The Macroeconomic Impact of Infrastructure Investment – or lack thereof - in the US

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Abstract. Federal and state investment on infrastructure, including new roads, sanitation, and power plants, is key to economic growth and recovery. I concluded, through a review of prior publications and empirical studies, that infrastructure investment can stimulate both economic output growth and employment. Timing of the investment and the government's chosen method of funding are two significant factors that influence the impact of infrastructure investment. Infrastructure spending shows greater influence during economic recessions for both economic output and unemployment as more labor force and resources are available. Both deficit-financed and deficit-neutral methods have short- and long-term benefits on output and employment growth, but to varied degrees. In the short run, the two strategies have little to no impact on output and employment since several conflicting force would mitigate each other. In the long term, however, deficit-neutral method tends to have greater impact on output and employment since there will be no “crowding out” of private investment.

Keywords: public investment, economic growth, employment.

1. Introduction

Infrastructure, viewed by many as a crucial factor of improving the living standards of Americans, has not been valued much by the government in recent years. As figure 1 shows, state and local capital spending as a share of GDP peaked at 3 percent in 1965 and since then has declined to about 1.8 percent in 2017[1]. In the 1990s, when the economy was especially robust, the federal government and states expanded public spending. Also, in 2009, there was a small increase of infrastructure spending because of the 2009 Recovery Act. However, besides these two time periods, there has been a declining trend in infrastructure investment. Many of the infrastructure are also in a poor condition in the US. The American Society of Civil Engineers (ASCE) rated the infrastructure of the United States as D+ or “deficient” [2]. The United States' drinking water treatment and distribution infrastructure require $473 billion in investments over the next 20 years, according to the Environmental Protection Agency [3]. Indicated by the most recent report by the Federal Highway Administration, about 20 percent of the country's roads are in poor conditions [4]. Moreover, compared to other nations, the United States lags behind many advanced economies regarding the infrastructure investment as a percentage of GDP. In figure 2, it shows that the US’s transportation infrastructure investment takes only 0.6 percent of GDP in 2014, which is lower than the average – 0.8 percent – among other G7 countries [5].

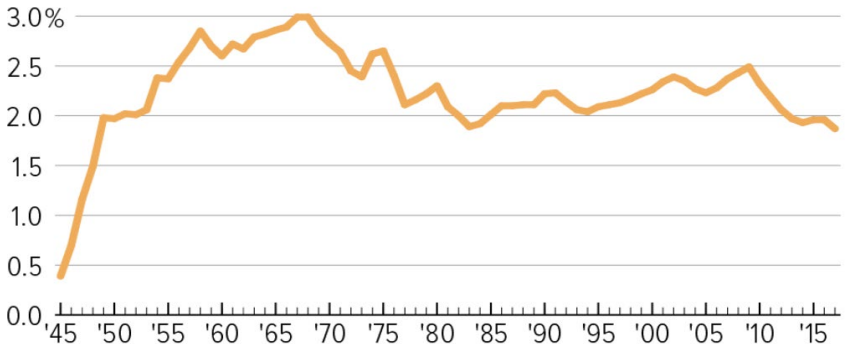

Figure 1 State and Local capital spending as share of GDP, 1945-2017 [1]

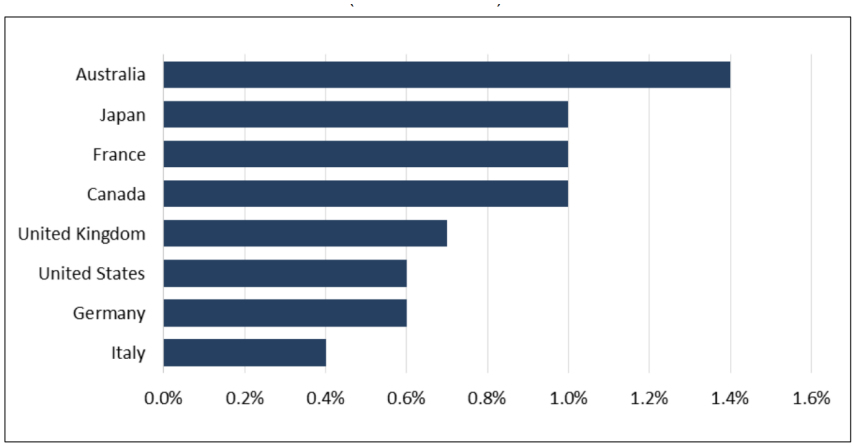

Figure 2 Transportation infrastructure investment in G7 countries, 2014 [2]

State and federal investments on vital infrastructure – transportation, power plants, and water sanitation – are crucial to economic growth, employment, and promoting economic recovery. Gordon [6] proposes that core infrastructure contributed to the surge in people's expectation and productivity in the United States during the early 20th century. Commerce requires good conditions of roads to reduce the transportation cost. For example, as Leff Yeffe and Fernald [7-8] pointed out, the U.S. interstate highway program was strongly associated with increase in productivity and economic output. Electrical facilities need upgraded equipment to function more efficiently. Education will be further improved if schools have convenient teaching tools. For households, more infrastructure means more final goods and services could be produced and consumed. The current poor conditions of the U.S. infrastructure would also provide rooms for more improvements. What is more important is that during COVID time, improvement on sanitation and medical instrument will reduce the pressure on economic recovery because infrastructure investment could function both as a short term and long-term stimuli. Additionally, public infrastructure investment can stimulate employment expansion. The new infrastructure projects will provide employment prospects without requiring workers to have a high level of education, because construction does not require a great deal of skilled labor. In fact, especially when the country is currently in a recovery stage, more idle workers will be available so that the time required for infrastructure investment to exert its impact is relatively short.

In this paper, I examine mainly the macroeconomic impact of increased infrastructure investment on economic growth and employment through summary of past research and analysis of current situations. Numerous studies have demonstrated the favorable effect of infrastructure expenditures on economic output and employment. The paper proceeds as follows. Section 2.1 includes first a general analysis of the economic output effect and how the impact would be altered under different business cycles and financing methods. The resulting money supply would then encourage people to consume and invest, thereby increasing the overall GDP. I also find that the economic output would be positively affected especially when the economy is operating under its potential. Therefore, infrastructure could serve as both long term and short-term stimuli to push the current economy out of its recovery phase. Section 2.2 talks about the impact of infrastructure spending on employment. Supported by many empirical studies, I found that infrastructure investment has a direct positive influence on employment. Similar to its impact on economic output, during economic recessions unemployment rate will be relatively more affected compared to economic expansions. The deficit financed method would reduce unemployment rate as there would be less "crowding out" effect in the long run.

2. Macroeconomic analysis of infrastructure investment

2.1 Economic Output Effect

Government investment expenditures, such as infrastructure spending, will improve potential economic output over the long term. A rise in public capital expenditures on highways, water sanitation, and electric utilities would have a direct impact on GDP growth, as it would assist individuals and businesses become more productive over time. For example, if roads were renewed by the government, the commute times and distances would be greatly shortened; therefore, businesses could provide their goods and services to consumers more quickly at a lower transportation cost. Alternatively, if the government chooses to invest more on schools and education, people would tend to leave work and enter school for advanced degree and potential high wages. After competing school, however, the people who had left the labor force would rejoin it and have higher productivity[9]. This increase of federal investment would also add to aggregate demand, thereby making the real GDP in the short run higher than it would have been otherwise. These factors together would result in productivity growth and in the long run increase the economic output. Nevertheless, this is only a general analysis on the impact of more infrastructure investment. In fact, the effect will vary under different timing of business cycles and financing strategies. The sections that follow will examine the impact of infrastructure expenditure under the current economic situation and the potential future financing strategies

The business cycle timing of infrastructure investment is a key determinant of economic output. According to modern economic theories, public investments undertaken during an economic recession would have a greater impact on economic growth in the short term since many economic input factors are underutilized and will be utilized for production more quickly[10]. For instance, when an economic recession strikes, the number of unemployed workers would increase. This allows production growth to aggregate quickly when the government provides additional infrastructure investment since a large number of unemployed workforce is available. In addition, since construction requires relatively less skilled labor, the required labor to build constructions would be called up relatively quickly. However, while the economy is expanding, the stimulus to economic activity is diminished because there is less excess capacity. For example, when the economy is expanding healthily, meaning the unemployment rate is low and factories are in full capacities, fewer economic inputs could be used quickly. Therefore, more infrastructure investment would result in a smaller boost to the economic output in economic expansion than in economic recession.

Since 2009, the U.S. economy has been expanding, and unemployment has been around 5%, indicating that more infrastructure expenditure is unneeded. However, the U.S. economy is now facing a slow growth rate and secular stagnation mostly because of COVID-19 and the whole economy does not operate at its full potential. According to Federal Reserve Economic Data (FRED), the real potential GDP in 2020 Q3 is $19424.19 billion, whereas the real GDP in 2020 Q3 is $18560.774 billion[11-12]. Similarly, the real potential GDP in 2022 Q1 is $20003.73 billion, but the actual real GDP in 2022 Q1 is $19735.895 billion[11-12]. What is more, the current COVID-19 has brought great uncertainty. If a new variant with a high fatality rate strikes, the U.S. government would adopt large containment measures that would cause a large recession because the longer the delay, the larger is the number of infections and the externalities associated with economic activities[13]. If this is the case, then it would be optimal for the U.S. government to adopt expansionary fiscal policies, such as additional infrastructure investment on transportation and sanitation, which could help push the economy out of the recession phase since public spending stimulates the economy more during recession than do during expansion – improvement on transportation would reduce the time for supplies to arrive, and water sanitation would help prevent virus from spreading.

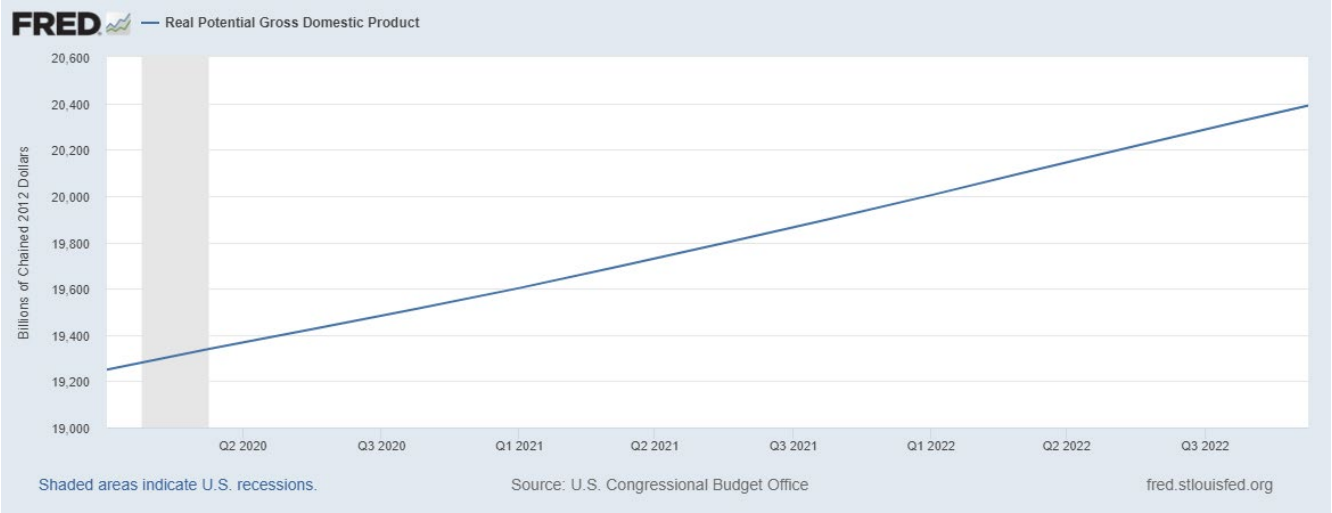

Figure 3 Real Potential Gross Domestic Product, 2020-2022[11]

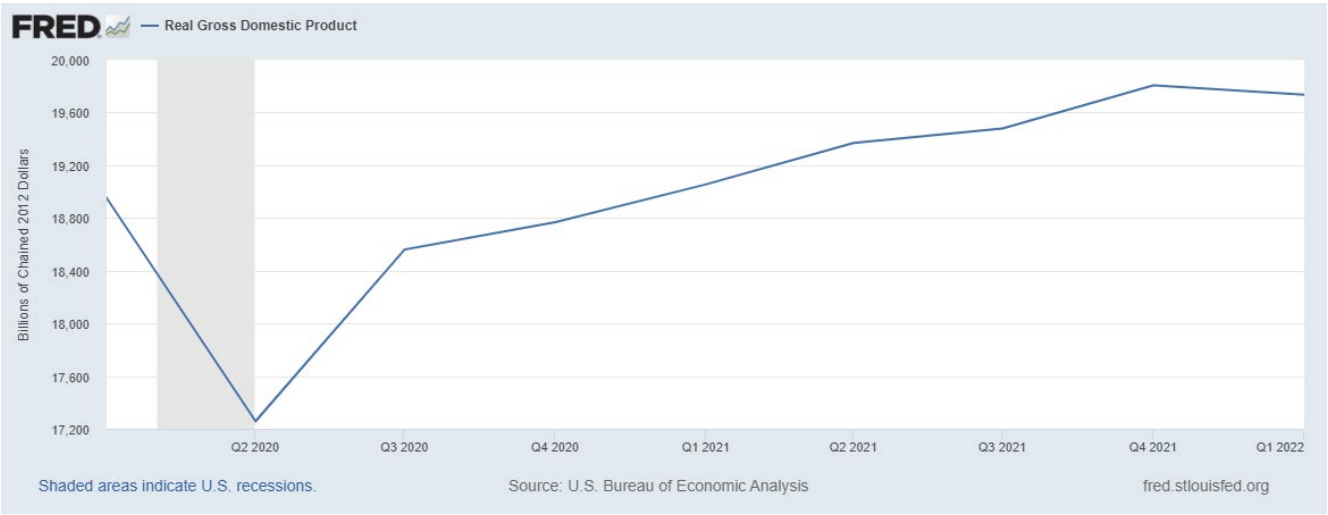

Figure 4 Real Gross Domestic Product, 2020-2022[12]

Ample research has suggested that additional infrastructure investment would result in a smaller impact on economic growth in economic expansion compared to economic recession. An report published in 2012 estimates that the impact could be around 1.5 times smaller during an expansion than during a recession: a 1% increase in public investment would stimulate economic growth by about 2.3% during an expansion and 3.4% during an economic recession[14]. Almansour et al. [15] indicated that a 1% increase in public investment would boost the GDP by 1.5% in economic recession in the first year and 3 percent after four years – whereas during an economic expansion there was no significant change in the economic output.

Especially in this period when the growth of GDP decreases due to COVID, infrastructure could serve as short term and long term stimuli both directly and indirectly through multiplier effects – as more services ae sold from the contractors, greater public spending boosts economic growth. The multiplier effects state that one dollar of government spending could bring more than one dollar increment in economic output. For instance, when the government decides to raise expenditure on infrastructure projects and employs more contractors, the contractors' workers will have more disposable income to spend on the goods and services of other firms. The resulting change in money supply depends on American people's marginal propensity to consume (MPC). Empirical studies estimate that the aggregate marginal propensity to consume ranges from 0.05 to 0.9[16]. Using the PWBM dynamic overlapping generations model, a group of researchers estimate that the values for the MPC by income quintile are 0.55, 0.40, 0.22, 0.13, and 0.12 respectively[17]. That is to say, 2 trillion dollars spent on infrastructure projects could increase the overall money supply by 4.44 trillion dollars at most. These numbers are higher than the values in the normal times because the researchers

included the current recession – people tend to use extra income to smooth out consumption. Moreover, because the U.S. dollar is de facto a reverse currency for many central banks, American consumers may buy relatively cheaper overseas products and services without having to generate an equivalent number of commodities in return; hence, their marginal propensity to save tends to be low [18]. The resulting money flow, from the government to contractors and workers, would eventually increase the GDP by more the government had initially invested. Theoretically, the increase in money supply will then lower the nominal interest rate and attract more Americans to invest and consume, thus resulting in substantial growth of real economic output. Additionally, Ramey[19] argues that the long-run government investment multiplier is vitally dependent on both the production function elasticity of output to public capital and on investment timing with respect to the socially optimal amount of public capital — stronger output elasticity and starting below socially optimal output increase the long-run multiplier. In the literature review done by Bom and Lighart, the mean production function elasticity of output to public capital was determined to be 0.08 in the short run and 0.12 in the long run [20]. Utilizing the benefits of the United States interstate highway system, Fernald[8] calculates a production function elasticity of output to roads of 0.35. Therefore, given that the output elasticity is relatively high for public spending and the economy is currently operating below its potential, the long-term multiplier of infrastructure investment will be high as well. Some might argue that an increase of real GDP would also accompany with an increase of price level and inflation rate; however. if the government could release carefully managed pilot projects to see how the economy reacts so that they would know how much more investment would be needed to fulfill the negative output gap, the potential inflation could be controlled.

Many research and empirical studies have concluded that an increase in infrastructure spending would impact economic growth positively. For private sector economic output, Bom and Ligthart[20] have estimated that a 1% increase in the public capital stock would lead to a higher level of private sector economic output by 0.083 percent in the short term. Similarly in the long term, the same 1% increase would increase the private-sector economic output by 0.122 %[20]. Furthermore, the U.S. Congressional Budget Office(CBO) currently estimates that the long run private sector output would be increased by 0.06%, which is about $9.2 billion – if there is an increase in public capital[9]. Other empirical studies also show support of a sizable long run and short run multiplier. Using structural vector autoregressions on a group of OECD countries, Ilzetzki et al. [21] found multipliers ranged between 0.4 in the short run and 1.6 in the long run. Comparing government consumption and investment spending multipliers, Bohem[22] estimated a long-run multiplier of 1.6 for government investment spending. Leff Yaffe [7] found a long run multiplier estimate of 1.8 by incorporating state panel data to assess the output effects of the construction of the United States interstate highway network.

Moreover, the influence of infrastructure varies based on the government's choice of financing methods. Two of them will be analyzed in this section – deficit financed method and deficit neutral method. If the U.S. government chooses to adopt the deficit financed method, meaning there would be no changed in government spending to offset the new spending, the effect to the economic output is unclear as there will be two opposing forces. This is because when the increase in federal investment improves the productivity and real GDP, the amount of taxable incomes will rise, which means government deficit will shrink. However, the improvement of productivity will lead to higher return on capital and demand for loanable funds, which boosts the real interest rate and the cost to the government of paying the debts. Stupak[10] argues in his report that the long term influence of deficit-financed method would be mitigated in the long run as there will be “crowding out” of private investment. Nevertheless, this would only occur if the government needs to borrow additional amount of money to fill the gap; given that the federal government is running a budget surplus from March to April – 308,215.06053 million of dollars – the U.S. government in fact does not need to increase its borrowing[23]. Alternately, if the government chooses the deficit neutral strategy, which entails a reduction in other government spending or an increase in tax rates, economic production will not change in the short term. This is because when the government spending remains level, the aggregate

demand will not be influenced and interest rates will not change. However, in the long run, deficit neutral method might increase the real GDP since there will be no "crowding out" of private investment, unlike the deficit financed method.

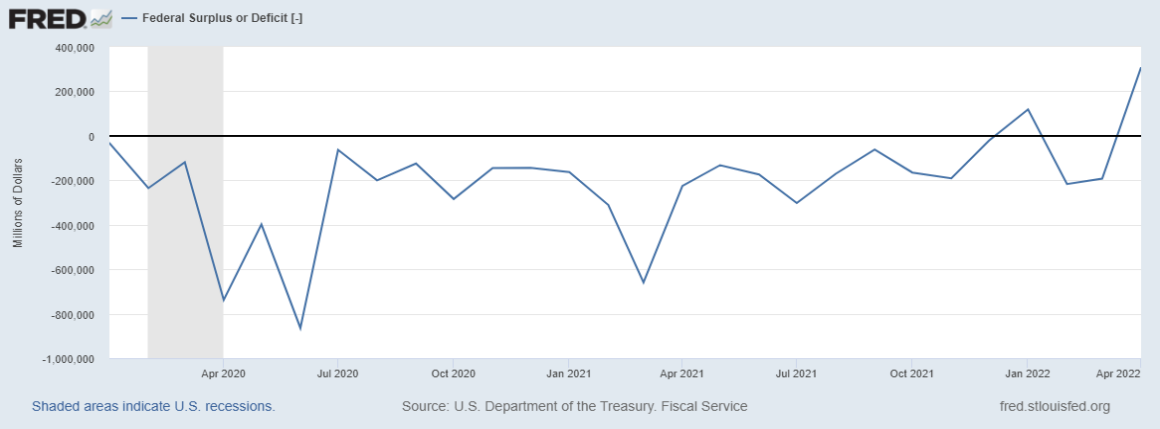

Figure 5 Federal Surplus or Deficit, 2020-2022[23]

International Monetary Fund(IMF) researchers have tried to quantify the changes to economic output made separately by deficit financed method and deficit neutral method. They found that the output effects of public investment tend to be smaller when public investment are financed by deficit-neutral method than debt-financed method. In particular, although a debt-financed public investment shock of 1 percentage point of GDP increases output by approximately 0.9% in the same year and by 2.9% four years after the shock, the short- and medium-term output effects of a deficit-neutral public investment shock are not statistically different from zero[24]. Similarly, the CBO concluded that a $100 billion boost in funding would result in a $20 billion gain in GDP in the short term and a $1 billion increase in GDP after 10 years under the deficit-financed option[25]. In contrast, when the deficit is neutral, the same amount of public spending will not improve GDP in the short run, but will grow it by $4 billion over the next decade[25].

2.2 Employment Effect

Changes in economic output are frequently correlated with shifts in the unemployment rate; when GDP rises, the unemployment rate tends to fall since more labor is required to generate more goods and services. This is widely known as the Okun's law, which is used as a rule of thumb in macroeconomics. Although often being referred to as a "law", Okun's law is actually not stable over time because it is sensitive to the business cycles[26]. During economic recessions, the inverse relationship between economic growth and unemployment rate is especially obvious. This results from more available labor work during recessions. In contrast, when the economy expands healthily, there are fewer idle workers and the society operates near the natural rate of employment. Moreover, some researchers also proposed that faster productivity growth encouraged by infrastructure investment would reduce long term unemployment rate without increase in inflation rate[27]. This can be explained by the fact that when consumers' expenditure grows, businesses will invest more in capital and labor to meet consumers' demand. Also, every dollar spent on government investment goes to some companies' revenue, thereby increasing payroll and employment. Current research focusing on the employment effect includes measures on demand for labor and unemployment rate, and they often show positive change in employment but differed on degrees of influence.

According to Abiad et al., a 1 percentage point increase in public investment reduces the unemployment rate in OECD nations by 0.11 percentage points in the short term and 0.35 percentage points in the long term[24]. Similarly, Demetriades and Mamuneas [28] observed in 2000 that the impact of increasing public capital on labor demand boosted labor demand by 1.13 percent in the short term, 1.07 percent in the medium term, and 0.08 percent in the long term for the United States. Leduc and Wilson [29] found that higher state highway spending led to employment increases in

sectors most directly affected by highway expenditures under the American Recovery and Reinvestment Act (ARRA) – each $1 million of ARRA highway grants a state received resulted in approximately two additional road construction jobs. Given that ARRA highway grants totaled approximately $25 billion nationally, this suggests a countrywide impact of approximately 50,000 jobs, or a 16 % increase in road construction employment since September 2008[29]. They also detected moderate spill-over effect on the employment sector that benefited the most from Federal highway grants. Garin[30], also examining the employment effect of ARRA, found a dollar of additional Recovery Act spending on local construction increased local construction payrolls by thirty cents during the five years after the Act's passage, nearly exactly labor's share of construction revenues nationwide. Using the same underlying data, Dube et al. [31] and Dupor and McRory [32] reported an own-county effect of 5-10 job-years per $1 million, plus an additional 20-30 job-years per $1 million in neighboring counties, for a total cost per job-year of $30,000.

In addition to the favorable impact infrastructure has on employment, the influence of public infrastructure investments on employment is expected to vary during economic expansions and contractions, as the labor force available during each business cycle would be different. During a recession, the economy often operates below its natural rate of employment and potential, resulting in a greater number of unemployed workers. Therefore, an increase in infrastructure projects will offer employment prospects for the unemployed. During an economic expansion, fewer individuals will be unemployed, and the natural unemployment rate will remain low[10]. The global contraction of economy due to COVID has been devastating to employment. In 2020, 8.8% of worldwide working hours, or 255 million full-time employment, were lost[33]. According to FRED, the current unemployment rate is 3.6[34]. Part of the unemployment decrease was due to the programs released during the pandemic, including the CARES Act, American Rescue Plan, and regular unemployment insurance(UI) benefit in total of $650 billion between March 2020 and September 2021 provided by Federal Pandemic Unemployment Compensation (FPUC), Pandemic Unemployment Assistance (PUA), and Pandemic Emergency Unemployment Compensation (PEUC)[35]. Likewise, infrastructure investment would have similar effect on unemployment because it is also a type of government public spending during the pandemic.

Figure 6 Unemployment Rate, 2020-2022[34]

Abiad et al. analyzed the impact of additional public spending under different business cycles. They discovered that when the economy is growing healthily, an increase in public investment reduces the unemployment rate by 0.5% after the first year and 0.75% after the fourth year[24]. However, under economic recessions, the researchers found no significant impact on employment[24]. Focusing on public investment for the post-COVID-19 recovery phase, Moszoro[36] found that one percentage point of global GDP in additional spending on public investment can directly generate more than seven million jobs worldwide. The projected direct and indirect macroeconomic effects of one percent change of GDP on employment range from 20 to 33 million jobs [37]. In a similar vein, $1 million in US infrastructure spending can generate between 3 and 6.6 jobs in advanced economies, 10.4 to 17.2 jobs in emerging market economies, and 16 to 30.2 jobs in low-income developing nations[33].

Moreover, the impact of infrastructure spending on employment also depends on different financing methods, similarly to its impact on economic output. When deficit neutral, the demand for labor may not be affected because although people's incomes increase, the decrease of other government spending or the increase of tax rate may mitigate firm owners' willingness to invest more in labor capital. Conversely, economists estimate that the demand for labor will be affected positively, leading to a reduction of unemployment rate when deficit financed[24]. In the long run, however, deficit-neutral method theoretically would bring more benefit to the economy because there will be no "crowding out" of private investment, resulting in a promising economic growth. On the long run, the deficit-financed plan is anticipated to have less of an impact on employment, as "crowding out" is likely to occur, resulting in a smaller decline in the unemployment rate.

Researchers at the IMF analyze the effects of infrastructure investment under various modes of financing, concluding that the deficit-financed technique has a more favorable effect on the unemployment rate than the deficit-neutral option. They discovered that a rise in public investment as a proportion of GDP was associated with a fall in the unemployment rate of approximately 2 percent; nevertheless, they projected a nearly null impact on employment under a deficit-neutral method[24].

3. Conclusion

This paper has studied both the economic output effect and employment effect of infrastructure investment. The theoretical analysis reviews past literature and analyzes the macroeconomic effects under current economic conditions, which is based on past research and theories. The empirical evidence includes estimates on aggregate and regional levels under different measures. The following summarizes the key finding in this paper.

First, infrastructure investment has direct positive impact on economic output because of increased aggregate demand and domestic income. The resulting money flow will also be able to fill the negative output gap because U.S. consumers' marginal propensity to consume tend to be high. The long run multiplier would be sizable as well since the society is producing below its socially optimal output level. Additionally, during economic recessions, economic output will be augmented more as more idle workers are available. Both financing methods – deficit-financed and deficit-neutral – would raise the overall GDP, but to differing degrees for a number of reasons:(1) two opposing forces, increased government spending and increased tax rate, would occur under deficit-neutral method; (2) improved productivity and higher interest rate under deficit-financed method; (3) In contrast to the deficit-financed strategy, there will be no long-term "crowding out" of private investment under the deficit-neutral method.

Second, the increase of infrastructure spending will spur job growth and reduce unemployment rate. This is owing to the fact that when customers spend more on goods and services, companies will invest more in capital and labor to match consumer demand. Moreover, every dollar of government spending goes to some companies' revenue, thereby increasing payroll and employment. Similar to the economic output effect, in the midst of economic expansion, there is no significant impact on employment – whereas in recessions employment will be stimulated as more resources could be called up quickly. What is more, different from deficit-neutral method, the demand for labor will be affected positively, leading to a reduction of the unemployment rate when deficit financed as people's willingness to consume will not be mitigated by increment of tax rate or reduction of other government spending.

Questions still remained, however. When deficit financed, government tends to increase borrowing to decrease its budget deficit, which would result in "crowding out" of private investment and harm to economy in the long term. Although the government is currently running a budget surplus, it is very likely that the government will run a budget deficit in the future because the economy needs more stimuli and government spending to be pushed out of the recovery phase. Another issue in the empirical studies is that many have concluded their results based on the assumption that public

investment is fully efficient. This may be an overestimation of the influence of infrastructure spending on output and unemployment because it often takes time for funds to be spent and put into effect, as infrastructure projects must first be selected and funded, and then companies must bid on the project, a process that typically takes several months. In light of the fact that public investments are not always efficient, future study should concentrate on determining the magnitude of the "crowding out" effect on infrastructure investment.

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