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Reconciling Reversal of Fortune in early United States Development within a Unified Growth Framework

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This paper attempts to explain demographic-economic development in the Thirteen Colonies/United States during AD1700-AD1860, when slavery was an important feature in the period. This paper models how the use of slaves in production affected long-run productivity. The key hypothesis of the model is that productivity growth is positively related to the fraction of the workforce comprised of free workers, who had property rights over their production. The geographic and political environments in US-South relatively favored the buildup of Black slaves, through the above model mechanism it suffered from slower productivity growth and a reversal of fortune.

Key Words: Reversal of fortune; Unified Growth Theory; Transatlantic Migration and Slavery Trade.

JEL Classification Numbers: N10, O50, P52.

"We can send from here [West Indies] in the name of the Holy Trinity, all the slaves and brazilwood that can be sold." (Columbus 1498[2004], 59)

"Free labor has the inspiration of hope; pure slavery has no hope." (Lincoln 1859[1990], 160)

1. INTRODUCTION

We need a unified growth theory for the Western Hemisphere. The discovery of America by Christopher Columbus in AD1492 initiated the Atlantic European powers' (Spain, Portugal, England, France, and the Netherlands) exploration and colonization of the American continents. For the purpose of exploiting economic opportunities or spreading political and

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religious influences, these European powers either encouraged internal migration or traded African slaves to promote settlement in the American land.[1] Due to the difference in legal status between European migrants and African slaves, the population structure constituted from these two sources had implications on economic progress. With this background, this paper specifically focuses on reconciling the development and divergence (reversal of fortune) in the Thirteen Colonies/United States during the colonization era within a unified growth framework.[2]

Reversal of fortune refers to the reverse in relative per capita incomes between two locations. It can occur on two levels: within-country and across-countries. One within-country example took place in the United States. At the turn of the eighteen century, the southern part of the Thirteen Colonies/United States (hereafter US-South) was originally richer than the northern part (hereafter US-North); however, this situation had been reversed by the mid-nineteenth century. Reversal of fortune also occurred at country level. For example, Bolivia, Ecuador and Peru were once the most developed regions in America in AD1500. However, they are among the poorest countries in America today. On the other hand, the United States and Canada were the most underdeveloped areas in America in AD1500, but now they are among the richest countries in the world (Maddison 2008).

In section 3, we review the demographic-economic data in the Thirteen Colonies/United States in the colonization era. In section 4, we develop a unified growth model with transatlantic migration and slavery trade. The model is distinct from traditional unified growth models (Galor, and Weil 2000, Galor, and Moav 2002) in two aspects, which are highly relevant to American development history. On the demography aspect, ours incorporates migration and slavery trade which can raise population stock within a region/country in ways other than natural increase. On the production aspect, productivity growth depends on population composition compartmentalized by institution: slavery institution destines the Black slaves to not own property rights over their labor and wealth, therefore removing the Blacks' incentive to learn and improve their work; ceteris paribus, a greater Black population share implies slower productivity growth (*population composition effect on productivity growth*).

[1] In this paper, the term "migration" or "migrants" refers to the voluntary White (European) labor flows from Europe to America, but not to the involuntary Black (African) labor flows from Africa to America.

[2] Colonization of America began with the arrival of Christopher Columbus in AD1492. American decolonization started with the American Revolution in AD1775. By AD1860 most American countries had gained independence from the European powers. In this paper, "colonization era" refers to the period AD1492-AD1860. Slavery was an important labor market institution characterizing this period. Christopher Columbus and Abraham Lincoln are two representative figures defining the opening and closing of slavery in America. See the quotes ahead of the Introduction.

In section 5, we apply the model to simulate the reversal of fortune between US-North and US-South during AD1700-AD1860 (Lindert, and Williamson 2016a, Engerman, and Sokoloff 1997). By calibrating the unified growth model to the historical experience of the United States, we replicate the relative economic decline of the US-South. In particular, the US-South was characterized by slow natural population growth, low willingness of White migration, and small slavery trade cost. Then we put forward hypothesis to account for these parameter differences — albeit its higher initial productivity, the US-South possessed geographic and political factors that discouraged White migration and encouraged the use of Black slaves. The colonial producers resorted to importing Black slaves in US-South. Through the population composition effect on productivity growth, this hampered the region's economic progress in the long run.

Our theory also implies that, after the abolishment of slavery institution in America by the late-nineteenth century, the population composition effect on productivity growth would fade away.[3] Still, the US-North with higher productivity at the time of abolishment of slavery institution would retain its per capita income lead. Hence the early divergence pattern between US-North and US-South emerged by the late-nineteenth century persists till today. Section 6 highlights some discussion and section 7 concludes.

2. RELATED LITERATURE

2.1. Population and long-run development

In the recent years, the literature has studied the channels through which population fosters long-term development. In American context, Ashraf, and Galor (2013) posited that the low genetic diversity of native American populations and the high genetic diversity of African populations relative to the European and Asian populations, have detrimental effects on development. Putterman, and Weil (2010) posed that, history of a population's ancestors matters more than the history of the place they live today in determining their current per capita income.[4] Engerman, and Sokoloff

[3]Note the distinction between transatlantic slavery trade abolition and slavery institution abolishment. The former refers to the prohibition of slavery imports from other countries, while the latter refers to freeing of slaves within a country. For example, in the United States, transatlantic slavery trade was abolished in AD1807, while slavery institution was repealed only in AD1865. In this paper, the term "slavery trade" refers to transatlantic slavery trade but not to the internal slavery trade within a country.

[4]Acemoglu, Johnson, and Robinson (2001) operationalized "institutions" by protection against the risk of expropriation of private investments by governments and constitutional limits on executive power, and found that institutions explained the reversal of fortune. Chanda, Justin Cook, and Putterman (2014) operationalized "human capital" by literacy and quality of governance, and found that reversal of fortune disappeared

(2013, 101) stated that, "one of the most fundamental consequences of European colonization may have been in altering the composition of the populations in the societies colonized". Easterly, and Levine (2016) found a strong positive relationship between European share of population during colonization ("Euro share") and the level of per capita income today in non-European countries. Landes (1998, 311) argued that Spanish America fell in terms of wealth relative to British America because the Spanish Crown kept European outsiders away from entering its colonies, depriving skill and knowledge progress in Spanish America. How was population structure in an American region/country determined, and how did it affect the region/country's economic fortune during the colonization era? We will develop a unified growth model with transatlantic migration and slavery trade to answer these questions (section 4).

2.2. Unified growth theories

Since the turn of the new millennium, growth economists have shifted their attention to explaining long-term development patterns through the unified growth theories. Galor, and Weil (2000) and Galor, and Moav (2002) suggested that the inherent Malthusian interaction between population size/composition and technology level speeds up the pace of technological progress, and eventually will lead to industrialization and demographic transition. The literature has evolved to incorporate more structural changes that went along with demographic-economic development. Unified growth models with physical and human capital accumulation (Galor, and Weil 1996, Galor, and Moav 2006), inequality (Galor, and Moav 2004, Galor, Moav, and Vollrath 2009), trade (Galor, and Mountford 2006, 2008), child labor laws (Hazan, and Berdugo 2002, Doepke 2004), mortality (Lagerlof 2003, Voigtländer, and Voth 2013a), structural transformation (Strulik, and Weisdorf 2008, Vollrath 2009) and female empowerment (Diebolt, and Perrin 2013a, 2013b) have been proposed.

However, in the above works, the role of international labor movement was ignored, and this is especially important in early American development history. In the demography side, the native Indians did not contribute to the buildup of population stock in most American countries during the colonization era.[5] Instead, the population increase came mainly from transatlantic migration and slavery trade, as well as the natural increase of the migrated Europeans (Whites) and imported Africans (Blacks). Table 1 reproduces Engerman, and Sokoloff (1997)'s population compo-

when they analyzed populations (human capital) rather than geographic regions (Diamond 2014).

[5]Denevan (1992, xxix) postulated that the native Indian population "dropped from about 53.9 million in 1492 to only about 5.6 million by 1650", that is, about 90% depopulation rate within around 150 years.

sition estimates in selected American regions/countries at different time points during the colonization era. By the turn of the nineteenth century, most of the New World economies were populated with Whites and Blacks rather than with Indians. In the production side, we saw from the past subsection that Euro share had a strong positive correlation with economic development (Easterly, and Levine 2016). Therefore any unified growth theory aiming to explain long-run American development and divergence should take transatlantic movement of European and African labor and the implication on growth into account.

TABLE 1.

Population composition in selected American regions/countries

Economy	Year	White (%)	Black (%)	Indian (%)
1. Barbados	1690	25	75	-
2. Barbados	1801	19.3	80.7	-
3. Mexico	1793	18	10	72
4. Peru	1795	12.6	7.3	80.1
5. Venezuela	1800-09	25	62	13
6. Cuba	1792	49	51	-
7. Brazil	1798	31.1	61.2	7.8
8. Chile	1790	8.3	6.7	85
9. U.S.-Nation	1860	84.9	14	1.1
10. U.S. South	1860	61.7	37.7	0.7
11. U.S. North	1860	96.2	2.6	1.3
12. Canada	1881	97	0.5	2.5
13. Argentina	1918	95.6	1.2	3.2

Source: Engerman, and Sokoloff (1997) Table 10.4.

In another dimension, relative to the Eastern Hemisphere, there was less work done on simulating long-run economic development in the Western Hemisphere using unified growth models. See exceptions from Hansen, and Prescott (2002), Doepke (2004), Lord, and Rangazas (2006) and Mourmouras, and Rangazas (2009). But they either did not specify simulation time frames or placed the starting point after AD1800. This paper focuses on the Thirteen Colonies/United States during the colonization era, in particular AD1700-AD1860 (section 5).

2.3. Geography hypothesis versus Institutions hypothesis

The geography hypothesis and the institutions hypothesis aim to explain the divergent growth experience across countries. There are at least three versions of the geography hypothesis. The first focuses on climate. Climate can affect individual work effort and productivity. For example, Montesquieu (1899, 221-224) and Marshall (1895, 276) stated that people

are more vigorous under cold climates. A related aspect is the disease environment. Malaney, and Sachs (2002) posed that, malaria-endemic countries suffer from slower economic growth, because malaria adversely affects saving and investment, health and worker productivity, and so forth. Weil (2013, 467) mentioned that, because protohumans evolved in tropical areas in Africa, there was ample time for local parasites to develop and attack humans there, making Africa a less healthy and unproductive region.

The second focuses on natural topography. Smith (1994, 20-21) mentioned the importance of access to sea-coast and navigable rivers to a nation's market widening and development. Bloom, Canning, and Sevilla (2003) found that countries with favorable geography (cool, coastal countries with high, year-round rainfall) are more likely to escape from a poverty trap. Diamond (1997, 366, 407) advanced that, in addition to Eurasia's head start and wild animal and plant species, the east-west orientation of Eurasia has facilitated the diffusion of animals, plants, people, ideas and technology across the continent, because of the similar latitude and climate. On the contrary, the north-south orientation of America and Africa posed barriers to diffusion because of the changes in latitude and ecology. This gave the Eurasians developmental advantage by AD1492.

The third focuses on resource. This turns our attention to the resource blessing versus resource curse debate. For the blessing side, Levine (1987, 97) and Pomeranz (2000, 267) argued that the Industrial Revolution started in Britain because "England is built upon an underground mountain of coal", and its access to continental North American food supply brought on the rise of English manufactures. Habakkuk (1967, 12-13, 104-106) stated that land abundance and the resulting labor scarcity in the United States encouraged entrepreneurs to search for labor-saving innovations; this led to the rise of the American System of Manufacturers and rapid industrial progress in the United States during the nineteenth century. For the curse side, empirical evidence indicated that resource-abundant countries tended to grow slower in the recent decades (Sachs, and Warner 1997, van der Ploeg 2011, 380). One explanation for this is the Dutch disease, where the blooming resource sector would lead to deindustrialization through real exchange rate appreciation (Corden, and Neary 1982); via learning-by-doing this could contribute to long-term welfare loss (Krugman 1987).

The institutions hypothesis takes a rival view against "geography is destiny". North (1990, 3) defines institutions as "rules of the game in a society" that shape human interaction.[6] North, and Thomas (1973, 1-2) stated that

[6]Smith (1994, 484-485) stated that, the wealth of society equals the exchangeable value of the whole produce of its industry. Free market system, led by the "invisible hand", would align the interests of individuals with the society. It is the individual's endeavors to purse activities that are most highly valued by the others, that create the greatest wealth of the society. Hayek (1963, 231) mentioned that freedom of economic

efficient economic organization, which entails the establishment of institutional arrangements and property rights that provide economic initiatives, is the key to economic growth. Acemoglu, and Robinson (2012) argued that nations fail because of the existence of extractive political institutions, which incur extractive economic institutions that create entry barriers and unfair regulations, impeding economic progress for the masses. In contrast, societies that feature inclusive political institutions give rise to inclusive economic institutions, which secure property rights and promote entrepreneurship, and hence economic growth. Hall, and Jones (1999) found evidence that institutions and government policies drive cross-country differences in capital accumulation, productivity and per worker output.

The institutions hypothesis has been applied to account for the reversal of fortune across American countries. For example, North, Summerhill, and Weingast (2000) stated that, in post-Revolutionary United States, the credible system of limited government based on the full separation of powers had laid the cornerstone of political order and market-preserving federalism, providing the basis for long-run growth. In contrast, in colonial Spanish America, the Crown focused on short-term resource exploitation, leaving its colonies with little experience in autonomous governance, leading to political disorder and poor economic performance after their independence. Engerman, and Sokoloff (1997) proposed that it was the interplay between resource thrust or inequalities and the governmental policies toward maintaining them that shaped economic divergence among American countries. For the within-United States divergence, they proposed that US-South lagged behind US-North in evolution of political and economic institutions that promoted widespread commercialization and market development, causing the region's relative decline in the nineteenth century.

In this paper, we argue that geography and institutions, rather than being crashing views, take inseparable roles in understanding Thirteen Colonies/United States development and divergence from the long-run perspective (section 5.3).

3. HISTORICAL CONTENT AND BACKGROUND

This section reviews per capita income and demographic development in the Thirteen Colonies/United States during the eighteenth and early-nineteenth centuries. Table 2 shows Lindert, and Williamson (2016a)'s estimates of real per capita income in the Thirteen Colonies during AD1650-AD1774. In this paper, US-North refers to colonies/states north of the Mason-Dixon line (New England and Middle Colonies), while US-South

activity under the rule of law ("free system") would make continuous growth of wealth and technological knowledge possible.

to those south of the Mason-Dixon line (Upper South and Lower South).[7] New England, which mainly traded its fishery and timber products, possessed per capita income levels similar to that of Britain and grew slowly throughout AD1650-AD1774. Middle Colonies, which focused on exporting its mixed farming products, was stagnating but possessed higher income levels than New England during the eighteenth century. The Upper South and Lower South, which specialized in tobacco and rice production respectively, were much wealthier than the northern colonies throughout the colonial period, but were suffering from per capita income declines at the same time.

TABLE 2.

Real per capita income of the Thirteen Colonies, AD1650-AD1774

		1650	1675	1700	1725	1750	1770	1774
US-North	New England	1.13	1.45	1.76	1.88	1.84	2.11	1.93
	Middle Colonies			2.6	2.52	2.6	2.6	2.72
US-South	Upper South		5.98	5.11	4.22	3.94	3.9	3.8
	Lower South			6.77	6.42	5.87	5.11	5.54
All 13 colonies				3.45	3.21	3.21	3.27	3.29
Britain		1.22	1.52	2.06	2.03	2.09	2.12	1.96

Source: Lindert, and Williamson (2016a) Table 6, per capita income in bare-bones welfare ratios. Note that in Lindert, and Williamson (2016a)'s original article, New England includes NH, MA, RI and CT; Middle Colonies includes NY, NJ and PA; Upper South includes VA, MD and DE; Lower South includes GA, NC and SC.

During the American Revolution (AD1775-AD1783), the Thirteen Colonies declared independence in AD1776 and turned into the United States of America. Table 3 shows Lindert, and Williamson (2013)'s estimates of real per capita income growth rate in the Thirteen States during the early Republic period (AD1774-AD1840).

The Thirteen States suffered from per capita income downswing in the two decades following the Revolutionary Wars, with US-South witnessing the sharpest decline. In the first four decades of the nineteenth century, the Thirteen States grew at an impressive average rate of 1.56% per annum. US-North, in particular New England, grew much faster than US-South did. Combining the estimates from Table 2 and Table 3, Figure 1 depicts real per capita income evolution in the Thirteen Colonies/States during AD1650-AD1840. It reveals the reversal of fortune between US-North (solid lines) and US-South (dashed lines): US-North, which was initially poorer during

[7]Note that the definitions of New England, Middle Colonies, Upper South and Lower South vary in our sources (see Table 2 to Table 4). Unless specified, we will stick to definitions stated in Table 4.

TABLE 3.

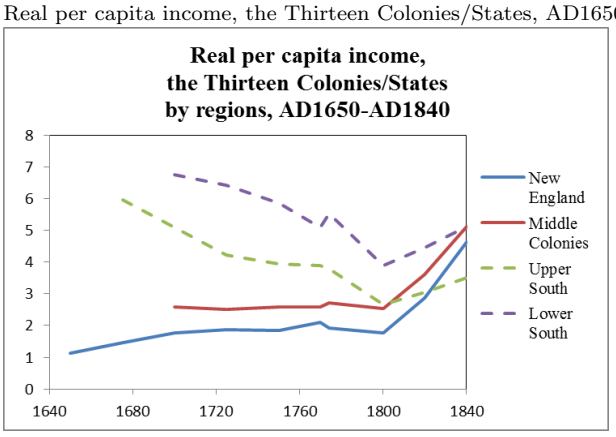
Per annum real per capita income growth rate of the Thirteen States, AD1774-AD1840

		1774-1800 (%)	1800-1840 (%)
US-North	New England	−0.33	2.44
	Middle Colonies	−0.27	1.77
US-South		−1.35	0.69
All three U.S. regions		−0.86	1.56

Source: Lindert, and Williamson (2013) Table 6. Note that in Lindert, and Williamson (2013)'s original article, New England includes CT, MA, ME, NH, RI and VT; Middle Colonies (Middle Atlantic) includes NY, NJ, PA, DE, MD and DC; US-South (South Atlantic) includes VA, GA, NC and SC.

the seventeenth and eighteenth centuries, surpassed US-South in overall sense by AD1840.

FIG. 1. Real per capita income, the Thirteen Colonies/States, AD1650-AD1840



Source: Table 2 and Table 3.

Next we come to Galenson (1996)'s estimates of White-Black population evolution in the Thirteen Colonies. Table 4 shows the White populations in US-North and US-South, with the numbers in parentheses denoting the White population share, in each decade during AD1620-AD1770. From the settlement in Jamestown till the eve of the American Revolution, the White populations were increasing in both US-North and US-South, with the former rising about twice faster than the latter.

The White population growth was fueled by natural increase and transatlantic migration. Table 5 shows the White migration from British Isles to British America in each decade from AD1630 to AD1770. During this time frame, the total number of White migrants to US-North was about half that

TABLE 4.

White population of British America, in thousands, by region, AD1620-AD1770

Year	US-North	US-South
1620		1 (NA)
1630	2 (NA)	2 (NA)
1640	16 (NA)	8 (NA)
1650	27 (96%)	12 (100%)
1660	38 (95%)	25 (96%)
1670	59 (98%)	43 (93%)
1680	81 (96%)	62 (94%)
1690	118 (97%)	78 (90%)
1700	141 (96%)	99 (86%)
1710	176 (95%)	120 (81%)
1720	259 (95%)	153 (77%)
1730	346 (95%)	205 (72%)
1740	485 (95%)	271 (67%)
1750	625 (95%)	309 (59%)
1760	836 (95%)	432 (60%)
1770	1087 (96%)	587 (59%)

Source: Galenson (1996) Table 4.2. Parentheses indicating percentage of Whites in population. US-North refers to New England and Middle Colonies, while US-South refers to Upper South and Lower South. New England contains Maine (ME), New Hampshire (NH), Vermont (VT), Plymouth, Massachusetts (MA), Rhode Island (RI) and Connecticut (CT). Middle Colonies contains New York (NY), New Jersey (NJ), Pennsylvania (PA), and Delaware (DE). Upper South contains Maryland (MD) and Virginia (VA). Lower South contains Georgia (GA), North Carolina (NC), and South Carolina (SC).

to US-South. This implies that US-North had a higher natural population growth rate.[8]

Table 6 shows the Black populations in US-North and US-South, with the numbers in parentheses representing the Black population share, in each decade during AD1650-AD1770. Before the AD1680s, the Black populations grew slowly in US-North and US-South. After that, this trend continued in US-North, and the Blacks constituted less than 5% of the population in US-North in most of the time. In contrast, the Black population grew fast in US-South. By the eve of the American Revolution, US-South possessed a Black population which was eight times larger than

[8]One factor that contributed to the higher natural population growth rate in US-North was the lower mortality rate there. See Table 10 for Wells (1992)'s estimates of life expectancy among selected regions in the Thirteen Colonies/United States during the eighteenth century. In general US-North was a healthier place than US-South and the people there enjoyed longer life expectancies.

TABLE 5.

Decennial net migration of Whites from British Isles to British America, in thousands, by region, AD1630-AD1770

Decade Beginning	US-North	US-South
1630	11	11
1640	5	14
1650	3	18
1660	8	20
1670	5	18
1680	12	13
1690	−10	3
1700	−4	25
1710	30	22
1720	13	48
1730	36	46
1740	3	−1
1750	31	33
1760	15	32
1770	−11	26
Total	147	328

Source: Galenson (1996) Table 4.5. See Table 4 for definitions of US-North and US-South.

that in US-North, and the Blacks dominated 41% of the US-South population.

The Black population growth was fueled by natural increase and transatlantic slavery trade. Table 7 shows the number of Blacks flowing to British America in each decade from AD1650 to AD1770. We interpret the data reflecting the number of African slaves imported to British America.[9] Throughout the seventeenth and eighteenth centuries, US-North almost did not import slaves. On the other hand, US-South was importing slaves in every decade except the decade of American Revolution. Throughout these two centuries, the total number of Blacks imported to US-South (219,000) was about two-thirds the number of Whites migrating to US-South (328,000).

Next we briefly review the labor market institutions in British America. The first was indentured servitude. More than half of British migrants re-

[9]We interpret all Blacks as slaves in British America during the eighteenth and early-nineteenth centuries. The two are conceptually different, but statistics indicates that they were similar. For example, U.S. Bureau of the Census (1966, Table 60, 1975, series A 6-8)'s data indicated that 18% of United States population were slaves in AD1790, which closely matches the 21% nationwide Black population share implied by our AD1770 data from Table 4 and Table 6. Similarly, 13% of United States population were slaves in AD1860, which closely matches the 14% nationwide Black population share in the United States in AD1860 (from our Table 1).

TABLE 6.

Black population of British America, in thousands, by region, AD1650-AD1770

Year	US-North	US-South
1650	1 (4%)	0 (0%)
1660	2 (5%)	1 (4%)
1670	1 (2%)	3 (7%)
1680	3 (4%)	4 (6%)
1690	4 (3%)	9 (10%)
1700	6 (4%)	16 (14%)
1710	9 (5%)	29 (19%)
1720	15 (5%)	46 (23%)
1730	18 (5%)	79 (28%)
1740	26 (5%)	134 (33%)
1750	32 (5%)	211 (41%)
1760	42 (5%)	285 (40%)
1770	50 (4%)	406 (41%)

Source: Galenson (1996) Table 4.3. Parentheses indicating percentage of Blacks in population. See Table 4 for definitions of US-North and US-South.

TABLE 7.

Decennial net flow of Blacks to British America in thousands, by region, AD1650-AD1770

Decade Beginning	US-North	US-South
1650	0	1
1660	0	2
1670	0	2
1680	0	8
1690	0	9
1700	1	13
1710	4	17
1720	2	17
1730	2	40
1740	0	59
1750	1	21
1760	−3	40
1770	−7	−10
Total	0	219

Source: Galenson (1996) Table 4.6. See Table 4 for definitions of US-North and US-South.

lied on indentured servitude contracts to cover the migration expenditure (Allen, Murphy, and Schneider 2012). Indentured servitude was a credit

system where prospective servants paid for their passages to America by signing contracts with recruiting agents, promising to work in a particular colony under stated conditions for a specified number of years. The servants would then be shipped to the designated colony. The recruiting agents would sell, in a second market, the contracts to American planters or farmers, who would provide maintenance to the servants during the contract terms. The conditions of the servitude were regulated by local American courts. The servants would be freed after the contracts expired (Galenson 1981a).

Another labor market institution was slavery. British America obtained overseas slaves through transatlantic slavery trade before the abolitions in the United States and in the British Empire in AD1807. The transported people were usually enslaved, kidnapped and raided Africans (Thornton 1996). Slaves were treated as properties of their owners; their legal status involved serving for life as would their progeny (Galenson 1981a). The British common law did not protect slaves from mistreatment by their masters. In contrast, the slave owners had absolute power and authority to force the slaves to work, buy and sell them, use them as collaterals or gifts as they wished (Finkelman 2012).

4. THE UNIFIED MODEL

In this section, we develop the unified growth model with transatlantic migration and slavery trade, and simulate the development process of the Thirteen Colonies/United States during AD1700-AD1860. The distinctive features of our unified growth model comprise transatlantic labor movement, which raises population stock in a country through channels other than natural increase (section 4.1.1), and slavery institution, which compartmentalizes the population, depriving the Black labor at the cost of overall productivity advancement in the colony (sections 4.1.2-4.1.3). We also include important events including United States land acquisition and slavery trade abolition that occurred within the time period (sections 4.1.5-4.1.6).

4.1. Model Setting

Suppose that the world economy consists of two countries, country A ("colony") and country B ("home"). Country A is an American colony of a European country B; they are geographically separated by the Atlantic Ocean. Africa is a region where Black slavery labor can be obtained. The "colonial producer" owns the land in country A, while the "home landlord" owns the land in country B. They hire labor to produce, and earn land rents in return. There are two types of individuals: "Whites" (European descendants) and "Blacks" (African descendants). Each individual

is endowed with one unit of labor which is supplied inelastically. Time is discrete and indexed by t. Each time period spreads for 10 years.

4.1.1. Demography side

Europeans in country B enjoy the freedom to migrate to country A. Following Harris, and Todaro (1970), we hypothesize that the number of migrants moving from country B to country A at time t, M_t, is a positive function of the country A-country B expected wage differential at time t:

$$M_t = m([w_t^A]^e - [w_t^B]^e), \quad m > 0, \tag{1}$$

where $[w_t^A]^e$ and $[w_t^B]^e$ are the expected wages in country A and in country B at time t respectively.[10] We interpret m as a measure of willingness to migrate from country B to country A; it contains all factors other than wage that affect the number of migrants, for example, mortality rate, forms of work organization, racial composition of labor force in American destination (Galenson 1981b, 144-145). We make the rational expectation assumption: the expected wage differential at time t ($[w_t^A]^e - [w_t^B]^e$) equals the actual wage differential at time t, ($w_t^A - w_t^B$), where w_t^A and w_t^B are the wages in the two countries at time t. Hence (1) becomes:

$$M_t = m(w_t^A - w_t^B). \tag{2}$$

Next we come to demographic process in the two countries. There are two types of individuals in country A (colony): the Whites and the Blacks. The total population size in country A at time t, L_t^A, is:

$$L_t^A = L_t^H + L_t^F, \tag{3}$$

where L_t^H is the White population size in country A at time t, L_t^F is the Black population size in country A at time t.

The White population size in country A at time t, L_t^H, evolves from two sources: natural increase and current transatlantic migration:

$$L_t^H = (1 + g^{L^H})L_{t-1}^H + M_t, \tag{4}$$

[10] Harris, and Todaro (1970, 129) studied rural-to-urban migration. They hypothesized that the number of migrants moving from rural area to urban area is a positive function of urban-rural expected wage differential. Using their notations:

$$\dot{N}_u = \psi(w_u^e - w_A), \text{ where } \psi' > 0, \quad \psi(0) = 0,$$

where $\dot{N}_u$ is the time derivative of urban population (migration), w_u^e is the expected urban wage, w_A is the rural wage, $\psi(.)$ is a positive increasing function. In our equation (1), we assume $\psi(.)$ to take a linear form for simplicity.

where g^{L^H} is the exogenous White natural population growth rate in country A, $(1+g^{L^H})L^H_{t-1}$ is the natural increase in White population at time t, M_t is the endogenously determined number of transatlantic migrants at time t.[11] The White population size in country A at $t=1$, L^H_1, is historically given.

Similarly, the Black population size in country A at time t, L^F_t, evolves from two sources: natural increase and current transatlantic slavery trade:

$$L^F_t = (1+g^{L^F})L^F_{t-1} + Q_t, \tag{5}$$

where g^{L^F} is the exogenous Black natural population growth rate in country A, $(1+g^{L^F})L^F_{t-1}$ is the natural increase in Black population at time t, Q_t is the endogenously determined number of Black slaves imported at time t. The Black population size in country A at $t=1$, L^F_1, is historically given.

There is only one type of individuals in country B (home): the Whites. We assume that the home country would never import African slaves. The population size in country B at time t, L^B_t, equals the natural increased amount minus the number of transatlantic migrants:

$$L^B_t = (1+g^{L^B})L^B_{t-1} - M_t, \tag{6}$$

where g^{L^B} is the exogenous natural population growth rate in country B. The population size in country B at $t=1$, L^B_1, is again historically given.

To simplify our analysis, we make the small colony assumption. When the number of migrants is much smaller than the population size in country B (home), transatlantic migration would hardly affect the population size at home.[12] Hence (6) can be approximated by:

$$L^B_t = (1+g^{L^B})L^B_{t-1}. \tag{7}$$

4.1.2. Production side

[11] In our model, to focus on the role of transatlantic migration and slavery trade, we made the simplifying assumption of exogenous natural population growth for both the White and Black population. Tamura, Simon, and Murphy (2016, 33) constructed a model with endogenous fertility and human capital accumulation choices, which can fit both the fertility changes, schooling changes and state productivity differences in the United States from AD1800(20) to AD2000.

[12] For example, from Maddison (2008)'s estimates, in AD1700, British Isles (United Kingdom and Ireland) had a population of about 10 million. From our Table 5, the average decennial migration from British Isles to British America during AD1700-AD1770 was only about 18 thousand, which was less than 0.2% of British Isles' population in AD1700.

The home landlord and colonial producer make production decisions subject to technological and institutional constraints. For production technologies, in country B (home), output at time t is produced with Cobb-Douglas technology, using labor and home land as inputs:

$$Y_t^B = z_t^B (L_t^B)^\alpha (T^B)^{1-\alpha}, \quad \alpha \in (0,1), \tag{8}$$

where z_t^B is productivity level in country B at time t, T^B is the amount of land in country B.

Similarly, in country A (colony), output at time t is produced according to Cobb-Douglas technology, using labor and colonial land as inputs:

$$Y_t^A = z_t^A (L_t^A)^\alpha (T^A)^{1-\alpha}, \quad \alpha \in (0,1), \tag{9}$$

where z_t^A is productivity level in country A at time t, T^A is the amount of land in country A.

For institution, country B possesses free labor market: at each time t, by inelastically supplying one unit of labor, each White worker earns a wage income of w_t^B. The home landlord owns land and production technology in country B. He or she decides how many domestic labor to hire to maximize land rent at home, taking home wage as given:

$$\max_{L_t^B} Y_t^B - w_t^B L_t^B \quad \text{subject to (8)}. \tag{10}$$

First order condition of (10), together with home labor market clearing implies:

$$w_t^B = z_t^B \cdot \alpha (L_t^B)^{\alpha-1} (T^B)^{1-\alpha}, \tag{11}$$

That is, home wage equals marginal product of home labor at each time t.

Colonial labor market features free White labor and Black slavery: at each time t, every individual inelastically supplies one unit of labor; in return, each White worker earns a wage income of w_t^A, while each Black worker gets nothing (slavery institution). The colonial producer owns land and production technology in country A, and maximizes the land rent there. Besides hiring domestic and migrant workers, he or she possesses one more choice variable: to engage in transatlantic slavery trade and import African slaves. We assume the cost of engaging in transatlantic slavery trade is increasing in the number of slaves imported and takes the form of $f \cdot (Q_t)^2$, where f is a positive constant.[13] The slavery trade cost parameter f reflects

[13] We assume slavery trade cost takes a quadratic rather than a linear form, otherwise the equilibrium system will have an indeterminate solution.

the direct cost of engaging in trading activity, as well as political pressure against slavery imports. The colonial producer decides the numbers of White labor to hire, and Black slaves to import, taking colony wage as given:

$$\max_{L_t^H, Q_t} Y_t^A - w_t^A L_t^H - f(Q_t)^2 \text{ subject to (9), (5),} \tag{12}$$

where $w_t^A L_t^H$ is the total wage payment to the Whites at time t, $f(Q_t)^2$ is the slavery trade cost at time t. No wage payment is made to the Blacks for all time t. First order condition of (12), together with White and Black labor market clearings in the colony, implies:

$$w_t^A = z_t^A \cdot \alpha (L_t^A)^{\alpha-1} (T^A)^{1-\alpha}, \tag{13}$$

$$z_t^A \cdot \alpha (L_t^A)^{\alpha-1} (T^A)^{1-\alpha} = 2 f Q_t. \tag{14}$$

Equation (13) means colony wage equals marginal product of Whites in colony, while (14) states marginal product of Blacks in colony equals marginal slavery trade cost at each time t.

4.1.3. Productivity growth

Productivity growth occurs at home and in the colony in every period. We assume a simple exogenous productivity growth in country B (home). Productivity level in country B at time $t+1$, z_{t+1}^B, is:

$$z_{t+1}^B = z_t^B (1 + \mu_t^B). \tag{15}$$

The μ_t^B term is the exogenous productivity growth rate at time t. Productivity level in country B at $t = 1$, z_1^B, is historically given.

For country A (colony), population composition compartmentalized by the slavery institution affects the pace of productivity growth. Productivity level in country A at time $t+1$, z_{t+1}^A, is:

$$z_{t+1}^A = z_t^A \left[1 + \left(\frac{L_t^H}{L_t^A} \right)^{\sigma} \cdot \mu_t^A \right], \quad \sigma > 0. \tag{16}$$

The White population share (or "Euro share") term $\frac{L_t^H}{L_t^A}$ captures the "social capability" of country A to engage in productivity growth (Ohkawa, and Rosovsky 1973, 212); that is, how conducive the population in country A is to improving technological practice and productivity.[14] We argue

[14] Easterly, and Levine (2016) posited that a higher Euro share had lasting positive impacts on economic development in colonized countries, because the Europeans brought

that, since the Blacks and their descendants had been deprived of the title to their human capital and wealth, they have no incentive to learn and improve their work.[15] Hence, the greater the Black population share, the slower productivity growth would be, relative to the full potential rate μ_t^A. We call this the *population composition effect on productivity growth.* And σ is a positive constant reflecting the strength of this effect. Productivity level in country A at $t = 1$, z_1^A, is historically given.

4.1.4. Per capita income

Lastly, denote per capita incomes in country A and in country B at time t as y_t^A and y_t^B respectively:

$$y_t^A \equiv \frac{Y_t^A}{L_t^A}, \text{ and} \tag{17}$$

$$y_t^B \equiv \frac{Y_t^B}{L_t^B}. \tag{18}$$

From (17) and (18), we have the standard population dilution effect on per capita income: given total output in the economy, a larger population size implies a smaller per capita income for each individual.

4.1.5. United States Land Acquisition

In AD1776 the Thirteen Colonies broke away from the British Empire, and established the United States of America. Before the American Civil War in AD1861-AD1865, the United States was rapidly expanding its territories westwards. Table 8 shows the total land area of the United States from AD1776 to AD1860.

The three most significant United States land acquisitions during AD1776-AD1860 were the Treaty of Paris which marked the end of American Revolution in AD1783, the Louisiana Purchase from Napoleonic France in AD1803 and the Treaty of Guadalupe Hidalgo which concluded the

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along with them human capital, technology, familiarity with global markets, and political institutions during colonization.

[15] Smith (1994, 742) stated that, "[s]laves, however, are very seldom inventive; and all the most important improvements . . . have been the discoveries of freemen."
Emerson (1844[2004]) declared that "[s]lavery is no scholar, no improver".
Fogel, and Engerman (1989, 108) posed that, "under the unbridled exploitation of slavery . . . the blacks had little incentive to improve themselves".
Acemoglu, and Robinson (2012, 75) stated that, "Barbados did not have inclusive economic institutions, since two-thirds of the population were slaves with no access to education or economic opportunities, and no ability or incentive to use their talents or skills".

TABLE 8.

Total land area of the United States, AD1776-AD1860

Year	Total land area (square miles)
1776	349,250
1790	864,746
1800	864,746
1810	1,681,828
1820	1,749,462
1830	1,749,462
1840	1,749,462
1850	2,940,042
1860	2,969,640

Source: U.S. Bureau of the Census (1975), Historical statistics of the United States, colonial times to 1970, Series J 1-2. The AD1776 land area is based on summing the land areas in today's Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, Georgia, North Carolina, and South Carolina provided by U.S. Bureau of the Census (2012, Table 18), converted to square miles.

Mexican-American War in AD1848. Since its independence, the United States has enlarged its land territories by 8.5 times its initial size by AD1860.

One of the most important features of United States land acquisition was that territory was expanded over sparsely-populated land. Turner's famous frontier thesis in AD1893 stressed this:

"The existence of an area of free land, its continuous recession, and the advance of American settlement westward, explain American development." (Turner 1976, 1)

The frontier or free land refers to geographic regions with "a low man-land ratio and unusually abundant, unexploited, natural resources" (Billington 1966, 25).[16] While Turner (1976)'s emphasis was on the role of frontier in promoting individualism, democracy and nationalism, ours is on the demographic-economic impact of such rapid increases in United States' natural resource base.[17]

[16]Turner (1976, 3) emphasized that the "most significant thing about the American frontier is, that it lies at the hither edge of free land ... which has a density of two or more [settlement] to the square mile".

[17]Findlay, and Lundahl (1994, 70) and Barbier (2011, xiv) noted that, the analysis of frontier-based development "has been used extensively by historians and geographers for a wide variety of times and places, but has been neglected by economists." Some exceptions are the contributions of Vandenbroucke (2008a, 2008b), who employed optimal growth models to identify the quantitatively important force driving westward move-

In our model, we include three periods of permanent "land shocks" to capture the three aforementioned United States land expansions: we assume the colony land area T^A to be raised by factors of $\frac{864,746}{349,250}$, $\frac{1,681,828}{864,746}$ and $\frac{2,940,042}{1,681,828}$ in AD1790, AD1810 and AD1850 respectively (ratios from Table 8).

4.1.6. United States Slavery Trade Abolition

The United States Congress began to regulate slavery trade in AD1794. In AD1800, it dramatically raised fines for illegal citizen participation in slavery trade, and awarded the officers and crews who made the slavery trade seizure the right to the value of the vessel. In AD1803, new fines were introduced for people who brought slaves or any "negro, mulatto, or other person of color" into states that banned slave importation. In AD1807, the Congress passed the Act Prohibiting Importation of Slaves, where fines and imprisonment were raised to high enough levels that discouraged most slave smugglers (Finkelman 2012, 120-121).

In terms of our model, these raised the slavery trade cost parameter f to a prohibitively-high level $f = 1$ from AD1810 onwards, to reflect the implementation of the Prohibiting Act.

4.2. Equilibrium Analysis

We define the equilibrium growth path of the economy.[18] The first period of our model is indexed by $t = 1$, with initial conditions $\{L_1^H, L_1^F, L_1^B; z_1^A, z_1^B\}$. The equilibrium constitutes sequences of production variables $\{Y_t^A, Y_t^B; y_t^A, y_t^B\}_{t=1}^{\infty}$, productivity variables $\{z_t^A, z_t^B\}_{t=1}^{\infty}$, population variables $\{L_t^A, L_t^H, L_t^F, L_t^B; M_t, Q_t\}_{t=1}^{\infty}$ and wages $\{w_t^A, w_t^B\}_{t=1}^{\infty}$ which satisfy:

(i) Home landlord and colonial producer rent maximization and labor market clearing: $\{w_t^A, w_t^B, Q_t\}$ satisfy (11), (13) and (14) at time t.

(ii) Output production: Given current productivity levels $\{z_t^A, z_t^B\}$, land and labor inputs $\{T^A, T^B, L_t^A, L_t^B\}$, output in the two countries $\{Y_t^A, Y_t^B\}$ are obtained from production functions (9) and (8) at time t.

(iii) Transatlantic migration: Given wages $\{w_t^A, w_t^B\}$, number of migrates M_t is determined by (2) at time t.

(iv) Population evolution: $\{L_t^A, L_t^H, L_t^F, L_t^B\}_{t=1}^{\infty}$ evolve according to (3), (4), (5) and (7).

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ment of population in the West of the United States in the 19th century, and concluded that the declining transportation costs was the key driving force.

[18] See Appendix 1 for the four internal adjustment mechanisms by how productivity growth, natural population growth, land acquisition and increase in slavery trade cost drive the evolution of numbers of migrants and imported slaves in the model.

(v) Productivity growth: $\{z_t^A, z_t^B\}_{t=1}^{\infty}$ evolve according to (16) and (15).
(vi) Per capita income: $\{y_t^A, y_t^B\}_{t=1}^{\infty}$ are defined by (17) and (18).

5. REVERSAL OF FORTUNE WITHIN THE UNITED STATES

In section 5.1 we calibrate the model. In section 5.2 we simulate the reversal of fortune between US-North and US-South during AD1700-AD1860. In section 5.3 we provide in-depth explanation for the reversal of fortune.

5.1. Model calibration

The model in section 4 naturally extends to two-colonies case. To apply the model to US-North (with subscript N) and US-South (with subscript S), we consider the world economy consisting of three regions/countries: US-North, US-South and Britain, the former two being American colonies of Britain.[19] We identify Britain as including today's United Kingdom and Ireland.[20] Assume there is no inter-colonial migration between US-North and US-South, then we can directly apply the model to the two pairs of home-colony dyads: Britain-US-North and Britain-US-South.

Parameters and initial conditions are chosen to match historical land areas, population levels and growth, income levels and growth, migrations and slavery imports in the three regions/countries. Each model period corresponds to 10 years. The main calibration results are:

Land area: Using the states areas being identified as US-North and US-South (U.S. Bureau of the Census 2012, Table 18), the initial land areas covered by the two regions in AD1700 are $424,397km^2$ and $480,157km^2$ respectively. For Britain's case, we sum the land areas of today's United Kingdom and Ireland provided by the Central Intelligence Agency (2021). The land areas of Britain is $310,813km^2$.

Initial population and output: Using AD1700 values from Table 4 and Table 6, we take the initial White populations in US-North and US-South to be 141,000 and 99,000 respectively, and the initial Black populations in the two regions to be 6,000 and 16,000 respectively. For Britain, we

[19] Before AD1780, the definitions of US-North and US-South follow from Table 4. After AD1780, we assume that the land areas of US-North and US-South would be enlarged by the same factors as the total land area of the United States did in Table 8.

[20] Note that we treat United Kingdom and Ireland as one united country in the British Isles. This allows us to match the migration data from Table 5 (the White migration from British Isles to British America). Historically, United Kingdom and Ireland integrated into one country under the name of "United Kingdom of Great Britain and Ireland" during AD1801-AD1922.

sum the AD1700 population estimates for the United Kingdom and Ireland provided by Maddison (2008) to obtain $L_1^B = 10,490,000$.

Income level: From Table 2, we take the initial per capita income in US-North as the AD1700 simple average of those in New England and Middle Colonies ($y_1^{AN} = \frac{1.76+2.6}{2} = 2.18$), and initial per capita income in US-South as the AD1700 simple average of those in Upper South and Lower South ($y_1^{AS} = \frac{5.11+6.77}{2} = 5.94$). Using (9) and (17), the initial productivity levels in the two regions are $z_1^{AN} = 1.15$ and $z_1^{AS} = 2.52$ respectively.

Migration and slavery import: Applying (2) to average decennial migration to US-North and US-South during AD1700-AD1770 (Table 5) and the implied AD1700 wages, we get $m^N = 369,048$ and $m^S = 18,870$.[21] Similarly, applying (13)-(14), $2fQ_t = w_t^A$, to average decennial Blacks imported to US-North and US-South during AD1700-AD1770 (Table 7) and the implied AD1700 wages, we obtain $f^N = 0.000436$ and $f^S = 0.0000402$.

Population growth: Assuming constant natural population growth rates in the three regions/countries, applying population accumulation equations $L_8^H = (1+g^{L^H})^7 L_1^H + M_8 + (1+g^{L^H})M_7 + \cdots + (1+g^{L^H})^6 M_2$ and $L_8^F = (1+g^{L^F})^7 L_1^F + Q_8 + (1+g^{L^F})Q_7 + \cdots + (1+g^{L^F})^6 Q_2$ to AD1700-AD1770 data in Table 4 to Table 7, we obtain $g^{L^{HN}} = 0.29$ and $g^{L^{FN}} = 0.24$ in US-North, $g^{L^{HS}} = 0.15$ and $g^{L^{FS}} = 0.21$ in US-South. For Britain, Maddison (2008) only provided population estimates for the United Kingdom and Ireland in AD1700 and AD1820, which are 10,490,000 and 28,340,000 respectively. Use $L_{13}^B = (1+g^{L^B})^{12} L_1^B$ to get $g^{L^B} = 0.086$.

Income growth: For the Cobb-Douglas production function parameter, we follow Vollrath (2009) to set $\alpha = 0.4$. We calibrate $\mu_t^B = 0.079$ in AD1700-AD1820 and $\mu_t^B = 0.170$ in AD1820-AD1860 to match per capita income growth trend in Britain, provided by Maddison (2008). For the United States, we calibrate $\mu_t^A = 0.2$ and $\sigma = 3$ to match per capita income growth trend in US-North and US-South during AD1700-AD1840.

Land acquisition and slavery trade abolition: For United States land acquisition, we assume the land areas of both US-North and US-South to be raised by factors of $\frac{864,746}{349,250}$, $\frac{1,681,828}{864,746}$ and $\frac{2,940,042}{1,681,828}$ in AD1790, AD1810 and AD1850 respectively. For slavery trade abolition, we raise f^N and f^S to prohibitively-high levels $f^N = f^S = 1$ from AD1810 onwards.

Table 9 summarizes the benchmark parameters and initial values:

[21] Note that our Cobb-Douglas production function formulation implies that $w_t^A = \alpha y_t^A$ and $w_t^B = \alpha y_t^B$. Also, we use average decennial migration during AD1700-AD1770 instead of the decennial migration during AD1700-AD1710 to sort out the fluctuations in number of migrants during the eighteenth century.

TABLE 9.

Calibrated parameters, reversal of fortune between US-North and US-South, AD1700-AD1860

Symbol	Interpretation	Value	
		US-North (N)	US-South (S)
Parameters			
T^A	Land area in American region	424,397 for AD1700-AD1789 $424,397 \times \frac{864,746}{349,250}$ for AD1790-AD1809 $424,397 \times \frac{1,681,828}{349,250}$ for AD1810-AD1849 $424,397 \times \frac{2,940,042}{349,250}$ for AD1850-AD1860	480,157 for AD1700-AD1789 $480,157 \times \frac{864,746}{349,250}$ for AD1790-AD1809 $480,157 \times \frac{1,681,828}{349,250}$ for AD1810-AD1849 $480,157 \times \frac{2,940,042}{349,250}$ for AD1850-AD1860
T^B	Land area in Britain	310,813	310,813
m	Willingness to migrate	369,048	18,870
f	Slavery trade cost parameter	0.000436 for AD1700-AD1809 1 for AD1810-AD1860	0.0000402 for AD1700-AD1809 1 for AD1810-AD1860
g^{L^H}	White natural population growth rate in American region	0.29	0.15
g^{L^F}	Black natural population growth rate in American region	0.24	0.21
g^{L^B}	Natural population growth rate in Britain	0.086	0.086
μ^A	Productivity growth parameter (U.S.)	0.2	0.2
μ^B	Productivity growth parameter (Britain)	0.079 for AD1700-AD1819 0.170 for AD1820-AD1860	0.079 for AD1700-AD1819 0.170 for AD1820-AD1860
α	Production function parameter	0.4	0.4
Initial conditions in AD1700			
L_1^H	Initial White population in American region	141,000	99,000
L_1^F	Initial Black population in American region	6,000	16,000
L_1^B	Initial population in Britain	10,490,000	10,490,000
z_1^A	Initial productivity level in American region	1.15	2.52
z_1^B	Initial productivity level in Britain	17.0	17.0

Inspecting Table 9, the most important structural differences between US-North and US-South lie in the divergence of natural population growth rates ($g^{L^{HN}} = 0.29$, $g^{L^{FN}} = 0.24$ and $g^{L^{HS}} = 0.15$, $g^{L^{FS}} = 0.21$), British willingness to migrate ($m^N = 369,048$ versus $m^S = 18,870$) and slavery trade cost parameter ($f^N = 0.000436$ versus $f^S = 0.0000402$).

5.2. Simulation: US-North and US-South AD1700-AD1860

Figure 2 depicts the simulated development paths for US-North (blue solid lines) and US-South (red dashed line) during AD1700-AD1860, with the (blue) dots and (red) crosses representing their respective data points implied from Table 2 to Table 7. The panels show the evolution of (a) per capita income in US-North and US-South, (b) productivity growth rate in US-North and US-South, (c) White population share in US-North and US-South, (d) number of White migrants to US-North and US-South, (e) number of Black slaves imported to US-North and US-South, and (f) per capita income in Britain during AD1700-AD1860.

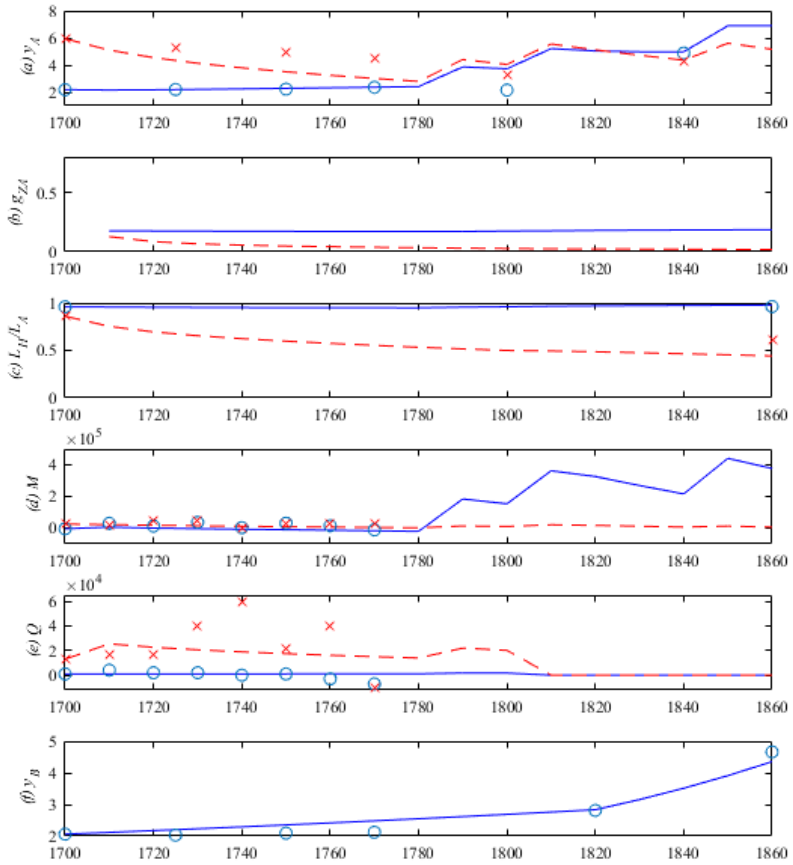
US-South was initially more prosperous than US-North (panel (a)), thanks to its higher starting productivity. Yet, the lower British willingness to migrate to US-South and the lower slavery trade cost parameter in US-South prior to AD1810 encouraged the import of African slaves there (panel (e)). Consequently, the Black population was relatively building up in US-South (panel (c)). Through population composition effect on productivity growth and population dilution effect, US-South suffered from a significant per capita income decline prior to AD1780 (panel (a)). On the other hand, US-North enjoyed a faster productivity growth during AD1700-AD1860 (panel (b)), allowing it to overtake US-South in terms of per capita income level in around AD1820 (panel (a)). After the overtake, US-South was still suffering from slow productivity growth due to its persistently low White population share (panel (c)), and its per capita income was lagging behind US-North in the remaining simulation periods.

From our simulation result, at AD1840 US-South would possess 0.88 of per capita income enjoyed by US-North. And population composition effect on productivity growth is crucial to this result. If we run a counterfactual simulation that evades the population composition effect (by setting $\sigma = 0$), then at AD1840 US-South would possess 3.8 times per capita income of US-North.[22]

Our next question is what accounts for the structural parameter differences (lower g^{L^H}, g^{L^F}, m, f in US-South), which in turn explains the divergence between US-North and US-South. In the next subsection we propose the GeoPopulation-Institution hypothesis to provide an explanation.

[22]Lindert, and Williamson (2016b, 110) stated that it is hard to identify the importance of slavery in determining US-South's relative decline during AD1774-AD1860, and our model provides a way to assess slavery's quantitative impact on the reversal of fortune.

FIG. 2. Development paths, US-North and US-South, AD1700-AD1860



Note: Solid (blue) lines: US-North. Dashed (red) lines: US-South, parameters from Table 9. The panels show evolution of (a) per capita income in US-North and US-South, (b) productivity growth rate in US-North and US-South, (c) White population share in US-North and US-South, (d) number of White migrants to US-North and US-South, (e) number of Black slaves imported to US-North and US-South, and (f) per capita income in Britain during AD1700-AD1860. (Blue) Dots are the implied US-North data, while (red) crosses are the implied US-South data from Table 2 to Table 7.

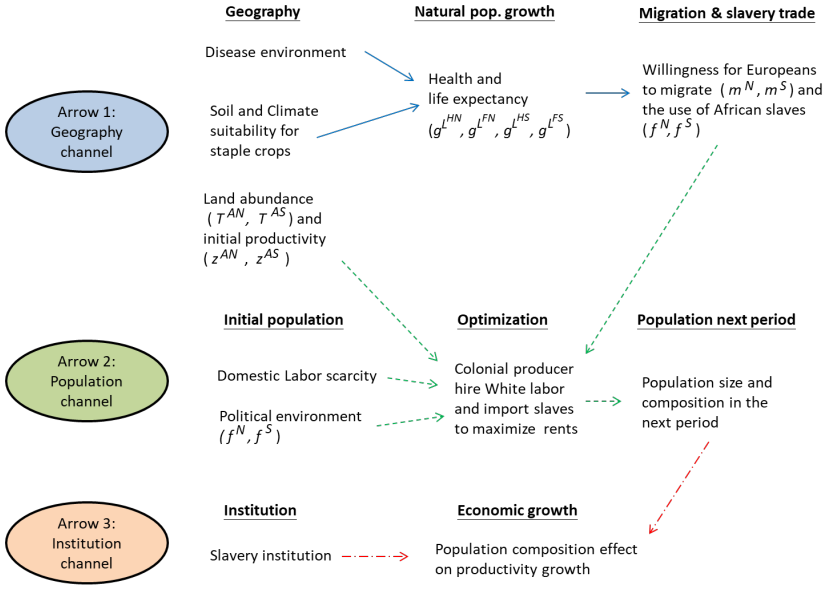
5.3. The GeoPopulation-Institution Hypothesis

The GeoPopulation-Institution hypothesis, as its name suggests, highlights the interplay among geography, population and institution in explaining American development and divergence during the colonization era.

The core content of the hypothesis is that, whenever its geographic or political environments relatively favored the buildup of Black slaves (or more generally, non-White forced labor), through slavery institution that disincentivized the Blacks to make improvements, an American region/country was likely to be cursed by the reversal of fortune. From our calibration in the previous subsection, the region being cursed by the reversal of fortune (US-South) possessed low natural population growth rates ($g^{L^{HS}}$, $g^{L^{FS}} < g^{L^{HN}}$, $g^{L^{FN}}$), low European willingness to migrate ($m^S < m^N$) and low slavery trade cost parameter ($f^S < f^N$). We will argue how the GeoPopulation-Institution hypothesis explains these parameter differences.

Figure 3 depicts the breakdown of GeoPopulation-Institution hypothesis, which can be split into three components: the geography channel, the population channel and the institution channel.

FIG. 3. Breakdown of GeoPopulation-Institution hypothesis



For the geography channel, disease environment, soil and climate suitability for growing staple crops affected mortalities and life expectancies, generating different degrees of attractiveness to potential European settlers and the use of African slaves in US-North and US-South. The warm and humid climate of US-South was hospitable to malaria, yellow fever and hookworm, continuing to threaten the local health environment (Savitt, and Young 1988, ch.2-4, McCandless 2011, ch.3). Making the health prob-

lem worse in the lowcountry area was that the factor endowments there fostered rice cultivation, putting laborers to work under a rigorous regime (Galenson 1981b, 154-156). These made US-South an unhealthy place, as reflected by the shorter life expectancies when compared to US-North (Table 10). Hence US-South possessed a slower natural population growth ($g^{L^{HS}}$, $g^{L^{FS}} < g^{L^{HN}}$, $g^{L^{FN}}$) and discouraged Europeans from immigrating ($m^S < m^N$). On the other hand, the Africans "had developed better biological defenses against the troublesome parasites" (Rutman, and Rutman 1976, 35, Silver 1990, 160), making them an attractive labor choice in the plantation complex in US-South ($f^S < f^N$).[23] Summarizing this channel, low natural population growth rates would be associated with low European willingness to migrate and small slavery trade cost parameter.

TABLE 10.

Estimates of life expectancy at age 30 in selected counties, the Thirteen Colonies/United States, the eighteenth century

Place and time	Life expectancy at 30
US-North	
Hingham, Mass., 1721-1800	38.4/38.6
Salem, Mass., 18th c.	30.3
Andover, Mass., 1730-1759	36.3
East Haven, Conn., 1773-1822	36.4
Philadelphia gentry, 1700-1800	31.2/33.7
US-South	
Maryland legislators, Native 1700-1767	27
Immigrant 1700-1758	26.6
Middlesex County, Vir., 1650-1710	19.4
Perquimans County, NC., 18th c.	23.1

Source: Wells (1992) Table 3.

For the population channel, corresponding to the willingness of European migration and the use of slaves created by the geography channel, as well as domestic labor scarcity and political environment, transatlantic migration and slavery trade took place and shaped the demographic process. In US-North, the "hostility" of White labors rendered the use of Black slaves "unprofitable" ($f^S < f^N$) (Litwack 1961, 6). Taking European willingness to migrate (m^N, m^S), slavery trade cost parameter (f^N, f^S) and domestic labor scarcity into account, colonial producers would make deci-

[23]This might also be one reason contributing to the higher Black natural population growth rate than the White's in US-South in Table 10. In contrast, in US-North, the winters there might have been "unfavourable to the African constitution", making the Whites a preferred labor choice to the Blacks (Litwack 1961, 4).

sions on White labor hiring and Black slavery import to maximize their rents, altering population size and composition in the colonies (sections 4.1.1 and 4.1.2). Colonial producers would import more African slaves if White labors were scarce, or if it was less costly to import African slaves.[24] That means, low European willingness to migrate and low slavery trade cost parameter would lead to the relative buildup of Black slaves in US-South. By the eve of the American Revolution, these turned US-South into a settlement region characterized by a higher Black population share (Table 6). In addition, two geographic factors — initial productivity (z_1^{AN}, z_1^{AS}) and land abundance (T^{AN}, T^{AS}) would also contribute to population evolution.[25] Ceteris paribus, the higher initial productivity or the larger land area was, the more Europeans migrating for the higher colony wage and slaves being imported by the colonial producer would be; this speeded up the population stockpile.

For the institution channel, the change in White-Black population mix would affect economic growth through the population composition effect on productivity growth (section 4.1.3). The slavery institution deprived the Blacks from the rights to property and choice of work, and disincentivized them from learning, innovating and making improvements (Smith 1994, Emerson 1844[2004], Fogel, and Engerman 1989, Acemoglu, and Robinson 2012). In contrast, White labors, who usually came in the form of indentured servants, retained basic legal rights during the indenture period and were set free after the indenture expired (section 3). The wage the free Whites earned would encourage them to propagate their work.[26] Therefore the greater the Black population share was, the slower productivity growth would be. The relative buildup of Black slaves in US-South was detrimental to economic progress in the long run and eventually caused the region's relative decline.

We emphasize again, in our GeoPopulation-Institution hypothesis, that natural geography, population structure and slavery institution are inte-

[24] Galenson (1981b, 149-156, 1984) stated that, from the mid-seventeenth to eighteenth centuries, facing the short supply and rising relative price of English servants, colonial planters in West Indies, the Chesapeake, South Carolina, and Georgia turned from White servants to Black slaves as the primary source of bound labor.

[25] Before American industrialization, productivity mainly refers to whether the land could grow valuable crops for sale. For example, US-South was blessed with fertile soil, long, warm and humid summers, making it suitable for growing cash crops (tobacco, rice, indigo, cotton, etc.).

[26] Smith (1994, 93) stated that, "[t]he liberal reward of labour, as it encourages the propagation, so it increases the industry of the common people. The wages of labour are the encouragement of industry, which, like every other human quality, improves in proportion to the encouragement it receives."

grated components in explaining development and divergence in the Thirteen Colonies/United States during the colonization era. Without geography, we could explain neither the relative growth of the Black population in US-South (disease environment and soil/climate suitability for staple crops). Without slavery institution, we could not account for the reversal of fortune between US-North and US-South (disincentivized Blacks in learning and improving). The population channel (demographic process of White-Black population evolution) provides the key linkage through which geography and institution interact to foster Thirteen Colonies/United States development and divergence during the colonization era.

To summarize this section, our unified growth model simulated demographic-economic evolution in US-North and US-South, and replicated the reversal of fortune between the two regions. We proposed the GeoPopulation-Institution hypothesis to account for the in-depth reasons behind the reversal of fortune.

6. DISCUSSION

6.1. Population composition effect on growth

In our theory, the population composition effect on productivity growth provides the crucial link between geography and institution to account for the reversal of fortune in the United States. Our theory does not claim that the Black people were by themselves burden for economic growth. Indeed, the slavery institution that dissipated liberal returns to Blacks' labor was the crux to this effect. More generally, social stratification, either politically, economically, socially or culturally, can have implications on actual or perceived discrimination, affecting a country's ability to engage in technological or organizational progress (Bénabou 2005), or even threatening national security (Gurr 1993).[27] Taking this into account in designing incentive systems to promote learning and propagation would be important for nations to realize their full growth potentials.

Our theory of population composition effect on productivity growth also has implications on the post-AD1860s divergence between US-North and US-South. One crucial component of our theory is legal asymmetry between the Whites and the Blacks under slavery institution during the

[27]Societies being stratified by income, power, age, gender, race and ethnicity, and so on, is perhaps a never-ending issue. Marx, and Engels (1888[1848], 12) put, "[t]he history of all hitherto existing society is the history of class struggles." They reviewed how the capitalist class displaced the feudal aristocracy as the supreme class in the modern society, and predicted that the capitalist exploitation of workers would lead to social revolutions that overthrow the capitalist system itself.

colonization era. The implication is that, after the abolition of slavery institution in the United States in AD1865, the population composition effect would fade away. Still, US-North with higher productivity at the time of abolition of slavery institution would retain its per capita income lead. Hence the early divergence pattern between US-North and US-South emerged by the late-nineteenth century persists till today.[28]

6.2. Eurasian UGT versus American UGT

Our theory addresses one issue that traditional unified growth theories fail to convey: the absolute decline of per capita income in American countries during the colonization era. Traditional unified growth theories (Galor, and Weil 2000, Galor, and Moav 2002) predict that over the course of economic development, an economy experiences first Malthusian income stagnation, and then Post-Malthusian and Modern Growth when per capita income keeps on rising. However, we witness absolute per capita income declines in the Thirteen Colonies during AD1700-AD1774 (Table 2), as well as in Spanish-Mexico and in Caribbean countries during AD1700-AD1820 (Coatsworth 2005, Table 1). Our model reconciles the absolute decline pattern in the Thirteen Colonies (panel (a) in Figure 2). The underlying mechanism is that transatlantic migration and slavery trade added demographic pressure into the starting-thin American population. In the eighteenth century when productivity growth was slow, such demographic pressure exerted a significant and dominant population dilution effect on per capita income, leading to the absolute per capita income declines. Yet, for the sake of simplicity, we have treated variables like fertility, food prices as outside and constant factors in our model. It would be interesting to consider how these variables are codetermined in unified growth models.[29]

More generally, we need two sets of unified growth theories to explain the world economic history, one for the Eastern Hemisphere (Eurasian UGT) and another for the Western Hemisphere (American UGT). In the Eastern Hemisphere, during the long Malthusian era, domestic population stock-

[28] In reality, the fading of population composition effect might take a long time. For example, in the United States, slavery institution was abolished in AD1865 (Thirteenth Amendment to the United States Constitution), but equal opportunities to race were legislated nearly a century later (The Civil Rights Act of 1964).

[29] For example, Malthus (1826, 517) stated that the fast population growth in the United States at the time of his writing was the result of a combination of factors:
"[O]n account of the extreme cheapness of good land, and a situation favourable to the exportation of grain, a capital could not be more advantageously employed than in agriculture; which, at the same time that it affords the greatest quantity of healthy work, supplies the most valuable produce to the society. The consequence of these favourable circumstances united, was a rapidity of increase almost without parallel in history."

piled and productivity advanced due to the population scale effect on productivity growth. At some point in time productivity growth was fast enough so that economies broke away from the Malthusian Trap of income stagnation, and entered the Post-Malthusian or Modern Growth era (Galor, and Weil 2000). This characterizes the historical experience of Eurasian countries. However, in the Western Hemisphere, it was not the native Indians who built up large enough population stocks for ideas to spread and pulled the economies out of the Malthusian Trap. They had been destroyed even before they had a chance to do so. Since the arrival of Christopher Columbus in AD1492, the Europeans brought along with them "guns, germs and steel" to conquer the New World at a dramatic rate. At the time of the collapse of the Inca Empire in AD1533, the population density in America was about thirty-times thinner than that in Europe (Maddison 2003, 113), while the American productivity level (in terms of wide adoption of iron tools) lagged the European counterpart by more than two millennia (Diamond 1997, Table 18.1). According to the European experience, both the population density and productivity level in America were far from reaching the Post-Malthusian cutting edges.

It was at this time that the Columbian Exchange of human population took place in the American landscapes, where the native American Indians were rapidly replaced by European Whites and African Blacks from the other side of the Atlantic Ocean, generating structural breaks on the original Malthusian population-productivity evolution dynamics, and furnishing the New World with a new start.[30] Therefore AD1492 would be a natural starting point for us to construct unified growth theories for the Western Hemisphere, when transatlantic labor movement and slavery institution soon followed.[31] Due to data availability, our model simulation starts with AD1700 but we believe our unified growth theory applies to America since Christopher Columbus and his crews spotted the New Land

[30] Since Christopher Columbus's arrival, in the next three centuries American countries in general experienced first Indian depopulations and then fast rates of Whites and Blacks reproduction. From Maddison (2008), the population in the future United States was two million in AD1500, and it dropped to one million in AD1700, and then it rebounded to about ten million in AD1820. For Latin America, the figures were about eighteen million in AD1500, about nine million in AD1600 and about twenty-two million in AD1820. Diamond (1997, 354) labeled the capture of Atahuallpa, the last independent ruler in Inca Empire, as a symbol of the "collision of hemispheres", when then the largest population replacement in recorded history began in America's land.

[31] Borrowing Blaut (1992, 1)'s words: "the date 1492 represents the breakpoint between two fundamentally different evolutionary epochs."

and set foot on the New World.[32] By the late-nineteenth century, the Whites and the Blacks had built up large enough population and productivity levels in America, and the slavery institutions had been abolished. Then the unified growth theories in the two Hemispheres converged to explain the development in individual nations and divergence in the world economy in the centuries to come.

7. CONCLUSION

This paper investigates how geography, population and institution fostered the evolution of European settlement, African slavery import and the standard of living in the Thirteen Colonies/United States during the colonization era. To reconcile the reversal of fortune between US-North and US-South (Lindert, and Williamson 2016a), we construct a unified growth model with transatlantic migration and slavery trade, where the pace of productivity growth depends on the White-Black population structure. Slavery institution deprives Black slaves' labor and wealth, removing their incentives to learn and make improvements. Therefore, the US-South, featured with a greater Black population share, was less conducive to economic progress and suffered from reversal of fortune during the colonization era. From the calibration, the root causes of the relative fall of the US-South economy were its poorer demographic performance, lower Whites' willingness to immigrate and smaller slavery trade cost parameter.

We put forward the GeoPopulation-Institution hypothesis to account for the above parameter differences. The hypothesis can be split into three parts: (1) the geography channel: disease environment, soil and climate conditions discouraged European migration and promoted African slavery import in US-South; (2) the population channel: this translated into the relative buildup of Black slavery population in US-South; and (3) the institution channel: through the population composition effect on productivity growth, US-South suffered from a relative economic decline.

The reversal of fortune between US-North and US-South is just one episode to show how we can use the unified growth model and the GeoPopulation-Institution hypothesis to reconcile development and divergence in the Western Hemisphere during the colonization era. We believe that geographic factors (disease environment, soils and climates, resource abundance, territory expansion), population structure (White, Black and Indian labor) and

[32] See Christopher Columbus's quote ahead of the Introduction. Columbus brought the idea of taking advantage of the "brazilwood" and Indian "slaves" in West Indies during his third voyage in AD1498.

labor market institutions (slavery institution, overseas slavery trade abolition, migration restriction, forced labor systems) are inseparable elements in explaining the rise and fall of nations in American landscapes during the colonization era. Further research efforts to study how demographic-economic variables interact with socio-political environment in time- and spatial-specific contexts to shape the wealth of nations in the American continents will surely improve our understanding on the world economic history, as well as our ability to shape the future.

APPENDIX: INTERNAL ADJUSTMENT MECHANISMS IN THE MODEL

Propositions 1 to 4 state four internal adjustment mechanisms in our model: they show how productivity growth, natural population growth, land acquisition and increase in slavery trade cost drive the evolution of numbers of migrants and imported slaves across time:

PROPOSITION 1 (Productivity growth effect on migration and slavery trade). $\frac{\partial M_t}{\partial z_t^A} > 0$ *and* $\frac{\partial Q_t}{\partial z_t^A} > 0$*;* $\frac{\partial M_t}{\partial z_t^B} < 0$ *and* $\frac{\partial Q_t}{\partial z_t^B} > 0$

(i) Ceteris paribus, productivity growth in country A raises the numbers of migrants and slaves imported to country A, that is, $\frac{\partial M_t}{\partial z_t^A} > 0$ *and* $\frac{\partial Q_t}{\partial z_t^A} > 0$.

(ii) On the other hand, productivity growth in country B reduces the number of migrants and raises the number of slaves imported to country A, that is, $\frac{\partial M_t}{\partial z_t^B} < 0$ *and* $\frac{\partial Q_t}{\partial z_t^B} > 0$.

Proof. Use (2), (11), (13) to get $M_t = m[z_t^A \cdot \alpha(L_t^A)^{\alpha-}(T^A)^{1-\alpha} - z_t^B \cdot \alpha(L_t^B)^{\alpha-1}(T^B)^{1-\alpha}]$, with (4), (5), (7) we obtain

$$M_t = m\left\{ z_t^A \cdot \alpha \left[\underbrace{(1+g^{L^H})L_{t-1}^H + M_t + (1+g^{L^F})L_{t-1}^F + Q_t}_{L_t^A} \right]^{\alpha-1} (T^A)^{1-\alpha} - z_t^B \cdot \alpha \left[\underbrace{(1+g^{L^B})L_{t-1}^B}_{L_t^B} \right]^{\alpha-1} (T^B)^{1-\alpha} \right\}. \tag{A.1}$$

Note (13) and (14) implies

$$w_t^A = 2fQ_t. \tag{A.2}$$

Taking total derivatives of (A.1) with respect to z_t^A to obtain

$$\frac{\partial M_t}{\partial z_t^A} = m\alpha(T^A)^{1-\alpha}\left[(L_t^A)^{\alpha-1} + z_t^A(\alpha-1)(L_t^A)^{\alpha-2}\left(\frac{\partial M_t}{\partial z_t^A} + \frac{\partial Q_t}{\partial z_t^A}\right)\right]. \tag{A.3}$$

Taking total derivatives of (A.2) with respect to z_t^A, and make use of $\frac{\partial M_t}{\partial z_t^A} = m\frac{\partial w_t^A}{\partial z_t^A}$ (from (2)) to obtain

$$\frac{\partial Q_t}{\partial z_t^A} = \left(\frac{1}{2fm}\right)\frac{\partial M_t}{\partial z_t^A}. \tag{A.4}$$

Combine (A.3) and (A.4) to get

$$\frac{\partial M_t}{\partial z_t^A} = \frac{m\alpha(L_t^A)^{\alpha-1}(T^A)^{1-\alpha}}{1 - m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(1+\frac{1}{2fm}\right)} > 0. \tag{A.5}$$

By (A.4) $\frac{\partial Q_t}{\partial z_t^A} > 0$ too.

Taking total derivatives of (A.1) with respect to z_t^B to obtain

$$\frac{\partial M_t}{\partial z_t^B} = m\left[\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(\frac{\partial M_t}{\partial z_t^B} + \frac{\partial Q_t}{\partial z_t^B}\right) - \alpha(L_t^B)^{\alpha-1}(T^B)^{1-\alpha}\right]. \tag{A.6}$$

Use (3), (4), (5) to rewrite (13) as $w_t^A = z_t^A \cdot \alpha[(1+g^{L^H})L_{t-1}^H + M_t + (1+g^{L^F})L_{t-1}^F + Q_t]^{\alpha-1}(T^A)^{1-\alpha}$. Taking total derivatives of this expression and (A.2) with respect to z_t^B, we get

$$\begin{aligned} \frac{\partial Q_t}{\partial z_t^B} &= \frac{1}{2f}\left[\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(\frac{\partial M_t}{\partial z_t^B} + \frac{\partial Q_t}{\partial z_t^B}\right)\right] \\ \text{or } \frac{\partial Q_t}{\partial z_t^B} &= \frac{\frac{1}{2f}\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}}{1-\frac{1}{2f}\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}} \cdot \frac{\partial M_t}{\partial z_t^B}. \end{aligned} \tag{A.7}$$

Plug (A.7) into (A.6), rearranging to get

$$\frac{\partial M_t}{\partial z_t^B} = \frac{-m\alpha(L_t^B)^{\alpha-1}(T^B)^{1-\alpha}}{1 - m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left[\frac{1}{1-\frac{1}{2f}\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}}\right]} < 0. \tag{A.8}$$

By (A.7), $\frac{\partial Q_t}{\partial z_t^B} > 0$. ∎

Explanation: (i) Productivity growth in colony raises colony wage and marginal product of Black labor, thereby raising M_t and Q_t. (ii) Productivity growth at home raises home wage and reduces migrants M_t. Marginal product of Black labor in colony increases and so Q_t rises.

PROPOSITION 2 (Natural population growth effect on migration and slavery trade). $\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}} < 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}} < 0$ *;* $\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}} < 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}} < 0$*;* $\frac{\partial M_t}{\partial(1+g^{L^B})L^B_{t-1}} > 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^B})L^B_{t-1}} < 0$

(i) Ceteris paribus, White natural population growth in country A reduces the numbers of migrants and slaves imported to country A, that is, $\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}} < 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}} < 0$.

(ii) Similarly, Black natural population growth in country A reduces the numbers of migrants and slaves imported to country A, that is, $\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}} < 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}} < 0$.

(iii) On the other hand, natural population growth in country B raises the number of migrants and reduces the number of slaves imported to country A, that is, $\frac{\partial M_t}{\partial(1+g^{L^B})L^B_{t-1}} > 0$ *and* $\frac{\partial Q_t}{\partial(1+g^{L^B})L^B_{t-1}} < 0$.

Proof. Taking total derivatives of (A.1) with respect to $(1+g^{L^H})L^H_{t-1}$, which reflects the White population originating from natural increase at time t, to obtain

$$\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}} = mz_t^A\alpha(\alpha-1)(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left[1+\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}}+\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}}\right]. \tag{A.9}$$

Taking total derivatives of (A.2) with respect to $(1+g^{L^H})L^H_{t-1}$ to obtain $\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}} = \left(\frac{1}{2f}\right)\frac{\partial w_t^A}{\partial(1+g^{L^H})L^H_{t-1}}$. Note from (2) that $\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}} = m\frac{\partial w_t^A}{\partial(1+g^{L^H})L^H_{t-1}}$, which implies

$$\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}} = \left(\frac{1}{2fm}\right)\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}}. \tag{A.10}$$

Combine (A.9) and (A.10) to get

$$\frac{\partial M_t}{\partial(1+g^{L^H})L^H_{t-1}} = \frac{m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}}{1-m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}(1+\frac{1}{2fm})} < 0. \tag{A.11}$$

By (A.10) $\frac{\partial Q_t}{\partial(1+g^{L^H})L^H_{t-1}} < 0$ too.

Taking total derivatives of (A.1) with respect to $(1+g^{L^F})L^F_{t-1}$, which reflects the Black population originating from natural increase at time t,

to obtain

$$\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}} = mz^A_t\alpha(\alpha-1)(L^A_t)^{\alpha-2}(T^A)^{1-\alpha}\left[1+\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}}+\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}}\right]. \tag{A.12}$$

Taking total derivatives of (A.2) with respect to $(1+g^{L^F})L^F_{t-1}$ to obtain $\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}} = \left(\frac{1}{2f}\right)\frac{\partial w^A_t}{\partial(1+g^{L^F})L^F_{t-1}}$. Note from (2) that $\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}} = m\frac{\partial w^A_t}{\partial(1+g^{L^F})L^F_{t-1}}$, which implies

$$\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}} = \left(\frac{1}{2fm}\right)\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}}. \tag{A.13}$$

Combine (A.12) and (A.13) to get

$$\frac{\partial M_t}{\partial(1+g^{L^F})L^F_{t-1}} = \frac{m\alpha(\alpha-1)z^A_t(L^A_t)^{\alpha-2}(T^A)^{1-\alpha}}{1-m\alpha(\alpha-1)z^A_t(L^A_t)^{\alpha-2}(T^A)^{1-\alpha}\left(1+\frac{1}{2fm}\right)} < 0. \tag{A.14}$$

By (A.13) $\frac{\partial Q_t}{\partial(1+g^{L^F})L^F_{t-1}} < 0$ too.

Taking total derivatives of (A.1) with respect to $(1+g^{L^B})L^B_{t-1}$, which reflects country B's population originating from natural increase at time t, yields

$$\frac{\partial M_t}{\partial(1+g^{L^B})L^B_{t-1}} = -m\alpha(\alpha-1)z^B_t(L^B_t)^{\alpha-2}(T^B)^{1-\alpha} > 0. \tag{A.15}$$

Taking total derivatives of (A.2) with respect to $(1+g^{L^B})L^B_{t-1}$ to get

$$\frac{\partial Q_t}{\partial(1+g^{L^B})L^B_{t-1}} = \left(\frac{1}{2f}\right)\frac{\partial w^A_t}{\partial(1+g^{L^B})L^B_{t-1}}. \tag{A.16}$$

Use (3), (4), (5) to rewrite (13) as $w^A_t = z^A_t\cdot\alpha[(1+g^{L^H})L^H_{t-1}+M_t+(1+g^{L^F})L^F_{t-1}+Q_t]^{\alpha-1}(T^A)^{1-\alpha}$. Taking total derivatives with respect to $(1+g^{L^B})L^B_{t-1}$ and plug it into (A.16) to obtain

$$\frac{\partial Q_t}{\partial(1+g^{L^B})L^B_{t-1}} = \frac{\frac{1}{2f}\alpha(\alpha-1)z^A_t(L^A_t)^{\alpha-2}(T^A)^{1-\alpha}\frac{\partial M_t}{\partial(1+g^{L^B})L^B_{t-1}}}{1-\frac{1}{2f}\alpha(\alpha-1)z^A_t(L^A_t)^{\alpha-2}(T^A)^{1-\alpha}} < 0, \tag{A.17}$$

where we have use (A.15). ∎

Explanation: (i), (ii) Rising natural population in colony reduces colony wage and marginal product of Black labor, thereby lowering M_t and Q_t. (iii) Natural population growth at home lowers home wage and increases migrants M_t. Marginal product of Black labor in colony decreases and so Q_t falls.

PROPOSITION 3 (Land acquisition effect on migration and slavery trade). $\frac{\partial M_t}{\partial T^A} > 0$ *and* $\frac{\partial Q_t}{\partial T^A} > 0$ *Ceteris paribus, land expansion in country A raises the numbers of migrants and slaves imported to country A, that is,* $\frac{\partial M_t}{\partial T^A} > 0$ *and* $\frac{\partial Q_t}{\partial T^A} > 0$.

Proof. Taking total derivatives of (A.1) with respect to T^A to get

$$\frac{\partial M_t}{\partial T^A} = m\left[z_t^A \alpha(1-\alpha)(L_t^A)^{\alpha-1}(T^A)^{-\alpha} + z_t^A \alpha(\alpha-1)(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(\frac{\partial M_t}{\partial T^A} + \frac{\partial Q_t}{\partial T^A}\right)\right]. \tag{A.18}$$

Taking total derivatives of (A.2) with respect to T^A, together with $\frac{\partial M_t}{\partial T^A} = m\frac{\partial w_t^A}{\partial T^A}$ (from (2)) to get

$$\frac{\partial Q_t}{\partial T^A} = \left(\frac{1}{2fm}\right)\frac{\partial Q_t}{\partial T^A}. \tag{A.19}$$

Combine (A.18) and (A.19) to obtain

$$\frac{\partial M_t}{\partial T^A} = \frac{mz_t^A \alpha(1-\alpha)(L_t^A)^{\alpha-1}(T^A)^{-\alpha}}{1 - mz_t^A \alpha(\alpha-1)(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(1+\frac{1}{2fm}\right)} > 0. \tag{A.20}$$

By (A.19) $\frac{\partial Q_t}{\partial T^A} > 0$ too. ∎

Explanation: Land expansions would increase the marginal products of White and Black labor in the colony, encouraging White migration and Black slavery import.

PROPOSITION 4 (Slavery-trade-cost-increase effect on migration and slavery trade). $\frac{\partial M_t}{\partial f} > 0$ *and* $\frac{\partial Q_t}{\partial f} < 0$ *Ceteris paribus, an increase in slavery trade cost parameter raises the number of migrants and reduces the number of slaves imported to country A, that is,* $\frac{\partial M_t}{\partial f} > 0$ *and* $\frac{\partial Q_t}{\partial f} < 0$.

Proof. Taking total derivatives of (A.1) with respect to f to obtain

$$\frac{\partial M_t}{\partial f} = mz_t^A \alpha(\alpha-1)(L_t^A)^{\alpha-1}(T^A)^{1-\alpha}\left(\frac{\partial M_t}{\partial f} + \frac{\partial Q_t}{\partial f}\right). \tag{A.21}$$

Taking total derivatives of (A.2) with respect to f to get $\frac{\partial w_t^A}{\partial f} = 2f\frac{\partial Q_t}{\partial f} + 2Q_t$. Note from (2) that $\frac{\partial M_t}{\partial f} = m\frac{\partial w_t^A}{\partial f}$, which implies

$$\frac{\partial Q_t}{\partial f} = -\frac{1}{f}Q_t + \left(\frac{1}{2fm}\right)\frac{\partial M_t}{\partial f}. \tag{A.22}$$

Combine (A.21) and (A.22) to get

$$\frac{\partial M_t}{\partial f} = \frac{-m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(\frac{1}{f}Q_t\right)}{1-m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(1+\frac{1}{2fm}\right)} > 0. \tag{A.23}$$

Plug (A.23) into (A.22) to get

$$\frac{\partial Q_t}{\partial f} = -\frac{1}{f}Q_t\left[\frac{1-m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}}{1-m\alpha(\alpha-1)z_t^A(L_t^A)^{\alpha-2}(T^A)^{1-\alpha}\left(1+\frac{1}{2fm}\right)}\right] < 0. \tag{A.24}$$

∎

Explanation: The increase in slavery trade cost parameter f reduces slavery import. This will raise marginal product of White labor and hence their wage in the colony (when compared to the case of no rise in f), thereby attracting more White migration to the colony.

REFERENCES

Acemoglu, Daron, Simon Johnson, and James A. Robinson, 2001. The Colonial Origins of Comparative Development: An Empirical Investigation. *The American Economic Review* **91(5)**, 1369-1401.

Acemoglu, Daron and James A. Robinson, 2012. Why nations fail : the origins of power, prosperity, and poverty. 1st ed. New York: Crown Publishers.

Allen, Robert C., Tommy E. Murphy, and Eric B. Schneider, 2012. The Colonial Origins of the Divergence in the Americas: A Labor Market Approach. *The Journal of Economic History* **72(4)**, 863-894.

Ashraf, Quamrul and Oded Galor, 2013. The "Out of Africa" Hypothesis, Human Genetic Diversity, and Comparative Economic Development. *The American Economic Review* **103(1)**, 1-46.

Barbier, Edward, 2011. Scarcity and frontiers : how economies have developed through natural resource exploitation. Cambridge, UK: Cambridge University Press.

Bénabou, Roland, 2005. Inequality, Technology and the Social Contract. In Handbook of economic growth. Edited by Philippe Aghion and Steven N. Durlauf, 1595-1638. Amsterdam: Elsevier.

Billington, Ray Allen, 1966. America's frontier heritage. New York: Holt, Rinehart & Winston.

Blaut, James M., 1992. 1492 : the debate on colonialism, Eurocentrism, and history. Trenton, New Jersey: Africa World Press.

Bloom, David E., David Canning, and Jaypee Sevilla, 2003. Geography and Poverty Traps. *Journal of Economic Growth* **8(4)**, 355-378.

Central Intelligence Agency, 2021. The World FactBook [cited August 3, 2021]. Available from http://www.cia.gov/.

Chanda, Areendam, C. Justin Cook, and Louis Putterman, 2014. Persistence of Fortune: Accounting for Population Movements, There Was No Post-Columbian Reversal. *American Economic Journal: Macroeconomics* **6(3)**, 1-28.

Coatsworth, John H., 2005. Structures, Endowments, and Institutions in the Economic History of Latin America. *Latin American Research Review* **40(3)**, 126-144.

Columbus, Christopher, 1498[2004]. In A History of Latin America (7th Edition). Edited by Benjamin Keen and Haynes Keith. Boston: Houghton Mifflin.

Corden, W. M. and J. P. Neary, 1982. Booming Sector and De-Industrialisation in a Small Open Economy. *The Economic journal (London)* **92(368)**, 825-848.

Denevan, William M., 1992. The Native population of the Americas in 1492. 2nd ed. Madison, Wisconsin: University of Wisconsin Press.

Diamond, Jared, 1997. Guns, germs, and steel : the fates of human societies. New York: W. W. Norton & Company.

Diamond, Jared, 2014. Reversals of national fortune, and social science methodologies. *Proceedings of the National Academy of Sciences — PNAS* **111(50)**, 17709-17714.

Diebolt, Claude and Faustine Perrin, 2013a. From Stagnation to Sustained Growth: The Role of Female Empowerment. AFC Working Papers Nr.4, 2013.

Diebolt, Claude and Faustine Perrin, 2013b. From Stagnation to Sustained Growth: The Role of Female Empowerment. *The American Economic Review* **103(3)**, 545-549.

Doepke, Matthias, 2004. Accounting for Fertility Decline During the Transition to Growth. *Journal of Economic Growth* **9(3)**, 347-383.

Easterly, William and Ross Levine, 2016. The European origins of economic development. *Journal of Economic Growth* **21(3)**, 225-257.

Emerson, Ralph Waldo, 1844[2004]. An Address Delivered in the Court-house in Concord, Massachusetts, on 1st August, 1844, on the Anniversary of the Emancipation of the Negroes in the British West Indies. In British Capitalism and Caribbean Slavery: The Legacy of Eric Williams. Edited by Barbara L. Solow and Stanley L. Engerman. Cambridge: Cambridge University Press.

Engerman, Stanley L. and Kenneth L. Sokoloff, 1997. Factor Endowments, Institutions, and Differential Paths of Growth among New World Economies: A View from Economic Historians of the United States. In How Latin America fell behind : essays on the economic histories of Brazil and Mexico, 1800-1914. Edited by Stephen H. Haber, 260-304. Stanford, Calif.: Stanford Unviversity Press.

Engerman, Stanley L. and Kenneth L. Sokoloff, 2013. Five Hundred Years of European Colonization: Inequality and Paths of Development. In Settler economies in world history. Edited by Christopher Lloyd, Jacob Metzer and Ricchard Sutch, 65-103. Boston: Brill.

Findlay, Ronald and Mats Lundahl, 1994. Natural Resources, Vent-for-Surplus, and the Staples Theory. In From classical economics to development economics. Edited by Gerald M. Meier, 68-93. Basingstoke, Hampshire: Macmillan Press.

Finkelman, Paul, 2012. Slavery in the United States: Persons or Property? In The legal understanding of slavery : from the historical to the contemporary. Edited by Jean Allain, 105-134. Oxford, U.K. : Oxford University Press.

Fogel, Robert William and Stanley L. Engerman, 1989. Time on the cross : the economics of American Negro slavery. New York: Norton.

Galenson, David W., 1981a. The Market Evaluation of Human Capital: The Case of Indentured Servitude. *Journal of Political Economy* **89(3)**, 446-467.

Galenson, David W., 1981b. White servitude in colonial America : an economic analysis. Cambridge: Cambridge University Press.

Galenson, David W., 1984. The Rise and Fall of Indentured Servitude in the Americas: An Economic Analysis. *The Journal of Economic History* **44(1)**, 1-26.

Galenson, David W., 1996. The Settlement and Growth of the Colonies: Population, Labor, and Economic Development. In The Cambridge economic history of the United States. Vol. 1, Colonial era. Edited by Stanley L. Engerman and Robert E. Gallman, 135-208. Cambridge: Cambridge University Press.

Galor, Oded and Omer Moav, 2002. Natural selection and the origin of economic growth. *Quarterly Journal of Economics* **117(4)**, 1133-1191.

Galor, Oded and Omer Moav, 2004. From Physical to Human Capital Accumulation: Inequality and the Process of Development. *Review of Economic Studies* **71(4)**, 1001-1026.

Galor, Oded and Omer Moav, 2006. Das Human-Kapital: A Theory of the Demise of the Class Structure. *Review of Economic Studies* **73(1)**, 85-117.

Galor, Oded, Omer Moav, and Dietrich Vollrath, 2009. Inequality in landownership, the emergence of human-capital promoting institutions, and the great divergence. *Review of Economic Studies* **76(1)**, 143-179.

Galor, Oded and Andrew Mountford, 2006. Trade and the Great Divergence: The Family Connection. *The American Economic Review* **96(2)**, 299-303.

Galor, Oded, and Andrew Mountford, 2008. Trading Population for Productivity: Theory and Evidence. *Review of Economic Studies* **75(4)**, 1143-1179.

Galor, Oded and David Nathan Weil, 1996. The Gender Gap, Fertility, and Growth. *The American Economic Review* **86(3)**, 374-387.

Galor, Oded and David Nathan Weil, 2000. Population, technology, and growth: From malthusian stagnation to the demographic transition and beyond. *The American Economic Review* **90(4)**, 806-828.

Gurr, Ted Robert, 1993. Why Minorities Rebel: A Global Analysis of Communal Mobilization and Conflict Since 1945. *International political science review* **14(2)**, 161-201.

Habakkuk, H. J., 1967. American and British technology in the nineteenth century: the search for labour-saving inventions. Cambridge: Cambridge University Press.

Hall, Robert E. and Charles I. Jones, 1999. Why do Some Countries Produce So Much More Output Per Worker than Others? *Quarterly Journal of Economics* **114(1)**, 83-116.

Hansen, Gary D. and Edward C. Prescott, 2002. Malthus to Solow. *The American Economic Review* **92(4)**, 1205-1217.

Harris, John R. and Michael P. Todaro, 1970. Migration, Unemployment and Development: A Two-Sector Analysis. *The American Economic Review* **60(1)**, 126-142.

Hayek, Friedrich A. von, 1963. The constitution of liberty. London: Routledge & Kegan Paul.

Hazan, Moshe and Binyamin Berdugo, 2002. Child Labour, Fertility, and Economic Growth. *Economic Journal* **112(482)**, 810-828.

Krugman, Paul, 1987. The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher. *Journal of development economics* **27(1-2)**, 41-55.

Lagerlof, N. P., 2003. From Malthus to Modern Growth: Can Epidemics Explain the Three Regimes? *International Economic Review* **44(2)**, 755-777.

Landes, David S., 1998. The wealth and poverty of nations: why some are so rich and some so poor. 1st ed. New York: W.W. Norton.

Levine, David, 1987. Reproducing families: the political economy of English population history. Cambridge: Cambridge University Press.

Lincoln, Abraham, 1859[1990]. In Lincoln on Democracy. Edited by Mario Matthew Cuomo and Harold Holzer. New York: HarperCollins.

Lindert, Peter H. and Jeffrey G. Williamson, 2013. American Incomes Before and After the Revolution. *The Journal of Economic History* **73(3)**, 725-765.

Lindert, Peter H. and Jeffrey G. Williamson, 2016a. American colonial incomes, 1650-1774. *Economic History Review* **69(1)**, 54-77.

Lindert, Peter H. and Jeffrey G. Williamson, 2016b. Unequal Gains: American Growth and Inequality since 1700. Princeton: Princeton University Press.

Litwack, Leon F., 1961. North of slavery: the Negro in the free States, 1790-1860. Chicago: University of Chicago Press.

Lord, William and Peter Rangazas, 2006. Fertility and Development: The Roles of Schooling and Family Production. *Journal of Economic Growth* **11(3)**, 229-261.

Maddison, Angus, 2003. The world economy: historical statistics. Edited by Cooperation Organisation for Economic and Centre Development. Development. Paris, France: Development Centre of the Organisation for Economic Co-operation and Development.

Maddison, Angus, 2008. Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD [cited April 1, 2016]. Available from http://www.ggdc.net/maddison/oriindex.htm.

Malaney, Pia and Jeffrey Sachs, 2002. The economic and social burden of malaria. *Nature* **415(6872)**, 680-685.

Malthus, Thomas Robert, 1826. An essay on the principle of population. 6th ed. London: John Murray.

Marshall, Alfred, 1895. Principles of economics. Third ed. London: Macmillan.

Marx, Karl and Frederick Engels, 1888[1848]. Manifesto of the Communist Party. Chicago: Charles H. Kerr & Company.

McCandless, Peter, 2011. Slavery, disease, and suffering in the southern Lowcountry. Cambridge: Cambridge University Press.

Montesquieu, Charles de Secondat, 1899. The spirit of laws. New York: The Colonial Press.

Mourmouras, Alex and Peter Rangazas, 2009. Reconciling Kuznets and Habbakuk in a Unified Growth Theory. *Journal of Economic Growth* **14(2)**, 149-181.

North, Douglass C., 1990. Institutions, institutional change, and economic performance. Cambridge: Cambridge University Press.

North, Douglass C., Williams Summerhill, and Barry R. Weingast, 2000. Order, disorder, and economic change: Latin America versus North America. In Governing for prosperity. Edited by Bruce Bueno de Mesquita and Hilton L. Root, 17-58. New Haven: Yale University Press.

North, Douglass C. and Robert Paul Thomas, 1973. The rise of the Western world : a new economic history. Cambridge: Cambridge University Press.

Ohkawa, Kazushi and Henry Rosovsky, 1973. Japanese economic growth: trend acceleration in the twentieth century. Stanford, Calif.: Stanford University Press.

Pomeranz, Kenneth, 2000. The great divergence: China, Europe, and the making of the modern world economy. Princeton, New Jersey: Princeton University Press.

Putterman, Louis and David N. Weil, 2010. Post-1500 Population Flows and The Long-Run Determinants of Economic Growth and Inequality. *The Quarterly Journal of Economics* **125(4)**, 1627-1682.

Rutman, D. B. and A. H. Rutman, 1976. Of Agues and Fevers: Malaria in the Early Chesapeake. *The William and Mary Quarterly* **33(1)**, 31-60.

Sachs, Jeffrey D. and Andrew M. Warner, 1997. Natural resource abundance and economic growth. Center for International Development and Harvard Institute for International Development, November.

Savitt, Todd L. and James Harvey Young, 1988. Disease and Distinctiveness in the American South. Knoxville: The University of Tennessee Press.

Silver, Timothy, 1990. A new face on the countryside: Indians, colonists, and slaves in South Atlantic forests, 1500-1800. Cambridge: Cambridge University Press.

Smith, Adam, 1994. An inquiry into the nature and causes of the wealth of nations. New York: Modern Library.

Strulik, Holger and Jacob Weisdorf, 2008. Population, food, and knowledge: a simple unified growth theory. *Journal of Economic Growth* **13(3)**, 195-216.

Tamura, Robert, Curtis Simon, and Kevin M. Murphy, 2016. Black and White Fertility, Differential Baby Booms: The Value of Equal Education Opportunity. *Journal of Demographic Economics* **82(1)**, 27-109.

Thornton, John K., 1996. The African Background to American Colonization. In The Cambridge economic history of the United States. Vol. 1, Colonial era. Edited by Stanley L. Engerman and Robert E. Gallman, 53-94. Cambridge: Cambridge University Press.

Turner, Frederick Jackson, 1976. The frontier in American history. Huntington, New York: Robert E. Kriger Publishing Co. U.S. Bureau of the Census, 1966, A century of population growth, from the first census of the United States to the twelfth, 1790-1900. New York: Johnson Reprint Corp.

U.S. Bureau of the Census, 1975. Historical statistics of the United States colonial times to 1970. Bicentennial ed. Washington, D.C.: Department of Commerce, Bureau of the Census.

U.S. Bureau of the Census, 2012. 2010 Census of Population and Housing, Population and Housing Unit Counts (CPH-2-1, United States Summary). Washington, D.C.: US Government Printing Office.

van der Ploeg, F., 2011. Natural Resources: Curse or Blessing? *Journal of Economic Literature* **49(2)**, 366-420.

Vandenbroucke, Guillaume, 2008a. The U.S. Westward Expansion. *International economic review* **49(1)**, 81-110.

Vandenbroucke, Guillaume, 2008b. The American frontier: Technology versus immigration. *Review of economic dynamics* **11(2)**, 283-301.

Voigtländer, Nico, and Hans-Joachim Voth, 2013. The Three Horsemen of Riches: Plague, War, and Urbanization in Early Modern Europe. *The Review of Economic Studies* **80(2)**, 774-811.

Vollrath, Dietrich, 2009. The Dual Economy in Long-Run Development. *Journal of Economic Growth* **14(4)**, 287-312.

Weil, David N., 2013. Economic growth. 3rd ed. Boston, MA: Pearson Addison-Wesley.

Wells, Robert V., 1992. The Population of England's Colonies in America: Old English or New Americans? *Population Studies* **46(1)**, 85-102.