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

By Sotiris Kampanelis

This article examines the ‘early start’ hypothesis at the local level in the context of Australian colonization. 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 colonization reflects a relatively random variation in the duration of the western presence at the local level, causing uneven urban development.

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‘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)

1. Introduction

This paper 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 colonization, 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.[1] Thus, in the present paper, time is proposed to be an endowment for long-term economic development.

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

[1] 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.

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.[2] 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).[3] 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. 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.

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

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

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 colonization 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 colonization 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 paper proceeds as follows: Section 2 proposes the potential channels through which time affects long-term economic development. Section 3 provides a brief historical background of the Australian urban environment. Section 4 describes the data and presents the empirical strategy related to my baseline results. In Section 5, I report the main results and a set of robustness tests. Section 6 examines issues related to land selection and heterogeneity as well as the non-linear relationship between time and economic development. Finally, Section 7 concludes.

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 colonizers' 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.[4] 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, such a labour force is a source of long-term economic development. This is in line with Cantoni and Yuchtman (2014),

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

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. 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 colonization 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 20th 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.

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 A1 in the online Appendix). 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.[5] 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 B1 in the online Appendix.

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 online Appendix, Table B6 shows a sample of LGAs and the events that reveal the beginning of their economic activity. In

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

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.

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).[6] 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).[7]

Regarding the selection of my independent variables, I follow the literature as well as specific Australian land, environmental and historical events.[8]

4.2 Empirical strategy

To investigate whether there is a relationship between the length of the time that there has been European economic activity within an LGA and its long-term economic development, I first apply the OLS estimations. I regress my three development indexes (Y) for LGA $\boldsymbol{i}$ on the time length (***Time***), including a set of location ($\boldsymbol{L}$) and climatic ($\boldsymbol{C}$) control variables. The model also incorporates state-fixed effects ($\boldsymbol{\eta_s}$) to capture unobserved state characteristics, such as state institutions. ε_i denotes the stochastic error term.

[6] School life expectancy is the expected number of years of schooling.
[7] In Table B2 in the online Appendix, I provide results for GLP (Gross Local Domestic Product) per capita as an additional robustness check.
[8] 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).

$$Y_i = \alpha \times Time_i + \beta_1 \times L_i + \beta_2 \times C_i + \eta_s + \varepsilon_i \quad (1)$$

The coefficient of interest indicates the impact of time on the outcome variables. 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 1 presents their descriptive statistics.

[Insert Table 1 about here]

5. Estimation results

This section reports the effect of time on economic development and presents several robustness checks of the baseline results. Tables 2 to 5 provide the baseline results of this paper, while Tables 6 to 13 put forth additional evidence of the validity of my hypothesis.[9]

5.1 The effect of time of westernization on economic development

Table 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.[10] In spite of employing a rich conditioning set, the strong positive association between time and economic development retains its economic and statistical significance. 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.

[Insert Table 2 about here]

Table 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 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

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

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

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

[Insert Table 3 about here]

In column 1 of Table 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, 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.

[Insert Table 4 about here]

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).[11] 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 $\in$ [$\boldsymbol{Y_1}$,$\boldsymbol{Y_{219}}$].

In columns 1, 5 and 9 in Table 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

[11] 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.

Conley's (1999) method with a cutoff distance of 100 km.[12] 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.[13] Overall, the results in Table 5 suggest that spatial correlation among LGAs is not a driving factor for my findings.

[Insert Table 5 about here]

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 (5.2 and 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.

5.2 Robustness checks

5.2.1 Omitted Variable Bias

An important issue related to my results is how to credibly interpret them as causal. Omitted variable bias may distort my results. For this reason, in Table 6, I employ Oster's (forthcoming) technique which assumes that the selection on the observed controls is proportional to the selection on the unobserved controls. For each one of my baseline most conservative specifications whose coefficients are shown in column 1, I calculate an Rmax value which is 30% higher than their R^2 and assumes that all relevant observed and unobservable variables are included as controls. Using the Rmax value for each specification, I calculate a set of coefficients as well as a variable δ reported in columns 2 and 4, respectively. Importantly, the sets of corrected and non-corrected coefficients safely exclude zero and the absolute value of each δ is always higher than one. These

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

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.

[Insert Table 6 about here]

5.2.2 Initial Purpose

One may argue that the main initial purpose of colonizing 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 colonizers 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 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.[14]

[Insert Table 7 about here]

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 8, I report estimates excluding

[14] In the online Appendix Table 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.

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 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 8 suggest a strong and significant effect of time on long-term economic development.

[Insert Table 8 about here]

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 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 A2 the online Appendix. Table 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 9 the time variable enters into all regressions with a positive and statistically-significant coefficient.[15]

[Insert Table 9 about here]

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 10 remains positive and significant, though the indigenous population is highly significant in columns 1 and 2, indicating a positive effect of time since westernization on local long-term economic development.

[Insert Table 10 about here]

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.

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

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 11 shows that coefficients on time retain their statistical significance at the 1% level.

[Insert Table 11 about here]

6. Sensitivity analysis

6.1 Rational Selection

This section discusses the colonies' potential selection problem. I argue that Europeans chose their colonies in a process that was relatively random. 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 colonization period, it can be concluded that Europeans had access to Australia only from the coasts.[16] Consequently, coastal places were colonized 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 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)

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

and mammals (O'Dea, 1991). Assuming that their colonial activity was not random, 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 three ways. First, I exploit the Paleobiology database (2017), which provides coordinates of uncultivated mammal fossils from the Holocene period.[17] I calculate the distance of each LGA from its closest fossil as an index for the suitability for mammalian life. Second, 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 12a shows that distance from the closest mammal fossil as well as 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.[18] However, these results do not impose any selection bias. If colonizers 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 colonized first, thus confirming the notion that something accidental 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.

[Insert Table 12a about here]

Third, since Australian colonization started in Sydney, I use the least cost path analysis from ArcGIS to find the additional cost in terms of environmental obstacles that colonizers need to

[17] This period is the current geological era. It started approximately 11,700 years ago.

[18] In addition, in the online Appendix Table 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 colonized 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.

overcome in order to move from their initial colony to any other colony within Australia.[19] If colonizers 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 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.

[Insert Table 12b about here]

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 interaction (conflicts) between Europeans and various local clans.[20] 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

[19] As seen in the online Appendix, the notes in Figure A3 describe the least cost path measure from Sydney to Melbourne. Moreover, in the online Appendix Table 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 colonizers to choose a place for establishment.

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

rights from the beginning of the European colonization, I do not expect any land selection bias based on the colonizers' skills.

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 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 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 online Appendix I run all of my baseline regressions while restricting 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.

[Insert Table 13 about here]

6.3 Non-Linearity

Finally, I test whether the quadratic form of my main variable of interest influences economic development. I present this relationship depicting the margin plot graphs. Figure 1 illustrates an exponential and positive relationship between time and median income. Figures 2 and 3 illustrate that the same effect on education variables is initially positive, though it becomes negative for places that have been settled after 1900. The results may suggest that, in more recent cities, higher technology substitutes the effect of time on accumulation of human capital. Nevertheless, the most important finding is that even cities which have been constructed under the most recent technology do not achieve the high education levels as of those with a long history.

[Insert Figures 1,2,3 about here]

7. Conclusion

In this paper, 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.

Since Australia is a huge island, the limitations of technology during the era of its colonization 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 my main hypothesis—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 colonizer'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.

Supplementary material

Supplementary material is available on the OUP website. These are the data and replication files and the online Appendix.

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References

Acemoglu, D., Johnson, S. and Robinson, J. A., 2001. The Colonial Origins of Comparative Development: An Empirical Investigation. American Economic Review, 91, 1369-1401.

Acemoglu, D. and Robinson, J., 2012. Why Nations Fail: The Origins of Power, Prosperity, and Poverty. 1 ed. Crown Business, New York.

Acemoglu, D., Robinson, J. and Johnson, S., 2003. Disease and Development in Historical Perspective. Journal of the European Economic Association, 1, 397-405.

Ahsan, H. and Haque, M., 2017. Threshold effects of human capital: Schooling and economic growth. Economics Letters, 156, 48-52.

Akcomak, S., Webbink, D. and ter Weel, B., 2015. Why Did the Netherlands Develop so Early? The legacy of the Brethren of the common life. The Economic Journal, 126, 821-860.

Anselin, L., 2001. Spatial Econometrics. In: B. H. Bataggi, ed. A Companion to Theoretical Econometrics. Blackwell, Oxford, 310-330.

Atkinson, A. B. and Stiglitz, J. E., 1969. A New View of Technological Change. The Economic Journal, 79, 573-578.

Bate, W., 1974. The Urban Sprinkle: Country Towns and Australian Regional History. In: J. W. McCarty and C. B. Schedvin, eds. Urbanization in Australia The Nineteenth Century. Sydney University Press, Sydney, 106-119.

Belich, J., 2009. Replenishing the Earth. The Settler Revolution and the Rise of the Anglo-World, 1783-1939. Oxford University Press, Oxford.

Bockstette, V., Chanda, A. and Putterman, L., 2002. States and Markets: The Advantage of an Early Start. Journal of Economic Growth, 7, 347-369.

Borcan, O., Olsson, O. and Putterman, L., 2018. State History and Economic Development: Evidence from Six Millennia. Journal of Economic Growth, 23, 1–40.

Butlin, N. G., 1994. Forming a Colonial Economy. Cambridge University Press, Cambridge.

Cameron, C. and Miller, D. L., 2015. A Practitioner's Guide to Cluster-Robust Inference. The Journal of Human Resources, 50, 317-372.

Campante, F. R. and Do, Q., 2014. Isolated Capital Cities, Accountability, and Corruption: Evidence from US States. The American Economic Review, 104, 2456-2481.

Cantoni, D. and Yuchtman, N., 2014. Medieval Universities, Legal Institutions, and the Commercial Revolution. The Quarterly Journal of Economics, 129, 823–887.

Carlino, G. A., Chatterjee, S. and Hunt, R. M., 2007. Urban density and the rate of invention. Journal of Urban Economics, 61, 389–419.

Central Intelligence Agency., 2017. The world factbook. [Online], Available at: https://www.cia.gov/index.html [last accessed 21 June 2018]

Chanda, A., Cook, C. J. and Putterman, L., 2014. Persistence of Fortune: Accounting for Population Movements, There Was No Post-Columbian Reversal. American Economic Journal: Macroeconomics, 6, 1-28.

Chanda, A. and Putterman, L., 2007. Early Starts, Reversals and Catch-up in the Process of Economic Development. The Scandinavian Journal of Economics, 109, 387–413.

Chronopoulos, D. K., Kampanelis, S., Oto-Peralías, D. and Wilson, J. O. S., 2017. Spreading Civilizations: Ancient Colonialism and Economic Development Along the Mediterranean. SSRN.

Comin, D., Easterly, W. and Erick, G., 2010. Was the Wealth of Nations Determined in 1000 BC?. American Economic Journal: Macroeconomics, 2, 65-97.

Conley, T., 1999. GMM estimation with cross sectional dependence. Journal of Econometrics, 92, 1-45.

Coulibaly, S., Deichmann, U., Freire, M. E., Gill, I. S., Goh, C., Kopp, A. D.; Lall, S. V., Montenegro, C. E., Packard, T G.; Ross-Larson, B. C., Uchida, H., 2009. World development report 2009: Reshaping Economic Geography. World development report. World Bank Group, Washington, DC.

Dasgupta, P. and Stiglitz, J., 1988. Learning-by-Doing, Market Structure and Industrial and Trade Policies. Oxford Economic Papers, 40, 246-268.

Davison, G., 2001. Gold-rush Melbourne. In: I. McCalman, A. Cook and A. Reeves, eds. Gold: Forgotten Histories and Lost Objects of Australia. Cambridge University Press, Cambridge.

Droller, F., 2017. Migration, Population Composition, and Long Run Economic development: Evidence from Settlements in the Pampas. The Economic Journal, 128, 2321-2352

Ellison, G., Glaeser, E. L. and Kerr, W., 2010. What Causes Industry Agglomeration?. American Economic Review, 100, 1195–1213.

Feyrer, J. and Sacerdote, B., 2009. Colonialism and Modern Income: Islands as Natural Experiments. Review of Economics and Statistics, 91, 245-262.

Frost, L., 2014. Urbanization. In: S. Ville and G. Withers, eds. The Cambridge Economic History of Australia. Cambridge University Press, Cambridge, 245–264.

Glaeser, E. L. and Gottlieb, J. D., 2009. The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States. Journal of Economic Literature, 47, 983-1028.

Grosjean, P. and Khattar, R., Forthcoming. It's Raining Men! Hallelujah?. It's Raining Men! Hallelujah? The Long-Run Consequences of Male-Biased Sex Ratios, The Review of Economic Studies.

Guiso, L., Sapienza, P. and Zingales, L. 2011. "Civic Capital as the Missing Link.' In: J. Benhabib, A. Bisin, and M. O. Jackson, eds. Social Economics Handbook', Elsevier, Amsterdam, and Boston, 417– 480

Henderson, J. V., Storeygard, A. and Weil, D. N., 2012. Measuring Economic Growth from Outer Space. American Economic Review, 102, 994–1028.

Karskens, G., 2013. The early colonial presence, 1788-1822. In: A. Bashford and S. Macintyre, eds. The Cambridge History of Australia. Cambridge University Press, Cambridge, 91-120.

Konishi, S. and Nugent, M., 2013. Newcomers, c.1600-1800. In: A. Bashford and S. Macintyre, eds. The Cambridge History of Australia. Cambridge University Press, Cambridge, 2-67.

Levine, R., 2005. Law, Endowments and Property Rights. The Journal of Economic Perspectives, 19, 61-88.

Lucas Jr, R. E., 1988. On the mechanics of economic development. Journal of Monetary Economics, 22, 3-42.

Meredith, D. and Oxley, D., 2014. The convict economy. In: The Cambridge Economic History of Australia. Cambridge University Press, Canberra, 97-122.

Merrett, D. T., 1978. Australian capital cities in the twentieth century. In: J. W. McCarty and C. B. Schedvin, ed. Australian Capital Cities: Historical Essays. Sydney University Press, Sydney.

Michalopoulos, S. and Papaioannou, E., 2013. Pre-colonial Ethnic Institutions and Contemporary African Development. Econometrica, 81, 113-152.

North, D. C., 1994. Economic Performance Through Time. The American Economic Review, 84, 359-368.

O'Dea, K., 1991. Traditional Diet and Food Preferences of Australian Aboriginal Hunter-Gatherers. Philosophical Transactions: Biological Sciences, 334, 233-241.

Oster, E., Forthcoming. Unobservable Selection and Coefficient Stability: Theory and Evidence. Journal of Business and Economic Statistics.

Oto-Peralías, D. and Romero-Ávila, D., 2016. The economic consequences of the Spanish Reconquest: the long-term effects of medieval conquest and colonization. Journal of Economic Growth, 21, 561-628.

Papaioannou, E. and Siourounis, G., 2008. Democratisation and Growth. The Economic Journal, 118, 1520–1551.

Putterman, L. and Weil, D. N., 2010. Post-1500 Population Flows and the Long-Run Determinants of Economic Growth and Inequality. Quarterly Journal of Economics, 125, 1627-1682.

Rosenthal, S. S. and Strange, W. C., 2001. The Determinants of Agglomeration. Journal of Urban Economics, 50, 191-229.

Spolaore, E. and Wacziarg, R., 2013. How Deep are the Roots of Economic Development?. Journal of Economic Literature, 51, 325-369.

Stephen L, P., 1994. Technology Adoption, Learning-by-Doing, and Economic Growth. Journal of Economic Theory, 63, 346-369.

Stokey, N. L., 1988. Learning by Doing and the Introduction of New Goods. Journal of Political Economy, 96, 701-717.

Tonkinson, R. and Berndt, R. M., 2017. Encyclopædia Britannica. [Online] ,Available at: https://www.britannica.com/topic/Australian-Aboriginal [last accessed 25 June 2018]

Weaver, J. C., 1996. Beyond the Fatal Shore: Pastoral Squatting and the Occupation of Australia, 1826 to 1852. The American Historical Review, 101, 981-100.

Table 1

Descriptive Statistics

Variable	Obs.	Mean	Std.Dev.	Min	Max
Time	219	143.3425	31.35688	20	212
Log Median Income 2013	219	10.6522	0.190697	9.666308	11.45001
Postschool qualifications 2011	219	50.68356	7.176958	31	75.3
Postgraduate degree 2011	219	1.521005	1.660694	0	10.6
Latitude	219	-30.65488	6.886132	-43.1892	-12.39851
Longitude	219	140.5759	11.58533	114.167	153.4862
Distance to the State Capital	219	3.698335	3.816698	0	19.28992
Distance to the Country Capital	219	9.887064	7.302966	0	27.61139
Distance to Railway Station	219	0.4203491	0.743418	0.0014568	4.726361
Distance to the Mine	219	0.7019051	0.6379759	0.0209522	3.75078
Distance to the Port	219	135.1238	142.2811	0.7199746	836.8619
Distance to the Sea	219	147.985	182.0681	0.2618518	898.0354
Area	219	1.333957	3.483852	0.0005497	36.00006
Temperature	219	17.75239	4.40604	9.679308	27.36778
Precipitation	219	76.80108	42.92622	18.73002	260.4245
Elevation	219	0.2464551	0.1927969	0.0074444	1.013671
Ruggedness	219	0.1067073	0.0825988	0.002118	0.398755
Land Water % (Rivers and Lakes)	219	1.037214	1.958564	0	13.53136
Cyclones Intensity	219	2.060566	2.438191	0	12.38461
Agriculture Suitability	218	0.4637826	0.1984775	1.40E-07	1.720912
St. Dev. Precipitation	219	91.68013	90.73142	4.060763	679.2093
St. Dev. Temperature	219	6.570418	4.745877	0.3856946	22.14425
LGA Population 2016	219	44986.82	102189.7	267	1131155
Proportion of Aboriginals	214	8.234579	12.84513	0.3	84.5
Distance to the Closest Mammal	219	264.5984	220.2006	0.2942827	873.8462
Cost Path	219	5.15E+07	5.18E+07	0	1.74E+08
GLP per Capita 2016	216	0.1301367	0.2551922	0.0031797	2.035559
Temperature for Wheat	219	3.022962	1.113052	1	5
Malaria Likelihood	219	0.2043745	0.1639477	0	0.7367766

Notes: Variables descriptions are provided in the online Appendix Table B1. Source: Author’s calculations.

Table 2
Time Since First Economic Activity and Economic Development

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 online Appendix Table 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
Time Since First Economic Activity and Economic Development

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**
		(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 online Appendix Table 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 4
Time Since First Economic Activity and Economic Development

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 online Appendix Table 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 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 online Appendix Table 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 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 1-3. 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 online Appendix Table B1. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively. Source: Author’s calculations.

Table 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 online Appendix Table 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 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 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 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 online Appendix Table 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 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 online Appendix Table 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 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 online Appendix Table 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 11

Time Since First Economic Activity and Economic Development: Malaria

	Dependent Variable		
	Log Median Income 2013	Post-school qualifications 2011	Post-graduate degree 2011
	(1)	(2)	(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 online Appendix Table 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 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: Distance to the Closest Mammal as Dependent Variable								
Time	-0.3203	0.5564	-0.1320	0.2771	-0.1828	0.0982	-0.1933	0.2252
	(0.6738)	(0.7491)	(0.5305)	(0.5583)	(0.5426)	(0.5376)	(0.5149)	(0.5090)
R-squared	0.367	-0.005	0.334	-0.006	0.292	-0.007	0.303	-0.004
Observations	94	94	126	126	146	146	183	183
Panel C: 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 D: 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 E: 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 F: 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 G: 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 online Appendix Table 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 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 online Appendix Table 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.

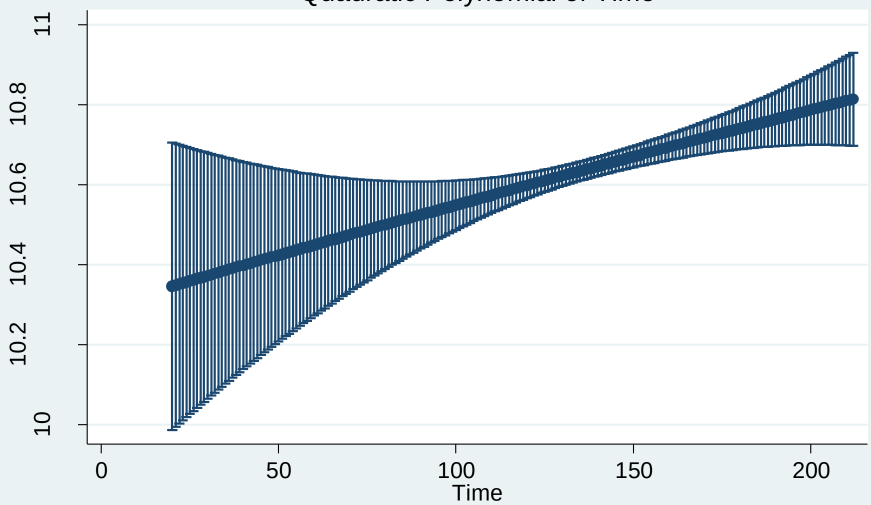
Table 13

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

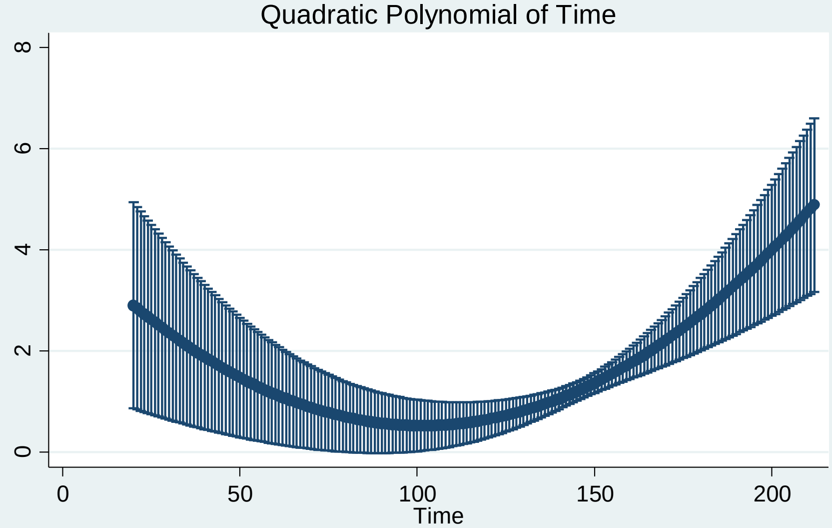
Notes: Variables descriptions are provided in the online Appendix Table B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively.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

Figure1-Predictive Margins with 95% CIs
Quadratic Polynomial of Time



Source: Author's calculations

Figure 3-Predictive Margins with 95% CIs
Quadratic Polynomial of Time



Source: Author's calculations

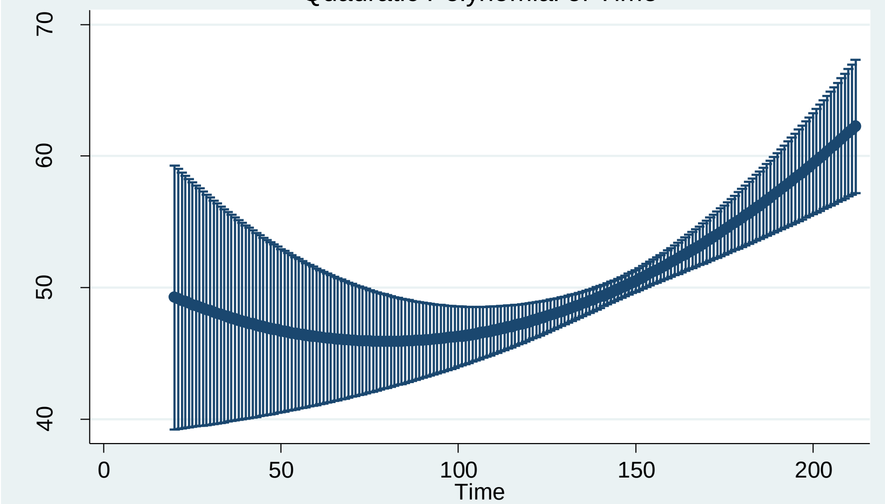


Figure 2-Predictive Margins with 95% CIs
Quadratic Polynomial of Time

Source: Author's calculations

Online Appendix

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

By Sotiris Kampanelis

Table 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 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 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 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 online Appendix Table 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 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 online Appendix Table 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 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 online Appendix Table 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.

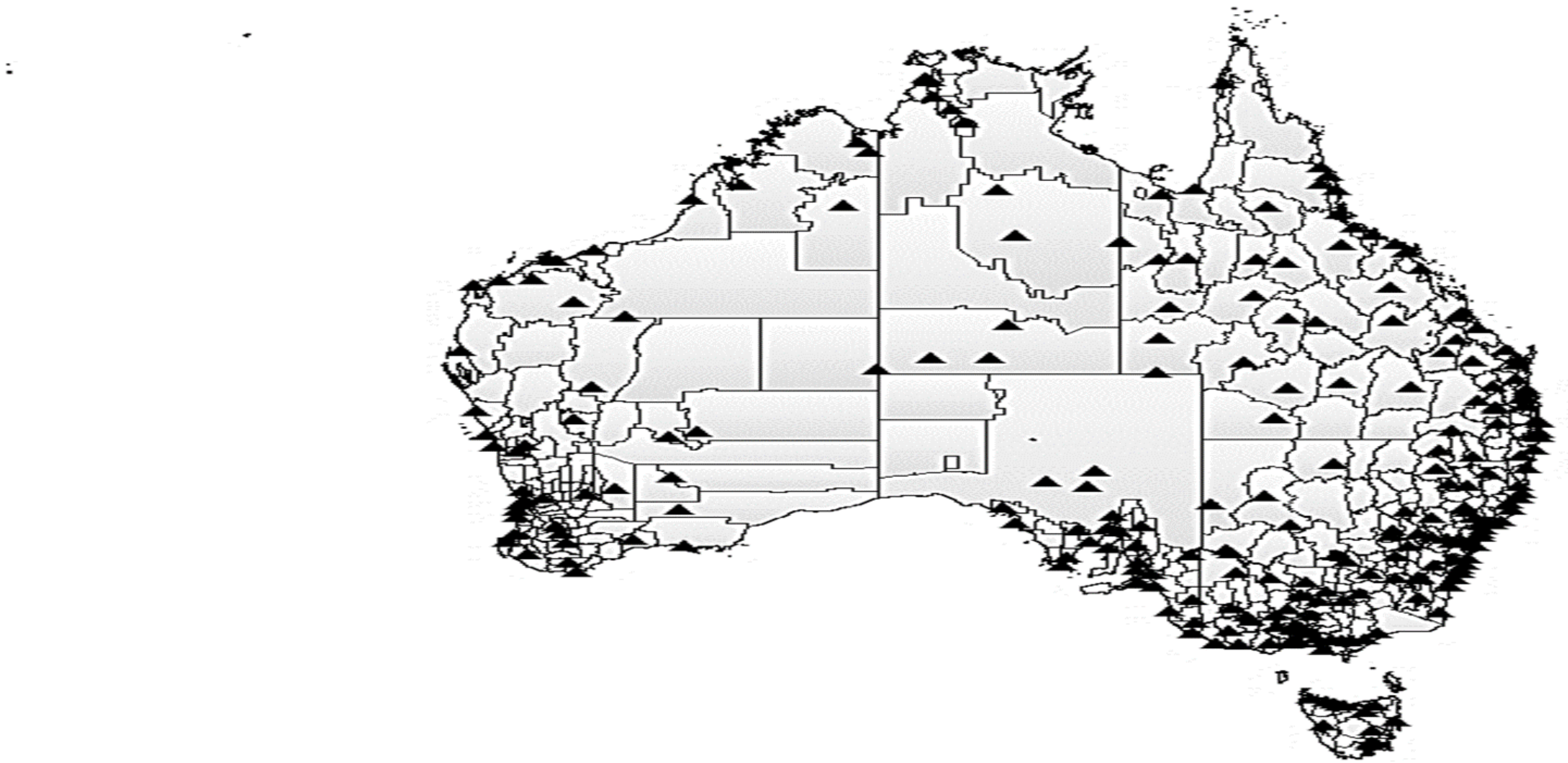
Table B5

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

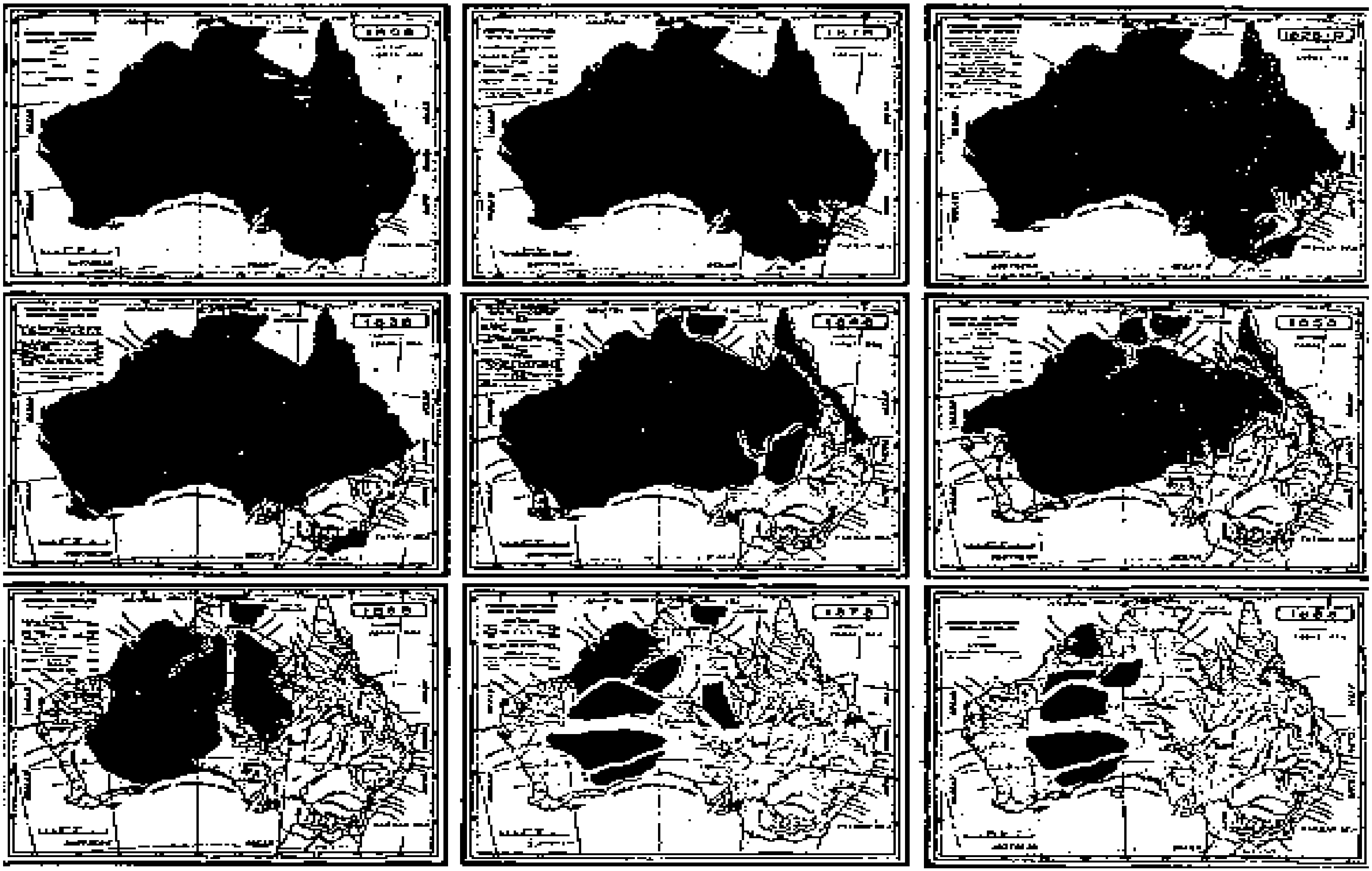
Notes: Variables descriptions are provided in the online Appendix Table B1. The estimations include a constant term, which is omitted for space considerations. Robust standard errors are in parentheses. *, ** and *** mean that the coefficient is statistically significant at 10%, 5% and 1% respectively.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

Fig. A1. *Significant Cities and Towns*



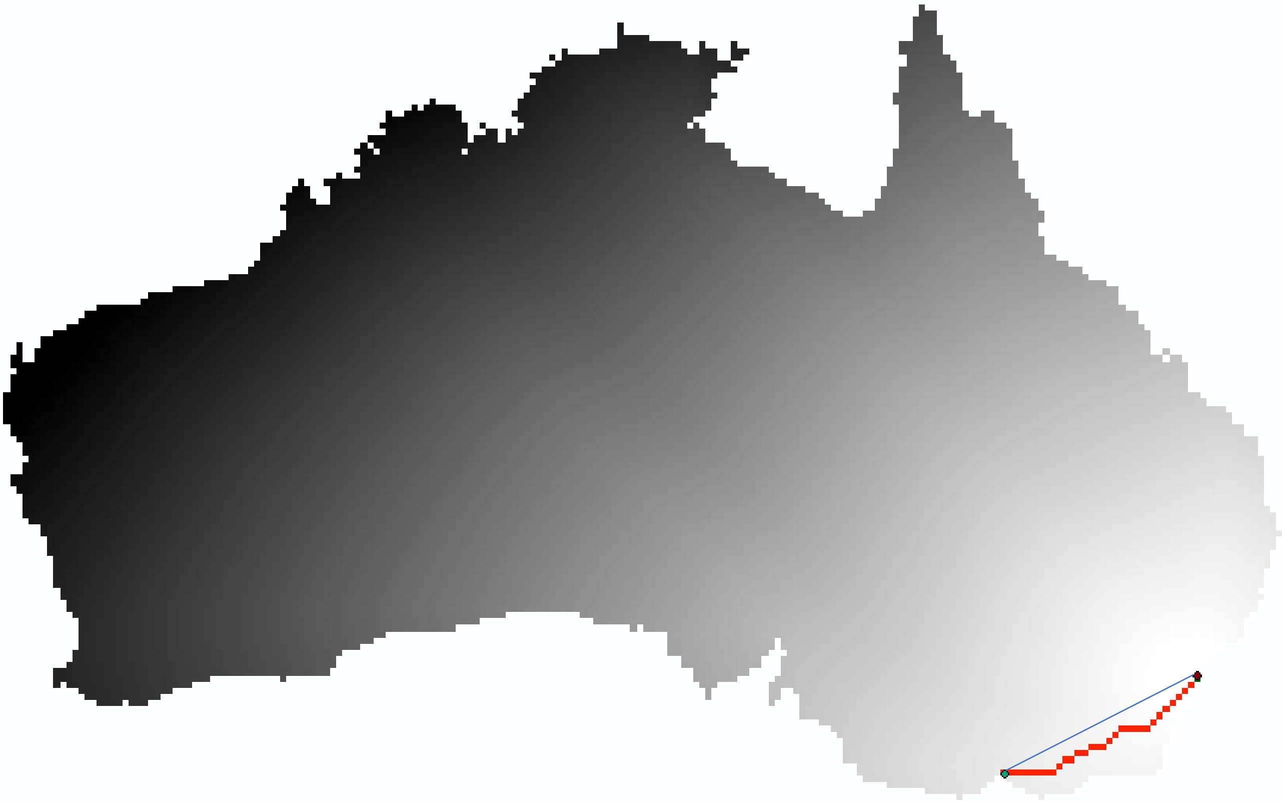
Notes: Black triangles illustrate the set of significant Australian cities and towns (249) I use to identify the sample of Local Government Areas. Source: Author's elaboration.

Fig.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.

Fig.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 colonizer 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.

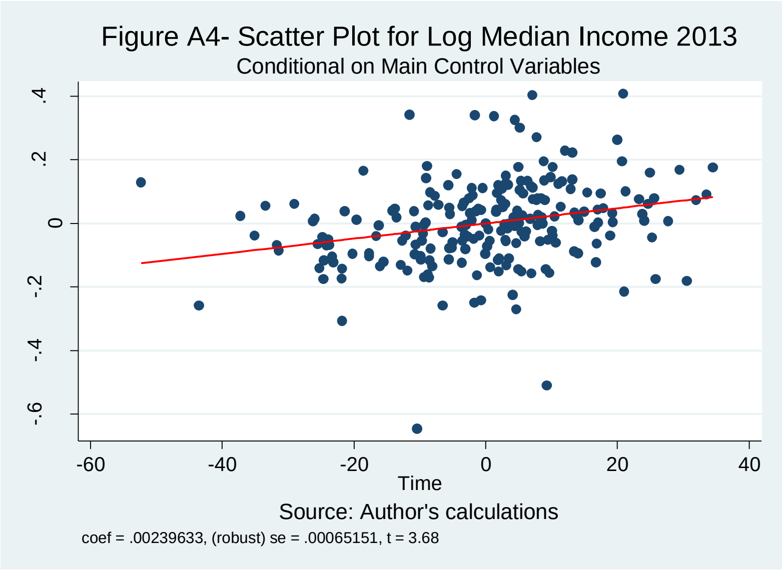


Figure A4- Scatter Plot for Log Median Income 2013
Conditional on Main Control Variables
-.6
-.4
-.2
0
.2
.4
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .00239633, (robust) se = .00065151, t = 3.68

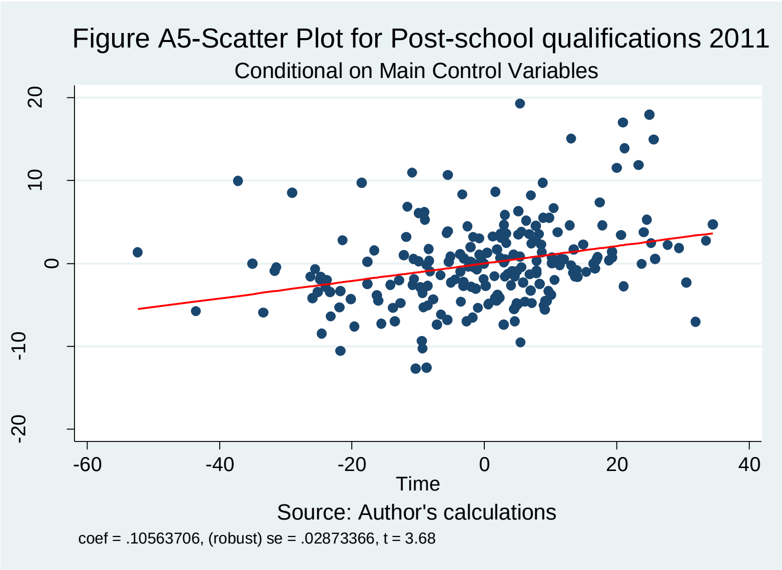


Figure A5-Scatter Plot for Post-school qualifications 2011
Conditional on Main Control Variables
-20
-10
0
10
20
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .10563706, (robust) se = .02873366, t = 3.68

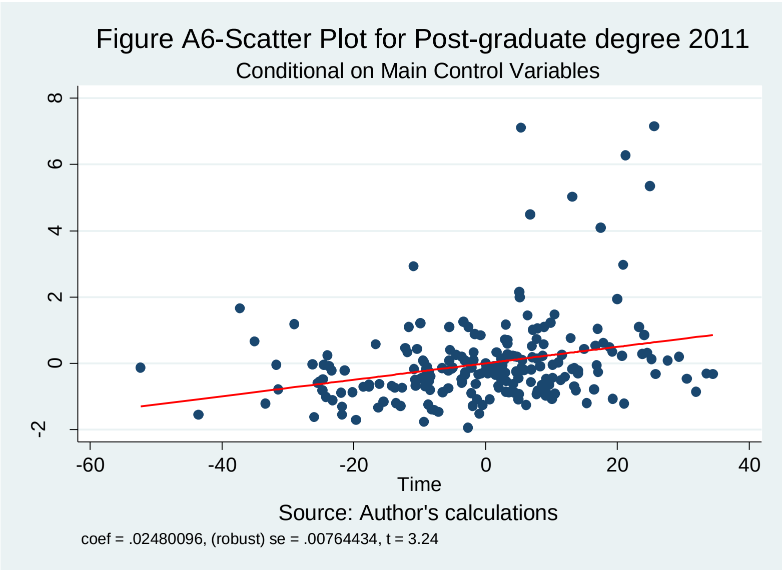


Figure A6-Scatter Plot for Post-graduate degree 2011
Conditional on Main Control Variables
-2
0
2
4
6
8
-60
-40
-20
0
20
40
Time
Source: Author's calculations
coef = .02480096, (robust) se = .00764434, t = 3.24

Table B6 (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.