ONLINE APPENDIX TO "CROSS-REGION TRANSFER MULTIPLIERS IN A MONETARY UNION: EVIDENCE FROM SOCIAL SECURITY AND STIMULUS PAYMENTS"

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1. Data Sources, Variable Construction, and Descriptive Statistics

1.1. Data Sources (Dependent Variables, Controls).

- Earnings by place of work (labor income), personal income, and instrumented transfers from the BEA Regional Economic Accounts (http://www.bea.gov/regional/downloadzip.cfm), Quarterly State Personal Income Tables SQ4 and SQ35 (accessed September 30, 2015).[1]
- Quarterly state GDP from BEA Regional Economic Accounts, "quarterly GDP by state", all industries (accessed December 10, 2015).
- All variables are deflated by the Quarterly Personal Consumption Expenditures Chain-Type Price Index (PCE) from the St. Louis FRED and BEA (PCECTPI; accessed July 9, 2017; https://fred.stlouisfed.org/).
- US aggregate GDP (chained 2009 dollars) from the St. Louis FRED (GDPC1; accessed May 24, 2015).
- Nominal West Texas Intermediate (WTI) Oil Prices are from the St. Louis FRED (WTISPLC; accessed July 22, 2017).
- Manufacturing share of state GDP: (i) for the 2001–2008 sample: constructed as the 2001–2008 average of nominal GDP in manufacturing (NAICS industries 31–33) divided by total state GDP. NAICS annual GDP from bea.gov/regional (accessed May 12, 2015) (ii) for the 1952–1974 sample: constructed as the 1952–1974 average of nominal GDP in SIC manufacturing divided by total state GDP. SIC annual GDP is from bea.gov/regional (accessed May 12, 2015).

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[1]Earnings by place of work are sourced mostly from high-quality administrative records (BLS's Quarterly Census of Employment and Wages (QCEW) program) and make up around 75%-80% of personal income.

- State population estimates from the US Census Bureau website (archived data at bottom of page; accessed May 24, 2015). Annual estimates are linearly interpolated to quarterly.
- Congressional voting records for the 2001 Economic Growth and Tax Relief Reconciliation Act (EGTRRA) and 2008 Economic Stimulus Act (accessed August 13, 2018 from https://www.govtrack.us/).

1.2. **Construction of Exogenous Transfer Variables.**

2008 Stimulus Payments—Low-Income Rebate Component (Temporary). Aggregate payouts and cross-state allocation are taken from BEA (2009); also see BEA (2008).[2] Aggregate payouts were $28.25 billion in 2008Q2 and $1.35 billion in 2008Q3 (not annualized).

2008 Stimulus Payments—Mid-Income Tax Refund Component (Temporary). According to BEA (2008), the middle-income component was $49.75bn (not annualized) in 2008Q2. Parker et al. (2013) reports $15bn in payouts in 2008Q3 in total, leaving around $13.65bn in the mid-income component once the refundable low-income component has been subtracted. I calculate payments to residents of each state by (i) calculating that state's share of total middle-income payouts and then (ii) multiplying that share by $49.75bn in 2008Q2 and $13.65bn in 2008Q3.[3]

I calculate each state's share of total middle-income payouts using IRS data on 2007 income tax returns (Tax Year 2007: Historical Table 2 (SOI Bulletin)[4]) and eligibility rules for the tax rebate. This calculation involves a number of assumptions given the aggregated nature of the SOI Bulletin data. Payouts are calculated by the number of single and joint taxpayers in each income bracket in each state, after adjusting for the fraction of returns that do not pay any income tax. The IRS SOI provide use fairly wide income brackets, so I use the Census Bureau's Current Population Survey (Table HINC-06) to approximate the phaseout of the payments for higher income earners within income brackets using the US-wide income distribution. Allocating these 2008 transfers across states using IRS microdata on individual level tax returns delivers similar results (not reported).[5]

Note that the cross-state allocation of total transfers in 2008Q2 is almost identical to contemporaneous growth in "All other personal current transfer receipts" (Online Appendix Figure 2, Panel B) as calculated by the BEA, suggesting an accurate cross-state allocation.

[2] The BEA classifies tax rebates as transfers if they are at least partially refundable, which includes all 2008 transfers (low income and middle income) but excludes the 2001 transfers. Note that before September 2015 (and in early drafts of this paper), only the component of the 2008 stimulus payment classified by the BEA as a transfer was that accruing to households that did not pay any net federal taxes. That is why the 2008 low-income rebate is classified separately in BEA (2008, 2009). The rest of the payment (to those who paid net federal taxes, which I call the "middle-income" component) was previously classified as a tax cut. The change was part of the 2015 revisions to the National Income and Product Accounts (see McCulla and Smith 2015).

[3] Households receiving either payment also received $300 for each eligible child. Due to a lack of data on the number eligible children (for those with a tax liability) across states, I assume that the $300 child payments for those with tax liabilities are allocated across states in proportion to the other payments and so do not affect the *share* of payments received in each state. An alternative approach is to approximate the number of children of taxpayers with a tax liability using information on the number and amount of child tax credits in each income group in each state. Doing this generates almost identical multipliers (not reported).

[4] https://www.irs.gov/uac/SOI-Tax-Stats-Historic-Table-2 This is the same source for the 2000 tax returns used in calculating the cross-region allocation of the 2001 stimulus payments.

[5] Microdata are not necessarily more accurate because many respondents have their state identifier missing.

2001 Stimulus Payments (Temporary). Johnson et al. (2006) report a payout of \$38 billion (not annualized) in 2001Q3. This is allocated across states using IRS data on 2000 income tax returns (Tax Year 2000: Historical Table 2 (SOI Bulletin)) and eligibility rules for the tax rebate. Payouts are calculated using the number of single (\$300), joint (\$600), and head of household (\$500) taxpayers in each income bracket in each state, after adjusting for the fraction of returns that do not pay any income tax (and households that would receive partial payments).[6] As above, my estimate of the payments to residents of each state is that state's share of total payouts × \$38 billion.[7] The results are quite robust to alternative assumptions. Note that the 2001 stimulus payments are classified as tax cuts (not transfers) by the BEA and so are excluded from the instrument in instrumental variable (IV) specifications.

Social Security Payments (Permanent). The aggregate size of Social Security payments are taken from Table 1 in Romer and Romer (2016). Romer and Romer report aggregate monthly payment increases as a share of personal income at annual rates, with the date reflecting the first month the higher payments were received.[8] This is converted into non-annualized payment increases in the quarter. The payments are then allocated across states using each state's share of total Social Security payments one year beforehand.[9] Lagged Social Security payments by state (for the cross-state allocation) are taken from BEA Quarterly State Personal Income Table SQ35, which provides a breakdown of personal current transfer receipts by subcategory.[10]

TABLE 1. Descriptive Statistics

	Obs.	Mean	SD	p10	p90	Min.	Max.
	Panel A: Social Security Transfers (1952-1974)						
|Perm. Social Security Transfers|*	1295	0.20%	0.22%	0.02%	0.48%	0.00%	1.50%
|Temp. Social Security Transfers|*	298	0.61%	0.22%	0.35%	0.90%	0.08%	1.24%
Growth Labor Income per capita	4413	0.54%	1.50%	-1.40%	2.34%	-4.59%	4.64%
	Panel B: Temporary Transfers (2001-2008 or 2005-2008)						
|Pooled Temporary Transfers*	249	2.47%	1.12%	0.72%	3.91%	0.49%	6.47%
|2008 Rebates (low-income)|*	149	0.87%	0.77%	0.05%	1.85%	0.03%	3.89%
|2008 Tax Refund (mid-income)|*	149	1.63%	0.77%	0.63%	2.62%	0.45%	3.26%
|2001 Stimulus Payments|*	100	2.42%	0.29%	1.99%	2.74%	1.76%	3.05%
Growth Labor Income per capita	1588	0.21%	1.08%	-1.16%	1.55%	-3.89%	4.63%
Growth GDP per capita	742	0.06%	1.33%	-1.57%	1.59%	-4.40%	4.62%

Notes: *Absolute value of change in transfers as share of quarterly labor income, non-zero observations only (after dropping labor income growth outliers). The observations column reports the sample size after dropping labor income growth outliers. The table shows quarterly state-level data. The small minimum transfer sizes in 2008 (in absolute value) are mostly for 2008Q4.

[6] See Johnson et al. (2006), footnote 11.

[7] My cross-state allocation adds to around \$42bn, which is similar to the \$38bn in payouts according to official data.

[8] This is, confusingly, usually one month after the effective date reported by the Social Security Administration for the same benefit increase. For example, Romer and Romer quote the Senate Finance and Ways and Means Committee regarding the March 1968 Social Security increases that were "first payable for the month of February 1968 and will be reflected in checks received in early March" (Romer and Romer 2016, Online Appendix, p. 9).

[9] For example, in the case of an increase in Social Security benefits in the first month of the quarter, $\Delta tr_{US,t}$ in main text Equation (1) is the dollar value of Romer and Romer's permanent transfer change, and $stateshare_{i,t-4} = tr^{SS}_{i,t-4} / \sum_{i=1}^{50} tr^{SS}_{t-4}$ is that state's share of total Social Security transfers four quarters before.

[10] The cross-state allocation is almost identical to using the total amount of monthly benefits in current payment status from hand-entered Social Security bulletin tables (not reported).

2. Background on Transfer Size and Cyclicality

This section provides some background on the size and types of federal *gross* transfers to individuals and how federal *net* transfers to residents of US regions change in response to asymmetric shocks in those regions.

2.1. **How Large Are Federal *Gross* Transfers to Individuals?** My preferred National Income and Product Accounts (NIPA) measure of transfers to individuals is Government Social Benefits (to Persons) excluding Medicare, which is the closest conceptually to the measure in the theoretical model, and is worth \$1.4 trillion in 2017, up from \$1.25 trillion in 2010 (Appendix Table 2, Panel B). This transfer measure is substantially larger than government consumption, which was around \$1 trillion in both 2010 and 2017 (Appendix Table 2, Panel C). Moreover, since 2013, transfers to individuals have been larger than government consumption and investment combined (not reported).

The main component of transfers to individuals is Social Security (old-age pensions), which is between half and two-thirds of my preferred transfer measure. Refundable tax credits, such as the Earned Income Tax Credit (EITC), are the next largest category, over \$130 billion per year. Federal unemployment insurance (UI) was large in 2010, in part due to emergency compensation during the period of high unemployment, though UI payments were small in 2017.[11] Veterans' benefits (mostly pensions) are also a large and rapidly increasing category. Other categories include SNAP (food stamps) and SSI (disability benefits).[12]

There are several different definitions of transfers in the NIPA data, though many of them do not relate to transfers to individual as studied in this paper. The most aggregate measure is "Current Transfer Payments" in BEA NIPA Table 3.2 for the federal government.[13] However, this includes "Grants-in-Aid to States and Local Governments," which are not transfers to individuals.[14] The other major component of "Current Transfer Payments" is "Government Social Benefits (to Persons)." However, NIPA Table 3.12 shows that about 1/3 (=\$695bn/\$2092bn in 2017) of these are for Medicare, which in most cases are payments from the federal government to medical providers in exchange for a medical service or product. These payments are arguably different from the transfers to individuals considered in this paper: the individual cannot choose to save or spend the payment, and it is spent on medical services (mostly) produced in the individual's location. Hence, my preferred measure is Government Social Benefits (to persons) excluding Medicare benefits.

[11] Unemployment insurance is a joint federal-state program. In normal times, state governments fund the program through their own taxes and set the local program rules. During recessions (especially the Great Recession), the federal government plays a greater role, paying for extensions of unemployment benefits in areas with high unemployment rates and lending states in financial difficulties money for unemployment programs.

[12] Food stamps are in some ways similar to Medicare, in that the government pays for a good/service. However, food stamps can be saved (for up to a year) and spent on a wide variety of goods at the discretion of the recipient. The regular and essential nature of the payments means they are more fungible.

[13] Oh and Reis (2012) also produce descriptive statistics on the size of transfers, but these are for the general government rather than the federal government (from NIPA Table 3.1).

[14] For example, whether they are spent or saved depends on the politics and budgetary institutions of the state or local government in question rather than on individual credit constraints or the permanent income hypothesis (for Ricardian households).

TABLE 2. Size of Federal Transfers to Individuals

	2010		2017	
A. Federal Government Social Benefits (To Persons)	$1757.5bn		$2091.7bn	
A1. Medicare	$513.4bn		$695.3bn	
B. Federal transfers to individuals (A less A1)	$1244.1bn	100%	$1396.4bn	100%
B1. Social Security (old age pension)	$690.2bn	55%	$926.1bn	66%
B2. Refundable tax credits	$144.3bn	12%	$136.8bn	10%
B3. Unemployment Insurance	$138.9bn	11%	$29.1bn	2%
B4. Veterans' benefits	$56.4bn	5%	$97.5bn	7%
B5. SNAP ("Food Stamps")	$66.5bn	5%	$64.0bn	5%
B6. Supplemental security income (disability)	$44.6bn	4%	$52.0bn	4%
B7. Other categories (not listed above)	$103.2bn	8%	$90.9bn	7%
C. Federal Government Consumption Expenditure	$1000.7bn		$968.8bn	

Sources: BEA NIPA Table 3.12 (Panels A and B) and NIPA Table 3.2 (Panel C). *Notes:* Current USD. Accessed December 4, 2018.

2.2. **The Cyclicality of Federal *Net* Transfers to Individuals in Different States.** This section summarizes the regional literature cited in the introduction of the main text, which suggests the US federal fiscal system generates a countercyclical net transfer of \$0.20–\$0.40 for every dollar fall in regional incomes in the US.[15] This discussion is in terms of net transfers—federal transfers received less federal taxes paid—because they have a symmetric effect on individual disposable income for state residents. Based on this regional evidence, I calibrate a default normalized tax change (NTC) equal to 0.3—a \$0.30 net transfer per dollar fall in income—in my assessment of the size of the smoothing benefits of the federal fiscal system in main text Section V.

One of the most recent papers in this literature is Feyrer and Sacerdote (2013), which finds that when state per capita GDP falls by \$1, federal taxes levied on residents of that state fall by \$0.25, with no statistically significant change in spending (over 1996–2011). Sala-i-Martin and Sachs (1991) estimate elasticities over 1970–1988 for US regions and find that a \$1 reduction in a region's per capita income (relative to the national average) triggers a decrease in federal taxes of \$0.34 and an increase in federal transfers by \$0.06. Bayoumi and Masson (1995) find regional disposable income is smoothed by around \$0.30 on the dollar for census regions over 1971–1986.

There are two main measurement issues related to these countercyclicality statistics in my context. The most important is that all three papers include intergovernmental transfers (to state and local governments) in their federal transfer or spending measure. While intergovernmental transfers are not net transfers to individuals, the bias from their inclusion is likely to be small: in Bayoumi and Masson (1995), only \$0.07 out of \$0.30 is due to intergovernmental transfers (reducing the total to \$0.23 per \$1 fall in income), and for Feyrer and Sacerdote (2013) and Sala-i-Martin and Sachs (1991), the vast majority of the estimated effect is through taxes.[16] The second issue is the measure of income used. Feyrer and Sacerdote (2013) use state GDP per capita, whereas Bayoumi and Masson (1995) and Sala-i-Martin and Sachs (1991) use per capita personal income,

[15]As the focus of my policy discussion is on asymmetric regional business cycles, rather than national recessions, there is naturally little discretionary policy response from the federal government (in most cases).
[16]This makes sense as federal tax rates are at least proportional to income—or more progressive—meaning that tax payments rise with income.

which is usually smaller. In my theoretical model, there is no capital (or steady-state government spending), so these personal income and GDP are roughly equivalent.

The estimates in the regional literature are broadly consistent with, though slightly larger than, those of Auerbach and Feenberg (2000) for the US as a whole. Auerbach and Feenberg (2000) estimate the size of changes in national disposable income due to automatic stabilizers over 1962–1995 (using a tax simulator rather than regressions) and find that a \$1 reduction in adjusted gross income (AGI) reduces net income taxes paid by about \$0.25, with the largest effect though taxes. However, they also note that AGI is only around 60% of GDP, which would effectively lower their estimate of the NTC to around \$0.15 per \$1 of GDP, which I use as a robustness calculation in the main text. Based on Auerbach and Feenberg's (2000) evidence, my default NTC calibration can be viewed reasonably conservative given my claims about the limited ability of the federal fiscal system to smooth regional shocks.

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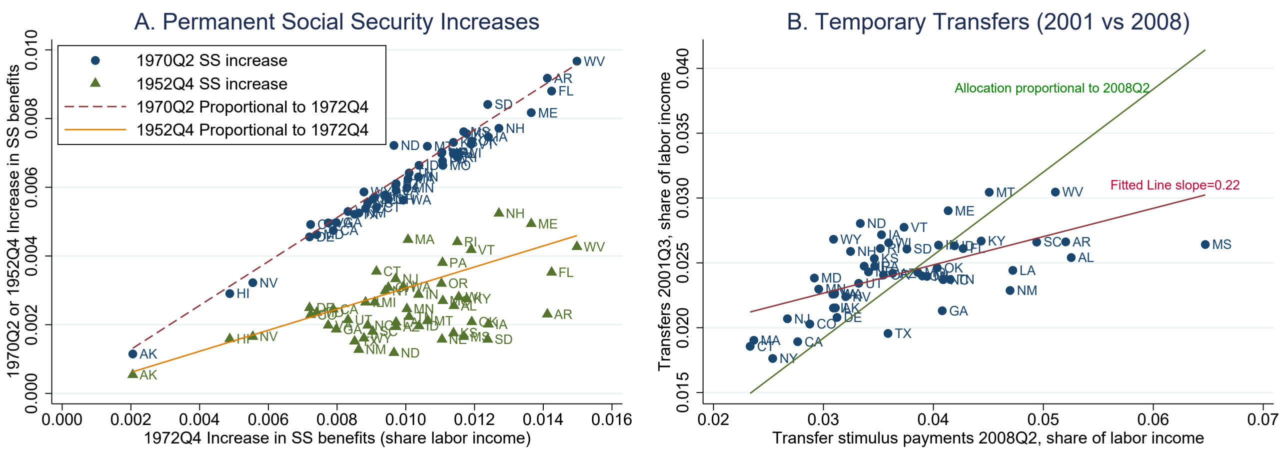
3. Additional Empirical Robustness Tests

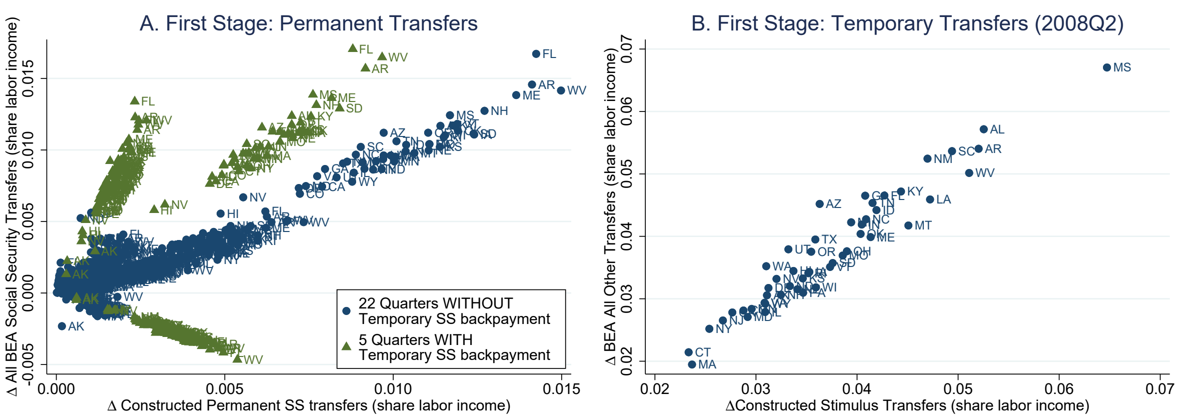


Notes: Panel A: This figure plots the cross-state allocation of 1972Q4 Social Security benefit increases (share of quarterly labor income) on the x-axis against the cross-state allocation of 1970Q2 Social Security increases (2 years earlier; blue circles) or 1952Q4 Social Security increases (20 years earlier; green triangles) on the y-axis (also as share of labor income). The red (yellow) line indicates the hypothetical size of Social Security increases in 1970Q2 (1952Q4) if the total Social Security benefit increases had simply been allocated across states in proportion to the increases 1972Q4. The aggregate size of these increases are 1952Q4 0.23% of personal income (PI); 1972Q4 0.75% PI; and 1970Q2 0.48% PI. Panel B: This figure plots the size of the transfers across states in 2008Q2 (x-axis) against the size of the transfers across states in 2001Q3 (y-axis), both as share of labor income. The red line shows the fitted relationship, whereas the green line shows what the relationship would be if the 2001 transfer had been proportional to transfer in 2008. Sources: BEA, IRS, Romer and Romer (2016), author's calculations.

Figure 1. Cross-State Allocation of Transfers over Time

3.1. **Additional Figures and Tables (Referenced in the Main Text).** Appendix Figure 1, Panel A shows that, after adjusting for the aggregate size of the transfer, the cross-state allocation of permanent Social Security increases is essentially constant over short intervals (2.5 years, blue dots), but there is substantial variation in the identity of low and high transfer states over long intervals (20 years, green triangles). Panel B shows that the identity of low and high transfer states varies across the 2001 and 2008 transfer policies.

Appendix Figure 2 plots my constructed exogenous measures of cross-region transfers (x-axis) against comparable—but potentially endogenous—measures from the BEA (y-axis) for permanent Social Security increases (Panel A) and temporary stimulus transfers in 2008 (Panel B).[17] This also represents the first stage of IV specifications from Table 1 in the main text. The figures show that the exogenous and endogenous transfers are similar in size in the relevant quarters, suggesting a first-stage coefficient close to 1 and providing a cross-check on my construction of the exogenous transfer variables.[18] Note that in Panel A, my constructed measure of permanent Social Security increases naturally does not explain well the change in Social Security transfers in the handful of quarters that had large Social Security backpayments (green triangles), but does explain well all the other quarters (blue circles).



Notes: Panel A: The constructed measure is permanent Social Security increases (x-axis), and the potentially endogenous BEA measure is the change in all Social Security transfers (y-axis) (both as a share of labor income). In green triangles are the quarters where the permanent Social Security benefit increases coincide with temporary Social Security transfer increases or decreases (due to the payment or withdrawal of backpayments), which distorts the relationship and motivates adding these backpayments as controls in the regression in the main text. In quarters without temporary Social Security changes (blue circles), the relationship between constructed BEA Social Security benefit increases is strongly positive, and the slope is close to a 45 degree diagonal. Panel B: The constructed measure is 2008 Economic Stimulus Payments (x-axis), and the potentially endogenous measure is BEA category "All other current transfers" (y-axis) (both as a share of labor income). The relationship is close to a 45-degree diagonal.

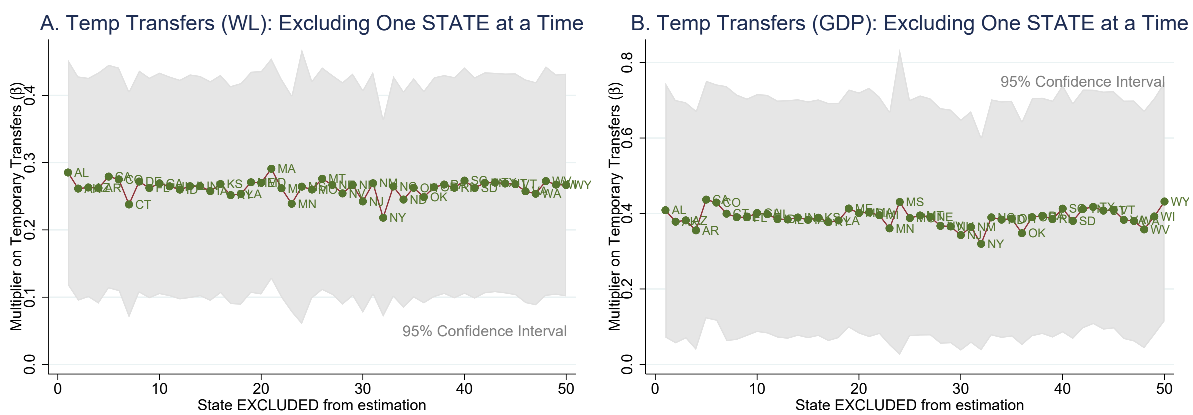
Figure 2. First Stage: Constructed Transfer and Comparable BEA Measure

Appendix Figure 3 shows that the temporary cross-region transfer multiplier is robust to dropping one state at a time using either the labor income (Panel A) or GDP (Panel B) specifications.

[17] I cannot draw a comparable figure for the 2001 stimulus payments, as these were not classified as transfers by the BEA.

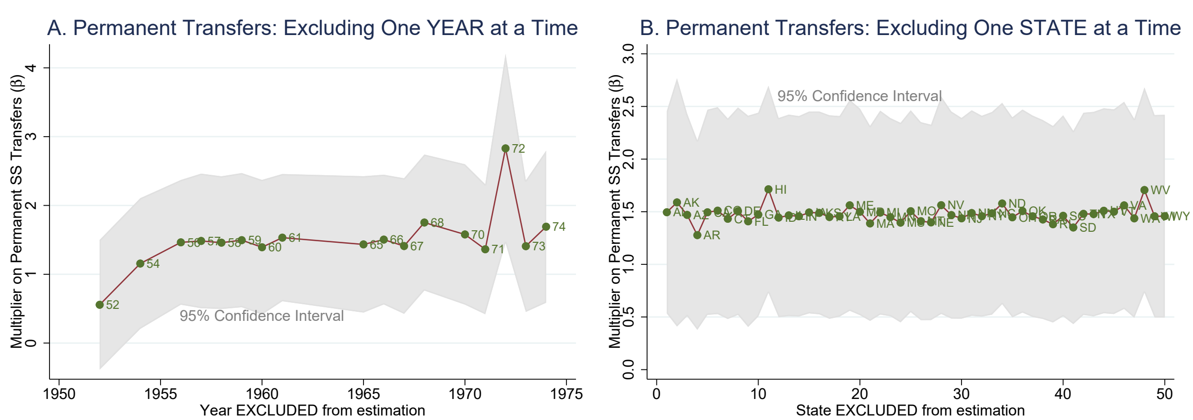
[18] One would not expect an exact linear relationship in either figure. For Panel A, the potentially endogenous transfers include the effects of changing demographics, cross-state migration, local business cycles, and changes in eligibility rules. For Panel B the potentially endogenous transfers include the effect of some other transfer programs beyond stimulus payments.

Appendix 4 shows that the permanent Social Security cross-region transfer multiplier is also robust to dropping one state at a time (Panel B), though the multiplier does change somewhat if either 1952 or 1972 is dropped (Panel A). However, as the effect of these years is mostly offsetting, dropping both influential years (as in main text Table 1) has little effect on the estimates.



Notes: Figures show the multiplier on temporary transfers excluding one state at a time. Dependent variable: real growth labor income per capita (Panel A) or real growth GDP per capita (Panel B). Using the parsimonious specification from the main text (with state and time fixed effects). 95% confidence intervals are shaded.

FIGURE 3. Temporary Transfers Dropping States One by One: Labor Income (Panel A) and GDP (Panel B)

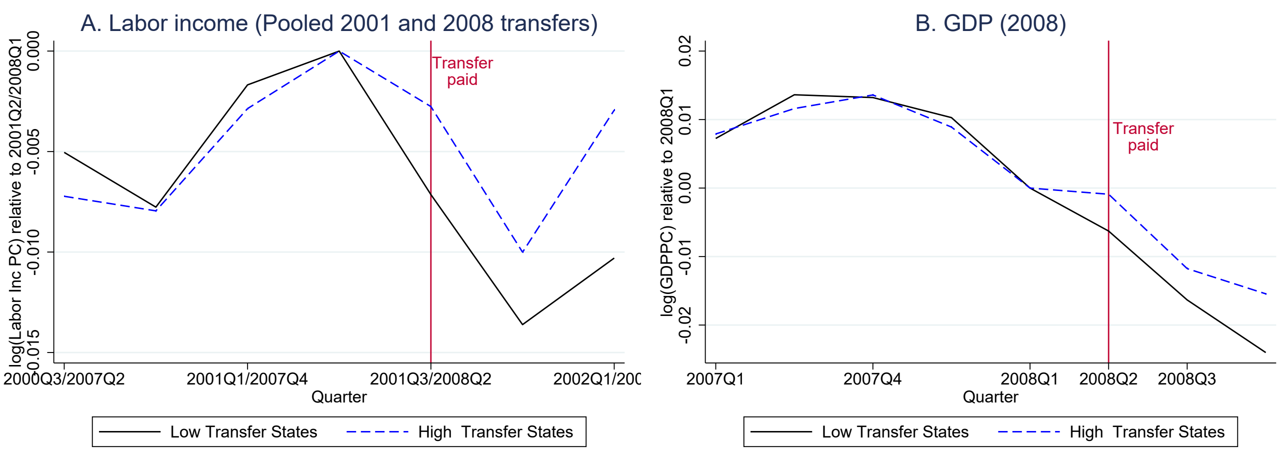


Notes: Figures show the multiplier on permanent transfers excluding either one year (Panel A) or one state (Panel B). Parsimonious specification from main text that includes state and time fixed effects. 95% confidence intervals are shaded.

FIGURE 4. Permanent Social Security Transfers Dropping Years (Panel A) or States (Panel B) One by One

Appendix Figure 5 is a "parallel trends" plot, which shows that states receiving relatively larger or smaller transfers had similar growth trajectories before the transfer was paid, on average, but the high transfer states grew faster in the quarter of payment. One can also see that there is some evidence of a persistent gap in normalized income between high and low transfer states in the following quarters. However, dividing states into only two groups removes much of the important variation in transfer size, and so the regression estimates are preferred.

To generate the plots, I put states in descending order based on the size of the transfer they received in 2001 or 2008 (as a share of labor income or GDP), and then I group the first half of states as "high transfer states" and the second half as "low transfer states." For each state, I normalize log per capita income relative to the quarter before the transfer was paid, 2001Q2 or 2008Q1 (e.g., $lnY^{pc}_{i,t} - lnY^{pc}_{i,2001Q2}$ or $lnY^{pc}_{i,t} - lnY^{pc}_{i,2008Q1}$). For GDP, the low (high) transfer lines in Appendix Figure 5 Panel B are the average of normalized income across the low (high) transfer states. For labor income, the low (high) transfer lines in Appendix Figure 5 Panel A also pool across all low (high) states in 2001 and 2008.[19]

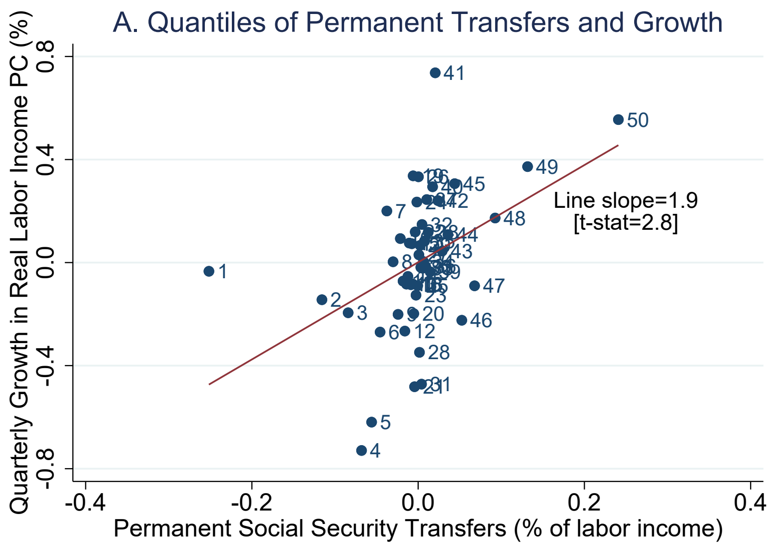


Notes: See text for information on the construction of the figure.

FIGURE 5. Parallel Trends

[19]That is, for Panel B, I calculate the mean of $lnGDP^{pc}_{i,t} - lnGDP^{pc}_{i,2008Q2}$ within each group ($i \in High, or\ i \in Low$), for each quarter t. For Panel A, I first calculate the rank j or k of each state according to their size of the transfer as a share of labor income in 2001 (j) or 2008 (k) (where $j, k = 1$ is the state with the largest transfer as share of labor income). The high transfer line is given by the average normalized income of all the high transfer states in quarter t: $\frac{1}{48}\left[\sum_{j=1}^{24}(ln(WL)^{pc}_{j,t} - ln(WL)^{pc}_{j,2001Q2}) + \sum_{k=1}^{24}(ln(WL)^{pc}_{k,t} - ln(WL)^{pc}_{k,2008Q1})\right]$. The low transfer line is calculated in an analogous way for states ranked $j, k = 25..48$. As the specification is in levels, I do not drop outliers, and I instead drop Alaska and Wyoming (both small and volatile states with a combined population of around 1 million), which is why the high and low transfer groups have only 24 states.

Figure 6 repeats Figure 1, Panel A from the main text but including bins with Social Security residuals that are close to zero (which make the relationship less visually obvious). The inclusion or exclusion of these bins does not affect the line slope.



Notes: This graph is the same as Figure 1, Panel A (main text) but includes the bins where Social Security residuals are less than 0.015% of labor income in absolute value. The fitted line slope and t-statistic are identical to those in the figure in the main text.

Figure 6. Permanent Transfers Bin Plot—Including Transfer Residuals Close to Zero

Appendix Table 3 replicates Table 2 from the main text but using the parsimonious specification rather than the benchmark specification (i.e., Appendix Table 3 does not include controls for population growth and state sensitivity to the national business cycle). The results are broadly similar. The multipliers on the 2001 transfer in the payment quarter (labor income specification) and on the low-income rebates (GDP specification) are both about 0.15 larger than those in the main text. However, these differences are only around half a standard error and so are likely to be insignificant. The p-values of tests of equality of coefficients are generally a little lower here than in the main text, though they are always above 5%. I put more weight on the benchmark specification reported in main text Table 2 because some of the larger coefficients may be due to omitted variables (which the benchmark specification partially addresses).

3.2. **Robustness Tests to Alternative Standard Errors and Outliers.** In this subsection, I discuss robustness tests to different standard errors (Appendix Table 4, Columns 2–4) and to adding back in extreme outliers (Appendix Table 4 Columns 5–6). Column 1 of Appendix Table 4 repeats the multiplier estimates from the main text (with robust standard errors clustered by state and excluding extreme outliers). All regressions in Appendix Table 4 use the parsimonious specification (with only state and time fixed effects).

Table 3. Temporary Transfers Multipliers: Heterogeneity by Quarter and Transfer Policy (Parsimonious Specification)

A. Heterogeneity by quarter			B. Heterogeneity by transfer component		
	Labor Income	GDP		Labor Income	GDP
2008Q2 Δ Transfer (paid)	0.26	0.89	2008 Δ Tax rebates	0.33	0.77
	(0.14)	(0.37)	(low-income)	(0.09)	(0.27)
2008Q3 Δ Transfer	0.23	-0.07	2008 Δ Tax refunds	-0.07	-0.56
(withdrawn)	(0.12)	(0.26)	(middle-income)	(0.29)	(0.54)
2001Q3 Δ Transfer (paid)	1.01		2001 Δ Tax refunds	0.51	
	(0.33)			(0.23)	
2001Q4 Δ Transfer	-0.02				
(withdrawn)	(0.41)				
P-value (equal coefficients)	0.148	0.104	P-value (equal coefficients)	0.175	0.055
State and quarter FEs	Yes	Yes	State and quarter fixed	Yes	Yes
Benchmark controls	No	No	Benchmark controls	No	No
Observations	1588	742	Observations	1588	742

Notes: Each column represents a regression of the growth rate of real labor income per capita or real GDP per capita on the change in normalized temporary transfers. Growth outliers greater than 20% (annualized, absolute value) are dropped. The regressor is disaggregated by the quarter of payment/withdrawal (Column A) or by the transfer policy (Column B). All regressions are estimated with the parsimonious specification from the main text (state and quarter FEs and no further controls). Robust standard errors are in parentheses (clustered by state).

Alternative Standard Errors. The results for permanent Social Security transfers are in Panel A. Removing clustering in Column 2 increases standard errors from 0.5 to 0.6 (p-value = 1.5%), while simple homoskedastic standard errors in Column 3 are also around 0.5 (p-value < 1%). One might also be concerned that shocks in one state might spill over to nearby states, for example, through local supply chains, and so errors will be correlated spatially. In Column 4, I correct for this using Conley's (1999) spatial correlation-robust standard errors, which are slightly larger (0.64) but still yield a multiplier that is significant at the 5% level.[20]

The results for temporary transfers are in Panel B (labor income specification) and Panel C (GDP specification) of Appendix Table 4. Removing clustering (Column 2) or correcting of spatial correlation (as above, Column 4) have little effect on significance. Homoskedastic errors are larger (Column 3), resulting in a loss of significance for the GDP specification (though the labor income specification is still significant at the 5% level). This is not a major worry, as states are very diverse—for example, California has a GDP nearly 100 times that of a number of small states—and so homoskedasticity is an extreme assumption.

Including Outliers. By default, I exclude all observations with an annualized per capita growth rate of more than 20% in absolute value, which is very conservative given that this rate is ten times US trend growth.[21] Large diversified state economies—like California—almost never have any outliers this extreme. However, several small states have very volatile growth processes that breach this threshold occasionally, perhaps driven by whether shocks, crop failures, or the opening of a new mine/oil well, which can make those states and quarters influential.

[20]I consider states "nearby" if their largest cities are within 400 kms (≈250 miles), motivated by the feasibility of a return business trip by land within the day. These are calculated using Hsiang's (2010) ols_spatial_HAC Stata ado file.

[21]In an earlier draft, I dropped outliers that were more than three standard deviations from the mean, which produced very similar results (though this meant the set of outliers would change with the sample).

Table 4. Alternative Standard Errors and the Effect of Outliers

	(1)	(2)	(3)	(4)	(5)	(6)
		Alternative Standard Errors			Including All Outliers	
	Main Text	No Clustering	Homo-skedastic	Spatial Correlation	All Observations (Default SE)	Excluding Smallest States (AK and WY)
Panel A: Permanent Social Security Transfers (Labor Income 1952-1974)						
Multiplier	1.47	1.47	1.47	1.47	1.99	3.14
	(0.49)	(0.61)	(0.50)	(0.64)	(1.10)	(0.98)
Obs.	4,413	4,413	4,413	4,413	4,600	4,416
Panel B: Temporary Stimulus Transfers (Labor Income 2001-2008)						
Multiplier	0.26	0.26	0.26	0.26	0.26	0.26
	(0.08)	(0.08)	(0.11)	(0.07)	(0.08)	(0.09)
Obs.	1,588	1,588	1,588	1,588	1,600	1,536
Panel C: Temporary Stimulus Transfers (GDP 2005-2008)						
Multiplier	0.39	0.39	0.39	0.39	-0.09	0.42
	(0.16)	(0.19)	(0.24)	(0.18)	(0.39)	(0.17)
Obs.	742	742	742	742	750	720

Notes: This table repeats the multiplier estimates from the main text in Column 1 and then changes the standard errors (Columns 2–4) or treatment of outliers (Columns 5–6). Standard errors (SEs) in parentheses. Column 1 repeats the multiplier estimates using the parsimonious specification from the main text (Table 1, row A1 transposed), which have heteroskedasticity-robust SEs clustered at the state level and outliers dropped if growth is above 20% in absolute value (annualized). Relative to the main text, Column 2 removes clustering (only robust SEs) and Column 3 reports homoskedastic SEs; Column 4 reports Conley's (1999) SEs (clustered by state), which allow for spatial correlation if the largest cities of states are within 400 km (250 miles). Column 5 reports results including all observations (with default SEs), and Column 6 reports results with all observations except Alaska (AK) and Wyoming (WY), the two smallest states in the middle of the sample with a combined population of less than one million in 1980 (with default SEs). Each cell reports the impact multiplier from a regression of the growth rate of per capita labor income (Panels A and B) or per capita GDP (Column C) on the normalized change in permanent Social Security transfers (Panel A) or temporary stimulus transfers (Panels B and C), as in Equation 2 in the main text (parsimonious specification). All regressions include state and quarter fixed effects.

For permanent transfers, adding back these outliers in Column 5 increases the estimated permanent transfer multiplier to 1.99 but more than doubles the standard errors (p-value increases to 8%). However, the estimates produced with all observations are very sensitive to these outliers and individual small states and are not reflective of the general relationship between transfers and growth. In Column 6, I show that by dropping only the two smallest states (Alaska and Wyoming) with a combined population of less than one million in 1980, the multiplier increases to 3.14, which then becomes statistically significant at the 1% level. This illustrates the importance of dropping extreme observations.

For temporary transfers, adding back extreme outliers where $|\text{growth}| > 20\%$ (annualized) in Column 5 has little effect on the labor income specification but results in the multiplier in the GDP specification going to zero (Column 5). This is driven by a couple of small economically undiversified states (larger diversified economies almost never have extreme outliers). Dropping the same two smallest states as above (Alaska and Wyoming, with a combined population of less than one million in 1980) restores the size and significance of multiplier in the GDP specification (Column 6).

3.3. **Voting Records for Temporary Stimulus Transfers.** Although my research design addresses the most important type of reverse causality by construction (countercyclicality), there is

Table 5. Determinants of Congressional Voting Records for Stimulus Packages

	(1) 2001	(2) 2008 (WL)	(3) 2008 (GDP)	(4) 2001	(5) 2008 (WL)	(6) 2008 (GDP)
Dependent Variable: Share of votes for transfer policy by representatives/senators from state						
Transfer size in state	11.15	-1.86	0.59			
(share of WL or GDP)	(17.02)	(3.42)	(5.13)			
State Growth Rate				7.39	3.43	1.69
(legislated quarter)				(5.09)	(1.95)	(1.14)
State Growth Rate				3.34	1.25	-1.71
(payment quarter)				(5.93)	(1.87)	(2.06)
Observations	48	50	50	48	46	48
Time and State FEs	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the share of votes in favor of the stimulus legislation (from govtrack.us) across the senators/representatives of each state in each chamber, averaged across the two chambers. Independent variables are the transfer size (as share of labor income or GDP) or state per capita growth rates (GDP or labor income) in the quarter when the transfer was legislated, or in the quarter it was first paid out. Robust standard errors are in parentheses. Growth outliers greater than 20% (annualized, absolute value) are dropped.

still a concern of reverse causality for temporary stimulus transfers via the legislative process.[22] That is, it could be that congressmen/congresswomen from states with worse recessions were more supportive of the transfer legislation and perhaps twisted the eligibility rules so it benefited their states. I test that hypothesis specifically in Appendix Table 5 using data on the voting records of congressmen/congresswomen from each state. The dependent variable used is a measure of the fraction of votes in favor of the legislation cast by representatives and senators from each state, averaging the fraction of "yea" votes from the House of Representatives and the fraction of "yea" votes from the Senate.[23]

In the first three columns of Appendix Table 5, I test the extent to which the size of the transfer drove the voting behavior of legislators from that state. It turns out that there is no statistically significant relationship between the size of the transfer received (as a share of labor income or GDP) and the likelihood the representatives/senators voted in favor of either the 2001 or 2008 legislation. In Columns 4–6, I test the extent to which the voting behavior was driven by state economic growth, either contemporaneously when the legislation was voted upon or in the following quarter when the transfer payments were made. Overall, there is no significant relationship (at the 5% level) between state economic growth and the likelihood the representatives/senators voted in favor of either the 2001 or 2008 legislation.

These results are not surprising, as votes were mostly along party lines in 2001 (Republicans for, Democrats against) or bipartisan in 2008 and eligibility for stimulus transfers was a simple function of prior-year income.

[22]Permanent Social Security measures are exogenous even at the aggregate level by Romer and Romer's narrative.
[23]For example, if two out of three representatives and one out of two senators from a state voted in favor, the dependent variable for that state would be $0.5 \times (2/3 + 0.5) = 0.58$.

3.4. **Alternative Cumulative Multipliers.** In this subsection, I provide additional detail on the estimation of cumulative multipliers presented in Figure 3 in the main text as well as some robustness tests using alternative specifications.

Permanent Transfers. For permanent transfers, the main specification (in Figure 3 in the main text) uses a projection method approach as in main text Equation 3 (repeated as Equation 3.1 here). This is estimated with OLS, and for horizons $h \geq 1$, I also drop the top and bottom 1% outliers.[24] Benchmark controls are included: population growth and US GDP growth $\times$ state fixed effects (FEs).

$$\sum_{j=0}^{h} \frac{Y_{i,t+j} - Y_{i,t-1}}{Y_{i,t-1}} = \beta_h \sum_{j=0}^{h} \frac{tr_{i,t+j} - tr_{i,t-1}}{Y_{i,t-1}} + \delta' X_{it} + \mu_t + \mu_i + e_{it}. \tag{3.1}$$

Cumulative multipliers for permanent transfers are shown in Table 6, Panel A. The first column repeats the results of the main specification used in Figure 3 in the main text. Cumulative multipliers are relatively constant at about 1.5 and are statistically significant at the 5% or 1% level. The second column uses a parsimonious specification instead, similar to that in the first row of Table 1 in the main text. Again, multipliers are around 1.5 over all horizons and are significant at the 5% level (at least). The final column includes the top and bottom 1% outliers. Comparing the first and final columns (which both have benchmark controls), one can see that at longer horizons the outliers increase the estimated multiplier to around two (and also reduce precision). As those higher multipliers are mostly due to a very small number of observations, the multipliers in the main results in the first column are preferred, as they are more representative of the general relationship.

Temporary Transfers. For temporary transfers, cumulative multipliers for $h = 1$ are calculated using a distributed lag specification, where an extra lag of transfers $\beta_1 \Delta tr_{i,t-1}/Y_{i,t-2}$ is added to Equation 2 in the main text for $h = 1$ to form Equation 3.2 below. Because the transfer is a one-off, the cumulative multiplier over two quarters is simply $\beta_0 + \beta_1$.[25] Benchmark controls of population growth and US GDP growth $\times$ state FEs are included (Column 1, and in Figure 3 of the main text), though I also report a parsimonious specification (Column 2). Column 3 of Table 6 uses a projection method as a robustness test (like Equation 3.1).

$$\Delta Y_{i,t}/Y_{i,t-1} = \sum_{j=0}^{h} \beta_j \Delta tr_{i,t-j}/Y_{i,t-j-1} + \boldsymbol{\delta' X_{it}} + \mu_t + \mu_i + e_{it}. \tag{3.2}$$

[24] I continue to drop observations where the absolute value of the growth rate is in excess of 20% annualized. For example, if $|(Y_{i,t+1} - Y_{i,t-1})/Y_{i,t-1}| > 1.20^{1/2} - 1$ for $h = 1$ (two quarters). But due to mean reversion, this cutoff becomes less stringent at longer horizons, making dropping top and bottom 1% outliers necessary. The 1% outliers are chosen based on the full sample. The changing overlap with the outliers defined in excess of 20% results in small changes in the sample size for different $h \geq 1$.

[25] Note that the cumulative multiplier expression will be different if transfers are not one-off. Also note that for $h = 1$, I extend the sample one quarter to account for the extra lagged effects, as the 2008 transfers were close to the end of the sample, which does not have a large effect on the results.

Table 6. Alternative Cumulative Multiplier Specifications

	Panel A: Permanent Social Security Transfers (Labor Income)					
	Default (benchmark)		Parsimonious		Including 1% Outliers	
Horizon:	Multiplier	Obs.	Multiplier	Obs.	Multiplier	Obs.
h=0 (impact multiplier)	1.29 (0.54)	4413	1.47 (0.49)	4413	1.29 (0.54)	4413
h=1	1.22 (0.58)	4306	1.28 (0.56)	4306	1.60 (0.67)	4392
h=2	1.39 (0.69)	4299	1.40 (0.69)	4299	1.79 (0.83)	4385
h=3	1.74 (0.76)	4297	1.66 (0.76)	4297	2.30 (0.96)	4383
	Panel B: Temporary Stimulus Transfers (Labor Income)					
	Default (benchmark)		Parsimonious		Projection Method	
Horizon:	Multiplier	Obs.	Multiplier	Obs.	Multiplier	Obs.
h=0 (default impact multiplier)	0.31 (0.09)	1588	0.26 (0.08)	1588	0.31 (0.09)	1588
h=1	0.26 (0.18)	1628	0.10 (0.14)	1628	0.23 (0.08)	1557
h=0 (with extra lag)	0.29 (0.10)	1588	0.21 (0.09)	1588		
	Panel C: Temporary Stimulus Transfers (GDP)					
	Default (benchmark)		Parsimonious		Projection Method	
Horizon:	Multiplier	Obs.	Multiplier	Obs.	Multiplier	Obs.
h=0 (default impact multiplier)	0.41 (0.18)	742	0.39 (0.16)	742	0.41 (0.18)	742
h=1	0.81 (0.55)	789	0.51 (0.46)	789	0.08 (0.31)	727
h=0 (with extra lag)	0.68 (0.3)	742	0.45 (0.24)	742		

Notes: Robust standard errors are in parentheses (clustered by state). Outliers |growth|> 20% (annualized) are dropped. The top and bottom 1% growth outliers also dropped for projection method specifications for $h \geq 1$, except where noted. All specifications include state and time fixed effects and are estimated with OLS. The default benchmark specification includes controls for population growth and US GDP growth × state fixed effects (the parsimonious specification excludes these controls).

Panel B reports results for growth in per capita labor income. As in main text Figure 3, Column 1 shows that the point estimates of the cumulative multiplier over the first six months ($h = 1$) are fairly similar to the impact multiplier of 0.3 for labor income, though less precisely estimated (leading to a loss of significance). The projection specification (Column 3) also has a $h = 1$ cumulative multiplier similar to the impact multiplier, though it is significant at the 1% level. While the parsimonious specification cumulative multiplier (Column 2) is a bit smaller, it is insignificantly different from the impact multiplier of 0.3.

Panel C reports results for growth in GDP per capita. As in Figure 3 in the main text (Column 1), there is some evidence of a higher cumulative multiplier of 0.8 at $h = 1$, double the impact multiplier of 0.4 reported in main text Table 1. But as standard errors also triple in width to 0.55, this difference is insignificant and not precisely estimated enough to be informative. The pattern of higher cumulative multipliers for $h = 1$ for GDP is also not robust to other specifications. For example, with a parsimonious specification (Column 2), the cumulative multiplier at $h = 1$

is only slightly larger than the impact multiplier, and using projection methods (Column 3), the cumulative multiplier is actually smaller than the impact multiplier (though both are insignificant).

The final rows of Panel B and C present alternative estimates of the impact multiplier: estimated in a specification with an extra lag of transfers (i.e., I estimate Equation 3.2 with $h = 1$, but only report β_0).[26] This does not affect the labor income regressions, but it does increase the impact multiplier for GDP in the benchmark specification (to 0.68) and almost doubles the standard errors. However, as before, the larger impact multiplier for GDP with a lagged transfer term only appears using the benchmark specification and is not present in the parsimonious specification (Column 2, final row).[27] Moreover, the extra lag (β_1 in Equation 3.2) is not significant at the 10% level in either labor income and GDP specifications (not reported), which is why they are not included in the results in the main text.

3.5. **Alternative Specifications in Detrended Levels.** In this section, I re-estimate the main results using a detrended levels specification based on Ramey and Zubairy (2018), adapted to my state-level context, rather than using the default growth rate specification as in the main text. After a restriction (not rejected in the data), the detrended levels specification generates similar impact and cumulative multipliers as those in the main text, though the cumulative multipliers are less precisely estimated.

To recap, the growth rate specification in the main text (main text Equation 2) is a regression of state-level growth rates (left hand side) on scaled first differences of the fiscal variable (right hand side). This is a standard specification in the multiplier literature, for example, in Barro and Redlick (2011), Nakamura and Steinsson (2014), Miyamoto, Nguyen, and Sergeyev (2018), and Kraay (2014). In contrast, Ramey and Zubairy (2018) regress detrended US GDP on detrended government spending, detrending both variables by dividing by a polynomial trend of US GDP.

As my data are at the state level, I also detrend here using a state-level trend (of GDP or labor income). This is important given many states have their own shocks that can lead trend growth to depart from the US average.[28] As the typical state is much less diversified than the US as a whole, its business cycle is more volatile, so instead of using a polynomial trend, I use a HP trend in log GDP per capita or log labor income per capita.[29]

3.5.1. *Impact Multipliers.* For the estimation of impact multipliers, my (second-stage) specification is

$$Y_{i,t}^{DT} = \gamma_0 \widehat{tr}_{i,t}^{DT} + \gamma_1 tr_{i,t-1}^{DT} + \Lambda Y_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}, \tag{3.3}$$

[26]Recall that the default impact multipliers are calculated using main text Equation 2, which is the same as Equation 3.2 with $h = 0$. Even if not reported, the extra lag can affect β_0 if $\Delta tr_{i,t-1}/Y_{i,t-2}$ and $\Delta tr_{i,t}/Y_{i,t-1}$ are correlated.

[27]This parsimonious specification is the same as that in row C3 of main text Table 1, with the same impact multiplier.

[28]For example, relative income in many "Rust Belt" states fell following the decline of manufacturing, and relative income in Appalachian states declined following closure of many coal mines.

[29]It is also not clear what degree polynomial would be appropriate, and the degree would vary across states.

where $X_{it}^{DT} \equiv \frac{X_{i,t}}{\widetilde{Y}_{i,t}}$ denotes the variable X in state i at time t that has been detrended by dividing by $\widetilde{Y}_{i,t}$, the exponential of HP trend of $logY_{it}$.[30] As in the main text, $Y_{it} = (WL)_{i,t}^{pc}$ (equivalent to labor income per capita) or quarterly GDP per capita $Y_{it} = GDP_{i,t}^{pc}$. μ_t and μ_i are time and state fixed effects as before. Following Ramey and Zubairy (2018), I include controls for both the lag of the detrended fiscal variable $tr_{i,t-1}^{DT}$ and a lag dependent variable $Y_{i,t-1}^{DT}$.[31] I call this the "unrestricted specification."

Following the literature, I estimate Equation 3.3 by IV where $tr_{i,t}^{DT}$ are potentially endogenous per capita transfers: total BEA Social Security benefits or the BEA "All Other Current Transfers." These variables are instrumented by my exogenous transfer series, denoted here as $extr_{i,t}^{DT}$: detrended exogenous per capita Social Security benefit increases or one-off per capita stimulus payments (respectively) as in (first-stage) Equation 3.4:

$$tr_{i,t}^{DT} = \phi_0 extr_{i,t}^{DT} + \theta_0 Y_{i,t-1}^{DT} + \theta_1 tr_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}. \tag{3.4}$$

A potential complication in estimating in levels is that the endogenous transfer variable $tr_{i,t}^{DT}$ is a flow of transfer payments every quarter, whereas $extr_{i,t}^{DT}$ is the detrended size of the temporary transfer in 2008Q2 or 2008Q3 (zero otherwise) or the size of the (detrended) increase Social Security stipends only in those quarters of a legislated increase (and zero otherwise).[32] However, this is not a problem since the lag of the detrended transfer variable $tr_{i,t-1}^{DT}$ from second-stage Equation 3.3, which naturally also appears in first-stage Equation 3.4, has a coefficient close to one and thus explains the majority of the day-to-day size of the transfer (with $extr_{i,t}^{DT}$ explaining jumps)—see first-stage estimates in Panel A2 of Table 7.[33]

Appendix Table 7, Panel A1 shows the second-stage results (impact multipliers) for the unrestricted specification. For permanent Social Security transfers (first column), one can see that the impact multiplier is 1.3 and significant at the 5% level—similar to the results in Table 1 in the main text. For temporary transfers, the impact multipliers are around 0.2 for both per capita labor income (Column 2) and per capita GDP (Column 3) as dependent variables. For labor income, this is similar to the size of the coefficient in the main text, though less significant (at the 10% rather than the 1% level). For GDP, the impact multiplier is insignificant and smaller than that in the main text.

Restricted Specification. Note that the coefficient on lagged transfers in Appendix Table 7, Panel A1 is almost equal to the negative of the coefficient on impact multiplier, $\gamma_1 \approx -\gamma_0$. The p-values of this restriction are also presented in Appendix Table 7, Panel A, and I fail to reject this restriction at the 10% level. For temporary transfers, this implies that the multiplier on payment

[30] That is, I calculate $\widetilde{Y}_{i,t} = exp(\text{hptrend}(\text{log}Y_{it}))$, with typical quarterly smoothing parameter of 1600.

[31] Ramey and Zubairy's baseline controls are lagged detrended real GDP per capita and lagged detrended government spending (p. 862).

[32] The 2001 stimulus payments are classified by the BEA as tax cuts rather than as part of "other current transfers" (as they are non-refundable), so they are excluded from the instrument.

[33] $Y_{i,t-1}^{DT}$ also appears in the first-stage regression but has an insignificant coefficient close to zero.

of the transfer is the same as the multiplier on withdrawal of the transfer, as in the main text. Applying the restriction $\gamma_0 = -\gamma_1$ means that the endogenous transfer variable is now in changes $\Delta\widehat{tr}_{i,t}^{DT}$ as in Equation 3.5:

$$Y_{i,t}^{DT} = \gamma_0 \Delta\widehat{tr}_{i,t}^{DT} + \Lambda Y_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}. \tag{3.5}$$

$\Delta\widehat{tr}_{i,t}^{DT}$ is instrumented by the change in exogenous permanent per capita Social Security increases or temporary per capita stimulus payments $\Delta extr_{i,t}^{DT}$ as in Equation 3.6. For temporary transfers, $\Delta extr_{i,t}^{DT} = extr_{i,t}^{DT}$ on the quarter of payment, but $\Delta extr_{i,t}^{DT}$ is negative in the following quarter when the transfers are withdrawn. However, for permanent Social Security increases, the exogenous transfer variable $extr_{i,t}^{DT}$ is effectively already in changes (as the Social Security increases are permanent, and is non-zero only in those quarters of increase), and so $\Delta extr_{i,t}^{DT} = extr_{i,t}^{DT}$.

$$\Delta tr_{i,t}^{DT} = \phi_0 \Delta extr_{i,t}^{DT} + \theta_0 Y_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}. \tag{3.6}$$

Appendix Table 7, Panel B1 shows the second-stage results for the restricted specification. For permanent Social Security increases, the multiplier is (unsurprisingly) similar in size and significance to the unrestricted specification (and the multipliers in the main text). For temporary stimulus transfers (for both labor income and GDP), multipliers are similar in size to those using the unrestricted specification (about 0.2), but standard errors are halved, resulting in estimates that are significant at the 1% level.[34] In sum, once I apply the restriction $\gamma_0 \approx -\gamma_1$ (not rejected at 10% in the data), the size and significance of the impact multipliers are fairly similar to those in the main text (smaller for GDP but still significant).

Why are multipliers so similar in two specifications that are ostensibly very different? This occurs because Equation 3.3 with the restriction $\gamma_0 = -\gamma_1$ "almost" collapses to the growth rate specification in the main text. Specifically, when I impose $\gamma_0 = -\gamma_1$, with some rearrangement Equation 3.5 becomes Equation 3.7. Because trend per capita income is similar to last quarter's per capita income, $\widetilde{Y}_{i,t} \approx Y_{i,t-1}$, the dependent variable is similar to the quarterly growth rate in the main text ($\Delta Y_{i,t}^{DT} \approx \Delta Y_{i,t}/Y_{i,t-1}$) and the independent variable is similar to the scaled change in transfer ($\Delta tr_{i,t}^{DT} \approx \Delta tr_{i,t}/Y_{i,t-1}$). Λ is close enough to 1 so that $(\Lambda - 1)Y_{i,t-1}^{DT}$ does not have a large effect on estimates.

$$\Delta Y_{i,t}^{DT} = \gamma \Delta\hat{tr}_{i,t}^{DT} + (\Lambda - 1) Y_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}. \tag{3.7}$$

Finally, note the size of the first-stage F-statistics in Appendix Table 7. In Panel A2 (unrestricted specification) they are around 270–600 (relative to a rule-of-thumb cutoff of 10). In Panel B2 (restricted specification), the first-stage F-statistics for temporary transfers are now over 850.

[34]The standard errors are much smaller because now both payment and withdrawal quarters can be used to estimate the multiplier, effectively doubling the number of non-zero observations.

Table 7. Levels Specification—Impact Multipliers

	Permanent Tr. (Social Security)	**Temporary Transfers** (2001 and 2008 Stimulus Payments)	
	Second Stage: Dependent Variable is Detrended Per Capita:		
	Labor Income (1952-74)	Labor Income (2001-08)	GDP (2005-08)
Instrumented $tr_{i,t}^{DT}$:	Social Security Transfers	Other Current Transfers	Other Current Transfers
	Panel A1. Second stage – unrestricted specification		
$\gamma_0 \widehat{tr}_{i,t}^{DT}$	1.30	0.20	0.18
	(0.53)	(0.12)	(0.12)
$\gamma_1 tr_{i,t-1}^{DT}$	-1.19	-0.12	-0.14
	(0.49)	(0.11)	(0.10)
$\delta_1 Y_{i,t-1}^{DT}$	0.81	0.77	0.76
	(0.019)	(0.03)	(0.04)
P-value: $\gamma_0 = -\gamma_1$	0.19	0.13	0.70
Observations	4413	1588	742
	Panel B1. Second stage – restricted specification		
$\gamma \Delta \widehat{tr}_{i,t}^{DT}$	1.61	0.17	0.18
	(0.68)	(0.06)	(0.06)
$\delta_1 Y_{i,t-1}^{DT}$	0.81	0.76	0.76
	(0.02)	(0.03)	(0.04)
	First Stage: Dependent Variable is Detrended Endogenous Transfers		
	Panel A2. First stage – unrestricted specification ($tr_{i,t}^{DT}$)		
$\phi_0 extr_{i,t}^{DT}$	0.82	1.02	1.01
	(0.03)	(0.05)	(0.06)
$\theta_0 Y_{i,t-1}^{DT}$	-0.00	-0.02	-0.02
	(0.00)	(0.01)	(0.02)
$\theta_1 tr_{i,t-1}^{DT}$	0.97	0.77	0.49
	(0.00)	(0.09)	(0.06)
First stage F-stat:	602	456	278
	Panel B2. First stage – restricted specification ($\Delta tr_{i,t}^{DT}$)		
$\phi_0 \Delta extr_{i,t}^{DT}$	0.76	1.12	1.09
	(0.03)	(0.04)	(0.04)
$\theta_0 Y_{i,t-1}^{DT}$	-0.00	-0.01	-0.00
	(0.00)	(0.01)	(0.01)
First stage F-stat:	621	869	855

Notes: Robust standard errors are in parentheses, clustered by state. See subsection 3.5.1 for a description of the regressions in each panel. Outliers |growth|> 20% (annualized) are dropped, as in growth rate specifications.

Combined with a first-stage coefficient of close to 1, the high F-stat verifies my approach of estimating a reduced-form specification in the main text.

3.5.2. *Cumulative Multipliers.* This subsection estimates cumulative multipliers over several quarters using a detrended levels specification as a cross-check to Figure 3 in the main text.[35] I use the unrestricted projection specification in Equation 3.8, which is an extension of Equation 3.3 using a direct projection approach. As before, this equation is estimated with instrumental variables, with the first stage as in Equation 3.9.[36]

[35]This captures the dynamic effects of transfers over two quarters for one-off payments ($h+1=2$, based on Parker et al. 2013) or one year for permanent transfers ($h+1=4$ quarters, based on Romer and Romer 2016).

[36]That is, $\sum_{j=0}^{h} tr_{i,t+j}^{DT}$ is instrumented using $h+1$ instruments. A \$1 increase in exogenous transfers leads to a \$0.73–\$0.93 cumulative increase in endogenous transfers (depending on the horizon and transfer type). As before, $extr_{i,t}^{DT}$ represents the increase in payments for permanent transfers, but the payments themselves for temporary transfers. Results instrumenting with $\phi \sum_{j=0}^{h} extr_{i,t+j}^{DT}$ rather than $\sum_{j=0}^{h} \phi_j extr_{i,t+j}^{DT}$ are similar (not reported).

TABLE 8. Levels Specification—Cumulative Multipliers

	Permanent Tr. (Social Security)		**Temporary Transfers** (2001 and 2008 Stimulus Payments)			
	Dependent Variable is quarterly growth in real per capita:					
	Labor Income (1952-74)		Labor Income (2001-08)		GDP (2005-08)	
Instrumented:	Social Security Transfers		Other Current Transfers		Other Current Transfers	
Horizon	Multiplier	Obs./F-stat	Multiplier	Obs./F-stat	Multiplier	Obs./F-stat
$h = 0$	1.30	4413 / 602	0.20	1588 / 456	0.18	742 / 278
	(0.53)		(0.12)		(0.12)	
$h = 1$	1.53	4357 / 755	0.07	1560 / 109	0.14	729 / 34
	(0.97)		(0.25)		(0.30)	
$h = 2$	1.21	4355 /549				
	(0.98)					
$h = 3$	0.94	4357 / 639				
	(0.89)					

Notes: Robust standard errors are in parentheses clustered by state. This table reports cumulative multipliers for horizons over $h+1$ quarters using a detrended levels specification and direct projection methods, as in Equation 3.8. Potentially endogenous Social Security and other current transfers are instrumented with exogenous Social Security increases and one-off stimulus payments (respectively), as in Equation 3.9. Outliers dropped as described in the text.

$$\sum_{j=0}^{h} Y_{i,t+j}^{DT} = \beta_h \sum_{j=0}^{h} tr_{i,t+j}^{DT} + \Lambda Y_{i,t-1}^{DT} + \gamma_1 tr_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}, \tag{3.8}$$

$$\sum_{j=0}^{h} tr_{i,t+j}^{DT} = \sum_{j=0}^{h} \phi_j extr_{i,t+j}^{DT} + \theta_1 Y_{i,t-1}^{DT} + \theta_2 tr_{i,t-1}^{DT} + \mu_t + \mu_i + e_{it}. \tag{3.9}$$

The results are shown in Appendix Table 8.[37] This specification collapses to the unrestricted levels specification (Equation 3.3) when $h = 0$ (the same as the first row of Appendix Table 7, Panel A1). For permanent Social Security transfers, the cumulative multipliers over longer horizons are quite similar to those estimated in the main text (especially for $h = 1$ and $h = 2$). However, they are much more imprecisely estimated (standard errors are almost twice as large)—making the cumulative multipliers at longer horizons insignificant. For temporary transfers, the multipliers at $h = 1$ are smaller than cumulative multipliers and impact multipliers in the main text, though they are also imprecisely estimated. In part due to these wider standard errors, I always fail to reject the restriction that the cumulative multipliers estimated here are equal to impact multipliers or the cumulative multipliers in Figure 3 of the main text. The growth rate specification used in the main text also produces cumulative multipliers that are generally more precisely estimated, which is another reason why they are preferred.

3.6. **Regressions on Simulated Data with Alternative Dynamics.** Given the different specifications for estimating cumulative transfer multipliers above, a natural question is whether all

[37]For $h \geq 1$, top and bottom 1% outliers are dropped to make sure that the estimated coefficient is representative of a general relationship. Outliers |growth|$>$ 20% (annualized) are also dropped, as in growth rate specifications.

methods can estimate cumulative multipliers correctly for alternative dynamic paths if cumulative multipliers differ from impact multipliers. In this section, I conduct simple quasi-Monte Carlo simulations for two alternative dynamic responses to transfers to help answer this question. Unlike a true Monte Carlo exercise, for simplicity these simulations are non-stochastic and in the time series only, but stochastic panel variants are similar (not reported). Given the simple data generating process, this exercise presents a minimum threshold for the specifications to pass.

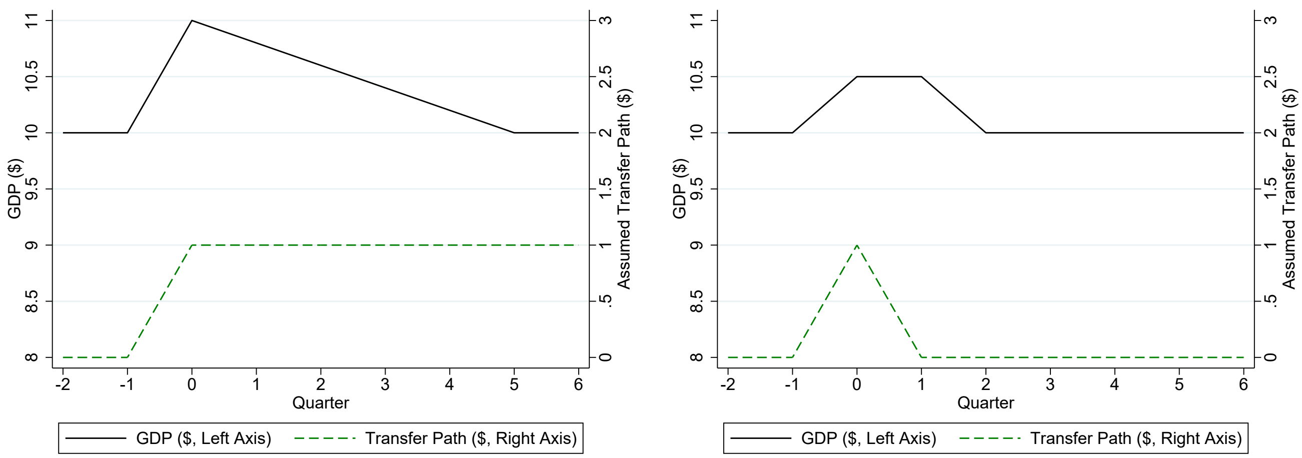


FIGURE 7. Simulated Alternative Output Responses to Transfers: Permanent (Left) and Temporary (Right)

First, I consider a permanent \$1 transfer that boosts output initially by \$1 at $t = 0$, but then GDP returns to baseline linearly over the next five quarters (Appendix Figure 7, left side). The true cumulative multiplier is initially 1 but then falls over time to $\mathcal{C}_3 = 0.7$ by $h = 3$ and falls eventually to 0 over longer horizons.[38] I then estimate cumulative multipliers using a projection approach in growth rates (similar to Equation 3.1), a projection approach in levels (similar to Equation 3.8), or as a distributed lag specification (similar to Equation 3.2 but with up to five lags of permanent transfers). All three specifications fairly accurately estimate cumulative multipliers, so in the main text I use the growth rate projection method common in the literature.

Second, I consider a one-off transfer of \$1 at $t = 0$, which has both a contemporaneous and a lagged effect on output (Appendix Figure 7, right side); GDP increases by \$0.5 in $t = 0$, the higher GDP level is maintained at $t = 1$, and then GDP falls back to trend at $t = 2$, yielding an impact multiplier of 0.5 ($h = 0$) and a cumulative multiplier of 1 by the second quarter ($h = 1$).[39] In this case, the distributed lag model correctly estimates both the impact and cumulative multipliers correctly, but both the levels and growth projection method are downward biased. For example at $h = 1$, the levels cumulative projection multiplier is 0.75 rather than 1 (though that specification

[38]This dynamic output response is motivated by a New Keynesian model where prices and wages adjust more quickly.

[39]This dynamic output response is motivated by some evidence from Johnson, Parker, and Souleles (2006) of a lagged consumption response to a one-off transfer.

can estimate impact multiplier correctly).[40] The growth cumulative multiplier is biased downward to 0.26 for $h = 0$ and 0.43 for $h = 1$. As such, I conclude that the best method to estimate cumulative temporary transfer multipliers is a distributed lag specification—as used in main text Figure 3 in the main text and as the default in Appendix Table 6.

Note, however, that the downward bias at $h = 0$ in contemporaneous growth rates depends on there actually being a lagged effect of temporary transfers on output. When I test for that in the data, I find that later lags are insignificant at the 10% level and the extra lag has little effect on the estimated impact multiplier in main text Table 1 (row C3). If there is only a contemporaneous effect, then all methods estimate the correct impact multiplier (not reported).

3.7. **Regressions Using Endogenous Transfer Measures.** Appendix Table 9 reports naive regressions of per capita growth in labor income or GDP on endogenous measures of transfers. The estimated specification is the same as Equation 2 in the main text but where the exogenous transfers have been replaced by three BEA measures of transfers that are potentially endogenous: all current transfers, all Social Security transfers, and all other current transfers. The estimated coefficients are often negative or insignificant and are always are more negative than the ones reported in the main text (for the comparable samples) This is unsurprising since these coefficient estimates likely suffer from some reverse causality (running from the income measures to the transfers), as transfers are typically countercyclical.

Table 9. Naive Regressions on Endogenous Transfers

Dependent Variable:	Labor Income (1952-74)		Labor Income (2001-08)		GDP (2005-08)	
All Current Transfers	-1.10		-0.11		0.03	
	(0.19)		(0.06)		(0.13)	
All Social Security Transfers		0.74				
		(0.32)				
All Other Current Transfers				-0.06		0.08
				(0.07)		(0.14)
Observations	4,413	4,413	1,588	1,588	742	742
Time and State FEs	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are in parentheses (clustered by state). Outliers |growth| > 20% (annualized) are dropped. The specification is the same as that in the main text (Equation 2) except the exogenous transfers are replaced by endogenous transfers.

[40]The downward bias here is because of a mismatch in the timing of the cumulative transfer and cumulative output: for $h = 1$, $\sum_{j=0}^{h} tr_{i,t+j}^{DT}$ increases to its maximum value ahead of $\sum_{j=0}^{h} Y_{i,t+j}^{DT}$ and falls before it.

4. Model Description, Calibration, and List of Equations

4.1. **Model Description and Calibration.** Consider a monetary union consisting of a small region (home)—like an individual US state—and the rest of the monetary union combined (foreign, denoted with $\star$). The home region has population n (close to zero), and the large region (the rest of the US) has population $1-n$. In the simple analytical model, I take the limit such that the home region becomes atomistic ($n \to 0$) so that it cannot affect the rest of the monetary union. Each region produces their own variety of good using only labor, named Y_h (produced by home) or Y_f (produced in the rest of the monetary union). Both goods are perfectly traded and are used for consumption in both regions and for domestic government purchases in the region in which they are produced. Both regions have home bias in consumption, and the two consumption goods are imperfectly substitutable. The relative price of the two goods (the terms of trade) is $s_t = P_{f,t}/P_{h,t}$. In the full quantitative New Keynesian model, $P_{f,t}$ and $P_{h,t}$ are sticky in the Calvo sense (and wages are also sticky), but in the analytical models I assume that $P_{f,t}$ and $P_{h,t}$ (and nominal wages in each region) are either perfectly fixed or perfectly flexible (for the Neoclassical model). There are two types of household in each region: Ricardian households (population share $1-\omega$) that can save and borrow using a risk-free bond, and hand-to-mouth households (henceforth HtM households, with population share ω) that consume their whole income each period. In the Neoclassical model, all households are Ricardian ($\omega \to 0$).

I solve the model by log-linearizing around the non-stochastic steady state where variables with a hat $\hat{x}$ reflect log-deviations from steady-state values (except for fiscal variables, which are expressed as share-of-GDP deviation from steady-state values).[41] A list of log-linear equations is provided in Appendix 4.2. I present the details of the model from the perspective of the home region, with the set-up in the foreign region being analogous.

4.1.1. *Ricardian Housforeholds' Problem (notation ′).* Each home Ricardian household $j \in [\omega, 1]$ maximizes utility (Equation 4.1):

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[lnc'_t(j) - L'_t(j)^{1+\varphi}/(1+\varphi) \right], \tag{4.1}$$

subject to a budget constraint (written in nominal terms):

$$P_t c'_t(j) = P_{h,t} b'_t(j) - R_{t-1} P_{h,t-1} b'_{t-1}(j) + W_t(j) L'_t(j) + P_{h,t,} Tr'_t + P_{h,t,} \Pi'_t + \chi_t,$$

where Tr'_t is net transfers from the government, Π'_t is profits from firms, $W_t(j)L'_t(j)$ is labor income, and P_t is the consumption price index in the home region.

If wages are flexible, each Ricardian household chooses labor supply $L'_t(j)$, consumption $c'_t(j)$, and real borrowing (b'_t) (all defined in per capita terms), taking wages and prices as given.[42]

[41] The steady-state has zero debt, is symmetric (adjusting for size), and has equal per capita income and equal prices (with $s_t = P_f/P_h = 1$). I solve the model using Dynare.

[42] Because labor of different households are perfect substitutes when wages are flexible, $W_t(j) = W_t$, and hence all Ricardian households will choose the same c'_t and b'_t, and L'_t.

When wages are sticky (see Section 4.1.4), each household has a differentiated labor variety and faces a downward-sloping labor demand curve for its labor (Equation 4.5). In that case, each household j chooses a nominal wage $W(j)$ (which it might not be able to change with probability θ_w each period) and provides whatever labor $L'_t(j)$ is demanded at that wage. It also chooses consumption $c'_t(j)$ and real borrowing (b'_t) (defined per Ricardian household).[43]

4.1.2. *Hand-to-Mouth Household's Problem (notation ″).* The HtM households consume their whole income hand-to-mouth as in Galí et al. (2007). Each home HtM household $j \in [0, \omega]$ maximizes utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ln(c''_t(j)) - L''_t(j)^{1+\varphi}/(1+\varphi) \right],$$

subject to the budget constraint (written in nominal terms):

$$P_t c''_t(j) = W_t(j) L''_t(j) + P_{h,t,} Tr''_t + P_{h,t} \Pi''_t.$$

The HtM household's income consists of net transfers from the government Tr''_t, labor income $W_t(j)L''_t(j)$, and profits from firms Π''_t. When wages are flexible, the HtM HH chooses $L''_t(j)$ and $c''_t(j)$, taking wages and prices as given (as $W_t(j) = W_t$, $L''_t(j) = L''_t$ and $c''_t(j) = c''_t$).

When wages are Calvo-sticky (see Section 4.1.4), each HtM household has differentiated labor variety and faces a downward-sloping labor demand curve (Equation 4.5). Following Erceg et al. (2006), I assume that HtM households set their wage at the average of that of the Ricardian households and hence supply the same amount of labor as the Ricardian households, on average. In log-linearized terms, this means $\hat{L}''_t = \hat{L}'_t = \hat{L}_t$.[44]

4.1.3. *Goods Demand and the Aggregate Resource Constraint.* Consumption in the home region (also per capita) is a constant elasticity of substitution (CES) index of varieties h and f produced by the two regions (c''_t is analogous):

$$c'_t = \left[\alpha^{1/\theta_T} c'^{(\theta_T - 1)/\theta_T}_{h,t} + (1-\alpha)^{1/\theta_T} c'^{(\theta_T - 1)/\theta_T}_{f,t} \right]^{\frac{\theta_T}{\theta_T - 1}}$$

$$c_t = (1-\omega) c'_t + \omega c''_t.$$

This results in the following standard demand equations for $c'_{h,t}$ and $c'_{f,t}$ and the consumer price index ($c''_{h,t}$ and $c''_{f,t}$ are analogous):[45]

[43] $\chi_t = D_t - E_t(Q_{t+1}D_{t+1})$ are revenues from Arrow securities D_t, less purchases next period $E_t(Q_{t+1}D_{t+1})$. Traded only with other home Ricardian households, they insure consumption against Calvo wage draws, ensuring $c'_t(j) = c'_t$ and $b'_t(j) = b'_t \; \forall j$. If wages are flexible, $\chi_t = 0$.

[44] Cogan et al. (2010, p. 293) make the same labor market assumptions, motivating it by a union.

[45] Log-linearizing with some algebra, consumption demand can be expressed in terms of the log terms of trade $\hat{s}_t = \hat{p}_{f,t} - \hat{p}_{h,t}$: $\hat{c}_{h,t} = \hat{c}_t + \theta_T(1-\alpha)\hat{s}_t$ and $\hat{c}_{f,t} = \hat{c}_t - \theta_T \alpha \hat{s}_t$. Note that $\gamma = 1 - n(1-\alpha)/(1-n)$ is the weight on f goods in the foreign region's utility function, which sets per capita income equal in steady state across countries with $S_{ss} = 1$.

$$c'_{h,t} = \alpha \left[P_{h,t}/P_t\right]^{-\theta_T} c'_t \tag{4.2}$$

$$c'_{f,t} = (1-\alpha) \left[P_{f,t}/P_t\right]^{-\theta_T} c'_t$$

$$P_t = \left[\alpha P_{h,t}^{1-\theta_T} + (1-\alpha) P_{f,t}^{1-\theta_T}\right]^{1/(1-\theta_T)}$$

Output of good h is consumed at home or abroad (an analogous condition for f). $g_{h,t}$ are government purchases of home goods, and $c^{\star}_{h,t}$ is foreign consumption demand for the home good. $g_{h,t}$, home government purchases, are usually funded by per capita lump-sum taxation across the rest of the monetary union (for the cross-region purchase multiplier) and are zero in steady state ($g_h^{SS} = 0$). $g_{h,t}$ can also be financed by a lump-sum tax on home Ricardian households (with $g_{f,t}$ funded by foreign Ricardian households), which is the financing assumption for calculating the aggregate purchase multiplier (when $g_{h,t} = g_{f,t} = g_t$). The aggregate resource constraint (written in home per capita terms, adjusting for different population sizes) is

$$Y_{h,t} = c_{h,t} + \frac{(1-n)}{n} c^{\star}_{h,t} + g_{h,t}.$$

Log-linearized, the terms of trade are given by

$$\hat{s}_t = \hat{p}_{f,t} - \hat{p}_{h,t} = \hat{\pi}_{f,t} - \hat{\pi}_{h,t} + \hat{s}_{t-1}. \tag{4.3}$$

4.1.4. *Production, Sticky Wages, and Sticky Prices.* As is standard in New Keynesian models (e.g., Galí and Monacelli 2005), final output in each region is produced by a unit continuum of monopolistically competitive firms in each region $Y_{h,t} = \left(\int_0^1 Y_{h,t}(i)^{\frac{\sigma_X - 1}{\sigma_X}} di\right)^{\frac{\sigma_X}{\sigma_X - 1}}$. Each firm uses labor as their only input such that for each firm i, $Y_{h,t}(i) = L_{h,t}(i)$ and $L_{h,t} = \int_0^1 L_{h,t}(i).di$. As the marginal product of labor is unity, (i) the aggregate real marginal cost is the real product wage $MC_{h,t} = w_{h,t} = W_t/P_{h,t}$, and (ii) the markup is the inverse of the real product wage $X_t = 1/w_{h,t}$. Taking a log-linear approximation around the steady state,[46] $\hat{mc}_{h,t} = \hat{w}_{h,t} = -\hat{X}_t$.

Firms face a downward-sloping demand curve for their variety and must choose a nominal price, taking into consideration the Calvo probability θ_p that they may not be able to change their price each quarter in the future. As shown in Galí and Monacelli (2005) and elsewhere, this price setting problem leads to a standard New Keynesian Phillips curve (Equation 4.4), where $\hat{\pi}_{h,t} = lnP_{h,t} - lnP_{h,t-1}$ is home producer price inflation:

$$\hat{\pi}_{h,t} = \beta E_t \hat{\pi}_{h,t+1} + \kappa \hat{mc}_{h,t}. \tag{4.4}$$

[46] The steady-state markup is $X = \sigma_X/(\sigma_X - 1)$. Firms are identical apart from their ability to re-optimize prices each period. Deviations from these aggregates are second order.

Wages are sticky as in Erceg, Henderson, and Levin (2000) and Galí (2008). L_t is a CES composite of differentiated labor inputs from each household j: $L_t = \left[\int_0^1 L_t(j)^{1-\frac{1}{\epsilon_w}} dj\right]^{\frac{\epsilon_w}{\epsilon_w - 1}}$. The demand for each variety j is

$$L_t(j) = (W_t(j)/W_t)^{-\epsilon_w} L_t, \tag{4.5}$$

where $W_t = [\int_0^1 W_t(j)^{1-\epsilon_w} dj]^{\frac{1}{1-\epsilon_w}}$.

$$\hat{Y}_{h,t} = \hat{L}_t. \tag{4.6}$$

As mentioned above, each Ricardian household $j \in [\omega, 1]$ can reset its wage each period with probability $1 - \theta_w$ (HtM HH set their wage at the average of Ricardian households). Given the wage-setting decisions by households that do re-optimize, and the fact that households that do not re-optimize must keep their nominal wages at last period's value, there is an analog of the Phillips curve (Equation 4.7). In particular, nominal wage inflation $\hat{\pi}_{w,t} = logW_t - logW_{t-1}$ will be a function of expected wage inflation tomorrow and the deviations of the Ricardian household's marginal rate of substitution from their steady-state level.

$$\hat{\pi}_{w,t} = \beta \mathbb{E}_t \hat{\pi}_{w,t+1} - \lambda \hat{\mu}_t, \tag{4.7}$$

$$\hat{\mu}_t = \underbrace{\hat{w}_{h,t} - (1-\alpha)\hat{s}_t}_{real \quad cons \quad wage} - \left[\varphi \hat{L}_t + \hat{c}'_t\right], \tag{4.8}$$

where $\lambda = \frac{(1-\theta_w)(1-\theta_w\beta)}{\theta_w(1+\varphi\varepsilon_w)}$ and $\hat{w}_{h,t} = \hat{w}_{h,t-1} + \hat{\pi}^w_t - \hat{\pi}_{h,t}$ is the real product wage. The setup in the foreign region is analogous.

4.1.5. *Monetary Policy and Interest Rates.* Monetary policy is irrelevant for the size of the cross-region transfer multiplier because the home region is very small and so does not affect monetary-union-wide inflation.[47] However, it is crucial for closed economy aggregate multipliers, which are very sensitive to the degree of monetary accommodation of inflation. I assume two different interest rate rules:

- Volker-Greenspan "lean against the wind" monetary policy rule (from Nakamura and Steinsson 2014) with $\phi_\pi = 1.5$, $\phi_y = 0.5$, and $\rho_r = 0.8$:[48]

$$\hat{R}^{US}_t = \rho_r \hat{R}^{US}_{t-1} + (1-\rho_r)\left[\phi_\pi \hat{\pi}^{US}_t + \phi_y \hat{Y}^{US}_t\right]. \tag{4.9}$$

[47] Cross-region transfers are also symmetric policies, so any effect in the home region is offset by the opposite movement in the foreign region. In the empirical work, monetary policy is also subsumed into the time fixed effect.

[48] Where $\hat{\pi}^{US}_t = n\hat{\pi}_{h,t} + (1-n)\hat{\pi}_{f,t}$ is US-wide inflation, $\hat{Y}^{US}_t = n\hat{Y}_{h,t} + (1-n)\hat{Y}_{f,t}$ is US-wide GDP, and $\hat{R}^{AGG}_t = lnR^{AGG}_t - lnR^{AGG}$ is the log deviation of the nominal interest rate from its steady-state level.

- A constant real rate interest rate policy, where the forward-looking Taylor coefficient approaches 1 ($\phi_\pi^{FL} \to 1^+$). This is an example of "accommodative" monetary policy:[49]

$$\hat{R}_t^{US} = \phi_\pi^{FL} E_t \hat{\pi}_{t+1}^{US}. \tag{4.10}$$

To ensure stationarity, I add a small debt-elastic interest spread ψ as in Schmitt-Grohe and Uribe (2003), which slowly moves the model back to steady state (where $(1-\omega)\hat{b}_t^{\prime Y}$ is the deviation of borrowing from steady state as share of home GDP).[50] $s\hat{p}_t$ is a spread shock used to generate a regional recession in Section 5.2:

$$\hat{R}_t = \hat{R}_t^{US} + \psi(1-\omega)\hat{b}_t^{\prime Y} + s\hat{p}_t. \tag{4.11}$$

4.1.6. *Fiscal Policy.* **Cross-Region Transfers.** Cross-region transfers (federally financed transfers) consist of exogenous balanced budget lump-sum transfers from all households in the foreign region to all households in the home region in proportion to their population share (i.e., HtM households receive a fraction ω of transfers). Because the home region is small, this is almost identical to results when (i) lump-sum taxes to pay for the transfers fall on the whole monetary union (rather than just the foreign region) and (ii) the taxes to pay the transfer are levied on the foreign Ricardian households.

Government Purchases. Government purchases are purchases of home goods (not valued by households), usually financed by equal per capita lump-sum taxes levied on the residents of the large foreign region.

Aggregate Transfers/Purchases. I model aggregate closed economy government purchase/transfer shocks as simultaneous (and equally sized) purchase/transfers shocks in each region, financed by lump-sum taxes on the Ricardian households in the same region.[51] Ricardian households can be thought of as the wealthier households (who pay the majority of the taxes), and due to Ricardian equivalence, this is equivalent to a debt-funded transfer with future lump-sum taxes falling on Ricardian households. The degree of targeting of transfers is the fraction ω_T of the transfer received by the HtM households. My default assumption is that transfers are untargeted; that is, the fraction of the transfers received by HtM households is the same as their population share $\omega_T = \omega$ (which is why I abstract from ω_T in most of the main text). As an extension, I also allow for aggregate targeted transfers, where $\omega < \omega_T \leq 1$.

Both transfers and purchases are expressed as deviations from steady state as a share of GDP ($\hat{tr}_h^Y$ and $\hat{g}_h^Y$), which usually follows an AR(1) process with quarterly persistence ρ.

[49]One could also consider the zero lower bound (ZLB), where $\hat{R}_t^{US} = 0$ for a certain number of periods and then returns to the rule in Equation 4.9. However, multipliers under that rule are very sensitive to the persistence of fiscal policy relative to the persistence of the rule (and there are issues of indeterminacy), and so characterizing accommodative monetary policy by a constant interest rate rule is simpler.

[50]Note that because $\hat{b}_t^{\prime Y}$ is borrowing as share of GDP per Ricardian household, to get aggregate home borrowing as a share of GDP, we must multiply by the number of Ricardian households $(1-\omega)$.

[51]That is, an aggregate transfer is a self-financed transfer in the home region occurring at the same time as a self-financed transfer in the foreign region (of the same size in per capita terms).

4.1.7. *Calibration.* The main parameters are listed in Appendix Table 10. One of the key parameters for the transfer multiplier is the HtM household share. Although my HtM HH share of $\omega = 1/3$ is taken from the evidence in Kaplan et al. (2014), it is in the middle of the range of other papers in the literature for the US. For example, Kaplan and Violante (2014) estimate 18%–35%, Iacoviello (2005) estimates 36%, Cogan et al. (2010) calibrate 26%, and Campbell and Mankiw (1989) calibrate 50%.[52]

Table 10. Model Parameters

	New Keynesian Model	Neoclassical Model	Source/Target (2005-08)
Home Bias (α)	0.69	0.69	Nakamura and Steinsson (2014)
Frisch Labor Elasticity (φ^{-1})	1	1	Nakamura and Steinsson (2014)
CES Home-Foreign Elasticity (θ_T)	2	2	Nakamura and Steinsson (2014)
Quarterly Discount Rate (β)	0.99	0.99	Nakamura and Steinsson (2014)
Calvo Prob. No Price Change (θ_p)	0.75	-	Nakamura and Steinsson (2014)
Calvo Prob. No Wage Change (θ_w)	0.75	-	Barattieri et al. (2014)/ Christiano et al. (2005)
Hand-to-mouth HH Share (ω)	1/3	-	Kaplan et al. (2014)
Country/Region Size (n)	0.02	0.02	Average size of US state

4.2. **List of Log-Linear Equations.** This subsection lists the log-linear equations of the model (which correspond to those in Dynare). Note: Quantity variables are typically in per capita terms, except for fiscal variables, which are share of per capita GDP (and hence are scaled by population shares in per capita equations). Equations with a # are for expositional clarity and can be easily removed via substitution. In the equation names, "H" denotes the home region and "F" denotes the foreign region. γ is defined by the balanced trade condition $(1-\gamma)(1-n) = n(1-\alpha)$ (assuming no steady-state debt). $\Pi_{SS}/Y_{ss} = (X-1)/X$ is the profit share of GDP. $X = \sigma_X/(\sigma_X - 1) = 1.05$ is the steady-state markup.

Equation 1 (Euler Eq. H): $\hat{c}'_t = E_t\hat{c}'_{t+1} - E_t\left[\hat{R}_t - (\alpha\hat{\pi}_{h,t+1} + (1-\alpha)\hat{\pi}_{f,t+1})\right]$

Equation 2 (Euler Eq. F): $\hat{c}'^{\star}_t = E_t\hat{c}'^{\star}_{t+1} - E_t\left[\hat{R}^{US}_t - (\gamma\hat{\pi}_{f,t+1} + (1-\gamma)\hat{\pi}_{h,t+1})\right]$

Equation 3 (Definition C):# $\hat{c}_t = \omega\hat{c}''_t + (1-\omega)\hat{c}'_t$

Equation 4 (Definition $C^\star$):# $\hat{c}^\star_t = \omega\hat{c}''^{\star}_t + (1-\omega)\hat{c}^{\star\prime}_t$

Equation 5 (H Demand by H): $\hat{c}_{h,t} = \theta_T(1-\alpha)\hat{s}_t + \hat{c}_t$

Equation 6 (F Demand by H): $\hat{c}_{f,t} = -\theta_T\alpha\hat{s}_t + \hat{c}_t$

Equation 7 (H Demand by F): $\hat{c}^\star_{h,t} = \theta_T\gamma\hat{s}_t + \hat{c}^\star_t$

Equation 8 (F Demand by F): $\hat{c}^\star_{f,t} = -\theta_T(1-\gamma)\hat{s}_t + \hat{c}^\star_t$

Equation 9 (Terms of Trade): $\hat{s}_t = \hat{s}_{t-1} + \hat{\pi}_{f,t} - \hat{\pi}_{h,t}$

Equation 10 (Aggregate Labor H): $\hat{L}_{h,t} = \omega\hat{L}''_t + (1-\omega)\hat{L}'_t$

Equation 11 (Aggregate Labor F): $\hat{L}_{f,t} = \omega\hat{L}''^{\star}_{,t} + (1-\omega)\hat{L}'^{\star}_t$

[52]Other parameters are $\psi = 0.00005$ for the debt-elastic interest spread (Schmitt-Grohe and Uribe 2003, annual figure of 0.00074 converted to quarterly figure) and CES elasticity across labor varieties in the New Keynesian model ($\varepsilon_w = 21$; Christiano et al. 2005).

Equation 12 (Output H)#: $\hat{y}_{h,t} = \hat{L}_{h,t}$

Equation 13 (Output F)#: $\hat{y}_{f,t} = \hat{L}_{f,t}$

Equation 14 (Markup H)#: $\hat{w}_{h,t} = -\hat{X}_{h,t}$

Equation 15 (Markup F)#: $\hat{w}_{f,t} = -\hat{X}_{f,t}$

Equation 16 (Philips curve H): $\hat{\pi}_{h,t} = \beta E_t \hat{\pi}_{h,t+1} - \kappa \hat{X}_{h,t}$

Equation 17 (Philips curve F): $\hat{\pi}_{f,t} = \beta E_t \hat{\pi}_{f,t+1} - \kappa \hat{X}_{f,t}$

Equation 18 (Taylor rule Volker-Greenspan) $\hat{R}_t^{US} = \rho_r \hat{R}_{t-1}^{US} + (1-\rho_r)\left[\phi_\pi \hat{\pi}_t^{US} + \phi_y \hat{Y}_t^{US}\right]$

or (Taylor rule FL): $\hat{R}_t^{US} = \phi_\pi^{FL} E_t \hat{\pi}_{t+1}^{US}$

Equation 19 (Aggregate inflation)#: $\hat{\pi}_t^{US} = n\hat{\pi}_t^h + (1-n)\hat{\pi}_t^f$

Equation 20 (Aggregate resource constraint H): $\hat{y}_{h,t} = \alpha \hat{c}_{h,t} + (1-\alpha)\,\hat{c}_h^\star + \hat{g}_{h,t}^Y$,
where $\hat{g}_{h,t}^Y = \hat{g}_{h,t}^{Y,SF} + \hat{g}_{h,t}^{Y,CR}$

Equation 21 (Aggregate resource constraint F): $\hat{y}_{f,t} = (1-\gamma)\hat{c}_{f,t} + \gamma \hat{c}_{f,t}^\star + \hat{g}_{f,t}^Y$,
where $\hat{g}_{f,t}^Y = \hat{g}_{f,t}^{Y,SF}$

Equation 22 (Budget Constraint (BC) Ricardian HH H):[53]

$$\hat{b}_t^{\prime Y} = \beta^{-1}\hat{b}_{t-1}^{\prime Y} - \left\{\left(1 - \frac{\Pi_{SS}}{Y_{ss}}\right)\left(\hat{w}_{h,t} + \hat{L}_t'\right) + \frac{\hat{Tr}_t^{Y\prime}}{(1-\omega)} + \frac{\Pi_{SS}}{Y_{ss}}\hat{\Pi}_t\right\} + \left(\hat{c}_t' + (1-\alpha)\hat{s}_t\right)$$

Equation 23 (BC HtM HH H): $\left(1 - \frac{\Pi_{SS}}{Y_{ss}}\right)\left(\hat{w}_{h,t} + \hat{L}_t''\right) + \frac{1}{\omega}\hat{Tr}_t^{Y\prime\prime} + \frac{\Pi_{SS}}{Y_{ss}}\hat{\Pi}_t = \hat{c}_t'' + (1-\alpha)\hat{s}_t$

Equation 24 (BC HtM HH F): $\left(1 - \frac{\Pi_{SS}}{Y_{ss}}\right)\left(\hat{w}_{f,t} + \hat{L}_t^{\prime\prime\star}\right) + \frac{1}{\omega}\hat{Tr}_t^{Y\prime\prime\star} + \frac{\Pi_{SS}}{Y_{ss}}\hat{\Pi}_t^\star = \hat{c}_t^{\prime\prime\star} - (1-\gamma)\hat{s}_t$

Equation 25 (Debt-elastic interest spread): $\hat{R}_t = \hat{R}_t^{US} + \psi(1-\omega)\hat{b}_t^{\prime Y} + s\hat{p}_t$

Equation 26 (Labor-leisure FOC H Ric): $\hat{\mu}_{h,t}' = \hat{w}_{h,t} - \left[\varphi \hat{L}_t' + \hat{c}_t' + (1-\alpha)\hat{s}_t\right]$

Equation 27 (Labor-leisure FOC H HtM)#: $\hat{\mu}_{h,t}'' = \hat{w}_{h,t} - \left[\varphi \hat{L}_t'' + \hat{c}_t'' + (1-\alpha)\hat{s}_t\right]$

Equation 28 (Labor-leisure FOC F Ric): $\hat{\mu}_{f,t}' = \hat{w}_{f,t} - [\varphi L_t^{\prime\star} + \hat{c}_t^{\prime\star} - (1-\gamma)\hat{s}_t]$

Equation 29 (Labor-leisure FOC F HtM)#: $\hat{\mu}_{f,t}'' = \hat{w}_{f,t} - [\varphi L_t^{\prime\prime\star} + \hat{c}_t^{\prime\prime\star} - (1-\gamma)\hat{s}_t]$

If wages are sticky (as in the main New Keynesian model), the following four equations apply (SW = sticky wages):

Equation 30SW (Equal work H): $\hat{L}_t' = \hat{L}_t''$

Equation 31SW (Equal work F): $\hat{L}_t^{\prime\star} = \hat{L}_t^{\prime\prime\star}$

Equation 32SW (Phillips curve SW H): $\hat{\pi}_{h,t}^w = \beta \mathbb{E}_t \hat{\pi}_{h,t+1}^w - \lambda \hat{\mu}_{h,t}'$

Equation 33SW (Phillips curve SW F): $\hat{\pi}_{f,t}^w = \beta \mathbb{E}_t \hat{\pi}_{f,t+1}^w - \lambda \hat{\mu}_{f,t}'$

If wages are flexible (as in the Neoclassical model), Equation 30SW–33SW are replaced by 30FW–33FW (FW = flexible wages):[54]

Equation 30FW (Labor-leisure FOC H Ric holds): $\hat{\mu}_h' = 0$

[53] Recall $b_{ss}/Y_{ss} = 0$ in the symmetric calibration. The analogous equation for the foreign region is excluded via Walras's law. This also means that we do not need to define the transfers received by the foreign Ricardian household.

[54] Combined with Equations 26–29, this implies that with flexible wages the standard labor-leisure FOCs apply: H Ric: $\hat{w}_{h,t} = \varphi \hat{L}_t' + \hat{c}_t' + (1-\alpha)\hat{s}_t$; H HtM: $\hat{w}_{h,t} = \varphi \hat{L}_t'' + \hat{c}_t'' + (1-\alpha)\hat{s}_t$; F Ric: $\hat{w}_{f,t} = \varphi L_t^{\prime\star} + \hat{c}_t^{\prime\star} - (1-\gamma)\hat{s}_t$; F HtM: $\hat{w}_{f,t} = \varphi L_t^{\prime\prime\star} + \hat{c}_t^{\prime\prime\star} - (1-\gamma)\hat{s}_t$.

Equation 31FW (Labor-leisure FOC H HtM holds): $\hat{\mu}''_h = 0$
Equation 32FW (Labor-leisure FOC F Ric holds): $\hat{\mu}'_f = 0$
Equation 33FW (Labor-leisure FOC H HtM holds): $\hat{\mu}''_f = 0$
Equation 34 (Definition wage inflation H)#:[55] $\hat{w}_{h,t} = \hat{w}_{h,t-1} + \hat{\pi}^w_{h,t} - \hat{\pi}_{h,t}$.
Equation 35 (Definition wage inflation F)#: $\hat{w}_{f,t} = \hat{w}_{f,t-1} + \hat{\pi}^w_{f,t} - \hat{\pi}_{f,t}$
Equation 36 (Profit definition H): $\hat{\Pi}_t = \hat{y}_{h,t} + \hat{X}_{h,t}/(\bar{X} - 1)$
Equation 37 (Profit definition F): $\hat{\Pi}^\star_t = \hat{y}_{f,t} + \hat{X}_{f,t}/(\bar{X} - 1)$
Equation 38 (US GDP): $\hat{Y}^{US}_t = n\hat{Y}_{h,t} + (1-n)\hat{Y}_{f,t}$
Equation 39 (Measured GDP H)#: $\hat{Y}_{meas.,t} = (1-n)(\hat{Y}_{h,t} - \hat{Y}_{f,t} - \hat{s}_t)$
Equation 40 (Measured labor income H)#: $\hat{WL}_{meas.,t} = (1-n)(\hat{w}_{h,t} + \hat{L}_{h,t} - (\hat{w}_{f,t} + \hat{L}_{f,t}) - \hat{s}_t)$

Exogenous processes:

(Home cross-region government purchases shock): $\hat{g}^{Y,CR}_{h,t} = \rho\hat{g}^{Y,CR}_{h,t-1} + e^{CR}_{G,t}$
(Home self-funded government purchases spending shock): $\hat{g}^{Y,SF}_{h,t} = \rho\hat{g}^{Y,SF}_{h,t-1} + e^{SF}_{h,G,t} + e^{AGG}_{G,t}$

(Cross-region transfer shock) $tr^Y_{CR,t} = \begin{cases} \rho tr_{CR,t-1} + e_{CR,t} & if\ exogenous \\ -0.3\hat{y}_{h,t} & if\ countercyclical \end{cases}$

(Self-funded transfer shock) $tr^{Y,SF}_{h,t} = \begin{cases} \rho tr^{Y,SF}_{h,t-1} + e^{SF}_t + e^{AGG}_{tr,t} & if\ exogenous \\ -0.3\hat{y}_{h,t} & if\ countercyclical \end{cases}$

(Spread shock for state-level recession) $spread_t = \rho_s spread_{t-1} + e_{sp}$
Fiscal expressions for allocating transfers: [56]
(Transfers received by home HtM): $\hat{Tr}^{Y''}_t = \omega_T \left(tr^Y_{CR,t} + tr^Y_{SF,t}\right)$
(Transfers received by foreign HtM): $\hat{Tr}^{Y''\star}_t = \omega_T \hat{tr}^{Y,SF}_{f,t} - \omega_T \frac{n}{1-n}\left[tr_{CR,t} + \hat{g}^{Y,CR}_{h,t}\right]$
(Transfers received by home Ricardian HH): $\hat{Tr}^{Y'}_t = (1-\omega_T)tr^Y_{CR,t} - \omega_T tr^Y_{SF,t} - \hat{g}^{Y,SF}_{h,t}$

Aggregate Fiscal Policy. I model aggregate closed economy government purchase or transfers as a simultaneous equal-sized self-financed purchase or transfer shocks in each region, triggered by the same shock $e^{AGG}_{G,t}$ (for purchases) or $e^{AGG}_{tr,t}$ (for transfers).[57]
(Foreign self-funded purchases shock): $\hat{g}^{Y,SF}_{f,t} = \rho\hat{g}^{Y,SF}_{f,t-1} + e^{SF}_{f,G,t} + e^{AGG}_{G,t}$
(Foreign self-funded transfer shock): $\hat{tr}^{Y,SF}_{f,t} = \rho\hat{tr}^{Y,SF}_{f,t-1} + e^{SF}_{f,tr,t} + e^{AGG}_{tr,t}$

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5. Smoothing State-Level Business Cycles

5.1. **Calibrating the Persistence of State Business Cycles.** This subsection calculates the persistence of asymmetric state-level business cycles, which determine the persistence of countercyclical net transfers generated by automatic stabilizers and hence the size of the associated cross-region transfer multiplier. The calculation involves two steps. First, I regress state-level log

[55] In the flexible wage case, Equations 34 and 35 are optional, as they just define nominal wage growth $\hat{\pi}^w_{h,t}$ and $\hat{\pi}^w_{f,t}$
[56] Note that this expression assumes that the home households do not pay for cross-region transfers or purchases. Results are almost identical if instead they pay a share $n = 2\%$.
[57] Note that $\hat{g}^{Y,SF}_{f,t}$ and $\hat{tr}^{Y,SF}_{f,t}$ do not appear anywhere in terms of financing. This is because they are funded by foreign Ricardian households, which is the surplus equation due to Walras's law.

real per capita labor income $log(WL^{pc}_{i,t})$ on both a time trend and US-wide log real per capita labor income $log(WL^{pc}_{US,t})$ (Equation 5.1) and collect the residual $\hat{e}^{WLpc}_{i,t}$. The controls remove effect of trends and aggregate variation (respectively) to uncover the asymmetric state-level business cycle. Then I estimate the quarterly persistence ρ_i of the residual $\hat{e}^{WLpc}_{i,t}$ using Equation 5.2. My measure of income is quarterly real labor income per capita for each state (deflated by the PCE) over 1950–2010, as in the main text.[58]

$$log(WL^{pc}_{i,t}) = \alpha_0 + \alpha_1 t + \alpha_2 log(WL^{pc}_{US,t}) + e^{WL}_{i,t} \rightarrow \hat{e}^{WLpc}_{i,t}, \tag{5.1}$$

$$\hat{e}^{WLpc}_{i,t} = \alpha_i + \rho_i \hat{e}^{WLpc}_{i,t-1} + \varepsilon_{i,t}. \tag{5.2}$$

The mean quarterly persistence across the 50 US states is $\hat{\rho} = 0.935$, which corresponds to a half-life of around 10 quarters (2.5 years). This is the measure of persistence that I use in my assessment of the federal fiscal system's ability to smooth regional shocks. The 90th percentile of the distribution is around $\rho_A = 0.98$ (half-life of 8.5 years), and the 10th percentile is 0.88 (half-life of around 1.3 years). For robustness, I also calculated persistence of state-level business cycles two other methodologies, which generated similar results.[59]

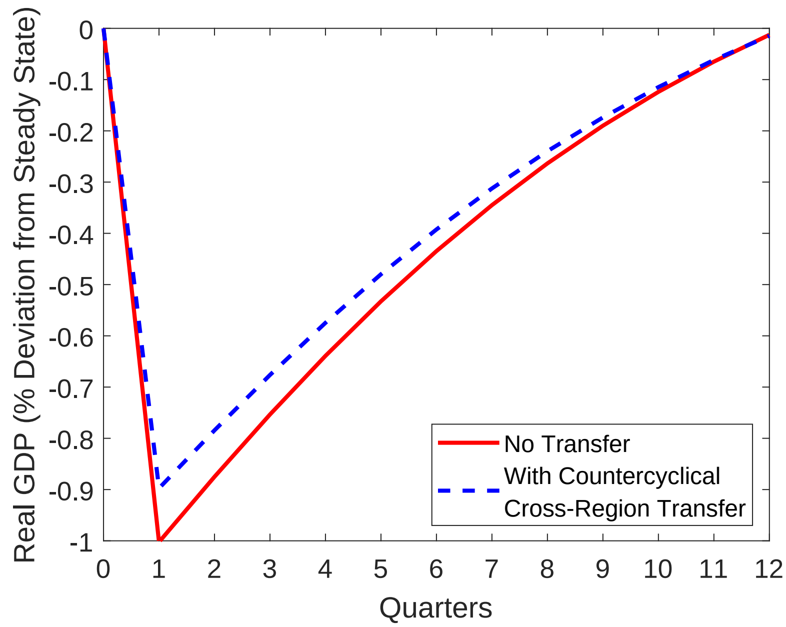
5.2. **Simulation of a Recession in a Small US State.** In this subsection, I show that my back-of-the-envelope calculation in the main text (Equation 5.3) of the smoothing gains from countercyclical cross-region transfers, $\mathcal{S}$, are very similar to those in simulated regional recession in the full New Keynesian model. Note that with the default model parameters, I have difficulty generating a state-level recession as persistent as the median estimated in subsection 5.1 by demand shocks. So instead I generate a slightly less persistent recession (at the 10th rather 50th percentile of persistence across states), which generates similar results and shows that my back-of-the-envelope calculation is quite accurate:

$$\mathcal{S} = \frac{NTC \times \mathcal{M}_{Tr}}{1 + NTC \times \mathcal{M}_{Tr}}. \tag{5.3}$$

Following Farhi, Gopinath and Itskhoki (2014), I generate an asymmetric recession in the small home region by subjecting it to a shock that increases the spread on borrowing by home consumers (there are no other shocks). This leads Ricardian households to save more, reducing consumption

[58]This means that I have 244 observations, which should be enough to counter the well-known small sample downward bias in estimating first-order autocorrelation coefficients.

[59]The first alternative method involves regressing log state-level per capita labor income relative to that in the US ($log(WL^{pc}_{i,t}/WL^{pc}_{US,t})$) on its first lag and a time trend in single step, which uncovers a mean persistence estimate across states of $\hat{\rho} = 0.943$. The second alternative method involves an unrestricted specification that nests the default and first alternative methods as special cases. Specifically, I regress state-level log real per capita labor income $log(WL^{pc}_{i,t})$ on its own first lag, a time trend, and the contemporaneous and first lags of US-wide log real per capita labor income $log(WL^{pc}_{US,t})$. The average persistence is $\rho = 0.936$, almost the same as for the default method. Both alternative methods generate similar rates of persistence for each individual state as the default method.



Notes: The figure shows path of GDP in the home region in response to a small but highly persistent spread shock that increases regional interest rates by around 0.2% (annualized), with quarterly persistence $\rho_s = 0.985$. The solid red line shows the path of home GDP generated by the spread shock, without any automatic stabilizers: a 1 percentage point fall in GDP initially, with a quarterly output persistence of $\rho_y = 0.88$. The dotted blue line shows the path of GDP with a 30 cents on the dollar net federal cross-region transfer, which results in a 0.9 percentage point initial fall in output. That is, the fraction smoothed by the cross-region transfer is $\mathcal{S} = (-1ppt - -0.9ppt)/-1\% = 10\%$.

FIGURE 8. Simulated Regional Recession: With and without Countercyclical Transfers

demand for the home good and sending the regional economy into recession. I calibrate the quarterly persistence of the spread shock $\rho_s = 0.985$ to generate a recession with output persistence $\rho_y = 0.88$—the persistence of asymmetric business cycles at the 10th percentile of US states (rather than $\rho_y = 0.935$ as in the main text).[60] I calibrate the size of the spread shock—around 0.2% in annual terms—to generate an initial fall in GDP of 1% without any countercyclical fiscal transfers. This path for home output is the solid red line in Appendix Figure 8.

I then simulate the same model with the same spread shock but with countercyclical cross-region transfers. Based on the literature cited in Appendix 2 and the introduction of the main text, I calibrate the countercyclicality of transfer to be \$0.30 on the dollar (i.e., a \$1 fall in GDP in a region generates a \$0.30 net federal transfer to households in the home region), a normalized tax change (NTC) of 0.3. The path of output with countercyclical cross-region transfers is shown as the dashed blue line in Appendix Figure 8: instead of falling by 1 percentage point, GDP falls by 0.9 percentage points, suggesting $\mathcal{S} = (-1ppt - -0.9ppt)/-1ppt = 10\%$ of the shock is smoothed.[61]

How does this compare with the back-of-the-envelope calculation in Equation 5.3? At this level of persistence, the cross-region transfer impact multiplier is $\mathcal{M}_{Tr} = 0.37$. Hence, Equation 5.3

[60]The persistence of output in response to this shock naturally depends on other parameters, like the price and wage stickiness, which need to be increased to generate a more persistent recession.

[61]The cross-region smoothing coefficient $\mathcal{S}$ is reported for the first quarter but is also 10% for the first six quarters.

implies a smoothing coefficient of $\mathcal{S} = (0.3 \times 0.37)/(1 + 0.3 \times 0.37) = 10\%$, which is exactly the same as in the full model simulation.

6. Aggregate Closed Economy Multipliers

For comparison with the literature on aggregate multipliers (e.g., Uhlig 2010), in the main text I report aggregate *present value* multipliers, which are calculated as follows after a fiscal shock (time is measured in quarters):[62]

$$\mathcal{M}_{Tr}^{AggPV} \equiv \frac{\sum_{i=0}^{400} \beta^i \hat{Y}_{t+i}^{US}}{\sum_{i=0}^{400} \beta^i \hat{Tr}_{t+i}^{US}} \qquad or \qquad \mathcal{M}_{G}^{AggPV} \equiv \frac{\sum_{i=0}^{400} \beta^i \hat{Y}_{t+i}^{US}}{\sum_{i=0}^{400} \beta^i \hat{G}_{t+i}^{US}}. \tag{6.1}$$

where $\hat{Y}_t^{US} = n\hat{Y}_{h,t} + (1-n)\hat{Y}_{f,t}$ is US-wide aggregate GDP (deviation from steady state), $\hat{Tr}_t^{US}$ is a US-wide transfer from Ricardian households to the whole population (expressed as a share of GDP), and $\hat{G}_t^{US}$ is a US-wide government purchase (as a share of GDP) also funded by lump-sum taxes on Ricardian households.[63]

Aggregate Transfer and Purchase Multipliers in the New Keynesian Model. The New Keynesian model consistent with my cross-region empirical evidence generates the closed economy transfer and purchase multipliers in Appendix Table 11. In that model, aggregate transfer multipliers are equal to aggregate purchase multipliers scaled by the fraction of transfers targeted at HtM households (ω_T). For fully targeted transfers, $\omega_T = 1$, the aggregate transfer multiplier is the same as the purchase multiplier (Column 3).[64] For untargeted transfers, where the fraction of transfers received by the HtM households is equal to their population share of 1/3, the aggregate transfer multiplier in Column 1 is just 1/3 of the purchase multiplier. In Column 2, I also consider an intermediate case where transfers are partially targeted: HtM households receive twice the transfer suggested by their population share ($\omega_T = 2\omega = 2/3$), which has a transfer multiplier twice that in Column 1.

In the first row of Appendix Table 11, I show that transfer and purchase multipliers are small ($\ll 1$) in the New Keynesian model with typical monetary policy from the Volker-Greenspan era (when monetary policy "leans against the wind"): a Taylor rule of $\hat{R}_t^{US} = \rho_r \hat{R}_{t-1}^{US} + (1-\rho_r)\left[\phi_\pi \hat{\pi}_t^{US} + \phi_y \hat{Y}_t^{US}\right]$, where $\rho_r = 0.8$, $\phi_\pi = 1.5$ and $\phi_y = 0.5$ (parameters from Nakamura and Steinsson 2014). Here the central bank responds to increases in inflation or output by raising

[62] In contrast, the rest of the paper reports impact multipliers in the cross-section: $\mathcal{M}_{Tr} \equiv \hat{Y}_{h,t}/\hat{Tr}_{h,t}^Y$ and $\mathcal{M}_G \equiv \hat{Y}_{h,t}/\hat{g}_{h,t}^Y$

[63] At business cycle frequencies, the present value multipliers are similar to the two-year annual multipliers in Nakamura and Steinsson (2014) (not reported).

[64] A \$1 targeted transfer and a \$1 purchase have the same sized multipliers because (i) they generate the same tax burden on Ricardian households (for this shock, Ricardian households pay all lump-sum taxes), and (ii) they generate the same increase in aggregate demand, as they are both spent. In the background is the assumption that labor supply of HtM households is not affected by higher consumption (due to the way sticky wages are set). Giambattista and Pennings (2017) allow for wealth effects on labor supply of HtM households and show that with monetary policy that "leans against the wind," wealth effects reduce aggregate transfer multipliers, but at the ZLB, they increase aggregate multipliers.

interest rates, which reduces consumption demand by Ricardian households. All fiscal multipliers are much less than 1 and are less than 0.25 for untargeted transfers. With this monetary policy rule, present value multipliers fall as the fiscal shock becomes more persistent.

TABLE 11. Closed Economy Aggregate Present Value Multipliers

Monetary Policy and Persistence	1. Untargeted Transfers ($\omega_T = \omega = 1/3$)	2. Partially Targeted Transfers ($\omega_T = 2\omega = 2/3$)	3. Purchases or Fully Targeted Transfers ($\omega_T = 1$)
Volker-Greenspan Monetary Policy			
$\rho = 0$ (One off fiscal shock)	0.22	0.44	0.65
$\rho = 0.935$ (Business Cycle*)	0.07	0.15	0.22
Accommodative Monetary Policy	0.5	1	1.5
Fixed Real Rates (any $\rho < 1$)	(Here the transfer multiplier is simply $\omega_T/(1-\omega)$, with $\omega = 1/3$)		

Notes: *state asymmetric business cycle frequencies from the main text (similar to the persistence of military spending shocks in Nakamura and Steinsson 2014). This table reports aggregate closed economy present value multipliers for transfers and purchases. Rows change the monetary policy rule (Volker-Greenspan versus constant real interest rate) and fiscal shock persistence ρ. Columns report the type of fiscal shock and degree of targeting of the transfer. ω is the population share of hand-to-mouth households, and ω_T is the fraction of transfers targeted at those hand-to-mouth households.

In the final row of Appendix Table 11, I calculate aggregate fiscal multipliers in the New Keynesian model when monetary policy is more accommodative of inflation, that is, real interest rates are fixed. This simple benchmark keeps Ricardian households' consumption constant at its steady-state level and consequently generates a closed economy purchase multiplier of 1 when there are no HtM households (Woodford 2011). With HtM households, the purchase multiplier becomes $\frac{1}{1-\omega}$ and the transfer multiplier becomes $\frac{\omega_T}{1-\omega}$. Hence, the purchase multiplier is greater than 1 if the share of HtM households is positive ($\omega > 0$), and the transfer multiplier is large (≥ 1) if transfers are sufficiently well targeted at the hand-to-mouth ($\omega_T \geq 1-\omega$). With my default calibration, $\omega = 1/3$, the purchase and fully targeted transfer multipliers are 1.5 and the untargeted transfer multiplier is 0.5. While these are natural targeting benchmarks, policymakers typically try to make transfer-based stimulus at least partially targeted at households that will spend it. In Column 2, I show that when HtM households receive double their population share, the transfer multiplier will be 1, which represents the cutoff, where $\omega_T \geq 1-\omega$.

It is important to note that for most of the period since the Great Recession, monetary policy has been much more accommodative than a fixed real interest rate, which would increase both transfer and purchase multipliers above those in final row of Appendix Table 11 in the New Keynesian model. The Fed Funds Rate has been stuck at the zero lower bound (ZLB) from December 2008 to December 2015, and again since March 2020, and will likely stay at zero for an extended period. Exactly how much larger the multipliers would be depends on the length the ZLB is expected to bind, the persistence of fiscal stimulus, and other factors (see Giambattista and Pennings 2017).[65]

In sum, aggregate *purchase* multipliers in my New Keynesian model (consistent with the cross-sectional empirical evidence) are quite consistent with Nakamura and Steinsson (2014): small

[65]For comparison, aggregate closed economy purchase multipliers in the Neoclassical model are equal to $0.5 = (1+\varphi)^{-1}$ and naturally do not depend on the monetary policy rule (or the persistence of the purchase). Aggregate transfer multipliers are not defined in Neoclassical model, as there is only one type of household.

multipliers ($\ll 1$) when monetary policy "leans against the wind" but large (≥ 1) multipliers when monetary policy is more accommodative of inflation. I add evidence for the aggregate transfer multiplier: transfers need to be *both* well targeted at HtM households *and* monetary policy needs to be accommodative in order for the aggregate transfer multiplier to large (≥ 1). These multipliers are also similar to those in Giambattista and Pennings (2017).

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7. Propositions and Proofs

In this section, I present proofs of Propositions 1 and 2 (stated and referenced, respectively, in Section III from the main text). Named/integer-numbered equations refer to those from the list of log-linearized equations in Appendix 4.2.[66] The proofs of both propositions use the following lemma:

Lemma. *Consider an AR(1) cross-region transfer or purchases shock with persistence ρ in the (A) simple New Keynesian model or (B) simple Neoclassical model. Then along the adjustment path following the shock, $\left[\hat{Y}_t - \hat{Y}_\infty\right]$ also follows an AR(1) process with persistence ρ, where $\hat{Y}_\infty$ is the limit to which home output converges. Note: an alternative formulation of the result in the lemma is that, along the adjustment path,*

$$\hat{Y}_{h,t+1} = \rho \hat{Y}_{h,t} + (1-\rho)\hat{Y}_{h,\infty}. \tag{7.1}$$

Proof. *[Part A. Simple New Keynesian Model]* Let $\hat{Tr}_t^{Y\prime\prime} = \hat{tr}_{CR,t}^{Y}$ be the transfer received by the hand-to-mouth households (HtM HHs). For a purchase shock, let $\hat{Tr}_t^{Y\prime\prime} = 0$. As prices are fixed and there are no aggregate or foreign shocks, $\hat{s}_t = \hat{\pi}_{h,t} = \hat{\pi}_{f,t} = \hat{R}_t = 0$ and $\hat{c}' \equiv \hat{c}'_t = E_t\hat{c}'_{t+1} = \hat{c}'_{t+1}$, so consumption of the Ricardian household will be constant after an initial adjustment (as there is perfect foresight along the adjustment path). Combining Equation 23 (BC HtM HH H), Equation 14 (Markup H), and Equation 36 (Profit Definition H) to eliminate $\hat{\Pi}_t$, setting $\hat{s}_t = 0$, and substituting for transfers, the budget constraint of the HtM HH is

$$\hat{c}''_t = \hat{Y}_{h,t} + \rho^t \hat{tr}_0^{Y\prime\prime}. \tag{7.2}$$

Note that $\hat{L}'_t = \hat{L}''_t = \hat{Y}_{h,t}$ (the first equality comes from sticky wage condition).[67] As the home region is small ($n \to 0$), foreign aggregate output and consumption is unaffected ($\hat{c}^\star_t = 0$) by either shock (given the absence of foreign or aggregate shocks). As $\hat{s}_t = 0$, $\hat{c}^\star_{h,t} = \hat{c}^\star_t = 0$. Applying Equation 3 (Defn C), Equation 5 (H Dem by H), and Equation 6 (F Dem by H), Equation 20 (Agg res constraint H) becomes

[66] Analytical expressions are compared to numerical multiplier estimates in the Dynare code.

[67] Note that so long as wages are sticky—such that $\hat{L}'_t = \hat{L}''_t$—it does not matter how sticky they are when prices are fixed. This is because profits and wages enter into both HtM and Ricardian household budget constraints symmetrically. In the case of less sticky wages, an increase in demand will require a larger increase in wages, but this is offset in the budget constraint by a fall in profits.

$$\hat{Y}_{h,t} = \alpha\left[\omega \hat{c}_t'' + (1-\omega)\hat{c}'\right] + \rho^t \hat{g}_{h,0}^Y. \tag{7.3}$$

Substituting Equation 7.2 and rearranging,

$$\hat{Y}_{h,t} = \frac{\alpha\left[\omega\rho^t t\hat{r}_0^{Y\prime\prime} + (1-\omega)\hat{c}'\right] + \rho^t \hat{g}_{h,0}^Y}{1-\alpha\omega}. \tag{7.4}$$

In the limit, as $t \to \infty$ (as $\rho < 1$),

$$\hat{Y}_{h,\infty} = \frac{\alpha(1-\omega)\hat{c}'}{1-\alpha\omega}. \tag{7.5}$$

Combining Equations 7.4 and 7.5,

$$\hat{Y}_{h,t} - \hat{Y}_{h,\infty} = \frac{\alpha\left[\omega\rho^t t\hat{r}_0^{Y\prime\prime} + (1-\omega)\hat{c}'\right] + \rho^t \hat{g}_{h,0}^Y}{1-\alpha\omega} - \frac{\alpha(1-\omega)\hat{c}'}{1-\alpha\omega} = \rho^t \frac{\alpha\omega t\hat{r}_0^{Y\prime\prime} + \hat{g}_{h,0}^Y}{1-\alpha\omega}. \tag{7.6}$$

As such, $\hat{Y}_{h,t} - \hat{Y}_{h,\infty}$ follows an AR(1) path along the adjustment path following a shock:

$$\hat{Y}_{h,t+1} - \hat{Y}_{h,\infty} = \rho^{t+1}\frac{\alpha\omega t\hat{r}_0^{Y\prime\prime} + \hat{g}_{h,0}^Y}{1-\alpha\omega} = \rho\rho^t\frac{\alpha\omega t\hat{r}_0^{Y\prime\prime} + \hat{g}_{h,0}^Y}{1-\alpha\omega} = \rho\left[\hat{Y}_{h,t} - \hat{Y}_{h,\infty}\right]. \tag{7.7}$$

$\square$

Proof. *[Part B. Simple Neoclassical Model]* For cross-region transfer shocks in the neoclassical model, the Ricardian household only responds to the present value of the transfer and the economy moves instantly to the new equilibrium, so $E_t\hat{Y}_{h,t+1} = \hat{Y}_{h,t} = \hat{Y}_{h,\infty}$, and so the lemma is trivially satisfied.

For government purchases, combine Equation 1 (Euler H) with Equation 9 (Terms of Trade), noting that in the simple neoclassical model (in response to a local shock), $\hat{R}_t = \hat{\pi}_{f,t+1} = 0$ (as $n \to 0$). This implies

$$\hat{c}_t' = E_t\hat{c}_{t+1}' - \alpha E_t\left[\hat{s}_{t+1} - \hat{s}_t\right]. \tag{7.8}$$

Combine Equation 5 (H Demand by H) and Equation 7 (H Demand by F) and substitute into Equation 20 (Agg res constraint H), noting that as there are no foreign shocks and $n \to 0$, $\hat{c}_t^\star = 0$ (and $\gamma \to 1$). This yields

$$\hat{Y}_{h,t} = \alpha\hat{c}_t + \theta_T(1-\alpha)(1+\alpha)\hat{s}_t + \hat{g}_{h,t}^Y. \tag{7.9}$$

Substitute Equation 26FW (Labor-leisure FOC H Ric) with $\hat{w}_{h,t} = -X_{h,t} = 0$ (as markups are constant) and $\hat{Y}_{h,t} = \hat{L}_{h,t}$ into equations 7.8 and 7.9 to eliminate $\hat{c}_t$ and $\hat{c}_{t+1}$. Then combine these equations to substitute out for $\hat{s}_t$ and $\hat{s}_{t+1}$, noting that along the perfect-foresight adjustment path,

$E_t\hat{Y}_{h,t+1} = \hat{Y}_{h,t+1}$ and $E_t\hat{g}^Y_{h,t+1} = \rho\hat{g}^Y_{h,t}$ (where ρ is the persistence of the purchases shock). This yields

$$\hat{Y}_{h,t} = \hat{Y}_{h,t+1} + (1-\rho)\Xi\hat{g}^Y_{h,t}, \tag{7.10}$$

where $\Xi = [1+\alpha^2\varphi + (1-\alpha^2)\theta_T\varphi]^{-1}$

Solving forward the infinite sum, and letting $Y_{h,\infty} \equiv lim_{t\to\infty}\hat{Y}_{h,t}$, then

$$\hat{Y}_{h,t} - \hat{Y}_{h,\infty} = \Xi\hat{g}^Y_{h,t}. \tag{7.11}$$

Starting with $\hat{Y}_{h,t+1} - \hat{Y}_{h,\infty}$ and using a rearranged Equation 7.10,

$$\hat{Y}_{h,t+1} - \hat{Y}_{h,\infty} = \left[\hat{Y}_{h,t} - (1-\rho)\Xi\hat{g}^Y_{h,t}\right] - \hat{Y}_{h,\infty}.$$

Substituting using Equation 7.11,

$$\hat{Y}_{h,t+1} - \hat{Y}_{h,\infty} = \left[\hat{Y}_{h,t} - (1-\rho)(\hat{Y}_{h,t} - \hat{Y}_{h,\infty})\right] - \hat{Y}_{h,\infty}. \tag{7.12}$$

Rearranging Equation 7.12 yields the required result:

$$\hat{Y}_{h,t+1} - \hat{Y}_{h,\infty} = \rho(\hat{Y}_{h,t} - \hat{Y}_{h,\infty}).$$

□

Proposition 1. Cross-Region Transfer Multipliers (restated from main text):

Cross-region transfer impact multipliers in the rigid price/wage New Keynesian model (θ_p, $\theta_w \to 1$, $n \to 0$, $\psi = 0$) and Neoclassical model ($\theta_p \to 0$, $n \to 0$, $\psi = 0$, $\omega \to 0$) are given by

$$(a) \qquad \mathcal{M}^{NK}_{Tr} = \underbrace{\frac{\alpha}{1-\alpha}}_{Local\,GE(perm)} \times \underbrace{1 \times \frac{1-\beta}{1-\beta\rho}}_{MPC(perm)} + \underbrace{\frac{\alpha}{1-\alpha\omega}}_{Local\,GE(temp)} \times \underbrace{\omega \times [1 - \frac{1-\beta}{1-\beta\rho}]}_{MPC(temp)} \tag{7.13}$$

$$(b) \qquad \mathcal{M}^{NC}_{Tr} = \underbrace{-\frac{1}{1+\varphi}}_{Local\,GE(perm)} \times \underbrace{1 \times \frac{1-\beta}{1-\beta\rho}}_{MPC(perm)} + \quad 0. \tag{7.14}$$

Proof. [Proposition 1a] From the lemma, Equation 7.4 (with $\hat{g}^Y_{h,0} = 0$) and $t = 0$ becomes Equation 7.15, so we just need to solve for $\hat{c}'_0$:

$$\hat{Y}_{h,0} = \frac{\alpha\left[\omega t\hat{r}^{Y\prime\prime}_0 + (1-\omega)\hat{c}'_0\right]}{1-\alpha\omega}. \tag{7.15}$$

Solving the forward the budget constraint (Equation 22) of the Ricardian household forward (combined with $\hat{b}^Y_{-1} = 0$ and the transversality condition) implies

$$0 = \sum_{t=0}^{\infty} \beta^t \left(\hat{c}'_0 - \left\{ \hat{Y}_{h,t} + t\hat{r}^Y_{t,CR} \right\} \right). \tag{7.16}$$

Combined with Equation 7.1, consumption of the Ricardian household is

$$\hat{c}'_0 = \hat{Y}_\infty + \frac{1-\beta}{1-\beta\rho} \left[\hat{Y}_0 - \hat{Y}_\infty + t\hat{r}^Y_{0,CR} \right]. \tag{7.17}$$

Taking the limit as $t \to \infty$, Equation 7.4 (with $\hat{g}^Y_{h,0} = 0$) becomes[68]

$$\hat{Y}_{h,\infty} = \frac{\alpha \left[(1-\omega)\hat{c}'_0 \right]}{1-\alpha\omega}. \tag{7.18}$$

This yields a system of three equations 7.17, 7.18, and 7.15 in three unknowns ($\hat{Y}_{h,0}$, $\hat{Y}_{h,\infty}$, and $\hat{c}'_0$). With some algebra, one can eliminate $\hat{Y}_{h,\infty}$ and $\hat{c}'_0$ and solve for $\hat{Y}_0$, to recover Equation 7.13 as in the main text, where $\mathcal{M}^{NK}_{Tr} = \hat{Y}_{h,0}/t\hat{r}^Y_{0,CR}$. □

Proof. [Proposition 1b] The New Keynesian model nests the neoclassical model when $\kappa \to \infty$, $\omega \to 0$ and wages are flexible. As there are no dynamics, consumption is just the permanent value of the transfer. This means Equation 22 (BC Ricardian HH H) becomes

$$\hat{c}_t + (1-\alpha)\hat{s}_t = \hat{Y}_{h,t} + \frac{1-\beta}{1-\rho\beta} \hat{Tr}^{Y\prime}_t. \tag{7.19}$$

Combining Equation 26FW (Labor-leisure FOC H Ric) with Equation 14 (Markup H) suggests $\hat{w}_{h,t} = 0$, as markups are constant with flexible prices. Combining with the production function that $\hat{Y}_{h,t} = \hat{L}_t$,

$$0 = \varphi \hat{Y}_{h,t} + \hat{c}_t + (1-\alpha)\hat{s}_t. \tag{7.20}$$

Substituting $\hat{c}'_t + (1-\alpha)\hat{s}_t$ out of Equation 7.19 using Equation 7.20 and rearranging yields Equation 7.14. □

Proposition 2. Cross-Region Purchase Multipliers

Cross-region purchase impact multipliers in the rigid price/wage New Keynesian model ($\theta_p \to 1$, $n \to 0$, $\psi = 0$) and Neoclassical model ($\theta \to 0$, $n \to 0$, $\psi = 0$, ω=0) are given by

[68] Note that this uses $n \to 0$, $\hat{s}_t = \hat{\pi}_{h,t} = \hat{\pi}_{f,t} = \hat{R}_t = 0$ and Equation 7.5.

$$(7.21) \qquad (a) \qquad \mathcal{M}_G^{NK} = 1 + \mathcal{M}_{Tr}^{NK}$$

$$(7.22) \qquad (b) \qquad \mathcal{M}_G^{NC} = \left[1 - \frac{1-\beta}{1-\beta\rho}\right] \frac{1}{[1+\varphi\alpha^2+\varphi(1-\alpha^2)\theta_T]} > 0.$$

Proof. [Proposition 2a] Cross-region purchases do not involve any transfers in the budget constraint of home households, as they are paid for by foreign households. As $n \to 0$, the foreign region is unaffected by these payments. Setting the transfer term equal to zero in the budget constraint (Equation 22) of the Ricardian household and solving forward (combined with $\hat{b}_{-1}^Y = 0$ and the transversality condition) implies (as $\hat{s} = 0$)

$$(7.23) \qquad 0 = \sum_{t=0}^{\infty} \beta^t \left(\hat{c}_0' - \hat{Y}_{h,t}\right)$$

Combined with Equation 7.1, the Ricardian household's consumption is

$$(7.24) \qquad \hat{c}_0' = \hat{Y}_\infty + \frac{1-\beta}{1-\beta\rho}\left[\hat{Y}_0 - \hat{Y}_\infty\right].$$

Equation 7.4 for $t = 0$ (without with the transfer term equal zero) becomes

$$(7.25) \qquad \hat{Y}_{h,0} = \frac{\alpha(1-\omega)\hat{c}_0' + \hat{g}_{h,0}^Y}{1-\alpha\omega}.$$

Equations 7.24, 7.25, and 7.5 are a system of three equations in three unknowns $(\hat{c}_0', \hat{Y}_{h,\infty}, \hat{Y}_{h,0})$. Substituting out for the first two and solving for $\hat{Y}_{h,0}$ yields Equation 7.26, where the term in brackets is the cross-region transfer multiplier as in Equation 7.13:

$$(7.26) \qquad \frac{\hat{Y}_{h,0}}{\hat{g}_{h,0}^Y} = \left\{\frac{\alpha\omega}{1-\alpha\omega}\left[1 - \frac{1-\beta}{1-\beta\rho}\right] + \frac{\alpha}{1-\alpha}\frac{1-\beta}{1-\beta\rho}\right\} + 1.$$

□

Proof. [Proposition 2b]

Start with Equation 7.10 (from the lemma) and apply to the lemma (Equation 7.1) to get

$$(7.27) \qquad \hat{g}_{h,0}^Y = \left[1 + \alpha^2\varphi + \varphi(1-\alpha^2)\theta_T\right]\left[\hat{Y}_{h,0} - \hat{Y}_{h,\infty}\right].$$

Combine Equation 22 (BC Ricardian HH H) with Equation 26FW (labor-leisure FOC H Ric) and note that in the simple Neoclassical model, $\hat{w}_{h,t} = \frac{\Pi_{SS}}{Y_{ss}} = \omega = 0$, and $\hat{Y}_{h,t} = \hat{L}_{h,t}$, which yields

$$\hat{b}_t^Y = \beta^{-1}\hat{b}_{t-1}^Y - (1+\varphi)\hat{Y}_{h,t} - \hat{Tr}_t^{Y\prime}. \tag{7.28}$$

Solving Equation 7.28 forward (with $\hat{b}_{-1}^Y = 0$), and applying the transversality condition $lim_{t\to\infty}\beta^t\hat{b}_t^Y = 0$ and the Lemma yields:

$$\hat{Y}_{h,\infty} = -\frac{1-\beta}{1+\varphi}\frac{1}{(1-\rho)\beta}\hat{Tr}_0^{Y\prime} - \frac{(1-\beta)}{(1-\rho)\beta}\hat{Y}_{h,0}. \tag{7.29}$$

As $\hat{Tr}_0^{Y\prime} = 0$ (the funding comes from foreign), Equation 7.29 simplifies to

$$\hat{Y}_{h,\infty} = -\frac{(1-\beta)}{(1-\rho)\beta}\hat{Y}_{h,0}. \tag{7.30}$$

Substituting Equation 7.30 into Equation 7.27 yields

$$\hat{g}_{h,0}^Y = \left[1+\alpha^2\varphi + \varphi(1-\alpha^2)\theta_T\right]\left[1+\frac{(1-\beta)}{(1-\rho)\beta}\right]\hat{Y}_{h,0}.$$

Isolating $\hat{Y}_{h,0}$,

$$\hat{Y}_{h,0} = \frac{(1-\rho)\beta}{1-\beta\rho}\frac{1}{1+\alpha^2\varphi+\varphi(1-\alpha^2)\theta_T}\hat{g}_{h,0}^Y.$$

Adding and subtracting 1 to the numerator of the present value term and rearranging yields the expression for the multiplier:

$$\mathcal{M}_G^{NC} \equiv \frac{\hat{Y}_{h,0}}{\hat{g}_{CR,h,t}^Y} = \left[1-\frac{(1-\beta)}{1-\beta\rho}\right]\frac{1}{1+\alpha^2\varphi+\varphi(1-\alpha^2)\theta_T}.$$

□

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