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By

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Abstract

This paper examines the history of U.S. infrastructure since 1929 and in the process reports an interesting fact about the U.S. economy. Infrastructure as a percent of GDP began a steady decline around 1970, and the government budget deficit became positive and large at roughly the same time. The infrastructure pattern in other countries does not mirror that in the United States, so the United States appears to be a special case. The overall results suggest that the United States became less future oriented beginning around 1970. This change has persisted. This is the interesting fact. Whether it can be explained is doubtful.

1 Introduction

This paper examines the history of U.S. infrastructure since 1929 and in the process reports an interesting fact about the U.S. economy. Annual U.S. data for the 1929–2017 period on government fixed assets from the Bureau of Economic Analysis (BEA) show a large and close-to-monotonic decline in the size of infrastructure as a percent of GDP beginning around 1970 for most categories of infrastructure, both defense and nondefense. It is also the case, as will be seen, that the government budget deficit as a percent of GDP changed around 1970 from being close to zero to being large and positive.[1] This change in the deficit has been sustained except

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[1] "Government" here means both the federal government and state and local governments. More will be said about this below.

for a brief period in the late 1990's. The deficit data thus show that the government began consuming more relative to its income around 1970, and the infrastructure data show that the government began investing less as a fraction of GDP around the same time.

This paper also examines the history of infrastructure for other countries using annual data for the 1960–2015 period from the International Monetary Fund (IMF). It will be seen that no other country has a pattern similar to that of the United States, namely a roughly monotonic deecline in the ratio of infrastructure to GDP beginning around 1970. The United States appears to be a special case in this regard.

The overall results thus suggest that the United States became less future oriented, less concerned with future generations, beginning around 1970. This change has persisted. This is the interesting fact. Whether it can be explained is unclear. A brief discussion is offered in the last paragraph of the Conclusion.

Most of the work using the BEA and IMF data has been concerned with estimating the effects of infrastructure on aggregate output. Aschauer (1989) used an early version of the BEA data to examine whether private sector total factor productivity was affected by public sector infrastructure. Ford and Foret (1991) examined this question for other countries using the IMF data. Munnell (1992) is an early review article. A large literature followed Aschauer (1989), and much of this literature has been summarized in a meta study by Bom and Ligthart (2015). They reviewed 68 studies for the 1983–2008 period. A later study using panel time series data is Calderón, Moral-Benito, and Servén (2015). This question, while interesting, is not of concern here. Rather, the focus is on the historical patterns of infrastructure—category by category for the United States and country by country for the other countries. It does not appear that this type of examination has been done before. There is, of course, much discussion in the current media about the sad state of U.S. infrastructure, with many examples, but little historical analysis.

Section 2 discusses the BEA data and presents the U.S. graphs. Section 3 discusses the IMF data and presents the international graphs. The U.S. data on the government budget deficit are then discussed in Section 4. Section 5 concludes with a summary and some speculation.

2 BEA Data and Graphs

The BEA data are taken from Table 7.2 from the Fixed Assets Accounts Tables, dated November 20, 2018. These data are index numbers, and they were converted to 2012 dollars by using the nominal values for 2012 from Table 7.1. The two main categories in the BEA data are defense and nondefense. Nondefense includes both the federal government and state and local governments. Within defense are equipment, structures, and intellectual property products (IPP). Within equipment are aircraft, missiles, ships, vehicles, electronics, and other. Within nondefense there are also equipment, structures, and IPP. Within nondefense structures there are many categories. The ones examined here are educational, transportation, power, highways and streets, sewer systems, water systems, and an aggregation of all the rest, denoted "all other." The transportation category includes air passenger terminals, runways, land passenger terminals, mass transit, docks, and marinas.

In terms of notation, let D denote defense. The three subcategories are equipment (E), structures (S), and IPP (I). So three variables are DE, DS, and DI. Under DE there are six subcategories mentioned above, denoted $DE1$, ..., $DE6$. Let N denote nondefense. In BEA Table 7.2 nondefense is disaggregated into federal and state and local, and for present purposes these have been aggregated. The three subcategories are the same as for defense, so three variables are NE, NS, and NI. Under NS there are the seven subcategories mentioned above, where the seventh is "all other," denoted $NS1$, ..., $NS7$. The fixed asset data are constructed using the perpetual inventory method—see U.S. Department of Commerce (2003) plus discussion on the BEA website: $www.bea.gov$. The value of total government assets is equal to $DE + DS + DI + NE + NS + NI$; it will be denoted T.

Defense is $DE + DS + DI$, and nondefense is $NE + NS + NI$.

The reason that the federal government and state and local governments have not been treated separately is that much of the infrastructure investment done by state and local governments is financed by the federal government through grants in aid. The interest here is on total government infrastructure.

As noted in the Introduction, the infrastructure data have been divided by GDP for the analysis. Real GDP data were obtained from the BEA National Income and Product Accounts, Table 1.1.6, May 30, 2019. The data are in billions of 2012 dollars. They are available on an annual basis back to 1929. Let YA denote real GDP. YA is cyclical, and to avoid having the ratio of assets to GDP be cyclical because of this, a non-cyclical measure of GDP was constructed. $\log YA$ was plotted for the 1929–2017 period, and a peak-to-peak interpolation was done. The peaks were 1929, 1968, 2005, and 2017. In a few years, like in 1943, 1944, and 1945, the actual value was above the line. The three annual growth rates between the peaks are 3.8, 3.1, and 1.6. The non-cyclical measure of GDP was taken to be the exponential of the points on the interpolation lines. The results in this paper are unlikely to be sensitive to other measures of non-cyclical output. Y will be used to denote this non-cyclical measure of GDP, and it will simply be called GDP. Although the asset data are available back to 1925, only data since 1929 have been used because this is where the data on YA begin.

Figure 1 plots T/Y for the 1929–2017 period. The World War II years and the four years following clearly stand out, as expected. More interesting is the period after the war, say beginning in 1950. Figure 2 plots T/Y for the 1950–2017 period. Between 1950 and 1969 the ratio is fairly flat, although there is some increase in the 1950's. From 1970 on there is close to a monotonic decline, as mentioned above, from 1.169 in 1969 to 0.719 in 2017. This is a drop of 0.450, which is 38.5 percent of the level in 1969. The value of Y in 2017 is \$18,050.7 billions of 2012 dollars, and 0.450 times this is \$8,122.8 billion. If T/Y had not fallen from the level in 1969, T would thus be \$8,122.8 billion higher—\$21,110.3 billion instead

Figure 1

Total Infrastructure/GDP (T/Y)

1929--2017

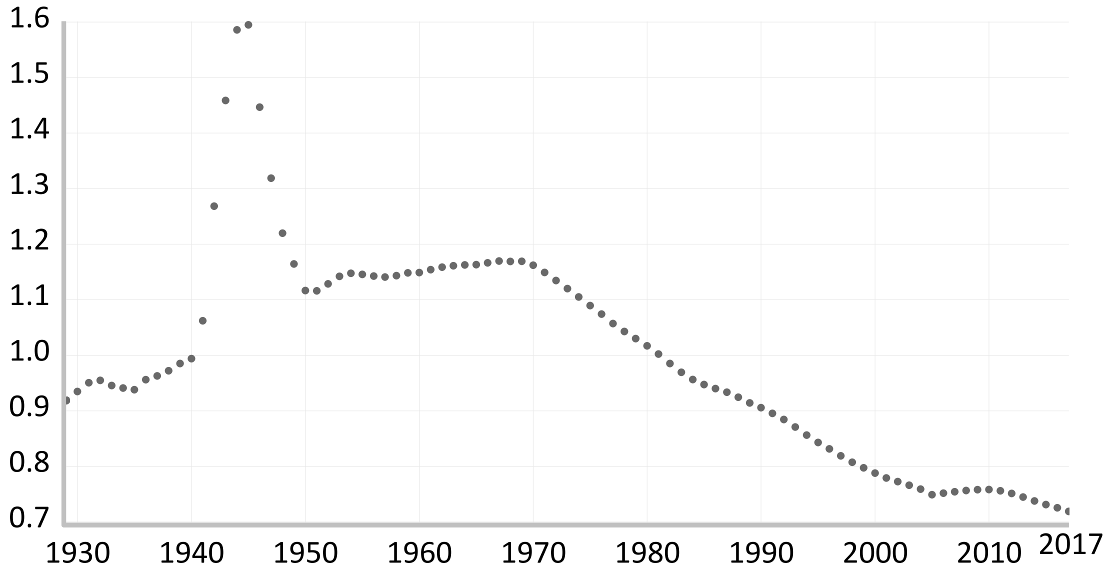
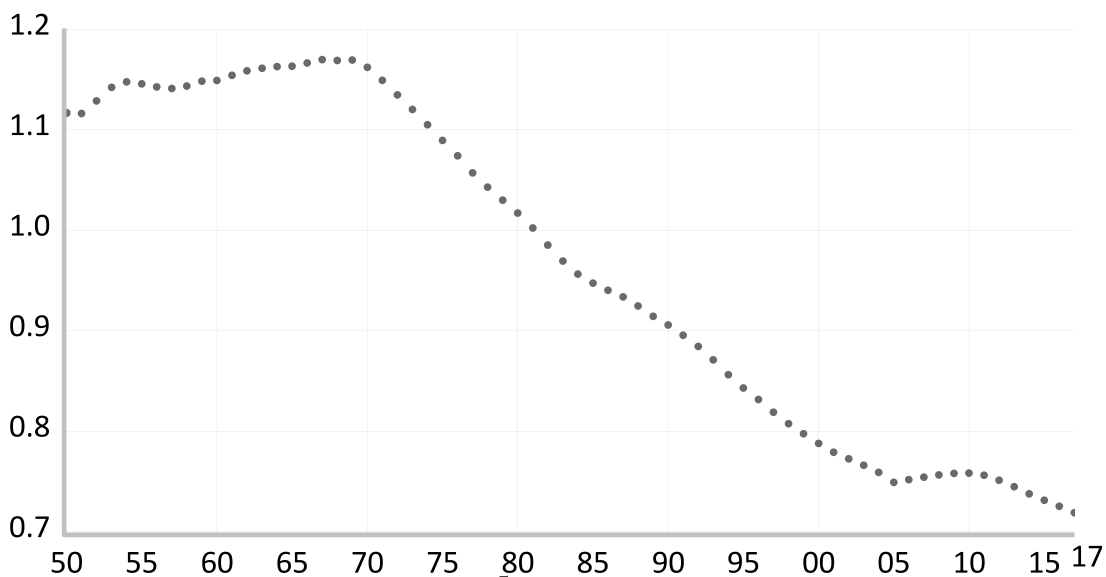


Figure 2

Total Infrastructure/GDP (T/Y) 1950--2017

Change 2017-1969=-0.450, Percent Change=-0.385



of the actual \$12,978.5 billion.

How does T break down between D and N? Figure 3 plots D/Y, and Figure 4 plots N/Y. Defense has declined roughly monotonically from the mid 1950's, whereas nondefense began its decline around 1970. Nondefense is larger than defense, and its pattern dominates the pattern for total infrastructure in Figure 2. Nondefense rose from 1950 to 1970 and then began its decline. From a low value in 2005, there was a slight rise until 2010, when the decline began again. The ratio of nondefense to GDP in 1969 was 0.844 versus 0.630 in 2017, a fall of 0.214, or 25.4 percent. The ratio of defense to GDP in 1969 was 0.325 versus 0.089 in 2017, a fall of 0.236, or 72.6 percent. Had the nondefense ratio been the same in 2017 as it was in 1969, nondefense infrastructure would have been \$3,862.8 billion higher. For defense the corresponding number is \$4,241.9 billion higher.[2]

Does the roughly monotonic decline in defense pertain to all three subcategories? The answer is yes for all three once the decline began, although for IPP the decline does not begin until the late 1980's—Figures 5, 6, and 7. What about the six subcategories for defense equipment—Figures 7a through 7f? (The plots in these figures begin in 1972, which is when the data begin.) For aircraft the fall is fairly steady until 2003, when the ratio flattens out. For missiles there is a rise in the 1980's through the early 1990's and then a decline. At least some of the decline reflects the effects of treaties. For ships there is roughly a monotonic decline. For vehicles there is an overall decline but considerable variation. For electronics there is again considerable variation with a positive trend. For other equipment there is also variation with a positive trend. Again the total defense equipment results are in Figure 7, which show a large overall decline.

The large decline in defense infrastructure may seem surprising, since many are of the view that the Unites States is spending too much on the military. The ratio D/Y in Figure 3 does level off in the 1980's before continuing to fall, which reflects the increased spending of the Reagan administration, but the overall trend

[2]These two numbers don't quite sum to \$8,122.8 above because of rounding.

Figure 3

Defense/GDP (D/Y) 1950--2017

Change 2017-1969=-0.236, Percent Change=-0.726

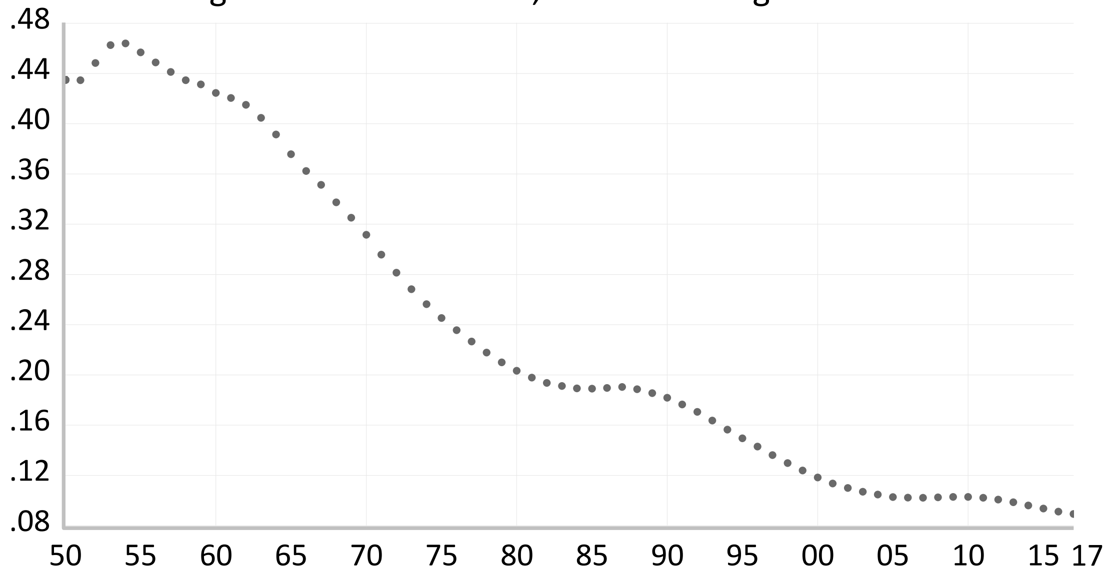


Figure 4

Nondefense/GDP (N/Y) 1950--2017

Change 2017-1969=-0.214, Percent Change=-0.254

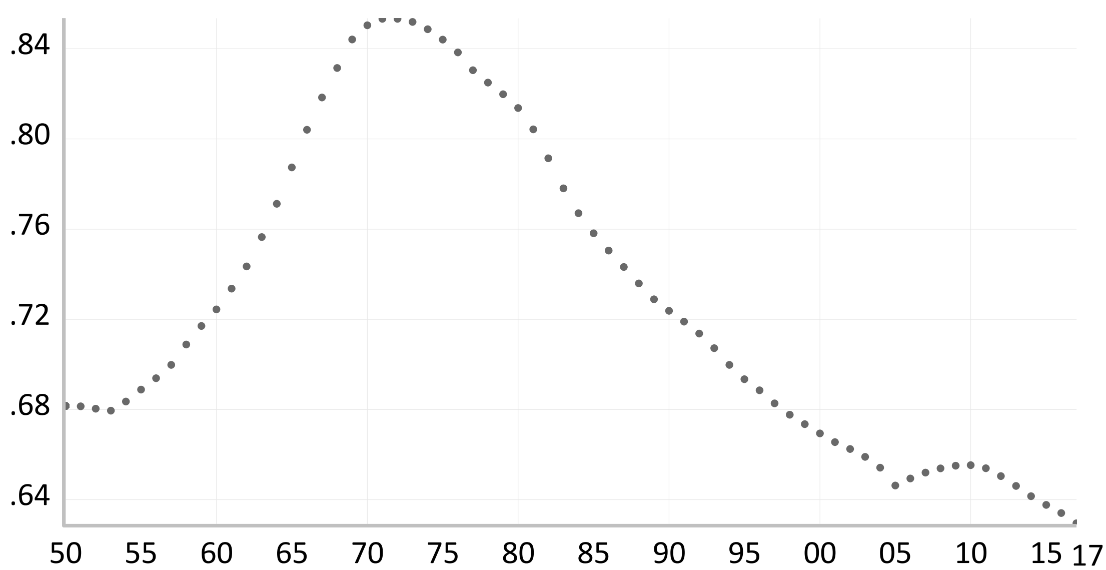


Figure 5

Defense Structures/GDP (DS/Y) 1950--2017

Change 2017-1969=-0.142, Percent Change=-0.785

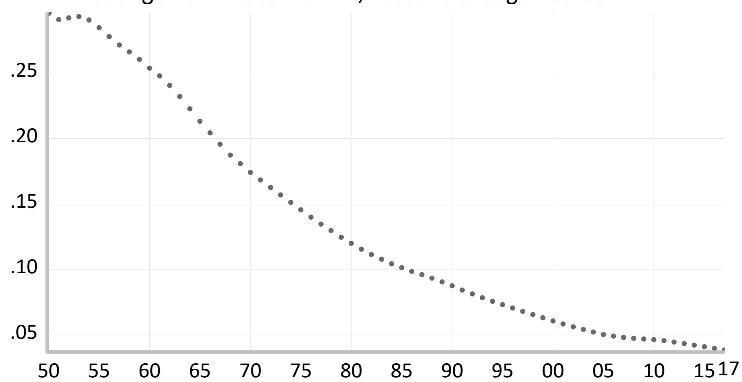


Figure 6

Defense IPP/GDP (DI/Y) 1950--2017

Change 2017-1969=-0.017, Percent Change=-0.500

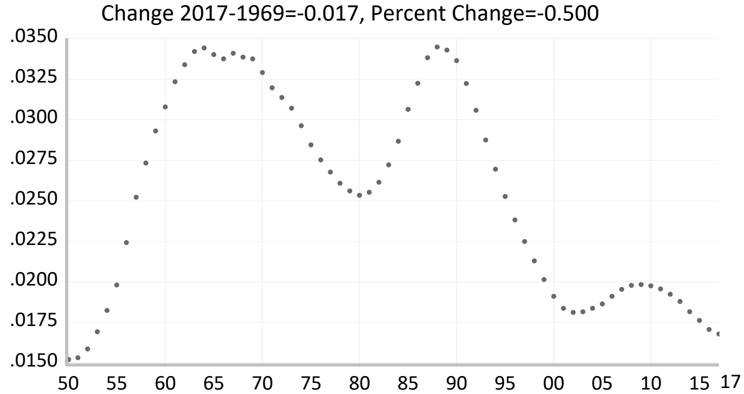


Figure 7

Defense Equipment/GDP (DE/Y) 1950--2017

Change 2017-1969=-0.077, Percent Change=-0.694

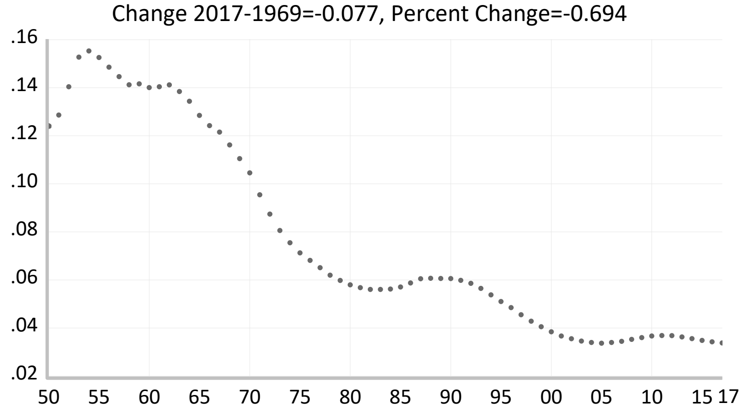


Figure 7a

Defense Aircraft/GDP (DE1/Y) 1972--2017

Change 2017-1972=-0.031, Percent Change=-0.775

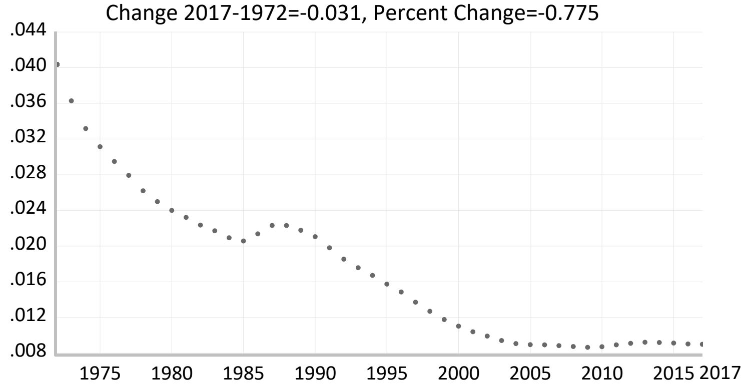


Figure 7b

Defense Missiles/GDP (DE2/Y) 1972--2017

Change 2017-1972=-0.012, Percent Change=-0.800

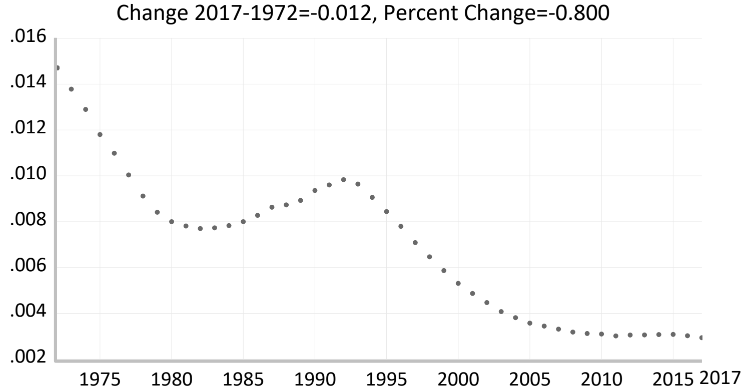


Figure 7c

Defense Ships/GDP (DE3/Y) 1972--2017

Change 2017-1972=-0.014, Percent Change=-0.636

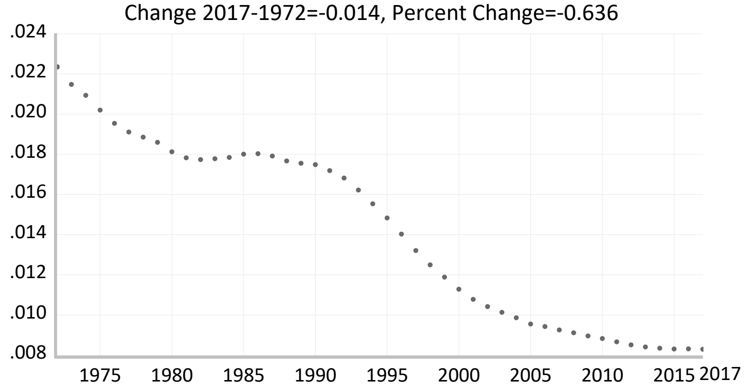


Figure 7d
Defense Vehicles/GDP (DE4/Y) 1972--2017
Change 2017-1972=-0.0022, Percent Change=-0.629

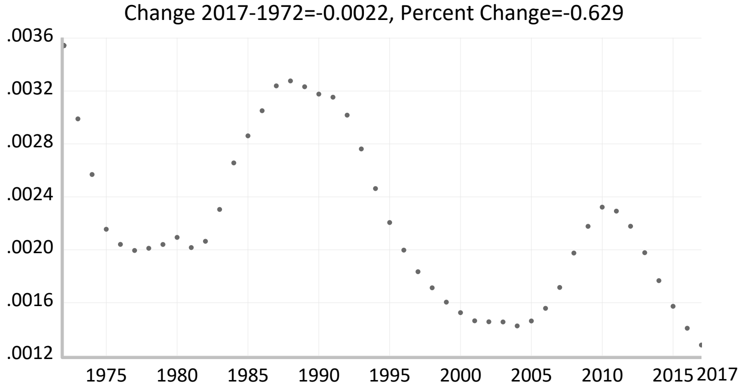


Figure 7e
Defense Electronics/GDP (DE5/Y) 1972--2017
Change 2017-1972=0.0000, Percent Change=0.000

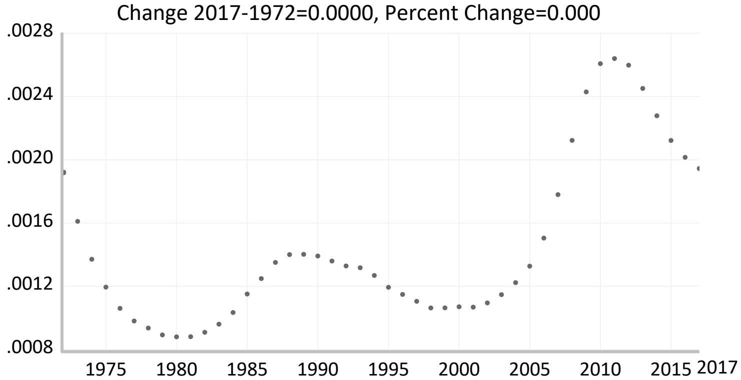
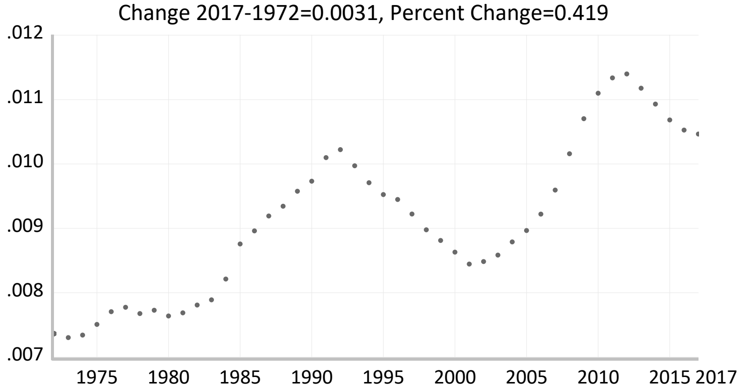


Figure 7f
Defense Other Equipment/GDP (DE6/Y) 1972--2017
Change 2017-1972=0.0031, Percent Change=0.419



is clearly downward. One might think that the downward trend is true of defense investment but not defense consumption, but this is not the case. The ratio of defense consumption to GDP has fallen from 0.1138 in 1969 to 0.0314 in 2017. (In this same period the ratio of defense gross investment to GDP fell from 0.0142 to 0.0081.)[3] The overall picture is thus of a substantial decline in defense spending as a percent of GDP since 1969.

Perhaps of more interest regarding infrastructure is nondefense. Figure 4 shows that there has been a large decline since 1970. What about the three subcategories for nondefense? These are in Figures 8, 9, and 10. Equipment and IPP do not show a decline since 1969, but they are very small as a fraction of GDP. The equipment ratio is 0.009 in 1969 and 0.021 in 2017. For IPP the ratio is 0.044 in both years. Almost all of nondefense is structures, plotted in Figure 10, which shows the roughly monotonic decline since 1970. The ratio in 1969 was 0.791 versus 0.565 in 2017, a decline of 0.226, or 28.6 percent.

What about the seven subcategories of structures—Figures 10a through 10g? Do all of these have declines since 1970? Education rose until 1970, fell until 1996, and then has had a gradual rise after that. Some of the rise before 1970 reflects investment in education for the baby boomers. Transportation has risen throughout the period, a dream for people interested in infrastructure. The bad news is that transportation is a small category relative to, say, highways and streets—Figure 10d. Highways and streets rose until 1970, partly reflecting the construction of the interstate highway system, and then declined as usual from 1970 on. The ratio for transportation in 1969 is 0.027 versus 0.042 in 2017, an increase of 0.015, or 55.6 percent. The ratio for highways and streets in 1969 is 0.325 versus 0.183 in 2017, a decrease of 0.142, or 43.7 percent. Power in Figure 10c, a small category, has declined since the mid 1980's. Sewer systems rose until 1980 and then declined. Water systems has declined since 1970. Finally, "all other" rose until 1980 and

[3]Defense consumption and defense gross investment are taken from BEA Table 3.9.3, lines 18 and 19. These data are index numbers, and they were converted to 2012 dollars using the dollar values in 2012 in Table 3.9.5. They were then divided by Y.

Figure 8

Nondefense Equipment/GDP (NE/Y) 1950--2017

Change 2017-1969=0.012, Percent Change=1.333

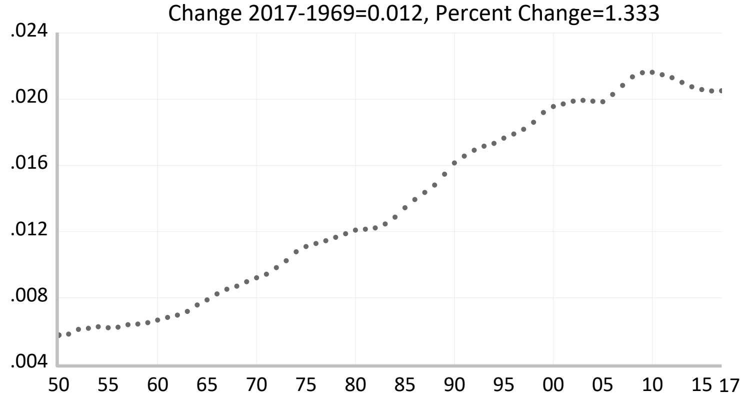


Figure 9

Nondefense IPP/GDP (NI/Y) 1950--2017

Change 2017-1969=0.000, Percent Change=0.000

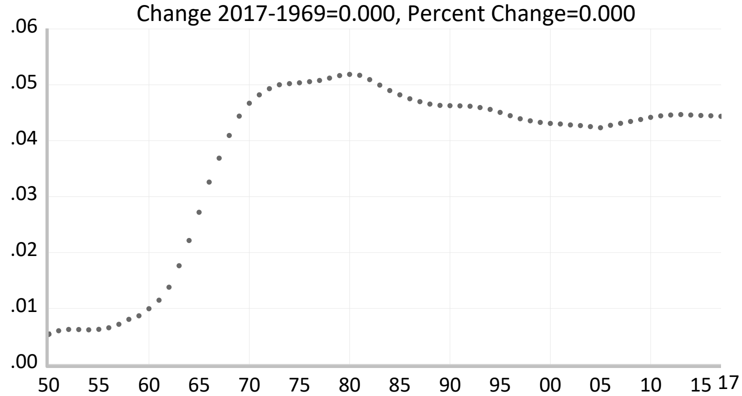


Figure 10

Nondefense Structures/GDP (NS/Y) 1950--2017

Change 2017-1969=-0.226, Percent Change=-0.286

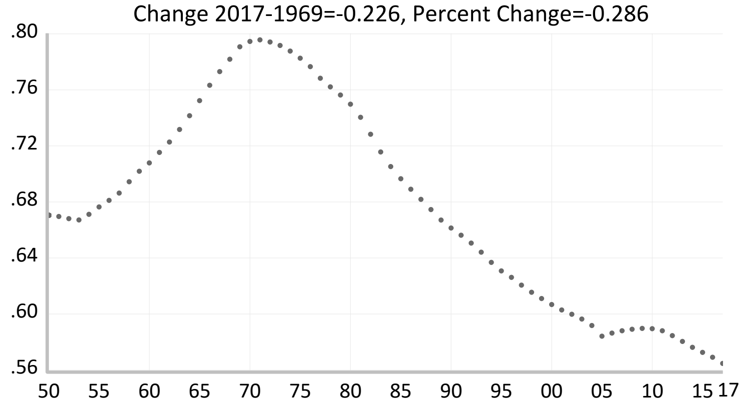


Figure 10a

Nondefense Educational/GDP (NS1/Y) 1950--2017

Change 2017-1969=-0.045, Percent Change=-0.263

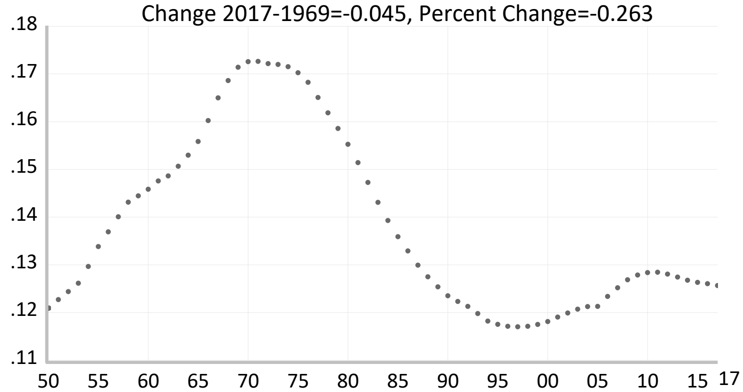


Figure 10b

Nondefense Transportation/GDP (NS2/Y) 1950--2017

Change 2017-1969=0.015, Percent Change=0.556

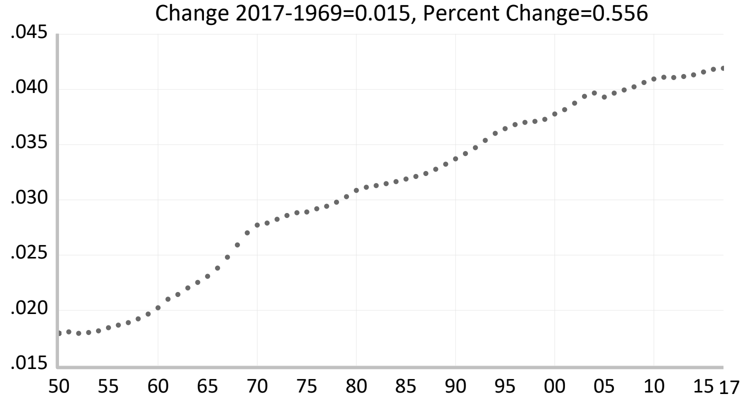


Figure 10c

Nondefense Power/GDP (NS3/Y) 1950--2017

Change 2017-1969=-0.006, Percent Change=-0.240

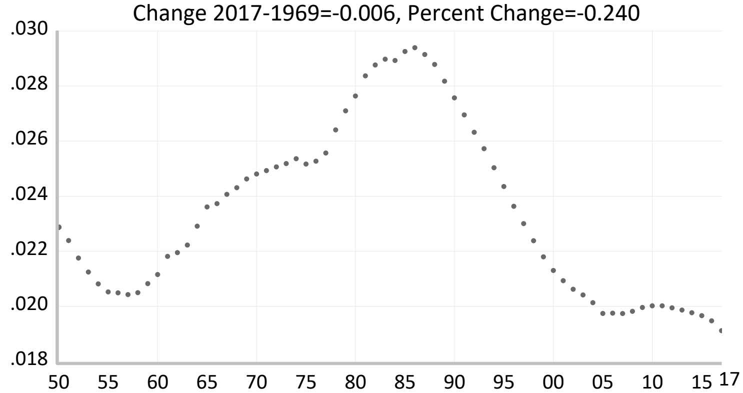


Figure 10d

Nondefense Highways and Streets/GDP (NS4/Y) 1950--2017

Change 2017-1969=-0.142, Percent Change=-0.437

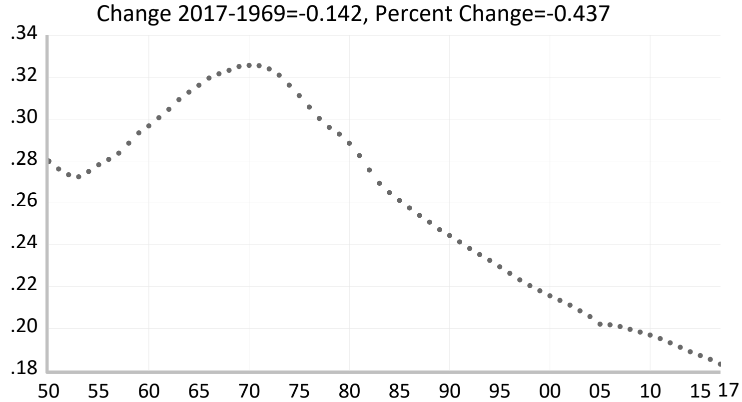


Figure 10e

Nondefense Sewer Systems/GDP (NS5/Y) 1950--2017

Change 2017-1969=-0.010, Percent Change=-0.204

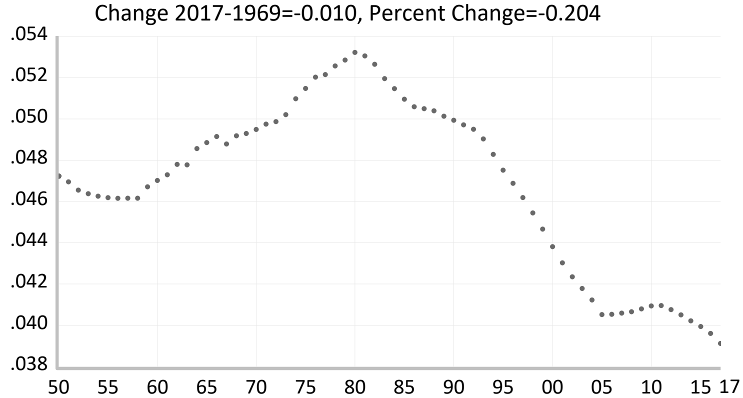


Figure 10f

Nondefense Water Systems/GDP (NS6/Y) 1950--2017

Change 2017-1969=-0.009, Percent Change=-0.237

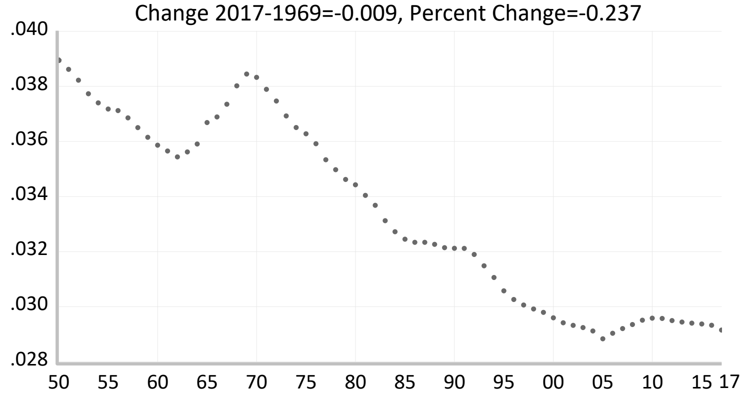
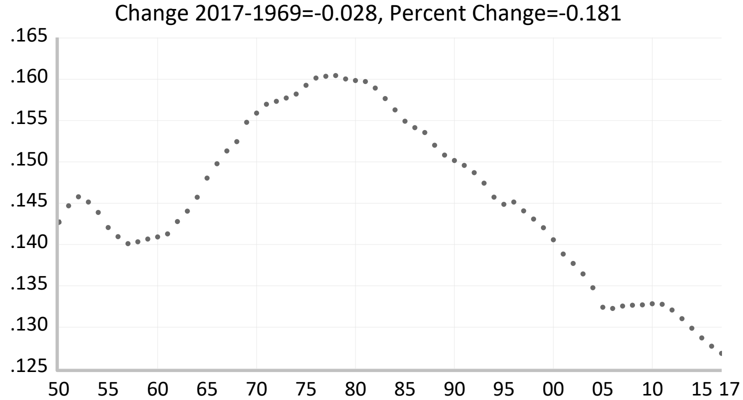


Figure 10g
Nondefense All Other Structures/GDP (NS7/Y) 1950--2017
Change 2017-1969=-0.028, Percent Change=-0.181



then began the decline. Again, the results for total nondefense structures are in Figure 10, which show the decline since 1970.

It is thus the case that nondefense has not done well. The category is dominated by structures, which has declined considerably since 1970.

3 IMF Data and Graphs

The Fiscal Affairs Department of the International Monetary Fund has compiled data on the stock of public capital in 170 counties. The data are annual, and for most countries they begin in 1960. They end in 2015. Data are also available for GDP. The units are in 2011 international dollars. Let T denote the capital stock and let Y denote GDP for a given country. For the results in this section Y is actual GDP. It has not been adjusted for cyclical variation.

The IMF categorizes countries into 1) low income developing countries (LIDC), 2) emerging markets (EM), and 3) advanced economics (AE). Four aggregates have been used here. First, countries were excluded from all aggregates if they had any missing data from 1965 on. Countries were used if they had missing data only between 1960 and 1964, where they simply were not included in the aggregates for these years. This left 140 countries out of 170. For each year the values of the capital stock were summed to get an aggregate capital stock, and the values of GDP were summed to get an aggregate GDP value. The ratio of the aggregate capital stock to aggregate GDP was then computed. This was done for all countries, all LIDC countries, all EM countries, and all AE countries. The United States was excluded from all calculations.

Figures 11–14 contain the aggregate plots: Figure 11 for all 140 countries, Figure 12 for the LIDC countries, Figure 13 for the EM countries, and Figure 14 for the AE countries. Figures 15a–15l contain plots for 12 individual countries. One question of interest for present purposes is whether these plots exhibit a pattern since 1970 similar to that for the United States in Figure 2, namely a roughly monotonic decline, ending roughly at the smallest value in the period. Five of the 16 plots end roughly at the smallest value: LIDC, AE, Germany, India, and the United Kingdom. For none of these does the decline begin in the early 1970's. For all but India the decline begins in the mid 1980's, and for India it begins in the mid 1990's. None of the other 11 plots show a pattern close to that of the United States. Some of the plots are somewhat erratic, which could be partly due to measurement error. Of the 11 plots that did not end at the smallest value, four have a value in 2015 that is smaller than the value in 1969: Canada, China, France, and Korea.

Figure 16 is a plot for the United States using the IMF data on both the capital stock and GDP. (GDP in this case has not been adjusted for business cycles.) The plot is similar to that in Figure 2, which is encouraging regarding the accuracy of the data. The decline begins more or less in 1970, although there is some decline in the 1960's. There are also more fluctuations going down. The ratios are also smaller using the IMF data. For example, in 1969 the ratio is 0.945 for IMF and 1.169 for BEA. In 2015 it is 0.643 for IMF and 0.731 for BEA. The decline between 1969 and 2015 is thus somewhat larger for BEA than for IMF: 0.438 versus 0.302. Probably the BEA data are more reliable.

Figure 11

All Countries, Public Capital/GDP 1960--2015

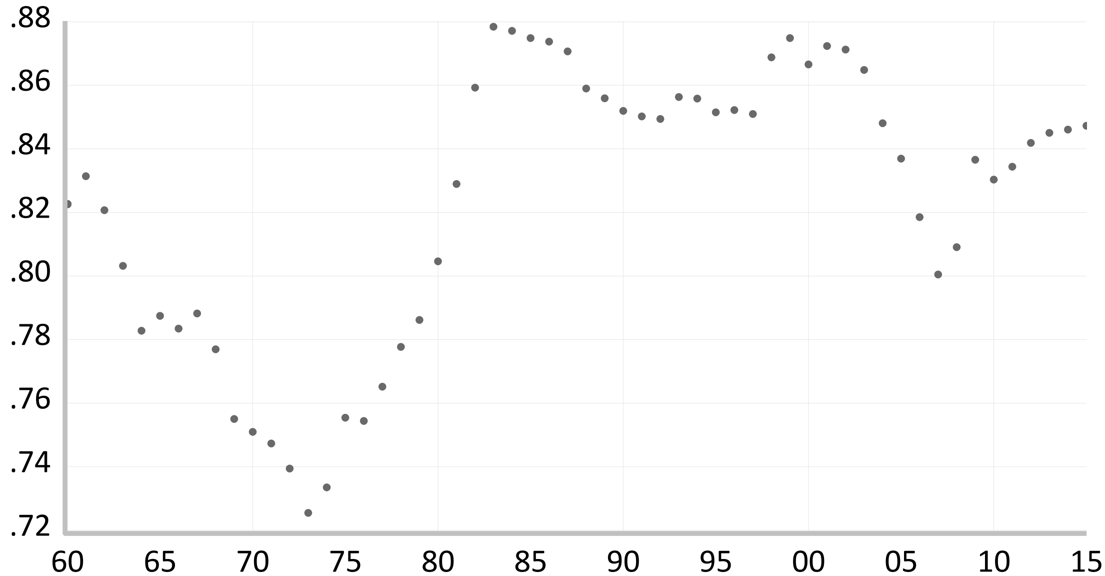


Figure 12

LIDC Countries, Public Capital/GDP 1960--2015

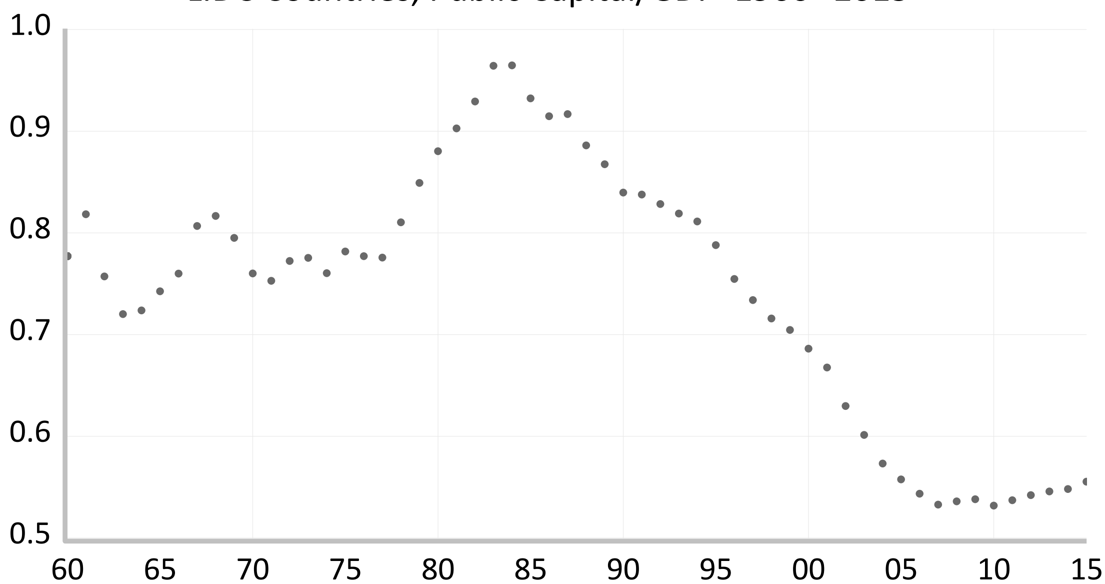


Figure 13

EM Countries, Public Capital/GDP 1960--2015

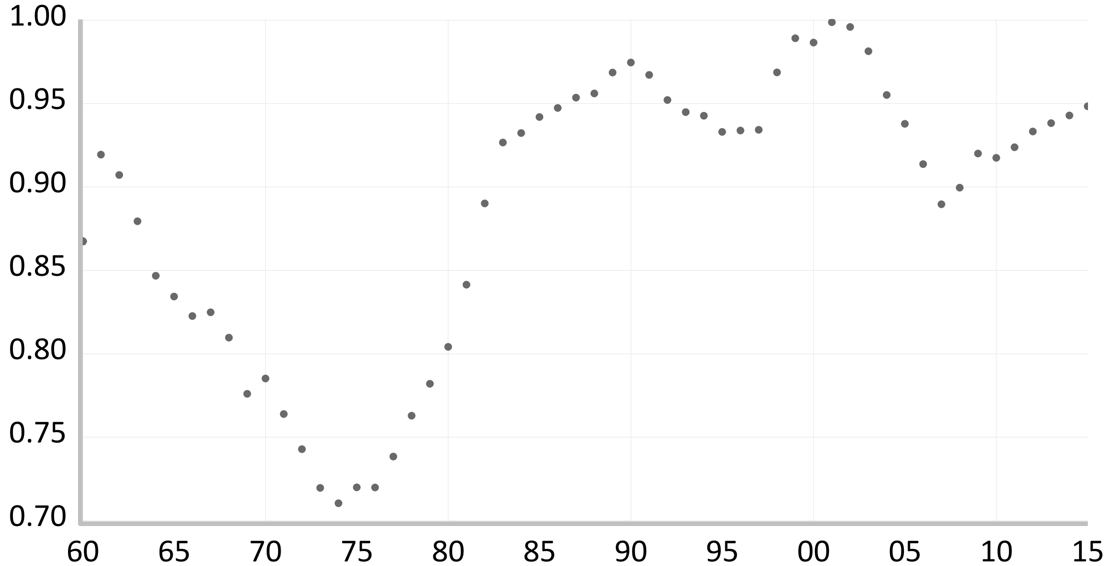


Figure 14

AE Countries, Public Capital/GDP 1960--2015

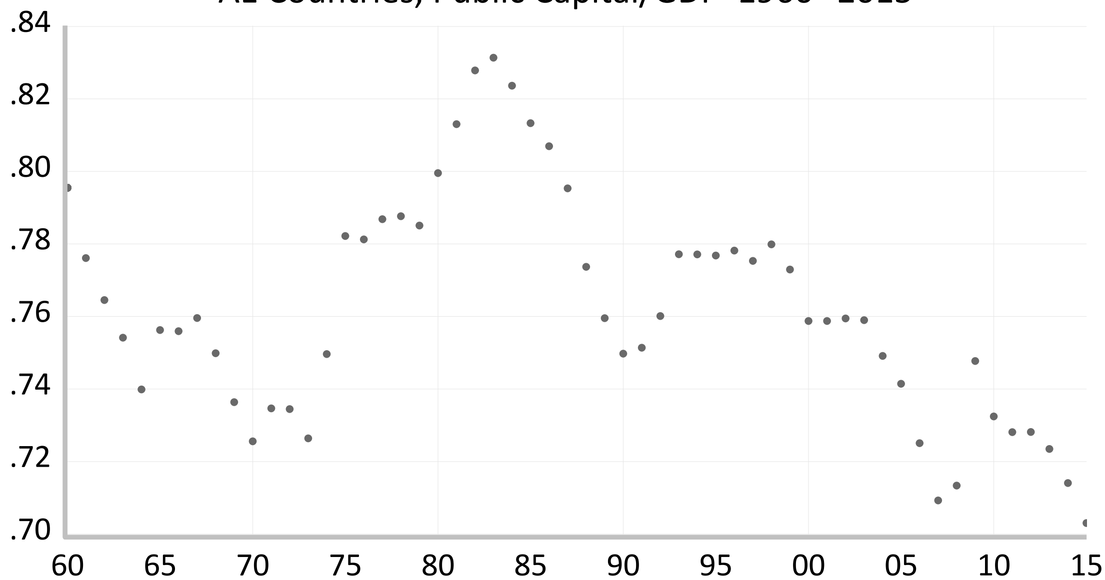


Figure 15a

Australia, Public Capital/GDP 1960--2015

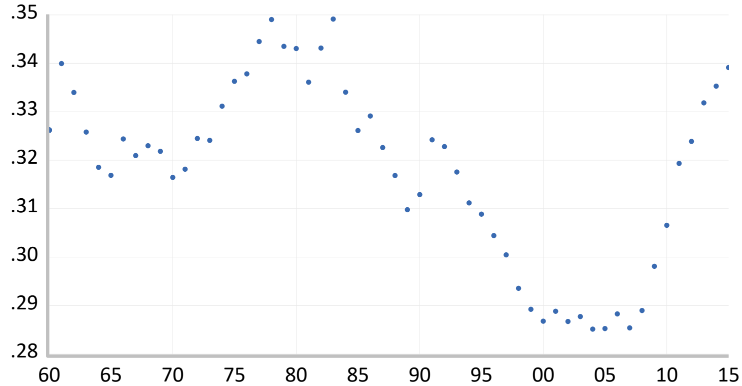


Figure 15b

Canada, Public Capital/GDP 1960--2015

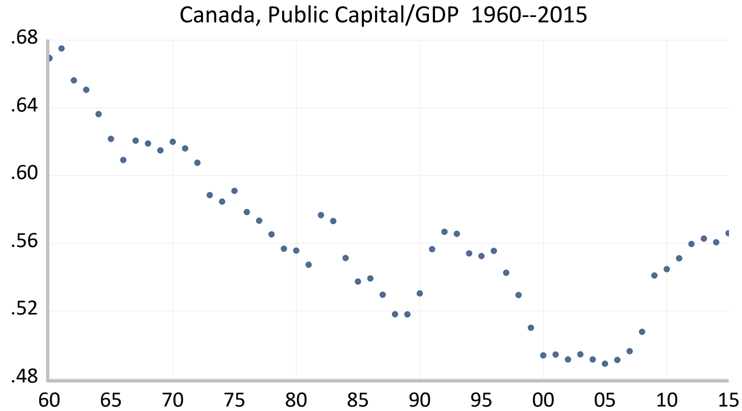


Figure 15c

China, Public Capital/GDP 1960--2015

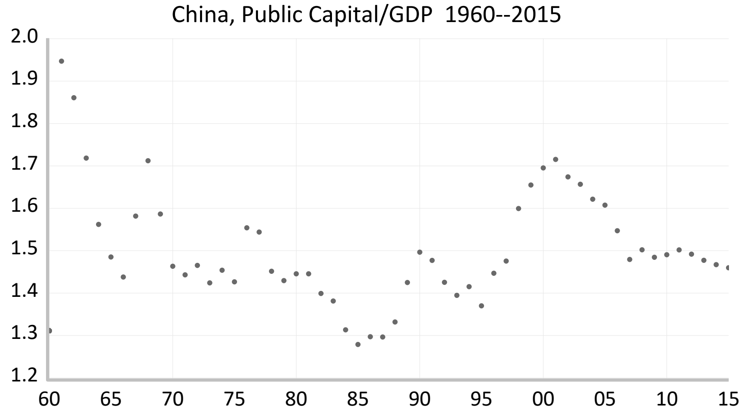


Figure 15d

France, Public Capital/GDP 1960--2015

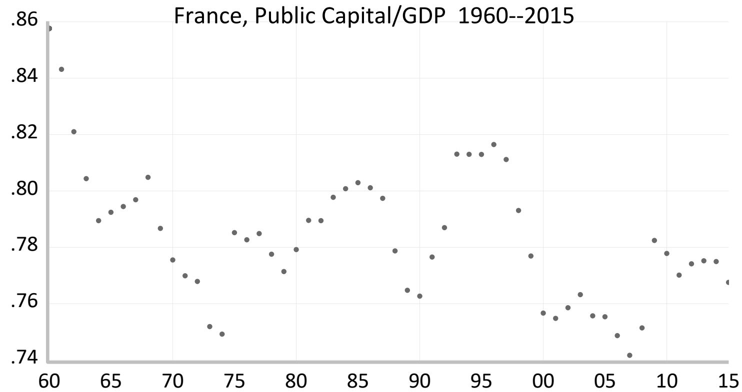


Figure 15e

Germany, Public Capital/GDP 1960--2015

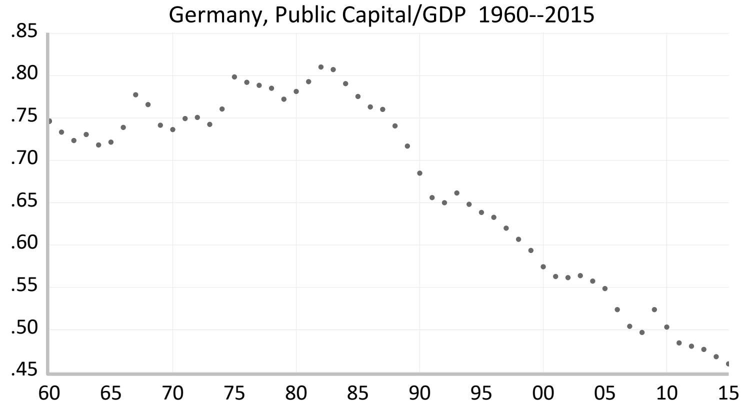


Figure 15f

India, Public Capital/GDP 1960--2015

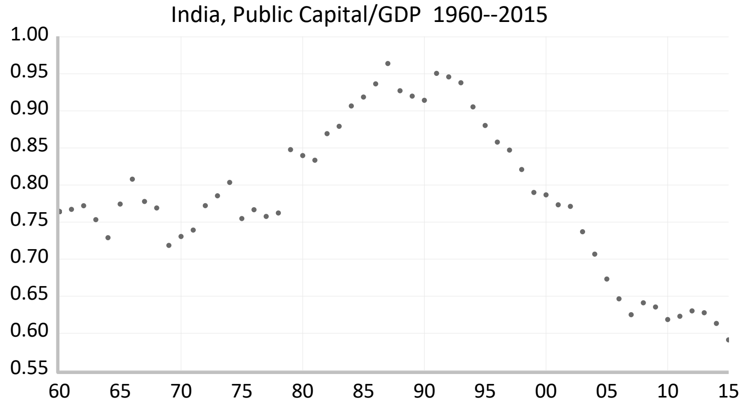


Figure 15g

Italy, Public Capital/GDP 1960--2015

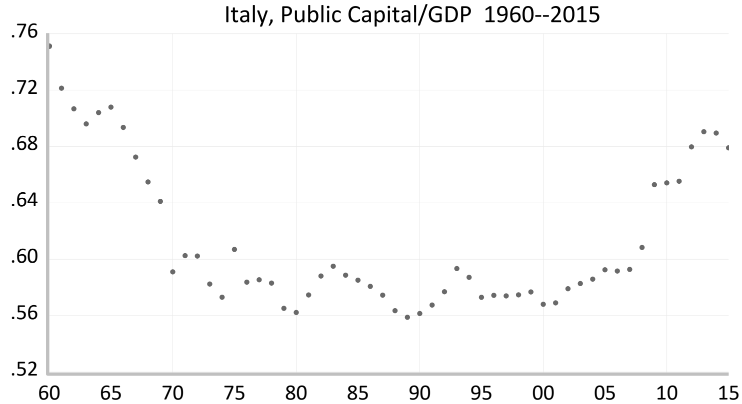


Figure 15h

Japan, Public Capital/GDP 1960--2015

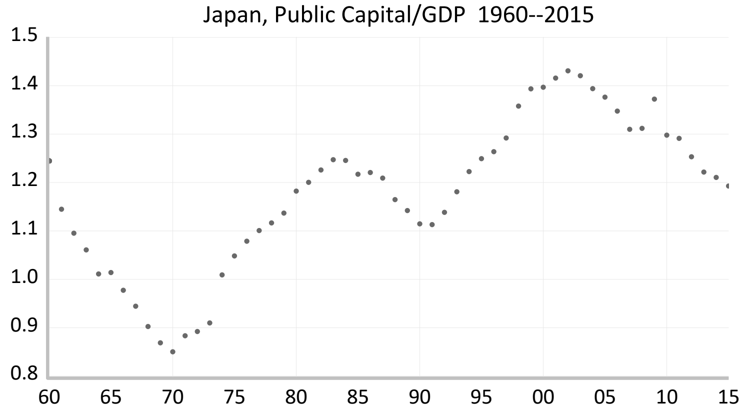


Figure 15i

Korea, Public Capital/GDP 1960--2015

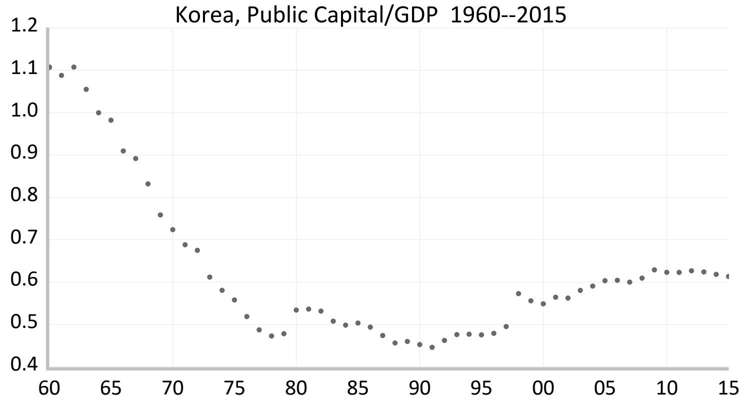


Figure 15j

Mexico, Public Capital/GDP 1960--2015

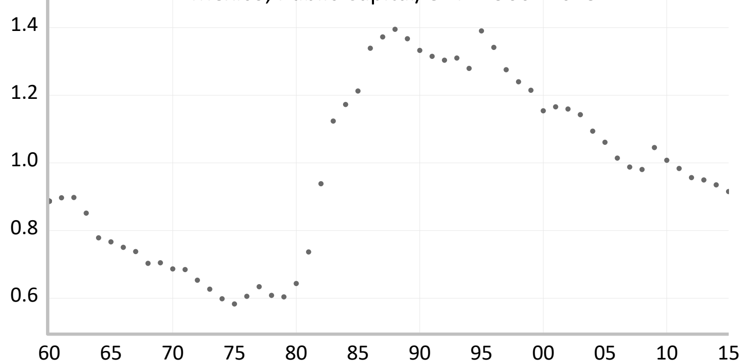


Figure 15k

Spain, Public Capital/GDP 1960--2015

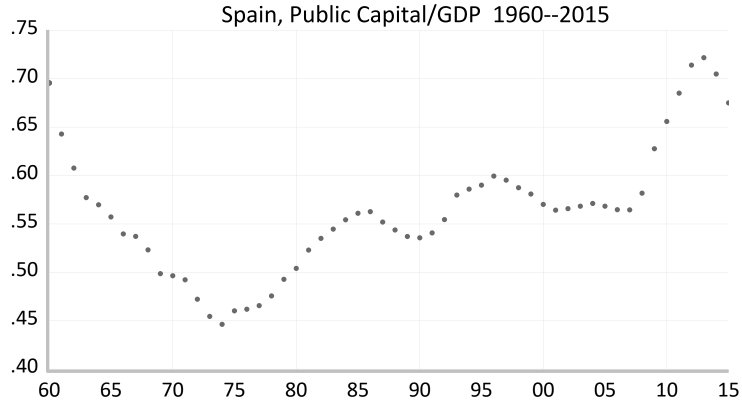


Figure 15l

United Kingdom, Public Capital/GDP 1960--2015

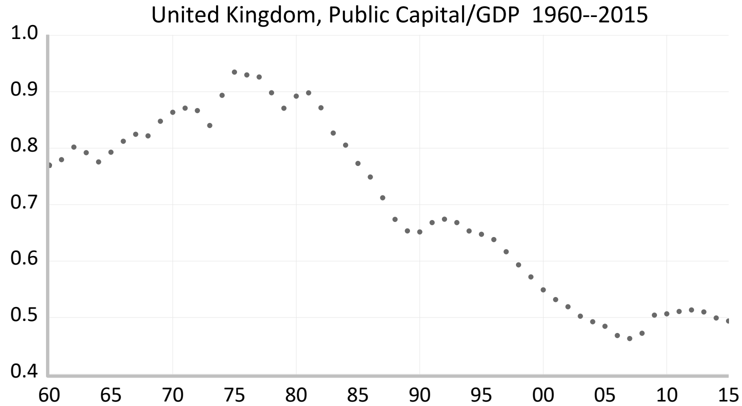
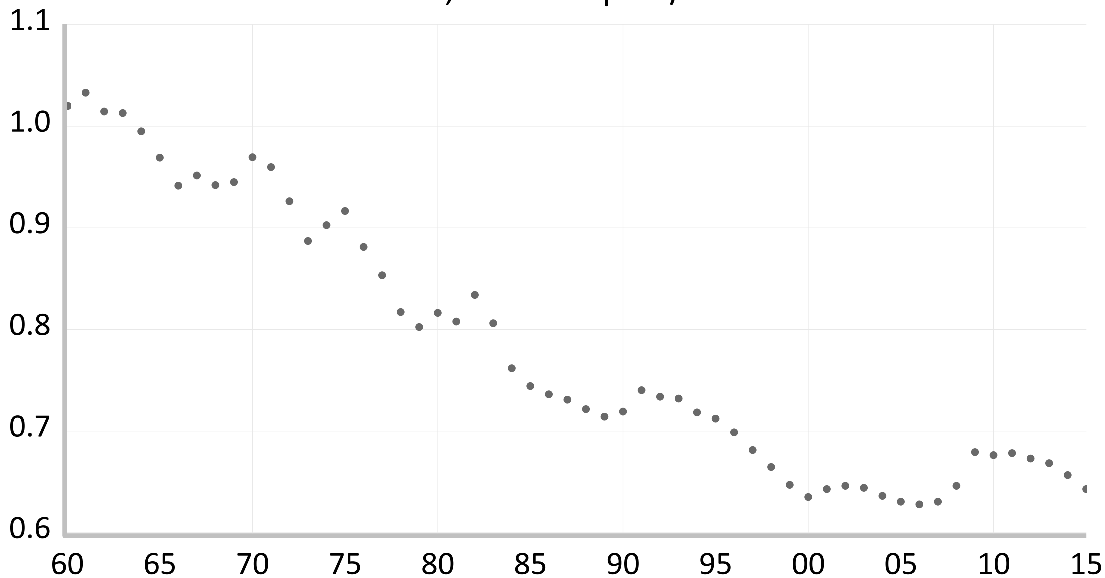


Figure 16

United States, Public Capital/GDP 1960--2015



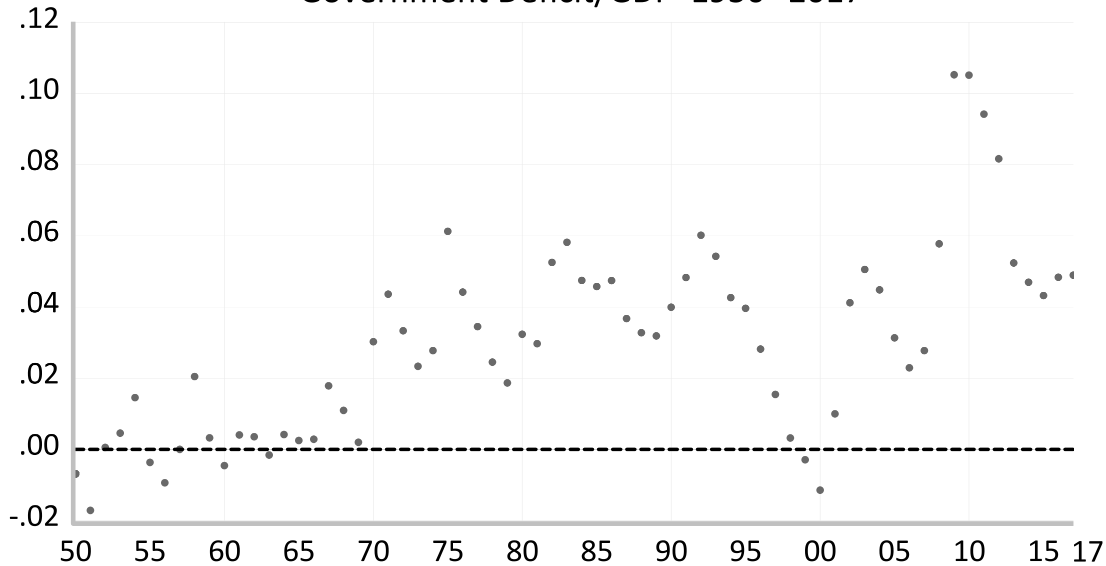
4 The Government Budget Deficit

As noted in the Introduction, the government budget deficit as a percent of GDP became large and positive beginning in 1970. Figure 17 plots the government deficit as a percent of GDP for 1950–2017. The deficit data are taken from BEA Table 3.1 in the National Income and Product Accounts, dated May 30, 2019. The deficit is the negative of "net government saving" on line 31, which is the difference between current receipts and current expenditures. The main categories of current expenditures are consumption expenditures, current transfer payments, and interest payments. The deficit has been divided by the GDP deflator to put it in real terms, and then the deficit in real terms is divided by Y to compute the ratio. The GDP deflator is taken from Table 1.1.9, line 1, also dated May 30, 2019.

Figure 17 shows that the deficit as a percent of GDP hovered near zero until 1970, when it became positive. It has remained positive except for 1999 and 2000.

Figure 17

Government Deficit/GDP 1950--2017



The average of the ratio is 0.0024 for 1950–1969, 0.0378 for 1970–1989, 0.0355 for 1990-2009, and 0.0651 for 2010-2017. Figures 17a and 17b plot the same variable for the federal government and state and local governments separately. The data are taken from BEA Tables 3.2 and 3.3. The two figures show that the increase in 1970 was from the federal government. State and local governments began contributing to the deficit in the early 1990's. The contribution became larger beginning about 2000.

5 Conclusion

With few exceptions the ratio of most categories of U.S. infrastructure to GDP is near an all time low, with declines that begin around 1970. The declines have been large. The decline is larger for defense than nondefense, but the nondefense decline is also large. The decline in the ratio of nondefense infrastructure to GDP

Figure 17a
Federal Government Deficit/GDP 1950--2017

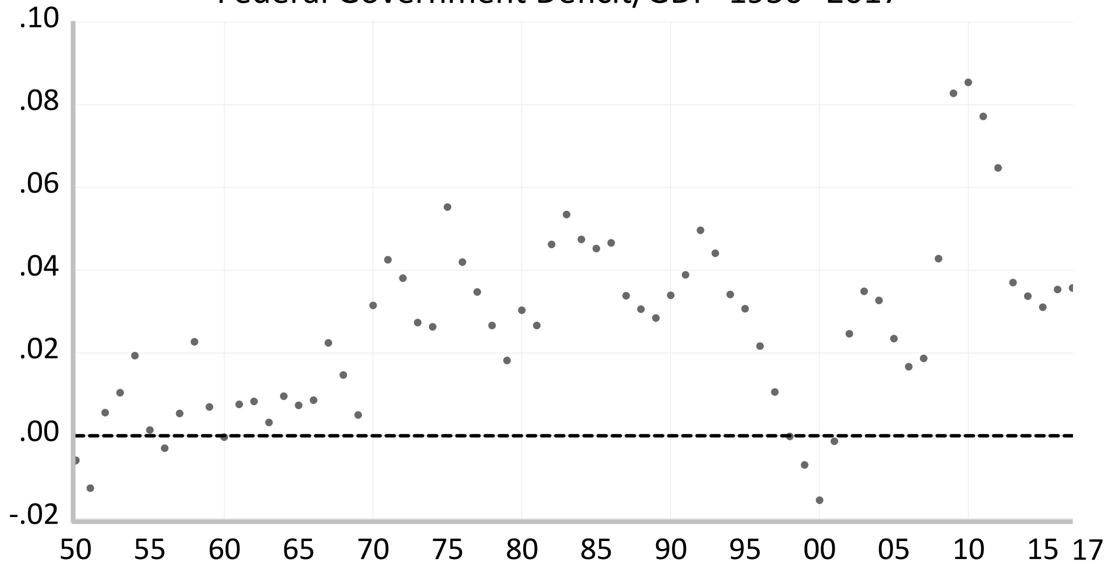
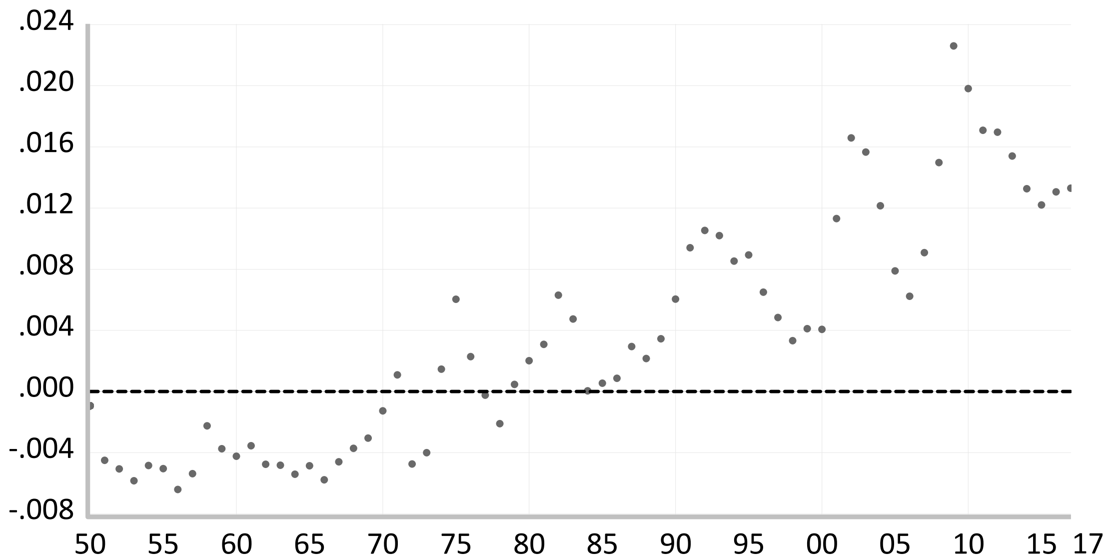


Figure 17b
State and Local Government Deficit/GDP 1950--2017



between 1969 and 2017 is 25.4 percent. If the ratio were the same in 2017 as in 1969, nondefense infrastructure would be $3,862.8 billion larger. The U.S. pattern of decline has not been mirrored in other countries.

As noted in the Introduction, the infrastructure results combined with the results for the government budget deficit suggest that the United States became less future oriented, less concerned with future generations, beginning about 1970. This change has persisted. The roughly monotonic decline in infrastructure as a percent of GDP since 1970 is remarkable. The government began consuming more relative to its income and investing less around 1970. This is not something that has happened in other countries, so it could be something special about the United States. Can this change be explained? Can one build a structural model to explain it? The years 1968, 1969, and 1970 had many noticeable events: the early baby boomers moving into their 20's; the assassinations of Martin Luther King Jr. and Robert Kennedy; the beginning of the women's movement; the draft, the bombing of Cambodia, and unrest on college campuses; Woodstock; Stonewall. Did any of these increase the impatience of the country in a permanent way? There are likely stories that could be woven, undoubtedly more than one, but it is unclear whether anything could be tested. The question is probably too big, but the fact is interesting.

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