

Cultural transmission, ancient trade routes, and contemporary economic activity: Evidence from Australia

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- Could current economic outcomes be determined by the transmission of ancient cultural norms and practices?

According to Oded Galor (The Journey of Humanity, 2022)

- Deep rooted factors largely account for cross-country variation in income per capita - 87%
- The dispersal of humans out of Africa -17%
- Time since human settlement & the Neolithic Revolution -3%
- Geo-climatic factors -27%
- Disease ecology -16%
- Political Institutional -3%
- *Cultural factors -21%*

- *Accumulation of knowledge* in the form of practices, techniques and tools that individuals acquire *intergenerationally*, allow societies to *survive and evolve* over millennia in different environments (Henrich, 2015).

- We shed light on this issue in the context of Australia, where the *Aboriginal knowledge* of the landscape was used by *Europeans to explore*, map and settle in their quest of colonisation (Kerwin, 2010; Norris and Harney, 2014).
- Aborigines created an extensive network of *trading routes* based on *orally transmitted maps* that were *passed through generations by word of mouth* (Flood, 1983; Veth and O'Connor, 2013; Kerwin, 2010; McBryde, 2000).

- Since Aborigines did not develop a written language, the Aboriginal know-how of the landscape *was transmitted intergenerationally by word of mouth*.
- *'Songlines' or Dreaming Tracks'* are a clear example of Aboriginal oral traditions, which were used to connect long distance trading routes.

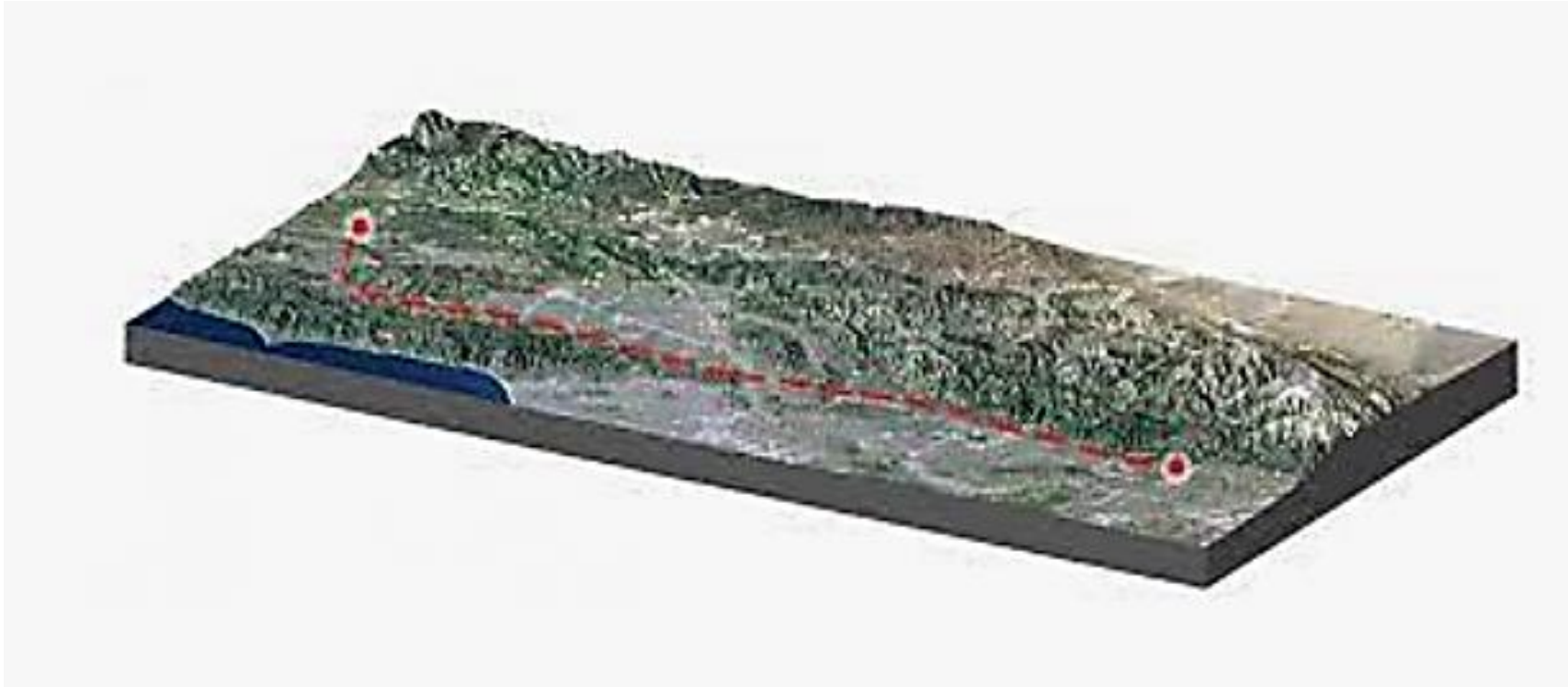
- Aborigines developed advanced ancient *traits* such as long-distance trading routes.
- Given the poor quality of the Australian soils, *trade routes were essential for the existence* of Aborigines.
- Aborigines needed to travel long distances constantly in the *search of food*. Such *nomadic* lifestyle led Aborigines to develop *exchanges of goods, services, cultural activities* with *neighbouring groups* as well as to accumulate essential know-how on the landscape.

- A question is whether the transmission of Aboriginal *knowledge* of the landscape *towards Europeans* played a crucial role in laying the foundations of modern development in Australia.
- Our main hypothesis is that Australian *regions that were more exposed to Aboriginal trade routes show higher economic activity today*.
- We posit that the persistence of Aboriginal trade routes can be explained by the *early transport infrastructure* that was put in place by Europeans as they settled in Australia.

- A **trilogy** of research articles on Aboriginal trade routes that was published by the anthropologist and archaeologist Frederick David McCarthy (1939).
- We construct a catalogue of *1,642 origin and destination points* that cover all Australian States (apart from Tasmania). Therefore, the main variable of interest consists of *821 Aboriginal trade routes*.

- In order to construct the Aboriginals' trade routes, we employ the *Human Mobility Index (HMI)* constructed by Özak (2018).
- This index provides the travel time on each square kilometer on land during the pre-industrial era considering *the temperature, relative humidity, cloud cover, slope, type of terrain (such as natural paths or loose sand), and heat-exhaustion risk.*
- Using this limitation as a parameter, we estimate the *least cost path* between all origin and destination points.

- What is the least cost path?



Aboriginal trade routes map



FIGURE I: Aboriginal trade routes in Australia

Notes: This map shows the Aboriginal trade routes in Australia based on McCarthy (1939)'s work. Whites lines denote trade routes. Trade routes were created using a least cost path algorithm. Authors' own elaboration using McCarthy (1939) and Özak (2018).

- To investigate the effects of ancient Aboriginal trade routes on current economic activity, we estimate the following probit regression, with standard errors clustered at the local government area level:

$$\text{Night light}_i = \alpha \text{Trade Routes}_i + \gamma X_i + \eta_i + \varepsilon_i$$

where i shows grid cells of **50km X 50km** for Australia. Our dependent variable *Night light* is a dummy, which takes the value 1 if the cell i has night light (and therefore economic activity), and 0 otherwise. *Trade Routes_i* is our main variable of interest, which takes the value 1 if the grid cell hosts at least one ancient Aboriginal trade route. X_i is a vector of **climatic, topographic, and geographic** variables. Moreover, our model includes local government areas fixed effects, η_i , to capture for all unobserved local characteristics such as market institutions. The coefficient of interest, α , reflects the effect of ancient Aboriginals' trade routes on current economic activity.

Which Nightlights?

- For each cell, we construct an indicator on economic activity by using night light emission data following Elvidge et al. (2017). They extract their measure from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor that detects detailed light images from human-made establishments for 2015.
- The main difference between **VIIRS** data and similar widely-used satellite night light data, such as the DMSP (Defense Meteorological Satellite Program), is that the former **provides 45 times smaller pixel footprints**.
- Indeed, Gibson et al. (2021) compare **VIIRS** lights with DMSP and conclude that the former source provides **100% less noisy relationship between city lights and GDP**. Moreover, they find that DMSP data are a poor proxy for GDP outside of cities as well as for spatial inequality.

Why Nightlights?

- Henderson et al. (2012) and Pinkovskiy and Sala-i-Martin (2016) use *nighttime light* to improve the data on *national accounts GDP*.
- Michalopoulos and Papaioannou (2013, 2014), and Alesina et al. (2016) use *nighttime light* as a measure of *living standards* across African ethnic groups.
- Hodler and Raschky (2014) exploit the annual panel nature of the data to find that the birthplace of a new national leader becomes *brighter* after he assumes power.
- Baskaran et al. (2015) relate *nighttime* light to *electoral cycles* in India.
- Storeygard (2016) uses *light* as a measure of *city-level income* across cities in Africa.
- Bleahey and Lin (2012) use *nighttime light* as a measure of *spatial distribution of contemporary economic activity*, to see whether portage sites still predict where economic activities are concentrated today, long after their original advantage became obsolete.

Covariates

- For each cell, we construct the coordinates, agriculture suitability, elevation, ruggedness (standard deviation of elevation), precipitation and standard deviation of precipitation, temperature and standard deviation of temperature, distance to the sea, and a binary that shows whether the cell is aligned to a shore.
- Moreover, we expand our bundle of potential confounding factors by calculating the distance from Sydney and State capitals, the distance from the closest historical mine, and the percentage of water (expressed by rivers and lakes) that exist in each cell.
- We investigate any relationship between our main variable of interest, the Aboriginal trade routes, and our environmental and topological variables.

Balancedness table: The effects of Environment on Trade routes selection

	Dependent Variable: Binary dummy for trade routes								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agriculture Suitability	0.0399 (0.0280)								
Elevation		-0.0002 (0.0002)							
Ruggedness			0.0015*** (0.0006)						
Precipitation				-0.0001 (0.0002)					
Temperature					0.0006 (0.0030)				
Distance to the Sea						0.0011 (0.0024)			
Coastal Dummy							-0.1515** (0.0733)		
Water Percentage								0.0020 (0.0018)	
Distance to Historical Mine									-0.0011 (0.0022)
Local Governement F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.392	0.393	0.396	0.392	0.392	0.392	0.396	0.392	0.392
Observations	3519	3519	3519	3519	3519	3519	3519	3519	3519

Notes: 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.

Aboriginal trade routes and Long-term Economic Activity

	Dependent Variable: Binary dummy for night light			
	(1)	(2)	(3)	(4)
Trade routes	0.0710*** (0.0245)	0.0766*** (0.0227)	0.0681*** (0.0232)	0.0589** (0.0245)
Latitude		-0.0210*** (0.0078)	-0.0156 (0.0155)	-0.0351 (0.0338)
Longitude		-0.0160 (0.0162)	-0.0150 (0.0167)	0.0531 (0.0423)
Agriculture Suitability			-0.0083 (0.0297)	-0.0521 (0.0423)
Elevation			-0.0000 (0.0002)	-0.0002 (0.0002)
Ruggedness			0.0002 (0.0012)	-0.0006 (0.0012)
Precipitation			0.0000 (0.0002)	-0.0002 (0.0002)
StDev Precipitation			0.0011* (0.0006)	0.0014** (0.0006)
Temperature			-0.0014 (0.0024)	-0.0045*** (0.0017)
StDev Temperature			0.0125 (0.0203)	0.0181 (0.0204)
Distance to the Sea				-0.0002 (0.0010)
Coastal Dummy				0.0736 (0.0470)
Distance to Sydney				0.0054 (0.0051)
Distance to State Capital				0.0013 (0.0008)
Distance to Historical Mine				-0.0122*** (0.0014)
Water Percentage				0.0028 (0.0036)
Local Government F.E.	Yes	Yes	Yes	Yes
R-squared	0.374	0.378	0.382	0.415
Observations	3519	3519	3519	3519

Notes: 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.

Robustness check-Homogenous sample

Aboriginal trade routes and contemporary economic activity: Homogenous sample

	Dependent Variable: Binary dummy for night light				
	> 25% Precipitation	< 25% Temperature	Distance To Paths=200km	Distance To Paths=100km	Distance To Paths=50km
	(1)	(2)	(3)	(4)	(5)
Trade routes	0.0670** (0.0305)	0.0617** (0.0304)	0.0592** (0.0244)	0.0607** (0.0249)	0.0750*** (0.0252)
Local Government FE	✓	✓	✓	✓	✓
Geographical & Historical Controls	✓	✓	✓	✓	✓
<i>N</i>	2,645	2,637	3,451	3,216	2,726
R2	0.425	0.476	0.420	0.424	0.419

Notes: 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.

Robustness check-Reducing cell size

Aboriginal trade routes and contemporary economic activity: 10 X 10 km analysis

Dependent Variable:	Binary dummy for night light			Population density	
	(1)	(2)	(3)	(4)	(5)
Trade routes	0.0564*** (0.0120)	0.0616*** (0.0134)	0.0577*** (0.0086)	0.0479*** (0.0079)	0.5940*** (0.1071)
Local Government FE	✓	✓	✓	✓	✓
Geographical & Historical Controls		✓	✓	✓	✓
<i>N</i>	81,312	81,312	81,309	81,309	81,309
R2	0.063	0.078	0.146	0.162	0.443

Notes: 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.

Along the routes and Contiguous analysis

- One could still argue that our cells that include an ancient trade route have also *unobservable* favourable characteristics (comparing them with their neighbour cells), which may attract more population and economic activity in the long-run.
- We develop a model that includes all 10km X 10km cells that host an ancient trade route and their neighbour cells that do not.

$$\text{Night light}_{i(j)} = a \text{Trade Routes}_{i(j)} + \gamma X_{i(j)} + \eta_{i(j)} + \varepsilon_{i(j)}$$

Robustness check-Neighbourhood analysis

Aboriginal trade routes and contemporary economic activity: Neighbourhood analysis

	Dependent Variable: Binary dummy for night light				
	Cell with Paths and Neighbours			Contiguous analysis	
	(1)	(2)	(3)	(4)	(5)
Trade routes	0.0345** (0.0087)	0.0372*** (0.0091)	0.0320*** (0.0038)	0.0223*** (0.0036)	0.0142*** (0.0018)
Local Government FE	✓	✓	✓	✓	✓
Geographical & Historical Controls		✓	✓	✓	
<i>N</i>	19,490	19,490	19,490	19,490	124,186
R2	0.079	0.120	0.252	0.274	0.759

Notes: 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.

Mechanisms

- As early settlements were discovered, essentially transport infrastructure was built to connect them with major colonies. This would suggest that such infrastructure would have been developed *along the lines of trade routes*, a conjecture that is well supported by recent anthropological evidence (Kerwin, 2010).
- Similar evidence explores the effects of ancient trade routes on historical and contemporary outcomes (Dalgaard et al., 2018; Flückiger et al., 2021; Ahmad and Chicoine, 2021).

Mechanisms

- In order to explore our main argument, we georeference two maps on early transport infrastructure in Australia. The first map shows all *early railways* that were built from 1880 until 1920, which we construct using a set of historical maps.
- The second map illustrates all *early highways* that Europeans constructed by the early 1950s.
- In addition, we digitise a map published by Robinson (1927) showing all *early European inland explorations* from 1813 until 1901.

Channels of persistence

Aboriginal trade routes and channels of persistence

	Early Railways	Early Highways	Early Explorations
	(1)	(2)	(3)
Trade routes	0.0400** (0.0189)	0.0816*** (0.0275)	0.1219*** (0.0328)
Local Government FE	✓	✓	✓
Geographical & Historical Controls	✓	✓	✓
<i>N</i>	3,519	3,519	3,519
R2	0.552	0.456	0.303

Notes: 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.

Was environment the primary criterion under which Europeans explored Australia?

	Dependent Variable: Binary dummy for early explorations								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Agriculture Suitability	0.0005 (0.0258)								
Elevation		0.0000 (0.0002)							
Ruggedness			0.0005 (0.0006)						
Precipitation				-0.0001 (0.0002)					
Temperature					-0.0001 (0.0024)				
Distance to the Sea						0.0006 (0.0023)			
Coastal Dummy							-0.0526 (0.0660)		
Water Percentage								-0.0010 (0.0018)	
Distance to Historical Mine									-0.0029 (0.0028)
Local Government F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.290	0.290	0.290	0.290	0.290	0.290	0.290	0.290	0.292
Observations	3519	3519	3519	3519	3519	3519	3519	3519	3519

Notes: 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.

Conclusion

- In this paper, we **document how the transmission of ancient cultural norms and practices affects present-day economic outcomes**. We focus on the case of Australian colonisation where Europeans relied on the Aboriginal knowledge and practices of the landscape to explore and settle.
- We show that regions with an **Aboriginal trade route have a higher probability of observing more economic activity today** in Australia.
- We provide evidence that the **transport infrastructure** that Europeans built to connect early settlements can explain the persistence of Aboriginal trade routes.
- We view our results as an important contribution to enhance our understanding of the role of culture in shaping macroeconomic societal outcomes over the long-run.

Contribution

- Our first contribution is the extraction of systematic information on the different locations through which Aborigines travelled across Australia.
- Our second contribution is the construction of a georeferenced map of Aboriginal trade routes in Australia.
- Our third contribution is the documentation of the long-run effects of Aboriginal trade routes on contemporary economic activity in Australia.
- Our final contribution is the exploration of potential mechanisms linking the persistence of Aboriginal trade routes.

Contribution in the literature

- Our findings complement the growing literature that explores *the role of culture in shaping societal outcomes* (Fernández and Fogli, 2005; Giuliano, 2007; Fernandez, 2007; Algan and Cahuc, 2010; 3 Voigtländer and Voth, 2012; Giuliano and Nunn, 2021).
- The main findings of the present paper also contribute to the literature on *cultural evolution* (Bisin and Verdier, 2000; McElreath et al., 2005; Toelch et al., 2009; Henrich, 2015; Doepke and Zilibotti, 2017).
- Our work also adds to the recent literature analysing *the long-term effects of ancient trade routes* (Wahl, 2017; Dalgaard et al., 2018; Barjamovic et al., 2019; De Benedictis et al., 2018; Michalopoulos et al., 2018; Garcia-López et al., 2015; De Benedictis et al., 2018; Flückiger et al., 2021; Baniya et al., 2020; Ahmad and Chicoine, 2021).

Contribution in the literature

- Our work also contributes to enhance our understanding of the well-established literature on *colonialism and contemporary development* (Sokoloff and Engerman, 2000; Acemoglu et al., 2001; Acemoglu et al., 2002; Glaeser et al., 2004; Glaeser et al., 2004; Acemoglu and Johnson, 2005; Dell, 2010; Bruhn and Gallego, 2012; Kampanelis, 2019).
- Finally, our results also contribute to the recent studies that have documented the role of *pre-colonial factors in shaping contemporary outcomes* (Gennaioli and Rainer (2007); Michalopoulos and Papaioannou (2013); Arias and Girod (2011); Angeles and Elizalde (2017); and Elizalde (2020))

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Thank you!