Investment Expenditures and the Transition from Feudalism to Capitalism

Lambert, Thomas

University of Louisville

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Thomas E. Lambert, PhD
Equine Industry Program and Economics Department
College of Business
University of Louisville
Louisville, KY 40292 USA
E-mail: Thomas.Lambert@Louisville.edu
Phone: 502-852-7838

Abstract

There is a great deal of literature on the role of capital investment in the economic transition from feudalism to capitalism. Investment in capital and new technology and agricultural techniques has not been considered worthwhile in a medieval economy because of a lack of strong peasant property rights and no incentive on the part of lords and barons to lend money to peasant farmers. Therefore, the medieval economy and standards of living at that time have been characterized as non-dynamic and static due to insufficient investment in innovative techniques and technology. The capital investment undertaken typically would have been in livestock, homes, or public investment in canals, bridges, and roads, although investment in the latter would have been hindered by a fragmented political system of fiefdoms and lack of a unified national government. This paper attempts to demonstrate empirically that a productive and sufficient level of investment out of accumulated capital income, taxation, and rents does not have a real impact on economic per capita growth until the 1600s in Britain perhaps due to the beginning of a strong, central government as well as to the level of capital, tax, and land income achieving an adequate threshold amount and providing some type of investment multiplier effect. A high wage share as a portion of national income also appears to be associated with higher investment levels. The types of investment, threshold amounts of investment out of profits and rents, and the price of labor seem to matter when it comes to raising GDP per capita to higher levels.

JEL Codes: B51, E11, E12, N13

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Introduction

Early economists were among the first to note how many business establishments and ventures took part or all of the proceeds of their profits and used them to buy more property, plant, inventory, and equipment if opportunities to expand and earn greater profits existed. This was in contrast to the way that most economic entities operated during feudalism, an economic system that was generally characterized as one that lacked the incentives or property rights to encourage producers to re-invest in or add to their productive capital (North and Thomas 1971 and 1973, McCloskey 1972, Brenner 1976 and 1985, Dimmock 2014). Since the serfs who worked on feudal manors had weak or little ownership in the lands they worked, their livestock, and the tools they used, there was little incentive to use any gains from their work to try to expand their efforts and output. This was especially true during the early middle ages. Any production above a level of subsistence for the peasant farmers and their families went to lords and barons as surplus, and therefore efforts to invest or innovate were not worthwhile. There was also little incentive for the lords to encourage the serfs to reinvest and innovate since the lords could often coerce and gain more output from them through simple intimidation and brute force (Dobb 1947, Brenner 1976 and 1985). Additionally, any surplus extracted from the feudal economy was believed to be wasted mostly on "unproductive" expenditures by the aristocracy on large palaces, court jesters, minstrels, the military, and cathedrals, or items which did not expand the productive capacity of a society by increasing the productivity of a labor force (Baran 1953 and 1957, Engels 1957, Smith 2000).

As feudalism began to unravel due to plagues and famines[1], which in turn caused labor shortages, and due to shortages of arable land space, small petty producers, merchant traders, and yeoman farmers started taking some of the surplus they earned and reinvested it into their operations to finance greater productivity and expansion (Brenner 1976 and 1985, Heller 2011, Dimmock 2014). This paper's empirical research found that it was not until the 1600s and through the 1800s, an era which took in the

[1] Which some have claimed were also caused indirectly by a mini ice age (e.g, Fagan 2000, Blom 2019 among others).

time periods of the English Agricultural Revolution and the Industrial Revolution, that capital income, investment spending, and investment levels began to reach a critical threshold of a society's economic surplus, or, that is, a society's cumulative capital and land income plus tax revenues (Baran 1957, Baran and Sweezy 1966, Xu 2019). With this, standards of living dramatically began to advance in England and the United Kingdom (UK). Productive outlets for investment made themselves available at this time which helped per capita economic growth, although first capital income had to rebound as a share of economic surplus and net national income after being in a lull for several prior centuries (1400s to 1600s). If data sources are correct (Clark 2009, Broadberry, et al 2015), capital income and economic surplus levels might have been higher in the 13th and 14th centuries than in the next several centuries and did not reach higher levels again until the 1800s in Britain. See Figures 1 to 3. Money for investment was available in the late medieval period, but because of no incentives for investment, it was mostly wasted on unproductive pursuits, and therefore it had little if much impact on economic growth. In the transition period of the 15th to 16th centuries, investment levels would still be predicted to be low since capitalism was still not the predominant economic system. High labor costs for several centuries (Clark 2009, Humphries and Weisdorf 2019) prevented the formation of a large enough economic surplus to justify investment. In the 17th century, the economic surplus began to grow again thanks to a growth in capital income, and this led to the beginning of a more consistent and greater level of capital investment.[2]

(Insert Figures 1 to 3 around here)

This paper proceeds as follows. The next section, Methods, describes the data sources used in the research for this paper, the definitions of key variables, and the statistical techniques used to analyze the data. Following this, the Results section gives an analysis and review of key findings. Finally, a

[2] Rimmer, Higgins, and Pollard (1971) assess the year to year rates of investment in the 18th and 19th centuries in the UK and estimate it to be slower than other estimates and believe a lot of capital investment undertaken was due to the rapid deterioration of many forms of plant and equipment. They cite the frequency with which horseshoes and many farm tools had to be replaced. Nonetheless, such replacement was necessary to propel agricultural output to higher levels, and therefore the investment expenditures were still productive.

Conclusion section discusses the implications of the findings for historical and modern economic performance and prospects.

Methods

Clark (2009) gives estimates on a yearly basis for a GDP price index and estimates on a decadal basis of capital income (income from businesses, housing, live-stock, canals, mines, railroads, and so on) and the real rates of return to capital for the years 1210 to 1860. Adjusting capital income according to the price index and using the formula

$$r = \text{Real Capital Income} / \text{Real Capital Stock},$$

where r is the real rate of return on capital, one can rearrange the formula and solve for real capital stock using

$$\text{Real Capital Stock} = \text{Real Capital Income} / r$$

which will provide estimates of total English and UK aggregate capital amounts over the years 1210 to 1860. Using linear interpolation, a larger sample of years of data can be estimated between decadal amounts.[3] Figure 4 illustrates the growth of real capital stock over several centuries, and it is shown that growth in the real capital stock does not really begin to climb somewhat until the 17th and 18th centuries with accelerating growth in the 19th century.

Linear regression models with Newey-West standard errors (used to avoid serial correlation) were employed to measure the association between various independent and dependent variables over several centuries of data. Since according to many authors capitalism either became the dominant form of economic organization either in the 1600s or 1700s in England or the UK[4], a Chow test (Chow 1960) was

[3] Doing this results in an ending year of 1859 rather than 1860.

[4] The United Kingdom formally came into existence in 1707 thanks to the Treaty of Union between England and Scotland although the two states had been unified through a common monarch when James I (James VI of Scotland) became King of England (Macinnes 2011).

performed for each model to assess whether the year 1600 or 1700 provided a break in the time series data, and if so, which year was a better marker for the beginning of the dominance of capitalism. Chow test results showed that there were breaks in the data for both years, although the year 1600 provided slightly more robust results.[5]

In the first set of models, the investment or capital stock levels shown in Figure 4 from 1209 to 1599 and then from 1600 to 1859 are used as dependent variables in separate bivariate regression equations and are hypothesized to be associated with the following independent variables:

1. Capital Income as a Percentage of the Economic Surplus (Clark 2009). The expectation is that as capital income becomes a larger share of the economic surplus, then capitalist enterprises should have greater funds at their disposal for expansion and greater accumulation and investment. Capital income as a share of the surplus should be on average from 1209 to 1599 less than that of 1600 and later due to the nascent stage of capitalist development and the dominance of agriculture during the first time period. Additionally, with the continuance of the enclosure movement in Britain over time, worker, not serf, exploitation should be expected to be more common. Therefore, this variable should be a better predictor of national capital stock from 1600 to 1859 than 1209 to 1599.
2. Wages as a Percentage of Net National Income (Clark 2009). This variable is hypothesized to be positively and highly correlated with the level of the capital stock in that higher wages are usually associated with greater productivity, and greater productivity is usually associated with greater levels of capital. Of course, the higher wages could be associated with higher levels of capital as capitalists try to substitute capital for high cost labor. Finally, it is to be expected that wages should be a much higher share of national income from 1600 to 1859 than 1209 to 1599 as the

[5] For most of the models, using a break year of 1600 usually yielded higher r-squared values for most of the models.

British economy becomes more capitalistic, and so therefore, the correlation between wages and the capital stock should be less in the earlier centuries versus the later ones.

Next, to see if investment makes any difference in two different estimates of real GDP per capita (Clark 2010, Broadberry, et al 2015), the following independent variables in separate bivariate regression equations are used to predict real GDP per capita from 1209 to 1599 and from 1600 to 1859 for the Clark data and from 1270 to 1599 and from 1600 to 1859 using the Broadberry, et al data.[6]

1. Real Annual Investment. This was found by calculating the change from year to year in the capital stock. For some years, this number was negative because of declines in the total amount of capital due perhaps to depreciation of capital stock being greater than total investment or perhaps due to natural disasters, crop failures, economic recession/depression, or war. The hypotheses are that investment amounts should not matter that much from the 13th to the 16th centuries for either data source but should matter from the 17th to the 19th centuries. In the earlier period, during feudalism and in the subsequent transition period from feudalism to capitalism, economic incentives were either mostly nonexistent or weak whereas in the later period they were much stronger. Capitalism was also probably not the predominant economic system until the 17th or 18th century according to many authors.
2. Baran Ratio. Using investment levels or capital stock estimates from the Clark (2009) data, one can calculate a Baran Ratio (Xu 2019) which shows the amount of investment on a yearly basis that comes out of a society's economic surplus, which in this case is the sum of Clark's capital and land income estimates plus taxes collected by the state. If borrowing is undertaken to finance investment (or perhaps treasure/loot from overseas exploration/conquest or war), then the Baran Ratio can be greater than one. Xu (2019) labels

[6] Chow tests showed 1600 to be an appropriate break in the time series for the Braoadberry, et al data.

this the Baran Ratio since the economist Paul Baran (1953 and 1957) believes that capital formation comes out of the economic surplus. Simply put on a yearly basis,

Baran Ratio = Investment / Economic Surplus .

Xu (2019) believes that Baran's concept of the economic surplus is important in understanding investment in a capitalist economy because investment spending can only come from the surplus generated from labor. That is, profits, gains, and rents earned by owners or landlords and the taxes collected by a government come mostly if not entirely from the labor employed in capitalist enterprises or farms. It is not until the Baran Ratio reaches a critical and sustained level that economic growth and higher levels of development can be attained. This could mostly occur when capitalism becomes the dominant economic system. For this variable, it is hypothesized that during the 13th to the 16th centuries that the Baran Ratio does not resonate with either measurement of real GDP per capita but then shows a statistically significant connection with them from the 17th to the 19th century.[7]

(Insert Tables 1 to 4 around here)

Results

Table 1 shows the descriptive statistics for the variables. With the exception of wages as a share of net national income, capital income as a share of the economic surplus, and Clark's real GDP per capita estimates, which show slight decreases perhaps due to greater variation in the numbers for the 13th to the 16th centuries, the averages of all of the variables show a substantive increase from the 13th to the 16th century time period to the 17th to the 19th century period. Levels of investment, the Broadberry, et al measurement of Real GDP, and the real capital stock all increase.

[7] An appendix to this paper contains the scatter diagrams for all models.

Table 2 has the results of the models which try to test for a correlation between the level of capital stock and 1) capital income as a percentage of the economic surplus and then 2) wages as a share of net national income. The variables in each model is statistically significant at an alpha of 5%, yet the models for the 1209 to 1599 period (Models 1 and 3) do not explain much of the variation in the level of the capital stock (only 3% for capital income / economic surplus percentage and only 5% for wages / net national income percentage). Models 2 and 4 explain a much greater amount of the variation in the capital stock (84% and 42% respectively) with Model 2 showing a 1% increase in capital stock as a portion of economic surplus being associated with around a £161 million increase in the real capital stock. Increases in capital income during this period are much more likely to be associated with investment in the capital stock than those of the 13Th to 16th centuries. In fact, Model 1 shows a negative relationship between capital income as a share of the economic surplus and capital stock levels. Model 4 shows that a 1% increase in wages / net national income percent is correlated with a nearly £243 million increase in the capital stock. One inference is that higher wages lead to greater investment as firms try to substitute capital for labor whereas another possibility is that causality indirectly runs the other way in that greater capital stock levels lead to greater productivity which in turn leads to higher wages as a share of national income. Either explanation is plausible.

Table 3 displays results with a similar pattern in that the 13th to 16th century values for independent variables do not correlate well with the dependent variable of Clark's estimate of real GDP per capita whereas those values for the 17th to the 19th century (Models 6 and 8) do show statistically significant associations with the dependent variable. Real annual investment spending from 1600 to 1859 and the Baran Ratio, 1600 to 1859, are statistically significant predictors of real GDP per capita from 1600 to 1859 and explain about 81% and 77% of the variation in real GDP per capita during this time, respectively. Rising investment levels appear to be associated with rising standards of living. A one million pound increase in real annual investment is associated with a 0.712 pound increase in real GDP per capita from 1600 to 1859, and a one unit increase in the Baran Ratio indicates a 14.3 pound increase

in real GDP per capita during this period. It could be argued that the Baran Ratio is somewhat akin to a spending multiplier in that the greater the share of investment spending out of the economic surplus (and in many years the economic surplus in addition to debt financing since many years had ratios greater than one) real GDP per capita goes up by an even greater amount.

Table 4 uses the same independent variables to predict the Broadberry, et al estimate of real GDP per capita for the same two time periods. As in Table 3, the models for the first time period (Models 9 and 11) do not really explain any of the variation in real GDP per capita, and neither independent variable is statistically significant. For the second time period (Models 10 and 12), each variable is statistically significant at a 5 percent alpha level. Model 10 shows that real annual investment explains about 68% of the variation in the Broadberry, et al estimate of real GDP per capita, and in Model 12 the Baran Ratio explains around 65% of the variation in real GDP per capita. A one million pound change in real annual investment, 1600 to 1859, is associated with around a £90 increase in the Broadberry, et al estimate of real GDP per capita. A one unit change in the Baran Ratio, 1600 to 1859, predicts an average increase in real GDP per capita of around £25.37 during the 17th to 19th centuries.

(Insert Figure 5 and Table 5 around here)

As an illustration of how investment opportunities and levels of investment mattered during each time period, Figure 5 shows estimates for the number in millions of oxen and horses used in England and Britain from 1221 to 1496 and then from 1550 to 1870 (Broadberry, et al 2015).[8] Although the choice of and employment of horses or oxen by farmers had something to do with terrain considerations (Langdon 1982 and 1986, Broadberry, et al 2015), a principal consideration was the cost of maintaining and keeping each type of animal (Langdon 1982 and 1986). Despite the versatility of the horse, oxen were cheaper to feed and when no longer useful or when the price of beef was high, could be sold or used for food. Horses were considered a luxury during early medieval times, and so oxen with their low costs were

[8] The authors omitted the period of 1497 to 1549 because of a lack of historical records and difficulties in coming up with accurate estimates. 17

preferred for tilling or plowing soil. It was not until farms became larger during the enclosure movement and when agricultural markets became larger and wider geographically during the 16th and 17th centuries that the horse became more useful despite its higher operating costs in not only farming but also in hauling and transporting agricultural output (Langdon 1982 and 1986). Langdon (1982 and 1986) argued that as the average farmer came to possess greater and greater amounts of land and greater affluence, he could afford to make the investment in the more costly yet more productive and multifaceted horse. In calculating Pearson correlation coefficients between the ratio of horse to oxen from 1221 to 1496 and the Baran Ratio and real annual investment for this period, Table 5 indicates little or no relationship between the two investment measurements and the ratio. However, the relationships are statistically significant and fairly strong for the period 1550 to 1859 as would be expected to be following Langdon's reasoning for the ascent of the horse.

Conclusion

The results of this paper are based upon estimates made from historical records reviewed by and extended by economic historians using different techniques. This is a limitation of the results found in this paper in that during the time periods examined not nearly as many complete and thorough economic records existed then as they do in modern times. Therefore, estimates have to suffice in order to do any type of economic and quantitative analyses of the time period that covers the transition from feudalism to capitalism, although the data used is based upon after the fact reconstruction of certain events.

Nonetheless, if the estimates are fairly accurate, the results found in this paper lend some credence to various arguments regarding the transition from feudalism to capitalism. That investment is largely ineffective or too small before the 17th or 18th centuries to impact standards of living is supported by the regression results. This bolsters the work of Crafts and Mills (2017) which argues that trend growth in England and the UK up until the industrial revolution basically hovered around zero. Additionally, the level of capital income as a portion of the economic surplus and the level of wages as a

share of national income in England and Britain seem to matter when it comes to increases in the capital stock, and the higher levels from 1600 to 1859 appear to make a difference in the capital stock.

One could also argue that the type of investment also mattered even though the models cannot show this directly. If Baran is correct, then a lot of the economic surplus would have been wasted in the 13th and 14th centuries when feudalism was still the dominant form of the economic system. Even with feudalism in decline in subsequent centuries, some of the economic surplus may have been "wasted" by the aristocracy on cathedrals, palaces, and wars rather than spent on productive machinery and tools. Various authors have noted that traders and merchants improved transportation technology but did not contribute much to changes in production technology (Sweezy 1976 (1950)). As Brenner (1985) notes, medieval guilds, through their monopoly power, also frustrated investment in innovative techniques, and it was not until petty producers came along that this began to change. He also writes that until larger farms came about along with the development of large pastoral land holdings, it was difficult for many yeoman farmers to innovate on smaller parcels of land. Larger land holdings and more advanced farming techniques yielded greater economies of scale than the typical smaller, medieval farms that featured mostly subsistence style farming (Brenner 1985, Heller 2011, Cockshot 2019). Feudalism and its institutions only slowly gave way to capitalism as capitalism was built on the "ruins" of a feudalistic system as those who were forced to leave common farm areas became the workers of the early manufacturers of the industrial revolution (McCloskey 1972, Marx and Engels 2004 (1848)).

For those readers familiar with the Dobby-Sweezy debate (Dobb 1947, Sweezy 1976 (1950) among many other publications) as well as the Brenner debate (Brenner 1976, Brenner 1985, Heller 1985, Heller 2011 among many others), the statistical findings of this paper are probably not surprising since many of these authors note the stagnation of most of the medieval period and economic decline in the late medieval period in Europe. They also note the slow and gradual transition from feudalism to capitalism and the takeoff of economic growth with the agricultural and industrial revolutions. This paper's findings also somewhat support the writings of those who emphasize the importance of property rights for

investment and economic advancement in that such rights were not strong enough for advancement until around the 16th and 17th centuries (North and Thomas 1971 and 1973, McCloskey 1972).

The notion of the Baran Ratio as having a possible multiplier effect for real GDP per capita, or a Baran Ratio multiplier, perhaps implies that investment expenditures as a portion of the economic surplus has to reach a certain level before economic growth and/or greater standards of living are achieved. According to Table 1, for the period of 1209 to 1599, the Baran Ratio average is -0.01 with a range of -1.89 to 2.27 whereas for 1600 to 1859 it averages 1.2 with a range of -1.03 to 4.25. It is only during the 1600 to 1859 epoch that the Baran Ratio variable is statistically significant in predicting real GDP per capita with coefficients of 14.3 and 25.37 for the Clark and Broadberry, et al measurements, respectively.

(Insert Figures 6 to 9 around here)

Much has been written about the post-World War II economic boom in the United States and in other advanced capitalistic nations that lasted until around the 1970s. Figures 6 and 7 show the growth in different forms of US nonresidential investment since the 1920s. From the late 1940s to the 1970s, the level of nonresidential fixed assets and nonresidential investment as a portion of Gross Domestic Product went up from around 10% to 14% of GDP, but then began to stagnate in the 1980s. Figure 8 illustrates that net private domestic investment as a share of GDP has usually been between 5 and 10% of GDP on annual basis but has not reached 10% since the 1980s and has hovered between 0 and 5% since 2007, the year before the start of the Great Recession of 2008-2009. These figures seem to suggest that US capitalism is coming up short in reinvesting it economic surplus in productive assets and new technology. This lack of reinvestment could also be showing up in declining rates of productivity increases in the US economy as shown in Figure 9. A lack of reinvestment would limit surplus absorption according to Baran and Sweezy (1966) unless more was spent on unproductive activities such as advertising, marketing, the industries of retailing or finance, insurance or real estate, etc. However, these activities do not increase the productive capacity of a society (just as feudalism's extravagant spending did not expand its capacity for output) and so may not help the long term resiliency of an economic system through helping to

develop it productivity and output per worker, which in turn help to raise its standard of living. If such productive reinvestment does not or cannot occur through private markets, then Keynesian economics would argue that it can occur through greater governmental spending on public works, education, and health care. On the other hand, in order to raise worker productivity, government policy could also take a less generous stance by refusing to enlarge infrastructure and social welfare programs and by giving employers more leeway in extracting more work and less pay from their workers. The latter would be somewhat akin to what the nobility often did to the serfs during the decline of feudalism. If capitalism has been struggling since the Great Recession to achieve greater levels of surplus absorption, then it has two alternatives. It can either allow for greater socialization of investment or it can engage in greater worker exploitation. The former implies a transition to a greater level of socialism within capitalism, the latter implies a course toward a certain degree of repression within a capitalistic system. The transition could be a long one and could depend upon how the economic surplus is generated and used.

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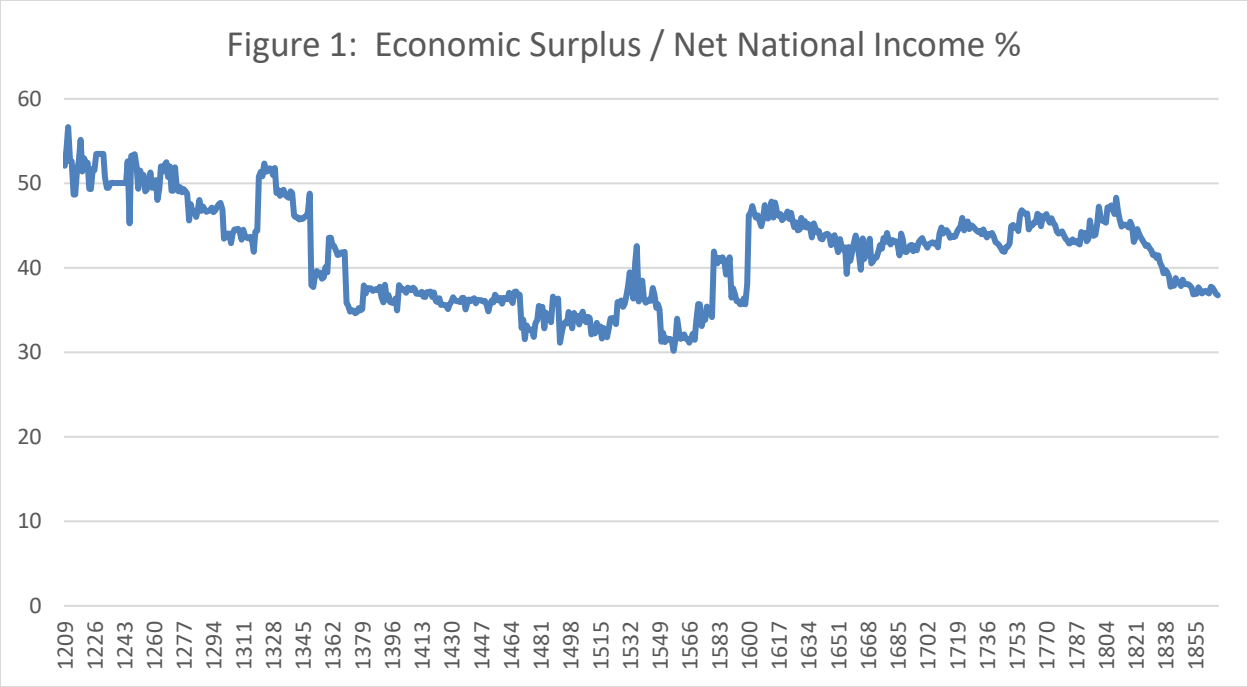
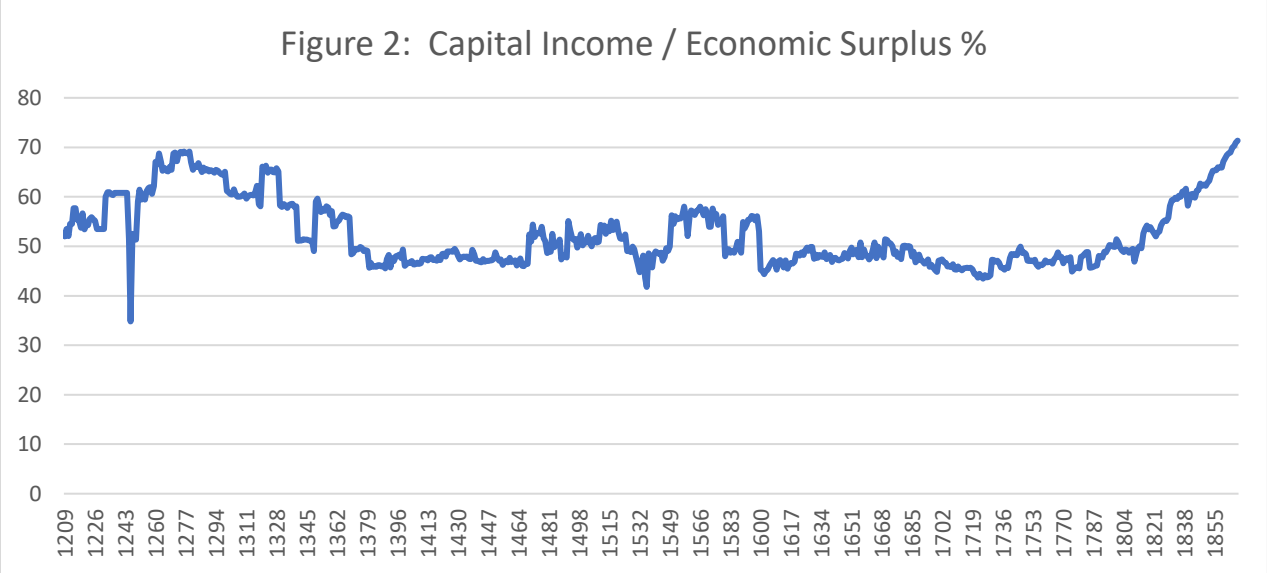
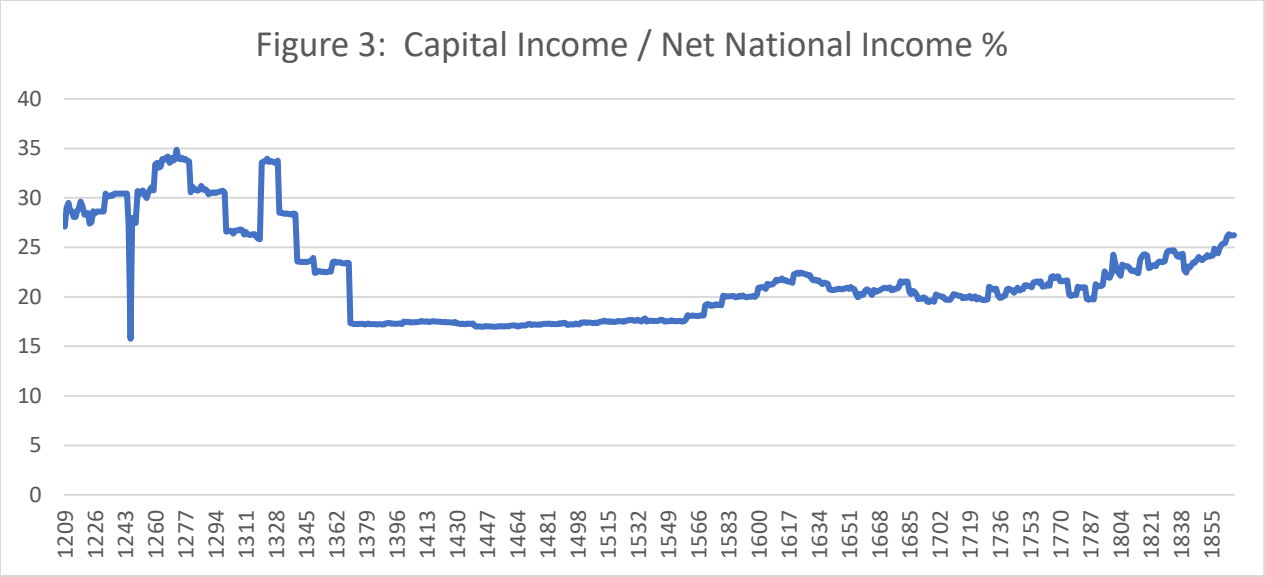


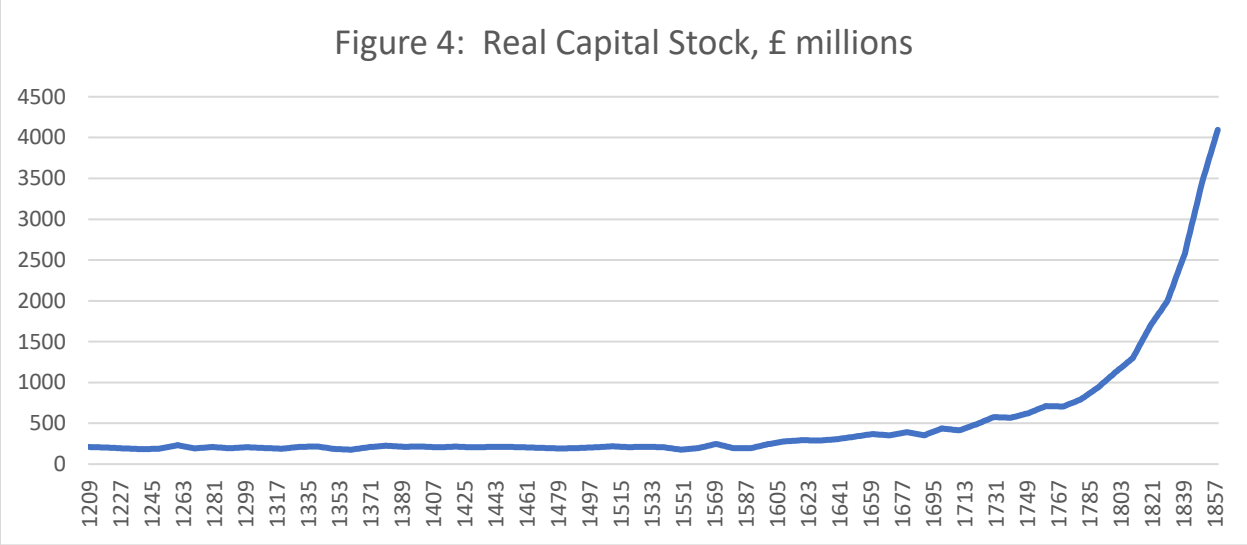
Source: Gregory Clark, "National Income, Prices, Wages, Land Rents, Population, England, 1209-1869", from his website, http://faculty.econ.ucdavis.edu/faculty/gclark/data.html .



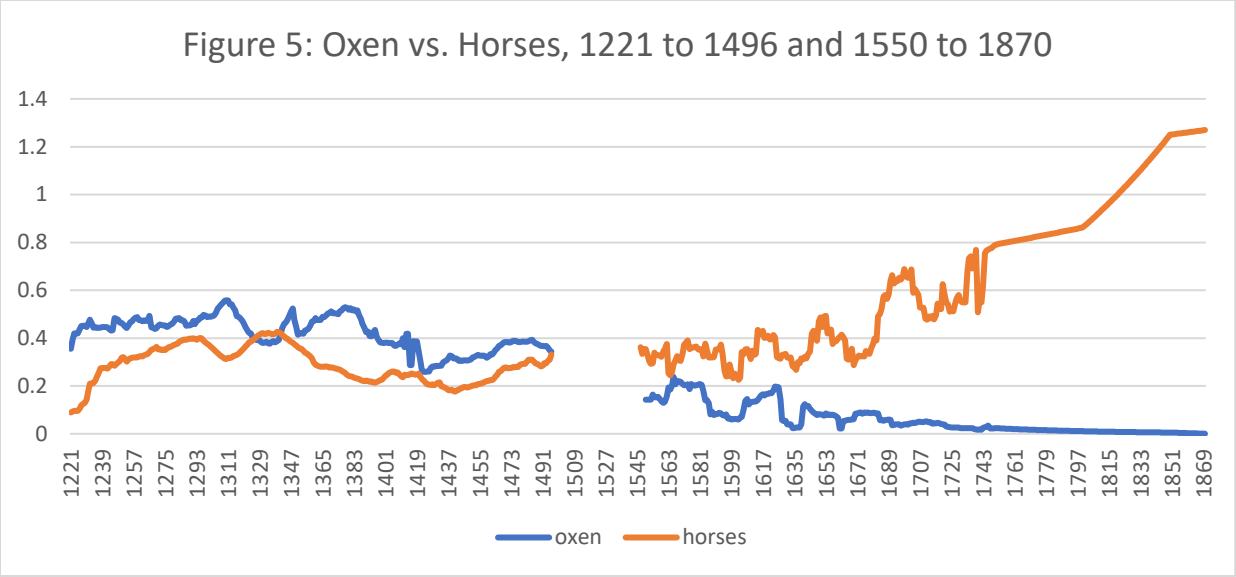
Source: Gregory Clark, "National Income, Prices, Wages, Land Rents, Population, England, 1209-1869", from his website, http://faculty.econ.ucdavis.edu/faculty/gclark/data.html .



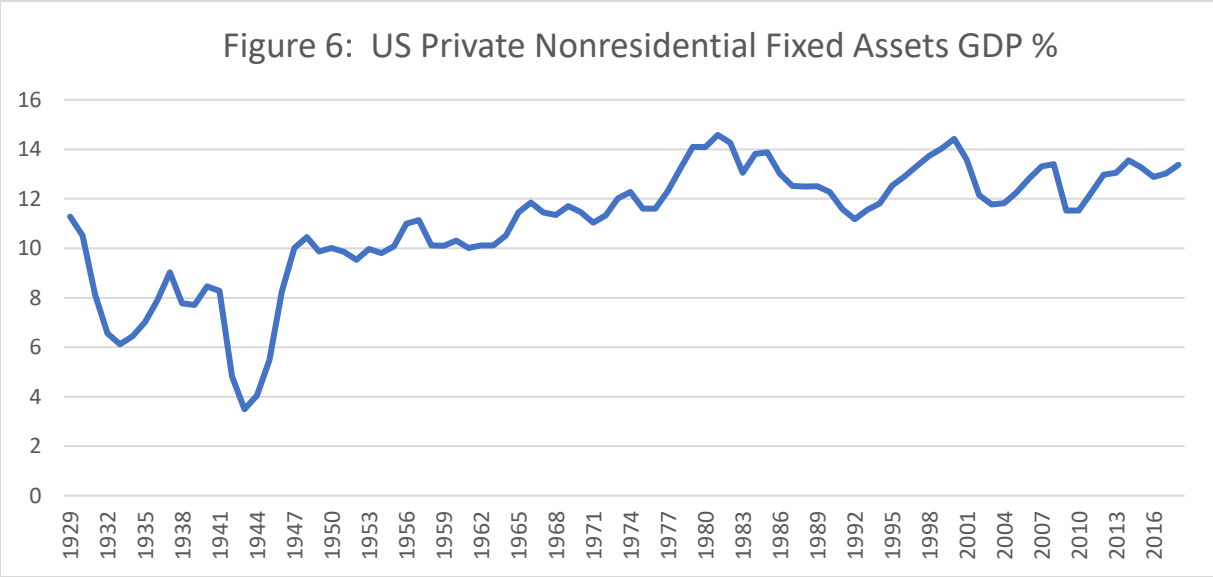
Source: Gregory Clark, "National Income, Prices, Wages, Land Rents, Population, England, 1209-1869", from his website, http://faculty.econ.ucdavis.edu/faculty/gclark/data.html .



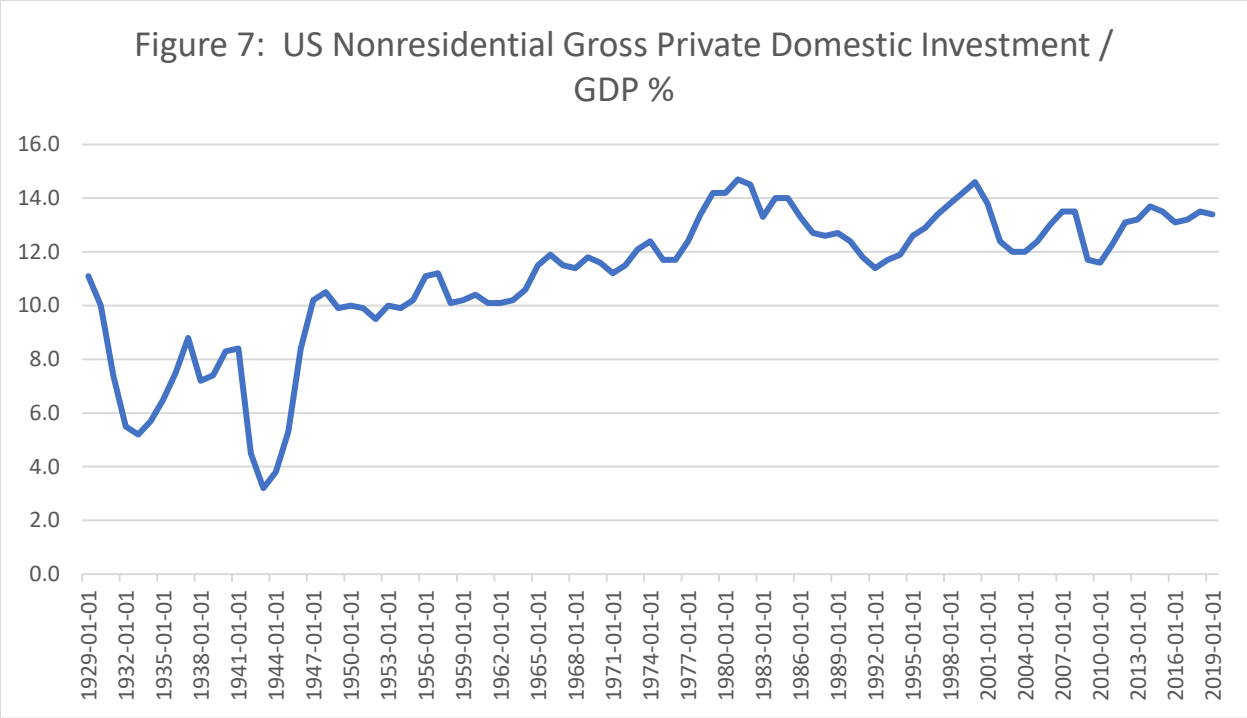
Source: Gregory Clark, "National Income, Prices, Wages, Land Rents, Population, England, 1209-1869", from his website, http://faculty.econ.ucdavis.edu/faculty/gclark/data.html .



Source: Adapted from Broadberry, et al (2015), Figure 2.01, page 54 and from the data from the website https://www.cambridge.org/gb/academic/subjects/history/economic-history/british-economic-growth-12701870?format=PB .



Source: United States Bureau of Economic Analysis.
https://apps.bea.gov/iTable/iTable.cfm?ReqID=10&step=2



Source: United States Bureau of Economic Analysis.
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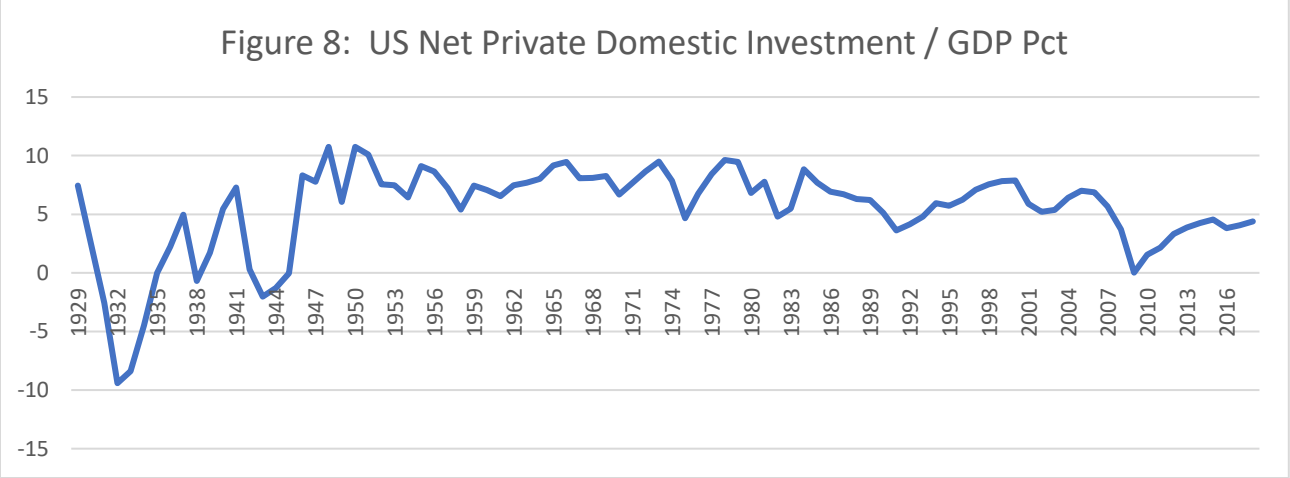
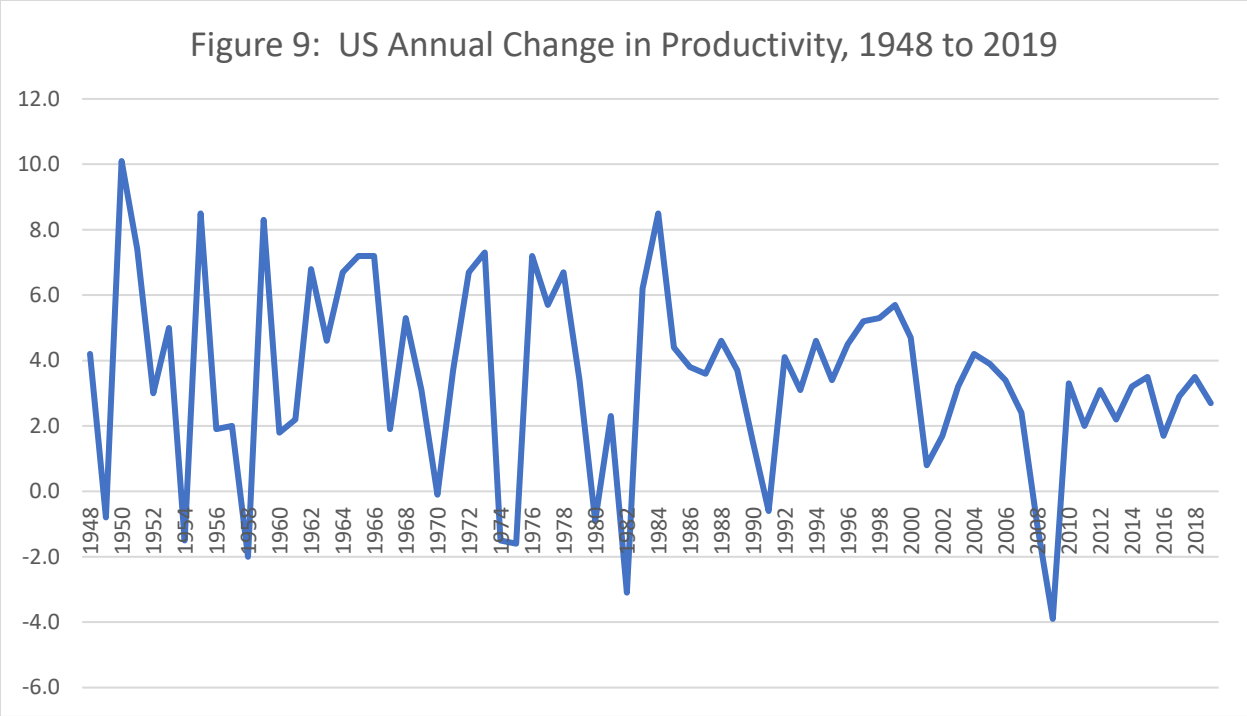


Source: United States Bureau of Economic Analysis.
https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2#reqid=19&step=2&isuri=1&1921=survey .



Source: US Bureau of Labor Statistics, Annual Nonfarm Business Output per Worker, Percent change from same quarter a year ago. www.bls.gov

Table 1—Descriptive Statistics

Descriptive Statistics--1209 to 1599

Variable	Mean	Std. Dev.	Min	Max
Baran Ratio	-0.01	0.61	-1.89	2.27
Broadberry, et all Real GDP per Capita (1270-1599)	62.40	9.91	40.35	83.36
Capital Inc / Econ Surplus	54.07	6.57	34.81	69.15
Clark Real GDP per Capita	108.98	21.57	64.71	149.18
Real Annual Investment	0.07	2.11	-5.12	5.03
Real Capital Stock	204.25	12.05	175.89	247.25
Wages/NNI %	59.40	6.85	43.34	69.82

Descriptive Statistics--1600 to 1859

Variable	Mean	Std. Dev.	Min	Max
Baran Ratio	1.20	1.11	-1.03	4.25
Broadberry, et all Real GDP per Capita	108.47	34.87	57.40	208.62
Capital Inc / Econ Surplus	49.48	5.02	43.48	65.97
Clark Real GDP per Capita	108.41	18.16	84.64	162.37
Real Annual Investment	14.83	22.99	-3.82	87.68
Real Capital Stock	899.07	879.54	244.56	4094.92
Wages/NNI %	56.43	2.35	51.70	63.14

Table 2--Dependent Variable is Capital Stock		
	b, 1209-1599 (Newey-West SE)	**b, 1600-1859 (Newey-West SE)**
Models 1 and 2		
Capital Income / Economic Surplus, 1209-1599	-3.25** (0.081)	
Constant	221.84	
Adj. r-squared: 0.03		
n=391		
Capital Income / Economic Surplus, 1600-1859		160.9** (4.51)
Constant		-7062.2
Adj. r-squared: 0.84		
n=260		
Models 3 and 4		
Wages as Percentage Net National Income, 1209-1599	0.414** (0.25)	
Constant	179.7	
Adj. r-squared: 0.05		
n=391		
Wages as Percentage Net National Income, 1600-1859		242.51** (26.1)
Constant		-12785.5
Adj. r-squared: 0.42		
n=260		

**p<0.01

*p<0.05

Table 3--Dependent Variable is Clark Real GDP per Capita		
	b, 1209-1599 (Newey-West SE)	**b, 1600-1859 (Newey-West SE)**
Models 5 and 6		
Real Annual Investment, 1209-1599	-0.043 (0.38)	
Constant	108.98	
Adj. r-squared: -0.003		
n=391		
Real Annual Investment, 1600-1859		0.712** (0.028)
Constant		97.85
Adj. r-squared: 0.81		
n=260		
Models 7 and 8		
Baran Ratio, 1209-1599	1.91 (1.22)	
Constant	109.001	
Adj. r-squared: 0.0004		
n=391		
Baran Ratio 1600-1859		14.3** (0.52)
Constant		91.22
Adj. r-squared: 0.77		
n=260		

**p<0.01

*p<0.05

Table 4--Dependent Variable is Broadberry, et al Real GDP per Capita		
	b, 1270-1599 (Newey-West SE)	**b, 1600-1859 (Newey-West SE)**
Models 9 and 10		
Real Annual Investment, 1270-1599	0.004 (0.29)	
Constant	62.4	
Adj. r-squared: -0.003		
n=330		
Real Annual Investment, 1600-1859		89.86** (0.06)
Constant		1.26
Adj. r-squared: 0.68		
n=260		
Models 11 and 12		
Baran Ratio, 1270-1599	1.31 (0.81)	
Constant	62.4	
Adj. r-squared: 0.004		
n=330		
Baran Ratio 1600-1859		25.37** (1.15)
Constant		77.97
Adj. r-squared: 0.65		
n=260		

**p<0.01

*p<0.05

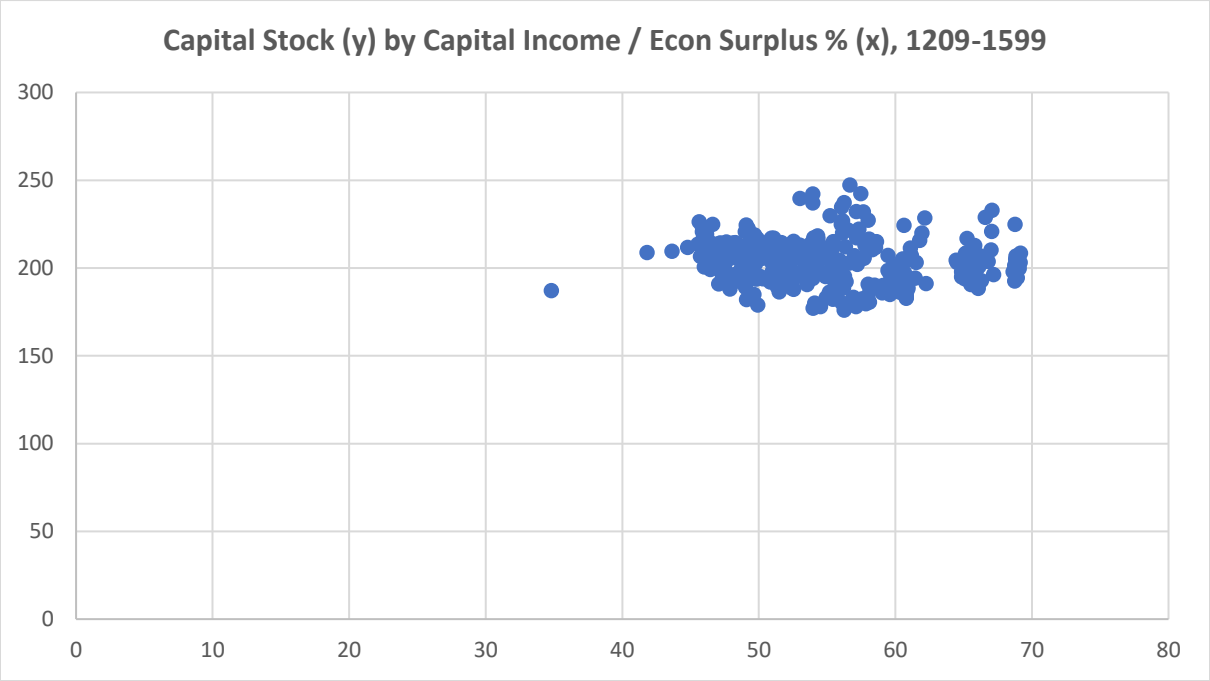
Table 5—Pearson Correlation Coefficients

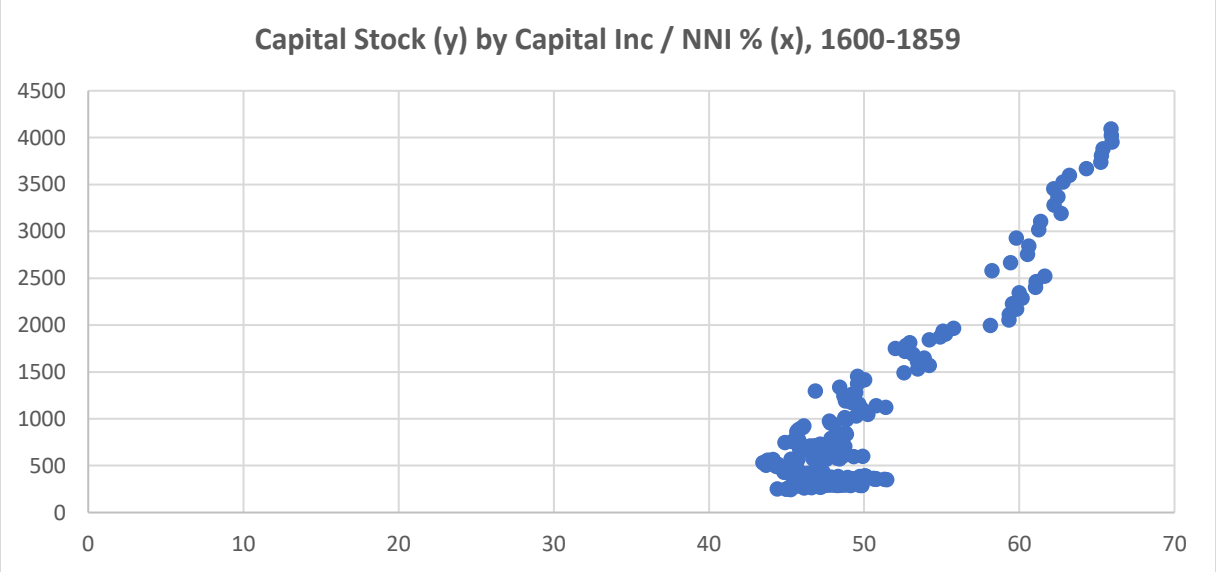
	Real Annual Investment, 1221 to 1496	Baran Ratio, 1221 to 1496
Ratio of Horse to Oxen, 1221 to 1496	0.054	-0.028
	Real Annual Investment, 1550 to 1859	**Baran Ratio, 1550 to 1859**
Ratio of Horse to Oxen, 1550 to 1859	0.93**	0.78**

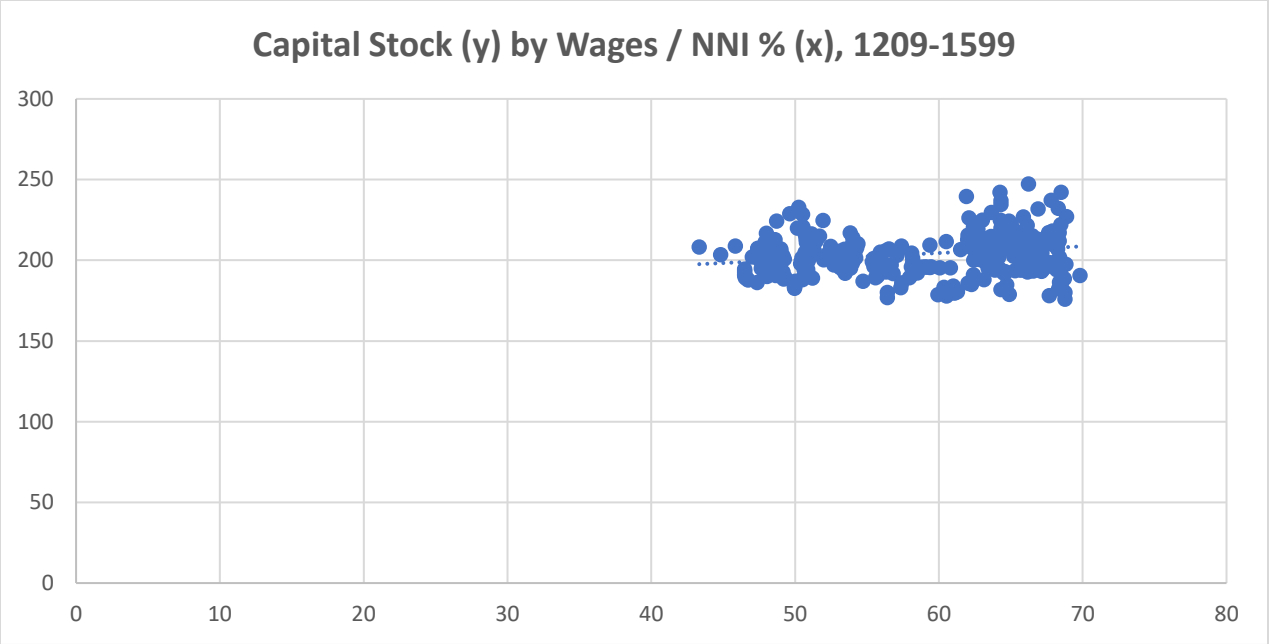
**p<0.01

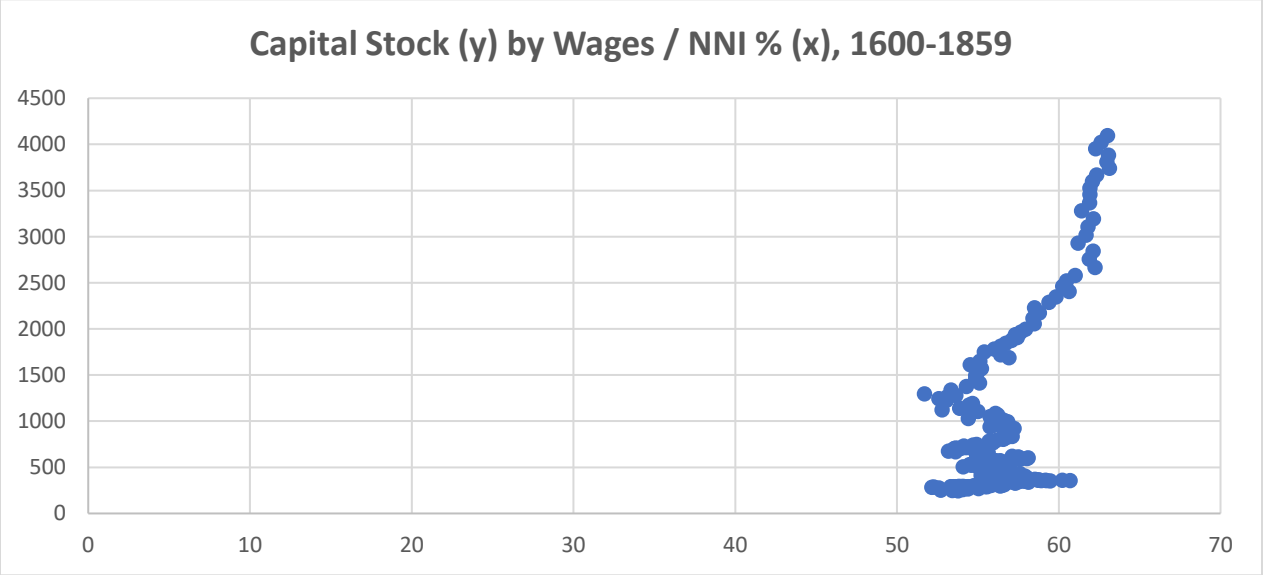
*p<0.05

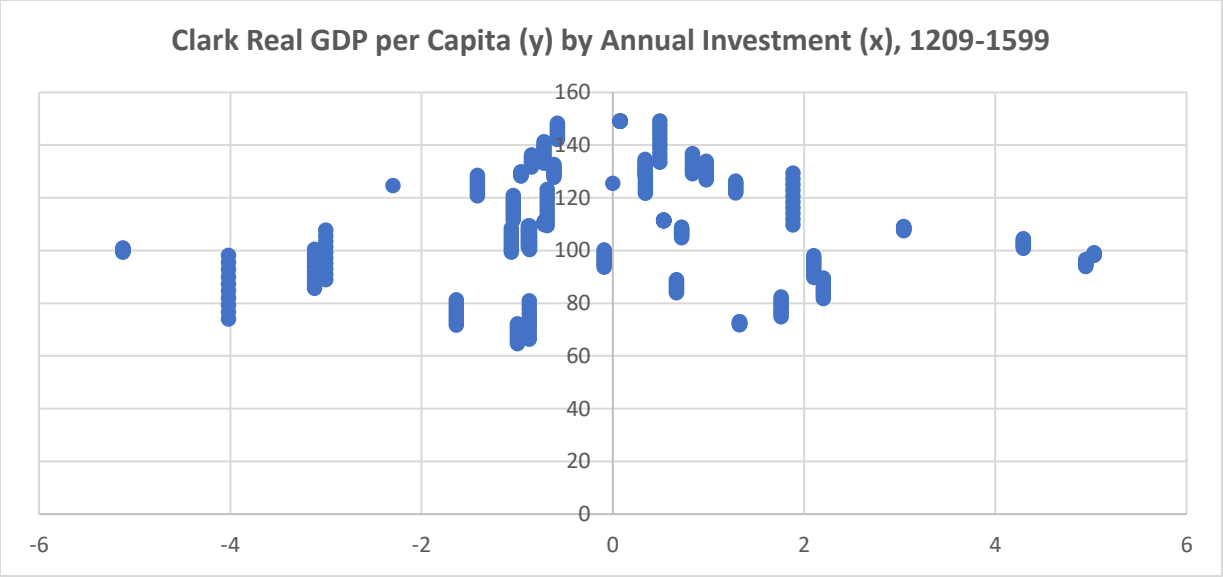
Appendix

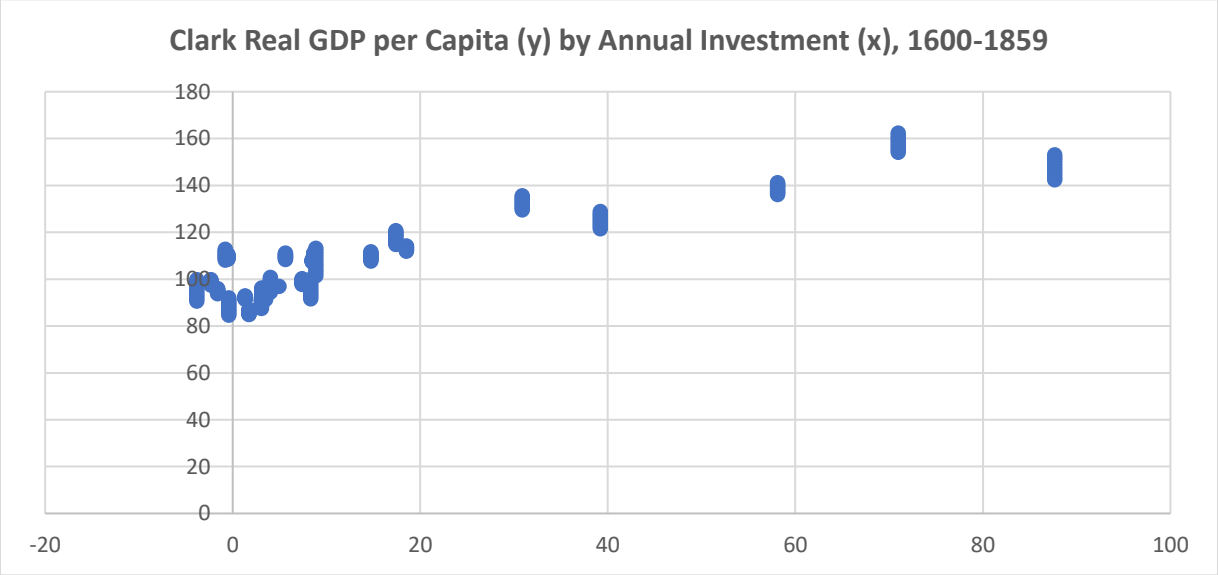

Capital Stock (y) by Capital Income / Econ Surplus % (x), 1209-1599
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80

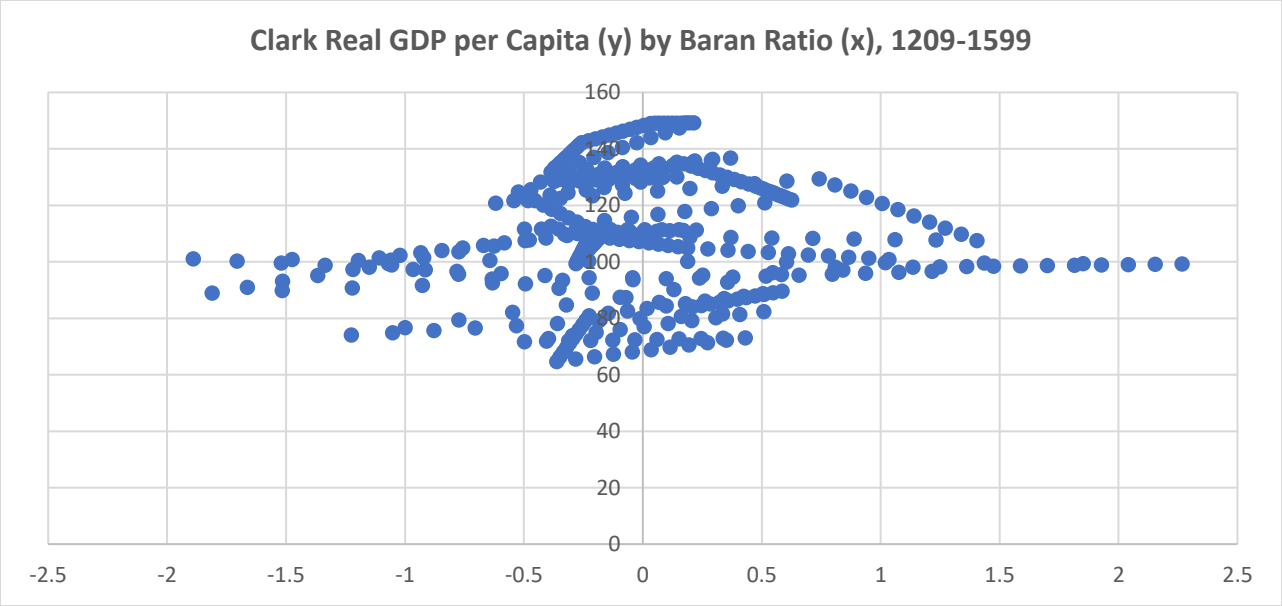

Capital Stock (y) by Capital Inc / NNI % (x), 1600-1859
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70

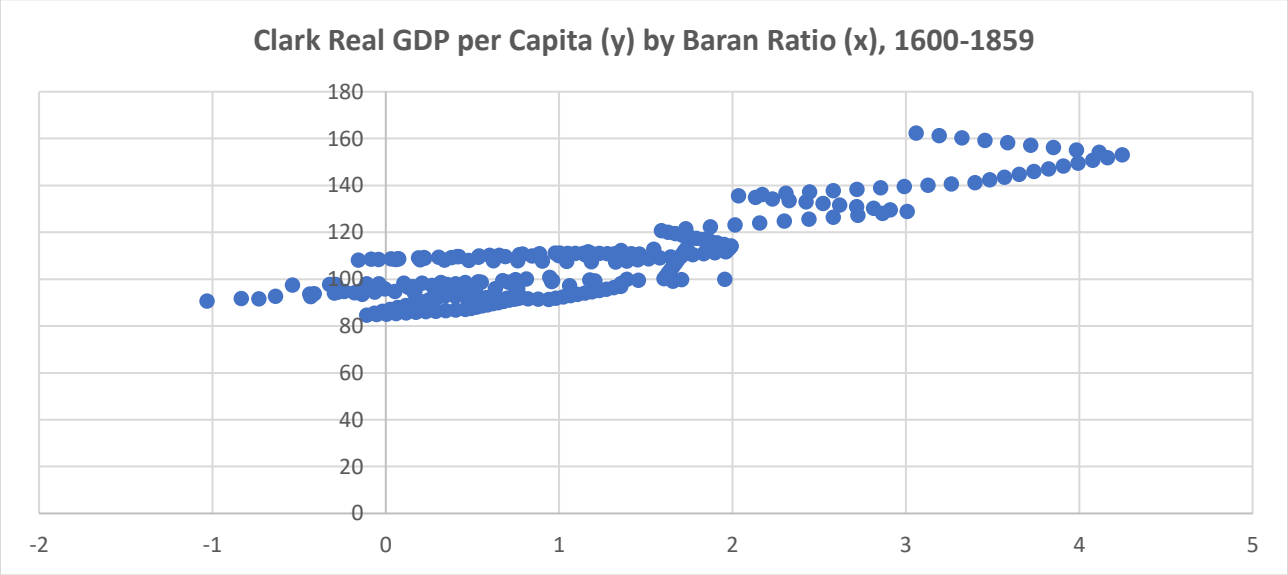

Capital Stock (y) by Wages / NNI % (x), 1209-1599
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80

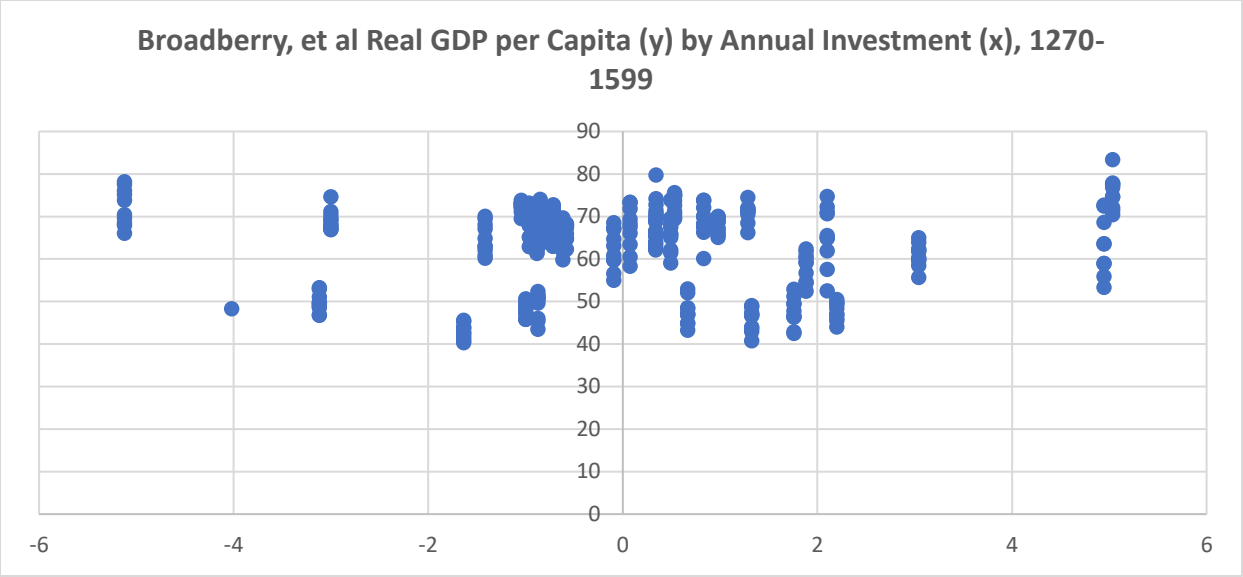

Capital Stock (y) by Wages / NNI % (x), 1600-1859
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70

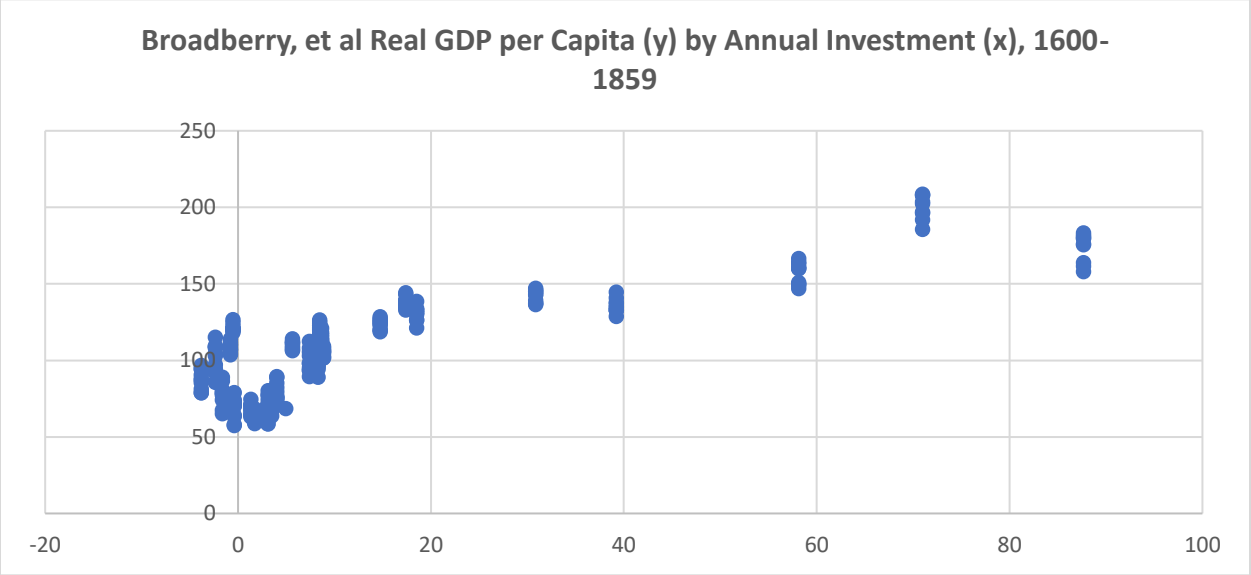

Clark Real GDP per Capita (y) by Annual Investment (x), 1209-1599
160
140
120
100
80
60
40
20
0
-6
-4
-2
0
2
4
6

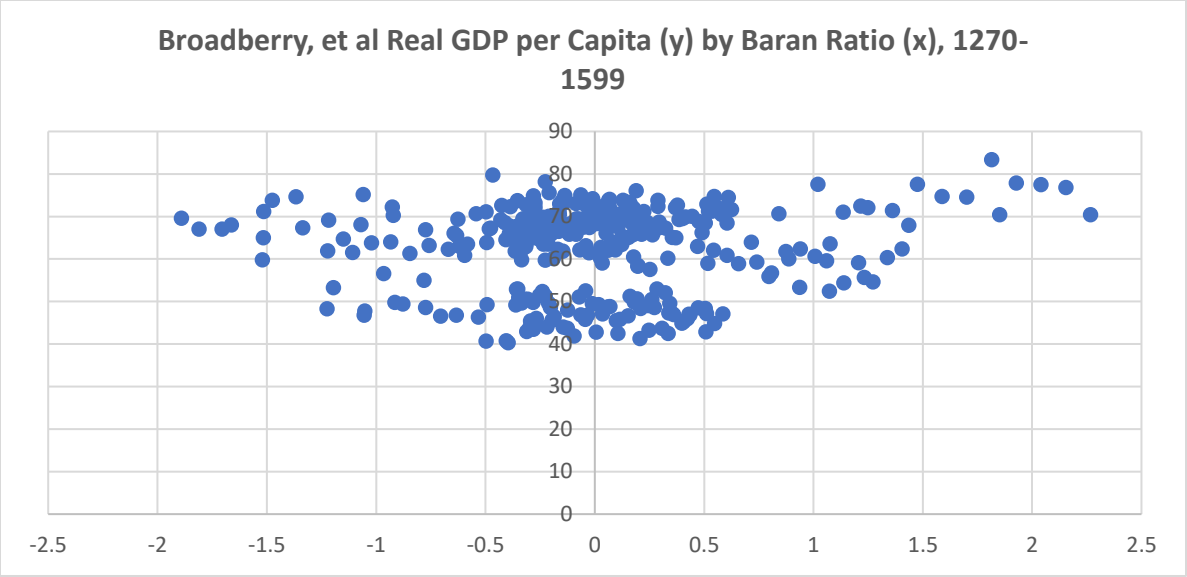

Clark Real GDP per Capita (y) by Annual Investment (x), 1600-1859
180
160
140
120
100
80
60
40
20
0
-20
0
20
40
60
80
100

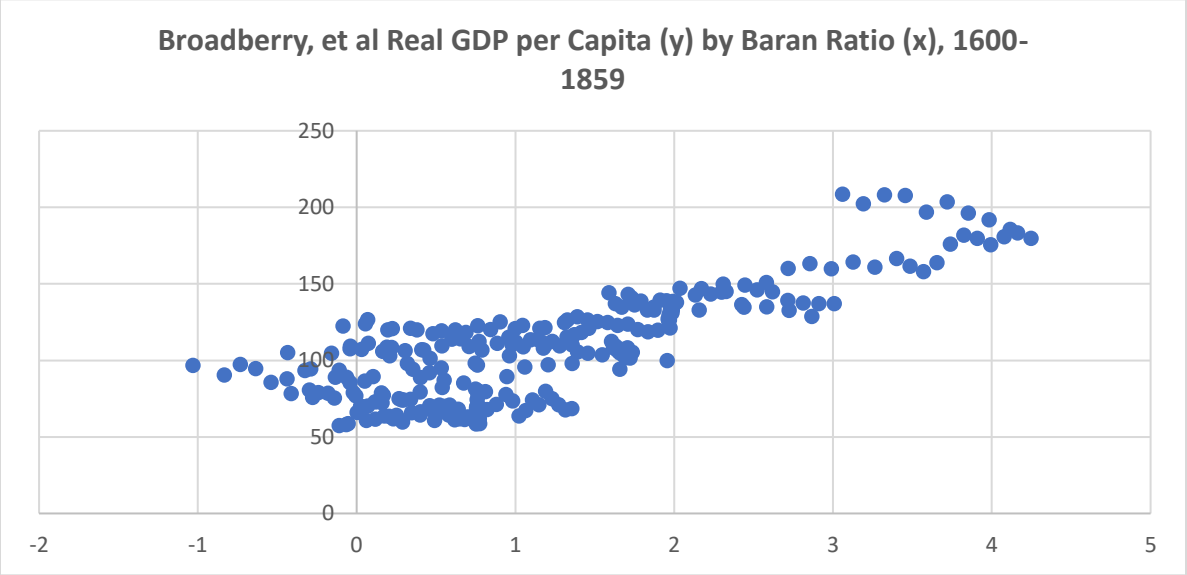

Clark Real GDP per Capita (y) by Baran Ratio (x), 1209-1599
160
140
120
100
80
60
40
20
0
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5


Clark Real GDP per Capita (y) by Baran Ratio (x), 1600-1859
180
160
140
120
100
80
60
40
20
0
-2
-1
0
1
2
3
4
5


Broadberry, et al Real GDP per Capita (y) by Annual Investment (x), 1270-1599
90
80
70
60
50
40
30
20
10
0
-6
-4
-2
0
2
4
6


Broadberry, et al Real GDP per Capita (y) by Annual Investment (x), 1600-1859
250
200
150
100
50
0
-20
0
20
40
60
80
100


Broadberry, et al Real GDP per Capita (y) by Baran Ratio (x), 1270-1599
90
80
70
60
50
40
30
20
10
0
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5


Broadberry, et al Real GDP per Capita (y) by Baran Ratio (x), 1600-1859
250
200
150
100
50
0
-2
-1
0
1
2
3
4
5