Online Appendix to "Sectoral Heterogeneity, Production Networks, and the Effects of Government Spending"*

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August 2, 2018

Abstract

This is an Online Appendix to "Sectoral Heterogeneity, Production Networks, and the Effects of Government Spending".

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A More on Calibration

This section presents further information on the calibration of the model. Tables A.1 – A.3 report the list of the 58 production sectors we consider. This level of disaggregation roughly corresponds to the 3-digit level of the NAICS codes. Notice that we have excluded all the financial sectors. Table A.4 shows the values of the parameters that are common to all sectors. We also report the target or the source that disciplines our calibration choice. Tables A.5 – A.7 report values of the parameters that vary across sectors (i.e., the contribution to the final consumption good, the contribution to the final investment good, the factor intensities, the degree of price rigidity). The tables that report the entire Input-Output matrix of the economy are available upon request.

Table A.1: Sectors 1-20.

1	Farms
2	Forestry, fishing, and related activities
3	Mining
4	Utilities
5	Construction
6	Wood products
7	Nonmetallic mineral products
8	Primary metals
9	Fabricated metal products
10	Machinery
11	Computer and electronic products
12	Electrical equipment, appliances, and components
13	Motor vehicles, bodies and trailers, and parts
14	Other transportation equipment
15	Furniture and related products
16	Miscellaneous manufacturing
17	Food and beverage and tobacco products
18	Textile mills and textile product mills
19	Apparel and leather and allied products
20	Paper products

Table A.2: Sectors 21-40.

21	Printing and related support activities
22	Petroleum and coal products
23	Chemical products
24	Plastics and rubber products
25	Wholesale trade
26	Motor vehicle and parts dealers
27	Food and beverage stores
28	General merchandise stores
29	Other retail
30	Air transportation
31	Rail transportation
32	Water transportation
33	Truck transportation
34	Transit and ground passenger transportation
35	Pipeline transportation
36	Other transportation and support activities
37	Warehousing and storage
38	Publishing industries, except internet (includes software)
39	Motion picture and sound recording industries
40	Broadcasting and telecommunications

Table A.3: Sectors 41-58.

41	Data processing, internet publishing, and other information services
42	Housing
43	Other real estate
44	Rental and leasing services and lessors of intangible assets
45	Legal services
46	Computer systems design and related services
47	Miscellaneous professional, scientific, and technical services
48	Management of companies and enterprises
49	Waste management and remediation services
50	Educational services
51	Ambulatory health care services
52	Nursing and residential care facilities
53	Social assistance
54	Performing arts, spectator sports, museums, and related activities
55	Amusements, gambling, and recreation industries
56	Accommodation
57	Food services and drinking places
58	Other services, except government

Table A.4: Calibration of Economy-Wide Parameters.

Parameter	Target/Source
$\beta = .995$	2% Steady-State Annual Interest Rate R
$\sigma = 2$	Standard Value
$\theta = 24.23$	0.33 Stead-State Total Hours N
$\eta = 0.5$	Frisch Elasticity = 2
$\delta = 0.025$	10% Annual Depreciation Rate
$\Omega = 17$	8 Quarters Peak Response of Investment
$\nu_N = 1$	Horvath (2000)
$\nu_K = 1$	$\nu_K = \nu_N$
$\epsilon = 4$	33% Steady-State Mark-Up
$\varphi_R = 0.8$	Clarida et al. (2000)
$\varphi_\Pi = 1.5$	Clarida et al. (2000)
$\varphi_Y = 0.2$	Clarida et al. (2000)
$\rho_G = 0.9$	Simulated Method of Moments Estimate

Table A.5: Calibration of Sectoral Parameters.

Sector	$\nu_{C,s}$	$\nu_{I,s}$	$\alpha_{N,s}$	$\alpha_{H,s}$	ϕ_s
1	$\nu_{C,1} = 0.0065$	$\nu_{I,1} = 0$	$\alpha_{N,1} = 0.1963$	$\alpha_{k,1} = 0.5921$	$\phi_1 = 0.3478$
2	$\nu_{C,2} = 0.0001$	$\nu_{I,2} = 0$	$\alpha_{N,2} = 0.5662$	$\alpha_{k,2} = 0.4070$	$\phi_2 = 0.6681$
3	$\nu_{C,3} = 0.0001$	$\nu_{I,3} = 0.0564$	$\alpha_{N,3} = 0.2892$	$\alpha_{H,3} = 0.3975$	$\phi_3 = 0.4118$
4	$\nu_{C,4} = 0.0261$	$\nu_{I,4} = 0$	$\alpha_{N,4} = 0.3398$	$\alpha_{k,4} = 0.4621$	$\phi_4 = 0.0291$
5	$\nu_{C,5} = 0.0001$	$\nu_{I,5} = 0.2424$	$\alpha_{N,5} = 0.6465$	$\alpha_{H,5} = 0.4821$	$\phi_5 = 0.8020$
6	$\nu_{C,6} = 0.0001$	$\nu_{I,6} = 0.0001$	$\alpha_{N,6} = 0.7652$	$\alpha_{H,6} = 0.6998$	$\phi_6 = 0.719$
7	$\nu_{C,7} = 0.0011$	$\nu_{I,7} = 0$	$\alpha_{N,7} = 0.6100$	$\alpha_{k,7} = 0.5802$	$\phi_7 = 0.5690$
8	$\nu_{C,8} = 0.001$	$\nu_{I,8} = 0$	$\alpha_{N,8} = 0.6425$	$\alpha_{k,8} = 0.7250$	$\phi_8 = 0.8905$
9	$\nu_{C,9} = 0.0014$	$\nu_{I,9} = 0.0074$	$\alpha_{N,9} = 0.6772$	$\alpha_{H,9} = 0.5834$	$\phi_9 = 0.9122$
10	$\nu_{C,10} = 0.0011$	$\nu_{I,10} = 0.1376$	$\alpha_{N,10} = 0.6746$	$\alpha_{H,10} = 0.6184$	$\phi_{10} = 0.8643$
11	$\nu_{C,11} = 0.0079$	$\nu_{I,11} = 0.1341$	$\alpha_{N,11} = 0.5858$	$\alpha_{H,11} = 0.4614$	$\phi_{11} = 0.7613$
12	$\nu_{C,12} = 0.0040$	$\nu_{I,12} = 0.0156$	$\alpha_{N,12} = 0.6342$	$\alpha_{H,12} = 0.5799$	$\phi_{12} = 0.7851$
13	$\nu_{C,13} = 0.0240$	$\nu_{I,13} = 0.1434$	$\alpha_{N,13} = 0.5714$	$\alpha_{H,13} = 0.7507$	$\phi_{13} = 0.6659$
14	$\nu_{C,14} = 0.0021$	$\nu_{I,14} = 0.0318$	$\alpha_{N,14} = 0.6668$	$\alpha_{H,14} = 0.5825$	$\phi_{14} = 0.6881$
15	$\nu_{C,15} = 0.0048$	$\nu_{I,15} = 0.0212$	$\alpha_{N,15} = 0.7383$	$\alpha_{H,15} = 0.6029$	$\phi_{15} = 0.8411$
16	$\nu_{C,16} = 0.0101$	$\nu_{I,16} = 0.0274$	$\alpha_{N,16} = 0.6170$	$\alpha_{H,16} = 0.5037$	$\phi_{16} = 0.8824$
17	$\nu_{C,17} = 0.0541$	$\nu_{I,17} = 0$	$\alpha_{N,17} = 0.4766$	$\alpha_{H,17} = 0.7434$	$\phi_{17} = 0.6633$
18	$\nu_{C,18} = 0.0029$	$\nu_{I,18} = 0.0010$	$\alpha_{N,18} = 0.7581$	$\alpha_{H,18} = 0.6992$	$\phi_{18} = 0.8765$
19	$\nu_{C,19} = 0.0172$	$\nu_{I,19} = 0$	$\alpha_{N,19} = 0.8203$	$\alpha_{H,19} = 0.6193$	$\phi_{19} = 0.9013$
20	$\nu_{C,20} = 0.0026$	$\nu_{I,20} = 0$	$\alpha_{N,20} = 0.5800$	$\alpha_{H,20} = 0.6640$	$\phi_{20} = 0.7865$

Table A.6: Calibration of Sectoral Parameters.

Sector	$\nu_{C,s}$	$\nu_{I,s}$	$\alpha_{N,s}$	$\alpha_{H,s}$	ϕ_s
21	$\nu_{C,21} = 0.0001$	$\nu_{I,21} = 0$	$\alpha_{N,21} = 0.7521$	$\alpha_{H,21} = 0.5647$	$\phi_{21} = 0.8545$
22	$\nu_{C,22} = 0.0191$	$\nu_{I,22} = 0$	$\alpha_{N,22} = 0.1545$	$\alpha_{H,22} = 0.7405$	$\phi_{22} = 0.0654$
23	$\nu_{C,23} = 0.0242$	$\nu_{I,23} = 0.0027$	$\alpha_{N,23} = 0.3315$	$\alpha_{H,23} = 0.5790$	$\phi_{23} = 0.7623$
24	$\nu_{C,24} = 0.0242$	$\nu_{I,24} = 0.001$	$\alpha_{N,24} = 0.6212$	$\alpha_{H,24} = 0.6623$	$\phi_{24} = 0.8022$
25	$\nu_{C,25} = 0.0408$	$\nu_{I,25} = 0.0869$	$\alpha_{N,25} = 0.6353$	$\alpha_{H,25} = 0.3510$	$\phi_{25} = 0.8807$
26	$\nu_{C,26} = 0.0141$	$\nu_{I,26} = 0.0097$	$\alpha_{N,26} = 0.7333$	$\alpha_{H,26} = 0.2973$	$\phi_{26} = 0.7389$
27	$\nu_{C,27} = 0.0191$	$\nu_{I,27} = 0.0001$	$\alpha_{N,27} = 0.7072$	$\alpha_{H,27} = 0.3295$	$\phi_{27} = 0.7389$
28	$\nu_{C,28} = 0.0196$	$\nu_{I,28} = 0.0016$	$\alpha_{N,28} = 0.8275$	$\alpha_{H,28} = 0.3724$	$\phi_{28} = 0.7389$
29	$\nu_{C,29} = 0.0649$	$\nu_{I,29} = 0.0139$	$\alpha_{N,29} = 0.6729$	$\alpha_{H,29} = 0.3922$	$\phi_{29} = 0.7391$
30	$\nu_{C,30} = 0.0093$	$\nu_{I,30} = 0.0012$	$\alpha_{N,30} = 0.7773$	$\alpha_{H,30} = 0.5593$	$\phi_{30} = 0.0385$
31	$\nu_{C,31} = 0.0001$	$\nu_{I,31} = 0.0014$	$\alpha_{N,31} = 0.6177$	$\alpha_{H,31} = 0.4502$	$\phi_{31} = 0.1667$
32	$\nu_{C,32} = 0.0015$	$\nu_{I,32} = 0.0001$	$\alpha_{N,32} = 0.4455$	$\alpha_{H,32} = 0.7070$	$\phi_{32} = 0.6372$
33	$\nu_{C,33} = 0.0085$	$\nu_{I,33} = 0.0154$	$\alpha_{N,33} = 0.6334$	$\alpha_{H,33} = 0.5350$	$\phi_{33} = 0.6721$
34	$\nu_{C,34} = 0.0032$	$\nu_{I,34} = 0$	$\alpha_{N,34} = 0.5788$	$\alpha_{H,34} = 0.3698$	$\phi_{34} = 0.9118$
35	$\nu_{C,35} = 0.0001$	$\nu_{I,35} = 0$	$\alpha_{N,35} = 0.3807$	$\alpha_{H,35} = 0.4685$	$\phi_{35} = 0.6721$
36	$\nu_{C,36} = 0.0001$	$\nu_{I,36} = 0$	$\alpha_{N,36} = 0.7008$	$\alpha_{H,36} = 0.4158$	$\phi_{36} = 0.0909$
37	$\nu_{C,37} = 0.0001$	$\nu_{I,37} = 0$	$\alpha_{N,37} = 0.7531$	$\alpha_{H,37} = 0.3279$	$\phi_{37} = 0.6667$
38	$\nu_{C,38} = 0.0083$	$\nu_{I,38} = 0$	$\alpha_{N,38} = 0.5079$	$\alpha_{H,38} = 0.4246$	$\phi_{38} = 0.2857$
39	$\nu_{C,39} = 0.0038$	$\nu_{I,39} = 0$	$\alpha_{N,39} = 0.3424$	$\alpha_{H,39} = 0.3964$	$\phi_{39} = 0.2857$
40	$\nu_{C,40} = 0.0295$	$\nu_{I,40} = 0.0057$	$\alpha_{N,40} = 0.3663$	$\alpha_{H,40} = 0.4928$	$\phi_{40} = 0.2366$

Table A.7: Calibration of Sectoral Parameters.

Sector	$\nu_{C,s}$	$\nu_{I,s}$	$\alpha_{N,s}$	$\alpha_{H,s}$	ϕ_s
41	$\nu_{C,41} = 0.0012$	$\nu_{I,41} = 0$	$\alpha_{N,41} = 0.6010$	$\alpha_{H,41} = 0.4176$	$\phi_{41} = 0.9370$
42	$\nu_{C,42} = 0.1661$	$\nu_{I,42} = 0$	$\alpha_{N,42} = 0.0120$	$\alpha_{H,42} = 0.0989$	$\phi_{42} = 0.7104$
43	$\nu_{C,43} = 0.0001$	$\nu_{I,43} = 0.0021$	$\alpha_{N,43} = 0.2331$	$\alpha_{H,43} = 0.6372$	$\phi_{43} = 0.2704$
44	$\nu_{C,44} = 0.0089$	$\nu_{I,44} = 0$	$\alpha_{N,44} = 0.1901$	$\alpha_{H,44} = 0.3739$	$\phi_{44} = 0.0909$
45	$\nu_{C,45} = 0.0101$	$\nu_{I,45} = 0$	$\alpha_{N,45} = 0.5705$	$\alpha_{H,45} = 0.2857$	$\phi_{45} = 0.9525$
46	$\nu_{C,46} = 0.0056$	$\nu_{I,46} = 0.0450$	$\alpha_{N,46} = 0.7210$	$\alpha_{H,46} = 0.3910$	$\phi_{46} = 0.8966$
47	$\nu_{C,47} = 0.0049$	$\nu_{I,47} = 0$	$\alpha_{N,47} = 0.8062$	$\alpha_{H,47} = 0.3647$	$\phi_{47} = 0.7781$
48	$\nu_{C,48} = 0.0017$	$\nu_{I,48} = 0$	$\alpha_{N,48} = 0.6164$	$\alpha_{H,48} = 0.5141$	$\phi_{48} = 0.8966$
49	$\nu_{C,49} = 0.0281$	$\nu_{I,49} = 0$	$\alpha_{N,49} = 0.9104$	$\alpha_{H,49} = 0.3963$	$\phi_{49} = 0.7059$
50	$\nu_{C,50} = 0.0787$	$\nu_{I,50} = 0$	$\alpha_{N,50} = 0.7820$	$\alpha_{H,50} = 0.3697$	$\phi_{50} = 0.8198$
51	$\nu_{C,51} = 0.0737$	$\nu_{I,51} = 0$	$\alpha_{N,51} = 0.9125$	$\alpha_{H,51} = 0.4454$	$\phi_{51} = 0.8768$
52	$\nu_{C,52} = 0.0190$	$\nu_{I,52} = 0$	$\alpha_{N,52} = 0.9491$	$\alpha_{H,52} = 0.3773$	$\phi_{52} = 0.8235$
53	$\nu_{C,53} = 0.0147$	$\nu_{I,53} = 0$	$\alpha_{N,53} = 0.8334$	$\alpha_{H,53} = 0.3840$	$\phi_{53} = 0.8567$
54	$\nu_{C,54} = 0.0058$	$\nu_{I,54} = 0$	$\alpha_{N,54} = 0.5635$	$\alpha_{H,54} = 0.3997$	$\phi_{54} = 0.7569$
55	$\nu_{C,55} = 0.0152$	$\nu_{I,55} = 0$	$\alpha_{N,55} = 0.6950$	$\alpha_{H,55} = 0.4361$	$\phi_{55} = 0.7959$
56	$\nu_{C,56} = 0.0103$	$\nu_{I,56} = 0$	$\alpha_{N,56} = 0.6364$	$\alpha_{H,56} = 0.4169$	$\phi_{56} = 0.1667$
57	$\nu_{C,57} = 0.0552$	$\nu_{I,57} = 0$	$\alpha_{N,57} = 0.7592$	$\alpha_{H,57} = 0.5003$	$\phi_{57} = 0.8507$
58	$\nu_{C,58} = 0.0552$	$\nu_{I,58} = 0.0001$	$\alpha_{N,58} = 0.7112$	$\alpha_{H,58} = 0.3845$	$\phi_{58} = 0.8336$

B The Government Spending Multiplier in a Multi-Sector Economy: Further Results

In the main text, Table 1 shows the contribution of the different dimensions of inter-sectoral linkages and sectoral heterogeneity on the size of the aggregate value-added multiplier. This section disentangles the aggregate output effects of government spending by reporting the consumption multipliers – Panel (a) of Table B.8 – and the investment multipliers – Panel (b) of Table B.8 – across the different versions of the baseline model. The purpose of this exercise is to determine whether the consumption and investment multipliers evolve similarly when adding the different layers of inter-sectoral linkages and sectoral heterogeneity to the one-sector economy. The results indicate that both the consumption and investment multipliers are significantly larger in the multi-sector economy than in the one-sector model, with sectoral heterogeneity in price rigidity and input-output interactions being chiefly responsible for this amplification.

Table B.8: Aggregate Consumption and Investment Multipliers across the Different Baseline Models.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Consumption Multiplier				
1 year	-0.2315	-0.2191	-0.2238	-0.1980	-0.1995	-0.1782	23.0%
2 years	-0.2350	-0.2333	-0.2425	-0.2137	-0.2156	-0.1885	19.8%
5 years	-0.2492	-0.2482	-0.2728	-0.2500	-0.2449	-0.2085	16.3%
Long-run	-0.3916	-0.3901	-0.4090	-0.3833	-0.3644	-0.2856	27.1%
			Panel (b): Aggregate Investment Multiplier				
1 year	-0.1085	-0.0759	-0.0781	-0.1091	-0.0697	-0.0583	46.3%
2 years	-0.1654	-0.1208	-0.1241	-0.1626	-0.1099	-0.0839	49.3%
5 years	-0.2614	-0.2133	-0.2044	-0.2368	-0.1827	-0.1322	49.4%
Long-run	-0.3017	-0.2606	-0.2365	-0.2428	-0.2089	-0.1494	50.5%

Notes: The table reports the 1-year, 2-year, 5-year, and long-run cumulative multipliers for aggregate consumption (Panel a) and aggregate investment (Panel b), associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy.

C The Government Spending Multiplier in a Multi-Sector Economy: Robustness Checks

This section presents the results of the robustness analysis discussed in Section 4.1 in the main text.

First, we consider the case of no mobility of labor and capital across sectors, such that $\nu_N \to 0$ and $\nu_K \to 0$. Table C.1 reports the aggregate value added multiplier associated with an aggregate government spending shock across the six model versions described in Section 4, as well as the marginal contribution of each dimension of the multi-sector economy to the difference in the multipliers implied by the "Fully Heterogeneous" economy and the "One-Sector" model. Table C.2 reports the consumption and investment multipliers. The main result that emerges from the two tables is that reducing the amount of mobility of labor and capital across sectors raises the size of the aggregate multipliers (output, consumption, or investment): the overall change in the size of the long-run cumulative value-added multiplier between the "Fully Heterogeneous" and the "One-Sector" models equals 87%, whereas the overall change in Table 1 in the main text is 84%.

Second, we set the Frisch elasticity to a lower value than that assumed in the baseline economies. More specifically, we lower this elasticity from 2 to 1 by setting $\eta = 1$. The results are reported in Tables C.3 and C.4, which are analogous to Tables C.1 and C.2, respectively. In this case, the multipliers are lower than in the baseline economies, consistently with the observation made by Hall (2009). Nevertheless, the role of sectoral heterogeneity as an amplification mechanism becomes much larger as the long-run aggregate multiplier implied by the "Fully Heterogeneous" is 5 times larger than that obtained in the "One-Sector" economy.

Third, we consider a different financing scheme of government spending. More specifically, we modify the government budget constraint by assuming that additional government spending (in excess of its steady-state level) is financed through distortionary labor-income taxes instead of lump-sum taxes. In this new specification, the government budget constraint becomes

$$\sum_{s=1}^{S} P_{s,t} G_{s,t} = PT + \tau_{N,t} W_t N_t$$

where $\tau_{N,t}$ denotes the labor income tax rate, which takes a value of 0 in the steady

state. In turn, the households' budget constraint becomes

$$P_t C_t + P_{I,t} I_t + B_{t+1} + PT = (1 - \tau_{N,t}) W_t N_t + R_{K,t} K_t + B_t R_{t-1} + \sum_{s=1}^{S} D_{s,t}.$$

The results pertaining to this case are shown in Tables C.5 and C.6. While the aggregate multipliers are uniformly lower under distortionary taxation than under lump-sum taxation, we still find that moving from the "One-Sector" to the "Fully Heterogeneous" economy raises substantially the output, consumption, and investment multipliers at all horizons.

In all of the three exercises just described, the dimensions that play the most prominent role in amplifying the aggregate output multiplier are sectoral heterogeneity in price rigidity and input-output interactions.

Table C.1: Aggregate Output Multiplier across the Different Models - Immobile Labor and Capital.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Output Multiplier				
1 year	0.6600	0.7050	0.6930	0.7055	0.7655	0.7950	20.5%
2 years	0.5996	0.6459	0.6220	0.6275	0.6983	0.7562	26.1%
5 years	0.4894	0.5385	0.5094	0.5126	0.5846	0.6761	38.2%
Long-run	0.3066	0.3493	0.3624	0.3796	0.4446	0.5738	87.2%
			Panel (b): Marginal Contribution				
1 year	-	33.3%	-8.9%	9.3%	44.4%	21.9%	-
2 years	-	29.6%	-15.3%	3.5%	45.2%	37.0%	-
5 years	-	26.3%	-15.6%	1.7%	38.6%	49.0%	-
Long-run	-	16.0%	4.9%	6.4%	24.3%	48.4%	-

Notes: Panel (a) reports the 1-year, 2-year, 5-year, and long-run cumulative aggregate output multipliers associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies labor and capital are immobile across sectors.

Table C.2: Aggregate Consumption and Investment Multipliers across the Different Models - Immobile Labor and Capital.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Consumption Multiplier				
1 year	-0.2315	-0.2191	-0.2268	-0.1916	-0.1795	-0.1590	31.3%
2 years	-0.2350	-0.2333	-0.2508	-0.2138	-0.2028	-0.1720	26.8%
5 years	-0.2492	-0.2482	-0.2858	-0.2554	-0.2401	-0.1989	20.2%
Long-run	-0.3916	-0.3901	-0.4059	-0.3818	-0.3558	-0.2808	28.3%
			Panel (b): Aggregate Investment Multiplier				
1 year	-0.1085	-0.0759	-0.0801	-0.1029	-0.0549	-0.0460	57.6%
2 years	-0.1654	-0.1208	-0.1272	-0.1587	-0.0989	-0.0718	56.6%
5 years	-0.2614	-0.2133	-0.2048	-0.2320	-0.1753	-0.1250	52.2%
Long-run	-0.3017	-0.2606	-0.2317	-0.2385	-0.1996	-0.1453	51.8%

Notes: The table reports the 1-year, 2-year, 5-year, and long-run cumulative multipliers for aggregate consumption (Panel a) and aggregate investment (Panel b), associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies labor and capital are immobile across sectors.

Table C.3: Aggregate Output Multiplier across the Different Models - Lower Frisch Elasticity.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Output Multiplier				
1 year	0.5643	0.6241	0.6148	0.6030	0.6510	0.6953	23.2%
2 years	0.4934	0.5518	0.5353	0.5166	0.5797	0.6451	30.7%
5 years	0.3630	0.4199	0.3987	0.3764	0.4493	0.5480	50.9%
Long-run	0.0784	0.1268	0.1373	0.1410	0.2151	0.3813	386.4%
			Panel (b): Marginal Contribution				
1 year	-	45.6%	-7.1%	-9.0%	36.6%	33.8%	-
2 years	-	38.5%	-10.9%	-12.3%	41.6%	43.1%	-
5 years	-	30.8%	-11.5%	-12.1%	39.4%	53.4%	-
Long-run	-	16.0%	3.5%	1.2%	24.5%	54.9%	-

Notes: Panel (a) reports the 1-year, 2-year, 5-year, and long-run cumulative aggregate output multipliers associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies the inverse of the Frisch elasticity is set to $\eta = 1$.

Table C.4: Aggregate Consumption and Investment Multipliers across the Different Models - Lower Frisch Elasticity.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Consumption Multiplier				
1 year	-0.2933	-0.2752	-0.2818	-0.2533	-0.2553	-0.2254	23.2%
2 years	-0.2930	-0.2904	-0.3023	-0.2681	-0.2736	-0.2390	18.4%
years	-0.3077	-0.3002	-0.3387	-0.3152	-0.3103	-0.2676	13.0%
Long-run	-0.5178	-0.5099	-0.5430	-0.5228	-0.4951	-0.3984	23.1%
			Panel (b): Investment Fiscal Multiplier				
1 year	-0.1424	-0.1007	-0.1034	-0.1437	-0.0937	-0.0793	44.3%
2 years	-0.2136	-0.1578	-0.1624	-0.2153	-0.1467	-0.1159	45.7%
5 years	-0.3293	-0.2799	-0.2626	-0.3084	-0.2404	-0.1844	44.0%
Long-run	-0.4038	-0.3633	-0.3197	-0.3362	-0.2898	-0.2203	45.4%

Notes: The table reports the 1-year, 2-year, 5-year, and long-run cumulative multipliers for aggregate consumption (Panel a) and aggregate investment (Panel b), associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies the inverse of the Frisch elasticity is set to $\eta = 1$.

Table C.5: Aggregate Output Multiplier across the Different Models - Distortionary Labor Income Taxes.

	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Output Multiplier				
1 year	0.1509	0.1671	0.1550	0.0681	0.1981	0.3339	121.3%
2 years	-0.0139	-0.0138	-0.0352	-0.1608	0.0140	0.1916	-
5 years	-0.3567	-0.3528	-0.3702	-0.5318	-0.3296	-0.0954	73.3%
Long-run	-0.9662	-0.9634	-0.8989	-1.0121	-0.8293	-0.4751	50.8%
			Panel (b): Marginal Contribution				
1 year	-	8.9%	-6.6%	-47.5%	71.0%	74.2%	-
2 years	-	-	-	-	-	-	-
5 years	-	1.5%	-6.7%	-61.8%	77.4%	89.6%	-
Long-run	-	0.6%	-13.1%	-23.1%	37.1%	72.1%	-

Notes: Panel (a) reports the 1-year, 2-year, 5-year, and long-run cumulative aggregate output multipliers associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies the additional government spending (in excess of its steady-state level) is financed through distortionary labor-income taxes instead of lump-sum taxes.

Table C.6: Aggregate Consumption and Investment Multipliers across the Different Models - Distortionary Labor Income Taxes.

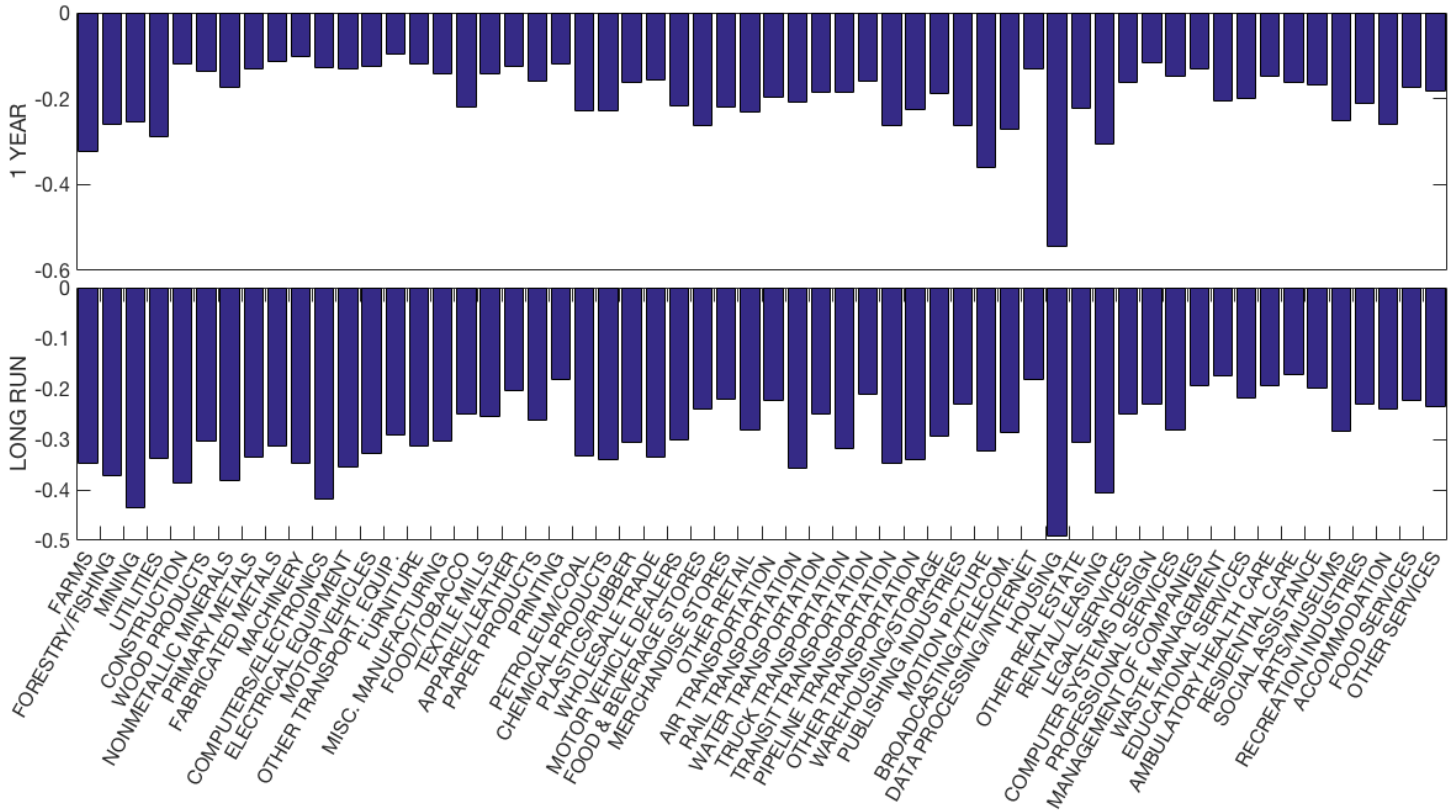
	One-Sector	Multi-Sector					Overall Change
		Symmetric Input-Output Matrix	Heterogeneous Shares	Heterogeneous Factor Intensities	Asymmetric Input-Output Matrix	Fully Heterogeneous	
			Panel (a): Aggregate Consumption Multiplier				
1 year	-0.5820	-0.5789	-0.5902	-0.5457	-0.5608	-0.4686	19.5%
2 years	-0.6172	-0.6143	-0.6346	-0.5889	-0.6048	-0.5061	18.0%
years	-0.6890	-0.6886	-0.7200	-0.7090	-0.6984	-0.5904	14.3%
Long-run	-1.1818	-1.1801	-1.1519	-1.1735	-1.1124	-9056	23.4%
			Panel (b): Investment Fiscal Multiplier				
1 year	-0.2671	-0.2540	-0.2548	-0.3862	-0.2411	-0.1975	26.1%
2 years	-0.3967	-0.3995	-0.4006	-0.5719	-0.3812	-0.3023	23.8%
5 years	-0.6677	-0.6642	-0.6502	-0.8228	-0.6312	-0.5050	24.4%
Long-run	-0.7844	-0.7833	-0.7470	-0.8386	-0.7169	-0.5695	27.4%

Notes: The table reports the 1-year, 2-year, 5-year, and long-run cumulative multipliers for aggregate consumption (Panel a) and aggregate investment (Panel b), associated with a common government spending shock in: (i) a fully symmetric version of the model without inter-sectoral linkages (i.e., the "One-Sector" economy), (ii) a version of the model that adds a symmetric Input-Output matrix (i.e., the "Symmetric Input-Output Matrix" economy), (iii) a version of the model that adds heterogeneity in consumption and investment shares, and in the steady-state levels of sectoral government spending (i.e., the "Heterogeneous Shares" economy), (iv) a version of the model that adds heterogeneity in the factor intensities in the sectoral production function (i.e., the "Heterogeneous Production Intensities" economy), (v) a version of the model that allows for an asymmetric Input-Output matrix (i.e., the "Asymmetric Input-Output Matrix" economy), and (vi) a version of the model that adds heterogeneity in the degree of price rigidity (i.e., the "Fully Heterogeneous" economy). Panel (b) reports the marginal contribution of each model version to the overall change in the size of the multiplier between the "One-Sector" economy and the "Fully Heterogeneous" economy. In all these economies the additional government spending (in excess of its steady-state level) is financed through distortionary labor-income taxes instead of lump-sum taxes.

D The Aggregate Effects of Sector-Specific Government Spending Shocks: Further Results

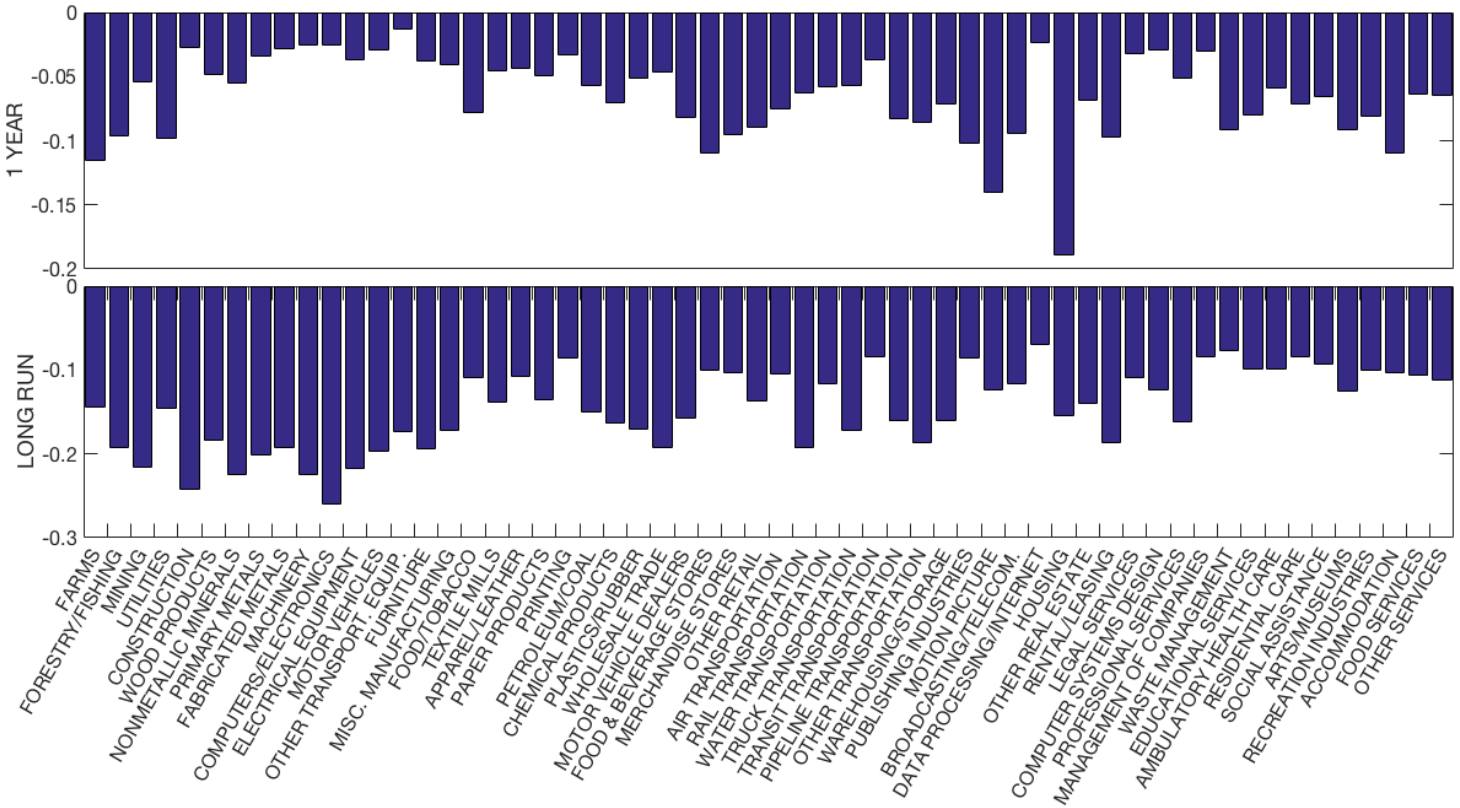
This section reports the responses of aggregate consumption, investment, employment, inflation, and the nominal interest rate to the different sector-specific government spending shocks. The results are shown in Figures D.2, D.1, D.3, D.4, and D.5, respectively, and are expressed as multipliers. In each figure, the top panel depicts the 1-year cumulative multipliers while the bottom panel shows the long-run cumulative multipliers.

Figure D.1: Aggregate Consumption Response to Sectoral Government Spending Shocks.



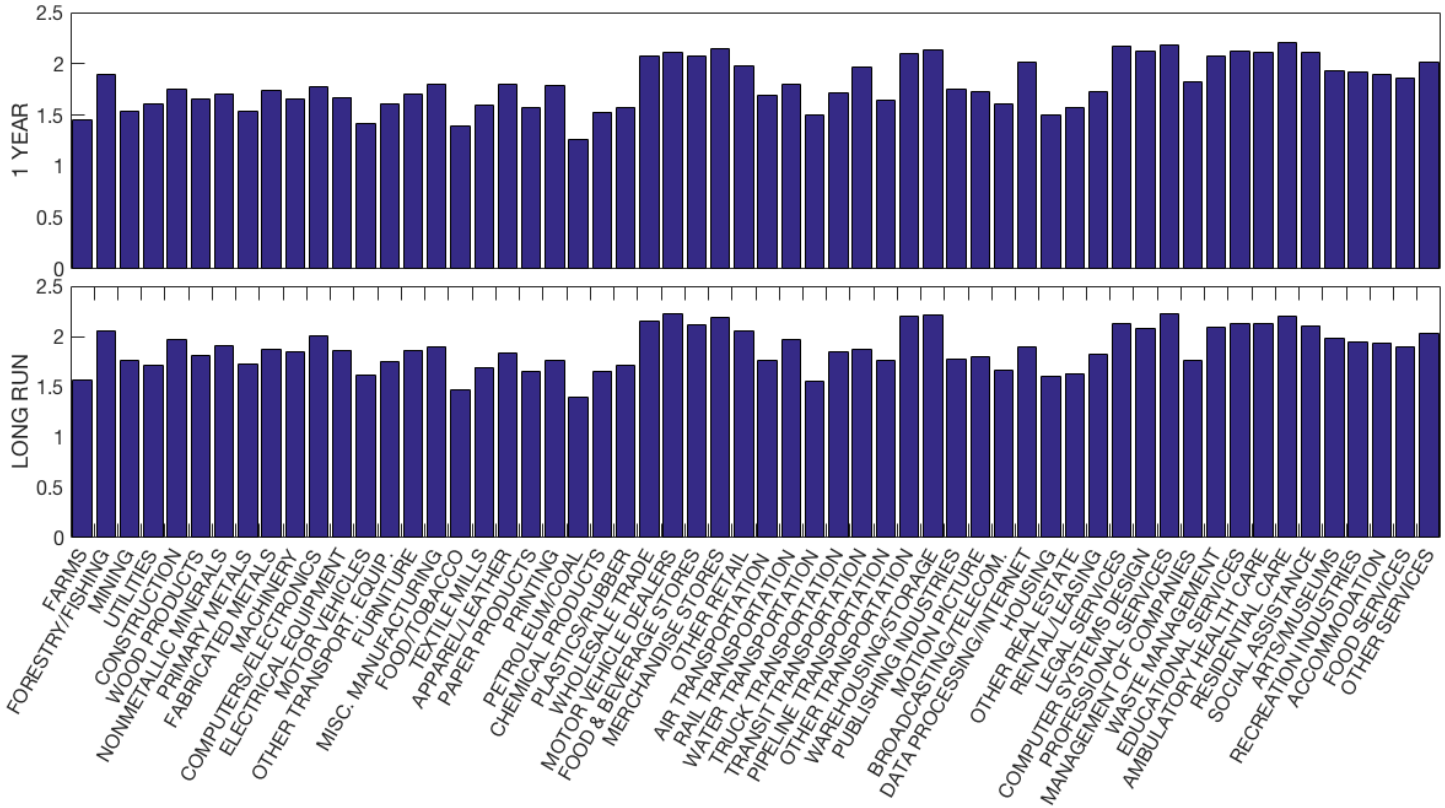
Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate consumption multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy.

Figure D.2: Aggregate Investment Response to Sectoral Government Spending Shocks.



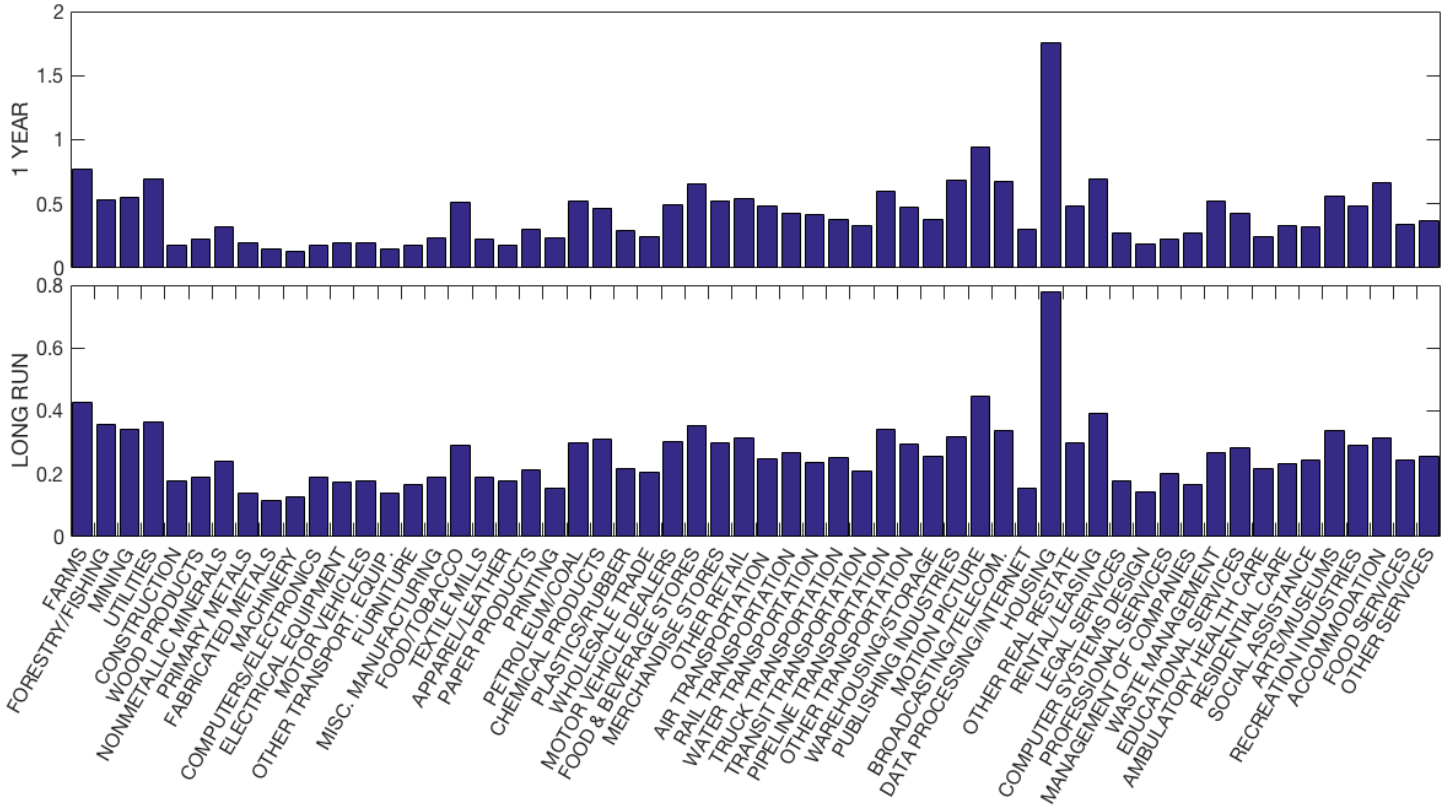
Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate investment multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy.

Figure D.3: Aggregate Employment Response to Sectoral Government Spending Shocks.



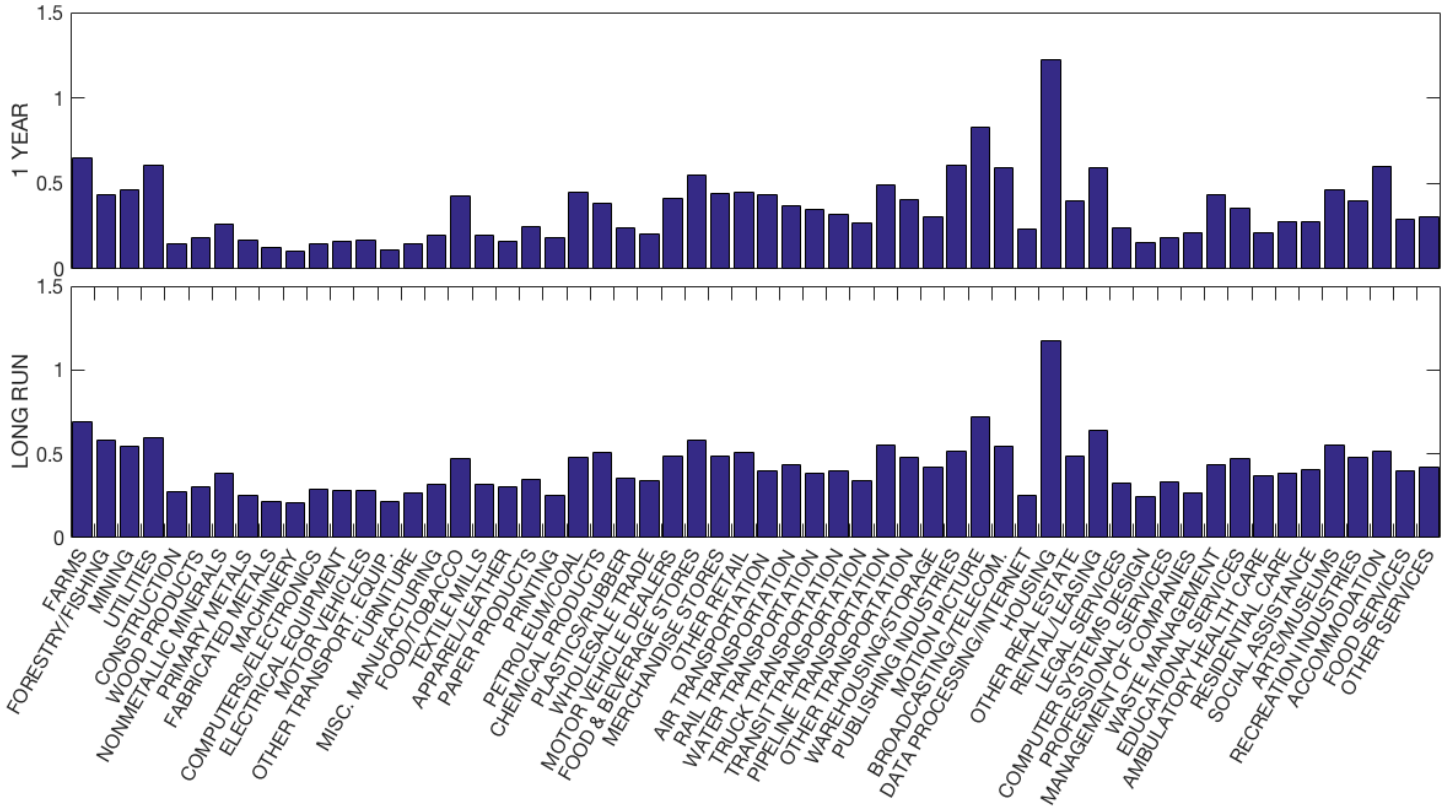
Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate employment multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy.

Figure D.4: Aggregate Inflation Response to Sectoral Government Spending Shocks.



Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate inflation multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy.

Figure D.5: Aggregate Nominal Interest Rate Response to Sectoral Government Spending Shocks.



Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate nominal interest rate multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy.

E The Aggregate Effects of Sector-Specific Government Spending Shocks: Robustness Checks

Figures E.6 - E.8 report the responses of aggregate value added to the sector-specific government spending shocks in three alternative versions of the baseline model: the case of no mobility of labor and capital across sectors (such that $\nu_n \to 0$ and $\nu_n \to 0$), the case in which the inverse of the Frisch elasticity is set to $\eta = 1$, and the case in which additional government spending (in excess of its steady-state level) is financed through distortionary labor-income taxes (instead of lump-sum taxes). Again, in each figure the top panel depicts the 1-year cumulative multipliers, while the bottom panel shows the long-run cumulative multipliers.

Preventing labor and capital mobility across sectors raises substantially the dispersion in the response of aggregate output to the sector-specific government spending shocks. Indeed, the 1-year multiplier ranges between -0.23 and 1.08, while the long-run multiplier varies between 0.14 and 1. The cross-sectional dispersion in the response of aggregate output is also highly correlated with the one implied by the baseline model (i.e., both for the 1-year and the long-run multiplier, the correlation in the response of aggregate value added implied by the baseline model and the case with no mobility of labor and capital is 0.96).

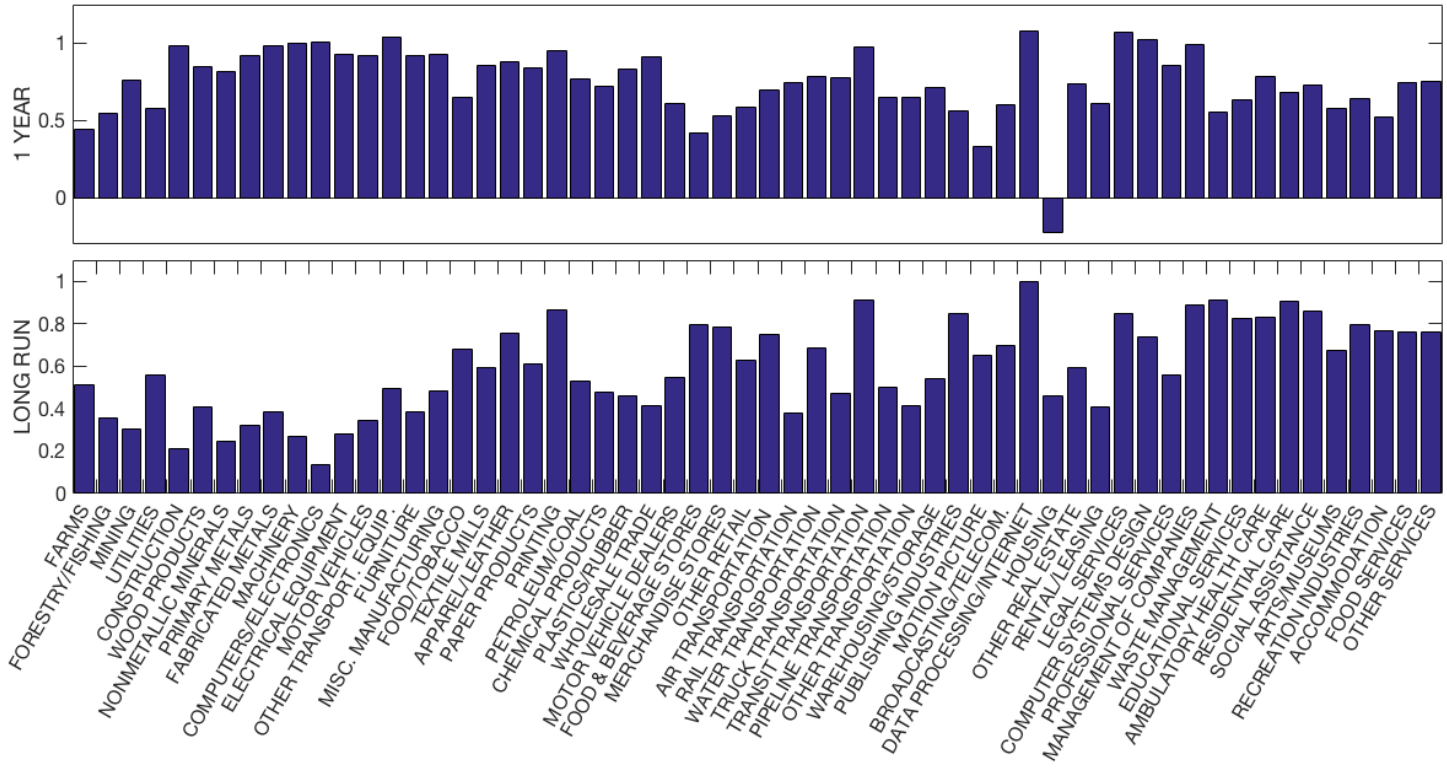
Lowering the Frisch elasticity of labor supply to unity implies a similar dispersion in the response of aggregate value added to the sector-specific government spending shocks, as the 1-year multiplier ranges between 0.21 and 0.83, while the long-run multiplier varies between 0.14 and 0.56. The correlation with the 1-year and long-run multipliers implied by the baseline model is 1 and 0.98, respectively.

Finally, the distortionary labor-income taxation scheme generates 1-year and long-run multipliers ranging between -0.36 and 0.44, and -0.73 and -0.27, respectively. Again, the cross-sectional variation in the response of aggregate output to the sector-specific shocks is similar to that implied by the baseline model, with a correlation of 0.98 and 0.99 for the 1-year and the long-run multipliers, respectively.

References

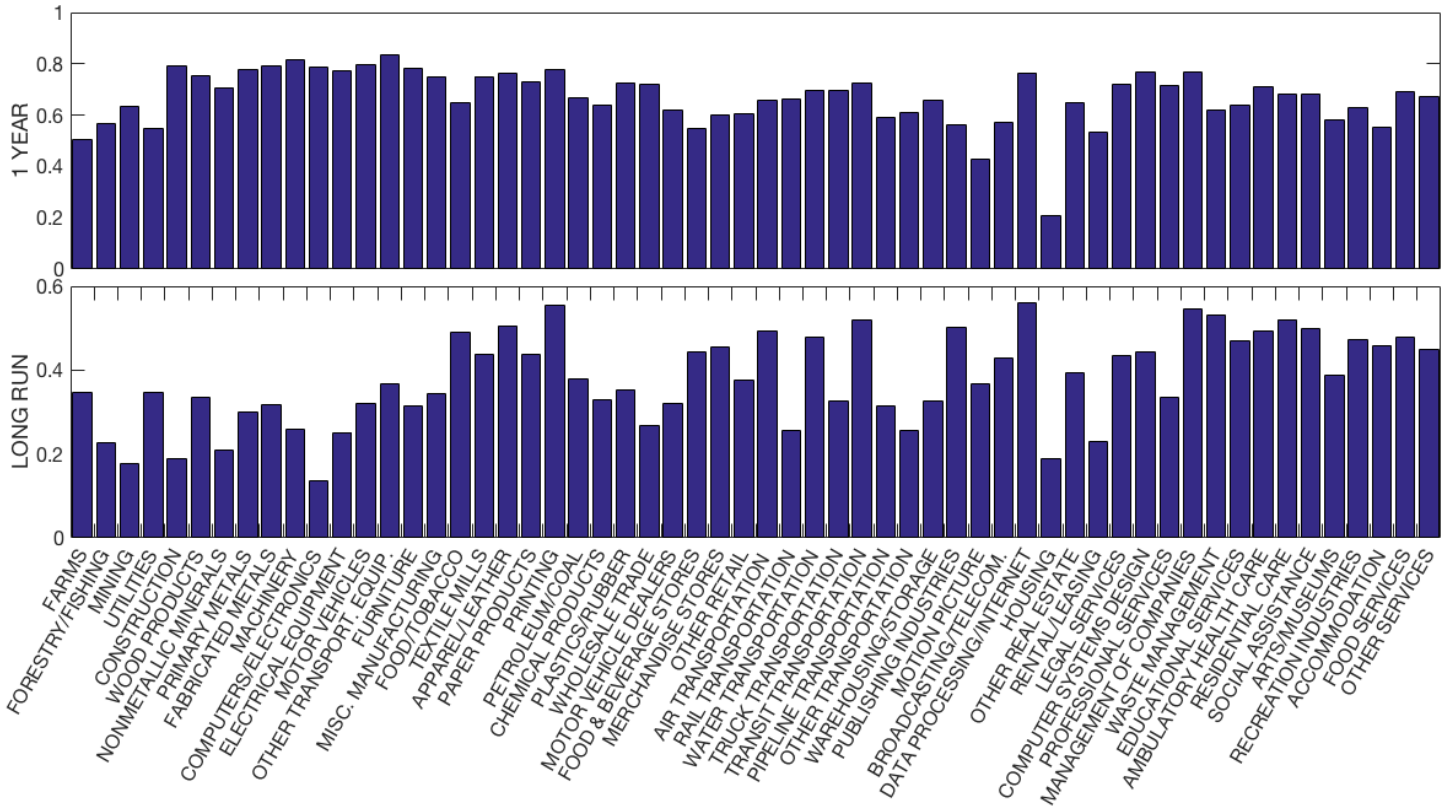
Hall, R. 2009. By How Much Does GDP Rise If the Government Buys More Output? *Brookings Papers on Economic Activity*, 2, 183-231.

Figure E.6: Aggregate Output Response to Sectoral Government Spending Shocks - Immobile Labor and Capital.



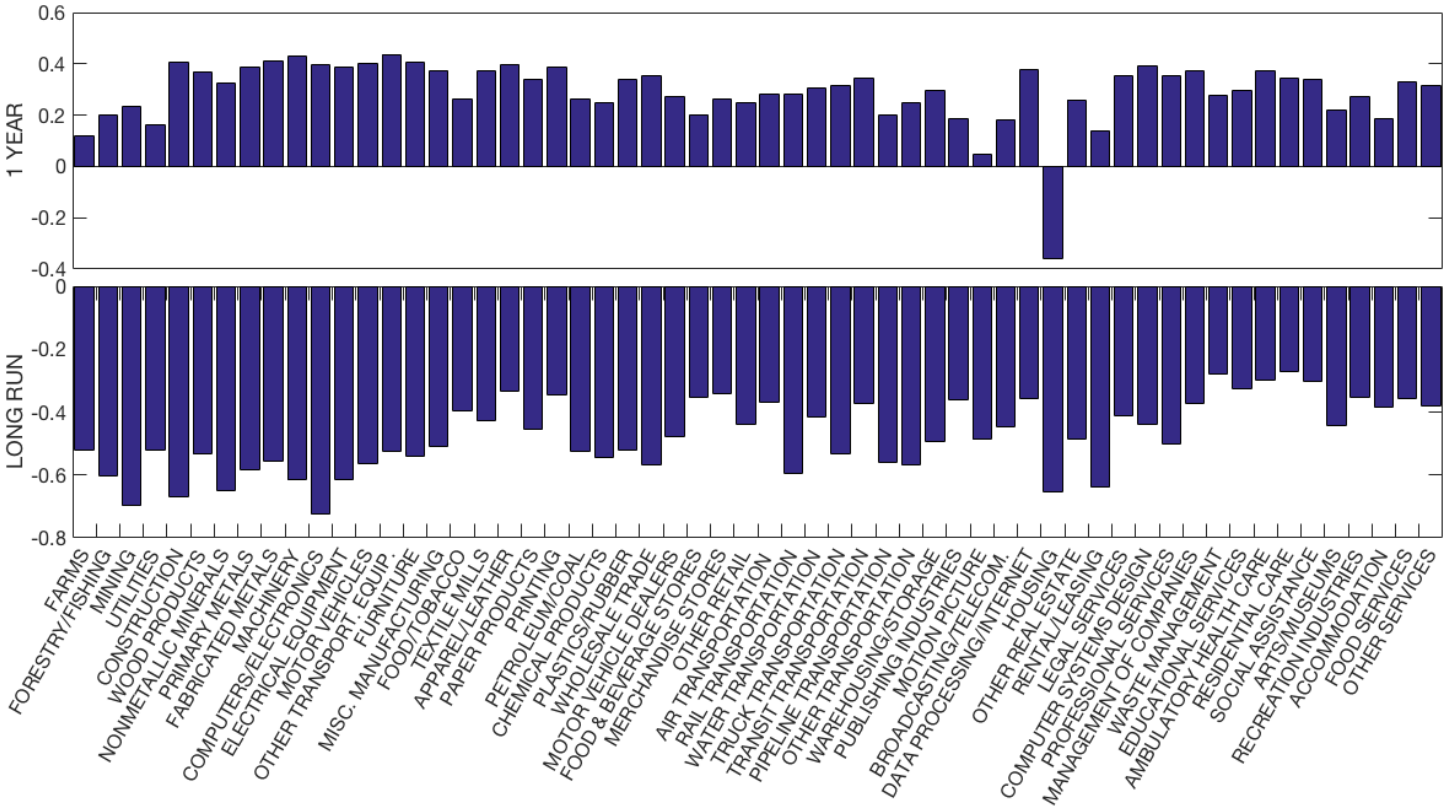
Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate output multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy in which labor and capital are immobile across sectors.

Figure E.7: Aggregate Output Response to Sectoral Government Spending Shocks - Lower Frisch Elasticity.



Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate output multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy in which the inverse of the Frisch elasticity is set to $\eta = 1$.

Figure E.8: Aggregate Output Response to Sectoral Government Spending Shocks - Distortionary Labor Income Taxes.



Note: The figure plots the 1-year (top panel) and long-run (bottom panel) cumulative aggregate output multipliers associated with each sectoral government spending shock. The multipliers are derived from the "Fully Heterogeneous" economy in which the additional government spending (in excess of its steady-state level) is financed through distortionary labor-income taxes instead of lump-sum taxes.