Regional Government Consumption and Investment Multipliers

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Abstract

Does regional government consumption stimulate local incomes more than regional government investment? I answer this question across U.S. states and metropolitan statistical areas (MSAs). I aggregate U.S. federal military procurement contracts from 1989 to 2023 to construct a panel dataset on regional government consumption and investment shocks. Regional government consumption multipliers are larger than regional government investment multipliers for personal income, employment, and labor income, even over a time horizon of 4 years. Regional government consumption also exhibits larger geographical spillovers to surrounding states than government investment. I construct a New Keynesian DSGE model of a two-sector, two-region monetary and fiscal union that can replicate the two key results. Finally, I construct a quantitative model of the United States as a 51-region monetary union, to measure quantitatively the stimulative effects of the 2021 Infrastructure Investment and Jobs Act. JEL Codes: E32, E62, H30, H57.[1]

1 Introduction

How do regional government consumption and government investment expenditures affect the regional and aggregate incomes of a monetary union? I measure regional government consumption and investment multipliers using panel data at the U.S. state-level and Metropolitan Statistical Area (henceforth MSA)-levels from 1989 to 2023. I provide empirical evidence that regional government consumption multipliers are larger than regional government investment multipliers, discuss the role of fiscal spillovers of different types of regional government spending, and construct a New Keynesian DSGE model based from Boehm (2020) and Nakamura and Steinsson (2014) to explain my results. Based on the baseline model, I also construct a quantitative model to estimate the effects of the 2021 Infrastructure Investment and Jobs Act (IIJA).

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Since the COVID-19 pandemic, there has been an increase in U.S. policy and academic interest on the stimulative effects of government investment. In November 2021, U.S. President Joe Biden signed the IIJA, which planned to allocate up to $1.2 trillion in government investment and other spending for the next 10 years. At the time, the White House cited an estimate that the IIJA would generate up to 1.5 million jobs per year at its peak.[2] Meanwhile, "modern supply-side economics", as stated by Treasury Secretary Janet Yellen, was intended to increase domestic productive capacity and labor supply.[3]. Much of the spending was directed towards economically depressed cities and states.[4] The policy relevance of government investment as compared to government consumption and their distribution across geographical regions within a monetary and fiscal union (the United States) merit some investigation on the regional and aggregate effects of regional government consumption and investment.

I use the concept of government (infrastructure) investment from Ramey (2021), which includes the government's purchases of goods and services to build and maintain public capital and infrastructure.[5] Government investment includes construction, repair, and maintenance of public infrastructure, including not limited to roads, railways, utilities, and government structures, facilities, and equipment, as well as government research and development (R&D). By contrast, government consumption is defined as government purchases of nondurable and durable goods or services which are not related to the building and maintenance of public capital, such as food, energy goods, and other nondurable (and some durable) goods.

To establish my results empirically, I use transaction-level data on U.S. federal military procurements, and categorize each transaction into either government consumption or government investment for each state (and, separately, MSA). I find that regional government consumption multipliers are generally larger than regional government investment multipliers up to 4 years after the initial shocks in regional government spending. This result is in line with those from the previous literature (Baxter and King, 1993; Boehm, 2020; Ramey, 2021). Under regional government consumption shocks, regional personal incomes, employment, and labor incomes increase by more than under regional government investment shocks. I also confirm that state-level regional multipliers are larger than MSA-level regional multipliers, confirming a theoretical prediction of Chodorow-Reich (2019). Importantly for this paper, I discuss the sign and magnitude of fiscal spillovers of regional government consumption and investment to other regions of the monetary union (the United States).

I then construct a New Keynesian DSGE model of a two-sector, two-region monetary and fiscal union with government consumption and investment, and productive public capital, and compute numerically regional fiscal multipliers based on that model. My model is a two-region monetary union version of the

[2]White House, November 6, 2021.

[3]The Economist, February 2, 2023 edition.

[4]According to the Economist Magazine on June 2023, much of these investments in industries, such as semiconductors, electric vehicles and batteries, clean energy, and biomanufacturing, have gone to Southern states such as Texas, Georgia, North Carolina, and South Carolina.

[5]While "government spending" is a broader concept that could also include transfers and public sector wages, this paper is on government "procurements" or purchases from private contracting firms, and thus in this paper the terms "government purchases", "government spending", and "government procurements" are used interchangeably.

	Consumption	Investment
Aggregate	Aggregate Consumption Multiplier	Aggregate Investment Multiplier
Regional	Regional Consumption Multiplier	Regional Investment Multiplier

Table 1: A 2×2 table of fiscal multiplier concepts.

one-region (closed economy) model in Boehm (2020). My model and the resulting model-based regional fiscal multipliers can replicate qualitatively the empirical result that regional government consumption multipliers are larger than those for investment. I also use the model to compare the magnitudes of theoretical regional and aggregate multipliers for government consumption and investment in my two-region monetary and fiscal union model.

Finally, I construct a quantitative model of a 51-region(state) monetary union, calibrated to U.S. state-level data such as inter-state trade flows, to estimate the state-level regional fiscal multipliers. In addition, I use the calibrated model to compute the fiscal spillover effects of each state's regional government spending to the rest of the United States, as well as the aggregate government consumption and investment multipliers. This model is used to estimate the regional and aggregate income effects of the Infrastructure Investment and Jobs Act, and I compare my estimates with those made at the time of the bill's passage in November 2021. My results imply that the effects of government investment concentrated in these regions would appear much later than across the typical business cycle, in raising regional incomes relative to other regions of the United States. However, it remains a question of policy goals on whether the U.S. federal government *should* increase regional government consumption or investment to raise regional incomes, either for short-run demand management during a recession, or for long-run regional economic development.

This paper is in the small but growing intersection of two branches of the fiscal multiplier literature: first, the literature on multipliers of heterogeneous types of government spending, particularly between government consumption and investment Baxter and King (1993); Boehm (2020); Ramey (2021); Muratori et al. (2023), and second, the literature on regional fiscal multipliers (Nakamura and Steinsson, 2014; Auerbach et al., 2020; Gabriel et al., 2023). Almost unique in this intersection is Muratori et al. (2023), which look at heterogeneous regional multipliers of government purchases in goods versus services. They also compile MSA-level data on government purchases of services and goods, and show that government purchases of services, which come primarily from more labor-intensive industries, have larger effects on employment and labor income than government purchases on goods.

One way is to think of a 2×2 table, with government consumption and investment multipliers on one axis, and aggregate and regional multipliers on the other, as in Table 1. Papers in the first literature, by assumption, have compared between aggregate government consumption and aggregate government investment multipliers. Those in the second literature, also by assumption, have compared between aggregate government consumption and regional government consumption multipliers. Both approaches leave out regional government investment multipliers. This paper completes the comparison across all four cells in the table, both in empirics and in theory.

The paper is structured as follows. In Section 2, I describe the data from which I construct my sample. In Section 3, I explain the empirical methodology, a modification of Nakamura and Steinsson (2014) and Muratori et al. (2023)'s panel 2SLS regressions with shift-share (Bartik) instruments. In Section 4, I show my main empirical result, that regional government consumption multipliers are larger than regional government investment multipliers. Section 5 specifies a New Keynesian DSGE model of a two-sector, two-region monetary union with government consumption and investment. Section 6 shows that my model can qualitatively replicate the empirical results, by showing model-computed regional fiscal multipliers and also comparisons with aggregate fiscal multipliers. In Section 7, I review both branches of the literature, to review the main theoretical mechanisms for differences in magnitude between government consumption and investment multipliers, and between regional and aggregate multipliers. Section 8 specifies a calibrated, state-level quantitative DSGE model of the United States. Section 9 discusses the theoretical results of the quantitative model, mainly the regional multipliers, fiscal spillovers, and aggregate multipliers of government consumption and government investment. I conclude in Section 10.

2 Data

I first summarize the different types of government consumption and investment, and explain my methodology for constructing my state-(and MSA-)level panel dataset.

2.1 Categorizing Government Consumption and Investment

I categorize federal procurement transactions into government consumption and government gross investment for each region and year. "Government consumption" here refers to government consumption expenditures, and "government investment" as more precisely government gross investment, as per Chapter 9 of the BEA NIPA Handbook.

Government consumption expenditures consist of services that are provided to the public for less than the cost of providing the service (such as the postal service) or, in some cases, for free (such as the military, public safety, and education). This "value added" component of consumption expenditures can be further categorized into compensation of general government employees and consumption of general government fixed capital. Government consumption also includes intermediate goods and services purchased, deducted by own-account investment (into government-owned fixed assets) and sales to other sectors.

Government gross investment counts additions to, or replacements of, government-owned fixed assets. Such spending can be for structures (ex. highways and schools), equipment (ex. military hardware), or intellectual property products (ex. software and research and development). Federally-funded expenditures for research and development, as part of government investment, can be financed through purchases (contracts) or through grants.

My data sample, based on the transaction-level dataset of federal procurements from USASpending.gov,

includes only contracts, i.e. agreements between the federal government and the recipient to provide goods and services for a fee.[6] I use contracts data mainly for the reason that the vast majority of DoD spending occurs in the form of contracts with private firms. For example, in Fiscal Year 2019, total DoD spending across the entire United States was $367.7 billion. Of this, $360.3 billion was in contracts.

2.2 Sample Construction

The construction of my dataset is based on Boehm (2016) and Muratori et al. (2023). I list the steps as follows:

1. I use transaction-level data of U.S. federal government purchases, for Fiscal Years 1989 to 2023. For Fiscal Years 2004 to 2023, I use federal military procurement data from USASpending.gov by filtering only procurements assigned by the Department of Defense. For Fiscal Years 1989 to 2003, I use data from the National Archives, which hosts an electronic database of DD-350 military procurement forms as mandated by the Department of Defense.

2. I classify each transaction into either government consumption or government investment based on its Product Service Code (PSC).[7] The PSC indicates the type of good purchased by the government. Each 4-digit PSC code indicates a category of research and development (R&D), services, or goods. I can identify government investment given the first letter (ex. 'Z': Maintenance, Repair, Alteration of Structures/Facilities) for or first two digits (ex. 62: Lighting Fixtures and Lamps), as well as government consumption of non-durables goods, durable goods, and services. In Appendix A, I list the categorization of types of government procurement by product service code.

   I must include an important caveat, in that I consider government investment as procurements of both goods *and services* procurement involved in government investment. By contrast, the Bureau of Economic Analysis (BEA) categorizes services entirely under government consumption, even though several categories of services are directly related to construction, maintenance or repair of structures and facilities under the PSC manual. The goal of this paper is to consider the multiplier effects of government procurements directly relating to construction, maintenance or repair on regional economic outcomes. Therefore, I count services relating to construction, maintenance, or repair of structures and facilities under government investment.

3. For each state i and each calendar year t, I sum up 'federal action obligation' amounts that the U.S. federal government had procured(i.e. purchased) in regional government consumption (denoted as C_{it}^g) and regional government investment (X_{it}^g, after capital eXpenditures).

[6] Other types of government spending listed under the USASpending.gov database include grants, direct payments to individuals or firms, and loans.

[7] See the PSC Manual at the General Services Administration website for more information.

4. Finally, I collect data on regional outcome variables Y_{it} from the BEA, which include annual state-level total personal income, annual state-level personal income *per capita*, and annual state-level labor and capital income. I use state-level total wages and salaries (both in cash and in kind) as regional labor income, and dividends, interest, and rents as regional capital income. Most of this data is based on the BLS's methodology on the labor share of output.

The data sample spans over all 50 states (excluding the District of Columbia) from 1989 to 2023. All nominal variables (government spending, personal income) are converted into per capita real variables by applying the BLS's national Consumer Price Index and by dividing by the population of each MSA in each year. In Table 2, I show the summary statistics of government consumption and investment, as well as its sub-categories, over 50 states and from 1989 to 2023. Due to my classification, government investment (across all states) spending is a larger fraction of total government purchases than government consumption. This is also true of my MSA-level dataset, which is similarly summarized in Table 2 of Appendix D.

Category	Mean	St. Dev.	Min	Max
Government Consumption	**1460.6**	**2412.0**	**-22.6**	**21063.0**
Durables	72.8	122.1	-60.6	1109.4
Nondurables	330.1	547.9	-72.4	5766.1
Services - Consumption	1,057.7	2,024.0	-29.6	18,198.7
Government Investment	**3,519.6**	**5,490.5**	**-149.6**	**49,765.9**
Services - Structural Investment	907.1	1,586.9	-7,709.0	21,808.7
Goods - Structural Investment	894.0	1,491.2	-231.3	23,724.0
Vehicles	1,075.5	2,569.4	-110.6	33,500.8
Research & Development	643.0	1,268.7	-148.0	12,724.8
Total	**4,980.2**	**7,502.8**	**-128.4**	**58,647.7**

Table 2: Summary statistics of government purchases summed across 50 states, 1989-2023 (1,750 observations), in billions of real US dollars (indexed at constant 2017 dollars).

3 Empirical Methodology

Here, the regional government investment multiplier is estimated through fixed effects panel data regression, with growth in regional income as the dependent variable and growth in regional investment (relative to regional income) as the right-hand side variable. I use the methodology commonly used in the regional fiscal multipliers literature (Nakamura and Steinsson, 2014; Auerbach et al., 2020).

I denote the outcome variable as Y_{it}, which is one of region-i, year-t personal income, personal income per capita, employment, or labor/capital income. For example, in the exposition below, I denote Y_{it} as MSA personal income. A specification with just the change in regional government spending G_{it} over h years

would be:

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \beta \frac{G_{i,t+h} - G_{i,t-1}}{Y_{i,t-1}} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{1}$$

where α_i and δ_t are region and time fixed effects respectively. β is intended to measure the h-period regional fiscal multiplier, i.e. the effect on change in regional personal income ($Y_{i,t+h} - Y_{i,t-1}$) of change in regional government spending ($G_{i,t+h} - G_{i,t-1}$). Both terms are divided by $Y_{i,t-1}$, both to normalize variables, and to directly estimate β as the regional fiscal multiplier.[8] For G_{it}, Nakamura and Steinsson (2014) compile data on state-level federal military procurement, as awarded by the Department of Defense (DoD). The assumption is, unlike many other types of government spending, national military spending by the DoD is driven by global geopolitical events, and not national or regional business cycles.

However, the estimate of β may still be biased due to endogeneity issues. As Nakamura and Steinsson (2014) and others note, military spending is "notoriously political", and political factors might affect both military spending and outcome variables such as personal income and personal income per capita. Therefore, an instrumental variables approach is required. The intuition in building the instrumental variable lies in the empirical fact that military procurement in some states are more sensitive to increases in national military procurement than that in other states. The identifying assumption is that the distribution of regional military spending does not respond to regional economic conditions. For example, the U.S. federal government would not increase military spending in Maryland relative to that in California simply because the state economy of Maryland is doing worse than that of California. With this identifying assumption, the specification above uses the variation in responses of DoD spending across states to measure the regional fiscal multiplier.

I follow the literature (Nakamura and Steinsson, 2014; Auerbach et al., 2020; Muratori et al., 2023) to construct a shift-share instrument Z_{it}^h for the right-hand side variable. The intuition is to utilize the difference between the actual right-hand side variable with what the region would receive given the region's average share of (the change in) national government spending. Specifically, I interact the "shift", or change in national government spending ($G_{t+h} - G_{t-1}$) as a ratio of regional personal income, with the average regional "share" of national government spending over time. I specify Z_{it}^h as shown below:

$$Z_{it}^h \equiv \underbrace{\left(\frac{G_{t+h} - G_{t-1}}{Y_{i,t-1}}\right)}_{\text{Shift}} \times \underbrace{\overline{\left(\frac{G_{it}}{G_t}\right)}}_{\text{Share}} \tag{2}$$

[8] Simply putting the growth rate in government spending, $\frac{G_{i,t+h} - G_{i,t-1}}{G_{i,t-1}}$, in the right-hand side changes the interpretation of β into an *elasticity* of regional income growth relative to regional government spending growth. However, transforming this value into a fiscal multiplier requires multiplying the elasticity estimate by some form of average share of government spending in income, G/Y. This is problematic if G_t/Y_t vary widely over time, as pointed out in the aggregate case in Ramey (2016), or across regions.

where the (average) share component is defined as:

$$\overline{\left(\frac{G_{it}}{G_t}\right)} \equiv \frac{1}{T}\sum_{t=1}^{T}\frac{G_{it}}{G_t} \tag{3}$$

Thus, we can implement a panel two-stage least squares (2SLS) regression, with the first stage regression being a two-way fixed effects panel regression with region and time fixed effects α_i^{first} and δ_t^{first}:

$$\frac{G_{i,t+h} - G_{i,t-1}}{Y_{i,t-1}} = \theta Z_{it}^h + \alpha_i^{first} + \delta_t^{first} + \eta_{it} \tag{4}$$

and the second stage regression using the predicted values of the right-hand side from the first stage regression.

Now looking at regional multipliers of government consumption C_{it}^g versus government investment X_{it}^g, I follow Muratori et al. (2023) and modify the specification above to include two endogenous variables. I also experiment with different time horizons for the fiscal multipliers, where h is the number of years since the government spending in year t:

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \beta_{reg,h}^c \frac{C_{i,t+h}^g - C_{i,t-1}^g}{Y_{i,t-1}} + \beta_{reg,h}^x \frac{X_{i,t+h}^g - X_{i,t-1}^g}{Y_{i,t-1}} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{5}$$

Here, $\beta_{reg,h}^c$ is the h-year change in regional government consumption on regional personal income $Y_{i,t-1}$, and $\beta_{reg,h}^x$ the analogous value of regional government investment. $h = 0$ can be interpreted as the impact multiplier of regional government spending. There are now two instrumental variables, $Z_{it}^{C,h}$ and $Z_{it}^{X,h}$, constructed analogously as before:

$$Z_{it}^{C,h} \equiv \left(\frac{C_{t+h}^g - C_{t-1}^g}{Y_{i,t-1}}\right) \times \overline{\left(\frac{C_{it}^g}{C_t^g}\right)} \tag{6}$$

$$Z_{it}^{X,h} \equiv \left(\frac{X_{t+h}^g - X_{t-1}^g}{Y_{i,t-1}}\right) \times \overline{\left(\frac{X_{it}^g}{X_t^g}\right)} \tag{7}$$

As prescribed by Ramey (2016) and others, I also compute the (more policy-relevant) h-year cumulative fiscal multipliers. The cumulative fiscal multiplier in the model can be understood as follows. For a given region(state) i, the i-period cumulative multipliers for government consumption $\beta_h^{c,cumul}$ and government investment $\beta_h^{x,cumul}$ are estimated as such:

$$\sum_{j=1}^{h}\frac{Y_{i,t+j} - Y_{i,t-1}}{Y_{i,t-1}} = \beta_h^{c,cumul}\sum_{j=1}^{h}\frac{C_{i,t+h}^g - C_{i,t-1}^g}{Y_{i,t-1}} + \beta_h^{x,cumul}\sum_{j=1}^{h}\frac{X_{i,t+h}^g - X_{i,t-1}^g}{Y_{i,t-1}} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{8}$$

As in Ramey (2016), I instrument the right-hand side variables using the shift-share instruments for $h = 0$, i.e. $Z_{i,t}^{C,0}$ and $Z_{i,t}^{X,0}$. This accounts for the possibility that the initial shock in government spending at period

t (or $h = 0$) is persistent over time.

To account for autocorrelation across time periods and regions, I use Driscoll-Kraay standard errors Driscoll and Kraay (1998) whenever possible.

4 Empirical Results

In this section, I list results for both state-level multipliers and MSA-level multipliers. I use the regional fiscal multiplier estimates at the state-level as a benchmark to contrast with the theoretical model in Section 5 and the quantitative model in Section 8, which can only be calibrated properly at the state level of geographical disaggregation. On the other hand, there are many more MSAs (356) than states (50), and thus the greater size of the MSA-level panel data provides greater statistical power. Thus, I list state-level results first, then MSA-level results as a robustness check.

Chodorow-Reich (2019) argues that, the higher the level of geographical disaggregation (states as opposed to MSAs), the larger the resulting regional fiscal multipliers. Obviously, more of the secondary effects of regional government spending will remain within the boundaries of larger regions (states) than smaller ones (MSAs). Extending this intuition, the aggregate fiscal multiplier of the entire monetary union should be larger than the regional fiscal multiplier of any of its regions, which is exactly Chodorow-Reich (2019)'s argument that the aggregate fiscal multiplier must be larger than or equal to the regional fiscal multipliers. Of course, this argument only takes the partial equilibrium effect of the monetary policy to its logical extreme, and abstracts from other general equilibrium effects such as the role of endogenous monetary policy or national fiscal policy.

4.1 Data Construction and Summary Statistics

For the main income variable $Y_{i,t}$, I use state-level personal income instead of GDP, for data availability reasons across state- and MSA-level data.[9]

In Table 3, I include summary statistics of state-level data for all 50 states from 1989 to 2023. I find that the ratio of state federal DoD purchases to state personal income ("State G / State Personal Income") has a mean value of 1.91%. The mean ratio of MSA federal DoD investment purchases to MSA personal income ("State X^g / MSA Personal Income", 1.30%) is more than twice as larger than that for consumption purchases ("MSA C^g / MSA Personal Income", 0.61%). Federal government investment ("State X^g / State Personal Income") is more volatile than federal government consumption ("MSA C^g / MSA Personal Income"), as evidenced by the higher standard deviation. The mean MSA share for all government spending types has to be the same at exactly 2%, since there are 50 states.

[9]The BEA is going through a comprehensive update of regional GDP. Currently, revised estimates at the state level are only available up to 1997 under the current classification, while data at the MSA level are only available from 2001 to 2023. In contrast, state- and MSA-level total personal income is available since 1969, hence the reason why I use personal income for $Y_{i,t}$.

	Mean	St. Dev.	Min	Max
State Personal Income ($B)	253.00	311.00	14.50	2,550.00
State Population (Million Persons)	5.92	6.56	0.45	39.50
State G / State Personal Income (%)	1.91	1.63	-0.25	12.26
State C^g / State Personal Income (%)	0.61	0.67	0.03	5.61
State X^g / State Personal Income (%)	1.30	1.23	-0.29	8.82
State share of G_t (%)	2.00	2.90	-0.04	22.27
State share of C_t^g (%)	2.00	3.02	-0.07	25.16
State share of X_t^g (%)	2.00	3.05	0.02	19.76
Labor Income / State Personal Income (%)	51.31	4.27	37.41	62.80
Capital Income / State Personal Income (%)	19.27	2.71	13.34	35.02

Table 3: Summary statistics for state-level data, 50 states (excluding the District of Columbia), 1989-2023 (observations: 1,750).

As for MSA-level data, there is greater possibility for outliers that can affect the results of the first-stage regression results and hence the results of the panel 2SLS regressions. Therefore, I winsorize h-year growth rates of dependent variables at the 1% and 99% levels.[10] I also drop data for MSAs which have at least one year with no recorded government spending in either federal government consumption or government investment. This leaves me with 356 MSAs for which I have all data available.

In Table 4, I show summary statistics of MSA-level data for the 356 MSAs from 1989 to 2023 (to 2022 in the case of employment). Again, the ratio of MSA federal DoD purchases to MSA personal income ("MSA G / MSA Personal Income") has a mean value of 2.26%, of which investment has a larger average share than and is more volatile than consumption across all MSA-year pairs. The mean MSA share for all government spending types is 0.29%, since there are 356 MSAs.

	Mean	St. Dev.	Min	Max
MSA Personal Income ($)	3.35E+10	8.85E+10	1.06E+09	1.50E+12
MSA Population (Persons)	706,004	1,574,793	46,744	2.01E+07
MSA G / MSA Personal Income (%)	2.26	4.89	-2.87	126.64
MSA C^g / MSA Personal Income (%)	0.63	1.42	-1.56	33.90
MSA X^g / MSA Personal Income (%)	1.63	4.34	-2.87	125.42
MSA share of G_t (%)	0.29	0.91	-0.10	14.08
MSA share of C_t^g (%)	0.29	1.04	-0.67	24.38
MSA share of X_t^g (%)	0.29	0.96	-0.14	16.23
Labor Income / MSA Personal Income (%)	50.87	8.15	19.09	88.69
Capital Income / MSA Personal Income (%)	19.06	4.69	9.34	59.18

Table 4: Summary statistics for MSA-level data, 356 MSAs, 1989-2023 (observations: 12,460).

An important thing to note is the larger shares of government investment to government consumption,

[10] I find that results are qualitatively similar whether the dependent variables are winsorized or not, albeit with both smaller estimates of coefficients and smaller standard errors under winsorization.

unlike in aggregate federal military spending as listed in the BEA National Income and Product Accounts (NIPA) tables. In NIPA Table 3.11.5, "National Defense Consumption Expenditures and Gross Investment by Type" national defense consumption expenditures consist approximately 80% of all national defense expenditures, while gross investment expenditures consist of the remaining 20%.

My data is different from the NIPA aggregates for the following reasons. First, government procurements do not include wages/compensation to government employees and depreciation of government capital, while these categories would all be included under government consumption expenditures in the BEA's NIPA tables (Cox et al., 2024). Second, the BEA includes all services expenditures into government consumption, regardless of the type of service. My classification, listed in Tables 8 and 9 of Appendix A, allocates some services into government investment. Some examples of service PSC codes assigned under government investment include those that begin with C (Architect/Engineer services), E (Purchase of structures, facilities and equipment/facilities), J (Maintenance, repair, and rebuilding of equipment), and A (Research and Development). With these differences, my definition of government investment, which includes any expenditures towards government structures, facilities and equipment, increases regional government investment relative to regional government consumption.

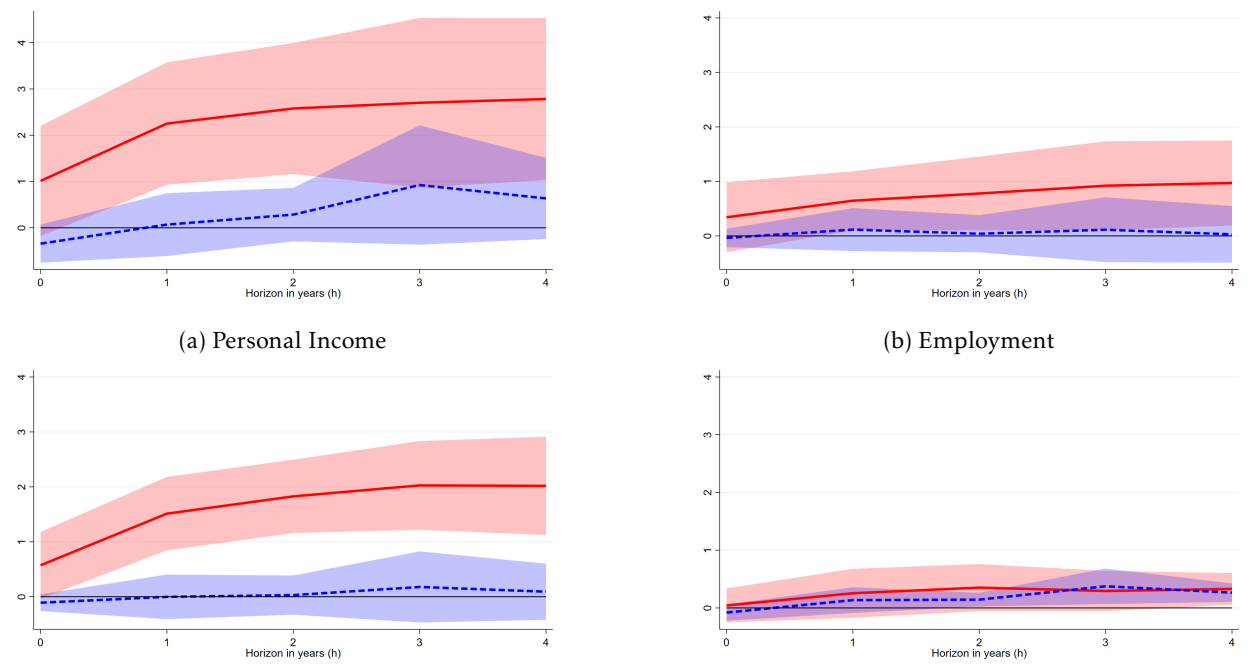
4.2 Results: State-level

As with Boehm (2020) and others, my hypothesis is that the regional government consumption multiplier is greater than the regional government investment multiplier for any given time horizon of h years, or:

$$\beta^{c}_{reg,h} > \beta^{x}_{reg,h} \text{ for } h \geq 0$$

In Figure 1, I show the results of the panel 2SLS regressions for various dependent variables. The regional government consumption multiplier $\beta^{c}_{reg,h}$ is generally larger than $\beta^{x}_{reg,h}$ for all regressions, and this difference increases across time. The difference is particularly visible for personal income (and personal income per capita), employment, and labor income. For example, the 2-year regional government consumption multiplier, corresponding to β^{c}_{1} under $h = 1$, is 2.253 (Driscoll-Kraay standard error = 0.805), while the 2-year regional government investment multiplier, β^{x}_{1}, is 0.069 (Driscoll-Kraay standard error = 0.413). Meanwhile, regional capital incomes increase little by either government consumption or investment. This implies that regional government consumption increases regional incomes primarily through its effects on the labor market, especially on the extensive margin (employment).

Table 10 in Appendix C shows the same results in table format, with Wald tests for equality of coefficients. I find that the hypothesis of equality of coefficients for regional government consumption and regional government investment is generally rejected at the 5% level around 3-4 years from the government spending shocks ($h = 3$ and $h = 4$). Given that I have two endogenous regressors, I use the weak identification test as proposed by Lewis and Mertens (2022), which allows for both multiple endogenous



(a) Personal Income

(b) Employment

(c) Labor Income

(d) Capital Income

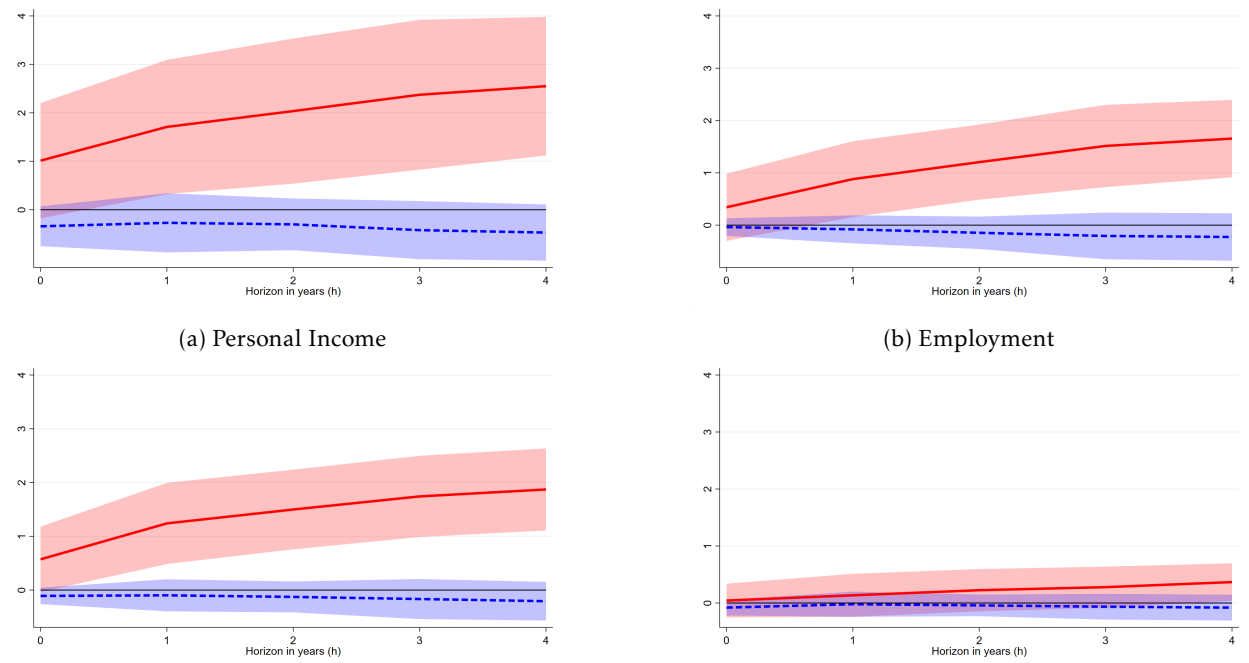
Figure 1: State-level regional fiscal multipliers for various dependent variables. Red: government consumption, blue: government investment. 90% confidence intervals. Each subfigure is plotted over a horizon from $h = 0$ to $h = 4$. For more details, and to see these results in tables, see Table 10.

regressors and adjusting for heteroskedasticity and autocorrelation. I compute test statistics ("LM Stat") and critical values ("LM Stat CV") for each regression, the latter of which are computed at a confidence level of 95% and a Nagar's relative bias threshold of 30%. For most of the regressions, the Lewis-Mertens test statistic is larger than the corresponding critical values.

In Figure 2, and in Appendix C, Table 11, I show the estimated *cumulative* regional multipliers. As expected, the cumulative regional government consumption multiplier $\beta_h^{c,cumul}$ is generally larger than its investment counterpart $\beta_h^{x,cumul}$. Assuming that regional government spending follows a first-order autoregressive (AR(1)) process, it is easy to see why the cumulative fiscal multipliers become smaller than the fiscal multipliers in Figure 1 below and Table 10 of Appendix C. Like before, Table 11 of Appendix C shows the same results in table format, with Wald tests for equality of coefficients and Lewis-Mertens tests for weak identification.

4.3 Fiscal Spillovers: State-level

I also estimate fiscal spillovers of state-level government consumption and investment shocks to other states in the monetary union (the United States). Given a state i, I denote the total personal income of the surrounding state i as $\tilde{Y}_{it}$. The standard specification that I have for estimating cumulative regional fiscal



(a) Personal Income

(b) Employment

(c) Labor Income

(d) Capital Income

Figure 2: State-level **cumulative** regional fiscal multipliers for various dependent variables. Red: government consumption, blue: government investment. 90% confidence intervals. Each subfigure is plotted over a horizon from $h = 0$ to $h = 4$. For more details, and to see these results in tables, see Table 11.

multipliers is a panel 2SLS regression for different time horizons $h = 0, 1, ..., 4$:

$$\sum_{k=0}^{h} \frac{Y_{i,t+k} - Y_{i,t-1}}{Y_{i,t-1}} = \beta^{c}_{reg,h} \sum_{k=0}^{h} \frac{C^{g}_{i,t+k} - C^{g}_{i,t-1}}{Y_{i,t-1}} + \beta^{x}_{reg,h} \sum_{k=0}^{h} \frac{X^{g}_{i,t+k} - X^{g}_{i,t-1}}{Y_{i,t-1}} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{9}$$

where C^{g}_{it} and X^{g}_{it} are region-i government consumption and government investment spending, respectively, in calendar year t, and $\beta^{c}_{reg,h}$ and $\beta^{x}_{reg,h}$ are the regional government consumption and investment multipliers, respectively, for a given time horizon h.

I similarly measure fiscal spillovers from shocks in region-i government spending as the response of all other regions excluding region i, denoted as $\tilde{Y}_{it}$, as such:

$$\sum_{k=0}^{h} \frac{\tilde{Y}_{i,t+k} - \tilde{Y}_{i,t-1}}{\tilde{Y}_{i,t-1}} = \beta^{c}_{spill,h} \sum_{k=0}^{h} \frac{C^{g}_{i,t+k} - C^{g}_{i,t-1}}{Y_{i,t-1}} + \beta^{x}_{spill,h} \sum_{k=0}^{h} \frac{X^{g}_{i,t+k} - X^{g}_{i,t-1}}{Y_{i,t-1}} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{10}$$

where $\tilde{Y}_{it}$ is the total personal income of the other regions surrounding region i.

The definition of the surrounding regions for state i can vary across papers. Dupor and Guerrero (2017) define spillovers from state i as the effect on personal income of a state $j \neq i$ that is the largest trading partner of state i. In this paper, I define spillovers over a weighted average of all other states $j \neq i$, weighted by distance. I construct a measure of $\tilde{Y}_{it}$ for a given outcome variable Y, which is one of personal income,

labor income, capital income, or employment. I denote the set of regions (states) in the monetary union (here, the United States) as $\mathcal{J}$. I sum across all states $j \in \mathcal{J}$ and $j \neq i$ the quantity that is the outcome variable of state j, Y_{jt}, divided by the geographical distance between the centers of states j and i, $Dist_{ij}$:

$$\tilde{Y}_{it} = \sum_{j \in \mathcal{J}, j \neq i} \frac{Y_{jt}}{Dist_{ij}} \tag{11}$$

In Tables 12 and 13 of Appendix C, I include the fiscal spillovers and cumulative fiscal spillovers at the state level, from each state i to the other 49 states. Generally, spillovers to the rest of the monetary union are positive, and regional government consumption shocks lead to more positive(larger) spillovers than regional government investment shocks. Unusually, the opposite is true only for spillovers of employment.

4.4 Results: MSA-level

In Table 15 of Appendix C, I list empirical results for *cumulative* MSA-level multipliers (excluding the District of Columbia). The main qualitative result remains the same: regional government consumption multipliers are larger than regional government investment multipliers. As stated before, this replicates a finding by Nakamura and Steinsson (2014)[11] and Chodorow-Reich (2019), that smaller regions imply smaller regional fiscal multipliers due to greater leakage of local demand to purchasing other regions' goods and services.

5 Theoretical Model

To summarize the results from the previous section, we find that:

1. Regional government consumption multipliers are greater than regional government investment multipliers.

2. Fiscal spillovers to surrounding regions are much larger for government consumption than for government investment.

To explain these empirical results, I need to develop a theoretical model that contains at least the following features: a consumption-goods sector and an investment-goods sector, two regions within a monetary union with aggregate monetary and fiscal policy, and regional government consumption and investment shocks. The introduction of regional government investment implies that the monetary union has regional public capital; we may think of the highways or waterworks in a given state as part of that regional public capital or infrastructure. Thus, this section describes the baseline model: a New Keynesian DSGE model of a two-sector, two-region monetary union, with government consumption and investment. The model is closely based from Boehm (2020), and also Nakamura and Steinsson (2014).

[11] The authors of that paper compare states with census regions, or regional groups of states.

5.1 Households

There are two regions, Home (H) and Foreign (F), with GDP weights ω_H and $\omega_F \equiv 1-\omega_H$ respectively. Each region has two sectors: a consumption-goods sector denoted as c, and an investment-goods sector denoted as x. Each region $j \in \{H,F\}$ has a representative household, whose lifetime utility is as follows:

$$U_i = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{{C_{jt}^{hh}}^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \Gamma(C_{jt}^g) - \phi_n \frac{{N_{jt}}^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} \right] \tag{12}$$

$$\text{s.t. } B_{jt} + P_{jt}^c C_{jt}^{hh} + P_{jt}^x (X_{jt}^c + X_{jt}^x) = B_{j,t-1}(1+i_{t-1}) + \Pi_{jt} - T_{jt} + \sum_{s\in\{c,x\}} W_{jt}^s N_{jt}^s + \omega_i \sum_{s\in\{c,x\}} \sum_{j\in\{H,F\}} R_{jt}^{k,s} K_{jt}^s \tag{13}$$

where C_{jt}^{hh} is region j's household private consumption, C_{jt}^g is government consumption, N_{jt}^s and K_{jt}^s are the household's labor supply and capital stock specific to region $i \in \{H,F\}$ and sector $s \in \{c,x\}$. W_{jt}^s and $R_{jt}^{k,s}$ are the corresponding wage level and return on capital. T_{jt} is regional lump-sum taxes. X_{jt}^c and X_{jt}^x are, respectively, investment flows into the consumption-sector and investment-sector capital stocks. The utility for regional government consumption C_{jt}^g is simply given as $\Gamma(\cdot)$, and is immaterial to the household's optimization problem as the household does not decide on it.

The region-j household's total labor supply, N_{jt}, is given as a CES aggregate of sectoral labor supplies:

$$N_{jt} = \left[{N_{jt}^c}^{\frac{\eta+\mu}{\eta}} + {N_{jt}^x}^{\frac{\eta+\mu}{\eta}} \right]^{\frac{\eta}{\eta+\mu}} \tag{14}$$

Here, η is the elasticity of substitution between labor supply in the consumption-goods sector N_{jt}^c and that in the investment-goods sector N_{jt}^x. $\mu \in [0,1]$ specifies the degree to which labor is *immobile* across the consumption-goods and investment-goods sectors. If $\mu = 0$, labor supply is fully mobile across sectors, and is perfectly immobile if $\mu = 1$.[12]

5.1.1 Trade across Regions

Home consumption C_{Ht} has three components: Home expenditures of Home-produced consumption goods C_{Ht}^H, Home expenditures of Foreign-produced consumption goods C_{Ht}^F, and government consumption in the Home region, C_{Ht}^g. This similarly holds for Foreign consumption C_{Ft}. C_{Ht} is a CES aggregator of Home household consumption C_{Ht}^{hh} and C_{Ht}^g, and the same is true for C_{Ft} of C_{Ft}^{hh} and C_{Ft}^g:

$$C_{Ht} = \left[(1-\omega_c^g)^{\frac{1}{\xi}} {C_{Ht}^{hh}}^{\frac{\xi-1}{\xi}} + {\omega_c^g}^{\frac{1}{\xi}} {C_{Ht}^g}^{\frac{\xi-1}{\xi}} \right]^{\frac{\xi}{\xi-1}} \tag{15}$$

$$C_{Ft} = \left[(1-\omega_c^g)^{\frac{1}{\xi}} {C_{Ft}^{hh}}^{\frac{\xi-1}{\xi}} + {\omega_c^g}^{\frac{1}{\xi}} {C_{Ft}^g}^{\frac{\xi-1}{\xi}} \right]^{\frac{\xi}{\xi-1}} \tag{16}$$

[12] Note that if $\mu = 0$, $N_{jt} = N_{jt}^c + N_{jt}^x$.

where ξ is the elasticity of substitution of goods within the same region.

C_{Ht}^{hh} itself is a CES aggregation of C_{Ht}^{H} and C_{Ht}^{F}, and similarly for Foreign household consumption C_{Ft}^{hh}:

$$C_{Ht}^{hh} = \left[(\chi_H^H)^{\frac{1}{\nu}} C_{Ht}^{H\ \frac{\nu-1}{\nu}} + (\chi_H^F)^{\frac{1}{\nu}} C_{Ht}^{F\ \frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}} \tag{17}$$

$$C_{Ft}^{hh} = \left[(\chi_F^F)^{\frac{1}{\nu}} C_{Ft}^{F\ \frac{\nu-1}{\nu}} + (\chi_F^H)^{\frac{1}{\nu}} C_{Ft}^{H\ \frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}} \tag{18}$$

where $\chi_H^H \in (0,1)$ is the degree of home bias in consumption goods in the Home region, and χ_F^F is the corresponding parameter in the Foreign region. I also define $\chi_H^F = 1 - \chi_H^H$ and $\chi_F^H = 1 - \chi_F^F$. ν is the elasticity of substitution among goods produced in different regions (i.e. in the case of the H household, C_{Ht}^{H} and C_{Ht}^{F}). Importantly for this paper, I denote C_{jt}^{i} as the flow of consumption goods produced in region i and consumed in region j, with corresponding price level $P_{jt}^{c,i}$. Then, aggregate consumption C_t is the sum of Home (C_{Ht}) and Foreign (C_{Ft}) consumption goods:

$$C_t = C_{Ht} + C_{Ft} \tag{19}$$

$$\text{with } C_t^{hh} = C_{Ht}^{hh} + C_{Ft}^{hh} \tag{20}$$

$$\text{and } C_t^{g} = C_{Ht}^{g} + C_{Ft}^{g} \tag{21}$$

where C_t^g is aggregate government consumption and C_t^{hh} is aggregate household(private) consumption.

In the steady state, consumption is defined by these first-order conditions:

$$C_{jt}^{i} = \chi_j^i \left(\frac{P_{jt}^{c,i}}{P_{jt}^{c}} \right)^{-\nu} C_{jt}^{hh} \ \forall i \in \{H,F\}\ j \in \{H,F\} \tag{22}$$

$$\text{with } P_{jt}^{c} = \left[\sum_{i \in \{H,F\}} \chi_j^i (P_{jt}^{c,i})^{1-\nu} \right]^{\frac{1}{1-\nu}} \ \forall j \in \{H,F\} \tag{23}$$

$$\text{and } P_t^c = \left[\omega_H P_{Ht}^{c\ \frac{1}{1-\nu}} + \omega_F P_{Ft}^{c\ \frac{1}{1-\nu}} \right]^{\frac{1}{1-\nu}} \tag{24}$$

where P_{jt}^{c} is the region-j price index for consumption goods (i.e. Consumer Price Index), and P_t^c is the union-wide price index for consumption goods.

Finally, I assume the Law of One Price, or that prices of varieties of consumption goods produced in the same region have the same price level:

$$P_{Ht}^{c,H} = P_{Ft}^{c,H} \tag{25}$$

$$P_{Ft}^{c,F} = P_{Ht}^{c,F} \tag{26}$$

5.2 Firms

5.2.1 Intermediate Goods Firms

Each intermediate consumption-goods firm $l \in [0,1]$ of region H uses sector-C capital stock $K^c_{jt}(l)$ and labor demand $N^c_{jt}(l)$ to produce three types of consumption goods: Home-produced goods to be consumed at Home $C^H_{H,t}$, those to be consumed at Foreign $C^H_{F,t}$, and at Home by the government $C^g_{H,t}$:

$$C^H_{Ht}(l) + C^H_{Ft}(l) + C^g_{Ht}(l) = \left(K^g_{Ht}\right)^{\alpha_g} \left(K^c_{Ht}(l)\right)^{\alpha} \left(N^c_{Ht}(l)\right)^{1-\alpha} \tag{27}$$

where α is the capital share of income and α_g is the degree of productivity of K^g_{jt}. This analogously holds for Foreign consumption goods:

$$C^F_{Ft}(l) + C^F_{Ht}(l) + C^g_{Ft}(l) = \left(K^g_{Ft}\right)^{\alpha_g} \left(K^c_{Ft}(l)\right)^{\alpha} \left(N^c_{Ft}(l)\right)^{1-\alpha} \tag{28}$$

As for intermediate investment-goods firms l of region j, they simply produce investment goods for the consumption goods sector X^c_{jt}, the investment goods sector X^x_{jt}, and government investment X^g_{jt}:

$$X^c_{Ht}(l) + X^x_{Ht}(l) + X^g_{Ht}(l) = (K^g_{Ht})^{\alpha_g} K^x_{Ht}(l)^{\alpha} N^x_{Ht}(l)^{1-\alpha} \tag{29}$$

$$X^c_{Ft}(l) + X^x_{Ft}(l) + X^g_{Ft}(l) = (K^g_{Ft})^{\alpha_g} K^x_{Ft}(l)^{\alpha} N^x_{Ft}(l)^{1-\alpha} \tag{30}$$

Under monopolistic competition, sector-s nominal marginal costs MC^s_{jt} can be implicitly expressed as such:

$$MC^s_{jt} = \frac{1}{(K^g_{jt})^{\alpha_g}} \left(\frac{R^{k,s}_{jt}}{\alpha}\right)^{\alpha} \left(\frac{W^s_{jt}}{1-\alpha}\right)^{1-\alpha} \tag{31}$$

with real wages and returns on capital as follows:

$$\frac{W^s_{jt}}{P^s_{jt}} = \frac{MC^s_{jt}}{P^s_{jt}} (1-\alpha)(K^g_{jt})^{\alpha_g} (K^s_{jt})^{\alpha} (N^s_{jt})^{-\alpha} \tag{32}$$

$$\frac{R^{k,s}_{jt}}{P^s_{jt}} = \frac{MC^s_{jt}}{P^s_{jt}} \alpha (K^g_{jt})^{\alpha_g} (K^s_{jt})^{\alpha-1} (N^s_{jt})^{1-\alpha} \tag{33}$$

For each firm l in region j and sector s, sectoral reset prices $\bar{P}^s_{jt}$ for intermediate goods firms that can adjust their prices under Calvo pricing are determined as follows:

$$\bar{P}^s_{jt} = (1-\beta\theta_s) \sum_{\tau=0}^{\infty} (\beta\theta_s)^{\tau} \mathbb{E}_t [MC^s_{j,t+\tau} + P^s_{j,t+\tau}] \tag{34}$$

where $\theta_s \in (0,1)$ is the sectoral Calvo pricing parameter.

5.2.2 Final Goods Firm

There is one final goods firm in each region, which aggregates the output of all intermediate goods firms of the same region. For $S \in \{C, X\}$, and region $i \in \{H, F\}$, regional production of the final good S_{jt} is defined as:

$$S_{jt} = \left[\int_0^1 S_{jt}(l)^{\frac{\xi-1}{\xi}} dl \right]^{\frac{\xi}{\xi-1}} \tag{35}$$

with associated region-j price index of sector-s good as:

$$P^s_{jt} = \left[\int_0^1 P^s_{jt}(l)^{1-\xi} dl \right]^{\frac{1}{1-\xi}} \tag{36}$$

5.2.3 Sectoral Capital

Capital K is specific to each region-sector combination, and depreciates at a rate of $\delta \in (0, 1)$. In addition to sectors c and x, there is also productive government or public capital, denoted as K^g_{jt}, which depreciates at a rate of $\delta_g \in (0, 1)$. Given $s \in \{c, x, g\}$, sector-s capital is adjusted by sector-s investment X^s_{jt}, with an adjustment cost function of $\theta(X/K)$. As is standard in the literature (Christiano et al., 2005), I assume that:

$$\theta\left(\frac{X}{K}\right) = \frac{X}{K},\ \theta'\left(\frac{X}{K}\right) = 1,\ \theta''\left(\frac{X}{K}\right) = -\zeta \tag{37}$$

Then, capital accumulation in each sector $s \in \{c, x, g\}$ is as follows:

$$K^s_{j,t+1} = (1-\delta)K^s_{jt} + \theta\left(\frac{X^s_{jt}}{K^s_{jt}}\right)K^s_{jt} \tag{38}$$

5.3 Market Clearing and Price Indices

The market-clearing conditions for each region j are as follows:

$$Y_{jt} = P^c C_{jt} + P^x X_{jt} \tag{39}$$

where C_{jt} is regional consumption, X_{jt} is regional investment, and Y_{jt} is regional real GDP, where P^c and P^x are steady state values of P^c_{jt} and P^x_{jt}.

Given the regional price index for consumer goods P^c_{jt} and investment goods P^x_{jt}, the regional GDP deflator P_{jt} is defined as such:

$$P_{jt} = \frac{P^c_{jt} C_{jt} + P^x_{jt} X_{jt}}{Y_{jt}} \tag{40}$$

The aggregate price index for investment goods P^x_t and the aggregate GDP deflator P_t are defined in

terms of their relevant Home and Foreign price indices:

$$P_t^x = \omega_H P_{Ht}^x + \omega_F P_{Ft}^x \tag{41}$$

$$P_t = \omega_H P_{Ht} + \omega_F P_{Ft} \tag{42}$$

Naturally, inflation rates are defined as the growth rate in the price indices. For example, the region-j GDP deflator inflation π_{jt} and aggregate GDP deflator inflation π_t are defined as follows:

$$\pi_{jt} = \frac{P_{jt}}{P_{j,t-1}} - 1, \ \pi_t = \frac{P_t}{P_{t-1}} - 1, \text{ etc.} \tag{43}$$

5.4 Factor Incomes

For this paper, I also define regional and aggregate factor incomes. Regional labor income Y_{jt}^L is earned locally, while regional capital income Y_{jt}^K is simply region j's share of *aggregate* capital income:

$$P_{jt} Y_{jt}^L = W_{jt}^c N_{jt}^c + W_{jt}^x N_{jt}^x \tag{44}$$

$$P_{jt} Y_{jt}^K = \omega_j \sum_{j \in \{H,F\}} \left(R_{jt}^{k,c} K_{jt}^c + R_{jt}^{k,x} K_{jt}^x \right) \tag{45}$$

where ω_H is the Home share of aggregate GDP, and $\omega_F \equiv 1 - \omega_H$ is the Foreign share of aggregate GDP.

5.5 Aggregate Fiscal Policy

I assume lump-sum taxation across both regions, and a fiscal union in which the fiscal union's (nominal) government purchases G_t are paid with (nominal) aggregate lump sum taxes T_t via a balanced budget $T_t = G_t$:

$$T_t = T_{Ht} + T_{Ft} \tag{46}$$

$$G_t = (P_{Ht}^c C_{Ht}^g + P_{Ht}^x X_{Ht}^g) + (P_{Ft}^c C_{Ft}^g + P_{Ft}^x X_{Ft}^g) \tag{47}$$

Finally, I define the AR(1) process for government spending shocks. $\tilde{c}_{jt}^g$ and $\tilde{x}_{jt}^g$ are the log (percentage) deviations of C_{jt}^g and X_{jt}^g from their steady-state values.

$$C_{jt}^g = (1 - \rho_c^g)\bar{C}_j^g + \rho_c^g C_{j,t-1}^g + \nu_{jt}^{gc} \tag{48}$$

$$X_{jt}^g = (1 - \rho_x^g)\bar{X}_j^g + \rho_x^g X_{j,t-1}^g + \nu_{jt}^{gx} \tag{49}$$

where $\rho_c^g \in [0,1)$ and $\rho_x^g \in [0,1)$ are the persistence parameters of regional government consumption and government investment respectively, and $\bar{C}_j^g$ and $\bar{X}_j^g$ are steady-state values of C_{jt}^g and X_{jt}^g. ν_{jt}^{gc} and ν_{jt}^{gx} are government consumption shocks and government investment shocks respectively, with mean 0.

5.6 Monetary Policy

The central bank sets the nominal interest rate i_t via a Taylor rule given the aggregate inflation rate π_t, as such:

$$i_t = (\beta^{-1} - 1) + \phi_\pi \pi_t + \phi_y \tilde{y}_t \tag{50}$$

where $\phi_\pi > 1$, based on the Taylor principle, and $\phi_y > 0$.

5.7 Calibration

As my model is based from Boehm (2020), I borrow most values from that paper for the calibrated parameters, which are in quarterly frequency. I list the parameters below in Table 5. The additional parameters required are the share of the Home region ω_H and the degree of home bias χ_H. I assume the size of the Home region to be $\omega_H = 0.02$. For the degree of home bias, I follow Nakamura and Steinsson (2014) in setting the region as $\phi = 0.7$. From their paper, they also note that the degree of home bias for the rest of the monetary union is $\chi_F = (\omega_H/(1-\omega_H))\chi_H$.[13]

Parameter	Value	Definition	Source
σ	0.25	Intertemporal elasticity of substitution	
η	0.75	Frisch elasticity of labor supply	
β	0.995	Discount factor	
ξ	7	Elasticity of substitution of goods within same region	
ν	2	Elasticity of substitution of goods across different regions	
μ	1	Degree of labor mobility	
α	1/3	Capital share	
δ	0.025	Depreciation Rate	
ζ	2	Adjustment cost parameter	
ρ_c^g	0.86	Persistence of government consumption shock	
ρ_x^g	0.86	Persistence of government investment shock	
ω_y^c	0.8	Consumption share of output	
ω_y^x	0.2	Investment share of output	
ω_c^g	0.175	Government share of consumption	
ω_x^g	0.175	Government share of investment	
α_g	0.05	Elasticity of output with respect to public capital	
θ_c	0.6	Calvo parameter for investment goods	
θ_x	0.6	Calvo parameter for consumption goods	
ϕ_π	1.1	Taylor rule coefficient for inflation	
ϕ_y	0	Taylor rule coefficient for output	
ω_H	0.02	Size of Home region	Average share of U.S. state
χ_H^H	0.7	Home bias of Home region	Nakamura and Steinsson (2014)

Table 5: List of calibrated parameters for the model. Unless stated otherwise, the calibrated values of parameters are from Boehm (2020).

[13] I assume in my model that government consumption and investment are produced and consumed entirely within the region. I run a separate exercise at the U.S. state-level where I classify government procurement contracts by the state of place of performance and state of the recipient. For a given state's government procurements, the recipients from within the state's borders supply a median share of approximately 70% to the state itself, i.e. the largest proportion of procurements in a given state is from recipients within the same state. In the sample period from 2001 to 2023 and across 50 states, this is true approximately 95% of the time.

6 Theoretical Model: Results

6.1 Computing model-derived multipliers

To estimate multipliers from the model, I borrow the methodology from Nakamura and Steinsson (2014), of estimating multipliers from data simulated from the model. I compute the simulated path of the endogenous variables of interest (here, income/output) for 250 quarters, and drop the first 50 periods to remove the effects of the initial steady state in determining the endogenous variables. Then, given the remaining 200 quarters, I take the 4-quarter average of the data and time-aggregate into annual frequency. Given this annualized data, I estimate and store the multipliers for that simulation. I run this procedure for 1,000 simulations. Given that I use simulated data from the model, standard errors are practically zero (to the magnitude of 1e-16).

In this exercise, I estimate three types of multipliers, in response to each type of Home government spending shock. First, there are the response of Home income Y_{Ht}. I denote these as $\beta^{H,c}_{H,h}$ and $\beta^{H,x}_{H,h}$, the region-H response to a region-H government consumption or investment shock, where h is the time horizon of the multiplier:

$$\frac{Y_{H,t+h} - Y_{H,t-1}}{Y_{H,t-1}} = \beta^{H,c}_{H,h} \frac{C^g_{H,t+h} - C^g_{H,t-1}}{Y_{H,t-1}} + \beta^{H,x}_{H,h} \frac{X^g_{H,t+h} - X^g_{H,t-1}}{Y_{H,t-1}} + \alpha_H + \epsilon_{Ht} \tag{51}$$

Second, there are the fiscal spillovers, or the response of Foreign income Y_{Ft} to the Home government spending shocks. I denote these as $\beta^{H,c}_{F,h}$ and $\beta^{H,x}_{F,h}$, with the source (origin) region H in the superscript and the affected (destination) region F in the subscript:

$$\frac{Y_{F,t+h} - Y_{F,t-1}}{Y_{F,t-1}} = \beta^{H,c}_{F,h} \frac{C^g_{H,t+h} - C^g_{H,t-1}}{Y_{H,t-1}} + \beta^{H,x}_{F,h} \frac{X^g_{H,t+h} - X^g_{H,t-1}}{Y_{H,t-1}} + \alpha_F + \epsilon_{Ft} \tag{52}$$

From these, I define the regional fiscal multipliers as the relative regional differences in the responses of Home and Foreign outcomes (in this case, regional income), as estimated from panel data. In other words, the regional fiscal multipliers $\beta^c_{reg,h}$ and $\beta^x_{reg,h}$, are defined as:

$$\beta^c_{reg,h} = \beta^{H,c}_{H,h} - \beta^{H,c}_{F,h} \tag{53}$$

$$\beta^x_{reg,h} = \beta^{H,x}_{H,h} - \beta^{H,x}_{F,h} \tag{54}$$

Meanwhile, there are the aggregate fiscal multipliers from Home government spending shocks, or the response of aggregate income $Y_t = Y_{Ht} + Y_{Ft}$ to the Home government spending shocks. I denote these as $\beta^{H,c}_{agg,h}$ and $\beta^{H,x}_{agg,h}$, where the subscript agg represents the aggregate monetary union:

$$\frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}} = \beta^{H,c}_{agg,h} \frac{C^g_{H,t+h} - C^g_{H,t-1}}{Y_{H,t-1}} + \beta^{H,x}_{agg,h} \frac{X^g_{H,t+h} - X^g_{H,t-1}}{Y_{H,t-1}} \tag{55}$$

In Appendix E, I include a general framework for aggregating regional fiscal multipliers. In this 2-region model, the aggregate fiscal multipliers from the Home government spending shocks are approximately a weighted average of the regional fiscal multipliers and the fiscal spillovers, both from Home government spending shocks:

$$\beta^{H,c}_{agg,h} \approx \omega_H \beta^{H,c}_{H,h} + \omega_F \beta^{H,c}_{F,h} \tag{56}$$

$$\beta^{H,x}_{agg,h} \approx \omega_H \beta^{H,x}_{H,h} + \omega_F \beta^{H,x}_{F,h} \tag{57}$$

where ω_H is the ratio of the Home region's income to aggregate income, and likewise for $\omega_F = 1 - \omega_H$.[14]

6.2 Model Results

I list the results in Table 6. The top panel lists consumption multipliers, while the bottom panel lists investment multipliers. Each column indicates the time horizon of the multipliers (not cumulative multipliers), from $h = 0$ to $h = 4$ years after the Home government consumption or investment shock.

The first row of each panel indicates $\beta^{H,s}_{H,h}$, the response of Home income to a sector-s Home government spending shock ($s \in \{c, x\}$). I note that, as in standard New Keynesian DSGE models, persistent government consumption or investment shocks lead to steadily decreasing multipliers over successive time horizons h. The second row of each panel $\beta^{H,s}_{F,h}$, the response of Foreign income to the same Home government spending shock. The third row, the regional fiscal multipliers $\beta^{s}_{reg,h}$, is simply the difference between the first and second rows. As hypothesized, the regional government consumption multipliers $\beta^{c}_{reg,h}$ are larger than the regional government investment multipliers $\beta^{x}_{reg,h}$.

The fourth row indicates the response of aggregate income to the sector-s Home government spending shock, $\beta^{H,s}_{agg,h} \approx \omega_H \beta^{H,s}_{H,h} + \omega_F \beta^{H,s}_{F,h}$. Finally, the fifth row indicates the response of aggregate income to sector-s government spending shocks in both the Home and Foreign regions, $\beta^{agg,s}_{agg,h} \approx \omega_H \beta^{H,s}_{agg,h} + \omega_F \beta^{F,s}_{agg,h}$. The multipliers in these final rows can be thought of as the aggregate fiscal multipliers from the aggregate (weighted average) of regional government spending shocks. [15]

At both the aggregate and regional levels, government consumption multipliers are larger than government investment multipliers.[16] I also note that aggregate government consumption multipliers are larger

[14] It is important to distinguish the aggregate fiscal multipliers $\beta^{H,c}_{agg,h}$ and $\beta^{H,x}_{agg,h}$ in this report with those that are generally used in policy discussions, which is the response of aggregate income Y_t to the weighted average/aggregate of the regional government spending shocks. I denote these policy-relevant aggregate fiscal multipliers as $\beta^{agg,c}_{agg,h}$ and $\beta^{agg,x}_{agg,h}$. Appendix E shows the derivation for which:

$$\beta^{agg,s}_{agg,h} \approx \omega_H \beta^{H,s}_{agg,h} + \omega_F \beta^{F,s}_{agg,h} \ \forall s \in \{c, x\} \tag{58}$$

[15] Note that the Home region is calibrated in the model as the size of an average U.S. state, or $\omega_H = 0.02$, so the Foreign region $\omega_F \equiv 1 - \omega_H = 0.98$ is the much larger region, the rest of the monetary union. This accounts for the much larger values in the fifth row than in the fourth row, because the fifth row also includes all the Home and Foreign responses of the *Foreign* government spending shocks.

[16] The aggregate case is the main result in Boehm (2020).

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
Consumption Multipliers					
$\beta^{H,c}_{H,h}$	0.367	0.322	0.309	0.303	0.300
$\beta^{H,c}_{F,h}$	0.038	0.037	0.037	0.036	0.035
$\beta^{c}_{reg,h}$	0.329	0.285	0.272	0.266	0.264
$\beta^{H,c}_{agg,h}$	0.044	0.042	0.042	0.041	0.041
$\beta^{agg,c}_{agg,h}$	0.645	0.678	0.683	0.682	0.681
Investment Multipliers					
$\beta^{H,x}_{H,h}$	0.146	0.130	0.128	0.126	0.120
$\beta^{H,x}_{F,h}$	-0.016	-0.018	-0.013	-0.014	-0.019
$\beta^{x}_{reg,h}$	0.163	0.149	0.144	0.142	0.140
$\beta^{H,x}_{agg,h}$	-0.013	-0.015	-0.010	-0.011	-0.016
$\beta^{agg,x}_{agg,h}$	0.119	0.111	0.109	0.109	0.111

Table 6: Model-computed multipliers on incomes. Top panel lists consumption multipliers, while bottom panel lists investment multipliers. See text for details on notation.

than regional government consumption multipliers. This confirms a key argument by Chodorow-Reich (2019), that the "cross-sectional" (regional) fiscal multipliers, the relative differences in income/output regional responses, are lower bounds of (smaller than) the aggregate fiscal multipliers, provided that there is no monetary response in national monetary policy (i.e. a monetary policy that keeps the aggregate real interest rate constant after the government spending shock).

However, this inequality is reversed for government investment multipliers. In fact, the second row of the bottom panel of Table 6 indicate that the fiscal spillovers of a Home government investment shock are actually negative. In the model, this occurs because consumption goods are traded across state borders, while investment goods produced in one region are consumed only within that region. A Home government investment shock increases only the Home production of investment goods. Meanwhile, the increase in Home (and thus aggregate) inflation leads to a tightening in aggregate monetary policy and an increase in the nominal interest rate, which reduces Foreign output. In other words, the model restricts the effects of spillovers from regional government investment more than from government consumption. This is still enough to replicate one of my empirical results, that geographic spillovers from regional government consumption are larger than those of government investment. This implies that, in reality, there may be less inter-state trade in investment goods than in consumption goods.

7 Literature Review and Discussion of Results

Here, I review the two branches of the fiscal multiplier literature, both on multipliers of government consumption and investment, as well as the literature on regional ("cross-sectional") multipliers. I bring explanations from both branches to explain my theoretical results. Both branches readdress old and persisting

macroeconomic questions about the crowding out effect, that government spending can crowd out private investment and thus dampen the expansionary effects of fiscal stimulus.

7.1 Literature on Government Consumption and Investment Multipliers

The early literature on heterogeneous multipliers (Barro, 1981; Aiyagari et al., 1992) have generally analyzed the effects of government consumption. These early models argue that, given an increase in government consumption and the taxation needed to finance it, households will increase their labor supply to make up for additional demand. Greater labor supply leads to higher marginal disutility of labor, which then reduces labor supply and household consumption. In other words, government consumption crowds out household consumption, but total output still increases, so the government consumption multiplier is positive. To the extent that private household is crowded out and with it the negative wealth effect, the greater the incentive for households to provide more labor, and thus the greater the effect on labor supply and output (Woodford, 2011). Meanwhile, government investment might accumulate into public infrastructure, transportation, utilities, and other public capital that increases the productivity of private capital and labor. Given this, a permanent (or persistent) increase in government investment would have a larger long-run multiplier effect on output than that in government consumption by increasing public capital (Baxter and King, 1993).

However, the more recent literature has found that short-run government investment multipliers are generally smaller than those of government consumption. Boehm (2020) and Ramey (2021) are two recent papers that find that a transitory positive shock to government investment leads to a fall in private investment, i.e. a high degree of crowding out. They provide two reasons.

The first is that the shadow value of capital does not shift much in response to transitory shocks to government investment. We begin with the premise that investment goods and capital depreciate slower than consumption goods (especially nondurables). The shadow value of capital is the *lifetime* marginal utility gained from the consumption goods that can be produced with an additional unit of capital, and therefore is not changed from a transitory increase in investment. Second, investment has a high intertemporal elasticity of substitution. A transitory increase in the demand for investment goods increases their price. Due to the slow depreciation rate and thus longer service life of investment goods, firms that face temporarily higher prices in investment goods would prefer to delay their purchases of investment goods. This implies that private investment is crowded out by government investment to a greater degree than private consumption is crowded out by government consumption. Households' labor supply does not increase under a government investment shock than they do under a government consumption shock, and so government investment shocks lead to smaller labor supply and output responses, and smaller multipliers.

A simple analogy helps to illustrate this point.[17] Assume a two-good economy with bread (consumption good) and tractors (investment good). Tractors are used to bake(produce) bread. A transitory increase in

[17] I thank Jonathan Wright for this analogy.

government demand for tractors raises the price of tractors, inducing bakers(private firms) to buy new tractors at a later period in which the price of tractors would fall back to their original level. This decreases the private demand for tractors, thus leading to a relatively small increase in the overall demand for tractors on net. By contrast, a transitory increase in government demand for bread raises the price of bread, but households cannot choose to buy bread at a later period as they need to eat bread now (or else they starve!). In other words, households prefer to smooth their consumption of bread, and so the private demand for bread does not decrease by as much under a government demand shock in bread as it would for tractors. Bakers still have to work harder to produce more bread for private consumption, thus leading to a larger increase in output under the government demand shock in bread (relative to that in tractors).

In more technical terms, a government consumption shock would crowd out private consumption, and the labor supply condition determines the trade-off between the marginal utility of consumption increases and the marginal disutility of labor. The crowding out of private consumption increases the marginal utility of consumption, so the household increases its labor supply in response. By contrast, a government investment shock crowds out private investment by far more, because today's investment increases consumption through the accumulation of private capital. The steady-state ratio of investment to capital is, in most standard DSGE models, the depreciation rate δ ($X = \delta K$), which is usually calibrated as between 2% and 3% at quarterly frequency.

An interesting corollary of this result is that, as in Proposition 2 of Boehm (2020), a more persistent government investment shock would lead to the (long-run) government investment multiplier being greater than the government consumption multiplier. The greater the persistence of the government investment shock, the longer the increase in the price of investment goods, and thus a larger effect on household wealth like under the government consumption shock. There is less room for intertemporal substitution (recall that under transitory shocks, the intertemporal elasticity of substitution for private investment is large), and so greater persistence in government investment shocks would lead to a larger long-run government investment multiplier. Additionally, the accumulation of productive public capital from the persistent government investment shock would increase output further; this effect is absent under the government consumption shock, although Boehm (2020) argues that this is quantitatively small, and that it is the persistence of the government investment shock that matter much more for the relative magnitude of long-run government investment and consumption multipliers.

Boehm (2020) sets up a New Keynesian DSGE model with a consumption-goods sector and an investment-goods sector, and introduces government consumption and investment shocks to explain how *aggregate* government consumption multipliers are larger than *aggregate* government investment multipliers. My theoretical model is a two-region monetary union version of that model, so much of that paper's results on aggregate multipliers carries over to my model's results on regional multipliers.

7.2 Literature on Regional and Aggregate Fiscal Multipliers

My paper is also placed in the literature on the estimation of regional fiscal multipliers using regional panel data, arguably starting from Nakamura and Steinsson (2014). There are some advantages in using regional data over aggregate time-series data to understand the effects of demand shocks: first, regional data allows for greater sample sizes and variation. Second, regional data places fewer restrictions on joint comovement of consumption and output, i.e. through a market clearing condition that must hold in aggregate (closed) economies (Auerbach et al., 2024).

The literature makes clear that regional fiscal multipliers are not the same concept as aggregate fiscal multipliers. Regions (U.S. states or MSAs) within the same aggregate economy (United States) are more open than the aggregate economy itself, and an increase in one region's income may increase demand for other regions' goods. Nevertheless, Chodorow-Reich (2019) argues that in most applicable cases, the regional fiscal multiplier serves as a lower bound for the aggregate economy multiplier, as the region's government purchases by the central fiscal authority (federal government) are financed by taxes across the monetary union. More precisely, the outside transfer-financed regional fiscal multiplier is a lower bound for the "no-monetary-response aggregate multiplier". The added qualification allows a more direct comparison of the aggregate fiscal multiplier with the regional fiscal multiplier, the latter of which differences out the effects of aggregate monetary policy across regions.

The main contributing factors towards the lower bound argument are the expenditure-switching effects and income effects. First, an increase in local government spending acts as a demand shock, increasing the prices of local goods and inducing local consumers to shift their expenditures towards goods and services from other regions (expenditure-switching effect). Second, an increase in local government spending increases consumption within the region, some of which is of goods from other regions (income effect). Both effects imply that some of the increase in local output/incomes from a local government spending shock "leaks" across regional boundaries, which lowers the measured regional fiscal multiplier relative to the aggregate fiscal multiplier.

7.3 Discussion of Results

My results, both empirical and theoretical, show that the lower bound finding only applies to government *consumption*. As seen before in Table 6, the regional government investment multiplier $\beta^{x}_{reg,h}$ is larger than the aggregate government investment multiplier $\beta^{agg,x}_{agg,h}$. To extend the analogy from Table 1 of the introduction, I complete the comparisons within the 2×2 matrix of multipliers.

There are two potential reasons for the finding with regional government investment multipliers. First, as discussed before, government consumption exhibits a larger crowding out effect on private consumption and thus a larger effect on labor supply and output. This applies for both at the aggregate and regional levels. A smaller output, and thus income, multiplier from regional government investment would im-

ply a smaller increase in the demand for other regions' goods and services. Second, investment goods are traded less across regional boundaries than consumption goods are. If regions exhibit greater home bias for investment goods, the same increase in regional incomes would lead to a smaller increase in demand of investment goods from other regions. Both these reasons reduce the spillover effects from regional government investment to other regions. Combined with the effects of an aggregate Taylor rule monetary policy, which still responds more than one-to-one to inflation, the general equilibrium effect of higher interest rates implies that one region's regional government investment shocks has a much weaker or even negative effect on other regions' output/income (as compared to government consumption). Under certain calibrations, this can lower the aggregate government investment multiplier relative to its regional counterpart.

In policy terms, this implies that fiscal authorities ought to be cautious about the short-term effects of government investment, as well as the use of government investment as fiscal stimulus during the onset of recessions. I discuss this in the next two sections, by constructing a quantitative model of the United States as a monetary and fiscal union.

8 Quantitative Model

8.1 The Infrastructure Investment and Jobs Act of 2021

In November 2021, President Joe Biden signed the Infrastructure Investment and Jobs Act (IIJA). The bill would have allocated, from Fiscal Years 2022 to 2031, $1.2 trillion in new government spending, of which around $890 billion would be in new government investment. (Zandi and Yaros, 2021), a contemporary brief by Moody's Analytics published in November 2021, stated that the government investment was planned to be in the transportation sector (rail, road, airports, ports, and public transit), clean water and utilities, clean energy and electric vehicle charging stations, and telecommunications. They also estimated that there would be between 800,000 to 2.4 million more jobs at the peak of the employment impact by the mid-2020s, which was cited by other sources[18]. At the time, the authors of the report also forecasted annual real GDP growth between 3.8% and 4.9% in 2022, and between 2.3% and 3.2% in 2023, depending on whether the IIJA was also passed with Biden's overall Build Back Better framework.

This paper examines those claims more closely, albeit with the benefit of hindsight and the actual trajectory of regional government consumption and investment. In this section, I construct a quantitative model of the United States as a monetary and fiscal union, with regional government consumption and investment shocks. The quantitative model is calibrated at the state level: the monetary union has 51 regions, namely the 50 states and the District of Columbia. I choose to specify the quantitative model at the state level, rather than the MSA level, due to data limitations. Given the role of fiscal spillovers in determining aggregate government consumption and investment multipliers, the model requires data on the trade flows across regions of the monetary and fiscal union. The data on inter-state trade flows is compiled completely

[18] See Holder and Harrison (2022) and Economic Policy Institute, November 10, 2021..

across all 50 states and the District of Columbia, specifically in the 2017 Commodity Flow Survey (CFS) as compiled by the U.S. Census Bureau. The CFS has limited inter-MSA trade flows on a select number of MSAs. Due to this data limitation, the quantitative model is specified at the state level, with trade flows across all 51 regions.

I also assume the additional government purchases incurred by the IIJA in each state as regional government consumption and investment shocks. I can then calibrate the quantitative model and specify the time path of the regional IIJA government consumption and investment shocks in 2022 and 2023, at annual frequency. With this model, I solve the model, and discuss results in Section 9.

8.2 Quantitative Model Setup, and Calibration and Shocks

I describe the quantitative model fully in Appendix F. Meanwhile, given the larger number of regions in this quantitative model of the United States, I highlight some necessary differences in calibration from the theoretical model to the quantitative model. The important differences include a full specification of trade flows across U.S. states, and the specification of the spending shocks.

To calibrate the share of state $i \in \mathcal{J}$ each state j's consumption basket, I use data on inter-state flows of goods and services from the 2017 Commodity Flow Survey. I also assume that a share of the production of goods and services in each state is non-tradable. This result in adding onto the home bias of consumption and investment goods. Here, I assume that the non-tradables share of the own region is 2/3 Carlino et al. (2023). Thus, denoting each $\chi_j^{trade,i}$ as the share of tradable goods produced in region i and consumed in (traded to) region j, I calibrate $\chi_j^i = \frac{2}{3} + \frac{1}{3}\chi_j^{trade,i}$ for $i = j$ and $\chi_j^i = \frac{1}{3}\chi_j^{trade,i}$ otherwise.

Second, for regional government spending shocks, I include all government purchases authorized via the IIJA as regional government consumption and investment shocks $\epsilon_{it}^{c,g}$ and $\epsilon_{it}^{x,g}$, for each region i in year t. An important distinction between the empirical sections and the quantitative model is that the government spending shocks are based from *all* government purchases, both military and non-military, as authorized via the IIJA.

For Fiscal Years 2022 to 2024, I aggregate transaction-level data on outlays across the 50 states and the District of Columbia from USASpending.gov. In addition to place of performance, Product Service Codes, and other variables, the transaction-level data also has information on whether the transaction was authorized as part of federal emergency spending. Normally, these codes are allocated for natural disasters. These codes were expanded to include the Biden Administration's stimulus since the onset of the COVID-19 pandemic, including the IIJA. Aggregating this data, USASpending.gov reports that around $100.4 billion were spent in outlays for Fiscal Years 2022 to 2024. Of the total outlays, $74.4 billion were spent in what this paper designates as government consumption, while the remaining $26.0 billion were spent on government investment.

Figures 6 and 7 in Appendix B.2 show the state-level distribution of government consumption and investment spending due to the IIJA. Overall, the geographical distribution of IIJA differs slightly across gov-

ernment consumption and government investment. Some of the largest recipient states of IIJA government consumption spending include Washington, Idaho, Colorado and Tennessee, while those for government investment include Michigan, South Carolina, and Virginia.

9 Quantitative Model: Results

One aspect of the quantitative model is that it can yield the regional government consumption and investment multipliers of each state. In my empirical results, I have so far estimated the *average* regional fiscal multipliers across all the states (or MSAs). The benefit of the quantitative model is that, assuming the calibration of the parameters, I can compute the effects of state j's regional sector-s government spending on state i's income, for any combination of j, s, and i.

For example, the response of a regional government consumption ($s = c$) shock in Maryland ($j = MD$) on Virginia($i = VA$)'s state-level income is different from that of a regional government investment ($s = x$) shock in Maryland on Delaware($i = DE$)'s state-level income. This would be due to differences in the multiplier effects of government consumption and investment, the relative size of the state economies of Virginia and Delaware, and also the shares of Virginia and Delaware's consumption goods that are produced in Maryland, even if all other parameters were the same across the states.

In this section, I will display three types of results: regional fiscal multipliers for government consumption and government investment and for each state, fiscal spillovers to the rest of the United States, and the aggregate fiscal multipliers for the United States. These multipliers quantify the effects of state-level government consumption and investment due to the IIJA on national income and employment.

Finally, I compare my estimates with Zandi and Yaros (2021)'s concurrent estimates as of the IIJA's passage in November 2021. It is perhaps unfair, with the benefit of hindsight, to compare my estimates with those made shortly around the time of the IIJA's passage in November 2021. However, this paper still provides two distinctions as compared to the estimates forecasted in Zandi and Yaros (2021): first, I introduce a more nuanced differentiation between the effects of government consumption and government investment. Second, I also show that the geographical distribution of government consumption and investment has aggregate implications.

9.1 Quantitative Model: Fiscal Multipliers [TO BE FINISHED]

Based on the calibrated model, I discuss on the regional fiscal multipliers of each state's federal government spending. Second, I will discuss on the fiscal spillovers from each state to the rest of the monetary union. Finally, I will discuss on the aggregate fiscal multipliers, which are computed easily given the regional fiscal multipliers and the fiscal spillovers. The aggregate multipliers are used to estimate the effects of the IIJA on national personal income (and employment).

I show the results of the quantitative model in Table 7, which shows simulated multipliers for government consumption (top panel) and investment (bottom panel). The main qualitative results still hold, similar to the 2-region model: regional government consumption multipliers are larger than regional government investment multipliers. The regional government consumption ($\beta^{c}_{reg,h}$) and investment ($\beta^{x}_{reg,h}$) multipliers are of similar magnitude to those in Table 6 under the 2-region model. In that aspect, the 2-region model is a close approximation of the quantitative model. However, one major difference is that we now we see positive spillovers from government consumption ($\beta^{c}_{spill,h}$) and, for longer horizons, for government investment ($\beta^{x}_{spill,h}$) as well. Compared to the 2-region model, the initial spillover effect to other states is presumably amplified by trade among all the other states. Because of this, and given the general framework for aggregation of multipliers (see Appendix E), the difference between the own-region (own) and spillover ($spill$) responses of government spending shocks need not exactly equal the regional fiscal multiplier (reg).

Finally, the regional government consumption multiplier $\beta^{c}_{reg,h}$ remains largers than its aggregate counterpart $\beta^{c}_{agg,h}$, while the quantitative model implies the opposite for investment multipliers ($\beta^{x}_{reg,h} < \beta^{x}_{agg,h}$). Based on the results of the quantitative model, regional government consumption has a 2-year regional multiplier effect of around 0.30 on regional income(GDP), while the combined effects of the aggregate government consumption shocks have an aggregate multiplier effect of around 0.45 on aggregate income. The same figures for investment are 0.134 (regional) and 0.204 (aggregate). However, government (infrastructure) investment in the long run increases productive public capital, which increases in aggregate the productivity of labor and private capital. This is one of the novel findings of this paper: even if government investment need not lead to large relative regional income differences, it can still lead to larger increases in aggregate income(GDP).

Currently, the largest shortcoming of this model is that the model-implied multipliers are too small relative to the empirical estimates in Section 4. I am working on a Two-Agent New Keynesian (TANK) version of the quantitative model, such that the model-implied multipliers can be closer to the empirical estimates.

9.2 Quantitative Model: Comparison with Concurrent Estimates

Here, I compare my estimates of the IIJA's impact on national personal income(proxied as GDP) with Zandi and Yaros (2021)'s estimates in November 2021. Recall that, of the total outlays $100.4 billion from the IIJA from Fiscal Years 2022-2024, $74.4 billion were spent in government consumption and $26.0 billion in government investment across the United States. Assuming that to be the aggregate of government spending *shocks*, the aggregate increase in U.S. GDP is $74.4 \times 0.451 + 26.0 \times 0.204 = \$38.86$ billion over 2 years from the time of the passage of the IIJA. Similarly, the effect over 5 years is $45.6 billion. Given that real U.S. GDP (in 2017 dollars terms) was $22.0 trillion,[19], this would be equivalent to 0.18% of 2022

[19] Bureau of Economic Analysis, NIPA Table 1.1.6.

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
Average Government Consumption Multipliers					
$\beta^{c}_{own,h}$	0.314	0.304	0.295	0.289	0.283
$\beta^{c}_{spill,h}$	0.064	0.147	0.201	0.221	0.210
$\beta^{c}_{reg,h}$	0.313	0.301	0.292	0.284	0.279
$\beta^{c}_{agg,h}$	0.378	0.451	0.496	0.510	0.493
Average Government Investment Multipliers					
$\beta^{x}_{own,h}$	0.132	0.135	0.137	0.139	0.140
$\beta^{x}_{spill,h}$	-0.032	0.069	0.149	0.197	0.210
$\beta^{x}_{reg,h}$	0.133	0.134	0.135	0.135	0.136
$\beta^{x}_{agg,h}$	0.100	0.204	0.286	0.335	0.350

Table 7: Cumulative multipliers computed from quantitative model. The top panel lists government consumption multipliers, and the bottom panel government investment multipliers. Each panel contains, in order, the average own-region income response (*own*), the average income response of the rest of the monetary union (*spill*), the (weighted) average regional fiscal multiplier (*reg*), and the average aggregate fiscal multiplier (*agg*). See text for more details on notation.

U.S. GDP over 2 years, and 0.21% over 5 years. Zandi and Yaros (2021) estimated that the combination of the IIJA and the American Rescue Plan (ARP), as compared to the effect of only the ARP's passage, would have had an additional 0.6%p (2.9% with the IIJA and ARP, 2.3% with only the ARP) effect on U.S. GDP in 2023. My estimate of the 2-year effect, a 0.18%p increase in U.S. GDP, is much lower than their estimate. This back-of-the-envelope exercise shows the importance of considering the different stimulative effects of government investment and government consumption, which the previous literature did not consider.

Meanwhile, it also should be noted that the original estimates of total IIJA spending were planned to be much larger: Zandi and Yaros (2021) estimated that the increase in total infrastructure spending alone would have been $316.7 billion across Fiscal Years 2022 to 2026. A government investment shock of that size would imply an aggregate effect of $110.85 billion over 5 years. Again using the 2022 U.S. GDP figure of $22.0 trillion, the full effect of the government investment shock would have corresponded to a 0.5%p cumulative increase in U.S. GDP after 5 years.

These results will change in future drafts of this paper, provided that I can successfully run the TANK version of the quantitative model.

10 Conclusion

In this paper, I complete the comparison of the 2×2 table of multipliers as I set out in the introduction: between government consumption and investment multipliers, and between aggregate and regional multipliers. I establish my empirical results by constructing a U.S. state-level panel dataset from 1989 to 2023, using transaction-level data on federal military expenditures for consumption and investment. My results confirm much of the literature on fiscal multipliers, both on government consumption and investment

(Boehm, 2020; Ramey, 2021) and regional fiscal multipliers (Chodorow-Reich, 2019). Regional government consumption multipliers are larger than regional government investment multipliers. This result bypasses a key empirical challenge in estimating the stimulative effects of *aggregate* government consumption and investment while dealing with their effects on endogenous and countercyclical monetary policy, as in a Taylor rule specification.

Meanwhile, this paper also updates the discipline's understanding on the relationship between regional and aggregate fiscal multipliers for government investment. While Chodorow-Reich (2019) is still true in that the regional government *consumption* multiplier is a lower bound of the aggregate government consumption multiplier, my model demonstrates that the opposite is true for government investment. Two reasons contribute to this finding. First, government investment is generally less stimulative in the short run than government consumption, due to the greater intertemporal elasticity of investment than consumption. Second, investment goods are generally traded less across regional borders than consumption goods, and so the spillover effects are smaller relative to the general equilibrium effects of a countercyclical monetary policy (as in a Taylor rule specification).

Motivated by the baseline model, my quantitative model of the United States as a 51-region monetary union is able to provide estimates of the regional and aggregate stimulative effects of the Infrastructure Investment and Jobs Act of 2021. There are positive regional effects of both regional government consumption and investment, and smaller but still positive spillover effects of both government consumption and investment. These add up to a positive multiplier effect on aggregate output, of around

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A Appendix: Categorization of Product Service Codes

Product service codes are assigned according to guidelines set by the General Services Administration (GSA). All product service codes are four-digit alphanumeric codes, and begin with either a letter code for services or a two-digit code for goods. I assign the following designation for dividing all product service codes into government investment and consumption. See Tables 8 and 9 for the complete categorization in this paper.

1. Investment: Structural investment, vehicles, and research and development
    - Structures, Facilities, and Equipment: construction, maintenance, and repair of structures, facilities, and equipment
        - Letter codes C, D, E, F, J, K, Y, and Z
        - Number codes 7 (IT/telecommunications), 11, 12, and 20-67.
    - Vehicles: motor vehicles and vehicle parts/accessories
        - Number codes 14-19
    - Research and development
        - Letter code A (Research & Development)
2. Consumption: Nondurable goods (food and beverages purchased for off-premises consumption, clothing and footwear, gasoline and other energy goods, etc.), durable goods, and services (housing and utilities, health care, transportation services, recreation services, food services and accommodations, financial services and insurance, etc.)
    - Nondurable goods (food and beverages purchased for off-premises consumption, clothing and footwear, gasoline and other energy goods, etc.)
        - Number codes 13 (Ammunition), 68 (Chemicals and Chemical Products), and 75-99
    - Durable goods: furnishings and durable household equipment, recreational goods and vehicles, and other durable goods
        - Number codes 10 (Weapons), 69, and 71-74.
    - Services not related to construction, maintenance, or repair of structures, facilities, and equipment
        - Letter codes B, G, H, and L-X

PSC Category	PSC Category Name	Category	C/X?
7	INFORMATION TECHNOLOGY AND TELECOMMUNICATIONS	Struct	X
10	WEAPONS	Dur	C
11	NUCLEAR ORDNANCE	Struct	X
12	FIRE CONTROL EQPT.	Struct	X
13	AMMUNITION AND EXPLOSIVES	Nondur	C
14	GUIDED MISSLES	Veh	X
15	AIRCRAFT/AIRFRAME STRUCTURE COMPTS	Veh	X
16	AIRCRAFT COMPONENTS/ACCESSORIES	Veh	X
17	AIRCRAFT LAUNCH/LAND/GROUND HANDLE	Veh	X
18	SPACE VEHICLES	Veh	X
19	SHIPS, SMALL CRAFT, PONTOON, DOCKS	Veh	X
20	SHIP AND MARINE EQUIPMENT	Struct	X
22	RAILWAY EQUIPMENT	Struct	X
23	MOTOR VEHICLES, CYCLES, TRAILERS	Struct	X
24	TRACTORS	Struct	X
25	VEHICULAR EQUIPMENT COMPONENTS	Struct	X
26	TIRES AND TUBES	Struct	X
28	ENGINES AND TURBINES AND COMPONENT	Struct	X
29	ENGINE ACCESSORIES	Struct	X
30	MECHANICAL POWER TRANSMISSION EQPT	Struct	X
31	BEARINGS	Struct	X
32	WOODWORKING MACHINERY AND EQPT	Struct	X
34	METALWORKING MACHINERY	Struct	X
35	SERVICE AND TRADE EQPT	Struct	X
36	SPECIAL INDUSTRY MACHINERY	Struct	X
37	AGRICULTURAL MACHINERY AND EQPT	Struct	X
38	CONSTRUCT/MINE/EXCAVATE/HIGHWY EQPT	Struct	X
39	MATERIALS HANDLING EQPT	Struct	X
40	ROPE, CABLE, CHAIN, FITTINGS	Struct	X
41	REFRIG, AIR CONDIT/CIRCULAT EQPT	Struct	X
42	FIRE/RESCUE/SAFETY; ENVIRO PROTECT	Struct	X
43	PUMPS AND COMPRESSORS	Struct	X
44	FURNACE/STEAM/DRYING; NUCL REACTOR	Struct	X
45	PLUMBING, HEATING, WASTE DISPOSAL	Struct	X
46	WATER PURIFICATION/SEWAGE TREATMENT	Struct	X
47	PIPE, TUBING, HOSE, AND FITTINGS	Struct	X
48	VALVES	Struct	X
49	MAINT/REPAIR SHOP EQPT	Struct	X
51	HAND TOOLS	Struct	X
52	MEASURING TOOLS	Struct	X
53	HARDWARE AND ABRASIVES	Struct	X
54	PREFAB STRUCTURES, FACILITIES, AND EQUIPMENT/SCAFFOLDING	Struct	X
55	LUMBER, MILLWORK, PLYWOOD, VENEER	Struct	X
56	CONSTRUCTION AND BUILDING MATERIAL	Struct	X
58	COMM/DETECT/COHERENT RADIATION	Struct	X
59	ELECTRICAL/ELECTRONIC EQPT COMPNTS	Struct	X
60	FIBER OPTIC	Struct	X

Table 8: My classification of government consumption (C) or government investment X by Product Service Code, Part 1. "PSC Category": First two numerals (product) or first letter (services) of PSC alphanumeric code. "PSC Category Name": Official category name based on PSC Manual. "Category": My classification of each PSC category into one of Dur (Durables), Nondur (Nondurables), R&D (Research and Development), Serv (Services), Struct (Structures, Facilities, and Equipment), or Veh (Vehicles). "C/X": C, government consumption, consists of nondurables and services. X, government investment, consists of durables, R&D, structures, facilities, and equipment, and vehicles.

PSC Category	PSC Category Name	Category	C/X?
61	ELECTRIC WIRE, POWER DISTRIB EQPT	Struct	X
62	LIGHTING FIXTURES, LAMPS	Struct	X
63	ALARM, SIGNAL, SECURITY DETECTION	Struct	X
65	MEDICAL/DENTAL/VETERINARY EQPT/SUPP	Struct	X
66	INSTRUMENTS AND LABORATORY EQPT	Struct	X
67	PHOTOGRAPHIC EQPT	Struct	X
68	CHEMICALS AND CHEMICAL PRODUCTS	Nondur	C
69	TRAINING AIDS AND DEVICES	Dur	C
71	FURNITURE	Dur	C
72	HOUSEHOLD/COMMERC FURNISH/APPLIANCE	Dur	C
73	FOOD PREPARATION/SERVING EQPT	Dur	C
74	OFFICE MACH/TEXT PROCESS/VISIB REC	Dur	C
75	OFFICE SUPPLIES AND DEVICES	Nondur	C
76	BOOKS, MAPS, OTHER PUBLICATIONS	Nondur	X
77	MUSICAL INST/PHONOGRAPH/HOME RADIO	Nondur	X
78	RECREATIONAL/ATHLETIC EQPT	Nondur	X
79	CLEANING EQPT AND SUPPLIES	Nondur	C
80	BRUSHES, PAINTS, SEALERS, ADHESIVES	Nondur	C
81	CONTAINERS/PACKAGING/PACKING SUPPL	Nondur	C
83	TEXTILE/LEATHER/FUR; TENT; FLAG	Nondur	C
84	CLOTHING/INDIVIDUAL EQPT, INSIGNIA	Nondur	C
85	TOILETRIES	Nondur	C
87	AGRICULTURAL SUPPLIES	Nondur	C
88	LIVE ANIMALS	Nondur	C
89	SUBSISTENCE	Nondur	C
91	FUELS, LUBRICANTS, OILS, WAXES	Nondur	C
93	NONMETALLIC FABRICATED MATERIALS	Nondur	C
94	NONMETALLIC CRUDE MATERIALS	Nondur	C
95	METAL BARS, SHEETS, SHAPES	Nondur	C
96	ORES, MINERALS AND PRIMARY PRODUCTS	Nondur	C
99	MISCELLANEOUS	Nondur	C
A	RESEARCH AND DEVELOPMENT	R&D	X
B	SPECIAL STUDIES/ANALYSIS, NOT R&D	Serv	C
C	ARCHITECT/ENGINEER SERVICES	Struct	X
D	ADP AND TELECOMMUNICATIONS	Struct	X
E	PURCHASE OF STRUCTURES, FACILITIES, AND EQUIPMENT/FACILITIES	Struct	X
F	NATURAL RESOURCES MANAGEMENT	Struct	X
G	SOCIAL SERVICES	Serv	C
H	QUALITY CONTROL, TEST, INSPECTION	Serv	C
J	MAINT, REPAIR, REBUILD EQUIPMENT	Struct	X
K	MODIFICATION OF EQUIPMENT	Struct	X
L	TECHNICAL REPRESENTATIVE SVCS.	Serv	C
M	OPERATION OF GOVT OWNED FACILITY	Serv	C
N	INSTALLATION OF EQUIPMENT	Serv	C
P	SALVAGE SERVICES	Serv	C
Q	MEDICAL SERVICES	Serv	C
R	SUPPORT SVCS (PROF, ADMIN, MGMT)	Serv	C
S	UTILITIES AND HOUSEKEEPING	Serv	C
T	PHOTO, MAP, PRINT, PUBLICATION	Serv	C
U	EDUCATION AND TRAINING	Serv	C
V	TRANSPORT, TRAVEL, RELOCATION	Serv	C
W	LEASE/RENT EQUIPMENT	Serv	C
X	LEASE/RENT FACILITIES	Serv	C
Y	CONSTRUCT OF STRUCTURES, FACILITIES, AND EQUIPMENT/FACILITIES	Struct	X
Z	MAINT, REPAIR, ALTER REAL PROPERTY	Struct	X

Table 9: Continuation of Table 8. See caption of that Table for more details.

B Appendix: Graphs of State-level Data

B.1 State DoD Spending as a Proportion of State Personal Income

To illustrate Nakamura and Steinsson (2014)'s point on different sensitivity of state-level DoD spending to changes in national DoD spending, I compare three states: California, Illinois, and Maryland. I also include additional graphs, each for DoD investment and DoD consumption. Orange lines indicate the national (unweighted) average of the corresponding proportions across all 50 states.

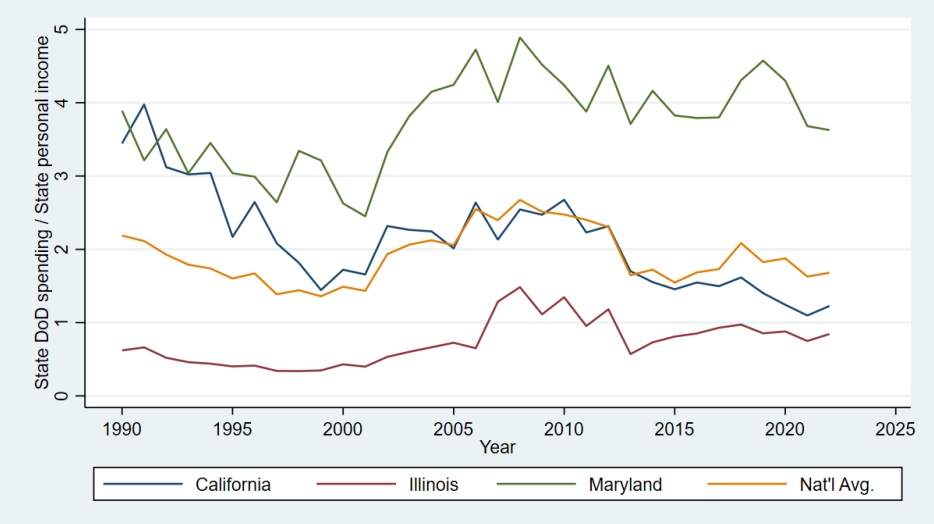


Figure 3: Ratio of State DoD spending to State personal income for California, Illinois, and Maryland. Yellow line is for national average of ratios across states. Y-axis in percentage points.

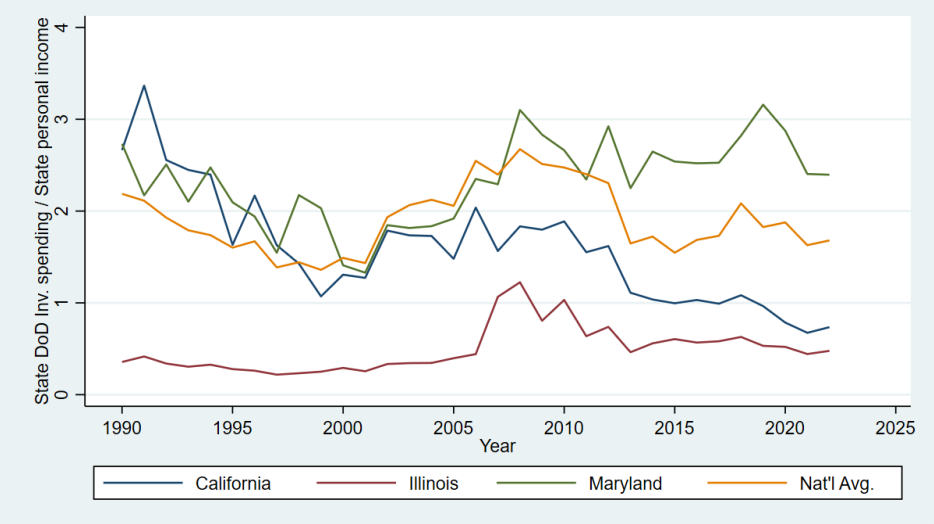


Figure 4: Ratio of State DoD investment spending to State personal income for California, Illinois, and Maryland. Yellow line is for national average of ratios across states. Y-axis in percentage points.

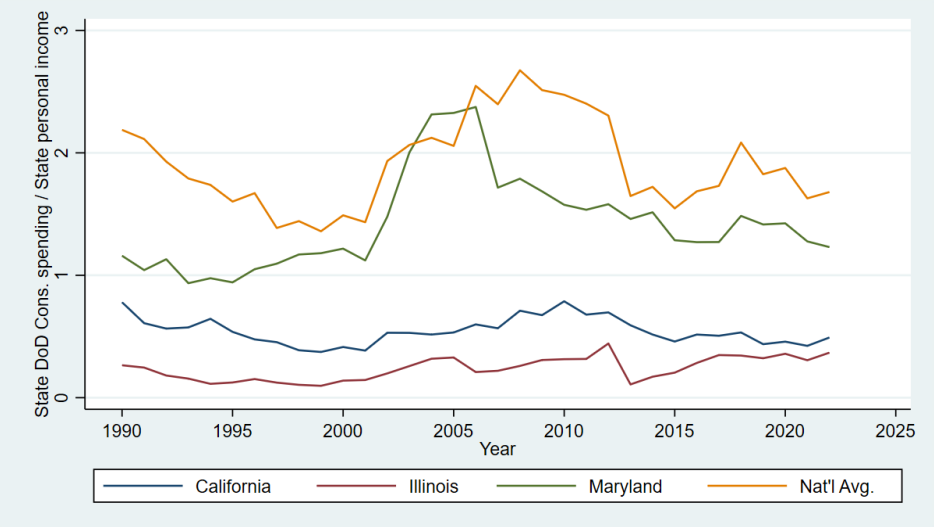


Figure 5: Ratio of State DoD consumption spending to State personal income for California, Illinois, and Maryland. Yellow line is for national average of ratios across states. Y-axis in percentage points.

B.2 State-level Distribution of IIJA Spending

I construct maps of the United States with state-level data of government consumption and investment that were allocated with the passage of the IIJA in November 2021. Here, I aggregate all spending from fiscal years 2022 to 2024. Figure 6 shows state-level government consumption, and Figure 7 government investment.

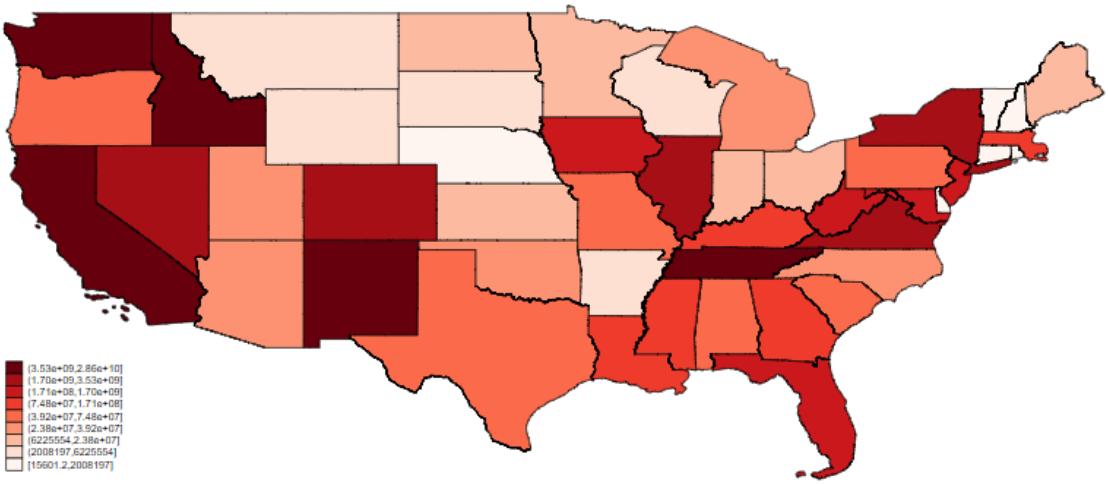


Figure 6: State-level distribution of government consumption expenditures as allocated via the IIJA, for fiscal years 2022-2024.

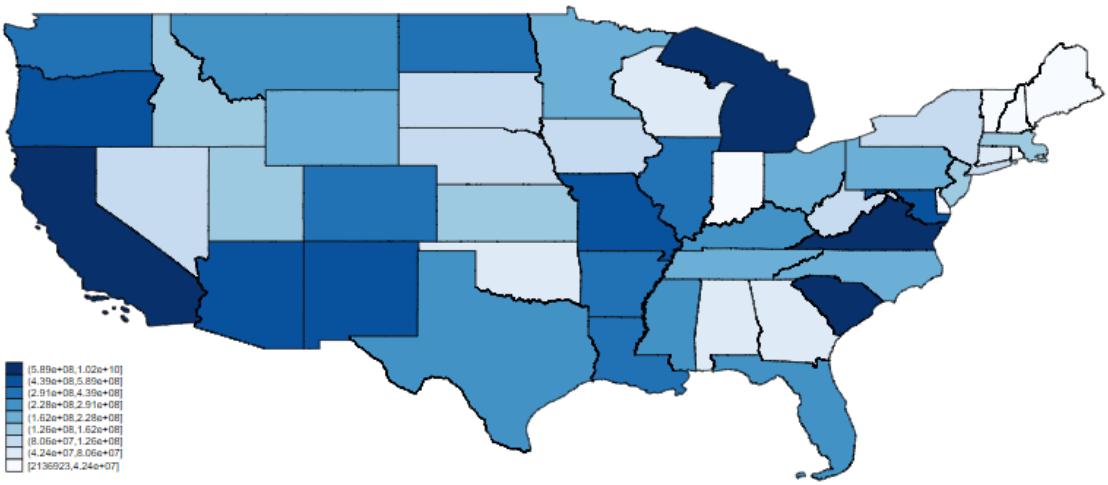


Figure 7: State-level distribution of government investment expenditures as allocated via the IIJA, for fiscal years 2022-2024.

C Appendix: Empirical Results

C.1 Empirical Results: State-level

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
			Personal Income, State		
C^g	1.013	2.253***	2.579***	2.702**	2.783**
	(0.723)	(0.805)	(0.861)	(1.114)	(1.064)
X^g	-0.343	0.069	0.285	0.925	0.635
	(0.250)	(0.413)	(0.351)	(0.784)	(0.533)
Test $\beta_h^c = \beta_h^x$	0.112	0.054	0.049	0.342	0.174
LM Stat	14.852	37.862	27.402	33.987	27.544
LM Stat CV	13.876	12.806	13.043	11.478	12.303
			Labor Income, State		
C^g	0.572	1.513***	1.827***	2.027***	2.018***
	(0.370)	(0.407)	(0.406)	(0.491)	(0.544)
X^g	-0.109	-0.003	0.030	0.178	0.092
	(0.093)	(0.247)	(0.217)	(0.394)	(0.311)
Test $\beta_h^c = \beta_h^x$	0.107	0.015	0.003	0.030	0.018
LM Stat	14.852	37.862	27.402	33.987	27.544
LM Stat CV	13.878	12.807	13.047	11.483	12.303
			Capital Income, State		
C^g	0.043	0.254	0.352	0.293	0.329*
	(0.180)	(0.258)	(0.248)	(0.212)	(0.167)
X^g	-0.080	0.135	0.144*	0.375*	0.265**
	(0.084)	(0.136)	(0.072)	(0.187)	(0.097)
Test $\beta_h^c = \beta_h^x$	0.566	0.731	0.466	0.806	0.757
LM Stat	14.852	37.862	27.402	33.987	27.544
LM Stat CV	13.891	12.805	13.076	11.491	12.351
			Employment, State		
C^g	0.342	0.646*	0.778*	0.922*	0.971*
	(0.390)	(0.328)	(0.411)	(0.496)	(0.475)
X^g	-0.037	0.116	0.040	0.113	0.029
	(0.103)	(0.239)	(0.208)	(0.361)	(0.316)
Test $\beta_h^c = \beta_h^x$	0.417	0.295	0.183	0.303	0.179
LM Stat	14.852	37.862	27.402	33.987	27.544
LM Stat CV	13.876	12.825	13.065	11.487	12.303
Obs	1,700	1,650	1,600	1,550	1,500

Table 10: State-level regional government consumption and investment multipliers, for various dependent variables. Each column stands for estimates of β_h^X and β_h^C, or h-year regional fiscal multipliers for C^g (government consumption) and X^g (government investment). Balanced panel consists of observations of 50 states (excluding the District of Columbia), from 1989 to 2023. Instruments are computed as stated in Section 3, over the same period. Panel 2SLS regressions, including year and state fixed effects, and Driscoll-Kraay standard errors. Standard errors are in parentheses. *, **, and *** represent the 10%, 5%, and 1% significance levels, respectively. See Section 4.2 in the main text for the description on weak identification tests from Lewis and Mertens (2022). Lewis-Mertens critical values are computed at a confidence level of 95% and Nagar's relative bias threshold of 30%.

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
	Personal Income, State, Cumulative				
C^g	1.013	1.709	2.036*	2.373*	2.550**
	(0.723)	(0.842)	(0.911)	(0.940)	(0.870)
X^g	-0.343	-0.271	-0.302	-0.422	-0.472
	(0.250)	(0.371)	(0.325)	(0.365)	(0.353)
Test $\beta_h^c = \beta_h^x$	0.112	0.073	0.044	0.021	0.007
LM Stat	14.852	17.293	12.837	14.516	12.786
LM Stat CV	13.876	13.354	13.945	14.163	14.587
	Labor Income, State, Cumulative				
C^g	0.572	1.240*	1.499**	1.742***	1.871***
	(0.370)	(0.459)	(0.450)	(0.459)	(0.464)
X^g	-0.109	-0.097	-0.127	-0.167	-0.207
	(0.093)	(0.181)	(0.175)	(0.226)	(0.219)
Test $\beta_h^c = \beta_h^x$	0.107	0.028	0.008	0.005	0.002
LM Stat	14.852	17.293	12.837	14.516	12.786
LM Stat CV	13.878	13.353	13.945	14.165	14.589
	Capital Income, State, Cumulative				
C^g	0.043	0.135	0.225	0.278	0.367
	(0.180)	(0.229)	(0.226)	(0.219)	(0.200)
X^g	-0.080	-0.022	-0.042	-0.065	-0.081
	(0.084)	(0.134)	(0.115)	(0.138)	(0.138)
Test $\beta_h^c = \beta_h^x$	0.566	0.612	0.373	0.262	0.124
LM Stat	14.852	17.293	12.837	14.516	12.786
LM Stat CV	13.891	13.386	13.949	14.166	14.587
	Employment, State, Cumulative				
C^g	0.342	0.880	1.205**	1.515**	1.655***
	(0.390)	(0.441)	(0.437)	(0.478)	(0.450)
X^g	-0.037	-0.081	-0.146	-0.207	-0.226
	(0.103)	(0.163)	(0.189)	(0.272)	(0.276)
Test $\beta_h^c = \beta_h^x$	0.417	0.086	0.020	0.012	0.005
LM Stat	14.852	17.293	12.837	14.516	12.786
LM Stat CV	13.876	13.364	13.957	14.172	14.589
Obs.	1,700	1,650	1,600	1,550	1,500

Table 11: *Cumulative* state-level regional government consumption and investment multipliers, for various dependent variables. Description is otherwise identical to that in Table 10.

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
	Personal Income, State, Spillovers				
C^g	0.065	0.114	0.141**	0.106	0.085
	(0.048)	(0.092)	(0.062)	(0.105)	(0.066)
X^g	-0.043	0.036	-0.019	0.035	-0.003
	(0.040)	(0.149)	(0.054)	(0.197)	(0.076)
Test $\beta_h^c = \beta_h^x$	0.128	0.737	0.150	0.807	0.455
	Labor Income, State, Spillovers				
C^g	0.037	0.078	0.084**	0.034	0.060
	(0.033)	(0.049)	(0.039)	(0.050)	(0.042)
X^g	0.009	0.014	0.023	0.124	0.061
	(0.012)	(0.070)	(0.035)	(0.104)	(0.046)
Test $\beta_h^c = \beta_h^x$	0.497	0.571	0.327	0.511	0.987
	Capital Income, State, Spillovers				
C^g	0.029	0.099	0.235**	0.243	0.144*
	(0.049)	(0.125)	(0.091)	(0.150)	(0.079)
X^g	-0.072	0.024	-0.103	-0.125	-0.098
	(0.053)	(0.251)	(0.098)	(0.274)	(0.122)
Test $\beta_h^c = \beta_h^x$	0.255	0.837	0.067	0.382	0.176
	Employment, State, Spillovers				
C^g	0.024	0.036	0.030	-0.093	0.006
	(0.037)	(0.056)	(0.043)	(0.074)	(0.051)
X^g	0.020	0.084	0.054	0.280**	0.078
	(0.019)	(0.079)	(0.044)	(0.137)	(0.057)
Test $\beta_h^c = \beta_h^x$	0.935	0.669	0.718	0.039	0.403
Obs	1,700	1,650	1,600	1,550	1,500

Table 12: State-level government consumption and investment fiscal spillovers, for various dependent variables. Description is otherwise identical to that in Table 10.

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
	Personal Income, State, Cumulative Spillovers				
C^g	0.065	0.102*	0.123**	0.127**	0.114*
	(0.048)	(0.060)	(0.056)	(0.060)	(0.059)
X^g	-0.043	-0.017	-0.017	-0.015	-0.008
	(0.040)	(0.067)	(0.059)	(0.073)	(0.069)
Test $\beta_h^c = \beta_h^x$	0.128	0.310	0.201	0.265	0.309
	Labor Income, State, Cumulative Spillovers				
C^g	0.037	0.061*	0.074**	0.073**	0.069*
	(0.033)	(0.035)	(0.034)	(0.035)	(0.035)
X^g	0.009	0.009	0.014	0.030	0.039
	(0.012)	(0.026)	(0.029)	(0.036)	(0.036)
Test $\beta_h^c = \beta_h^x$	0.497	0.327	0.270	0.460	0.596
	Capital Income, State, Cumulative Spillovers				
C^g	0.029	0.074	0.146*	0.171**	0.161**
	(0.049)	(0.069)	(0.072)	(0.078)	(0.073)
X^g	-0.072	-0.036	-0.057	-0.069	-0.068
	(0.053)	(0.104)	(0.097)	(0.113)	(0.107)
Test $\beta_h^c = \beta_h^x$	0.255	0.491	0.201	0.190	0.176
	Employment, State, Cumulative Spillovers				
C^g	0.024	0.040	0.041	0.020	0.013
	(0.037)	(0.041)	(0.041)	(0.045)	(0.042)
X^g	0.020	0.041	0.046	0.085*	0.084*
	(0.019)	(0.036)	(0.036)	(0.048)	(0.047)
Test $\beta_h^c = \beta_h^x$	0.935	0.994	0.926	0.340	0.263
KP F-stat	14.085	11.110	9.225	7.507	11.501
Obs	1,700	1,650	1,600	1,550	1,500

Table 13: *Cumulative* state-level government consumption and investment fiscal spillovers, for various dependent variables. Description is otherwise identical to that in Table 10.

C.2 Empirical Results: MSA-level

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
			Personal Income, MSA		
C^g	0.320**	0.527**	0.642***	0.800***	0.881***
	(0.127)	(0.234)	(0.222)	(0.215)	(0.168)
X^g	-0.011	0.020	0.029	0.072**	0.063
	(0.020)	(0.023)	(0.028)	(0.035)	(0.046)
Test $\beta_h^c = \beta_h^x$	0.012	0.046	0.016	0.004	0.000
LM Stat	56.275	61.036	87.557	73.380	103.880
LM Stat CV	28.705	28.886	28.507	28.251	28.219
			Labor Income, MSA		
C^g	0.195***	0.358***	0.448***	0.556***	0.607***
	(0.050)	(0.115)	(0.122)	(0.127)	(0.105)
X^g	0.006	0.020	0.032	0.058**	0.046
	(0.014)	(0.017)	(0.020)	(0.028)	(0.034)
Test $\beta_h^c = \beta_h^x$	0.002	0.011	0.004	0.001	0.000
LM Stat	56.275	61.036	87.557	73.380	103.880
LM Stat CV	28.754	28.884	28.506	28.253	28.222
			Capital Income, MSA		
C^g	0.071*	0.082*	0.111**	0.154***	0.173***
	(0.039)	(0.048)	(0.050)	(0.052)	(0.049)
X^g	0.004	0.009	0.011	0.007	-0.008
	(0.005)	(0.008)	(0.011)	(0.014)	(0.019)
Test $\beta_h^c = \beta_h^x$	0.110	0.153	0.073	0.016	0.003
LM Stat	56.275	61.036	87.557	73.380	103.880
LM Stat CV	28.771	28.868	28.503	28.244	28.206
Obs.	12,104	11,748	11,392	11,036	10,680
			Employment, MSA		
C^g	0.167***	0.322***	0.379***	0.475***	0.531***
	(0.051)	(0.110)	(0.112)	(0.116)	(0.092)
X^g	0.018	0.031	0.062**	0.120***	0.126***
	(0.021)	(0.028)	(0.030)	(0.036)	(0.038)
Test $\beta_h^c = \beta_h^x$	0.008	0.020	0.016	0.009	0.002
LM Stat	54.356	55.212	77.947	72.075	96.354
LM Stat CV	28.787	29.164	28.773	28.365	28.361
Obs.	11,748	11,392	11,036	10,680	10,324

Table 14: MSA-level government consumption and investment multipliers, for various dependent variables. Each column stands for estimates of β_h^C and β_h^X, or h-year impact regional fiscal multipliers by type of government spending (C^g for government consumption, X^g for government investment). Balanced panel consists of observations of 356 MSAs, from 1989 to 2023 (Employment regressions are from 1989 to 2022). Instruments are computed as stated in Section 3, over the same period. All regressions are panel 2SLS regressions, including year and state fixed effects, and Driscoll-Kraay standard errors with 3 lags. Standard errors are in parentheses. *, **, and *** represent the 10%, 5%, and 1% significance levels, respectively. I include Kleibergen-Paap Wald F-statistics for weak identification Tests, and p-values of Wald Tests for equality of coefficients of C^g and X^g.

	$h=0$	$h=1$	$h=2$	$h=3$	$h=4$
	Personal Income, MSA, Cumulative				
C^g	0.331**	0.450***	0.534***	0.608***	0.689***
	(0.126)	(0.163)	(0.134)	(0.130)	(0.137)
X^g	-0.020	0.014	0.031	0.062	0.072*
	(0.025)	(0.033)	(0.033)	(0.038)	(0.036)
Test $\beta_h^c = \beta_h^x$	0.012	0.018	0.001	0.000	0.000
LM Stat	56.275	52.232	43.394	22.185	19.632
LM Stat CV	28.705	28.925	28.547	27.885	27.673
	Labor Income, MSA, Cumulative				
C^g	0.188***	0.284***	0.355***	0.405***	0.454***
	(0.055)	(0.083)	(0.072)	(0.074)	(0.080)
X^g	0.013	0.034	0.047*	0.069***	0.074***
	(0.016)	(0.024)	(0.023)	(0.024)	(0.024)
Test $\beta_h^c = \beta_h^x$	0.011	0.015	0.001	0.000	0.000
LM Stat	56.275	52.232	43.394	22.185	19.632
LM Stat CV	28.754	28.950	28.543	27.877	27.665
	Capital Income, MSA, Cumulative				
C^g	0.071*	0.086*	0.105**	0.140**	0.166**
	(0.041)	(0.043)	(0.048)	(0.054)	(0.061)
X^g	-0.001	0.004	0.005	0.006	0.007
	(0.011)	(0.015)	(0.014)	(0.013)	(0.013)
Test $\beta_h^c = \beta_h^x$	0.128	0.109	0.067	0.027	0.017
LM Stat	56.275	52.232	43.394	22.185	19.632
LM Stat CV	28.771	28.970	28.571	27.878	27.660
	Employment, MSA, Cumulative				
C^g	0.156***	0.245***	0.284***	0.321***	0.378***
	(0.055)	(0.082)	(0.071)	(0.073)	(0.085)
X^g	0.027	0.061*	0.087***	0.119***	0.129***
	(0.023)	(0.033)	(0.030)	(0.030)	(0.030)
Test $\beta_h^c = \beta_h^x$	0.050	0.065	0.020	0.012	0.007
LM Stat	54.356	48.496	42.304	22.227	21.133
LM Stat CV	28.787	29.086	28.576	27.870	27.879
Obs	12,104	11,748	11,392	11,036	10,680

Table 15: MSA-level *cumulative* government consumption and investment multipliers, for various dependent variables. Each column stands for estimates of $\beta^C_{h,cumul}$ and $\beta^X_{h,cumul}$, or h-year cumulative regional fiscal multipliers by type of government spending (C^g for government consumption, X^g for government investment). Balanced panel consists of observations of 356 MSAs, from 1989 to 2023. Instruments are computed as stated in Section 3, over the same period. All regressions are panel 2SLS regressions, including year and state fixed effects, and Driscoll-Kraay standard errors with 3 lags. Standard errors are in parentheses. *, **, and *** represent the 10%, 5%, and 1% significance levels, respectively. I include Kleibergen-Paap Wald F-statistics for weak identification tests, and p-values of coefficients of C^g and X^g.

D Appendix: Theoretical Model

D.1 First Order Conditions

From the household's problem, we have the following first-order conditions:

$$(C_{jt}^h)^{-\frac{1}{\sigma}} = \lambda_{jt} P_{jt}^c \tag{59}$$

$$\phi N_{jt}^{\frac{1-\mu}{\eta}} N_{jt}^{c\,\frac{\mu}{\eta}} = \lambda_{jt} W_{jt}^c \tag{60}$$

$$\phi N_{jt}^{\frac{1-\mu}{\eta}} N_{jt}^{x\,\frac{\mu}{\eta}} = \lambda_{jt} W_{jt}^x \tag{61}$$

$$\lambda_{jt} = \beta(1+i_t)\mathbb{E}_t[\lambda_{t+1}] \tag{62}$$

$$P_{jt}^c = \gamma_{jt}^c \theta'\left(\frac{X_{jt}^c}{K_{jt}^c}\right) \tag{63}$$

$$P_{jt}^x = \gamma_{jt}^x \theta'\left(\frac{X_{jt}^x}{K_{jt}^x}\right) \tag{64}$$

$$\lambda_{jt}\gamma_{jt}^c = \beta\mathbb{E}_t\left[\lambda_{j,t+1}R_{j,t+1}^{k,c} + \lambda_{j,t+1}\gamma_{j,t+1}^c\left\{(1-\delta) + \theta\left(\frac{X_{j,t+1}^c}{K_{j,t+1}^c}\right) - \theta'\left(\frac{X_{j,t+1}^c}{K_{j,t+1}^c}\right)\left(\frac{X_{j,t+1}^c}{K_{j,t+1}^c}\right)\right\}\right] \tag{65}$$

$$\lambda_{jt}\gamma_{jt}^x = \beta\mathbb{E}_t\left[\lambda_{j,t+1}R_{j,t+1}^{k,x} + \lambda_{j,t+1}\gamma_{j,t+1}^x\left\{(1-\delta) + \theta\left(\frac{X_{j,t+1}^x}{K_{j,t+1}^x}\right) - \theta'\left(\frac{X_{j,t+1}^x}{K_{j,t+1}^x}\right)\left(\frac{X_{j,t+1}^x}{K_{j,t+1}^x}\right)\right\}\right] \tag{66}$$

where λ_{jt} is the Lagrangian multiplier for the household's budget constraint, and $\lambda_{jt}\gamma_{jt}^s$ is the Lagrangian multiplier for the sector-s capital accumulation process for $s \in \{c, x\}$.

Combining the households' first order conditions, we get the following:

Euler equation for consumption:

$$(C_{jt}^{hh})^{-\frac{1}{\sigma}} = \beta(1+i_t)\mathbb{E}_t\left[\frac{1}{1+\pi_{j,t+1}^c}(C_{j,t+1}^{hh})^{-\frac{1}{\sigma}}\right] \tag{67}$$

Investment choice:

$$1 = \frac{\gamma_{jt}^c}{P_{jt}^x}\theta'\left(\frac{X_{jt}^c}{K_{jt}^c}\right) \tag{68}$$

$$1 = \frac{\gamma_{jt}^x}{P_{jt}^x}\theta'\left(\frac{X_{jt}^x}{K_{jt}^x}\right) \tag{69}$$

Euler equations for capital:

$$\frac{\gamma^c_{jt}}{P^x_{jt}} = \mathbb{E}_t\left[\left(\frac{1+\pi^x_{j,t+1}}{1+i_t}\right)\left(\frac{R^{k,c}_{j,t+1}}{P^x_{j,t+1}} + \frac{\gamma^c_{j,t+1}}{P^x_{j,t+1}} \times \left\{(1-\delta) + \theta\left(\frac{X^c_{j,t+1}}{K^c_{j,t+1}}\right) - \theta'\left(\frac{X^c_{j,t+1}}{K^c_{j,t+1}}\right)\left(\frac{X^c_{j,t+1}}{K^c_{j,t+1}}\right)\right\}\right)\right] \tag{70}$$

$$\frac{\gamma^x_{jt}}{P^x_{jt}} = \mathbb{E}_t\left[\left(\frac{1+\pi^x_{j,t+1}}{1+i_t}\right)\left(\frac{R^{k,x}_{j,t+1}}{P^x_{j,t+1}} + \frac{\gamma^x_{j,t+1}}{P^x_{j,t+1}} \times \left\{(1-\delta) + \theta\left(\frac{X^x_{j,t+1}}{K^x_{j,t+1}}\right) - \theta'\left(\frac{X^x_{j,t+1}}{K^x_{j,t+1}}\right)\left(\frac{X^x_{j,t+1}}{K^x_{j,t+1}}\right)\right\}\right)\right] \tag{71}$$

Labor supply:

$$\phi(N_{jt})^{\frac{1-\mu}{\eta}}(N^x_{jt})^{\frac{\mu}{\eta}} = (C^{hh}_{jt})^{-\frac{1}{\sigma}}\frac{P^x_{jt}}{P^c_{jt}}\frac{W^x_{jt}}{P^x_{jt}} \tag{72}$$

$$\phi(N_{jt})^{\frac{1-\mu}{\eta}}(N^c_{jt})^{\frac{\mu}{\eta}} = (C^{hh}_{jt})^{-\frac{1}{\sigma}}\frac{W^c_{jt}}{P^x_{jt}} \tag{73}$$

D.2 Log-linearized Model

In steady state, the results from Boehm (2020) hold, in that:

$$s^x_y \equiv \frac{P^x X}{P^x X + P^c C} = \frac{P^x X}{Y} = \frac{\alpha\delta}{(1-s^g_x)(\beta^{-1}-1+\delta)},\ s^c_y = 1 - s^x_y \tag{74}$$

$$s^x_x \equiv \frac{X^x}{X} = \frac{\alpha\delta}{(1-s^g_x)(\beta^{-1}-1+\delta)} \tag{75}$$

$$s^c_x \equiv 1 - s^g_x - \frac{X^x}{X} = 1 - s^g_x - \frac{\alpha\delta}{(1-s^g_x)(\beta^{-1}-1+\delta)} \tag{76}$$

All log deviations of variables are in lower-case, tilde variables. Unless region subscripts are specified, all log-linearized equations hold for both regions $i \in \{H, F\}$.

Labor supply:

$$\frac{1-\mu}{\eta}\tilde{n}_{jt} + \frac{\mu}{\eta}\tilde{n}^x_{jt} = -\frac{1}{\sigma}\tilde{c}^{hh}_{jt} + \left(\widetilde{\frac{p^x_{jt}}{p^c_{jt}}}\right) + \left(\widetilde{\frac{w^x_{jt}}{p^x_{jt}}}\right) \tag{77}$$

$$\frac{1-\mu}{\eta}\tilde{n}_{jt} + \frac{\mu}{\eta}\tilde{n}^c_{jt} = -\frac{1}{\sigma}\tilde{c}^{hh}_{jt} + \left(\widetilde{\frac{w^c_{jt}}{p^c_{jt}}}\right) \tag{78}$$

Home Euler equation for consumption:

$$-\frac{1}{\sigma}\tilde{c}^{hh}_{Ht} = (i_t - \mathbb{E}_t\pi^c_{H,t+1}) - \frac{1}{\sigma}\mathbb{E}_t\tilde{c}^{hh}_{H,t+1} \tag{79}$$

Inter-regional risk sharing:

$$-\frac{1}{\sigma}(\tilde{c}^{hh}_{Ft} - \tilde{c}^{hh}_{F,t-1}) + \frac{1}{\sigma}(\tilde{c}^{hh}_{Ht} - \tilde{c}^{hh}_{H,t-1}) = \pi^c_{Ft} - \pi^c_{Ht} \tag{80}$$

Tradable goods:

$$(\tilde{c}^H_{Ht} - \tilde{c}^H_{H,t-1}) = (\tilde{c}^{hh}_{Ht} - \tilde{c}^{hh}_{H,t-1}) - \nu(\pi^{c,H}_{Ht} - \pi^c_{Ht}) \tag{81}$$

$$(\tilde{c}^F_{Ht} - \tilde{c}^F_{H,t-1}) = (\tilde{c}^{hh}_{Ht} - \tilde{c}^{hh}_{H,t-1}) - \nu(\pi^{c,F}_{Ht} - \pi^c_{Ht}) \tag{82}$$

$$(\tilde{c}^F_{Ft} - \tilde{c}^F_{F,t-1}) = (\tilde{c}^{hh}_{Ft} - \tilde{c}^{hh}_{F,t-1}) - \nu(\pi^{c,F}_{Ft} - \pi^c_{Ft}) \tag{83}$$

$$(\tilde{c}^H_{Ft} - \tilde{c}^H_{F,t-1}) = (\tilde{c}^{hh}_{Ft} - \tilde{c}^{hh}_{F,t-1}) - \nu(\pi^{c,H}_{Ft} - \pi^c_{Ft}) \tag{84}$$

Relative prices:

$$\pi^c_{Ht} = \chi^H_H \pi^{c,H}_{Ht} + \chi^F_H \pi^{c,F}_{Ht} \tag{85}$$

$$\pi^c_{Ft} = \chi^F_F \pi^{c,F}_{Ft} + \chi^H_F \pi^{c,H}_{Ft} \tag{86}$$

$$\pi^{c,H}_{Ht} = \pi^{c,H}_{Ft} \tag{87}$$

$$\pi^{c,F}_{Ft} = \pi^{c,F}_{Ht} \tag{88}$$

Regional consumption:

$$\tilde{c}_{jt} = (1 - s^g_c)\tilde{c}^{hh}_{jt} + s^g_c \tilde{c}^g_{jt},\ j \in \{H, F\} \tag{89}$$

$$\tilde{c}^{hh}_{jt} = \chi^H_j \tilde{c}^H_{jt} + \chi^F_j \tilde{c}^F_{jt},\ j \in \{H, F\} \tag{90}$$

Regional investment:

$$\tilde{x}_{jt} = s^c_x \tilde{x}^c_{jt} + s^x_x \tilde{x}^x_{jt} + s^g_x \tilde{x}^g_{jt},\ j \in \{H, F\} \tag{91}$$

Labor aggregator:

$$\tilde{n}_{jt} = s^c_y \tilde{n}^c_{jt} + s^x_y \tilde{n}^x_{jt} \tag{92}$$

Investment choice:

$$\left(\widetilde{\frac{\gamma^s_{jt}}{p^s_{jt}}}\right) = \zeta\delta(x^s_{jt} - k^s_{jt}),\ s \in \{c, x\} \tag{93}$$

$$\tag{94}$$

Euler equation for capital:

$$\left(\widetilde{\frac{\gamma^x_{jt}}{p^x_{jt}}}\right) + (\mathbb{E}_t r^x_{j,t+1} - r^x_{i,t}) = \mathbb{E}_t\left[(1-\beta(1-\delta))\left(\widetilde{\frac{r^x_{jt}}{p^x_{jt}}}\right) + \beta(1-\delta)\left(\widetilde{\frac{\gamma^x_{jt}}{p^x_{jt}}}\right) + \beta\zeta_\delta^2(\tilde{x}^x_{j,t+1} - \tilde{k}^x_{j,t+1})\right] \tag{95}$$

$$\left(\widetilde{\frac{\gamma^c_{jt}}{p^c_{jt}}}\right) + (\mathbb{E}_t r^x_{j,t+1} - r^x_{i,t}) = \mathbb{E}_t\left[(1-\beta(1-\delta))\left(\widetilde{\frac{r^c_{jt}}{p^c_{jt}}}\right) + \beta(1-\delta)\left(\widetilde{\frac{\gamma^c_{jt}}{p^c_{jt}}}\right) + \beta\zeta_\delta^2(\tilde{c}^c_{j,t+1} - \tilde{k}^c_{j,t+1})\right] \tag{96}$$

Sectoral capital accumulation:

$$\tilde{k}^s_{j,t+1} = (1-\delta)\tilde{k}^s_{i,t} + \delta\tilde{x}^s_{jt},\ s \in \{c,x\} \tag{97}$$

$$\tilde{k}^g_{j,t+1} = (1-\delta)\tilde{k}^g_{i,t} + \delta\tilde{x}^g_{jt} \tag{98}$$

Factor demands:

$$\left(\widetilde{\frac{w^s_{jt}}{p^s_{jt}}}\right) = \alpha_g\tilde{k}^g_{jt} + \alpha\tilde{k}^s_{jt} - \alpha\tilde{n}^s_{jt} + \left(\widetilde{\frac{mc^s_{jt}}{p^s_{jt}}}\right),\ s \in \{c,x\},\ j \in \{H,F\} \tag{99}$$

$$\left(\widetilde{\frac{r^s_{jt}}{p^s_{jt}}}\right) = \alpha_g\tilde{k}^g_{jt} - (1-\alpha)\tilde{k}^s_{jt} + (1-\alpha)\tilde{n}^s_{jt} + \left(\widetilde{\frac{mc^s_{jt}}{p^s_{jt}}}\right),\ s \in \{c,x\},\ j \in \{H,F\} \tag{100}$$

Production functions:

$$\omega_H\left(\alpha_g\tilde{k}^g_{Ht} + \alpha\tilde{k}^c_{Ht} + (1-\alpha)\tilde{n}^c_{Ht}\right) = \omega_H s^g_c\tilde{c}^g_{Ht} + \omega_H(1-s^g_c)\chi^H_H\tilde{c}^H_{Ht} + \omega_F(1-s^g_c)\chi^H_F\tilde{c}^H_{Ft} \tag{101}$$

$$\omega_F\left(\alpha_g\tilde{k}^g_{Ft} + \alpha\tilde{k}^c_{Ft} + (1-\alpha)\tilde{n}^c_{Ft}\right) = \omega_F s^g_c\tilde{c}^g_{Ft} + \omega_F(1-s^g_c)\chi^F_F\tilde{c}^F_{Ft} + \omega_H(1-s^g_c)\chi^F_H\tilde{c}^F_{Ht} \tag{102}$$

$$\alpha_g\tilde{k}^g_{Ht} + \alpha\tilde{k}^x_{Ht} + (1-\alpha)\tilde{n}^x_{Ht} = s^g_x\tilde{x}^g_{Ht} + s^c_x\tilde{x}^{c,H}_{Ht} + s^x_x\tilde{x}^{x,H}_{Ht} \tag{103}$$

$$\alpha_g\tilde{k}^g_{Ft} + \alpha\tilde{k}^x_{Ft} + (1-\alpha)\tilde{n}^x_{Ft} = s^g_x\tilde{x}^g_{Ft} + s^c_x\tilde{x}^{c,F}_{Ft} + s^x_x\tilde{x}^{x,F}_{Ft} \tag{104}$$

Sectoral Phillips curves ($\widetilde{mc}^s_{jt}$ is the percentage deviation from the steady state value of MC^s_{jt}, after a linear approximation):

$$\pi^s_{jt} = \frac{(1-\theta_s)(1-\theta_s\beta)}{\theta_s}\frac{\widetilde{mc}^s_{jt}}{p^s_{jt}} + \beta\mathbb{E}_t[\pi^s_{j,t+1}],\ s \in \{c,x\} \tag{105}$$

(106)

(107)

Fisher equations:

$$i_t = r^{k,s}_{jt} + \mathbb{E}_t\pi^s_{j,t+1},\ s \in \{c,x\} \tag{108}$$

Aggregation conditions:

$$\tilde{s}_t = \omega_H \tilde{s}_{Ht} + \omega_F \tilde{s}_{Ft},\ s \in \{c, x\} \tag{109}$$

$$(s_c^g s_y^c + s_x^g s_y^x)\tilde{g}_{jt} = s_x^g s_y^x \tilde{x}_{jt}^g + s_c^g s_y^c \tilde{c}_{jt}^g \tag{110}$$

$$\tilde{g}_t = \omega_H \tilde{g}_{Ht} + \omega_F \tilde{g}_{Ft} \tag{111}$$

$$\tilde{y}_{jt} = s_y^x \tilde{x}_{jt} + s_y^c \tilde{c}_{jt} \tag{112}$$

$$\tilde{y}_t = \omega_H \tilde{y}_{Ht} + \omega_F \tilde{y}_{Ft} \tag{113}$$

Price indices:

$$\pi_{jt} = s_y^x \pi_{jt}^x + s_y^c \pi_{jt}^c,\ j \in \{H, F\} \tag{114}$$

$$\pi_t^s = \omega_H \pi_{Ht}^s + \omega_F \pi_{Ft}^s,\ s \in \{c, x\} \tag{115}$$

$$\pi_t = \omega_H \pi_{Ht} + \omega_F \pi_{Ft} \tag{116}$$

Aggregate monetary policy:

$$i_t = \phi_\pi \pi_t + \phi_y y_t \tag{117}$$

Aggregate fiscal policy:

$$\tilde{t}_t = \omega_H \tilde{t}_{Ht} + \omega_F \tilde{t}_{Ft} \tag{118}$$

$$(s_c^g s_y^c + s_x^g s_y^x)(\tilde{t}_{Ht} - \tilde{t}_{H,t-1}) = s_y^c s_c^g (\pi_{Ht}^c + c_{Ht}^g - c_{H,t-1}^g) + s_y^x s_x^g (\pi_{Ht}^x + \tilde{x}_{Ht}^g - \tilde{x}_{H,t-1}^g) \tag{119}$$

$$(s_c^g s_y^c + s_x^g s_y^x)(\tilde{g}_{F,t} - \tilde{g}_{F,t-1}) = s_c^g s_y^c (\pi_{Ft}^c + c_{Ft}^g - c_{F,t-1}^g) + s_x^g s_y^x (\pi_{Ft}^x + \tilde{x}_{Ft}^g - \tilde{x}_{F,t-1}^g) \tag{120}$$

AR(1) government spending shock processes:

$$\tilde{x}_{jt}^g = \rho_x^g \tilde{x}_{j,t-1}^g + \varepsilon_{x,it}^g \tag{121}$$

$$\tilde{c}_{jt}^g = \rho_c^g \tilde{c}_{j,t-1}^g + \varepsilon_{c,it}^g \tag{122}$$

E Appendix: A General Framework for Aggregating Regional Fiscal Multipliers

Here, I provide a framework for aggregating regional fiscal multipliers. For government consumption and investment respectively, there are three categories of multipliers to measure, in response to regional government spending shocks in region j, $\epsilon_{jt}^{s,g}$ where $s \in \{c, x\}$:

1. $\beta_{reg}^{j,s}$: Change in state j's personal income Y_{jt} due to a regional government spending shock in sector s of region j
2. $\beta_{spillover}^{j,s}$: Spillover effects to personal income Y_{it} of state $i \neq j$, i.e., changes in state i's personal income due to $\epsilon_{jt}^{s,g}$
3. $\beta_{agg}^{j,s}$: Total change in national personal income Y_t from the set of all regional government spending shocks $\{\epsilon_{jt}^{s,g}\}$ across all regions $j \in \mathcal{J}$

The three types of multipliers are related as follows:

$$\beta_{agg}^{j,s} = \omega_j \beta_{reg}^{j,s} + \sum_{i \neq j} \omega_i \beta_{spillover}^{j,s}, \tag{123}$$

where ω_j is state j's share of national income (GDP).

Calibrating the model and assuming that all state-level IIJA government spending as regional government spending shocks, I can compute all three types of fiscal multipliers for both government consumption and investment. First, I provide a more general framework of thinking about region-specific regional fiscal multipliers, fiscal spillovers, and aggregate fiscal multipliers in a multiregion ($\mathcal{J} > 2$ regions) monetary union model.

I begin with an example in the case with only one sector in government spending, two regions, and a Home government spending ($G_{H,t}$) shock. The response of Home regional income(output) to the shock is the regional fiscal multiplier, while the response of Foreign regional income is the fiscal spillover from the Home to the Foreign region. In general, let us denote the h-year response of region-i income to a region-j government spending shock as $\beta_{i,h}^{j}$. Under this notation, the Home response from a Home government spending shock is $\beta_{j,h}^{j}$, and the fiscal spillovers to region i as $\beta_{i,h}^{j}$. In a monetary union with only two regions (Home and Foreign), we can denote $\beta_{H,h}^{H}$ and $\beta_{F,h}^{H}$ as the Home and Foreign income responses to Home government spending shocks (normalized to Home income):[20]

$$\frac{Y_{H,t+h} - Y_{H,t-1}}{Y_{H,t-1}} = \beta_{H,h}^{H} \frac{G_{H,t+h} - G_{H,t-1}}{Y_{H,t-1}} \tag{124}$$

$$\frac{Y_{F,t+h} - Y_{F,t-1}}{Y_{F,t-1}} = \beta_{F,h}^{H} \frac{G_{H,t+h} - G_{H,t-1}}{Y_{H,t-1}} \tag{125}$$

[20] For purposes of illustration, I omit the time and region fixed effects in the equations of this section.

Furthermore, let us denote the h-year response of *aggregate* income to the region-j government spending shock as $\beta^j_{agg,h}$, the aggregate fiscal multiplier. In that case, we can decompose $\beta^H_{agg,h}$ into a linear combination of $\beta^H_{H,h}$ and $\beta^H_{F,h}$ as follows:

$$\frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}} = \beta^H_{agg,h} \frac{G_{H,t+h} - G_{H,t-1}}{Y_{H,t-1}} \tag{126}$$

$$\begin{aligned}
\frac{Y_{t+h} - Y_{t-1}}{Y_{t-1}} &= \frac{(Y_{H,t+h} + Y_{F,t+h}) - (Y_{H,t-1} + Y_{F,t-1})}{Y_{t-1}} \\
&= \left(\frac{Y_{H,t-1}}{Y_{t-1}}\right)\left(\frac{Y_{H,t+h} - Y_{H,t-1}}{Y_{H,t-1}}\right) + \left(\frac{Y_{F,t-1}}{Y_{t-1}}\right)\left(\frac{Y_{F,t+h} - Y_{F,t-1}}{Y_{F,t-1}}\right) \\
&\approx \omega_H \left(\frac{Y_{H,t+h} - Y_{H,t-1}}{Y_{H,t-1}}\right) + \omega_F \left(\frac{Y_{F,t+h} - Y_{F,t-1}}{Y_{F,t-1}}\right) \\
&= \omega_H \left(\beta^H_{H,h} \frac{G_{H,t+h} - G_{H,t-1}}{Y_{H,t-1}}\right) + \omega_F \left(\beta^H_{F,h} \frac{G_{H,t+h} - G_{H,t-1}}{Y_{H,t-1}}\right)
\end{aligned} \tag{127}$$

$$\text{or } \beta^H_{agg,h} \approx \omega_H \beta^H_{H,h} + \omega_F \beta^H_{F,h} \tag{128}$$

where the approximation $Y_{j,t-1}/Y_{t-1} \approx \omega_j$ for $j \in \{H, F\}$ comes from the assumption that, in steady state, the ratio of region-j income $Y_{j,t-1}$ to aggregate income Y_{t-1} is equal to $\bar{Y}_j/\bar{Y} = \omega_j$.

This is easily extended into the context of a J-region monetary union with $J > 2$. $\beta^j_{spill,h}$, the *average* fiscal spillovers of a region-j government spending shock to the rest of the monetary union (all $i \neq j$) can be denoted as:

$$\begin{aligned}
\beta^j_{agg,h} &= \omega_j \beta^j_{j,h} + \sum_{i \neq j} \omega_i \beta^j_{i,h} \\
&= \omega_j \beta^j_{j,h} + (1 - \omega_j) \beta^j_{spill,h}
\end{aligned} \tag{129}$$

$$\text{or } \beta^j_{spill,h} = \frac{1}{1 - \omega_j} \sum_{i \neq j} \omega_i \beta^j_{i,h} \tag{130}$$

Now I extend this framework to a 2-sector, J-region monetary union model, with the region-i income response of a region-j, sector-s government spending shock denoted as $\beta^{j,s}_{i,h}$ (with an additional superscript s). Similar as before, the relationship between regional fiscal multipliers, fiscal spillovers, and aggregate fiscal multipliers of a region-j, sector-s government spending shock are derived into the following expressions:

$$\beta^{j,agg}_{i,h} \approx s^c_y \beta^{j,c}_{i,h} + s^x_y \beta^{j,x}_{i,h} \tag{131}$$

$$\beta^{j,agg}_{agg,h} \approx s^c_y \sum_{i \in \mathcal{J}} \omega_i \beta^{j,c}_{i,h} + s^x_y \sum_{i \in \mathcal{J}} \omega_i \beta^{j,x}_{i,h} \tag{132}$$

where $\beta^{j,agg}_{i,h}$ (with a *super*script *agg*) is the aggregate effect across *sectors* of region-j government spending shocks on region-i incomes, and $\beta^{j,s}_{agg,h}$ (with a **sub**script *agg*) is the aggregate effect of region-j, sector-s

government spending shocks on aggregate income, i.e. across all **regions** $\mathcal{J}$. Consistent with the notation above, we can define the sector-s regional fiscal multipliers $\beta^{j,s}_{reg,h}$, fiscal spillovers, and aggregate fiscal multipliers as such:

$$\beta^{j,s}_{reg,h} \equiv \beta^{j,s}_{j,h} \tag{133}$$

$$\beta^{j,s}_{spill,h} \equiv \frac{1}{1-\omega_j} \sum_{i \neq j} \omega_i \beta^{j,s}_{i,h} \tag{134}$$

$$\beta^{j,s}_{agg,h} = \sum_{i \in \mathcal{J}} \omega_j \beta^{j,s}_{i,h} = \omega_j \beta^{j,s}_{reg,h} + (1-\omega_j)\beta^{j,s}_{spill,h}, \tag{135}$$

thus demonstrating the relationship at the beginning of this section.

Notice that all these are the responses of variables from government spending shocks only from region j. In policy terms, we are interested in the aggregate fiscal multiplier as the response of the aggregate of regional incomes to the aggregate of the regional government spending shocks. To complete that analysis, we first need to take a weighted average of all sector-s, region-j government spending shocks across sectors $s \in \{c, x\}$ and regions $j \in \mathcal{J}$, and denote the aggregate fiscal multiplier from the aggregate of sector-s government spending shocks across all regions $j \in \mathcal{J}$ as $\beta^{agg,s}_{agg,h}$. We can then define $\beta^{agg,s}_{agg,h}$ as:

$$\beta^{agg,s}_{agg,h} \approx \sum_{j \in \mathcal{J}} \omega_j \beta^{j,s}_{agg,h} = \sum_{j \in \mathcal{J}} \omega_j \left[\omega_j \beta^{j,s}_{reg,h} + (1-\omega_j)\beta^{j,s}_{spill,h} \right] \tag{136}$$

Finally, the aggregate fiscal multiplier $\beta^{agg}_{agg,h}$, i.e. the response of aggregate income to the aggregation of all sector-s, region-j government spending shocks, can be simply approximated as:

$$\beta^{agg}_{agg,h} \approx s^c_y \beta^{agg,c}_{agg,h} + s^x_y \beta^{agg,x}_{agg,h} \tag{137}$$

In a multiregion model with J symmetric regions, we would predict that $\beta^{j,s}_{i,h} = \beta^{j',s}_{i',h}$ for all $i, i', j, j' \in \mathcal{J}$. However, this condition need not hold in an asymmetric model where some regions' households import or export more consumption goods from other regions due to different steady-state CES shares in their regional CES aggregator of consumption goods Norris (2019). These asymmetries, which determine interstate trade flows of goods, will determine the multiplier effect of regional government consumption and investment, as well as fiscal spillovers to other states.

F Appendix: Description of Quantitative Model

There are $J = 51$ regions in the monetary and fiscal union $\mathcal{J} = \{1, 2, \ldots, 51\}$.[21] As in the theoretical model, each region has its own sectoral labor supply N^c_{jt} and N^x_{jt}, sectoral capital K^c_{jt} and K^x_{jt}, and public capital K^g_{jt}. I assume no movement of labor or capital across regions. Using these inputs, each region produces its consumption goods C_{jt} and investment goods X_{jt}. The steady-state population share of each region j is denoted as $\omega_j \in [0, 1]$, where:

$$\sum_{j \in \mathcal{J}} \omega_i = 1$$

Consumption Equations: Consumption goods can be traded across regions. In this model, I denote C^i_{jt} as the flow of consumption goods produced in region $i \in \mathcal{J}$ and consumed in region j.[22] I also denote the steady-state share of household consumption in region j that are produced in region i as $\chi^i_j \in [0, 1]$, where:

$$\sum_{i \in \mathcal{J}} \chi^i_j = 1 \; \forall j$$

The representative household in region j purchases household consumption C^{hh}_{jt} as a CES aggregate of household consumption goods $C^{hh,i}_{jt}$ produced in regions $i \in \mathcal{J}$, or:

$$C^{hh}_{jt} = \left[\sum_{i \in \mathcal{J}} (\chi^i_j)^{\frac{1}{\nu}} (C^{hh,i}_{jt})^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}} \tag{138}$$

where $\nu > 1$ is the elasticity of substitution between different varieties of consumption goods. National (aggregate) household consumption is given as:

$$C^{hh}_t = \sum_{j \in \mathcal{J}} \omega_j C^{hh}_{jt} \tag{139}$$

The relative demand of $C^{hh,i}_{jt}$ is given as follows:

$$C^{hh,i}_{jt} = \chi^i_j C^{hh}_{jt} \left(\frac{P^{c,i}_{jt}}{P^c_{jt}} \right)^{-\nu} \tag{140}$$

where $P^{c,i}_{jt}$ is the price index of consumption good C^i_{jt}.

Region-j total consumption C_{jt} is given as a CES aggregate of C^{hh}_{jt} and C^g_{jt}:

$$C_{jt} = \left[(1 - \omega^g_c)^{\frac{1}{\nu}} (C^{hh}_{jt})^{\frac{\nu-1}{\nu}} + \omega^g_c (C^g_{jt})^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}} \tag{141}$$

[21] Alternatively, we can denote each $j \in \mathcal{J}$ as the state's FIPS code. This makes no material difference to the model.

[22] In this model, all variables associated with an origin region i and a destination region j will be denoted with i as the *super*script and j as the *sub*script.

and national total consumption C_t is given as the sum of regional consumption C_{jt}:

$$C_t = \sum_{j \in \mathcal{J}} C_{jt} \tag{142}$$

The region-j price index of consumption goods, P^c_{jt}, is then given as a CES aggregator of $P^{c,i}_{j,t}$ (denoting the price of consumption goods produced in regoin i and consumed in region j):

$$P^c_{jt} = \left[\sum_{i \in \mathcal{J}} \chi^i_j (P^{c,i}_{jt})^{1-\nu} \right]^{\frac{1}{1-\nu}} \tag{143}$$

Finally, the national price index of consumption goods, P^c_t is given as a weighted average of P^c_{jt}:

$$P^c_t = \sum_{j \in \mathcal{J}} \omega_j P^c_{jt} \tag{144}$$

Labor Supply: Regional and aggregate labor supplies are defined from region/sector-specific labor supplies, similar to in the theoretical model:

$$N_{jt} = \left[(N^c_{jt})^{\frac{\eta+\mu}{\eta}} + (N^x_{jt})^{\frac{\eta+\mu}{\eta}} \right]^{\frac{\eta}{\eta+\mu}} \tag{145}$$

$$N_t = \sum_{j \in \mathcal{J}} N_{jt} \tag{146}$$

Firms: Again, a monopolistically competitive intermediate-goods firm of variety $l \in [0,1]$ in region i and sector $s \in \{c, x\}$ satisfies the total sectoral demand for its goods, both government and private, across all regions $j \in \mathcal{J}$.

$$C^g_{jt}(l) + \sum_{j \in \mathcal{J}} C^j_{it}(l) = (K^g_{it})^{\alpha_g} (K^c_{it}(l))^{\alpha} (N^c_{it}(l))^{1-\alpha} \tag{147}$$

$$X^c_{jt}(l) + X^x_{jt}(l) + X^g_{jt}(l) = (K^g_{it})^{\alpha_g} (K^x_{it}(l))^{\alpha} (N^x_{it}(l))^{1-\alpha} \tag{148}$$

The region-j, sector-s marginal cost is derived as such:

$$MC^s_{jt} = \frac{1}{(K^g_{it})^{\alpha_g}} \left(\frac{R^s_{k,it}}{\alpha} \right)^{\alpha} \left(\frac{W^s_{it}}{1-\alpha} \right)^{1-\alpha}, \; s \in \{c, x\} \tag{149}$$

and the region-j, sector-s factor demands are given as follows:

$$\frac{W_{it}^s}{P_{it}^s} = \frac{MC_{it}^s}{P_{it}^s} \frac{1}{(K_{it}^g)^{\alpha_g}} (1-\alpha)(K_{it}^c(l))^{\alpha} (N_{it}^c(l))^{-\alpha} \tag{150}$$

$$\frac{R_{k,it}^s}{P_{it}^s} = \frac{MC_{it}^s}{P_{it}^s} \frac{1}{(K_{it}^g)^{\alpha_g}} \alpha (K_{it}^c(l))^{\alpha-1} (N_{it}^c(l))^{1-\alpha} \tag{151}$$

The region-j, sector-s output in is the aggregate across all outputs of the corresponding intermediate-goods firms l:

$$S_{it} = \left[\int_0^1 S_{it}(l)^{\frac{\epsilon-1}{\epsilon}} dl \right]^{\frac{\epsilon}{\epsilon-1}} \tag{152}$$

Capital accumulation is defined analogously to the theoretical model:

$$K_{i,t+1}^s = (1-\delta) K_{it}^s + \vartheta \left(\frac{X_{it}^s}{k_{it}^s} \right) K_{it}^s \tag{153}$$

Government: The federal government collects (nominal) lump-sum taxes across all regions in the monetary union, and with a balanced budget, allocates (nominal) government spending across all regions:

$$T_t = \sum_{j \in \mathcal{J}} T_{jt} \tag{154}$$

$$G_t = \sum_{j \in \mathcal{J}} (P_{jt}^c C_{jt}^g + P_{jt}^x X_{jt}^g) \tag{155}$$

$$T_t = G_t \tag{156}$$

Finally, the central bank sets the nominal interest rate i_t via a Taylor rule given the aggregate inflation rate π_t and the aggregate output gap $\tilde{y}_t$, as such:

$$i_t = (\beta^{-1} - 1) + \phi_\pi \pi_t + \phi_y \tilde{y}_t \tag{157}$$

where $\phi_\pi > 1$ via the Taylor principle and $\phi_y > 0$.

F.1 Linearization of Quantitative Model [TO BE FINISHED]

All equations hold for all $j \in \mathcal{J}$, unless stated otherwise.

Consumption Equations

$$\tilde{c}^{hh}_{jt} = \sum_{i \in \mathcal{J}} \chi^i_j \tilde{c}^i_{jt} \tag{158}$$

$$\tilde{c}^{g}_{jt} = \sum_{i \in \mathcal{J}} \chi^i_j \tilde{c}^{g,i}_{jt} \tag{159}$$

$$\tilde{c}_{jt} = s^g_c c^g_{jt} + (1 - s^g_c) c^{hh}_{jt} \tag{160}$$

$$\tilde{c}^{hh}_{t} = \sum_{j \in \mathcal{J}} \omega_j \tilde{c}_{jt} \tag{161}$$

$$\tilde{p}^{c}_{jt} = \sum_{i \in \mathcal{J}} \chi^i_j \tilde{p}^{c,i}_{jt} \tag{162}$$

$$\tilde{p}^{c}_{t} = \sum_{j \in \mathcal{J}} \omega_j \tilde{p}^{c}_{jt} \tag{163}$$

Labor Supply

$$n_{jt} = \omega^c_y n^c_{jt} + \omega^x_y n^x_{jt} \tag{164}$$

$$n_t = \sum_{j \in \mathcal{J}} \omega_j \tilde{n}_{jt} \tag{165}$$

Production functions:

$$\omega_j(\alpha_g \tilde{k}^g_{jt} + \alpha \tilde{k}^c_{jt} + (1-\alpha)\tilde{n}^c_{jt}) = \omega_j s^g_c \tilde{c}^g_{jt} + (1 - s^g_c) \sum_{i \in \mathcal{J}} \omega_i \chi^j_i \tilde{c}^j_{it} \tag{166}$$

$$\alpha_g \tilde{k}^g_{jt} + \alpha \tilde{k}^x_{jt} + (1-\alpha)\tilde{n}^x_{jt} = s^g_x \tilde{x}^g_{jt} + s^c_x \tilde{x}^c_{jt} + s^x_x \tilde{x}^x_{jt} \tag{167}$$

$$\tag{168}$$

Sectoral Phillips curves ($\widetilde{mc}^s_{it}$ is the percentage deviation from the steady state value of MC^s_{it}, after a linear approximation):

$$\pi^x_{jt} = \frac{(1-\theta_x)(1-\theta_x\beta)}{\theta_x} \frac{\widetilde{mc}^x_{jt}}{p^x_{jt}} + \beta \mathbb{E}_t[\pi^x_{j,t+1}] \tag{169}$$

$$\pi^c_{jt} = \frac{(1-\theta_c)(1-\theta_c\beta)}{\theta_c} \frac{\widetilde{mc}^c_{jt}}{p^c_{jt}} + \beta \mathbb{E}_t[\pi^c_{j,t+1}] \tag{170}$$

Fisher equations:

$$i_t = r^{k,x}_{jt} + \mathbb{E}_t \pi^x_{j,t+1} \tag{171}$$

$$i_t = r^{k,c}_{jt} + \mathbb{E}_t \pi^c_{j,t+1} \tag{172}$$

Policy

$$i_t = \phi_\pi \pi_t + \phi_y \tilde{y}_t \tag{173}$$

$$\tilde{t}_t = \tilde{g}_t \tag{174}$$

$$\tilde{t}_t = \sum_{j \in \mathcal{J}} \omega_j \tilde{t}_{jt} \tag{175}$$

$$\tilde{g}_t = \sum_{j \in \mathcal{J}} \omega_j \tilde{g}_{jt} \tag{176}$$

$$(s_c^g s_y^c + s_x^g s_y^x)\tilde{g}_{jt} = s_c^g s_y^c (\tilde{p}_{jt}^c + \tilde{c}_{jt}^g) + s_x^g s_y^x (\tilde{p}_{jt}^x + \tilde{x}_{jt}^g) \tag{177}$$

AR(1) government spending shock processes:

$$\tilde{x}_{it}^g = \rho_x^g \tilde{x}_{i,t-1}^g + \varepsilon_{x,it}^g \tag{178}$$

$$\tilde{c}_{it}^g = \rho_c^g \tilde{c}_{i,t-1}^g + \varepsilon_{c,it}^g \tag{179}$$