State Antiquity and Early Agricultural Transition as Deep Roots of Economic Development in Africa

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The study seeks to provide insights into the deeper causes of differences in income levels amongst African countries by examining whether state history and agricultural transition, as proposed deep roots of economic development, can explain modern income levels in Africa. We estimated cross-sectional growth regressions between modern per capita GDP levels, deep root factors and other controls for a sample of 49 countries. We further estimate two-staged least squares (2SLS) regressions to examine whether early technology serves as a possible transmission channel from early states and agricultural history to modern growth. Our results show a U-shaped relationship between agriculture history and income levels in which countries that transitioned more than 4,000 years ago were able to take advantage of early technology to gain a development head start. Countries which transitioned at later dates could not take advantage of early technology and experienced a 'reversal-of-fortunes' effect.

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Introduction

The origins of current failures and successes of economies can be traced far back in their histories. Economic historians are principally interested in understanding the deep roots of economic growth and the evolution and impact of institutions, as well as the historical origins of current economic problems (Hibbs and Olsson 2004). Some academics have noted that certain historical events such as the Neolithic transition, which gave birth to agriculture and the states of antiquity, can better explain the varying levels of modern development worldwide. For instance, Diamond (1997) conceptually argues that historical factors such as state antiquity and early agricultural transition, account more for present-day development patterns compared to growth factors prescribed by neoclassical and endogenous growth theories. Olsson and Hibbs (2005) present a formal theoretical description of how patterns in population growth, technology and income progressively evolve from the pre-historic era of hunting and gathering to the recent industrial era. However, the empirical support for these propositions is scanty, with some studies finding that historical variables can only predict growth before 1500AD but not in more recent periods (Chanda and Putterman 2007; Putterman 2008; Putterman and Weil 2010). Moreover, the geographical dummies used in some of these studies to distinguish regional effects tend to produce insignificant estimates on the 'African dummy' (Bockstette, Chanda, and Putterman 2002), hence warranting further investigation exclusively for African countries.

The purpose of this study is to examine whether state antiquity and agriculture history are significant predictors of modern-day growth patterns for a sample of 49 African countries. On the one hand, we measure state history using the State Antiquity Index of Bockstette, Chanda, and Putterman (2002) and Putterman and Weil (2010). The index is constructed by dividing the period 1 – 1950AD into 39-half centuries, and for each half century, attaining information from the Encyclopaedia Britannica for three questions relating to i) the type of supra-tribal government a country historically had, ii) whether the geographical scope of government was foreign or locally based, and iii) how much of the territory of the modern country was ruled by this government. The scores on the three questions were standardized over 50-year periods, such that a country today has a score of 50 if it was an independent republic, 0 if it had no government above the tribal stage, 25 if the entire territory was ruled by another country, and so forth (Bockstette, Chanda, and Putterman 2002). On the other hand, we capture early agriculture using the Agriculture Transition Index coded by Putterman (2008), which measures the number of years elapsed since an economy transitioned from reliance on hunting and gathering to reliance on agricultural farming.

To motivate our study, we plot two figures using coded data from Bockstette, Chanda, and Putterman (2002) and Putterman (2008), with Figure 1 (Figure 2) showing the relationship between state history (agricultural

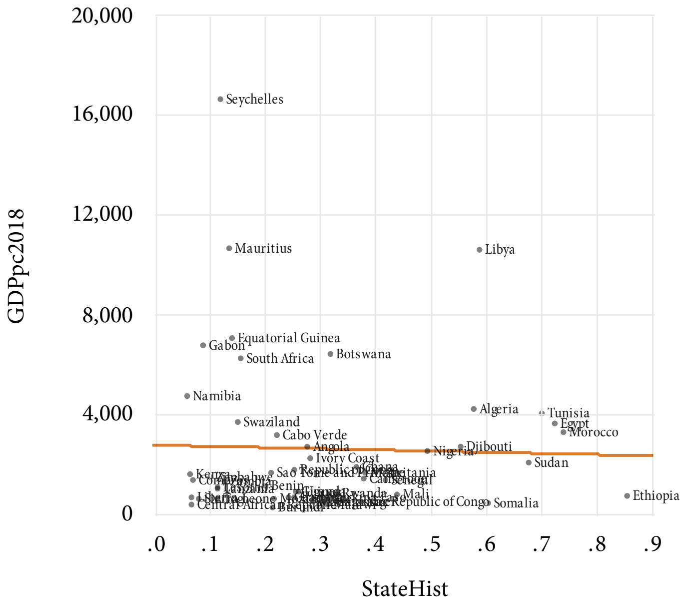

FIGURE 1 State Antiquity and 2018 Per Capita GDP in African Countries

NOTE *GDPpc* is GDP per capita in constant 2015US$. The StateHist variable is the index measure of the strength of early states ranging from 0 (no government structure above tribal level) to 1 (independent government structure).

transition) and 2018 per capita GDP (constant 2015 US$) in 54 African countries. Figures 1 and 2 show that Ethiopia and Sudan (Mauritius and Botswana) have Africa's strongest (weakest) early states, longer (shorter) historical transitions to agriculture and yet have the lowest (highest) per capita GDPs in the continent. Other anomalies include countries such as Libya (South Africa, Namibia and Eswatini) with higher (lower) state history and agricultural transitions, yet which mutually boast relatively high per capita GDPs. For a bulk majority of the remaining countries the relationship between state history and growth is not clear as countries with either lower or higher state history and agricultural transitions are mutually plagued by low per capita GDP levels. Moreover, the ordinary least squares (OLS) line fitted on the data reveals a positive but very weak correlation for state history–growth (Figure 1) whilst a negative relationship is observed for agriculture history (Figure 2). Overall, it is difficult to tell whether state history and agriculture transition are significant predicators of present-day growth patterns for African countries, an observation which warrants formal empirical investigating into the subject matter.

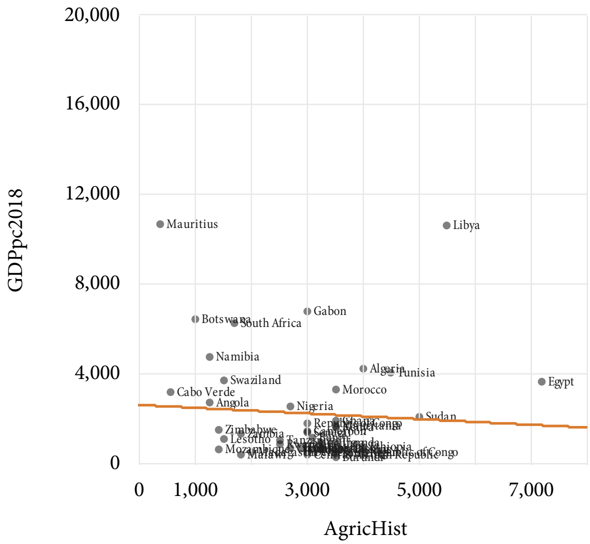

FIGURE 2 Agriculture Transition and 2018 Per Capita GDP in African Countries
NOTE *GDPpc* is GDP per capita in constant 2015US. The AgricHist variable is the number of years elapsed since a country transitioned from hunting and gathering to agricultural farming.

We contribute to the literature by investigating the influence of state history and agricultural transition on economic growth in Africa. The closest study to ours is presented by Cinyabuguma and Putterman (2011), who find that state history significantly explains SSA economic growth between 1960 and 1995. Our study refines their work in three ways. Firstly, we include agricultural transition as a proxy of the Neolithic revolution, which is considered an important turning point in human civilization that enabled technological change and income to grow independent of initial biogeographical conditions (Olsson and Hibbs 2005). According to conventional literature, state history and agriculture transition should be able to predict patterns in modern growth. Secondly, we examine the impact of state history and agricultural transition on more recent economic growth. This is important since Africa has experienced much development since the 2000s, which some authors refer to as the 'African miracle' (Young 2012; McMillan and Harttgen 2014; Rodrick 2018) and it would be interesting to know if Africa's deep historical structure is relevant for more recent growth patterns. Lastly, in line with Comin, Easterly, and Gong (2010), we explore the possibility of early technology as a transmission mechanism of early state development towards modern economic growth.

Our findings are at odds with those presented in the conventional literature in two ways. Firstly, whilst the previous studies either advocate for a positive or nonlinear relationship between state antiquity and economic growth before the 2000s (Cinyabuguma and Putterman 2011; Borcan, Olsson, and Putterman 2018), our study fails to find any significant linear or nonlinear relationship in the post-2000 period, implying that state antiquity matters less as the global economy transitions into the 4th industrial revolution. Secondly, whilst previous studies find a positive impact of agriculture transition on growth (Bockstette, Chanda, and Putterman 2002; Hibbs and Olsson 2004; Chanda and Putterman 2007; Putterman 2008; Bleaney and Dimico 2011; Borcan, Olsson, and Putterman 2018), our study reveals a U-shaped cross-sectional relationship between agriculture transition and economic growth, with countries which experienced the Neolithic transition before 1500AD tending to have higher modern economic growth rates. Our two-staged least squares analysis further identifies early adoption of technology as a possible transmission channel through which agricultural transition influences present-day economic growth.

Overall, our study shows that agricultural transition, as opposed to the formation of early states, is a significant predicator of modern economic growth in Africa through the transmission of early technology. African countries which lagged in adapting to the Neolithic revolution did not benefit from the use of earlier technology in terms of influencing modern growth. Therefore, African policymakers can learn from these findings the importance of early evolutionary adaption to technology as key to fostering development, not only for the 20-50 year long-run periods as commonly planned by global policymakers (i.e. 2050 United Nations Sustainable Development Goals), but for influencing growth in the coming centuries.

We structure the rest of the study as follows. The literature review is presented next. The third section outlines the data and methods. The fourth section presents the empirical findings of the study. The fifth section concludes.

Literature Review

In one of the most remarkable accounts of human history, Diamond (1997) provides a detailed historical account of human evolution since the Ice Age and covers over 13,000 years of development in different regions in the world. Diamond (1997) argues that the Neolithic revolution, describing the transition from hunter-gather to agricultural farming through domestication of wild plants and animals, led to the rise of human civilization and conferred a developmental head start on nations which experienced early transitions through written language, science, military technologies, and statehood. Thus, Diamond (1997) hypothesizes that differences in agricultural transition and early institutions explain the variation in present-day incomes, although he did not provide any measurable data or conduct formal analysis to confirm this hypothesis.

Bockstette, Chanda, and Putterman (2002) and Olsson and Hibbs (2005) were the first to devise formal measures of state history and agricultural transition, respectively, which were used to test Diamond's (1997) hypothesis on cross-sectional data. On the one hand, Bockstette, Chanda, and Putterman (2002) find that state history has a stronger impact on economic growth between 1960-1995 compared to other growth determinants like education, investment and population, although the regional dummies produce insignificant estimates for East Asia, Latin America and Africa. On the other hand, Olsson and Hibbs (2005) provide a formal theoretical model in which countries with favourable initial biogeographical conditions experienced early agricultural transition, giving them a 'head start' in transitioning into the industrial revolution through faster diffusion of endogenous knowledge. The authors then construct a dataset of 'years elapsed since agricultural transition' and 'biogeographical endowments' and use this data to prove that initial biogeographical conditions and Neolithic transition are significant predictors of modern income.

Following the contributions of Bockstette, Chanda, and Putterman (2002) and Hibbs and Olsson (2004), several studies have used their presented datasets to investigate the deeper roots of economic growth for different cross-sectional samples. For instance, Bleaney and Dimico (2011) use the Hibbs and Olsson (2004) dataset to investigate the relationship between biogeographical conditions (agricultural transition) and 2000 per capita income and find an insignificant (positive and significant) relationship between the variables. Further analysis reveals that the impact is weaker for ex-colonies, implying that colonialism deteriorated the economic advantages enjoyed by early colonies which had early agricultural transition and helped foster development in poorer colonies which had late agricultural transitions. Cinyabuguma and Putterman (2011) include the state history dataset of Bockstette, Chanda, and Putterman (2002) amongst a group of geographic, institutional and disease-related factors for 33 African countries and examine the effects of these variables on half-decade growth rates between 1960 and 2000. For all sub-periods, the authors find that state history and colonization explain modern growth more significantly than geographical and disease factors (i.e. malaria). Chanda and Putterman (2007) use both datasets of Bockstette, Chanda, and Putterman (2002) and Hibbs and Olsson (2004) to study the effects of state antiquity and Neolithic transition on economic growth between 1500 and 1998. Whilst the authors find a positive impact of agriculture history on growth in all years, a negative state history–growth relationship is found between 1500 and 1960, which turns negative or insignificant afterwards, i.e. 'reversal of fortunes' effect.

Some other literature also sought to refine the original datasets for empirical purposes. Putterman (2008) assembles a new dataset of agricultural transition for 117 countries which, unlike Hibbs and Olsson's (2004) data, assigns a unique date of transition for each of the observed countries. Nonetheless, Putterman (2008) finds little difference in the effect of both measures of agricultural transition on economic growth, which is significant in 1950 and insignificant for 1997 income levels. Putterman and Weil (2010) further construct a migration matrix in order to create an ancestry-adjusted dataset of state history and agricultural transition for 117 countries. The authors find that the predictability of agricultural transition improves substantially once adjusted for the location of current populations' ancestors in 1500 AD, suggesting that cross-border migration influenced early state development through the dissemination and exchange of knowledge. Murphy and Nowrasteh (2018) create the ancestry-adjusted indices of state history and agriculture history of Putterman and Weil (2010) for the case of 50 US states and find that both variables are related with modern growth. Further analysis reveals that these growth effects are transmitted through non-economic institutions such as social capital and government corruption. Borcan, Olsson, and Putterman (2018) employed Putterman and Weil's (2010) ancestry-adjusted dataset to analyse the impact of state history and agricultural history on growth. The authors find a linear and positive (humped-shaped) relationship between agricultural transitions (State history) and 2000 GDP growth.

As previously mentioned, our study extends this line of literature for African countries in three directions. Firstly, we examine the impact of state history and agricultural transition on economic growth in Africa for more recent periods of economic growth. Secondly, we follow Bockstette, Chanda, and Putterman (2002) and Borcan¸ Olsson, and Putterman (2018), and account for asymmetries in the empirical specifications to investigate the 'reversal of fortunes' hypothesis. Lastly, we build on previous studies and explore early technology as a possible transmission channel from of early historical antiques to modern growth.

Empirical Specifications and Data

We use three sets of regressions for our empirical analysis. Firstly, we use the baseline regression of Bockstette, Chanda, and Putterman (2002) to examine the impact of state history (*StateHist*) and agriculture history (*AgricHist*) on per capita GDP level in constant 2015 US$ (*GDPpc*), i.e.

$$GDPpc_i = \alpha + \beta\, StateHist_i + X\, Controls_i + error, \tag{1}$$

$$GDPpc_i = \alpha + \beta\, AgricHist_i + X\, Controls_i + error, \tag{2}$$

where we expect $\beta > 0$ as hypothesized by Diamond (1997).

Secondly, we follow Borcan, Olsson, and Putterman (2018) and incorporate squared terms on the state antiquity variables in the baseline regressions, i.e.

$$GDPpc_i = \alpha + \beta\, StateHist_i + \lambda\, StateHist_i^2 + X\, Controls_i + error, \tag{3}$$

$$GDPpc_i = \alpha + \beta\, AgricHist_i + \lambda\, AgricHist_i^2 + X\, Controls_i + error, \tag{4}$$

where a humped-shaped relationship exists if $\beta > 0$ and $\lambda < 0$, whereas a U-shaped relationship exists if $\beta > 0$ and $\lambda < 0$. In either case, the turning points are computed as $\partial GDPpc/\partial StateHist = 0$ and $\partial GDPpc/\partial AgricHist = 0$, respectively, which gives a solution of $-\beta/2\lambda$.

Lastly, we estimate two-stated least squares regression to test for early technology (Tech 1500) as a plausible transmission channel of the effects of state antiquity on modern growth. The first-stage regression, for state history, is given as:

$$Tech1500_i = \alpha + \beta\, StateHist_i + X\, Controls_i + error, \tag{5}$$

whereas that for agricultural transition is given as:

$$Tech1500_i = \alpha + \beta\, AgricHist_i + X\, Controls_i + error, \tag{6}$$

TABLE 1 Descriptive Statistics

	Mean	Standard deviation	Minimum	Maximum	Jarque-Bera	Probability
Outcome Variables						
GDPpc 2000	1956.65	2474.70	258.87	11178.15	124.12	0.00
GDPpc 2005	2260.67	2904.83	286.11	12674.01	79.78	0.00
GDPpc 2010	2483.89	3108.53	297.79	12925.67	72.04	0.00
GDPpc 2015	2563.40	3018.43	289.36	15157.53	95.57	0.00
GDPpc 2020	2414.56	2820.79	263.36	15551.56	194.91	0.00
Deep root Variables						
StateHist	0.33	0.23	0.03	0.96	5.76	0.06
AgricHist	2879.34	1277.61	362.00	7200.00	8.30	0.02
Tech1500	0.35	0.19	0.16	0.78	8.40	0.01
Covariates						
Landlocked	0.29	0.46	0	1	10.43	0.00
Climate	0.83	0.77	0	3	26.28	0.00
Dum_British	0.35	0.49	0	1	8.52	0.01
Dum_French	0.41	0.49	0	1	8.21	0.02
Dum_Portuguese	0.08	0.28	0	1	186.23	0.00

NOTE *Authors own computation results obtained from EViews.*

and the second-stage regressions for equations (5) and (6) are given by the nonlinear regression:

$$GDPpc_i = \alpha + \beta\, Tech1500_i + \lambda\, Tech1500_i^2 + X\, Controls_i + error. \quad (7)$$

In selecting appropriate control variables used in regressions (1)–(7), availability of data is a major concern for African countries. To this end, we follow Murphy and Nowrasteh (2018) and Putterman and Weil (2010) and use climate/precipitation, landlocked dummies, and colony dummies (i.e. British, French, and Portuguese) as control variables, which are notably available for all 49 African countries. We collect the empirical data from various sources. Firstly, the main outcome variable *GDPpc* is the GDP per capita at constant 2015 US$, which is sourced from the World Bank Development Indicators (WBDI), https://databank.worldbank.org/source/world-development-indicators. Secondly, the deep root variables state history, agricultural transition and early technology in 1500BCE are sourced from the papers of Borcan, Olsson, and Putterman (2018), Putterman (2008) and Comin, Easterly, and Gong (2010), respectively.

Thirdly, the precipitation average as a measure of climate is sourced from the CIA *World Factbook,* https://www.cia.gov/the-world-factbook/. Lastly, the landlocked and colony dummies are the authors' own creation.

The descriptive statistics of the variables used in our study are summarized in Table 1 and present some stylized facts for African countries.

Firstly, from Panel A we find that '*GDPpc*' has, on average, increased between 2000 and 2010, and yet decreased thereafter following the global recession period. It is also interesting to note that whilst the averages have changed over time, the rankings of the countries have not changed that much over the last two decades, with Burundi, CAR and DRC (Mauritius, South Africa and Botswana) consistently occupying the bottom (top) rankings of *GDPpc* amongst African countries.

Also, from Panel B, the 'StateHist' average of 0.33 implies that most African countries either had no government above the tribal stage or were ruled by other countries. It is only a few outliers like Ethiopia (0.96), Morocco (0.82), Egypt (0.79), and Tunisia (0.73) which developed more independent early states and, judging from their associated 'Tech1500' estimates, were also more technologically advanced centuries ago, i.e. Tunisia (0.78) and Egypt (0.76). Furthermore, the average agricultural transition for African countries occurred 2,880 years ago, with Egypt (7,200), Libya (5,500) and Sudan (5,000) having the earliest transitions, whilst islands such as Mauritius (362) and Cape Verde (538) have the most recent transitions.

From Panel C, the lower (higher) averages on landlocked and Portuguese colonial dummies (climate, French, and British colonial dummies) reflect the stylized fact that most African countries have humid temperatures, access to the sea and are former British or French colonies.

Empirical results

BASELINE RESULTS

We present our baseline estimates in Table 2, with panel A (panel B) showing our findings for the state history (agricultural transition) variable. Note that we estimate 5 versions of the baseline regression, each using different values of *GDPpc* in 5-year intervals between 2000 and 2020.

Whilst the landlocked and climate variables produce their expected negative and statistically significant estimates, the colonial dummies, state history and agricultural transition variables produce insignificant estimates. Generally, these findings contradict the positive state history–growth and agricultural history–growth relationships found in previous literature (Bockstette, Chanda, and Putterman 2002; Hibbs and Olsson 2004; Ols-

TABLE 2 Baseline Estimates

	2000 GDPpc	2005 GDPpc	2010 GDPpc	2015 GDPpc	2020 GDPpc
Panel A					
StateHist	−0.34	−0.18	−0.04	−0.06	0.09
	(0.65)	(0.81)	(0.97)	(0.94)	(0.90)
Landlocked	−1.07	1.05	−0.97	−0.91	−0.88
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Climate	−0.0002	−0.0002	−0.0002	−0.0002	−0.0003
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Dum_British	0.37	0.32	0.36	0.18	0.27
	(0.36)	(0.44)	(0.37)	(0.67)	(0.49)
Dum_French	−0.15	−0.22	−0.24	−0.32	−0.22
	(0.69)	(0.59)	(0.55)	(0.45)	(0.59)
Dum_Portuguese	−0.47	−0.39	−0.23	−0.28	−0.23
	(0.48)	(0.53)	(0.71)	(0.67)	(0.71)
Constant	7.65	7.71	7.69	7.82	7.67
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
R^2	0.24	0.21	0.22	0.20	0.21
Obs	49	49	49	49	49
Panel B					
AgricHist	−0.0002	−0.00016	−0.00015	−0.00019	−0.0002
	(0.18)	(0.18)	(0.21)	(0.15)	(0.23)
Landlocked	−1.13	−1.12	−1.07	−0.96	−0.92
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Climate	−0.00006	−0.0006	−0.0006	−0.0005	−0.0005
	(0.01)**	(0.00)***	(0.00)***	(0.01)**	(0.01)**
Dum_British	0.20	0.22	0.21	0.11	0.16
	(0.63)	(0.58)	(0.59)	(0.77)	(0.65)
Dum_French	−0.16	−0.13	−0.21	−0.19	−0.16
	(0.76)	(0.79)	(0.67)	(0.65)	(0.68)
Dum_Portuguese	−0.77	−0.65	−0.59	−0.62	−0.59
	(0.18)	(0.24)	(0.29)	(0.26)	(0.23)
Constant	8.31	8.44	8.56	8.61	8.44
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
R^2	0.33	0.34	0.34	0.27	0.27
Obs	45	45	45	46	46

Notes ***, **, * represent the 1%, 5%, and 10% critical levels, respectively. P-values reported in ().

son and Hibbs 2005; Cinyabuguma and Putterman 2011). However, they do complement the findings of Chanda and Putterman (2007), Putterman (2008) and Murphy and Nowrasteh (2018), who argue that state antiquity on mattered for growth during early periods and not in later periods.

TABLE 3 Nonlinear Estimates

	2000 GDPpc	2005 GDPpc	2010 GDPpc	2015 GDPpc	2020 GDPpc
Panel A					
StateHist	−1.68	−1.09	−1.32	−2.01	−1.96
	(0.49)	(0.66)	(0.58)	(0.37)	(0.36)
StateHist²	1.69	1.15	1.64	2.47	2.61
	(0.53)	(0.68)	(0.53)	(0.31)	(0.26)
Landlocked	−1.05	−1.04	−0.96	−0.89	−0.86
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Climate	−0.0003	−0.0002	−0.0001	−0.0001	−0.0001
	(0.25)	(0.34)	(0.44)	(0.47)	(0.49)
Dum_British	0.39	0.34	0.39	0.22	0.32
	(0.32)	(0.42)	(0.34)	(0.60)	(0.43)
Dum_French	−0.09	−0.17	−0.18	−0.23	−0.12
	(0.83)	(0.70)	(0.69)	(0.59)	(0.76)
Dum_Portuguese	−0.38	−0.34	−0.15	−0.15	−0.09
	(0.60)	(0.62)	(0.83)	(0.81)	(0.86)
Constant	7.78	7.79	7.82	8.01	7.86
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Turning point					
R^2	0.24	0.22	0.21	0.19	0.20
Obs	49	49	50	51	51
Panel B					
AgricHist	−0.001116	−0.0011	−0.0011	−0.0013	−0.0012
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
AgricHist²	1.43E−7	1.41E−7	1.45E−7	1.61E−7	1.67E−7
	(0.00)***	(0.01)**	(0.00)***	(0.00)***	(0.00)***
Landlocked	−1.01	−1.01	−0.96	−0.87	−0.83
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Climate	−0.0004	−0.0004	−0.0004	−0.0003	−0.0003
	(0.08)*	(0.05)*	(0.05)*	(0.08)*	(0.11)
Dum_British	0.02	0.04	0.03	−0.06	−0.005
	(0.94)	(0.89)	(0.92)	(0.84)	(0.98)
Dum_French	0.07	0.09	0.02	0.05	0.08
	(0.89)	(0.85)	(0.97)	(0.90)	(0.82)
Dum_Portuguese	−1.07	−0.95	−0.90	−0.97	−0.94
	(0.04)*	(0.05)*	(0.05)*	(0.02)**	(0.02)**
Constant	9.45	9.56	9.71	9.92	9.72
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Turning point	3,902	3,900	3,793	4,037	3,592
R^2	0.46	0.47	0.47	0.45	0.45
Obs	45	045	45	46	46

NOTES ***, **, * represent the 1%, 5%, and 10% critical levels, respectively. P-values reported in ().

Against these findings we proceed to examine for possible nonlinearities in the estimated regressions.

NONLINEAR RESULTS

We now test for possible nonlinearities in the estimate baseline regressions and present our findings in Table 3.

From Panel A, the inclusion of the squared term produces insignificant estimates on the state history variables across all periods. Conversely, the estimates of the agricultural transition (squared term of agricultural transition) produce statistically significant negative (positive) coefficients, implying that countries with earlier agricultural transition benefitted until a 'certain period' after which countries with earlier transition experienced lower modern growth rates. We estimate a turning point of '4,000' which is consistent across all time periods. Whilst these findings are reminiscent of the 'reversal of fortunes', we establish the effect to be driven by early agricultural transition such that countries which transitioned into agricultural farming less than 4,000 years ago were only fortunate if they experienced a later Neolithic transition (Bockstette, Chanda, and Putterman 2002; Chanda and Putterman 2007). For instance, countries such as Algeria, Ethiopia and Sudan which experienced the agricultural transition approximately 4,000 years ago advanced more slowly compared to other countries like Mauritius, South Africa and Botswana which experienced the Neolithic revolution less than 2,000 years ago but are more prosperous in modern days. Conversely, only African countries such as Egypt and Libya, which transitioned more than 4,000 years ago, benefitted from earlier transitions in terms of modern growth performance.

2SLS RESULTS

Lastly, we examine possible channels through which state history and agricultural transition could have affected modern income levels. We test Diamond's (1997) hypothesis that countries which had earlier development made use of early technology to foster faster industrial development over several centuries. We employ 2SLS estimates to test whether countries with dominant early states or those which experienced faster transition into agricultural farming were able to use early technology to gain a developmental head start which influences modern growth patterns.

Our findings reported in Tables 4 and 5 reveal that whilst early technology does not affect modern growth through state history (Table 4) there

TABLE 4 2SLS Estimates (state history)

	2000 GDPpc	2005 GDPpc	2010 GDPpc	2015 GDPpc	2020 GDPpc
Panel A: 2nd stage estimates					
Tech	−6.14	1.09	−2.23	−5.76	−7.19
	(0.82)	(0.97)	(0.94)	(0.82)	(0.78)
$Tech^2$	6.07	−2.08	2.22	6.58	8.72
	(0.85)	(0.96)	(0.95)	(0.83)	(0.76)
Constant	9.26	8.38	8.81	9.21	9.13
	(0.01)**	(0.04)*	(0.02)**	(0.01)**	(0.01)**
Controls	✓	✓	✓	✓	✓
Turning points	n/a	n/a	n/a	n/a	n/a
R^2	0.41	0.40	0.41	0.41	0.42
Obs	38	38	38	38	38
Panel B: 1st stage estimates					
StateHist	−1.68	−1.09	−1.32	−2.01	−1.96
	(0.49)	(0.66)	(0.58)	(0.37)	(0.36)
$StateHist^2$	1.69	1.15	1.64	2.47	2.61
	(0.53)	(0.68)	(0.53)	(0.31)	(0.26)
Constant	7.78	7.79	7.82	8.01	7.86
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Controls	✓	✓	✓	✓	✓
R^2	0.24	0.22	0.21	0.19	0.20
Obs	49	49	50	51	51

Notes ***, **, * represent the 1%, 5%, and 10% critical levels, respectively. P-values reported in ().

is a significant effect from early transition to early technology adoption to economic growth in the post-2000 era (Table 5).

Note that the 2nd stage estimates point to a nonlinear, U-shaped relationship between early technology and modern income, with an estimated break point of 0.48 – 0.52, and countries with early technology coefficients above these turning points have relatively higher present income levels, i.e. Egypt, Libya and Tunisia. Therefore, in differing from previous literature which finds a positive impact of early technology on modern growth (Ang 2013; 2015; Comin, Easterly, and Gong 2010), we find that only African countries which had early agricultural transition more than 5,000 years ago were able to take advantage of early technology to gain a developmental head start whose effects have lasted for thousands of years. For the remaining economies, a 'reversal-of-fortunes' effect holds as countries with longer agricultural transition could not take advantage

TABLE 5 2SLS Estimates (agricultural transition)

	2000 GDPpc	2005 GDPpc	2010 GDPpc	2015 GDPpc	2020 GDPpc
Panel A: 2nd stage estimates					
Tech	−24.04	−21.17	−20.20	−17.41	−17.16
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
$Tech^2$	24.62	20.58	20.08	17.38	16.33
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Constant	12.12	12.27	12.42	11.73	12.07
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Controls	✓	✓	✓	✓	✓
Turning points	0.48	0.51	0.50	0.50	0.52
R^2	0.45	0.48	0.44	0.41	0.45
Obs	38	38	38	38	38
Panel B: 1st stage estimates					
AgricHist	−0.001116	−0.0011	−0.0011	−0.0013	−0.0012
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
$AgricHist^2$	1.43E−7	1.41E−7	1.45E−7	1.61E−7	1.57E−7
	(0.00)***	(0.01)**	(0.00)***	(0.00)***	(0.00)***
Constant	9.45	9.56	9.71	9.92	9.72
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Controls	✓	✓	✓	✓	✓
R^2	0.46	0.47	0.47	0.45	0.45
Obs	45	045	45	46	46

Notes ***, **, * represent the 1%, 5%, and 10% critical levels, respectively. P-values reported in ().

of early technology whilst poorer states with later transitions benefitted from the technological pass-through effects of colonization by Western nations.

Conclusions

The African continent is known to be the cradle of mankind and yet is one of the most underdeveloped regions in the modern world. Our study investigates whether state history and agricultural transition, as deep roots of economic development, can explain differences in modern income levels in African countries. Our findings reveal that agricultural transition predicts present income levels, although the effect is nonlinear, with a negative (positive) effect found for countries which transitioned more than (less than) 4,000 years ago. Further investigations reveal that this effect is transmitted through the sophistication of early technology and only a few economies such as Egypt and Libya were able to take advantage of these early civilizations. Most African countries which experienced agricultural transmissions less than 4,000 years ago were not able to take advantage of early technology for development purposes. Notably, some islands like Mauritius and Southern African states (South Africa, Botswana, Namibia, Eswatini), which experienced late Neolithic transitions, have higher modern income levels due to the spillover effects of colonization on these 'late developers' and their low exposure to slave trades.

Overall, our study verifies Diamond's (1997) hypothesis by demonstrating that patterns in modern income levels can be explained by the timing of the Neolithic revolution. We particularly verify the 'reversal of fortunes' hypothesis as we find that African countries which experienced very early or very late agricultural transitions have higher present-day income levels. However, only African countries with very early transitions used early technology for a developmental head start, whilst those with very late transitions seemed to benefit from colonial transfers of knowledge and technology. Therefore, an importance policy lesson to be learnt from this study is the need for African countries to quickly adapt to newer evolutionary phases such as the 4th industrial revolution (4IR), since delayed adaptation to evolutionary changes makes African countries more vulnerable to dependency on Western economies for economic development.

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