.888*** | 0.955*** | 0.835*** | 0.952*** | 0.841*** |
| | (0.202) | (0.152) | (0.196) | (0.149) | (0.198) | (0.151) | (0.197) | (0.155) | (0.248) | (0.182) | (0.205) | (0.147) |
| Temperature | | 0.151 | | 0.141 | | 0.155 | | 0.146 | | 0.115 | | 0.137 |
| | | (0.156) | | (0.156) | | (0.156) | | (0.155) | | (0.169) | | (0.158) |
| Rainfall | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 | | 0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Elevation | | -0.001 | | -0.001 | | -0.001 | | -0.001 | | -0.002 | | -0.001 |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.001) |
| Ruggedness | | 0.004*** | | 0.004*** | | 0.004*** | | 0.004*** | | 0.005*** | | 0.004*** |
| | | (0.001) | | (0.001) | | (0.001) | | (0.001) | | (0.002) | | (0.001) |
| Soil quality | | 0.166 | | 0.159 | | 0.163 | | 0.152 | | 0.147 | | 0.147 |
| | | (0.144) | | (0.139) | | (0.14) | | (0.138) | | (0.143) | | (0.138) |
| Water quality | | 0.016*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.012*** | | 0.009** |
| | | (0.003) | | (0.003) | | (0.003) | | (0.003) | | (0.004) | | (0.004) |
| Island | | -1.035*** | | -1.031*** | | -1.025*** | | -0.969*** | | -0.99*** | | -1.06*** |
| | | (0.242) | | (0.24) | | (0.24) | | (0.228) | | (0.25) | | (0.237) |
| Coastal | | 0.211 | | 0.154 | | 0.159 | | 0.09 | | 0.282 | | 0.219 |
| | | (0.316) | | (0.301) | | (0.301) | | (0.306) | | (0.314) | | (0.312) |
| Latitude | | 0.183 | | 0.177 | | 0.187 | | 0.175 | | 0.139 | | 0.181 |
| | | (0.151) | | (0.15) | | (0.151) | | (0.15) | | (0.159) | | (0.153) |
| Longitude | | -0.003 | | -0.001 | | -0.001 | | -0.002 | | -0.018 | | -0.005 |
| | | (0.053) | | (0.052) | | (0.052) | | (0.054) | | (0.067) | | (0.055) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.29 | 0.21 | 0.29 | 0.21 | 0.29 | 0.22 | 0.29 | 0.22 | 0.29 | 0.21 | 0.29 |
| Observations | 809 | 808 | 834 | 833 | 830 | 830 | 803 | 802 | 722 | 721 | 786 | 785 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A6 Robustness checks: Controlling for the connectedness of the coast

| | The dependent variable is Log night light density | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Ancient colonies | 0.959*** | 0.973*** | 0.882*** | 0.881*** |
| | (0.196) | (0.18) | (0.149) | (0.149) |
| Geographic-climatic controls | | | Yes | Yes |
| Connectedness | | Yes | | Yes |
| Country fixed effects | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.21 | 0.29 | 0.29 |
| Observations | 838 | 838 | 837 | 837 |

Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A7 Robustness checks: Grid cells of 10,000 km2

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Ancient colonies | 0.721*** | 0.7*** | 0.663*** | 0.705*** | 0.737*** | 0.604*** | 0.716*** | 0.648*** |
| | (0.224) | (0.206) | (0.202) | (0.228) | (0.219) | (0.212) | (0.189) | (0.179) |
| Temperature | | -0.004 | | | | | | 0.228* |
| | | (0.072) | | | | | | (0.116) |
| Rainfall | | 0.001 | | | | | | 0 |
| | | (0.001) | | | | | | (0) |
| Elevation | | | -0.003*** | | | | | -0.002* |
| | | | (0.001) | | | | | (0.001) |
| Ruggedness | | | 0.005*** | | | | | 0.004*** |
| | | | (0.001) | | | | | (0.001) |
| Soil quality | | | | 0.085 | | | | 0.068 |
| | | | | (0.109) | | | | (0.079) |
| Water quality | | | | | 0.007*** | | | 0.007*** |
| | | | | | (0.002) | | | (0.002) |
| Island | | | | | | -1.14*** | | -0.773*** |
| | | | | | | (0.245) | | (0.218) |
| Coastal | | | | | | 0.451 | | 0.264 |
| | | | | | | (0.338) | | (0.195) |
| Latitude | | | | | | | 0.172*** | 0.207* |
| | | | | | | | (0.036) | (0.109) |
| Longitude | | | | | | | 0.03 | 0.05 |
| | | | | | | | (0.064) | (0.051) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.22 | 0.23 | 0.24 | 0.22 | 0.22 | 0.25 | 0.24 | 0.29 |
| Observations | 270 | 270 | 270 | 270 | 270 | 270 | 270 | 270 |

Notes: The units of analysis are 100x100 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors clustered at the country level are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A8 Robustness checks: Conley (1999)'s SEs.

| | The dependent variable is Log night light density | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Ancient colonies | 0.959*** | 0.981*** | 0.855*** | 0.929*** | 0.976*** | 0.886*** | 0.974*** | 0.882*** |
| | (0.145) | (0.145) | (0.155) | (0.144) | (0.145) | (0.153) | (0.137) | (0.147) |
| Temperature | | -0.021 | | | | | | 0.142 |
| | | (0.042) | | | | | | (0.114) |
| Rainfall | | 0.002*** | | | | | | 0.001** |
| | | (0.001) | | | | | | (0.001) |
| Elevation | | | -0.002*** | | | | | -0.001* |
| | | | (0.00) | | | | | (0.001) |
| Ruggedness | | | 0.005*** | | | | | 0.004*** |
| | | | (0.001) | | | | | (0.001) |
| Soil quality | | | | 0.18 | | | | 0.159 |
| | | | | (0.112) | | | | (0.103) |
| Water quality | | | | | 0.011*** | | | 0.012*** |
| | | | | | (0.004) | | | (0.004) |
| Island | | | | | | -1.455*** | | -1.031*** |
| | | | | | | (0.316) | | (0.317) |
| Coastal | | | | | | 0.253* | | 0.157 |
| | | | | | | (0.145) | | (0.158) |
| Latitude | | | | | | | 0.214*** | 0.178* |
| | | | | | | | (0.044) | (0.092) |
| Longitude | | | | | | | -0.003 | -0.001 |
| | | | | | | | (0.029) | (0.03) |
| Country fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-sq | 0.21 | 0.23 | 0.23 | 0.22 | 0.22 | 0.24 | 0.23 | 0.29 |
| Observations | 838 | 838 | 838 | 838 | 837 | 838 | 838 | 837 |

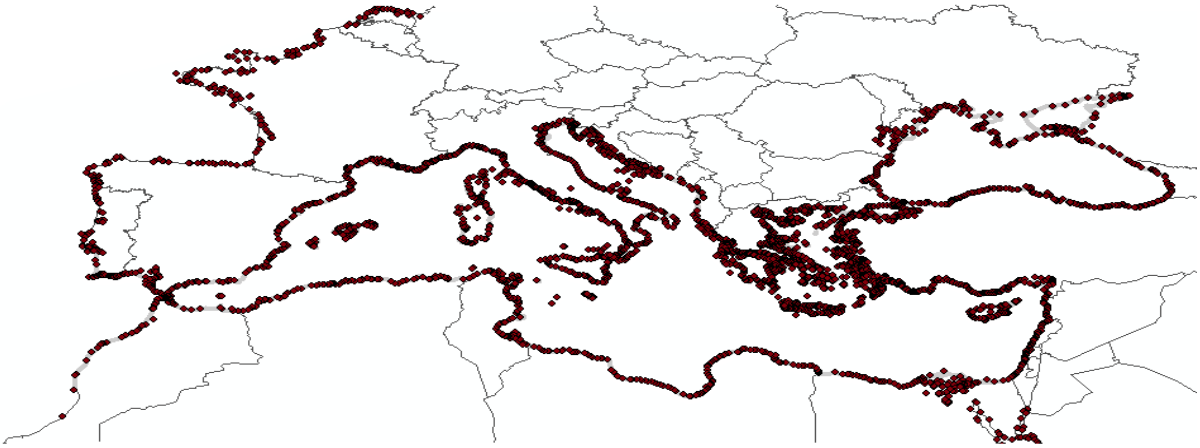
Notes: The units of analysis are 50x50 km grid-cells. Sample restricted to observations within 50 km of the Mediterranean coast. Variables descriptions are provided in Table 2. A1. The estimations include a constant term and a full set of country dummies, which are omitted for space considerations. Standard errors corrected for spatial dependence are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Table 2. A9 Testing Multicollinearity: VIF

| Variable | VIF | 1/VIF |
|---|---|---|
| Ancient colonies | 1.08 | 0.926262 |
| Temperature | 14.99 | 0.066705 |
| Rainfall | 2.39 | 0.417626 |
| Elevation | 8.97 | 0.111535 |
| Ruggedness | 5.44 | 0.183825 |
| Soil quality | 1.14 | 0.880655 |
| Water quality | 1.87 | 0.535309 |
| Island | 1.16 | 0.863316 |
| Coastal | 1.34 | 0.748347 |
| Latitude | 11.54 | 0.086686 |
| Longitude | 1.3 | 0.76782 |
| Mean VIF | 4.66 | |

*Note*: This table presents VIF values for all control variables. Variables with VIF value more than 10, are supposed to cause multicollinearity issues.

Figure 2. A1 Map of Ancient Harbours and Ports in the Mediterranean area



Notes: This map shows the geographic distribution of ancient harbours and ports.
Source: Graauw (2017).

# CHAPTER 3: It's time for Westernization: The advantages of the early start for long-term economic development at the local level

This article examines the 'early start' hypothesis at the local level in the context of Australian colonisation. It is found that the longer a place experiences economic activity under European management, the higher the level of economic development it achieves in the long-run. A theoretical framework is proposed under which a set of dynamic forces work in aggregate and enhance urban economic development. Results from several robustness checks that account for an array of possible biases validate the initial findings. Overall, the nature of Australian colonisation reflects a variation in the duration of the western presence at the local level, leading to the uneven development of urban areas.

'Towns are also complex organisms. It is not possible to make sense of them without studying them in a conceptually demanding way, with a reference to their economies, their demography, their social organization and the behaviour of a fair cross-section of their citizens.' (Bate, 1974, p.111)

## 3.1 Introduction

This chapter tests the 'early start' hypothesis at the local level. More specifically, I hypothesize that there is a positive effect of a longer economic experience, measured in years, on urban economic development. To examine this hypothesis, I use the natural experiment of Australian organized colonisation, which started in 1788. Europeans expanded along modern Australia parsimoniously and sluggishly due to the fact that they started from the coasts since the whole country is a large island. The relationships with the Aboriginals were usually non-friendly and the technology of that era was limited. This resulted in a relatively random variation in the year that even nearby places started to develop under European management. I exploit this variation in the European establishment of local places to examine my hypothesis. Using several econometric techniques and robustness checks, I find a positive effect of the length of time that an urban Local Government Area (LGA) has experienced European economic activity on its current economic development.[17] Thus, in the present chapter, time is proposed to be an endowment for long-term economic development.

[17] In most of the cases, Australian Local Government Areas (LGAs) are cities and towns by themselves. However, they can also be Boroughs, Shires and Councils incorporating more than one city or town.

North (1994) is one of the first to highlight the role of time as a factor in economic development. He claims that time allows humans to learn from their experiences, which in turn define the configuration, changes, and evolution of political and economic institutions, 'stock of knowledge', incentives and human beliefs. These parameters determine the long-term economic performance. More recent evidence suggests that time, expressed as depth of experience, is correlated with economic growth indexes, such as income per capita and institutional quality (Bockstette et al., 2002; Borcan et al., 2018). Moreover, earlier engagement with state capacity, jurisdictional hierarchy, technological adoption, transition to agriculture and educational provision are highly associated with economic benefits in the long-run (Comin et al., 2010; Michalopoulos and Papaioannou, 2013; Akcomak et al., 2015). It seems that the more time a society works as an economic and political entity, the higher the level of development it achieves in the long-run. Despite the growing body of literature which accredits time as a development factor, there is still limited evidence at the local level.

At the end of the 18th century, a fleet of European convicts arrived in Sydney and created a new type of settlement—a penal colony. This was the starting point of modern Australia. The majority of the felons saw the new colony as a source of wealth and freedom (Karskens, 2013). Despite their criminal past, their human capital transferred from Europe, was highly effective for the development of the new colonies. Apart from their general knowledge and skills, the convicts brought with them European institutions, culture, and technology, triggering a new age for Australia.[18] Soon cities and towns with substantial public buildings, houses and roads were ready to host the first free immigrants. In less than 100 years, Europeans had explored most of the Australian land.

Australia is a superb case when it comes to exploring the effects of time on economic development since its institutions, culture and political environment have so far been relatively homogenous and stable. Former convicts established Western European-like institutions in favour of the rule of law and investments (Acemoglu et al., 2001). Moreover, they also established democratic political institutions, continuing the precolonial indigenous tradition of an egalitarian way of life (Tonkinson and Berndt, 2017).[19] Apart from the long-term democratic principles, Grosjean and Khattar (forthcoming) argue that, in 1846, the population was ethnically and culturally homogenous, with 90% of people having English or Irish origins.

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[18] For the literature dealing with the role of human capital, institutions, culture and technology in the economic development see Chronopoulos et al. (2017).

[19] For studies related to the association and the positive effects of democracy on economic development see Papaioannou and Siourounis (2008).

Currently, Australia is still holding on to its relative homogeneity, with almost 65% of the population having Australian or British origins and English being the first spoken language (76.8%) (Central Intelligence Agency, 2017). Overall, the relative stability and homogeneity of Australia enables me to better isolate the effect of the ‘early start’ of the western economic activity.

To evaluate the ‘early start’ hypothesis locally, I regress the most urbanized Australian LGAs’ current economic development on the years (in number) they have experienced economic activity under European management, conditioning on a set of location, climatic and state-fixed effects variables. Technological limitations during the $18^{th}$ and $19^{th}$ centuries, coupled with the Australian geomorphology (since it is a large island) resulted in a clustered and highly-urbanized environment along its coasts. Hence, I use a range of spatial techniques to deal with spatial dependence concerns. Moreover, to validate my findings, I employ a battery of robustness checks and test for territory selection and heterogeneity effects. Interestingly, all results reaffirm that regions whose economic activity started earlier have higher current levels of economic development.

In addition to the ‘early start’ hypothesis, the current study relates to the broader literature that examines the long-term effects of colonisation on economic outcomes (Feyrer and Sacerdote, 2009; Putterman and Weil, 2010) as well as a vast body of literature that investigates the roots of economic development (Spolaore and Wacziarg, 2013). My work shows the positive effects of colonisation by more advanced civilizations and the sudden transfer of higher institutions and technology to less developed areas. Moreover, it describes the forces that trigger regional economic development.

The chapter proceeds as follows: Section 3.2 proposes the potential channels through which time affects long-term economic development. Section 3.3 provides a brief historical background of the Australian urban environment. Section 3.4 describes the data and presents the empirical strategy related to my baseline results. In Section 3.5, I report the main results and a set of robustness tests. Section 3.6 examines issues related to land selection and heterogeneity as well as the non-linear relationship between time and economic development. Finally, Section 3.7 concludes.

## 3.2 Why should time matter?

Several studies have examined the role of the ‘early start’ of economic activity in a region and its positive economic consequences in the long-run (Chanda and Putterman, 2007; Chanda et al., 2014). Since the phenomenon of regional evolution is dynamic in nature, time is a substantial parameter. In this section I describe continuous phenomena that enhance economies over time, assuming that they act as complements for their aggregate long-term economic development.

First, learning from experience, or learning-by-doing, has been characterized as an essential factor that impacts economies through—among others—industry production and higher technical knowledge (Atkinson and Stiglitz, 1969; Dasgupta and Stiglitz, 1988), human capital formation (Lucas Jr., 1988), public administration (Bockstette et al., 2002), and sustained growth (Stokey, 1988). Since time is a sine qua non for the dynamic process of gaining experience (learning) from past performance, I consider it a standout among the most vital channels for long-term economic development at the local level.

Second, industries within localities require time to adopt new technologies to enhance their efficiency (Stephen, 1994). Technological adoption and innovation costs are inversely related to the stock of previous technology (Comin et al., 2010). Consequently, regions with a longer history may not only incorporate new technologies from other markets more easily, but may also progress towards becoming business sector pioneers through inventions and patents.

Third, previous research has shown that there is a robust and positive relationship between the number of years that regions work under colonisers' rules and institutions and their long-term output (Feyrer and Sacerdote, 2009). As the relationship between the Aboriginals and Europeans was often hostile, time was a crucial stability factor for localities, since it helped the indigenous people to fully adopt inclusive European institutions and avoid turbulence (Acemoglu and Robinson, 2012).

Fourth, the concentration of more skilled (or more educated) workers in a locale is an indicator of higher wages and development. Akcomak et al. (2015) indicate that the role of early educational establishments, as a wellspring of human capital accumulation, gave rise to economic development in the Netherlands.[20] Moreover, Glaeser and Gottlieb (2009) argue that agglomeration economies and population growth are driving factors for skills and productivity, which in turn influence individual wages. Based on the above concepts, I contend that the spatial accumulation of knowledge or education is in favour of the foundation of agglomeration economies, which in turn attract an even more highly-skilled and educated labour force; indeed,

[20] In this case, the educational establishments were churches where religious people could read the Bible as well as several texts and books.

such a labour force is a source of long-term economic development. This is in line with Cantoni and Yuchtman (2014), who show that, in Germany, medieval universities played a causal and beneficial role in the local economic activity. Apparently, time plays a prominent role in the dynamic process of human capital accumulation.

An additional phenomenon that may enhance the standards of living and agglomeration within localities is that of labour pooling (Rosenthal and Strange, 2001). Ellison et al. (2010) claim that the accumulation of a particular type of worker in a region is a driving factor for new firms to select their establishment place. In this case, time plays a noteworthy role. The moment that a region's economy obtains a specific character (industrial, agrarian etc.) and starts attracting similar industries and a labour force is many steps forward from its foundation day.

Furthermore, localities benefit from the flow of ideas (Glaeser and Gottlieb, 2009). This stream of knowledge, ideas, opinions and beliefs among people, enterprises and institutions is an impetus for local economic development. Intellectual flows update firms and educational institutions, which in turn produce the most recent technology and innovation, triggering higher local economic development.

Lastly, Guiso et al. (2011)—among others—suggest that social capital has a positive relationship with economic development. The length of time that people interact within a region is a substantial parameter for the level of the regional social capital and economic development.

The data, however, do not allow me to determine empirically which of these forces could be the most substantial mechanism behind the effect of time on long-term economic development. Since all of the above forces through which time impacts economic development are significant, I do not impute any higher weight to one or some of them. I consider that, as time passes, their effect works in aggregate and facilitates the long-term economic development at the local level.

## 3.3 Urbanization history of Australia

Until 1717, the British penal system had been giving rise to overcrowded prisons. Several penal reforms were adopted in later years, resulting in a huge convict outflow from Britain, mainly to the United States and Australia (Meredith and Oxley, 2014). Australian colonization activity from Europeans started in 1788. The first felons arrived in Botany Bay—now Sydney—and started establishing their community. The convicts brought their skills and soon started working in several sectors, including agriculture, construction, and fishing (Karskens, 2013). Their relative freedom compared to in British prisons, as well as their desire to possess land as a source of power, were huge motivations for most of them to work hard (Weaver, 1996). By 1822, the number of felons had increased to 27,000, with the convict movement reaching a peak in 1833 when almost 7,000 convicts arrived in Australia within a year.

Australia's urbanization history starts from the beginning of the European colonisation period. In 1810, Sydney, the first colony, hosted more than half of the Australian population (Butlin, 1994). Nevertheless, several incidents led to the emergence of new urban centres. The extremely fertile land of Tasmania attracted an increasing number of ships, with free settlers creating the city of Hobart (Belich, 2009). Private companies were established in Perth until 1835. Melbourne, as an entry port to the Victorian goldfields, soon became the fastest-growing city in the world (Davison, 2001). Lastly, Adelaide arose as a wheat-growing colony, while Brisbane was another convict outpost.

After the 1860s, the new land legislations that permitted access to credit for small family farms, the railway construction that improved access to markets and reduced production costs, as well as new production techniques and efficient farming as a consequence of the industrial revolution that were adopted by cities, gave a comparative advantage to merchants who were close to metropolitan areas (Frost, 2014). Moreover, in highly-populated locations, public infrastructure, including roads, bridges, and sewerage systems, acted as a magnet for Australian inhabitants and newcomers.

After 1911, the share of the Australian population that was living within the biggest cities continued to increase (Butlin, 1994). New public investments related to electricity significantly affected industries, retail, and services. Soon, modern technology became necessary for the Australian inhabitants' lives. Cars and household appliances, such as dishwashers, were in high demand, giving the residents leisure time for cultural activities such as the cinema, music etc. Further innovative ideas applied by firms within cities, such as mail order shopping, attracted an even higher portion of the total market share from their competitors in the suburbs. Between 1921 and 1947, the five largest Australian cities attracted 1.4 million inhabitants from non-urban areas (Merrett, 1978).

During the second half of the 20$^{th}$ century, labour supply and the number of people living within cities continued to grow. Between 1947 and 1961, the Australian population increased by almost 3 million, with the largest part (2/3) settling in urban areas (Frost, 2014). From the

1970s, deindustrialisation, as well as overseas immigration, reshaped cities, and towns. The tertiary sector, services and information markets constituted a significant part of the total economic activities. Older cities, such as Brisbane, merged with their suburbs, thus creating megalopoleis. Most of the local economies, which used to be based on mining, farming, and more traditional economic sectors, became vulnerable to globalization and technological changes. In the first decade of the 21st century, controlled immigration continued, with almost 20% living outside of big cities or towns. Consequently, Australia is one of the most urbanized countries in the world.

## 3.4 Data and empirical strategy

The aim of the empirical analysis is to investigate the impact of time on the long-term economic development. This study combines data on current economic development with historical data on the initiation of economic activity in 219 urban Australian LGAs. Each LGA, which includes at least one major city or town (from the total sample of 249), has been selected to construct my sample (see Figure 3. A1 in the Appendix B). The list of major cities and towns was provided by the Natural Earth (2017) database as well as the Australian Bureau of Statistics (2016). In cases where more than one city or town is included in a LGA, I keep the one with the earliest recorded economic activity. Since Australia is a highly-urbanized country, the sample of the LGAs includes almost 90% of the country's total population.[21] The main variables consist of time, median income, education level, participation in higher technology, innovation, and sciences, as well as a set of climatic and location controls. More details about the definitions and sources of the variables are provided in Table 3. B1 in the Appendix B.

### 3.4.1 Data

My main independent variable is the number of years since economic activity started in each LGA until 2000. I assume that economic activity began when Europeans first settled or started any work or deed that reveals economic exploitation in a region. In the Appendix B, Table 3. B7 shows a sample of LGAs and the events that reveal the beginning of their economic activity. In most of the cases, towns and cities were built for specific purposes, such as mining, agriculture, trading, and labour hospitality. The main sources of this information are the Encyclopaedia Britannica (2015), Aussie Towns (2017) and Australian Heritage (2017) databases. These sources are complimented by the use of official local websites.

[21] The Central Intelligence Agency (2017) indicates that 89.4% of the total Australian population is urbanized.

Regarding the measures of economic development, I use three indicators. First, I use the logarithm of the total median income per capita. This is the total personal income from employment, investments, superannuation, and other minor sources of income, such as foreign investments, excluding government benefits (allowances, pensions). The second development index is education. Australia has one of the highest school life expectancy (in years) and lowest illiteracy rates in the world (Central Intelligence Agency, 2017).[22] For this reason, as an education index, I use the percentage of the population over 15 years old with a post-school qualification. Third, participation in higher technology, innovation and research is represented by the percentage of people with a postgraduate degree. The last development index differs from its education counterpart since it is a measure of research, patents, innovation, and the flow of ideas that generate additional growth (Carlino et al., 2007).[23]

Regarding the selection of my independent variables, I follow the literature as well as specific Australian land, environmental and historical events.[24]

### 3.4.2 Empirical strategy

I choose the Ordinary Least Squares (OLS) to examine the relationship between the length of the time that each LGA experiences European economic activity and its long-term economic development for the following reasons. First, OLS is used typically in prior studies which examine the role of: natural resource endowments (Barrios et al., 2010); historical legacy (Acemoglu et al., 2001); environmental conditions (Galor and Ozak, 2015); fiscal conditions (Bockstette et al., 2002); ideas (Glaeser and Gottlieb, 2009); state capacity (Borcan et al., 2018); and older institutions (Acemoglu and Robinson, 2012; Michalopoulos and Papaioannou, 2013; Michalopoulos and Papaioannou, 2017) on current economic development. Therefore, the control variables employed are drawn from the aforementioned body of literature. Second, based on the structure and availability of data and relevant prior research that exploits historical data, this is the most comprehensive way to investigate the effects of European existence in Australian cities on their current economic development. This is because there are no widely available time series of local level institutional and economic development (such as GDP, education etc).

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[22] School life expectancy is the expected number of years of schooling.

[23] In Table 3. B2 in the Appendix B, I provide results for GLP (Gross Local Domestic Product) per capita as an additional robustness check.

[24] For the literature dealing with the influence of geographic, climatic and location characteristics as well as natural endowments on the long-term economic development, see—among others—Campante and Do (2014), Oto-Peralias and Romero-Avila (2016), and Droller (2017).

I regress my three development indexes (Y) for LGA ***i*** on the time length (***Time***), including a set of location (***L***) and climatic (***C***) control variables. The model also incorporates state-fixed effects ($\eta_s$) to capture unobserved state characteristics, such as state institutions. $\varepsilon_i$ denotes the stochastic error term.

$$Y_i = \alpha \times Time_i + \beta_1 \times L_i + \beta_2 \times C_i + \eta_s + \varepsilon_i \quad (3.1)$$

The coefficient of interest indicates the impact of time on the outcome variables. Moreover, I control for an array of variables, which are commonly used in the economic development literature (Acemoglu et al., 2001; Banerjee and Iyer, 2005; Putterman and Weil, 2010; Michalopoulos and Papaioannou, 2016). These control variables typically include environmental, institutional, population and geographic characteristics (Spolaore and Wacziarg, 2013). My first location controls are latitude and longitude. Since Australia is the world's largest island, geographical coordinates are important control variables. Further location controls consist of distance from each state's capital and distance from the country's capital reflecting the penetration of national institutions, distances from the closest railway station, mine, and port as sources of trade, wealth, and accumulation of capital, as well as the distance from the sea which represents the access to profitable coastal activities such as fishing. In addition, I control with a dummy variable which is assigned the value of 1 if the LGA is tangent to the sea and 0 otherwise. Lastly, I control for the LGA land area.

Regarding the climatic control variables, I employ temperature, precipitation, elevation, ruggedness, and agriculture suitability. The agriculture suitability index describes the geological conditions of the soil and isolates the endogenous influences, such as agricultural technology, which may influence the land fertility. I expand the set so that it includes the percentage of water in each LGA's land as a source of agricultural activity and alternative inland navigation. Furthermore, I control for cyclones' intensity, which is a significant factor when it comes to the destruction of property and place abandonment in Australia. In addition, following Köppen's climate classification, I control for 6 binary dummies which are assigned the values of 1 or 0 and show whether there is temperate, grassland, desert, subtropical, tropical, and equatorial climate within each LGA. Moreover, I complement my set of climatic variables by calculating the standard deviation of precipitation and temperature, as well as the second order polynomial in average temperature and precipitation. Lastly, I complete my main (baseline) controls with a dummy which is assigned the value of 1 if the city or town within each LGA was established after 1900, since these places were potentially influenced by the global crisis of 1929, the second world war, modern technology, and recent immigration waves. Table 3.1 presents their descriptive statistics.

Table 3.1 Descriptive Statistics

| Variable | Obs. | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| Time | 219 | 143.34 | 31.35 | 20 | 212 |
| Log Median Income 2013 | 219 | 10.65 | 0.19 | 9.66 | 11.45 |
| Postschool qualifications 2011 | 219 | 50.68 | 7.17 | 31 | 75.3 |
| Postgraduate degree 2011 | 219 | 1.52 | 1.66 | 0 | 10.6 |
| Latitude | 219 | -30.65 | 6.88 | -43.18 | -12.39 |
| Longitude | 219 | 140.57 | 11.58 | 114.16 | 153.48 |
| Distance to the State Capital | 219 | 3.69 | 3.81 | 0 | 19.28 |
| Distance to the Country Capital | 219 | 9.88 | 7.30 | 0 | 27.61 |
| Distance to Railway Station | 219 | 0.42 | 0.74 | 0.001 | 4.72 |
| Distance to the Mine | 219 | 0.70 | 0.63 | 0.02 | 3.75 |
| Distance to the Port | 219 | 135.12 | 142.28 | 0.71 | 836.86 |
| Distance to the Sea | 219 | 147.98 | 182.06 | 0.26 | 898.03 |
| Area | 219 | 1.33 | 3.48 | 0.0005 | 36 |
| Temperature | 219 | 17.75 | 4.40 | 9.67 | 27.36 |
| Precipitation | 219 | 76.80 | 42.92 | 18.73 | 260.42 |
| Elevation | 219 | 0.24 | 0.19 | 0.007 | 1.01 |
| Ruggedness | 219 | 0.10 | 0.08 | 0.002 | 0.39 |
| Land Water % (Rivers and Lakes) | 219 | 1.03 | 1.95 | 0 | 13.53 |
| Cyclones Intensity | 219 | 2.06 | 2.43 | 0 | 12.38 |
| Agriculture Suitability | 218 | 0.46 | 0.19 | 1.40E-07 | 1.72 |
| St. Dev. Precipitation | 219 | 91.68 | 90.73 | 4.06 | 679.20 |
| St. Dev. Temperature | 219 | 6.57 | 4.74 | 0.38 | 22.14 |
| LGA Population 2016 | 219 | 44986.82 | 102189.7 | 267 | 1131155 |
| Proportion of Aboriginals | 214 | 8.23 | 12.84 | 0.3 | 84.5 |
| Distance to the Closest Mammal | 219 | 264.59 | 220.20 | 0.29 | 873.84 |
| Cost Path | 219 | 5.15E+07 | 5.18E+07 | 0 | 1.74E+08 |
| GLP per Capita 2016 | 216 | 0.13 | 0.25 | 0.003 | 2.03 |
| Temperature for Wheat | 219 | 3.02 | 1.11 | 1 | 5 |
| Malaria Likelihood | 219 | 0.20 | 0.16 | 0 | 0.73 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. Source: Author's calculations.

## 3.5 Estimation results

This section reports the effect of time on economic development and presents several robustness checks of the baseline results. Tables 3.2 to 3.5 provide the baseline results of this chapter, while Tables 3.6 to 3.13 put forth additional evidence of the validity of my hypothesis.[25]

[25] In the Appendix B, Figures 3. A4, 3. A5 and 3. A6 depict the conditional relationship between time and all my variables of interest.

### 3.5.1 The effect of time of westernization on economic development

Table 3.2 shows the effect of time on current economic development represented by the natural logarithm of the median income (per capita) in 2013. In column 1, the results show that the time variable is positively correlated with the median income, though the coefficient is not significant. In specification 2, including only location controls, the estimated coefficient becomes positive and significant. Latitude, longitude, distance from the country capital and mines enter the model with significant coefficients and expected signs, yet the other location controls are insignificant. In column 3, I expand the specification with an array of climatic controls, obtaining a positive and highly significant coefficient on the time variable. Column 4 reports the most saturated model using all baseline control variables.[26] In spite of employing a rich conditioning set, the strong positive association between time and economic development retains its economic and statistical significance.[27] The results in column 4 suggest that one standard deviation increase in time since the first economic activity, produces an average median income increase of (~)750 AUD. In other words, an additional unit of time (year) increases the median income by 0.24% (i.e., $e^{0.0024} - 1$). This means that a resident who lives in a one-century-older city in Australia receives, on average, a (~) 2,420 AUD higher salary per year.

Table 3.3 uses an alternative index as a measure of current economic development, namely education (as described in the data section). The coefficient on the time variable in column 1 is positive and significant. The estimate is much higher and more significant than the analogous conditional specification in Table 3.2. This result may be in line with Ahsan and Haque (2017), who argue that only those countries that exceed a specific threshold of development are able to utilize human capital (in terms of schooling) for growth purposes. This means that in Australia, as a highly developed country, the relationship between education demand and time may be higher compared to other development measures. In contrast, in less developed countries, all development measures may have a similar relationship with my time index. Columns 2 to 4 progressively add all my main control variables, which do not significantly affect the

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[26] When I control for agricultural suitability, I lose one observation. This is owing to a lack of data availability for the Queenscliff LGA.

[27] The coefficient of the variable Second Century is positive and highly significant. This suggests that cities which were founded after 1900 had a strong effect on current local economic development. This unsurprising given that many recent cities in Australia were established for industrial (mining, technological etc.) purposes, thus attracting skilled labour and new technologies. For this reason, I re-estimate my baseline specification after excluding all cities which were established during the 20th century. The coefficient of the main variable of interest remains positive and significant ($t_{stat}$= 3.63, 4.39, and 3.78 for Log Median Income 2013, Postschool qualifications 2011, Postgraduate degree 2011, respectively). This suggests that my findings are not driven by the most recently founded cities.

coefficient of interest, thus suggesting a positive association between time and education at the local level.

Table 3.2 Time Since First Economic Activity and Economic Development 1

| Dependent Variable: Log Median Income 2013 | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Time | 0.0009 | 0.0014** | 0.0013** | 0.0024*** |
| | (0.0008) | (0.0006) | (0.0006) | (0.0007) |
| Latitude | | 0.0434*** | 0.0054 | 0.0115 |
| | | (0.0127) | (0.0295) | (0.0276) |
| Longitude | | -0.0251*** | -0.0213*** | -0.0070 |
| | | (0.0070) | (0.0074) | (0.0082) |
| Distance to the State Capital | | -0.0027 | -0.0022 | -0.0069 |
| | | (0.0081) | (0.0087) | (0.0102) |
| Distance to the Country Capital | | -0.0455*** | -0.0363** | -0.0178 |
| | | (0.0134) | (0.0143) | (0.0134) |
| Distance to Railway Station | | 0.0066 | -0.0023 | -0.0148 |
| | | (0.0306) | (0.0302) | (0.0299) |
| Distance to the Mine | | -0.0782** | -0.0741** | -0.1101*** |
| | | (0.0331) | (0.0358) | (0.0322) |
| Distance to the Port | | -0.0001 | -0.0000 | -0.0001 |
| | | (0.0003) | (0.0003) | (0.0003) |
| Distance to the Sea | | -0.0001 | -0.0002 | -0.0000 |
| | | (0.0002) | (0.0003) | (0.0003) |
| Coastal Dummy | | 0.0162 | 0.0054 | 0.0007 |
| | | (0.0318) | (0.0403) | (0.0405) |
| Area | | 0.0020 | 0.0010 | 0.0065 |
| | | (0.0042) | (0.0042) | (0.0063) |
| Temperature | | | 0.0488 | -0.1348** |
| | | | (0.0336) | (0.0581) |
| Precipitation | | | -0.0001 | -0.0008 |
| | | | (0.0006) | (0.0025) |
| Elevation | | | 0.2223 | -0.1765 |
| | | | (0.2407) | (0.2161) |
| Ruggedness | | | -0.0055 | 1.5126** |
| | | | (0.2331) | (0.6805) |
| Land Water % (Rivers and Lakes) | | | -0.0033 | -0.0020 |
| | | | (0.0049) | (0.0051) |
| Cyclones Intensity | | | 0.0024 | -0.0017 |
| | | | (0.0103) | (0.0105) |
| Agriculture Suitability | | | -0.0323 | 0.0275 |
| | | | (0.0615) | (0.0547) |
| St. Dev. Precipitation | | | | -0.0004 |
| | | | | (0.0002) |
| St. Dev. Temperature | | | | -0.0249** |
| | | | | (0.0110) |
| Second Century | | | | 0.1500** |
| | | | | (0.0584) |
| Temperature & Precipitation polynomial | | | | Yes |
| Köppen Climate Dummy | | | | Yes |
| State F.E. | Yes | Yes | Yes | Yes |
| R-squared | 0.140 | 0.283 | 0.278 | 0.428 |
| Observations | 219 | 219 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

In column 1 of Table 3.4, I regress the percentage of people who have a postgraduate degree on the time since the first economic activity was observed within each LGA, simply conditioning on state-fixed effects. In line with the pattern shown in Table 3.3, the coefficient of time is positive and statistically significant. In column 4, I control for the full set of my baseline control variables. Nevertheless, the estimate of the variable of interest retains significance at the 99% confidence level, thus confirming my previous results regarding the positive influence of time on regional economic development.[28]

In addressing the spatial effects on the positive association between time and LGAs' economic development, I follow a set of econometric techniques dealing with the spatial autocorrelation problem. I start providing my estimations by clustering standard errors at the Statistical Area Level 4 (SA4).[29] Moreover, following Michalopoulos and Papaioannou (2013), I use Conley's (1999) method to correct for spatial dependence of unknown form. Lastly, I employ the spatial error correction model and the spatial lag correction model. The former treats spatial dependence as a nuisance, while the latter assumes that there is a spatial interaction of the dependent variable $\boldsymbol{Y_j}$ with the neighbouring regions N where N ∈ [$\boldsymbol{Y_1}$,$\boldsymbol{Y_{219}}$].

Table 3.3 Time Since First Economic Activity and Economic Development 2

| Dependent Variable: Post-school qualifications 2011 | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Time | 0.0540** | 0.0528** | 0.0571** | 0.1056*** |
| | (0.0273) | (0.0238) | (0.0235) | (0.0287) |
| Latitude | | 0.8327* | -1.8576** | -2.2480** |

[28] In Table 3. B6 in the Appendix B, I present the variance inflation factor (VIF) for all my control variables. The VIF shows how much the variance of an estimated regression coefficient increases when predictors are correlated. If the predictors are not correlated, the VIF value is equal to 1 As a rule of thumb, if the VIF exceeds 10, it is assumed that the regression coefficients are poorly estimated due to multicollinearity (Akinwande et al., 2015). Since the variables Temperature, St. Deviation of Temperature, Precipitation, Temperature and Precipitation polynomial, Latitude, Distance to the Country Capital, Temperate, Distance to the Sea, Ruggedness, Distance to the Port, and Longitude exceed number 10, someone could concern about multicollinearity issues. For this reason, I replicate our regressions excluding all variables with VIF more than 10. The main variable of interest remains positive and significant ($t_{stat}$= 2.68, 4.77, and 3.89 for Log Median Income 2013, Postschool qualifications 2011, and Postgraduate degree 2011, respectively). Thus, my results are robust after taking into consideration multicollinearity concerns.

[29] SA4 regions are the largest sub-state regions in Australia. Following Cameron and Miller (2015), I reject the case to cluster at the state level since the low number of Australian states may bias the standard errors downwards.

| | | | | |
|---|---|---|---|---|
| | | (0.4444) | (0.8989) | (0.9509) |
| Longitude | | -0.0310 | -0.0302 | -0.0153 |
| | | (0.2402) | (0.2440) | (0.2922) |
| Distance to the State Capital | | -0.1363 | -0.0836 | 0.0595 |
| | | (0.3043) | (0.3108) | (0.3746) |
| Distance to the Country Capital | | -0.4273 | -0.0100 | 0.1100 |
| | | (0.5090) | (0.5643) | (0.5887) |
| Distance to Railway Station | | -0.6515 | -0.9625 | -0.2854 |
| | | (1.0975) | (1.0838) | (1.0398) |
| Distance to the Mine | | -1.2301 | -1.0077 | -2.3123** |
| | | (0.9278) | (0.9845) | (1.0305) |
| Distance to the Port | | 0.0025 | 0.0034 | 0.0048 |
| | | (0.0096) | (0.0101) | (0.0117) |
| Distance to the Sea | | -0.0082 | -0.0137 | -0.0115 |
| | | (0.0092) | (0.0102) | (0.0102) |
| Coastal Dummy | | 2.8323** | 2.2756 | 2.0728 |
| | | (1.3480) | (1.6617) | (1.7046) |
| Area | | 0.0812 | 0.0432 | -0.0102 |
| | | (0.1801) | (0.1723) | (0.2125) |
| Temperature | | | 3.3804*** | 1.9244 |
| | | | (1.0468) | (2.4196) |
| Precipitation | | | 0.0404** | 0.0813 |
| | | | (0.0199) | (0.0994) |
| Elevation | | | 24.6821*** | 23.3863*** |
| | | | (6.5948) | (7.3624) |
| Ruggedness | | | -8.5597 | 5.9268 |
| | | | (7.7700) | (16.7860) |
| Land Water % (Rivers and Lakes) | | | 0.4377 | 0.4404 |
| | | | (0.3337) | (0.3243) |
| Cyclones Intensity | | | 0.7286* | 0.7418* |
| | | | (0.4197) | (0.4182) |
| Agriculture Suitability | | | -0.7026 | -0.7881 |
| | | | (2.5548) | (2.6172) |
| St. Dev. Precipitation | | | | -0.0109 |
| | | | | (0.0088) |
| St. Dev. Temperature | | | | -0.1773 |
| | | | | (0.2783) |
| Second Century | | | | 7.4618*** |
| | | | | (2.5289) |
| Temperature & Precipitation polynomial | | | | Yes |
| Köppen Climate Dummy | | | | Yes |
| State F.E. | Yes | Yes | Yes | Yes |
| R-squared | 0.157 | 0.299 | 0.360 | 0.410 |
| Observations | 219 | 219 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

Table 3.4 Time Since First Economic Activity and Economic Development 3

| Dependent Variable: Post-graduate degree 2011 | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |

| | | | | |
|---|---|---|---|---|
| Time | 0.0161*** | 0.0132** | 0.0127** | 0.0248*** |
| | (0.0060) | (0.0059) | (0.0050) | (0.0076) |
| Latitude | | -0.0305 | -0.5314*** | -0.6380*** |
| | | (0.0917) | (0.1806) | (0.2134) |
| Longitude | | 0.0681 | 0.0686 | 0.0267 |
| | | (0.0475) | (0.0558) | (0.0683) |
| Distance to the State Capital | | -0.0350 | -0.0172 | 0.0358 |
| | | (0.0608) | (0.0616) | (0.0624) |
| Distance to the Country Capital | | 0.0714 | 0.1193 | 0.1144 |
| | | (0.1187) | (0.1452) | (0.1506) |
| Distance to Railway Station | | 0.0439 | -0.0223 | 0.2624 |
| | | (0.1591) | (0.1874) | (0.1953) |
| Distance to the Mine | | 0.1703 | 0.3407* | 0.2152 |
| | | (0.1852) | (0.2046) | (0.1813) |
| Distance to the Port | | -0.0020 | -0.0010 | -0.0010 |
| | | (0.0017) | (0.0017) | (0.0019) |
| Distance to the Sea | | 0.0004 | -0.0028* | -0.0033** |
| | | (0.0016) | (0.0017) | (0.0017) |
| Coastal Dummy | | 0.0740 | 0.0166 | -0.0408 |
| | | (0.3810) | (0.4668) | (0.4694) |
| Area | | 0.0049 | -0.0320 | -0.0431 |
| | | (0.0285) | (0.0346) | (0.0418) |
| Temperature | | | 0.8057*** | 1.5564** |
| | | | (0.2329) | (0.6308) |
| Precipitation | | | 0.0126** | 0.0361 |
| | | | (0.0058) | (0.0262) |
| Elevation | | | 6.0334*** | 7.5871*** |
| | | | (1.4143) | (1.9292) |
| Ruggedness | | | -4.8079** | -3.0281 |
| | | | (2.2210) | (3.2310) |
| Land Water % (Rivers and Lakes) | | | 0.0856 | 0.0937 |
| | | | (0.1033) | (0.0996) |
| Cyclones Intensity | | | -0.0679 | -0.0247 |
| | | | (0.0876) | (0.0796) |
| Agriculture Suitability | | | -1.1422 | -1.4099 |
| | | | (0.8533) | (0.8853) |
| St. Dev. Precipitation | | | | -0.0024 |
| | | | | (0.0017) |
| St. Dev. Temperature | | | | -0.0262 |
| | | | | (0.0578) |
| Second Century | | | | 1.7750*** |
| | | | | (0.5744) |
| Temperature & Precipitation polynomial | | | | Yes |
| Köppen Climate Dummy | | | | Yes |
| State F.E. | Yes | Yes | Yes | Yes |
| R-squared | 0.177 | 0.175 | 0.258 | 0.292 |
| Observations | 219 | 219 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Table 3.5 Time Since First Economic Activity: Correcting for Spatial Autocorrelation

| | Dependent Variable | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Log Median Income 2013 | | | | Post-school qualifications 2011 | | | | Post-graduate degree 2011 | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Cluster at SA4 | 0.0024*** | | | | 0.1056*** | | | | 0.0248*** | | | |
| | (0.0006) | | | | (0.0265) | | | | (0.0083) | | | |
| Conley | | 0.0023*** | | | | 0.1056*** | | | | 0.0248*** | | |
| | | (0.0006) | | | | (0.0259) | | | | (0.0073) | | |
| Spatial Error Model | | | 0.0022*** | | | | 0.1094*** | | | | 0.0253*** | |
| | | | (0.0006) | | | | (0.0271) | | | | (0.0067) | |
| Spatial Lag Model | | | | 0.0022*** | | | | 0.1038*** | | | | 0.0248*** |
| | | | | (0.0006) | | | | (0.0266) | | | | (0.0069) |
| Main Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Moran's I | | | 3.087*** | | | | 1.060 | | | | -0.325 | |
| R-squared | 0.428 | | | | 0.410 | | | | 0.292 | | | |
| Observations | 218 | 218 | 218 | 218 | 218 | 218 | 218 | 218 | 218 | 218 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

In columns 1, 5 and 9 in Table 3.5, I present estimations of the most saturated model using cluster-robust standard errors (at SA4) to accommodate heteroscedasticity and within-cluster correlation. The coefficient of time is positive and highly significant. In columns 2, 6 and 10 I use Conley's (1999) method with a cutoff distance of 100 km.[30] All of the results remain positive and significant at the 99% confidence level. Furthermore, following Anselin (2001), I employ the spatial error model and the spatial lag model in columns 3, 7 and 11 and 4, 8 and 12, respectively. Although the Moran's I is not statistically significant for the spatial error regressions with the education variables, the results clearly point out that the length of time that urban places experience European economic activity has a critical effect on their economic development.[31] Overall, the results in Table 3.5 suggest that spatial correlation among LGAs is not a driving factor for my findings.

Although I use a wide variety of arguments and techniques to address the concerns regarding spatial dependence and endogeneity in the location of European colonies, a set of bias challenges still remains. Therefore, I run a set of robustness, balancedness and land heterogeneity tests, detailed in the next sections (3.5.2 and 3.6), that reaffirm my hypothesis. Although I interpret my coefficient as causal, I acknowledge that it is impossible to completely dispel all doubts. However, I believe that my analysis sheds light on the 'early start' hypothesis at the local level and the deeper roots of uneven regional development within the same country.

### 3.5.2 Robustness checks

#### 3.5.2.1 Omitted Variable Bias

An important issue is how to credibly interpret the results as evidence of a causal relationship between time and economic development. Omitted variable bias may distort the results. For this reason, in Table 3.6, I employ a technique which assumes that the selection on the observed controls is proportional to the selection on the unobserved controls (Oster, 2017). This allows me to provide results without worrying about confounding factors. The main assumption of the technique is that the unobservables can be recovered from the relationship between the treatment and observables. The intuition is to increase the R-squared (Rmax) from the baseline regression, as if I were able to observe all the unobservables. Therefore, for each one of my baseline specifications with coefficients shown in column 1, I calculate an Rmax

[30] Over the 100 km the spatial correlation is assumed to be zero.
[31] Moran's I test statistic is used to test whether data have spatial dependence.

value, which is 30% higher than the respective $R^2$, and assume that all relevant observed and unobservable variables are included as controls. Using the Rmax value for each baseline specification, I calculate a set of coefficients as well as a variable δ reported in columns 2 and 4, respectively. The new coefficients show the effects of time on current economic development as if there are  no ommited variables. Importantly, all of these coefficients are positive and significant. Moreover, the values of δ suggest the treatment effect of time is zero only if the omitted variables are 1.06 to 3.23 times as important for the current local economic development as the included control variables. Since I employ a significant number of control variables, it seems unlikely the unobserved characteristics to satisfy the above findings. Furthermore, the sets of corrected and non-corrected coefficients safely exclude zero, which is an important prerequisite in order to assume that unobservables do not affect my initial estimations. All findings suggest that my main results are robust and mitigate the concern that the effect of time on economic development is driven by omitted variable bias.

Table 3.6 Time Since First Economic Activity and Economic Development: Omitted Variables Bias

| Dependent Variable | Baseline Specification coefficient ƀ | Identified Set (ƀ,b(Rmax,Delta=1)) | Exclude Zero | Absolute Delta (δ) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| (Log) Median Income 2013 | 0.0024*** | [0.0024,0.0062] | Yes | 1.39>1 |
| Post-school qualification 2011 | 0.1056*** | [0.1056,0.2606] | Yes | 3.23>1 |
| Post-graduate degree 2011 | 0.0248*** | [0.0248,0.0742] | Yes | 1.06>1 |
| Main Control Variables | Yes | Yes | | |
| State F.E. | Yes | Yes | | |
| Observations | 218 | 218 | | |

*Notes*: Coefficients for the baseline specifications are obtained from OLS results illustrated in Tables 3.1-3.3. Results in columns 2 and 4 are calculated using Stata code psacalc provided by Oster (forthcoming), correcting baseline estimations for omitted variables bias. The estimations include a constant term, which is omitted for space considerations. Variables descriptions are provided in the Appendix B Table 3. B1. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

### 3.5.2.2 Initial Purpose

One may argue that the main initial purpose of colonising a LGA (locality) affects its economic path, creating time for it to play a more or less significant role in its long-term economic development. Thus, controlling for the main initial activity in each LGA may be important. Although in almost all LGAs colonisers were initially working in more than one major economic sector, I distinguish the LGAs based on three main initial categories of economic activity. For each category, I construct a dummy variable named Initial Event. Places whose initial main economic activity related to higher technology and scientific knowledge, such as mining, services and industry, are grouped as Initial Event 1. LGAs whose first settlers were mainly working within pastoralism, agricultural sectors and forestry are categorized as Initial Event 2. Lastly, LGAs whose initial economy was based on trade, are clustered as Initial Event 3. In Table 3.7, I estimate the most saturated specifications using my main control variables as well as the dummies that control for initial economic activity. The coefficients on time in all columns are positive and highly significant, thus suggesting that time exerts a positive and significant influnce on economic development, independent of the initial purpose for which each city was built. The coefficients on Initial Events show that early eaconomic activities related to agriculture, pastoralism and forestry are negatively associated with economic development in the long-run.[32]

Table 3.7 Time Since First Economic Activity and Economic Development: Initial Purpose

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| Time | 0.0022*** | 0.1024*** | 0.0252*** |
| | (0.0007) | (0.0275) | (0.0075) |
| Initial Event 2 (pastoralism, agriculture, forestry) | -0.0888*** | -3.5382*** | -0.8651*** |
| | (0.0229) | (0.9669) | (0.2913) |
| Initial Event 3 (trading) | 0.0034 | -0.9137 | -0.5865 |
| | (0.0326) | (1.3311) | (0.3904) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.477 | 0.457 | 0.338 |
| Observations | 218 | 218 | 218 |

*Notes:* Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

[32] In the Appendix B Table 3. B3, I employ an interaction model examining whether there is a differential effect of time on economic development for each Initial Event group. Although the interacted coefficient in column 2 is slightly significant, the results do not provide strong evidence that Initial Events are primary channels through which time affects long-term economic development.

#### 3.5.2.3 Excluding places

Since Australia is one of the most urbanized countries in the world, I test whether the coefficient on time changes when dropping the most urbanized LGAs (population 2016/ LGA area in $km^2$) as well as the capital of Australia. In Panel A in Table 3.8, I report estimates excluding progressively Sydney, Melbourne, Brisbane, Perth, Adelaide, and Canberra LGAs (~65% of total population in 2016). The coefficient of time remains positive and significant. I repeat the regressions dropping the bottom outliers, i.e. the 1%, 10% and 15% of the least urbanized Australian LGAs following population estimations from 2016. The positive and highly-significant correlation between time and local economic development in Panel B remains intact.

Nearly 18% of the Australian mainland is a desert. Although I control for a number of variables related to the soil quality and agriculture, one could be concerned as to whether my results are driven by the inferiority of some less fertile regions. I address this concern by running the most saturated models, excluding the driest 1%, 10% and 15% of Australian regions. Although the observations are significantly reduced (up to 186), the results in Panel C in Table 3.8 are positive and significant. All estimates in the table retain significance, thus implying that my main positive and significant results are not driven by the influence of the most arid Australian LGAs.

As an additional robustness check, I exclude all LGAs that have 0 percentage of postgraduate degrees. The coefficients of all estimations in Panel D in Table 3.8 suggest a strong and significant effect of time on long-term economic development.

#### 3.5.2.4 Embedding abandoned regions

One more challenge related to my results is to account for places that were initially settled (by Europeans) and started to develop, but for various reasons were abandoned. In order to alleviate this survivorship bias concern, I use a database showing the abandoned places in Australia, assuming the worst scenario against my hypothesis. Since these places are mainly within the poorest LGAs, the scenario that they have survived and were built in the earliest possible year would provide more conservative estimates. The backward shift of the starting year of their economic activity could negatively dominate over my positive and significant results. First, to identify the abandoned places, I follow the U.S. National Imagery and Mapping Agency (2017). From this database, I obtain 13 abandoned places in total. Ten of them were

Table 3.8 Time Since First economic activity and Economic Development: Excluding Places

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| **Panel A** | | | |
| **Excluding Sydney** | 0.0024*** | 00997*** | 0.0219*** |
| | (0.0007) | (0.0284) | (0.0073) |
| R-squared | 0.426 | 0.398 | 0.266 |
| Observations | 217 | 217 | 217 |
| **Excluding Sydney, Melbourne** | 0.0024*** | 0.0907*** | 0.0171*** |
| | (0.0007) | (0.0273) | (0.0058) |
| R-squared | 0.425 | 0.399 | 0.284 |
| Observations | 216 | 216 | 216 |
| **Excluding Sydney, Melbourne, Brisbane, Perth, Adelaide, Canberra** | 0.0022*** | 0.0724*** | 0.0103** |
| | (0.0007) | (0.0244) | (0.0040) |
| R-squared | 0.416 | 0.433 | 0.271 |
| Observations | 212 | 212 | 212 |
| **Panel B** | | | |
| **Excluding 1% least Urbanized** | 0.0024*** | 0.1041*** | 0.0246*** |
| | (0.0007) | (0.0290) | (0.0077) |
| R-squared | 0.430 | 0.400 | 0.291 |
| Observations | 216 | 216 | 216 |
| **Excluding 10% least Urbanized** | 0.0017*** | 0.0854*** | 0.0235*** |
| | (0.0006) | (0.0254) | (0.0079) |
| R-squared | 0.528 | 0.504 | 0.289 |
| Observations | 197 | 197 | 197 |
| **Excluding 15% least Urbanized** | 0.0016*** | 0.0814*** | 0.0218*** |
| | (0.0006) | (0.0259) | (0.0078) |
| R-squared | 0.539 | 0.509 | 0.289 |
| Observations | 185 | 185 | 185 |
| **Panel C** | | | |
| **Excluding 1% least Precipitation** | 0.0025*** | 0.1085*** | 0.0251*** |
| | (0.0007) | (0.0288) | (0.0076) |
| R-squared | 0.439 | 0.426 | 0.301 |
| Observations | 216 | 216 | 216 |
| **Excluding 10% least Precipitation** | 0.0025*** | 0.1134*** | 0.0255*** |
| | (0.0007) | (0.0294) | (0.0079) |
| R-squared | 0.474 | 0.410 | 0.305 |
| Observations | 197 | 197 | 197 |
| **Excluding 15% least Precipitation** | 0.0019*** | 0.1067*** | 0.0295*** |
| | (0.0007) | (0.0292) | (0.0085) |
| R-squared | 0.326 | 0.398 | 0.343 |
| Observations | 186 | 186 | 186 |
| **Panel D** | | | |
| **Excluding Zero Post-grad. Degree** | 0.0023*** | 0.1034*** | 0.0243*** |
| | (0.0007) | (0.0287) | (0.0077) |
| R-squared | 0.445 | 0.398 | 0.276 |
| Observations | 212 | 212 | 212 |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

concentrated in the desert part of Australia, while the other three were in more coastal LGAs. Second, to identify the terminus a quo of the abandoned places, I follow the map of the progress of Australian exploration depicted in Figure 3. A2 in the Appendix B. Table 3.9 displays the results of the most saturated baseline specifications accounting for this set of abandoned Australian places. Despite the adjustments that affect my data negatively, in Table 3.9 the time variable enters into all regressions with a positive and statistically-significant coefficient.[33]

Table 3.9 Time Since First Economic Activity and Economic Development: Abandoned places

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| Time | 0.0022*** | 0.1026*** | 0.0255*** |
| | (0.0007) | (0.0288) | (0.0077) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.430 | 0.444 | 0.285 |
| Observations | 219 | 219 | 219 |

*Notes:* Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

#### 3.5.2.5 The effects of the indigenous population

One issue that must be raised is the role of the indigenous population in the current Australian economy. Although their total population percentage is quite low (2.8% in 2016), their economic impact is high since they benefit substantially from government funds and have a considerably lower education level than the rest of the Australians. Therefore, I test my results using the proportion of Aboriginals and Torres Strait Islanders in each LGA as an additional control variable, though it is likely endogenous to the ethnic, political, institutional, and economic environment. My main variable of interest in Table 3. 10 remains positive and significant, though the indigenous population is highly significant in columns 1 and 2,

[33] Total observations increase since I add one more LGA with an abandoned settlement.

indicating a positive effect of time since westernization on local long-term economic development.

Table 3.10 Time Since First Economic Activity and Economic Development: Indigenous Population

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| Time | 0.0016** | 0.0797*** | 0.0238*** |
| | (0.0006) | (0.0287) | (0.0079) |
| Proportion of Aboriginals 2011 | -0.0082*** | -0.2547*** | -0.0069 |
| | (0.0019) | (0.0562) | (0.0126) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.534 | 0.484 | 0.291 |
| Observations | 213 | 213 | 213 |

*Notes:* Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

### 3.5.2.6 Precolonial institutions and disease environment

Following Michalopoulos and Papaioannou (2013), one could argue that the precolonial ethnic institutions in Australia are a highly important factor for my positive and significant results. Nevertheless, historical evidence shows that Aboriginals had neither chiefs (political jurisdictional hierarchy) nor centralised institutions of social and political control (Tonkinson and Berndt, 2017). Taking into consideration the relatively stable democratic institutions that Australia has experienced so far (reported in Section 1), the limited availability of pre- and post-colonial political institutions does not necessarily bias my results in a direction that is favourable to the hypothesis under examination.

Apart from institutions, the effect of the precolonial disease environment on current development is emphasised by Acemoglu et al. (2001) and Levine (2005). However, Acemoglu et al. (2003) argue that tuberculosis, pneumonia, and smallpox were less common in Australia than Europe before 1900, and that this is one of the main reasons why Europeans did not continue transferring convicts in the United States. In addition, Coulibaly et al. (2009) provide a map showing that the largest part of Australia has never been malarious. Instead, Weaver

(1996) argues for the place that European diseases hold in explaining the serious catastrophe of Aboriginals after 1826. Hence, local Australian diseases have never played a relevant role in the rate of European expansion. Nevertheless, I run my baseline regressions controlling for the likelihood (suitable temperature) that an Australian place can be infected by malaria. Table 3. 11 shows that coefficients on time retain their statistical significance at the 1% level.

Table 3.11 Time Since First Economic Activity and Economic Development: Malaria

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 (1) | Post-school qualifications 2011 (2) | Post-graduate degree 2011 (3) |
| Time | 0.0026*** | 0.1107*** | 0.0261*** |
| | (0.0007) | (0.0295) | (0.0078) |
| Malaria Likelihood | 1.0718*** | 28.2835** | 7.3528** |
| | (0.3067) | (14.1957) | (3.4184) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.454 | 0.422 | 0.307 |
| Observations | 218 | 218 | 218 |

*Notes:* Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

## 3.6 Sensitivity analysis

### 3.6.1 Rational Selection

This section discusses the colonies’ potential selection problem. I argue that Europeans chose their colonies in a process that was a function of several characteristics. First, taking into consideration the geomorphological characteristics of Australia, which is a large island, as well as the frontier of technology during the first Australian colonisation period, it can be concluded that Europeans had access to Australia only from the coasts.[34] Consequently, coastal places were colonised first.

Second, historical events indicate that coastal places which later became colonies had better (or at least the same) land suitability for agriculture and food resources. For instance, since Norfolk Island provided goods for 41% of Sydney’s population, British officials pondered the relocation of the whole colony (Karskens, 2013). However, Sydney’s community

[34] Studies related to the economic advantages of coastal areas include Henderson et al. (2012).

had already been established, thus making any population transfer operations infeasible. Moreover, Europeans had totally different dietary patterns compared to the indigenous people. Indeed, the indigenous tribes, as hunter-gatherers, based their diet on uncultivated plants (as well as roots and tubers) and wild animals, including reptiles and insects, while Europeans cultivated mainly cereals (and derivatives) and mammals (O'Dea, 1991). Assuming that their colonial activity was driven mainly by their dietary patterns, they should have first chosen places where they could meet their nutritional needs. For this reason, I test whether local colonial establishment patterns followed their dietary and living preferences in two ways. First, First, I calculate an index which takes higher values in places where temperature is optimum for wheat growing (20-25 degrees Celsius). I regress these two indexes as well as all of my climatic independent variables on time, controlling (or not) for state-fixed effects, on time. Table 3.12a shows that the optimum temperature for wheat growing are not significantly correlated with time. Moreover, agriculture suitability and land water percentage are not significantly correlated with time since first economic activity. I observe that elevation and ruggedness are positively and significantly correlated with time mainly after including places with a higher distance from the shore and without controlling for state-fixed effects.[35] However, these results do not impose any selection bias. If colonisers were rational, they should have been located first in fertile plains, avoiding rugged and high-altitude places or areas with tropical rainfalls that could destroy their crops. Thus, I would expect negative instead of positive coefficients. Overall, places with optimum climatic and geographic conditions for Europeans do not seem to have been colonised first, thus confirming the notion that not only the best Australian places in terms of environment influenced the European colonial establishment pattern. The variation of Australian land characteristics related to the natural environment leaves the time of European establishment in localities unexplained.

[35] In addition, in the Appendix B Table 3. B4 in Panel A, I test whether time is correlated with my main temperature variable. The results are negative and highly significant as expected, since coastal places that were colonised first due to Australian geomorphology always have a lower temperature than the landlocked desert. However, after controlling only for latitude and longitude they lose their significance, thus suggesting that other confounding factors drive the positive correlation.

Table 3.12a Comparative advantages of the land: Selection

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | **Distance from the sea** | | | | | | | |
| | <50km | | <100km | | <150km | | <300km | |
| | **Panel A: Agriculture Suitability as Dependent Variable** | | | | | | | |
| Time | -0.0008 | 0.0003 | -0.0002 | 0.0006 | -0.0003 | 0.0007 | -0.0004 | 0.0006 |
| | (0.0009) | (0.0009) | (0.0007) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0005) |
| R-squared | 0.118 | -0.009 | 0.116 | -0.000 | 0.103 | 0.003 | 0.094 | 0.004 |
| Observations | 93 | 93 | 125 | 125 | 145 | 145 | 182 | 182 |
| | **Panel B: Temperature for Wheat grow as Dependent Variable** | | | | | | | |
| Time | 0.0021 | 0.0005 | 0.0026 | 0.0023 | 0.0027 | 0.0018 | 0.0030 | 0.0012 |
| | (0.0030) | (0.0039) | (0.0028) | (0.0031) | (0.0029) | (0.0030) | (0.0027) | (0.0027) |
| R-squared | 0.533 | -0.011 | 0.415 | -0.004 | 0.356 | -0.005 | 0.319 | -0.004 |
| Observations | 94 | 94 | 126 | 126 | 146 | 146 | 183 | 183 |
| | **Panel C: Precipitation as Dependent Variable** | | | | | | | |
| Time | -0.1648 | 0.1629 | -0.0958 | 0.1034 | -0.0925 | 0.1418 | -0.0593 | 0.1833* |
| | (0.1239) | (0.1659) | (0.0995) | (0.1248) | (0.0992) | (0.1145) | (0.0985) | (0.1017) |
| R-squared | 0.566 | -0.000 | 0.533 | -0.003 | 0.483 | 0.004 | 0.372 | 0.012 |
| Observations | 94 | 94 | 126 | 126 | 146 | 146 | 183 | 183 |
| | **Panel D: Elevation as Dependent Variable** | | | | | | | |
| Time | -0.0002 | 0.0006* | -0.0000 | 0.0010** | -0.0002 | 0.0011** | 0.0000 | 0.0014*** |
| | (0.0003) | (0.0003) | (0.0004) | (0.0004) | (0.0005) | (0.0005) | (0.0005) | (0.0005) |
| R-squared | 0.424 | 0.025 | 0.172 | 0.034 | 0.217 | 0.029 | 0.223 | 0.043 |
| Observations | 94 | 94 | 126 | 126 | 146 | 146 | 183 | 183 |
| | **Panel E: Ruggedness as Dependent Variable** | | | | | | | |
| Time | -0.0003 | 0.0003 | -0.0002 | 0.0004* | -0.0002 | 0.0005** | -0.0002 | 0.0005** |
| | (0.0002) | (0.0003) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| R-squared | 0.462 | 0.006 | 0.284 | 0.016 | 0.304 | 0.025 | 0.243 | 0.025 |
| Observations | 94 | 94 | 126 | 126 | 146 | 146 | 183 | 183 |
| | **Panel F: Water Percentage (Lakes and Rivers) as Dependent Variable** | | | | | | | |
| Time | 0.0131 | 0.0028 | 0.0089 | 0.0010 | 0.0098 | 0.0013 | 0.0067 | -0.0014 |
| | (0.0096) | (0.0086) | (0.0071) | (0.0063) | (0.0066) | (0.0056) | (0.0058) | (0.0049) |
| | 1.37 | 0.32 | 1.25 | 0.16 | 1.49 | 0.23 | 1.16 | -0.28 |
| R-squared | 0.034 | -0.010 | 0.048 | -0.008 | 0.039 | -0.007 | 0.056 | -0.005 |
| Observations | 94 | 94 | 126 | 126 | 146 | 146 | 183 | 183 |
| State F.E. | Yes | No | Yes | No | Yes | No | Yes | No |

*Notes*: Variables descriptions are provided in the Appendix B Table3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

Third, since Australian colonisation started in Sydney, I use the least cost path analysis from ArcGIS to find the additional cost in terms of environmental obstacles that colonisers need to overcome in order to move from their initial colony to any other colony within Australia.[36] If colonisers were rational, the cost of travelling from Sydney could be a reasonable control for place selection for new colonies at least during the first years of European expansion. In Table 3. 12b, I estimate my baseline specifications using the cost path as an additional control. The coefficient on the cost path variable is not significant in any specification. In contrast, my main variable of interest retains its statistical significance even after controlling for the potential selection measure.

Table 3.12b Time Since First economic activity and Economic Development: Cost Path

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| Time | 0.0024*** | 0.1056*** | 0.0248*** |
| | (0.0007) | (0.0288) | (0.0077) |
| Cost Path | -5.31e-10 | 9.20e-09 | 1.22e-09 |
| | (6.11e-10) | (1.88e-08) | (5.26e-09) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.425 | 0.407 | 0.288 |
| Observations | 218 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Furthermore, Konishi and Nugent (2013) argue that the diversity of indigenous people across Australia meant that relationships with Europeans differed from one place to another. The European establishment encountered numerous reactions, from hostility to completely welcoming. Consequently, the occupation of the new land may have depended on the

[36] As seen in the Appendix B, the notes in Figure 3. A3 describe the least cost path measure from Sydney to Melbourne. Moreover, in the Appendix B Table 3. B4, Panel B shows that Cost Path is a potential selection measure which becomes insignificant after controlling for coordinates. This may show that the least cost of moving (in terms of 'worse' environment) within Australia was not a significant parameter for colonisers to choose a place for establishment.

interaction (conflicts) between Europeans and various local clans.[37] Since Europeans had little or no information about indigenous people, this introduced an element of randomness into the process of European settlement in Australia.

Lastly, the different quality dimension of settlers may have predisposed colonies to different long-term development paths through land selection and earlier establishment. For instance, if uneducated convicts were staying in different places than free settlers, these differences could have affected long term economic development at the local level through intergenerational mechanisms. On the contrary, this was not the case for Australia. Karskens (2013) points out that convicts had higher literacy rate than their compatriots back home since almost 50% of them were able to read and write. Moreover, they had expertise in farming, sailing, hunting, building etc. This suggests that there was not any inequality between them and free immigrants in terms of production skills. Furthermore, slavery never existed in Australia in contrast with the United States and convicts were not treated differently than free settlers. If this was not the case, convicts would have selected first places like woodlands where they could hide or escape. Since almost any settler had the same rights from the beginning of the European colonisation, I do not expect any land selection bias based on the colonisers' skills.

### 3.6.2 Heterogeneity

The Australian natural environment is highly heterogenous. Australian places can range from highly arid and warm to highly rainy and cold. Taking this heterogeneity into consideration, I test whether time differently influences development while someone is moving from one place to another. For example, if time differently influences median income while someone is moving from a fertile LGA to another with barren land, it would affect my hypothesis regarding the influence of time on economic development. In Table 3. 13, I present my baseline estimates, including the interaction terms of my main variable of interest with climatic and location characteristics. Most of the results impose negligible or no heterogeneity effects. As an exception, in column 5 in Panel C, the coefficient on time since first economic activity is negative and highly significant. However, the remaining interacted coefficients in the same column do not validate this result. Overall, Table 3. 13 mitigates serious concerns regarding land heterogeneity effects. To provide further evidence about any heterogenous effects of time on economic development among places with different natural environments, in Table B5 in the Appendix B I run all of my baseline regressions while restricting

[37] Indigenous Australians consisted of (approximately) 250 language groups and 500 clans.

progressively the distance from the coast from 100 km to 800 km. Surprisingly, estimates validate that time exerts a positive role on development, both when looking at the most fertile coastal Australian areas and the whole country.

### 3.6.3 Non-Linearity

Finally, I test whether the quadratic form of my main variable of interest (the time plus the time squared) influences economic development. I present this relationship providing margin plot graphs as well as regression coefficients (Table 3.14). All plots show that there is a positive relationship between the quadratic form of time and my development indexes. However, Table 3.14 shows that this relationship is not significant for the development variables related to income. Figure 3.1 illustrates a strict exponential and positive relationship between time and median income. Nevertheless, Figures 3.2 and 3.3 illustrate that the same effect on education variables is initially positive but becomes negative for places that have been settled after 1900. Thus, the curves' path in Figures 3.2 and 3.3 suggest that, in more recently established cities, higher technology substitutes the effect of time for the accumulation of human capital. Nevertheless, the most important finding is that even cities, which were constructed under the most recent technology do not achieve education levels as advanced as counterparts with a long history.

## 3.7 Conclusion

In this chapter, I examine the 'early start' hypothesis at the local level. I argue that the Australian LGAs that started their economic activity under European management earlier have higher current economic development. Australia is a noteworthy example to examine my hypothesis since its political, cultural, and institutional environment has been relatively stable and homogenous so far. Europeans continued the indigenous people's egalitarian tradition by establishing democratic institutions. Thus, Australia is relatively exempt from serious historical turbulence, which could otherwise affect my results. The overall Australian history and environment allow me to isolate the effect of length of time of European economic activity on urban economic development.

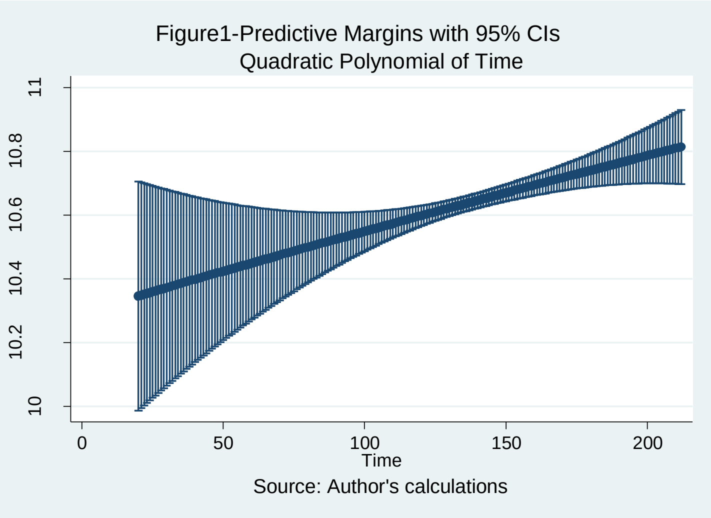
To test my hypothesis, I construct a dataset that includes the main Australian LGAs which are primarily cities and towns. I perform OLS estimations which show that there is a strong and positive association between the time that a LGA starts its economic activity and its current economic development. Since I find positive and significant results not only for one development index but for three, I believe that my inferences are not spurious.

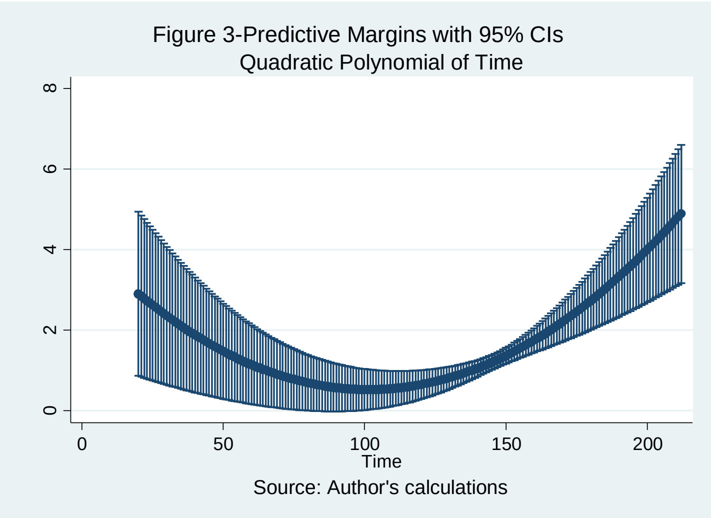
Table 3.13 Heterogeneity

| Interacted Variable | Coastal LGAs | Agriculture Suit. | Precipitation | Ruggedness | Temperature | Elevation |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A: Log Median income 2013 as Dependent Variable** | | | | | | |
| Time | 0.0024*** | 0.0024*** | 0.0025*** | 0.0024*** | 0.0024*** | 0.0026*** |
| | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0007) | (0.0006) |
| Time x Interacted variable | -0.0017* | -0.0015 | -8.37e-06 | -0.0027 | 0.0001 | 0.0079* |
| | (0.0010) | (0.0025) | (0.00001) | (0.0065) | (0.0001) | (0.0044) |
| R-squared | 0.440 | 0.426 | 0.460 | 0.425 | 0.426 | 0.451 |
| **Panel B: Post-school qualifications 2011 as Dependent Variable** | | | | | | |
| Time | 0.1053*** | 0.1043*** | 0.1162*** | 0.1038*** | 0.1018*** | 0.1085*** |
| | (0.0296) | (0.0287) | (0.0299) | (0.0285) | (0.0287) | (0.0283) |
| Time x Interacted variable | -0.0585 | -0.1085 | -0.0008* | -0.2226 | -0.0058 | 0.1292 |
| | (0.0380) | (0.1154) | (0.0004) | (0.2677) | (0.0053) | (0.1209) |
| R-squared | 0.420 | 0.412 | 0.422 | 0.410 | 0.413 | 0.412 |
| **Panel C: Post-graduate degree 2011 as Dependent Variable** | | | | | | |
| Time | 0.1053*** | 0.0243*** | 0.0247*** | 0.0244*** | 0.0232*** | 0.0243*** |
| | (0.0296) | (0.0074) | (0.0079) | (0.0074) | (0.0073) | (0.0074) |
| Time x Interacted variable | -0.0585 | -0.0426 | 4.71e-06 | -0.0477 | -0.0024*** | -0.0228 |
| | (0.0380) | (0.0362) | (0.0001) | (0.0876) | (0.0009) | (0.0291) |
| R-squared | 0.420 | 0.304 | 0.304 | 0.291 | 0.343 | 0.291 |
| Main Control Variables | Yes | Yes | Yes | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 218 | 218 | 218 | 218 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

# Figures 3.1, 3.2, 3.3



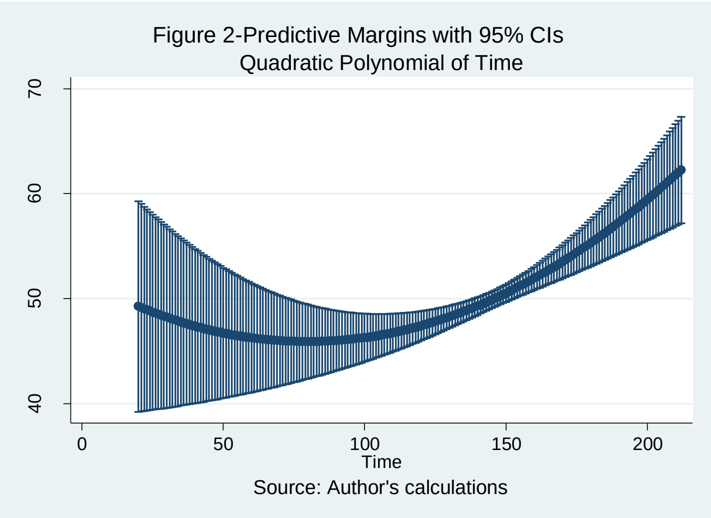



Table 3.14

***Time Since First Economic Activity and Economic Development: Quadratic form of Time***

| | Dependent Variable | | |
|---|---|---|---|
| | **Log Median Income 2013** | **Post-school qualifications 2011** | **Post-graduate degree 2011** |
| | (1) | (2) | (3) |
| Time | 0.0026 | -0.1492 | -0.0725*** |
| | (0.0032) | (0.0915) | (0.0231) |
| Time squared | -8.76e-07 | 0.0009** | 0.0003*** |
| | (0.00001) | (0.0003) | (0.00009) |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.5227 | 0.5346 | 0.4819 |
| Observations | 218 | 218 | 218 |

*Notes:* Variables descriptions are provided in Appendix B Table 3. B1. The estimations include a constant term which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively.

Since Australia is a huge island, the limitations of technology during the era of its colonisation and the usually non-friendly relationships with the Aboriginals forced Europeans to establish settlements starting from the coast before moving inland. To mitigate concerns related to any effects of regional spillovers on my results, I use a set of regressions which deal with spatial effects. I continue my analysis with a set of robustness checks that deal with the effect of the heterogenous Australian natural and population environment as well as survivorship and land selection bias. All results reaffirm that the time of westernization of Australian urban localities is a substantial factor in their long-term economic development.

I suggest several channels through which time plays a positive role in economic development in relatively stable and homogenous regions. The proposed forces behind this positive effect are learning-by-doing, adoption of new technology, number of years that a region works under a coloniser's institutions, human capital accumulation, labour pooling, the flow of ideas and social capital. I argue that these forces work in aggregate as time goes by, boosting economies. My findings warrant a further analysis of the weights of the forces that enhance long-term economic development. Lastly, for future work, I suggest the examination of my hypothesis in a region with historical turbulence and an unstable economic and political environment, such as countries in Sub-Saharan Africa.

# 3.8 Appendix B

Table 3. B1 Description of variables

| Variables | Description | Source |
|---|---|---|
| ***Main Dependent Variables*** | | |
| Log Median Income 2013 | Natural logarithm of the median total income (excl. Government pensions and allowance) ($AUD) | Australian Bureau of Statistics |
| Post-school qualifications 2011 | Percentage of total population aged 15 years and over with a post school qualification (%) | Australian Bureau of Statistics |
| Post-graduate degree 2011 | Percentage of total population with a postgraduate degree (%) | Australian Bureau of Statistics |
| ***Main Variable of Interest*** | | |
| Time | Number of years since the first economic activity observed in the Local Government Area | Encyclopaedia Britannica https://www.britannica.com/topic/list-of-cities-and-towns-in-Australia-2027337 and Australian Heritage http://www.heritageaustralia.com.au/historical-towns and Aussie Towns http://www.aussietowns.com.au/ |
| ***Main Control Variables*** | | |
| Latitude/Longitude | The geographic coordinates of the centroid of Local Government Areas, in decimal degrees | Author's elaboration |
| Agriculture Suitability | Average of seven key soil dimensions important for crop production: nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability to roots, excess salts, toxicities, and workability. The average value for each component is calculated for the surface area corresponding to the Local Government Area | Author's elaboration using data from Fischer et al. (2008) |
| Elevation | Average altitude of the surface area of the Local Government Area, in kilometres | Author's elaboration using data from DIVA-GIS |
| Ruggedness | Standard deviation of the altitude of the territory corresponding to the Local Government Area | Author's elaboration using data from DIVA-GIS |
| Temperature | Annual average temperature, in degrees of Celsius. It corresponds to the average value of the surface area of the Local Government Area | Author's elaboration using data from WorldClim Hijmans, Robert J., Susan E. Cameron, Juan L. Para, Peter G. Jones, and Andy Jarvis. 2005. 'Very High Resolution Interpolated Climate Surfaces for Global Land Areas.' International Journal of Climatology 25 (15): 1965–1978. |

**Table 3. B1 Description of variables (Continued)**

| Variables | Description | Source |
|---|---|---|
| Precipitation | Annual precipitation, in centimetres. It corresponds to the average value of the surface area of the Local Government Area | Author’s elaboration using data from WorldClim Hijmans, Robert J., Susan E. Cameron, Juan L. Para, Peter G. Jones, and Andy Jarvis. 2005. ‘Very High Resolution Interpolated Climate Surfaces for Global Land Areas.’ International Journal of Climatology 25 (15): 1965–1978. |
| Land Water % (Rivers and Lakes) | Percentage of water due to rivers and Lakes within Local Government area | Author’s elaboration using data from DIVA-GIS |
| Cyclones Intensity | Intensity of Cyclones within LGA | Author’s elaboration using data from https://data.csiro.au |
| Köppen Climate Dummy | Dummies for temperate, grassland, desert, subtropical, tropical and equatorial climate | Author’s elaboration using data from http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=kpngrp#maps |
| Area | Total area of the Local Government area, in ten thousand squares of kilometres | Author's elaboration using data from Australian Bureau of Statistics |
| Distance to the Sea | The geodesic distance from the centroid of each Local Government area to the nearest coastline, in kilometres | Author's elaboration using data from the thematicmapping.org (Bjorn Sandvik’s public domain map on world borders in the ESRI database) |
| Distance to the Country Capital | The geodesic distance from the centroid of each Local Government area to Canberra, in hundreds of kilometres | Author's elaboration |
| Distance to the State Capital | The geodesic distance from the centroid of each Local Government to the Capital of State within it falls, in hundreds of kilometres | Author's elaboration |
| Distance to Railway Station | The geodesic distance from the centroid of each Local Government to the nearest railway station, in hundreds of kilometres | Author's elaboration using data from U.S. National Imagery and Mapping Agency's (NIMA) |
| Distance to the Mine | The geodesic distance from the centroid of each Local Government to the nearest mine, in hundreds of kilometres | Author's elaboration using data from Australian Government/Geoscience Australia http://www.australianminesatlas.gov.au/mapping/downloads.html#ozmin |
| Distance to the Port | The geodesic distance from the centroid of each Local Government to the nearest port, in hundreds of kilometres | Author's elaboration using data from https://data.gov.au/dataset/australian-ports |
| Second Century | Dummy showing whether city established after 1900 | Encyclopaedia Britannica https://www.britannica.com/topic/list-of-cities-and-towns-in-Australia-2027337 and Australian Heritage http://www.heritageaustralia.com.au/historical-towns and Aussie Towns http://www.aussietowns.com.au/ |
| Coastal Dummy | Dummy showing whether the LGA is tangent to the coast | Author's elaboration using data from Australia Bureau of Statistics |

**Table 3. B1 Description of variables (Continued)**

| Variables | Description | Source |
|---|---|---|
| ***Other variables*** | | |
| Local Government areas | Australian local administrative areas | Australian Bureau of Statistics |
| Distance from Closest Mammal | The geodesic distance from the centroid of each Local Government area to the nearest mammal fossil during the Holocene period, in kilometres | https://paleobiodb.org/#/ |
| GLP per capita 2016 | Gross Local Government Area Product, on million Australian dollars ($) | http://economic-indicators.id.com.au/ |
| LGA Population 2016 | Number of persons | Australian Bureau of Statistics |
| Path Cost | Accumulated cost (in terms of Slope, Temperature, Agriculture Suitability, Precipitation and Cyclones) of approaching Local Government Areas starting from Sydney | Author's elaboration using Cost path analysis in ArcGIS |
| Malaria Likelihood | Malaria risk within Local Government area represented by the temperature suitability index for P. falciparum and P. vivax transmission | Author’s elaboration using data from https://map.ox.ac.uk/explorer/#/explorer |
| Initial Event | Initial Type of Economic Activity | Encyclopaedia Britannica https://www.britannica.com/topic/list-of-cities-and-towns-in-Australia-2027337 and Australian Heritage http://www.heritageaustralia.com.au/historical-towns and Aussie Towns http://www.aussietowns.com.au/ |
| Temperature for Wheat | Index from 1 to 5 showing suitability for wheat cultivation | Author’s elaboration using data from WorldClim Hijmans, Robert J., Susan E. Cameron, Juan L. Para, Peter G. Jones, and Andy Jarvis. 2005. ‘Very High Resolution Interpolated Climate Surfaces for Global Land Areas.’ International Journal of Climatology 25 (15): 1965–1978. |
| Abandoned populated places | Places used to be inhabited | U.S. National Imagery and Mapping Agency's (NIMA) |
| Proportion of Aboriginals 2011 | Percentage of Aboriginal and Torres Strait Islander Peoples of the total Australian population (%) | Australian Bureau of Statistics |

*Notes:* The units of analysis are local government areas. Populated places / significant urban areas come from the Natural Earth (2017) database (http://www.naturalearthdata.com/downloads/10m-cultural-vectors/10m-populated-places/) and the Australian Bureau of Statistics (2016) (http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/1270.0.55.004 July%202016?OpenDocument). Source: Author’s compilation.

Table 3. B2 Time Since First Economic Activity and Economic Development

| Dependent Variable: Log GLP per Capita 2016 | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Time | 0.0004 | 0.0018** | 0.0017** | 0.0018* |
| | (0.0008) | (0.0008) | (0.0007) | (0.0010) |
| Latitude | | 0.0432*** | -0.0313 | -0.0510 |
| | | (0.0137) | (0.0386) | (0.0311) |
| Longitude | | -0.0115 | -0.0101 | -0.0164 |
| | | (0.0102) | (0.0085) | (0.0121) |
| Distance to the State Capital | | -0.0271* | -0.0228 | -0.0198 |
| | | (0.0145) | (0.0149) | (0.0168) |
| Distance to the Country Capital | | -0.0144 | -0.0069 | -0.0103 |
| | | (0.0114) | (0.0107) | (0.0130) |
| Distance to Railway Station | | -0.0400 | -0.0486 | -0.0082 |
| | | (0.0358) | (0.0362) | (0.0406) |
| Distance to the Mine | | -0.0716** | -0.0547 | -0.0787** |
| | | (0.0342) | (0.0359) | (0.0387) |
| Distance to the Port | | 0.0008 | 0.0009 | 0.0008 |
| | | (0.0008) | (0.0008) | (0.0008) |
| Distance to the Sea | | -0.0002 | -0.0006 | -0.0005 |
| | | (0.0006) | (0.0006) | (0.0006) |
| Coastal Dummy | | 0.0432 | 0.0251 | 0.0206 |
| | | (0.0494) | (0.0643) | (0.0665) |
| Area | | 0.0429*** | 0.0362** | 0.0372** |
| | | (0.0132) | (0.0143) | (0.0151) |
| Temperature | | | 0.1089** | 0.1324 |
| | | | (0.0452) | (0.0990) |
| Precipitation | | | 0.0014** | 0.0019 |
| | | | (0.0006) | (0.0028) |
| Elevation | | | 0.7285*** | 0.9197*** |
| | | | (0.2635) | (0.2971) |
| Ruggedness | | | -0.4618* | 0.7433 |
| | | | (0.2575) | (0.7184) |
| Land Water % (Rivers and Lakes) | | | 0.0138 | 0.0133 |
| | | | (0.0188) | (0.0197) |
| Cyclones Intensity | | | 0.0014 | 0.0018 |
| | | | (0.0131) | (0.0139) |
| Agriculture Suitability | | | -0.1480* | -0.1858* |
| | | | (0.0841) | (0.0996) |
| St. Dev. Precipitation | | | | -0.0005** |
| | | | | (0.0002) |
| St. Dev. Temperature | | | | -0.0194* |
| | | | | (0.0116) |
| Second Century | | | | 0.0682 |
| | | | | (0.1079) |
| Temperature & Precipitation polynomial | | | | Yes |
| Köppen Climate Dummy | | | | Yes |
| State F.E. | Yes | Yes | Yes | Yes |
| R-squared | 0.088 | 0.257 | 0.303 | 0.312 |
| Observations | 216 | 216 | 215 | 215 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Table 3. B3 Initial Events as Potential Channels

| | Dependent Variable | | |
|---|---|---|---|
| | Log Median Income 2013 | Post-school qualifications 2011 | Post-graduate degree 2011 |
| | (1) | (2) | (3) |
| Time | 0.0016** | 0.0719** | 0.0328*** |
| | (0.0007) | (0.0350) | (0.0109) |
| Time x Initial Event 2 (pastoralism, agriculture, forestry) | 0.0011 | 0.0596* | -0.0148 |
| | (0.0010) | (0.0340) | (0.0089) |
| Time x Initial Event 3 (trading) | -0.0003 | 0.0288 | -0.0093 |
| | (0.0011) | (0.0544) | 0.0163 |
| Main Control Variables | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes |
| R-squared | 0.5773 | 0.5645 | 0.4680 |
| Observations | 218 | 218 | 218 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Table 3. B4 Correlations of Time

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | **Distance from the sea** | | | | | | | |
| | <100km | | <300km | | <100km | | <300km | |
| | **Panel A: Correlation between Time and Temperature** | | | | | | | |
| Time | -0.0208*** | -0.0593*** | -0.0249*** | -0.0675*** | 0.0035 | 0.0037 | 0.0025 | -0.0006 |
| | (0.0067) | (0.0107) | (0.0068) | (0.0094) | (0.0033) | (0.0034) | (0.0036) | (0.0036) |
| Latitude and Longitude | No | No | No | No | Yes | Yes | Yes | Yes |
| State F.E. | Yes | No | Yes | No | Yes | No | Yes | No |
| R-squared | 0.769 | 0.191 | 0.722 | 0.219 | 0.951 | 0.944 | 0.932 | 0.925 |
| Observations | 126 | 126 | 183 | 183 | 126 | 126 | 183 | 183 |
| | **Panel B: Correlation Between Time and Cost Path** | | | | | | | |
| Time | -1.54e+05*** | -8.64e+05*** | -1.69e+05*** | -9.88e+05*** | -29200 | 9430.167 | -17200 | 3686.953 |
| | (51000) | (128000) | (46500) | (106000) | (46500) | (48900) | (37200) | (38200) |
| Latitude and Longitude | No | No | No | No | Yes | Yes | Yes | Yes |
| State F.E. | Yes | No | Yes | No | Yes | No | Yes | No |
| R-squared | 0.914 | 0.263 | 0.912 | 0.32 | 0.939 | 0.926 | 0.951 | 0.944 |
| Observations | 126 | 126 | 183 | 183 | 126 | 126 | 183 | 183 |

*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Table 3. B5 Heterogeneity: Main Estimates by Distance from the Sea

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | **Distance from the sea** | | | | |
| | <100km | <200km | <300km | <400km | <500km | <600km | <700km | <800km |
| **Panel A: Log Median income 2013 as Dependent Variable** | | | | | | | | |
| Time | 0.0013* | 0.0017** | 0.0018*** | 0.0018*** | 0.0020*** | 0.0020*** | 0.0020*** | 0.0021*** |
| | (0.0007) | (0.0007) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) | (0.0006) |
| Main Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.585 | 0.482 | 0.494 | 0.525 | 0.510 | 0.493 | 0.475 | 0.465 |
| Observations | 125 | 163 | 182 | 197 | 204 | 209 | 212 | 216 |
| **Panel B: Post-school qualifications 2011 as Dependent Variable** | | | | | | | | |
| Time | 0.0916*** | 0.0828*** | 0.0856*** | 0.0791*** | 0.0863*** | 0.0843*** | 0.0846*** | 0.0899*** |
| | (0.0338) | (0.0293) | (0.0281) | (0.0259) | (0.0261) | (0.0266) | (0.0269) | (0.0269) |
| Main Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.508 | 0.469 | 0.458 | 0.479 | 0.468 | 0.460 | 0.433 | 0.445 |
| Observations | 125 | 163 | 182 | 197 | 204 | 209 | 212 | 216 |
| **Panel C: Post-graduate degree 2011 as Dependent Variable** | | | | | | | | |
| Time | 0.0270** | 0.0215** | 0.0215*** | 0.0196*** | 0.0207*** | 0.0209*** | 0.0209*** | 0.0223*** |
| | (0.0106) | (0.0085) | (0.0080) | (0.0073) | (0.0073) | (0.0073) | (0.0073) | (0.0074) |
| Main Control Variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| State F.E. | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.300 | 0.308 | 0.304 | 0.311 | 0.312 | 0.317 | 0.320 | 0.309 |
| Observations | 125 | 163 | 182 | 197 | 204 | 209 | 212 | 216 |

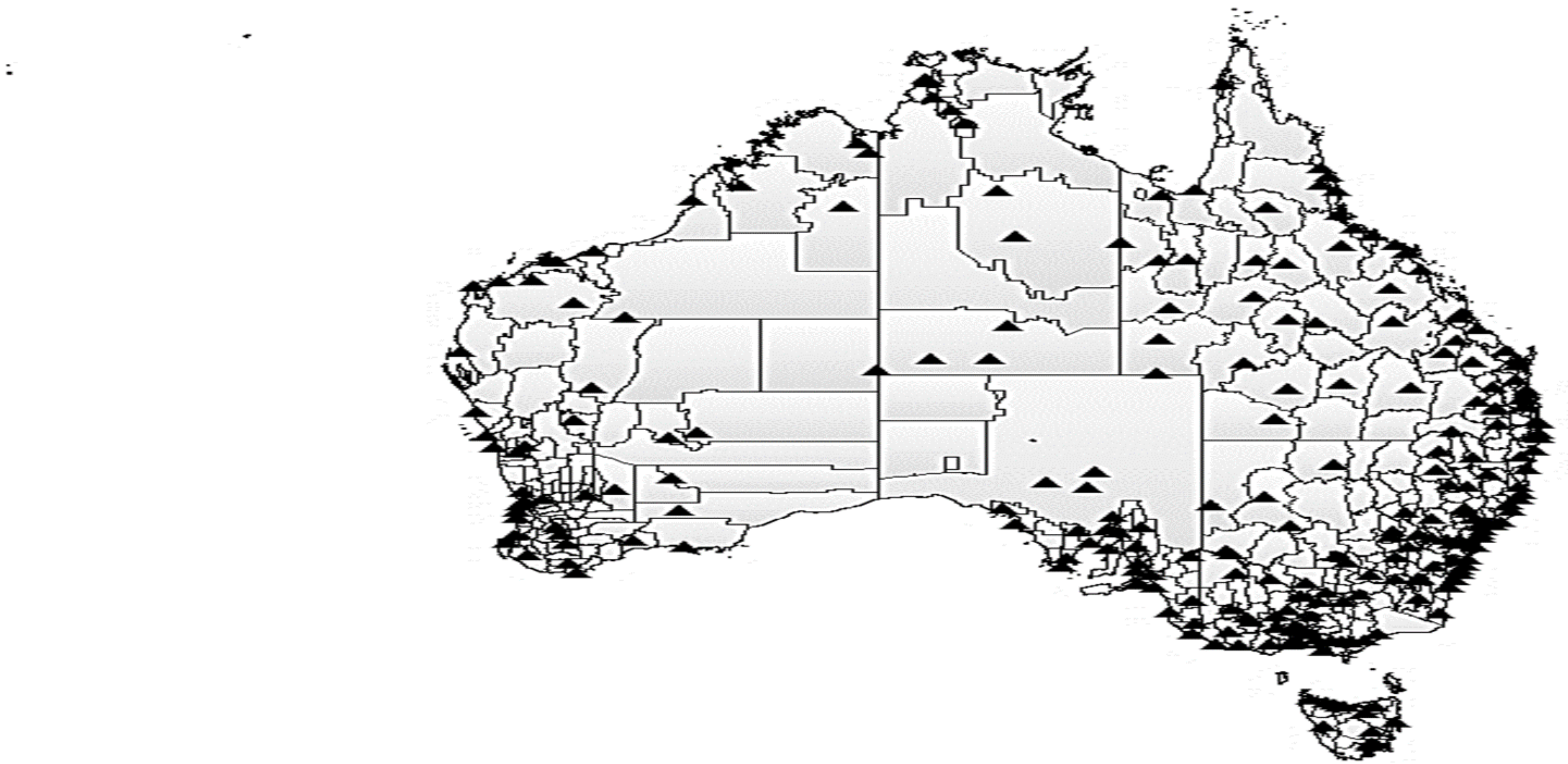
*Notes*: Variables descriptions are provided in the Appendix B Table 3. B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author's calculations.

Table 3. B6 Testing Multicollinearity: VIF

| Variable | VIF | 1/VIF |
|---|---|---|
| Temperature | 373.5 | 0.002677 |
| Squared Temperature | 220.56 | 0.004534 |
| Precipitation | 111.35 | 0.00898 |
| Latitude | 109.93 | 0.009097 |
| Temperature * Precipitation | 84.81 | 0.011792 |
| Squared Precipitation | 35.55 | 0.028128 |
| Distance to the Country Capital | 20.32 | 0.049203 |
| Temperate | 17.13 | 0.058383 |
| Distance to the Sea | 14.51 | 0.06892 |
| Ruggedness | 12.76 | 0.078388 |
| Distance to the Port | 12.21 | 0.08191 |
| Longitude | 12.17 | 0.082182 |
| Elevation | 9.76 | 0.102457 |
| Subtropical | 9.27 | 0.107917 |
| Grassland | 6.17 | 0.162083 |
| Tropical | 6.04 | 0.165593 |
| Equatorial | 5.64 | 0.177413 |
| Cyclones Intensity | 4.62 | 0.216331 |
| Time | 4.24 | 0.235587 |
| Distance to the State Capital | 4.14 | 0.241718 |
| St. Dev. Precipitation | 4.07 | 0.245559 |
| Distance to Railway Station | 2.92 | 0.342303 |
| Coastal Dummy | 2.75 | 0.363102 |
| Second Century | 2.69 | 0.371501 |
| Area | 2.65 | 0.377309 |
| Distance to the Mine | 1.78 | 0.56332 |
| Agriculture Suitability | 1.38 | 0.724463 |
| Land Water % (Rivers and Lakes) | 1.37 | 0.73246 |
| Mean VIF | 38.17 | |

*Note*: This table presents VIF values for all control variables. Variables with VIF value more than 10, are supposed to cause multicollinearity issues.

Figure 3. A1 Significant Cities and Towns



*Notes:* Black triangles illustrate the set of significant Australian cities and towns (249) I use to identify the sample of Local Government Areas. Source: Author's elaboration.

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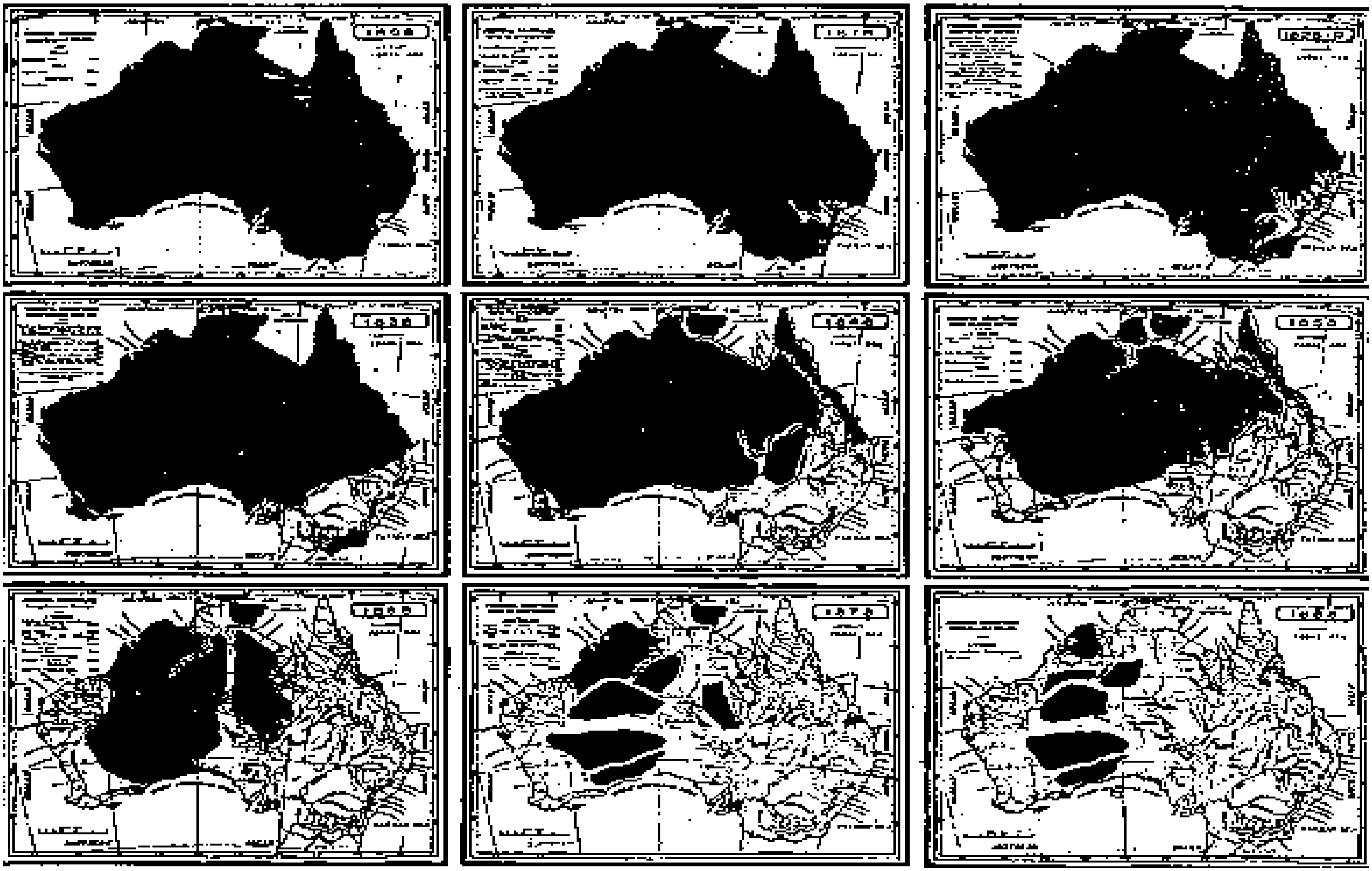
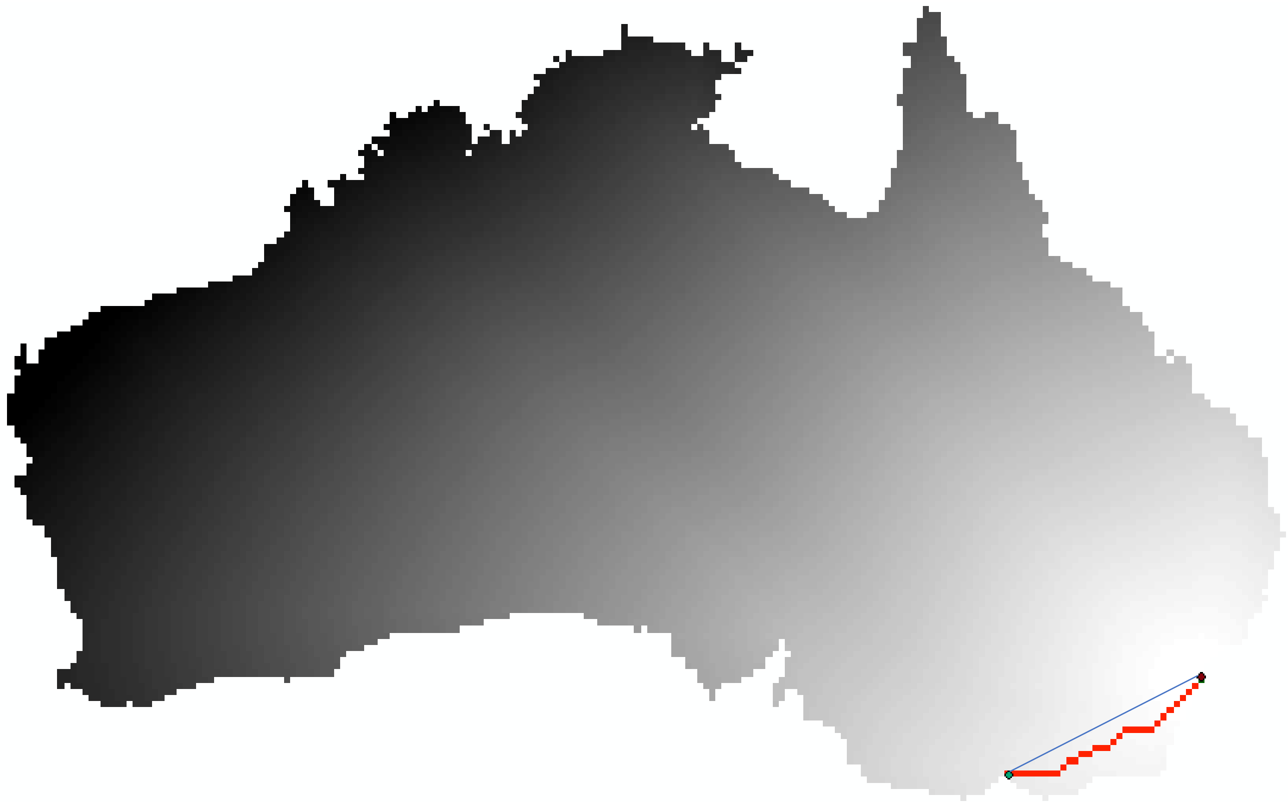
Figure 3. A2 Map of Australian Exploration by Europeans after 1806



*Notes:* The black colour depicts the area of unexplored territory from 1806 to 1888. Source: Australian Bureau of Statistics.

Figure 3. A3 Least Cost Path from Sydney to Melbourne



*Notes:* The red non-linear line depicts the least accumulated cost (easiest path) for colonizers to go from Sydney to Melbourne, expressed by 'worse' environmental conditions. Assuming that the coloniser is rational, she avoids following places with high altitude, ruggedness, temperature, tropical rainfalls and cyclones. Besides, she prefers to expand following localities with better agriculture suitability. The least cost path is not aligned with the shortest linear distance which is depicted by the blue line. Source: Author's calculations.

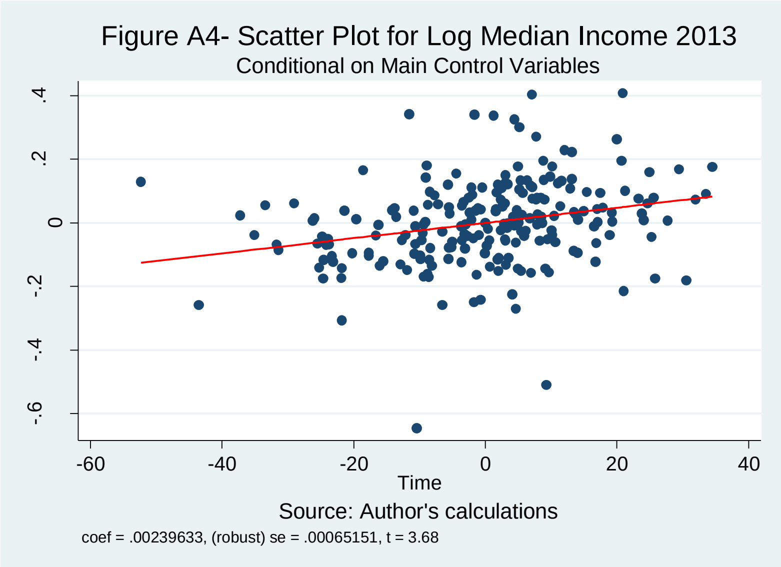


Figure A4- Scatter Plot for Log Median Income 2013
Conditional on Main Control Variables
.4
.2
0
-.2
-.4
-.6
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .00239633, (robust) se = .00065151, t = 3.68

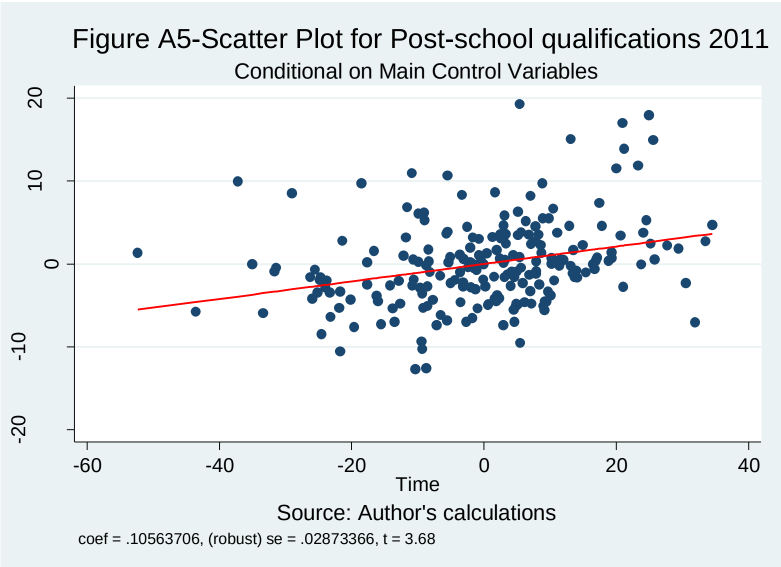


Figure A5-Scatter Plot for Post-school qualifications 2011
Conditional on Main Control Variables
20
10
0
-10
-20
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .10563706, (robust) se = .02873366, t = 3.68

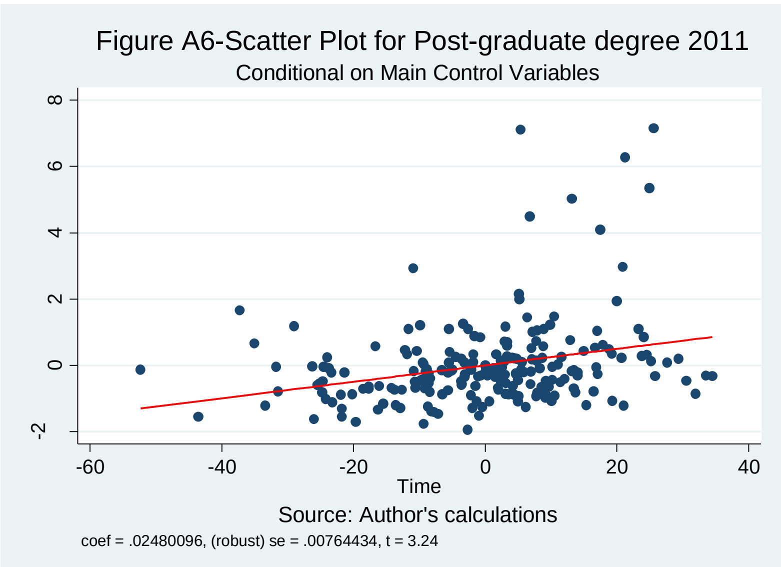


Figure A6-Scatter Plot for Post-graduate degree 2011
Conditional on Main Control Variables
8
6
4
2
0
-2
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .02480096, (robust) se = .00764434, t = 3.24

Table 3. B7 Examples of 'early start' events

| LGA Name | Date | Source | Early start event |
|---|---|---|---|
| Armidale | 1839 | EB | was founded |
| Ballina | 1828 | EB | the first settlers came |
| Bathurst | 1813 | AT | was founded |
| Merimbula | 1835 | AH | pastoral activities started |
| Katoomba | 1841 | EB | was declared as a municipality |
| Bourke | 1835 | EB | the first fort was built |
| Broken Hill | 1883 | EB | was founded for lead and silver |
| Byron Bay | 1860 | EB | was founded as a timber port |
| Wilcannia | 1850 | AH | became a river port |
| Cessnock | 1853 | AH | settlement began to develop |
| Grafton | 1838 | EB | was first settled |
| Coffs Harbour | 1847 | EB | was founded as a cedar-lumbering district |
| Cooma | 1849 | EB | was established |
| Cowra | 1846 | AT | was founded |
| Deniliquin | 1845 | EB | was established |
| Dubbo | 1824 | EB | received its first settlers |
| Batemans Bay | 1821 | AH | timber-getters and fishermen were operating |
| Forbes | 1861 | EB | was proclaimed a town |
| Gosford | 1822 | AH | settlement began by timber getters |
| Goulburn | 1818 | EB | settlement was established |
| Forster-Tuncurry | 1870 | AH | developed as twin towns |
| Taree | 1854 | EB | was established |
| Griffith | 1912 | AH | attracted settlers |
| Gunnedah | 1857 | AH | land was first sold to farmers |
| Richmond | 1794 | AH | white settlement of the area commenced |
| Inverell | 1848 | EB | was established |
| Kempsey | 1836 | EB | was established |

*Notes:* EB is Encyclopaedia Britannica, AT is Aussie Towns, and AH is Australian Heritage. Source: Author's compilation.

# CHAPTER 4: Does Local Finance Affect Intergenerational Mobility? Evidence from The United States

This chapter examines the effects of finance on upward economic mobility at the local level. We use the staggered exogenous cross-state, cross-year variation in the timing of interstate banking regulation, which started in the United States in 1994, as an index of higher competition. We argue that this banking reform had positive effects on economic mobility amongst individuals raised in families in the 25$^{th}$ percentile of the national income distribution. Moreover, we provide suggestive evidence that the link between the financial environment and poor children's intergenerational mobility is education attendance.

## 4.1 Introduction

In this chapter, we consider how local finance affects poor children's economic mobility. From 1994 onwards, a banking reform in the United States permitted interstate banking expansion, thus changing the financial environment at the local level. Using a cross- border contiguous-county pair analysis, we examine whether this banking reform determined adult outcomes of birth cohorts 1980-1986 who were raised in families in the 25$^{th}$ percentile of the U.S. national income distribution.

Following several studies that examine the effects of interstate banking reform on the real economy (Rice and Strahan, 2010; Favara and Imbs, 2015; and Cornaggia et al., 2015), we use an index that measures banking competition at the local level during children from 1980 to 1986 cohorts were growing up. In particular, by estimating the effects of banking reform on the economic mobility for children from poor families, we find positive and significant results. Our findings are robust to using an alternative measure of banking competition at the local level. Furthermore, we explore whether education is a potential channel linking interstate banking reform and economic mobility. We find that our measure of banking competition is positively associated with both college attendance and the proportion of people with high school or college/university diplomas, and negatively associated with school drop-out rates. This preliminary analysis warrants further exploration of the channels between banking competition and economic mobility using household or individual data.

Evidence on the effects of finance on real economic life goes back to Schumpeter (1912), who argues that well-working banking institutions boost technological advancement and growth by financing innovative and promising entrepreneurial projects. A seminal paper on these effects by Diamond and Dybvig (1983) highlights the probability of significant damage to the real economy in the event of bank-runs. A later seminal paper by Bernanke and Gertler (1989) shows that agency costs, moral hazard, and finance restrictions within a firm influence real capital investments. More recent literature has associated real-macroeconomic indicators, such as GDP, with portfolio diversification through the stock market (Saint-Paul, 1992), with savings rates (Jappelli and Pagano, 1994), with the allocation of capital and financial intermediation (Greenwood and Jovanovic, 1990), with long-term interest rates (Gürkaynak et al., 2005), with capital market imperfections (Aghion and Bolton, 1997), with stock market trading volumes (Atje and Jovanovic, 1993), and with the depth of the financial system (King and Levine, 1993).

Despite the advances in the literature that links real-world macroeconomic indicators with the financial environment, there is an important feature which is missing in this line of research, namely the effects of financial reforms on future generations' economic outcomes. In particular, there is no previous research on the impact of banking reforms on intergenerational mobility at the local level. We fill the void by examining the effects of the banking reform that took place in the United States during the 1990s on income outcomes of later generations. This staggered reform have been found to have had a significant effect on intergenerational mobility. Our contention is that the effects were persistent through time via parents' investments on their children during the reform. More specifically, we argue that parents who became less credit constrained due to more efficient banking system, were also able to support their offspring's education. This is a significant factor for children to receive higher or lower income as adults (Belley et al., 2014).

Based on the above hypothesis, this chapter relates to a strand of literature which examines the effects of households' credit constraints on children's schooling and economic outcomes as adults. If children's income as adults is dependent on their general education or skills acquired because of an investment in education, their parents' total earnings and access to credit may be significant factors in their financial success. Early research by Cameron and Heckman (1998) and Carneiro and Heckman (2002) shows that in the early 1980s family income had a negligible effect on youngsters' decision to go to college. However, later studies suggest that more recent cohorts' education is strongly related to parental income levels (Ellwood and Kane, 2000; Belley et al., 2014). In the case of most economies around the world, the latter findings are not far from reality. Credit constraints are a significant limitation to children's education, and the banking system plays an important role in the process. Most families do not rely on their own resources to finance their children's education, and the government or private loans are significant (if not the main) sources of education funding (Barr, 1993). Therefore, reforms designed to raise the efficiency of the banking sector and decrease poor households' credit constraints should be highly associated with better education and higher intergenerational mobility rates.

Secondly, this chapter contributes to the vast literature on the real-economy effects of the staggered banking regulation that occurred in the United States from 1994 onwards. These effects are associated with the amount as well as quality of innovation (Cornaggia et al., 2015; Amore et al., 2013), business cycles (Morgan et al., 2004), interstate trade (Michalski and Ors, 2012), banks' equity values and agency problems (Brook et al., 2002), labour markets (Kneer, 2013), real estate (Favara and Imbs, 2015), the performance of small firms (Rice and Strahan, 2010), and inequality (Beck et al, 2010). The effects of interstate bank regulation in the real economy is only a small part of the wider literature examining the influence of banking reform, which started in the 1970s and changed the whole financial environment in the United States. Since this change in the financial environment had the above real-economy effects at the local level, it is a critical issue to investigate whether these effects were intergenerationally persistent.

The third body of literature related to this study is associated with public policies that promote children's life outcomes. Huston et al. (2001) examine the New Hope programme implemented in the 1990s in Milwaukee, which offered guaranteed work randomly to lower-income workers living in disadvantaged areas. They find that children from families which were offered the programme improved their academic skills. Other implemented policies have been found to affect local economic development, institutional support, physical infrastructure, social services, violence, school quality and health (Sharkey, 2016). The staggered interstate banking reform that took place in the US from 1994 onwards can be seen as a place-conscious financial intervention programme. According to our results, it had a positive influence on upward economic mobility, plausibly through the easing of credit constraints (Becker and Tomes, 1979; Loury, 1981; Solon and Lee, 2009). Credit constraints are likely to be binding, especially for less wealthy families. For this reason, this study calls for a greater focus on policies that promote a more competitive financial environment at the local level and improve life outcomes for children from disadvantaged environments.

Public policies should have the goal of increasing intergenerational mobility for three main reasons. Firstly, if children's chances of prosperity depend entirely on the 'birth lottery,' then society's fairness is undermined, and further social and economic inequality will emerge. Secondly, if talented children are less likely to progress and use their inherited skills because of their parents' economic frictions, then economic growth is impeded. Thirdly, differences in intergenerational mobility between countries and regions can affect immigration. Young people tend to emigrate if economic prospects are lacking locally. This can create labour imbalances and clusters of human capital, causing further inequality.

The remainder of the chapter proceeds as follows: Section 4.2 provides a literature review on intergenerational mobility and describes the interstate banking reforms in the United States. Section 4.3 describes our process of data construction. Section 4.4 presents our empirical strategy and the sample of contiguous-counties. Section 4.5 shows our main results and several robustness checks. Section 4.6 proposes a link between the financial environment and economic mobility. Lastly, Section 4.7 concludes.

## 4.2 Theoretical Background and Research Motivation

The concept of intergenerational or economic mobility has attracted enormous academic attention over the last few decades. Intergenerational mobility reflects the ability of one generation to rise above the economic status of the previous generation and achieve better economic lifetime outcomes. The vast majority of economic mobility measures are based on the association between parents' and children's economic outcomes, such as occupation, earnings and income.

### 4.2.1 Estimating Intergenerational Mobility

Traditional estimates of intergenerational mobility are based on simple techniques, which estimate the relationship between (log) child's $(\mathbf{CHI})_i$ and (log) parental $(\mathbf{PI})_i$ earnings or income, called intergenerational elasticity (IGE). The equation for IGE is the following:

$$\boldsymbol{log}(\boldsymbol{CHI})_i = \boldsymbol{\alpha} + \boldsymbol{\beta}_1 \times \boldsymbol{log}(\boldsymbol{PI})_i + \boldsymbol{\varepsilon}_\iota \qquad (4.2.3)$$

where parameter $\boldsymbol{\beta_1}$ represents intergenerational elasticity (IGE). Since earnings or income are expressed as logarithms, the elasticity shows the percentage change in children's economic outcome depending on the corresponding change in their parents' earnings. Higher elasticity implies a greater degree of association between parents' earnings and children's earnings, which in turn means that intergenerational mobility is lower.

Although IGE has been widely used as a measure of economic mobility, alternative measures can also explain the persistence of economic and social statuses between generations. For instance, occupational status mobility describes the dependence of children's occupation on that of their parents. A significant advantage of this measure is that occupations during a lifecycle are generally more stable than income or earnings.[38] However, Kambourov and Manovskii (2008) argue that job mobility has increased substantially in recent decades.

Other methods for calculating economic mobility are based on wealth, education, consumption and health. Wealth incorporates accumulated income and can be transferred through generations via bequests or inter vivos transfers. Thus, it is highly significant in terms of parents' ability to invest in their children's human capital. The education mobility measure is also important, since education is an index of human capital and economic success. Hertz et al. (2007) calculate intergenerational persistence in terms of educational attainment for 42 nations around the world. Their results suggest that Latin American and Nordic countries experience the lowest and highest intergenerational educational mobility respectively. Regarding intergenerational persistence based in consumption, recent research by Charles et al. (2014) use expenditure data. Their results suggest that intergenerational expenditure rates remain always correlated, thus giving suggestive evidence that family factors play a significant role for consumption across generations. These factors may include preferences, non-pecuniary inter vivo transfers, access to credit, and cultural family characteristics. Furthermore, recent studies use health rates to measure intergenerational mobility. Access to health is a significant parameter and index of socio-economic status. Halliday et al. (2018) estimate health mobility in the United States, and find higher rates than for income mobility. They argue that social institutions and policies can have higher effects on intergenerational health persistence than

[38] It has been argued that intergenerational mobility measures using income or earnings suffer from a potential life cycle bias. The stage at which someone observes parents' and their children's earnings plays a significant role in deriving the intergenerational elasticity between them. For instance, if their children's earnings are measured during early adulthood, when annual income is typically lower than in later life, intergenerational mobility estimates can be biased.

income persistence. Lastly, due to a scarcity of data linking parents' and children's economic outcomes in most countries, a growing body of literature is investigating alternative methods of calculating intergenerational mobility. For instance, Güell et al. (2018) use the informational content of surnames (ICS) method. Using a database of Italian surnames and the corresponding taxable income, they derive mobility measures across Italian provinces based on surname distribution in each province. Similarly, Clark and Cummins (2015) use a database of rare names in England and Wales from 1858 until 2012, finding a significant correlation between the wealth of families extending as much as five generations. Overall, there are a number of measures of mobility that are used in the economic literature, but the most common remain those that are based on income or earnings data.

The above evidence suggests that measuring intergenerational mobility is not an easy task. Since in many countries family or personal income data, as well as ties amongst people within the same family tree, are not publicly available (or do not exist at all), calculating mobility has been a challenging issue. However, in the last few decades, both theoritical and empirical evidence on mobility rates has increased. This strand of literature is quite significant, since policies designed to promote equal opportunities decrease disparities amongst people both within countries and across countries.

### 4.2.2 Absolute or Relative Mobility?

Intergenerational measures based on income can be calculated either in absolute terms (absolute mobility) or in relative terms (relative mobility). The former compares people's absolute income with that of their parents. For instance, one may observe the mean income of children whose parents' were black collars. A significant limitation with this approach is that it does not incorporate macroeconomic factors such as growth or inflation. For example, if an individual has double the income of his father, it does not necessarily mean that he is better off financially. Rlative mobility compares the earnings status of an individual with that of their parents in relative terms, which can be a more objective measure to indicate a person's economic or social position within society.

### 4.2.3 Intergenerational Mobility – The Role of Individual Characteristics

A large body of empirical literature on intergenerational income mobility focuses mainly on individual characteristics that affect children's economic outcomes as adults. For instance, Ermisch et al. (2006) highlight the role of marriage preferences, showing that 40–50 per cent of the covariance between parents' and children's permanent family income is based on the person with whom the children are married. Similarly, recent research by Greenwood et al. (2014) shows that if husbands and wives in 2005 had been randomly matched to be married, then the Gini coefficient would have fallen from 0.43 to 0.34. Thus, income inequality, which is inversely related to intergenerational persistence (Corak, 2013; Becker et al., 2018), would have been smaller.

Additional interesting factors that affect mobility rates are inherited human characteristics, such as IQ. Black et al. (2009) investigate the relationship between fathers' and sons' IQ at age 18 using Norwegian military data. They show that a 10 per cent increase in the IQ of a father is associated with a 3.2 per cent increase in their son's IQ. In the same vein, Anger and Heineck (2010) examine intergenerational persistence in terms of cognitive skills using data from the German Socio-Economic Panel Study. Their findings show an even higher correlation. Although the above research provides suggestive evidence regarding the effects of genetically inherited characteristics on economic mobility, the results cannot be considered as causal, because cognitive skills can be influenced by both genetic and social factors.

Another individual characteristic that affects intergenerational mobility is gender. Chadwick and Solon (2002) estimate intergenerational income elasticities for daughters in the United States, finding a range from 0.35 to 0.49, which is lower than in the case of sons. Nevertheless, later research by Lee and Solon (2009) shows that estimates of intergenerational income elasticity in the United States for both genders have followed a convergent path, as depicted in the Appendix C Table 4.C.1.

Lastly, an important individual characteristic that influences intergenerational mobility is race. The composition of populations in countries such as the United States have their roots in historical events, such as European colonisation and slavery. Recently, Chetty et al. (2018) use a huge database of 20 million children with births between 1978 and 1983 to examine whether the persistence of disparities vary across racial groups. White children whose parents were in the 25$^{th}$ percentile of the national income distribution scale jumped on average to the 45$^{th}$ percentile as adults. The corresponding percentile for children whose parents were in the 75$^{th}$ percentile of the national income distribution scale was the 60$^{th}$. Another group of children with high mobility were the Hispanics, who moved on average from the 43$^{rd}$ to the 54$^{th}$ percentile. Asian children whose parents were in the 25$^{th}$ percentile of the national income distribution scale had even higher mobility than white children, jumping to the 56$^{th}$ percentile. However, Asian children with wealthier parents reached on average the 64th percentile. In contrast, black and American Indian children had a downward mobility of approximately 13 percentiles. Overall, the findings of Chetty et al. (2018) suggest that there are indeed huge disparities in income mobility between races in the US.

### 4.2.4 Intergenerational Mobility – The Role of Neighbourhoods

Early research on neighbourhood effects on intergenerational mobility shows a negligible influence. Specifically, Page and Solon (2003) investigate whether the correlation in earnings between brothers depended on where they grew up. They find that earnings depend more on whether the brothers grew up in the same family, rather than in the same neighbourhood. Moreover, they argue that general neighbourhood characteristics, such as an urban or rural environment, play a significant role in determining children's future earnings, whereas special characteristics in specific neighbourhoods do not matter. Similarly, Raaum et al. (2006) examine potential neighbourhood effects on people's earnings in Norway. They suggest that family characteristics have a significantly larger impact than neighbourhoods. Nevertheless, they claim that neighbourhood effects are much greater in the United States.

Although early research finds negligible effects of neighbourhoods on intergenerational mobility, recent research by Chetty and Hendren (2018a, b) suggests an array of social neighbourhood characteristics that do exert a significant and positive effect on intergenerational mobility. These include low levels of segregation by income and race, low levels of income inequality, better schools, low rates of violent crime, a large share of two-parent households, and a lower proportion of the African-American population. In the same vein, Bell et al. (2017) show that children's exposure to environments with high invention ratios increases the likelihood of becoming inventors themselves and achieving higher life outcomes. This chapter is based on the contention that neighbourhood environments in which poor children grow up are a causal and driving factor for their economic mobility.

### 4.2.5 Intergenerational Mobility – A Single or Multi-Period Process?

Early models of intergenerational mobility by Becker and Tomes (1979) and Becker and Tomes (1986) assume that early childhood and adolescence years constitute a single period, and that parents' investment in their children by age 18 affect their mobility chances equally. However, more advanced models suggest that parents' investment during any period of their children's pre-adult lives does not have the same effect on their economic outcomes. Cunha and Heckman (2007), Cunha et al. (2010) and Cunha (2013) investigate the impact of parents' investment in their children across time. They stress the importance of multiple periods in the early life-cycle and point out that children's cognitive and non-cognitive skills are formed over multiple periods as they grow up. For instance, skills related to IQ are malleable during early childhood, whereas personality skills that are associated with activities and social achievements are shaped more during adolecence.

Since children's skills formation is a multi-period process, several studies examine the effects of parents' income levels on children's human capital investment during different periods of early life. For instance, Løken et al. (2012) examine the effects of family income during early childhood (0–11) on the years of education, high-school dropout rates and IQ. They find that an increase of $17,414 in family income increases children's education from 0,05 to 0.74 years according to their family wealth. Milligan and Stabile (2011) find that child tax benefits that increase family income during childhood and preadolecence years (7–14) have positive effects on educational outcomes, such as test scores and physical health for boys and mental health for girls. Keane and Wolpin (2001) investigate the impact of family income on children during their adolecence years (16–17). They find that an increase of $3,000 increase children's college attendance by 0.2 per cent. It seems therefore that parents' financial condition plays a significant role for their children during all periods they are growing up.

### 4.2.6 Intergenerational Mobility – Cross-Country Differences

Recent literature on intergenerational mobility finds different rates of intergenerational mobility in different countries. International comparisons are quite significant, since they can help to identify the institutional and cultural characteristics that cause differences in intergenerational mobility between countries. However, international comparisons can be a challenging task due to data heterogeneity and the lack of data for some countries. Although Scandinavian countries provide a lot of data on parents' and children's economic outcomes, other countries do not have similar databases for even the last two generations. Moreover, even if the comparison refers to countries with high availability of data, life-cycle bias may be a serious threat for comparing intergenerational measures between two or more countries (Haider and Solon, 2006).

Nevertheless, substantial research over the last few decades compares intergenerational mobility measures between the United States and other countries. For instance, Corak (2006) examines intergenerational mobility rates for several countries around the world. More specifically, he finds that Canada as well as Finland, Norway and Denmark have the lowest intergenerational persistence with elasticities less than 0.2. Swedeen, Germany and France follow with elasticities 0.27, 0.32, and 0.41, respectively. The highest elasticities experience the United States and the United Kingdom. In this line, Causa et al. (2009) investigate wage and education persistence amongst 14 European OECD countries, and their results were similar to those of Corak (2006). They show that intergenerational elasticity in Nordic countries is quite low, whereas southern European countries and the United Kingdom have high wage elasticities. Lastly, they find that southern European countries, Luxembourg and Iceland have high levels of educational persistence. Similarly, Corak and Heisz (1999), Osterbacka (2001) and Bratsberg et al. (2007) find that Canada and Scandinavia have higher mobility rates than the United States, the UK and Italy.[39]

Overall, the results of these studies show a relatively consistent pattern of mobility across countries, with Canada and the Nordic countries experiencing the highest levels of intergenerational mobility, and the UK and southern European countries experiencing high elasticities between parents' and children's economic and social outcomes. The United States has similar rates as European countries. This may suggest that countries with similar institutions and cultural traits experience similar levels of mobility. Indeed, Nordic countries follow a more egalitarian education system and social policies against inequality. Since inequality and intergenerational persistence have a positive relationship, the above findings are not surprising.[40]

### 4.2.7 Intergenerational Mobility in The United States

One of the most important questions throughout American history has been whether equal opportunities are available to any social and economic class. The United States has been characterised as the 'land of opportunity,' suggesting that poor people have a higher chance of climbing up the income, educational and social ladders compared to other countries in the

[39] Apart from research that compares the United States with other countries in terms of their economic mobility rates, there are a lot of independent studies on individual country mobility estimations. For example, Björklund and Jäntti (1997) estimate mobility rates for Sweeden, Corak and Heisz (1999) provide estimates for Canada, Couch and Dunn (1997) examine the case of Germany, and Dearden et al. (1997) come up with intergenerational elasticities for Great Britain. Moreover, apart from developed nations, recent literature provides intergenerational mobility measures for developing countries. For instance, Dunn (2007) and Ferreira and Veloso (2006) provide intergenerational elasticities based on earnings for Brazil, Nunez and Miranda (2010) estimate intergenerational income elasticity for Chile, and Nimubona and Vencatachellum (2007) derive intergenerational education mobility data for South Africa.

[40] The positive relationship between inequality and intergenerational persistence is represented by the Great Gatsby Curve (Corak, 2013; Becker et al., 2018).

world. Early research on intergenerational mobility for the United States was not an easy task. Immigration during the 19th and 20th centuries was a frequent phenomenon, restructuring the population's composition not only at the country level but also at the local. The second principal difficulty with historical intergenerational mobility measures for the United States relates to the scarcity of data linking parents' and children's income, education and wealth. Therefore, research on intergenerational mobility until the late 1980s was either a historical analysis or based on theoritical models or occupational measures (Foote and Hatt, 1953; Cople Jaher, 1968, Hauser et al.,1975; Becker and Tomes, 1979).

A seminal empirical paper that studies intergenerational mobility measures in the US before the Second World War was that of Guest et al. (1989). He focuses on comparing mobility rates between the 19th and 20th centuries based on occupational measures. Using data from the 1880 census, they find occupational mobility measures for white men who were between 25 and 34 years old in 1900. Then, using information from the Occupational Change in a Generation I (OCGI) and II (OCGII) datasets, they provide similar occupational mobility measures for the 1960s and 1970s. Their results suggest that upward mobility at the end of the 19th century was much less than after the Second World War. They argue that farming was the major economic sector with the highest inheritance, but even with the absence of farmers in the sample, upward mobility was still lower in 1900 than during the second half of the 20th century.

Estimates of intergenerational mobility after the second world war seem to follow a concave pattern. Aaronson and Mazumder (2008) examine the trend in intergenerational mobility in the US from 1940 to 2000 based on income elasticity (IGE). Using data from the Integrated Public Use Microdata Series (IPUMS) of the decennial Censuses from 1940 to 2000, they compute intergenerational income elasticities per decade. Their results suggest that mobility increased during the post-war period but started decreasing after 1980.

Although in the last few decades intergenerational persistence in the United States has increased, it still seems to be much less than in other countries around the world. Early studies on recent mobility rates in the US find intergenerational correlations and IGEs of approximately 0.2 or less, suggesting a quite mobile society (Becker and Tomes, 1986). However, more recent studies, using several alternative databases that provide information about parents' and children's income and earnings, find higher intergenerational elasticities for the United States. Solon (1992) uses data from the Panel Study of Income Dynamics, and estimates intergenerational income elasticity at least 0.41. This indicates that the United States is a much less mobile society than what was believed. Similarly, Zimmerman (1992) use a 4-year average of fathers' annual earnings and a single year of sons' annual earnings, finding an intergenerational earnings elasticity of 0.4 or more. A following study by Mazumder (2005) uses a 16-year average of annual earnings of fathers and a 4-year average of sons' earnings, providing an estimated earnings elasticity of around 0.6. More recent research by Bratsberg et al. (2007) is based on the National Longitudinal Survey of Youth (NLSY79) database, and finds an income elasticity of 0.54. Although research during the previous decade finds similar results for intergenerational mobility rates in the United States, the most contemporary research outcomes diverge. More specifically, Chetty et al. (2014) use tax data and find an estimate of 0.34. On the other hand, Mitnik et al. (2015) exploit a new data set, the Statistics of Income Mobility Panel, thus finding an estimate of 0.66. Overall, recent research on intergenerational mobility measures in the United States gives various results. Life-cycle bias which is discussed above, sample sizes as well as an array of other biases may be responsible for the different estimations.[41]

### 4.2.8 Credit Constraints, Intergenerational mobility and Hypothesis Development

Capital market imperfections, such as credit constraints, have been highly associated with underinvestment in human capital, which is a driving force for intergenerational mobility rates. Early research by Becker and Tomes (1986) shows that credit constraints are a principal determinant of economic mobility, especially for lower income families. Solon's (2004) model suggests that parents' investment in their offspring's human capital is inversely related to their own consumption. The absence of credit constraints usually means that families can maximise their investment in their children's human capital. Moreover, if ability complements the marginal productivity of human capital accumulation, then children with higher abilities experience higher levels of investment from their parents. Furthermore, with the presence of credit constraints, less wealthy families do not invest optimally in their offspring's human capital. Therefore, any income increase can lead to an increase in parents' investment in their children's human capital. That means that intergenerational elasticity is likely to be greater for financially constrained families, suggesting that income elasticity is nonlinear with credit constraints. Recent literature advances the above hypothesis. For instance, Lochner and

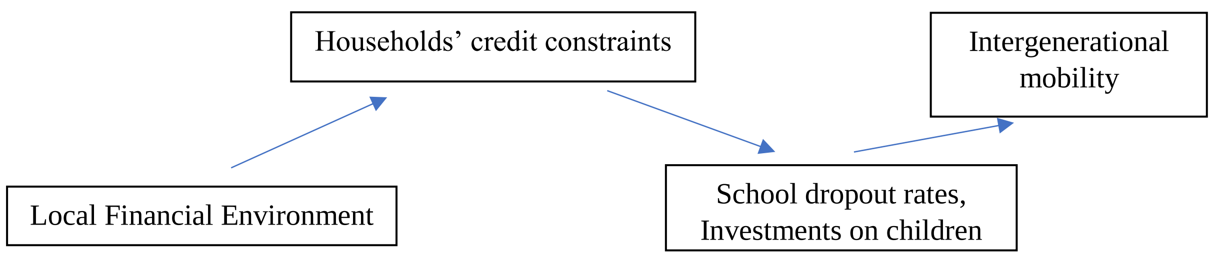
[41] For a discussion on the biases in intergenerational mobility measures, see Mitnik et al. (2015).

Monge-Naranjo (2011) develops a human capital model that assumes that borrowing constraints are only associated with the government's student loans (GLS). They find that GSL programmes and private lending are quite significant for young individuals' cognitive skills. Brown et al. (2012) find that financial aid can increase educational attainment amongst poor children, whose parents tend to underestimate their children's education.

Since traditional models suggest that credit constraints are less for higher income families, the intergenerational mobility curve follows a concave pattern. Nevertheless, there is a significant body of literature that finds a convex relationship between parents' and children's earnings. Han and Mulligan (2001) find that intergenerational mobility is lower amongst non-borrowing constrained families. Since high-ability parents (generally wealthier) are usually associated with high-ability children, the optimal level of investment in children is higher. Thus, intergenerational association can be convex. In the same vein, Bratsberg et al. (2007) find that Nordic countries, such as Norway, Denmark and Finland which experience a more egalitarian education public system, follow the convex pattern of intergenerational mobility. Children from disadvantaged families have the same adult earnings as those whose parents are wealthier. Therefore, intergenerational mobility is higher for lower income families.

Although with a few exceptions credit constraints do not suggest lower intergenerational mobility for children who belong to poor families, the opposite seems to be the most reasonable. In the real world, it seems that poor children who manage to acquire higher education have more chances of being in a higher income percentile in the national income distribution. The banking system is a major source of loans that can enhance poor families and promote their ability to finance their offspring's education (Teng Sun and Yannelis, 2016). Thus, we argue that locations with a better financial system will have higher intergenerational mobility rates. In other words, a more competitive banking system may enhance poor children's chances of climbing up the income ladder as adults. Figure 4.1 summarises this hypothesis.

Figure 4.1 Financial Environment and Mobility



*Notes:* Figure 4.1 summarizes the main hypothesis of the present research. Local financial environment may influence households' wealth. Poor children enjoy benefits related to their education due to the fact that banking reform may affect positively their parents' credit constraints. Thus, they may enjoy higher intergenerational mobility rates.

In order to find the effects of finance on intergenerational mobility at the local level, we use the interstate banking reform that started in 1994 in the United States. This staggered interstate banking reform provides a natural setting for identifying whether changes in the financial environment can affect intergenerational mobility. The new banking legislation permitted each state to erect barriers and frictions to out-of-state branch expansion, thus protecting the local banking monopolies that hindered bank performance and competition. The first barrier related to the age limit of a target bank. Each state imposed a number of years that a target institution had to be in existence in order to be acquired by an out-of-state bank, with a maximum of 5 years. The second restriction was 'de novo branching,' which permitted (or not) newly chartered out-of-state banks. The third interstate bank friction was the deposit concentration limitation. Each state had to decide whether any single bank or bank holding company, as an initial entry into the state, was able to hold more than 30 per cent of the state's total deposits. The last interstate barrier regulated the ability of an out-of-state bidder to make an individual branch interstate merger. The Interstate Banking and Branching Efficiency Act (IBBEA) eliminated previous restrictions on interstate banking and branching that had impeded the exogenous potential for competition.

Consequently, we have employed a fixed effects model that exploits the exogenous cross-state, cross-year variation in the timing of interstate banking reform to assess the effects of the financial environment on upward economic mobility. We restrict our sample to contiguous county pairs that are tangent to the state borders. These pairs of cross state-border counties constitute a better comparable sample due to their proximity. We find positive and significant results, thus suggesting that the financial environment at the local level is a substantial factor for poor children's economic mobility.

# 4.3 Data

## 4.3.1 Measure of Upward Economic Mobility

Despite the fact that intergenerational elasticity estimates (IGE) have been widely used in several studies, Chetty et al. (2014) stress out that the log-log specification is biased because of children with very low or zero incomes and because the relationship between log child income and log parent income is nonlinear. Therefore, they construct an alternative measure based on ranks. Specifically, they rank children into groups based on income. Furthermore, they rank the income of parents whose children belong in the same birth group. Running the following regression (4.3.1) of the percentile rank of children's *i* income who stay in area *j* on their parents' percentile income rank gives a slope $\mathrm{b}_1$ and intercept $\mathrm{b}_0$.

$$\boldsymbol{RC_{ji} = b_{0i} + b_1 \times RP_{ji} + \varepsilon_{ji}} \quad (4.3.1)$$

Combining the slope and the intercept, Chetty et al. (2014) find estimations for the expected rank of children whose parents were in the 25$^{\text{th}}$ percentile of the national income distribution. The expected rank is calculated with the following equation (4.3.2):

$$\boldsymbol{Exp(rank) = Est(b_{0i}) + 25 \times Est(b_1)} \quad (4.3.2)$$

The above expected rank is our measure of intergenerational mobility for children whose parents belong to the 25th percentile of their national income distribution. This rank is also called upward economic mobility. Due to the linearity property of the rank-rank economic mobility measure, the average rank of children whose parents have below-median income equals the average rank of children whose parents income belongs at the 25th percentile in the national distribution (Chetty et al., 2014).[42] These data are provided by Chetty and Hendren (2018b) at the county level for birth cohorts 1980 to 1986. We use intergenerational mobility data at age of 24, since at this age most of individuals have completed their studies and their income is likely to be more stable. For instance the measure of intergenerational mobility for birth cohort 1980 is provided at the county level when children become 24 years old; i.e. in 2004.

[42] The linearity property between parents' and children's rank in national income distribution is depicted in Figure V in Chetty et al. (2014).

### 4.3.2 Measure of competition

Our main variable of interest is a competition index from Rice and Strahan (2010). The interstate banking reform may have intensified competition at the local level, making the lending process (access to finance) from banks an easier task. Rice and Strahan (2010) use four barriers (described in Section 4.2.9) that each state imposed during the interstate banking reform period and construct a time-varying instrument that ranges from 0 to 4. These values represent low and high restrictiveness to out-of-state banking. Following Favara and Imbs (2015), we reverse this index, so that the 0 and 4 values show the least and the most open to out-of-state banking environment, respectively. Our measure of the financial environment, called *Openness*, is the average index during each birth cohort's (1980 to 1986) early childhood (10–13 years old), adolescence years (14–17), and early adulthood (18–21 years old). For instance, for people who belong to the birth cohort 1980, we average our measure of competition during 1990-1993, 1994-1997, and 1998-2001 and examine any effect on their chances to ascend the income ladder by the time (i.e. in 2004) they are 24 years old. Based on previous literature related on multiple-period parents' income effects on children's outcomes (explained in section 4.2.5), we expect to find positive and significant results for the impact of the banking environment on economic mobility for all the periods.

### 4.3.3 Measures of Economic and Socio-Demographic Variables

Our control variables at the county level consist of (log) median household income, total poverty, proportion of the labour force that is unemployed, the percentage of Hispanic persons, percentage of White non-Hispanic or Latino persons, percentage of African-American non-Hispanic or Latino persons, percentage of residents 25 years old or over who have a college diploma or higher, the percentage of residents 25 years old or over without a high school diploma, the percentage of female-households, the percentage of foreign-born residents, and finally rate of violent crime. All the variables have been selected based on the literature on the effects of finance on the real economy and the social characteristics that affect economic mobility (Beck et al., 2010; Chetty et al., 2014). For instance, for individuals who belong to the birth cohort 1980, we average our measure of competition during 1990-1993, 1994-1997, and 1998-2001, and examine any effect on their respective chances to ascend the income ladder by the time (i.e. in 2004) they are 24 years old. They are collected from the Unites States Census Bureau (2018), which provides socio-demographic, political, agricultural, economic and financial data at the local level.[43] All control variables follow the construction of the financial environment variable. For example, for the birth cohort 1980, the variables which represent origin are the average during 1990-1993, 1994-1997, and 1998-2001. Table 4.1 presents the summary statistics for the examined cohorts (1980-1986) as they were growing up (10–21 years old) .

Table 4.1 Summary Statistics

**Summary Statistics for 10-13 years old**

| Variable | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Expected income rank at age 24 | 7340 | 47.45 | 5.26 | 30.93 | 73.30 |
| Openness | 7340 | 0.43 | 0.88 | 0 | 4 |
| (Log) Median Income | 7340 | 10.38 | 0.23 | 9.59 | 11.20 |
| Poverty % | 7340 | 13.92 | 6.58 | 2.86 | 52.1 |
| Unemployment % | 7340 | 2.54 | 1.05 | 0.65 | 11.93 |
| College or More % | 7340 | 17.25 | 7.52 | 5.67 | 58.22 |
| Less than High School % | 7340 | 9.81 | 4.87 | 1.81 | 30.31 |
| Violent Crime per capita | 7340 | 0.01 | 0.01 | 0 | 0.15 |
| Female Head Households % | 7340 | 0.15 | 0.05 | 0.04 | 0.43 |
| Foreign born % | 7340 | 3.30 | 4.23 | 0.15 | 36.55 |
| Hispanic % | 7340 | 0.04 | 0.08 | 0.001 | 0.76 |
| Non-Hispanic White % | 7340 | 84.66 | 15.44 | 14.40 | 99.40 |
| Non-Hispanic Black % | 7340 | 9.30 | 12.94 | 0.03 | 68.04 |

**Summary Statistics for 14-17 years old**

| Variable | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Expected income rank at age 24 | 7340 | 47.45 | 5.26 | 30.93 | 73.30 |
| Openness | 7340 | 1.47 | 1.39 | 0 | 4 |
| (Log) Median Income | 7340 | 10.59 | 0.24 | 9.93 | 11.51 |
| Poverty % | 7340 | 12.62 | 5.39 | 2.77 | 39.9 |
| Unemployment % | 7340 | 2.08 | 0.88 | 0.58 | 11.93 |
| College or More % | 7340 | 18.60 | 8.02 | 5.95 | 62.04 |
| Less than High School % | 7340 | 8.11 | 4.18 | 1.48 | 26.31 |
| Violent Crime per capita | 7340 | 0.01 | 0.01 | 0 | 0.13 |
| Female Head Households % | 7340 | 0.16 | 0.05 | 0.05 | 0.44 |
| Foreign born % | 7340 | 3.82 | 4.69 | 0.21 | 38.77 |
| Hispanic % | 7340 | 0.04 | 0.08 | 0.002 | 0.78 |
| Non-Hispanic White % | 7340 | 82.49 | 16.50 | 11.66 | 99.02 |
| Non-Hispanic Black % | 7340 | 9.49 | 13.17 | 0.06 | 70.14 |

**Summary Statistics for 18-21 years old**

| Variable | Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Expected income rank at age 24 | 7340 | 47.45 | 5.26 | 30.93 | 73.30 |
| Openness | 7340 | 2.05 | 1.43 | 0 | 4 |
| (Log) Median Income | 7340 | 10.50 | 0.23 | 9.81 | 11.37 |
| Poverty % | 7340 | 12.61 | 5.13 | 2.77 | 36.25 |
| Unemployment % | 7340 | 2.08 | 0.67 | 0.63 | 9.11 |
| College or More % | 7340 | 20.17 | 8.58 | 6.43 | 68.80 |
| Less than High School % | 7340 | 6.80 | 3.62 | 1.33 | 25.81 |

[43] Linear interpolation is used for calculating data between census years. Table 4. C2 in the Appendix C provides all variables' descriptions and sources.

| | | | | | |
|---|---|---|---|---|---|
| Violent Crime per capita | 7340 | 0.01 | 0.01 | 0 | 0.09 |
| Female Head Households % | 7340 | 0.17 | 0.05 | 0.05 | 0.45 |
| Foreign born % | 7340 | 4.32 | 5.03 | 0.23 | 39.44 |
| Hispanic % | 7340 | 0.05 | 0.09 | 0.002 | 0.80 |
| Non-Hispanic White % | 7340 | 80.68 | 17.19 | 11.02 | 98.64 |
| Non-Hispanic Black % | 7340 | 9.69 | 13.31 | 0.09 | 72.66 |

*Notes:* This table presents the summary statistics of all our control variables during birth cohorts 1980-1986 are 10 to 13,14 to 17, and 18 to 21 years old. The Expected income rank at age 24 is our intergenerational mobility measure while the Openness variable represents our main measure of competition. Most of independent variables are mainly measured in percentages except from the Median Income and Crime.

## 4.4 Empirical Strategy and Sample Construction

Our analysis is based on cross-border contiguous counties. In our case, contiguous border counties provide a better test of the influence of local financial environment on economic mobility. The reason is twofold. First, counties which share a (state) border are similar in terms of socio-economic characteristics such as crime and schooling, which influence economic mobility. Second, the geographic proximity between two counties is likely to reveal that people share common beliefs, culture, and expectations for themselves as well as their children (Fritsch and Wyrwich, 2017). The similarity in socio-economic conditions between contiguous-border counties makes differences in banking reforms act as a quasi-natural experiment. Moreover, the potential similarity of the cross-border counties in terms of unobservable characteristics may reduce background noises and standard errors when we estimate treatment effects from banking reforms.

A growing body of literature examines the effects of exogenous shocks and sudden policy changes at the local level, using all counties that straddle a state border and form a pair with at least one county on the other side of the border. For example, Huang (2008) compares the economic performance (local economic growth) of contiguous counties on opposite sides of state borders, following staggered deregulatory banking reforms at the state level. He finds that bank deregulation accelerates local economic growth. Goodman (2018) examines whether differences in local autonomy among contiguous-border counties affect US special districts' public spending. This is because the US special districts are governmental units that exist separately from local governments such as counties and may substitute local governments' public spending if the latter cannot satisfy voters' demand (Goodman, 2018). He finds little evidence that changes in local autonomy lead to the increased utilization of special districts. Cahan (2019) compares neighbouring counties at the borders of US states to investigate the impact of staggered gubernatorial elections across states on local (public) employment. In the same vein, Dube et al. (2010) and Dube et al. (2016) use all contiguous US. counties, and finds that minimum wage reforms impacted on earnings and employment in restaurants and other low-wage sectors.

Based on the aforementioned research, contiguous-border counties are likely to be a more appropriate sample for estimating any effects arising from state-discontinuous policies within the US. In order to show that counties with higher proximity are more likely to be similar in terms of socio-economic characteristics, Dube et al. (2016) present smoothed local polynomial plots of the mean absolute difference in counties' characteristics. More specifically, the authors exploit counties' centroids distance, thus showing that contiguous-border counties whose centroids are further are less similar in terms of employment, population characteristics as well as private sector earnings. They find that cross-border counties whose centroids are less than 50 miles apart are much more similar in terms of the above characteristics than those whose centroids are 100 miles or more. As an additional exercise, they expand their test using all counties within the US, thus calculating the mean absolute difference between the above covariates among all potential pairs (1,737,884) constructed by the counties tangent to the state borders and every possible out-of-state county. Their results validate their initial findings. Counties at the state border constitute a more comparable sample for estimating spatially discontinuous reforms. These findings are validated by Goodman (2018) who argues that geography (proximity among counties) plays an important role when someone examines any effects from state-discontinous policies.

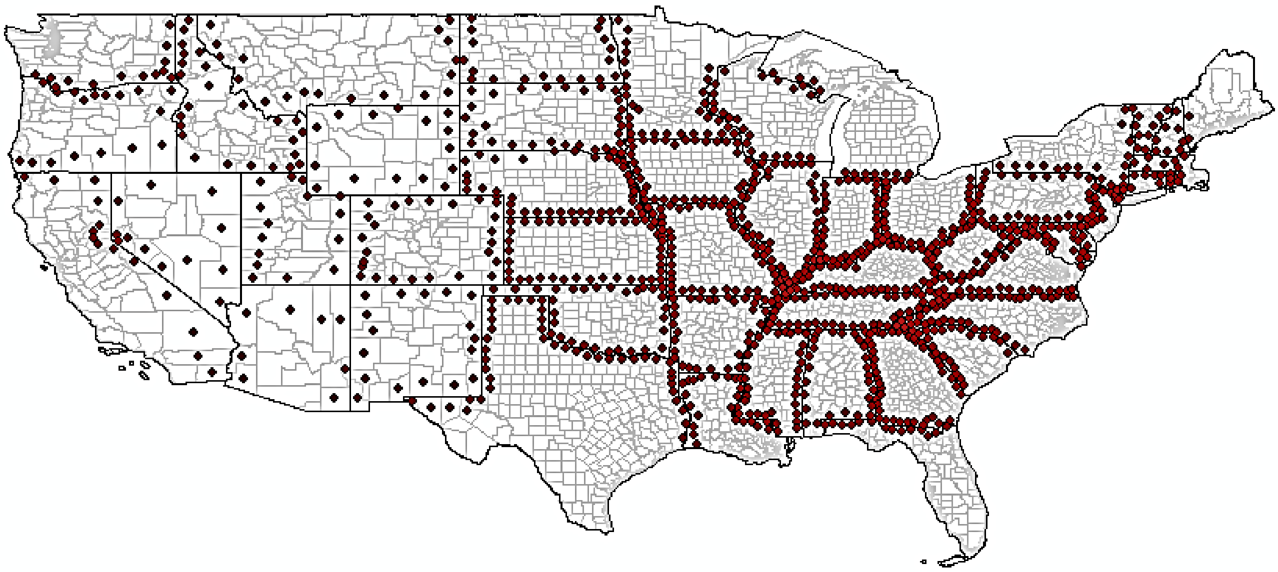
We extend Dube's et al. (2016) exercise to examine whether counties whose centroids are further than others are similar in terms of several social and population characteristics. These include: median income; percentage of population without a high school diploma; percentage of population with a college or higher degree; the rate of poverty; violent crime per capita; ratio of hispanic to total population; percentage of female households; and the percentage of people who were born in foreign countries. Moreover, we expand the distance between counties to 200km, thus examining a bigger sample (than that used by Dube's et al., 2016).[44] The results presented in Figure 4. C.1 in Appendix C, show that the differences in terms of the aforementioned social and population characteristics among cross-border county pairs within 100km decrease. After that point they increase for the period 1990-1993 (the years before the inter-state banking reforms). The U-shaped diagrams support the notion that the sample of

[44] Dube's et al. (2016) analysis use contiguous county pairs whose centroids are up to 75km.

cross-border contiguous counties is more suitable for estimating the impact of banking reforms on intergenerational mobility.

Following the aforementioned theoretical and technical method, we exploit variations in economic mobility and banking competition among counties tangential to state borders. We first construct cross-border contiguous county-pairs, where within-pair counties differ in the degree of out-of-state banking restrictions. Our unit of analysis is every county *i*, which is tangential to the state *a* that is adjacent to the county *j* in the adjacent state border *b*. Each county *i* is included in the sample as many times as it is in turn adjacent with a different county *j′* in a different state(s). For instance, Modoc county in California consists of a pair with both Klamath and Lake counties in Oregon. Thus, Modoc county is included in the sample twice. Figure 4.2 presents all the contiguous border counties on a map of the United States.

Figure 4.2 Contiguous counties



*Notes:* Red dots in Figure 4.2 depict the geographic distribution of contiguous counties in the United States.

Since each county is included in the sample as many times as it constitutes a pair with a different cross-border county, our initial sample consists of 2,362 observations. Since we observe each pair over several years, we end up with an unbalanced panel sample of 16,492 observations. We remove those with no or less-than-three-generations mobility data, and thus our sample fell to 7,340 observations. Due to the fact that the remaining county-pairs constitute roughly 37 per cent of the 1,382 urban counties that contain 91 per cent of the US population (based on the 2010 census), we consider that our sample is sufficiently representative to conduct our analysis.

To investigate our hypothesis within cross-border contiguous counties, we need a model allows us to consider changes in the financial environment before and after the inter-state reform in each state during the 1990s and the 2000s. These changes should be associated with economic mobility measures at the local level. Thus, we choose a model similar to those used across the banking literature and account for socio-economic variables that are likely to affect real economic variables such as GDP, inequality etc (Beck et al., 2010). More specifically we estimate the effect of banking environment on economic mobility using the following equation:

$$\boldsymbol{Mobility}_{i(a),j(b),t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \times \boldsymbol{Openness}_{i(a),j(b),t} + \gamma \times \boldsymbol{X}_{i(a),j(b),t} + \lambda \times \boldsymbol{W}_{i(a),j(b),t} + \boldsymbol{\varepsilon}_{i(a),j(b),t} \quad (4.4.1)$$

where $\mathbf{Openness}_{i(a),j(b),t}$ is our measure of competition in county i in state *a* which is adjacent to county(ies) *j'* in state *b* for birth cohort $\boldsymbol{t},\ \boldsymbol{t} \in [\mathbf{1980}, \mathbf{1986}]$; $\mathbf{Mobility}_{i(a),j(b),t}$ is our corresponding intergenerational mobility measure for each county $\boldsymbol{i}$; $\mathbf{X}_{i(a),j(b),t}$ is a vector of economic and socio-demographic controls, as explained in the data section; $\boldsymbol{W}_{i(a),j(b),t}$ is a county-cohort fixed-effects to account for any economy-wide temporal shocks within each county and birth cohort, and $\boldsymbol{\varepsilon}_{i(a),j(b),t}$ is an idiosyncratic error term for county $\boldsymbol{i}$ and cohort $\boldsymbol{t}$. Since we include the pair-group fixed effects, the coefficient for interest $\boldsymbol{\beta}_1$ indicates the potential impact of out-of-state banking reform on intergenerational mobility. We cluster the standard errors at the state and border segment level, since the treatment variable (banking reform) was constant for all counties within each state and due to the potential correlation between county-pairs along an entire border segment. The estimable model adopts a fixed effects approach. The difference in our competition index through the years of inter-state reform represents a differential pace of regulatory reform which affects economic mobility measures at the local level. This is akin with the contiguous-county models used by Dube et al. (2010) and Goodman (2018).

## 4.5 Main Results

This section provides the evidence for the positive effects on upward economic mobility of the interstate banking reform in the United States from 1994 onwards. We assume that the interstate banking reform in the United States after 1994 affected the mobility rates for children from cohorts 1980 to 1986 who were raised up by families at the 25th percentile in the national income distribution. Moreover, we address an array of concerns regarding our initial results and potential biases.

### 4.5.1 The Effects of Interstate Banking Competition on Upward Economic Mobility

Table 4.2 shows the effects of out-of-state banking reform (at a time when the 1980–1986 birth cohort were 10–13 years old) on economic mobility. The financial environment is represented by the *Openness* index, and our economic mobility variable is represented by the expected income rank at age 24 of children who were raised by families which were in the $25^{th}$ percentile of the national income distribution scale. Column (1) presents an unconditional estimation, controlling only for pair-group fixed effects. Although the results are not significant, they suggest that interstate banking reform in the United States after 1994 had a positive effect on upward economic mobility. In column (2), we expand our model by including five control variables related to the macroeconomic environment and education. Specifically, the poverty variable enters the model with a significant and negative sign, suggesting that higher poverty rates are affecting negatively intergenerational measures at the county level. The coefficient for the percentage of people without a high school degree has positive value. These results seem opposite to the expected. However, one could argue that the 1990s, when the 1980–1986 birth group were young children, were a period of high economic growth and technological change, and that areas with more unskilled (poorly educated) people may have had a higher demand for skilled labour during the 2000s. Therefore, if poorer children's education was positively affected by the interstate banking reforms, they may have also had more chances as adults to climb to a higher level of the income ladder. In other words, given the technological revolution of the 1990s and the high levels of poorly educated people, poorer children who were possibly educated to a higher degree during the 1990s because of the banking reforms may have been more in demand in the 2000s. This is in line with Acemoglu (1999), who argues that an increase in the proportion of skilled (more educated) workers at the local level can change the composition of the job market, reducing wage inequalities between skilled and unskilled workers (due to the disproportionate increase in the wages of skilled labour). In column (4) we control with an additional array of variables related to criminality, household conditions and racial origin.[45] This specification is our baseline model. Our main variable of interest retains its positive and significant coefficient, suggesting that the interstate banking reform that started in 1994 affected poor children's lifetime economic outcomes positively.

Table 4.2 Intergenerational Mobility and Out-of-state Bank Openness (10-13)

| | Dependent variable: Expected income rank at age 24 | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | b/se | b/se | b/se |
| Openness (10-13) | 0.4379 | 0.5401*** | 0.3937** |
| | (0.3472) | (0.1561) | (0.1918) |
| (Log) Median Income | | 1.4788 | -0.3543 |
| | | (2.1833) | (1.6370) |
| Poverty % | | -0.6704*** | -0.2390** |
| | | (0.0875) | (0.1015) |
| Unemployment % | | -0.1697 | -0.0884 |
| | | (0.2514) | (0.2177) |
| College or More % | | -0.0599 | 0.0052 |
| | | (0.0431) | (0.0400) |
| Less than High School % | | 0.6223*** | 0.5017*** |
| | | (0.1336) | (0.1485) |
| Violent Crime per capita | | | 21.2240 |
| | | | (13.9764) |
| Female Head Households % | | | -55.7411*** |
| | | | (10.5016) |
| Foreign born % | | | -0.1052 |
| | | | (0.1061) |
| Hispanic % | | | 6.6670 |
| | | | (7.0302) |
| Non-Hispanic White % | | | 0.0568 |
| | | | (0.0403) |
| Non-Hispanic Black % | | | 0.0374 |
| | | | (0.0367) |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.846 | 0.910 | 0.931 |
| Observations | 7340 | 7340 | 7340 |

*Notes:* This table reports estimates associating banking competition with upward economic mobility. Our mobility measure is the expected income rank of children at age 24 whose parents' income is at the 25th percentile in the national income distribution. The Openness variable represents our banking competition index. Column (1) presents estimations controlling only for pair-cohort fixed effects. In columns (2) and (3), we employ an additional array of economic and socio-demographic controls. Variables descriptions are provided

[45] In Table 4. C.3 in Appendix C we present the variance inflation factor (VIF) for all our control variables. The VIF is a value which shows how much the variance of an estimated regression coefficient increases when predictors are correlated. If the predictors are not correlated, the VIF value is equal to 1. Otherwise, it increases. As a rule of thumb, Akinwande et al. (2015) explain that if the VIF goes above 10, it can be assumed that the regression coefficients are poorly estimated due to multicollinearity. Since the variables of income, percent of white population, percent of female households, poverty, college or more, unemployment, and percent of people with less than high school diploma exceed number 10, there is a potential multicollinearity problem. For this reason, we replicate our regressions excluding all variables with VIF more than 10. Indeed, the main variable of interest is not significant. The results are provided in the Appendix C in Table 4. C.4. Thus, we must take into consideration that there may be a multicollinearity issue.

in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

In Tables 4.3 and 4.4, we perform the same analysis as in Table 4.2 for two different periods. Our hypothesis suggests that intergenerational mobility rates are affected by the financial environment during all the periods in which the 1980–1986 birth cohorts were growing up. This is because recent literature finds significant effects of parents' income and credit constraints on their children's outcomes during both childhood as a whole and early adulthood (Heckman and Mosso, 2014). Tables 4.3 and 4.4 examine whether the financial environment during the 1980–1986 birth cohorts were teenagers (14–17 years old) and young adults (18–21 years old) affected their intergenerational mobility. Specifically, in Table 4.3 we can observe that our coefficient is positive and significant, even without controlling for our socio-demographic variables. In column (3), the most conservative specification suggests that financial reform affected economic mobility more during adolescence than during other periods. Interestingly, our evidence is in line with a considerable body of literature that suggests that adolescence is the most significant time for policies that enhance disadvantaged children's education, and which can improve their personality and socio-emotional skills (Cunha and Heckman, 2007).

Table 4.3 Intergenerational Mobility and Out-of-state Bank Openness (14-17)

| Dependent variable: Expected income rank at age 24 | | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | b/se | b/se | b/se |
| Openness (14-17) | 0.4619* | 0.5405*** | 0.4791*** |
| | (0.2663) | (0.1450) | (0.1658) |
| (Log) Median Income | | 3.6711* | 1.8786 |
| | | (1.9516) | (1.8355) |
| Poverty % | | -0.7659*** | -0.1843 |
| | | (0.0970) | (0.1262) |
| Unemployment % | | 0.5169* | 0.4345 |
| | | (0.3069) | (0.2766) |
| College or More % | | -0.0761* | 0.0007 |
| | | (0.0388) | (0.0286) |
| Less than High School % | | 0.5494*** | 0.4751*** |
| | | (0.1057) | (0.1038) |
| Violent Crime per capita | | | 19.8144 |
| | | | (12.5281) |
| Female Head Households % | | | -55.2435*** |
| | | | (9.9370) |
| Foreign born % | | | -0.0559 |
| | | | (0.0863) |
| Hispanic % | | | 0.0505 |
| | | | (0.0567) |

| | | | |
|---|---|---|---|
| Non-Hispanic White % | | | 0.0710 |
| | | | (0.0434) |
| Non-Hispanic Black % | | | 0.0548 |
| | | | (0.0426) |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.845 | 0.908 | 0.931 |
| Observations | 7340 | 7340 | 7340 |

*Notes:* This table reports estimates associating banking competition with upward economic mobility. Our mobility measure is the expected income rank of children at age 24 whose parents' income is at the 25th percentile in the national income distribution. The Openness variable represents our banking competition index. Column (1) presents estimations controlling only for pair-cohort fixed effects. In columns (2) and (3), we employ an additional array of economic and socio-demographic controls. Variables descriptions are provided in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

In the same vein, the results in Table 4.4 suggest that the change in the financial environment during the 1990s and 2000s as a result of the interstate banking reform affected positively intergenerational mobility rates at the local level. Specifically, the coefficient in column (3) shows that any changes in the banking system when the 1980–1986 birth cohorts were young adults affected their mobility rates. Depending on our main hypothesis, fewer restrictions on interstate banking may have led to poorer parents (and also children during their early adulthood) to borrow money cheaply and pay for education. Therefore, we expect to find positive effects of interstate banking reform not only on high-school attendance rates but also on the college attendance. Overall, even if the financial environment has the higher impact on intergenerational mobility when the 1980–1986 birth cohorts were teenagers, it is not that different during the 10–13 and 18–21 periods. Therefore, the results suggest that parents' income levels and credit constraints are always significant for their offspring's education and income outcomes as adults.

Table 4.4 Intergenerational Mobility and Out-of-state Bank Openness (18-21)

| Dependent variable: Expected income rank at age 24 | | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | b/se | b/se | b/se |
| Openness (18-21) | 0.3578 | 0.4330** | 0.3511** |
| | (0.2563) | (0.1774) | (0.1581) |
| (Log) Median Income | | -2.9241 | -1.5041 |
| | | (2.4969) | (2.1668) |
| Poverty % | | -0.9971*** | -0.2765** |
| | | (0.1064) | (0.1259) |
| Unemployment % | | 0.1421 | 0.3138 |
| | | (0.4148) | (0.3424) |
| College or More % | | -0.0408 | 0.0014 |
| | | (0.0406) | (0.0281) |
| Less than High School % | | 0.5392*** | 0.4792*** |
| | | (0.0879) | (0.0933) |

| | | | |
|---|---|---|---|
| Violent Crime per capita | | | 27.0692 |
| | | | (17.4933) |
| Female Head Households % | | | -58.0311*** |
| | | | (10.4004) |
| Foreign born % | | | -0.0205 |
| | | | (0.0757) |
| Hispanic % | | | 3.9429 |
| | | | (5.2761) |
| Non-Hispanic White % | | | 0.0652 |
| | | | (0.0431) |
| Non-Hispanic Black % | | | 0.0572 |
| | | | (0.0400) |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.844 | 0.909 | 0.931 |
| Observations | 7340 | 7340 | 7340 |

This table reports estimates associating banking competition with upward economic mobility. Our mobility measure is the expected income rank of children at age 24 whose parents' income is at the 25th percentile in the national income distribution. The Openness variable represents our banking competition index. Column (1) presents estimations controlling only for pair-cohort fixed effects. In columns (2) and (3), we employ an additional array of economic and socio-demographic controls. Variables descriptions are provided in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

## 4.5.2 Mitigating Potential Biases

One concern regarding our estimates is the omitted variable bias. However, by using the difference-in-differences technique and controlling for all of our socio-demographic variables, as well as pair-cohort fixed effects, potential concerns may be mitigated. Secondly, one can argue that the period in which reform started in each state was driven by macroeconomic conditions, thus raising endogeneity issues. Nevertheless, Celerier and Matray (2018) find that the timing of interstate banking reform was independent of state-level macroeconomic conditions. Apart from the macroeconomic conditions that may be related with the time of the banking reform adoption, pre-reform banking environment could have reinforced or weakened the effect of the policy. This is due to the fact that the interstate regulation could have heterogenous effects in places with more or less fragile banking system. To examine this hypothesis, we used the following interaction model:

$$\boldsymbol{Mobility}_{i(a),j(b),t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \times \boldsymbol{Openness}_{i(a),j(b),t} + \boldsymbol{BankFrag}_a + \boldsymbol{Openness}_{i(a),j(b),t} \times \boldsymbol{BankFrag}_a + \gamma \times \boldsymbol{X}_{i(a),j(b),t} + \lambda \times \boldsymbol{W}_{i(a),j(b),t} + \boldsymbol{\varepsilon}_{i(a),j(b),t} \quad (4.5.1)$$

where $\mathbf{BankFrag}_a$ represents the fragility of the banking system in each county-pair (state) before the interstate banking regulation. More specifically, using data from Federal Deposit Insurance Corporation (1997) we represent the pre-reform banking system's fragility as the percentage of banks that failed in each state during the 1980's and early 1990's banking crisis era. Table 4.5 presents the results. All coefficients from the interacted variables are insignificant, moderating the possibility that pre-regulation banking environment drives our results. Lastly, a potential concern could be in relation to the reverse causality problem. Nevertheless, the nature of our study does not permit for this bias since any effects of interstate banking reform may only have lagged effects on intergenerational mobility.

Table 4.5 Heterogeneity: Pre-reform banking system fragility

| Dependent Variable: Expected income rank at age 24 | | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | b/se | b/se | b/se |
| | 10 to 13 | 14 to 17 | 18 to 21 |
| Openness | 0.3786* | 0.3764** | 0.3771** |
| | (0.2027) | (0.0057) | (0.1426) |
| Banking Fragility | -0.0177 | 0.0057 | -0.0073 |
| | (0.0259) | (0.0271) | (0.0341) |
| Openness x Banking Fragility | -0.0043 | -0.0181 | -0.0078 |
| | (0.0151) | (0.0121) | 0.0133 |
| Socio-demographic Controls | Yes | Yes | Yes |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.9308 | 0.9333 | 0.9353 |
| Observations | 7340 | 7340 | 7340 |

*Notes:* This table reports an interaction model associating upward economic mobility, as reflected in expected rank in the income distribution at age 24 for children from families at the 25th percentile, with out-of-state bank Openness. Standard errors clustered at the state and border segment levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

### 4.5.3 Robustness Check-Alternative Competition Index

Although our variable of interest, which is an index of banking competition at the local level, is used by a huge body of literature, we also examine our hypothesis using a different measure of the competitive environment constructed by Nguyen et al. (2018). This is a dummy which takes 1 if each state chooses not to adopt either the restriction for acquisition of individual branches by an out-of-state bank or impose a deposit cap equal or less than 30% on branch acquisitions. We average this index for the years when the 1980–1986 birth group are young children (10–13 years old), teenagers (14–17 years old) and early adults (18–21 years old), thus constructing an alternative index of competition. In columns (1) to (3) in Table 4.6, the competition indexes enter the models with positive and significant coefficients. This confirms that interstate banking reform had a positive effect on mobility rates amongst poorer children.

Table 4.6 Intergenerational Mobility and Out-of-state Bank Openness

| | (1) | (2) | (3) |
|---|---|---|---|
| | b/se | b/se | b/se |
| Competitive Index 10-13 | 1.3819** | | |
| | (0.6394) | | |
| Competitive Index 14-17 | | 0.8461** | |
| | | (0.3993) | |
| Competitive Index 18-21 | | | 0.6474* |
| | | | (0.3447) |
| Socio-demographic Controls | Yes | Yes | Yes |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.843 | 0.931 | 0.844 |
| Observations | 7382 | 7382 | 7382 |

*Notes:* This table reports estimates associating banking competition with upward economic mobility. Our mobility measure is the expected income rank of children at age 24 whose parents' income is at the 25th percentile in the national income distribution. The competitive index variable represents our banking competition index. In all columns we employ an array of economic and socio-demographic controls as well as pair-cohort fixed effects. Variables descriptions are provided in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

## 4.6 Interstate banking reform, interest rates, credit supply, and households' performance

Our research hinges on the assumption that the inter-state banking reform (after 1994) helped poorer households. We argue that (poor) households experienced higher access to credit and lower interest rates after inter-state banking reform. Dick and Lehnert (2010) find access to credit for poorer households was increased after the inter-state banking reform, thus letting previously excluded households enter the credit market. Moreover, they find that overall lending increased, thus suggesting that the deregulated banking environment helped more people to access to credit. They mention that this change could have happened due to lower interest rates or via a reduction in the financial constraints facing consumers. In the same vein, Rice and Strahan (2010) find that the owners of small firms in states with a more open banking environment borrow at interest rates 80 to 100 basis points lower than counterparts operating in less open states. Furthermore, Black and Strahan (2002) stress that inter-state banking reforms that fostered competition and consolidation helped entrepreneurs access credit. This evidence shows that the constrained access to credit was a significant parameter for less wealthy entrepreneurs (and householders) to expand their business and increase their family income. Lastly, Amore et al. (2013) and Cornaggia and Li (2019) argue bank credit supply is greater in states that adopted inter-state banking reforms more quickly. Overall, prior research suggests that the link between inter-state banking reforms and household wealth can be explained by lower interest rates, access to credit and increased credit supply.

## 4.7 Channels

This research suggests that a better financial environment at the local level may ease financial household's constraints and therefore poor children maximize their chances to achieve higher income as adults than their parents. Among several explanations, we investigate the case that children who grow up in a better environment in terms of credit supply increase their participation to both school and college, which is a driving force for higher intergenerational mobility. Previous research (Teng Sun and Yannelis, 2016) shows that lifting banking restrictions which increase credit supply, raise college attendance about 5%. Moreover, Beck al. (2010) find that the decreasing inequality rates due to higher bank competition and improved bank performance, may have been achieved through increasing investment on education in poor households. Thus, we test whether our *Openness* index relates to school and college attendance measures. We collect data on the college attendance at ages 18-21 and 19 from Chetty and Hendren (2018b) for birth cohorts 1980 to 1986. Moreover, we gather data for school dropout rates as well as the percentage of residents within each county with high school or higher diploma from the Unites States Census Bureau (2018).

Columns (1) to (4) in Table 4.7 provide suggestive evidence of the role of education as a channel between interstate banking reform and intergenerational mobility. The results are provided for all the periods during which the 1980–1986 birth cohorts were growing up. Columns (1) and (2) suggest in two ways that higher banking competition at the local level may have increased college attendance by children who grew up in lower income families. This is in line with the theories explained above, which associate lower credit constraints with higher college participation rates. Furthermore, columns (3) and (4) show that our *Openness* index is positively associated with school attendance. It seems that the more open the environment for out-of-state banking is, the lower the school dropout rates are and the higher the percentage of people with high school or higher diplomas is. These findings suggest that poor teenagers may benefit in terms of education from banking policies that help alleviate their parents' financial constraints. Since our results are positive and significant for all the periods and variables, we contend that education is a significant link between a financial environment and intergenerational mobility. Nevertheless, since we have not provided evidence using individual or longitudinal data, our findings warrant a further analysis of the channels between finance and mobility.

Table 4.7 Education as a Potential Channel: Upward Economic Mobility and Out-of-state Bank Openness

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | b/se | b/se | b/se | b/se |
| | Dependent variables | | | |
| | College attendance 18-23 | College attendance 19 | Dropout Percentage | High School or More Percentage |
| Openness 10-13 | 1.8041*** | 1.7679*** | -0.0322*** | 0.6903** |
| | (0.6474) | (0.4056) | (0.0079) | (0.3396) |
| R-squared | 0.816 | 0.801 | 0.913 | 0.872 |
| Observations | 6302 | 7340 | 7340 | 7340 |
| Openness 14-17 | 1.4007*** | 1.3366*** | -0.0223*** | 0.6134** |
| | (0.4880) | (0.3961) | (0.0069) | (0.2650) |
| R-squared | 0.818 | 0.803 | 0.900 | 0.869 |
| Observations | 6302 | 7340 | 7340 | 7340 |
| Openness 18-21 | 0.9097* | 0.9457** | -0.0183** | 0.6367** |
| | (0.5087) | (0.4145) | (0.0069) | (0.2457) |
| R-squared | 0.814 | 0.801 | 0.866 | 0.869 |
| Observations | 6302 | 7340 | 7340 | 7340 |

*Notes:* This table reports estimates associating an array of variables related to education, with out-of-state bank Openness. Variables descriptions are provided in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

## 4.8 Conclusion

In this chapter we examine the effects of the interstate banking reform that started in the US in 1994 on economic mobility. The new interstate banking laws that were applied at different times across different states gave some parts of the country the advantage of higher banking competition. Several studies have examined the effects of the increased competition on innovation, business cycles, trade, banking equity values, the agency problem, labour markets and real estate. However, to the best of our knowledge no previous research has examined the effects of the level of out-of-state banking restrictiveness on economic mobility.

To test our hypothesis, we construct a measure similar to the Rice and Strahan (2010) Index, which shows the degree of banking competition at the local level. Then, we calculate the mean *Openness* which is our index of banking competition when the 1980–1986 birth cohorts were 10–13, 14–17 and 18–21 years old. This is our main variable of interest.

Using data on poorer children's economic mobility from Chetty and Hendren (2018b), we estimate the effects of interstate banking on economic mobility. All the coefficients were positive and significant, suggesting that a more competitive financial environment during the childhood of the sample set improved their intergenerational mobility. We repeat our estimations using an alternative measure of banking competition, thus validating our initial results. Our results call for a greater focus on policies that promote a more competitive financial environment, which is a driving factor for higher levels of intergenerational mobility.

Nevertheless, more research should be done on other local characteristics that may influence intergenerational mobility. For future work, it is proposed to be examined whether the local history drives the level of economic mobility. For instance, using the early start hypothesis at the local level described in Kampanelis (2018), it might be investigated whether regions with longer economic history experience higher levels economic mobility.

## 4.9 Appendix C

Table 4. C.1 Income Elasticities in The United States

| ESTIMATED INTERGENERATIONAL INCOME ELASTICITIES BY YEAR AND GENDER IN THE UNITED STATES | | |
|---|---|---|
| **Year** | **Sons** | **Daughters** |
| 1977 | 0.34 | 0.05 |
| 1978 | 0.54 | 0.19 |
| 1979 | 0.5 | 0.2 |
| 1980 | 0.48 | 0.27 |
| 1981 | 0.42 | 0.37 |
| 1982 | 0.52 | 0.37 |
| 1983 | 0.46 | 0.45 |
| 1984 | 0.39 | 0.49 |
| 1985 | 0.41 | 0.53 |
| 1986 | 0.47 | 0.49 |
| 1987 | 0.41 | 0.5 |
| 1988 | 0.38 | 0.54 |
| 1989 | 0.42 | 0.56 |
| 1990 | 0.36 | 0.52 |
| 1991 | 0.43 | 0.53 |
| 1992 | 0.45 | 0.49 |
| 1993 | 0.49 | 0.5 |
| 1994 | 0.43 | 0.48 |
| 1995 | 0.4 | 0.48 |
| 1996 | 0.43 | 0.43 |
| 1998 | 0.47 | 0.45 |
| 2000 | 0.49 | 0.46 |

*Notes:* Table 4.C.1 presents intergenerational income elasticities through years based on gender identity in the United States. Data Source: Lee and Solon (2009)

Table 4. C.2 Description of Variables

| Variable | Description | Source |
|---|---|---|
| Expected income rank at age 24 | Economic mobility measure | Chetty et al (2018) |
| Openness | Banking competition index | Rice and Strahan (2010) |
| (Log) Median Income | Logarithm of Median income | Unites States Census Bureau (2018) |
| Poverty % | Percentage of people under poverty | Unites States Census Bureau (2018) |
| Unemployment % | Percentage of people under unemployment | Unites States Census Bureau (2018) |
| College or More % | Percentage of people with college or higher education | Unites States Census Bureau (2018) |
| Less than High School % | Percentage of people with less than high school education | Unites States Census Bureau (2018) |
| Violent Crime per capita | Violent crime density (by population) | Unites States Census Bureau (2018) |
| Female Head Households % | Female households' density (by population) | Unites States Census Bureau (2018) |
| Foreign born % | Percentage of people born outside the U.S. | Unites States Census Bureau (2018) |
| Hispanic % | Percentage of people with Hispanic origin | Unites States Census Bureau (2018) |
| Non-Hispanic White % | Percentage of people with non-Hispanic white origin | Unites States Census Bureau (2018) |
| Non-Hispanic Black % | Percentage of people with non-Hispanic black origin | Unites States Census Bureau (2018) |

Table 4. C.3 Testing Multicollinearity: VIF

| Variable | VIF | 1/VIF |
|---|---|---|
| (Log) Median Income | 339.6 | 0.002945 |
| Non-Hispanic White % | 167.16 | 0.005982 |
| Female Head Households % | 70.58 | 0.014168 |
| Poverty % | 32.98 | 0.030326 |
| College or More % | 17.73 | 0.056388 |
| Unemployment % | 14.73 | 0.067867 |
| Less than High School % | 10.95 | 0.091303 |
| Non-Hispanic Black % | 9.26 | 0.107938 |
| Foreign born % | 5.58 | 0.179149 |
| Hispanic % | 4.73 | 0.211222 |
| Violent Crime per capita | 3.63 | 0.275827 |
| Openness (18-21) | 2.41 | 0.414127 |
| Mean VIF | 56.61 | |

*Note*: This table presents VIF values for all control variables. Variables with VIF value more than 10, are supposed to cause multicollinearity issues.

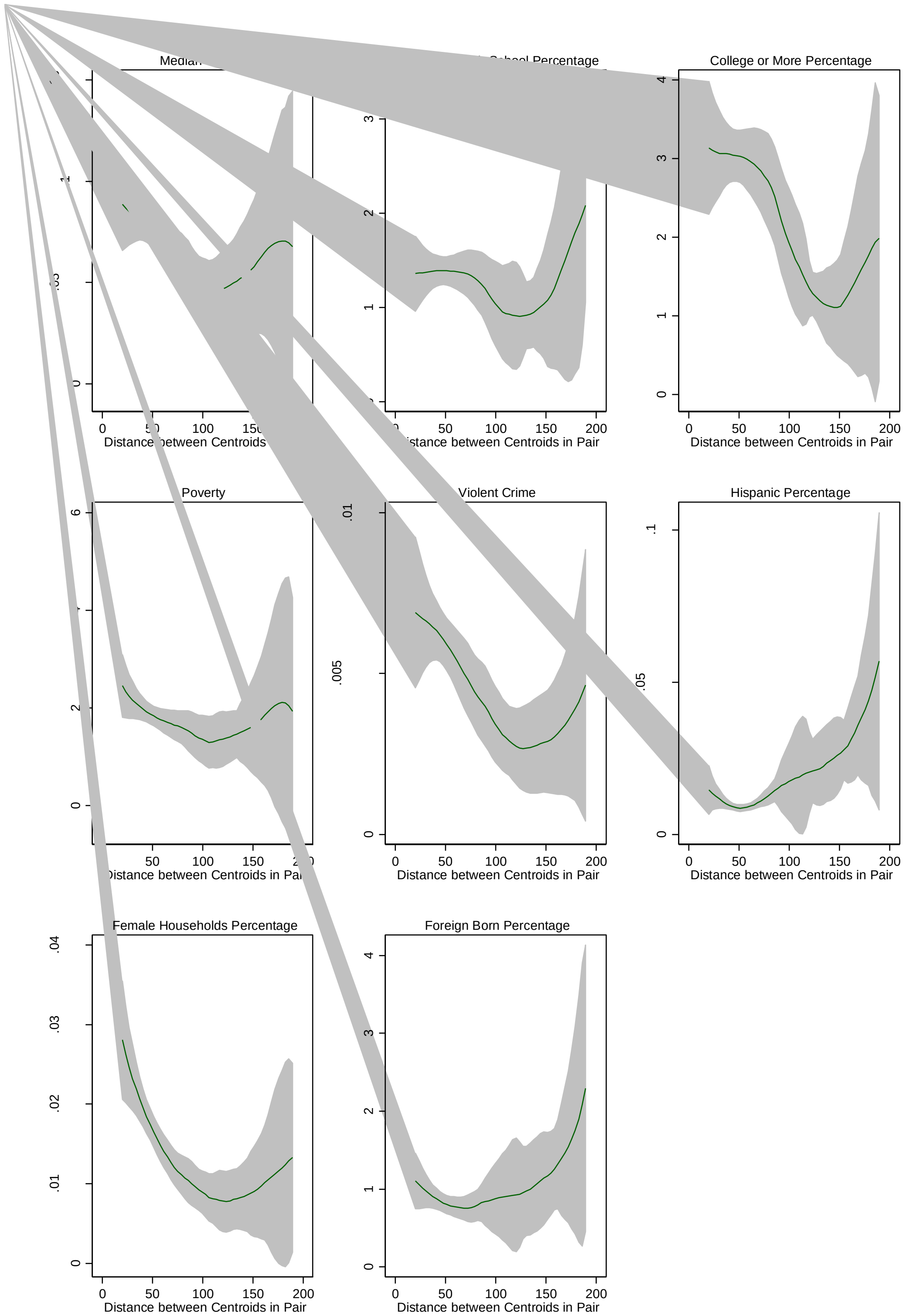
Table 4. C.4

Intergenerational Mobility and Out-of-state Bank Openness: Excluding controls with high VIF

| | (1) | (2) | (3) |
|---|---|---|---|
| | b/se | b/se | b/se |
| Openness 10-13 | 0.1584 | | |
| | (0.3743) | | |
| Openness 14-17 | | 0.0837 | |
| | | (0.3016) | |
| Openness 18-21 | | | 0.0521 |
| | | | (0.241) |
| Rest of Socio-demographic Controls | Yes | Yes | Yes |
| Pair-Cohort Fixed Effects | Yes | Yes | Yes |
| R-squared | 0.673 | 0.673 | 0.674 |
| Observations | 7340 | 7340 | 7340 |

This table reports estimates associating banking competition with upward economic mobility. Our mobility measure is the expected income rank of children at age 24 whose parents' income is at the 25th percentile in the national income distribution. The competitive index variable represents our banking competition index. In all columns we employ an array of economic and socio-demographic controls excluding those with VIF value higher than 10. Moreover, we control for pair-cohort fixed effects. Variables descriptions are provided in the data section. The estimations include a constant term, which is omitted for space considerations. Standard errors clustered at the state and border levels are in parentheses. *, **, and *** mean that the coefficient is statistically significant at 10%, 5%, and 1%, respectively.

Figure 4. C.1 Mean Absolute Difference in Covariates by Distance between Centroids of a Pairs



# CHAPTER 5: Conclusion

## 5.1 Aims, Findings and Contributions

The aim of this thesis is to analyse the effects of historical shocks such as colonialism on current economic development. The results of the study contribute to the existing literature by showing that development at the local level is a function of old as well as recent historical shocks regardless of when they occur. The more intense the shock is, the more persistent effects it has. Apart from the intensity, the duration that a historical shock that affects a locality plays a significant role for its long-term development or growth.

The second chapter shows that ancient historical shocks can in certain cases be persistent, thus affecting current development at the local level. This is a significant contribution since the existing literature analyses the influence of relatively more recent shocks. More specifically, the second chapter exploits the ancient colonisation activity around the Mediterranean Sea in order to show that ancient history still matters for current development. This is the first time that a research associates current development with ancient colonial events. In order to conduct this study, it is used historical sources, which show the places where ancient civilisations around the Mediterranean Sea established colonies. Moreover, we use a sophisticated method - light density at night from satellites for measuring development at the local level. We find that the locations where Greek, Phoenician and Etruscan civilisations set up colonies have higher luminosity (economic development) in the modern era relative to areas that were inhabited by less advanced civilisations. This suggests that there is a legacy from superior ancient civilisations that persists to the present day.

The third chapter advances the existing literature related to the effects of European colonisation on current economic development. In the chapter the results of the empirical analysis suggest that colonisers play a significant role in determining long-term economic development. Using the case of the Australian colonisation by Europeans, chapter 3 suggests that the more time local areas operate under European institutions and technology, the higher levels of development they experience. In order to examine this hypothesis, data are collected on the year of European arrival in Australian localities. Median income and education data are collected to proxy for economic development. Although similar research has been conducted in the past at the state level, there is still limited evidence at the local. Thus, the third chapter provides evidence which suggests that the duration of colonisers in a particular locality is a significant determinant of economic development.

Finally, the fourth chapter examines the effects of a more recent shock on intergenerational mobility. Previous research examines the effects of banking sector deregulatory reforms on household, firm and macroeconomic outcomes. However, to date no evidence exists as to whether financial reforms exert a positive influence on intergenerational mobility. For this reason, chapter 4 investigates the impact of banking reforms that took place in the United States during 1990s on intergenerational mobility at the local level. The main findings suggest that in places, which experienced higher competition following banking reforms, intergenerational mobility rates were higher. This is a significant contribution to the existing literature because no prior research has shown that banking reforms can have persistent effects on later generations.

## 5.2 Limitations and suggestions for further research

A common characteristic amongst the three main chapters of this thesis is the effect of historical shocks on current economic development. Although recent research on history, anthropology and geography have tried to develop and use historical data sources to explore modern day phenomena, there are still a limited number of databases that economists can use to associate historical events with contemporary economic variables.

Given the above limitation, Chapter 2 cannot provide any direct methodology to show the channels through which ancient colonisation has affected current economic development. Additionally, another limitation concerns the use of light density as a development measure. Research has shown that night-time luminosity as seen from satellites reflects not only economic development, but also urbanisation. Therefore, one could argue that the findings outlined in Chapter 2 represent merely the growth of cities rather than the effects of ancient colonisation on current development. Similarly, in Chapter 3 the channels linking the duration of European colonisation in Australia and current development are not shown empirically due to the lack of reliable data. Finally, in the fourth chapter the education as a channel between the interstate banking reform and intergenerational mobility is not examined in a highly detailed manner. This is because historical individual data on education per county in the United States is unavailable. Thus, only suggestive evidence is provided.

Although the lack of local historical data poses certain research difficulties, it may also open research avenues in the future. If new sources of historical data become available in the future, researchers could identify more channels linking historical shocks with current economic development. For instance, if someone has access to new data on institutions around the Mediterranean Sea at the local level in 1000 AC, she may show that this is the most significant channel between ancient colonisation activity and current development. Despite the limitations noted above, this thesis advances significantly the current literature which is related to the effects of historical shocks on contemporary economic development.

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