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The Supplemental Nutrition Assistance Program (SNAP) and the Economy: New Estimates of the SNAP Multiplier

Patrick Canning and Brian Stacy

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Abstract

The Supplemental Nutrition Assistance Program (SNAP) is one of the largest safety net programs in the United States—the U.S. Department of Agriculture spent $65.3 billion on the program in fiscal year 2018 and served an average of 40.3 million people per month. By design, SNAP has a countercyclical effect on the wider economy, that is, program enrollment increases when incomes fall and vice versa. The Great Recession of 2007-09 motivated new interest in the impacts of different Federal stimulus tools, including SNAP spending. We examine the countercyclical impacts of SNAP by measuring how SNAP benefits affect gross domestic product, employment, and incomes across the farm economy and for all other industries impacted by SNAP. A review of the literature suggests that SNAP spending during a recession stimulates economic output more than several other fiscal policy tools that have been used to increase economic activity. We estimate multiplier effects of SNAP expansion using a newly compiled Social Accounting Matrix multiplier model and the most recent data available for this purpose. We find that $1 billion in SNAP benefits spent during an economic downturn provides direct added income to the businesses where those benefits are spent and indirect added income to their suppliers and their employees, who in turn spend more and further increase the effect of the initial outlay. This multiplier effect generates an additional $0.5 billion, making the total effect of the $1 billion in SNAP benefits $1.5 billion in gross domestic product, which supports 13,560 new jobs—including $32 million added income going to agricultural industries that support 480 agricultural jobs.

Keyword: Automatic Stabilizer, fiscal stimulus, gross domestic income (GDI) multiplier, gross domestic product (GDP) multiplier, job impact, Social Accounting Matrix (SAM) multiplier model, Supplemental Nutrition Assistance Program (SNAP).

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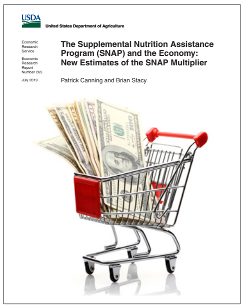


The Supplemental Nutrition Assistance Program (SNAP) and the Economy: New Estimates of the SNAP Multiplier

Patrick Canning and Brian Stacy

What Is the Issue?

SNAP is the largest food assistance program of the U.S. Department of Agriculture, which spent $65.3 billion on SNAP in fiscal year 2018 and served an average of 40.3 million individuals per month. The primary goal of SNAP is to reduce food insecurity, but the program also acts as an automatic stabilizer during economic downturns. As incomes fall, SNAP spending tends to increase as more individuals become eligible and enroll in the program. In addition, as SNAP enrollees spend their benefits, income is generated for all involved in the production, distribution, marketing, and sales of the final goods and products sold, creating a multiplier effect throughout the economy that may extend well beyond the initial money distributed for the SNAP benefit.

In this report, we estimate the impact that a hypothetical $1 billion increase in SNAP assistance will have on gross domestic product (GDP), employment, and incomes across different U.S. industries, highlighting agriculture. The induced effects of Government spending on the economy are usually discussed in terms of multipliers. The specific type of multiplier we measure in this report is the short-run change in total GDP per $1 increase in SNAP spending—"short-run" meaning roughly within 1 year of the spending increase.

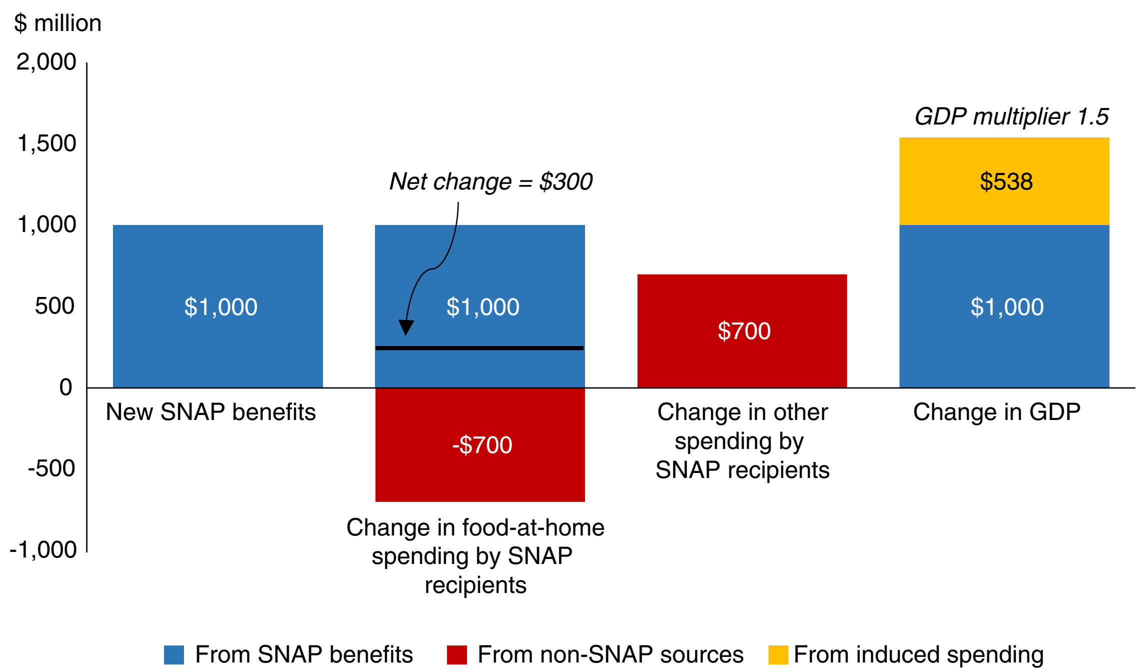
What Did the Study Find?

A survey of recent research shows that the multiplier values for temporary deficit-financed increases in Government spending range from 0.8 to 1.5. This means that $1 of additional Government spending, paid for with $1 of additional Government borrowing, increases GDP by around $.80 to $1.50. However, new research also suggests that programs like SNAP, where Government spending goes to low-income households, have relatively high multipliers with values up to $2 of economic activity per dollar spent.

Our model estimates the GDP multiplier for SNAP to be 1.5. Specifically, we find that $1 billion of additional monthly SNAP expenditures initially increases food spending from SNAP benefits by the full $1 billion and causes the benefit recipients to repurpose $0.7 billion of non-SNAP funds that were intended for food spending in that month to nonfood items. This leads to a $0.3 billion net increase in food spending and a $0.7 billion increase in spending on nonfood products. This total $1 billion in new spending induces further new spending in the economy that collectively increases GDP by $1.54 billion, supports 13,560 jobs, and creates $32 million in farm income. These findings are derived from a model that is most appropriate to conditions during a slowing economy and may be interpreted as upper-bound estimates of impacts when the economy is at or near full employment.

ERS is a primary source of economic research and analysis from the U.S. Department of Agriculture, providing timely information on economic and policy issues related to agriculture, food, the environment, and rural America.

$1 billion in new SNAP benefits raises GDP by $1.5 billion



Notes: SNAP = Supplemental Nutrition Assistance Program. GDP = Gross domestic product.
Induced Spending refers to spending occurring after the initial $1 billion SNAP expenditure, which is derived from income generated for all involved in the production, distribution, marketing, and sales of the final goods and products sold. Results are reported in 2016 dollars.

Source: U.S. Department of Agriculture, Economic Research Service.

How Was the Study Conducted?

We develop a Social Accounting Matrix multiplier model, FEDS-SAM (Food Environment Data System-Social Accounting Matrix). This approach is an extension of an input-output model, is widely used, and is an effective framework for exploring the impact of changes in Government expenditures on economywide measures of economic performance. The FEDS-SAM is based on empirically estimated marginal consumption and saving behaviors of two representative households—one representing all SNAP-recipient households and the other all non-SNAP-recipient households. The advantage of modeling marginal consumption and saving behaviors is that they are representative of how households respond to new Government spending. By distinguishing between SNAP and non-SNAP households, the analysis provides greater detail about how these two groups are affected by the spending levels.

We use the latest data available for this type of analysis. This allows for a FEDS-SAM baseline model that is based on an annual 2016 summary of the entire U.S. economy. We allow for international trade (imports and exports) to adjust in the model; in 2016, international imports accounted for over 17 percent of U.S. food expenditures. Finally, a comprehensive sensitivity analysis of FEDS-SAM macroeconomic scenarios is conducted to measure the sensitivity of our model results to the values of key behavioral parameters of the model. This contributes to our overall assessment that the key findings of the model are robust.

The Supplemental Nutrition Assistance Program (SNAP) and the Economy: New Estimates of the SNAP Multiplier

Introduction

As of the June 2019 jobs report, the U.S. economy had produced job gains for 105 consecutive months, according to the U.S. Department of Labor, Bureau of Labor Statistics. According to the National Bureau of Economic Research, the average economic expansion from 1945 to 2009 lasted 58.4 months, meaning the recent expansion—which is ongoing—has lasted considerably longer than average.[1] Economies expand and contract. Sometimes, with the recession of the early 2000s and the Great Recession as the most recent examples, the Federal Government uses fiscal policy to stimulate economic activity. It is useful to take stock of the latest research on the effectiveness of expansionary fiscal policies, and the role of the SNAP in particular, to give policymakers better information about the effectiveness of tools at their disposal during slack economic times.

SNAP is the largest of the 15 food assistance programs administered by USDA, which spent $65.3 billion on SNAP in fiscal year 2018 and served an average of 40.3 million individuals per month, according to Oliveira (2019). The primary goal of SNAP is to reduce food insecurity, but SNAP also serves as an automatic stabilizer during economic downturns. SNAP is an entitlement program, meaning that benefits are guaranteed to those who apply and meet eligibility criteria. Household eligibility for SNAP benefits is based in part on total household income and the total number of people in the household. As incomes fall, more individuals qualify for SNAP benefits, and Government spending automatically increases, which may help to smooth out the business cycle. Additionally, as SNAP enrollees spend more as a result of their benefit, income is generated for all involved in the production, distribution, marketing, and sales of goods and services sold, creating a multiplier effect on the economy that may extend well beyond the initial money distributed for the SNAP benefit. While this theory is well known, the size of the multiplier effect of SNAP expansion on the economy is less clear.

SNAP is a countercyclical program, meaning that spending on SNAP and the number of individuals in the program typically increases during recessions and falls in periods of economic expansions. Further, in an economic contraction, more people automatically become eligible because of falling incomes, and no congressional legislation is needed to approve increases in the SNAP caseload. Figure 1, reproduced from Oliveira, Prell, Tiehen, and Smallwood (2018), shows the number of participants, in millions, for SNAP from 1962 to 2016. Periods of recession, as defined by the National Bureau of Economic Research, are highlighted in gray. During the Great Recession from 2007 to 2009, the number of individuals participating in SNAP rose from 26.3 million to over 40 million.[2] By the end of the recession of March 2001 to November 2001, the number of individuals in SNAP had jumped from 17.2 million in 2000 to 19.1 million in 2002, and during the recession of July 1990 to March 1991, the number in SNAP jumped from 18.8 million in 1989 to 25.4 million in 1992. In the recovery period from June 1992, when unemployment peaked at 7.8 percent, to March

[1]See http://www.nber.org/cycles.html.

[2]http://www.ers.usda.gov/topics/food-nutrition-assistance/supplemental-nutrition-assistance-program-(SNAP)/arra.aspx. Also see http://www.fns.usda.gov/sites/default/files/pd/SNAPsummary.pdf.

2001, when the unemployment rate was 4.3 percent at the start of the 2001 recession, the number of individuals in SNAP fell from 25.4 million to 17.2 million. There was little change in the number in SNAP in the two recessions that took place in 1980 and 1981-1982, although 1981-82 was a period in which legislation was passed to reduce the size of the program.[3] Increases in SNAP spending also took place during the recessions in the 1970s, although this was a period of rapid growth and changes in the program as it was being rolled out across the States.

The countercyclical nature of SNAP links SNAP to the economy and agriculture. The fiscal stimulus effect of increased SNAP spending, and of fiscal spending generally, has been the focus of much research, particularly after the Great Recession. A number of recent studies have attempted to estimate the impact of these measures on the economy. The latest research on fiscal spending multipliers since the Great Recession indicates a few patterns. First, a range of empirical studies find multiplier effects for generic Government spending in the range of 0.8 to 1.5 (Ramey, 2011). Recent research also suggests the size of the multiplier may depend on the context, with larger multipliers when there are underemployed resources (slack) in the economy and when the spending is targeted toward low-income individuals, who have a higher propensity to spend money they receive as part of a stimulus program (Parker, Souleles, Johnson, and McClelland, 2013). This suggests an increase in SNAP expenditures may be relatively effective at raising economic output compared to other policies available, especially when there is slack in the economy and public spending is unlikely to crowd out private-sector spending. In a previous Economic Research Service report, Hanson (2010) developed the Food Assistance National Input-Output Multiplier (FANIOM) model to answer this question and found that an additional $1 billion increase in SNAP spending would increase total economic activity by $1.79 billion.

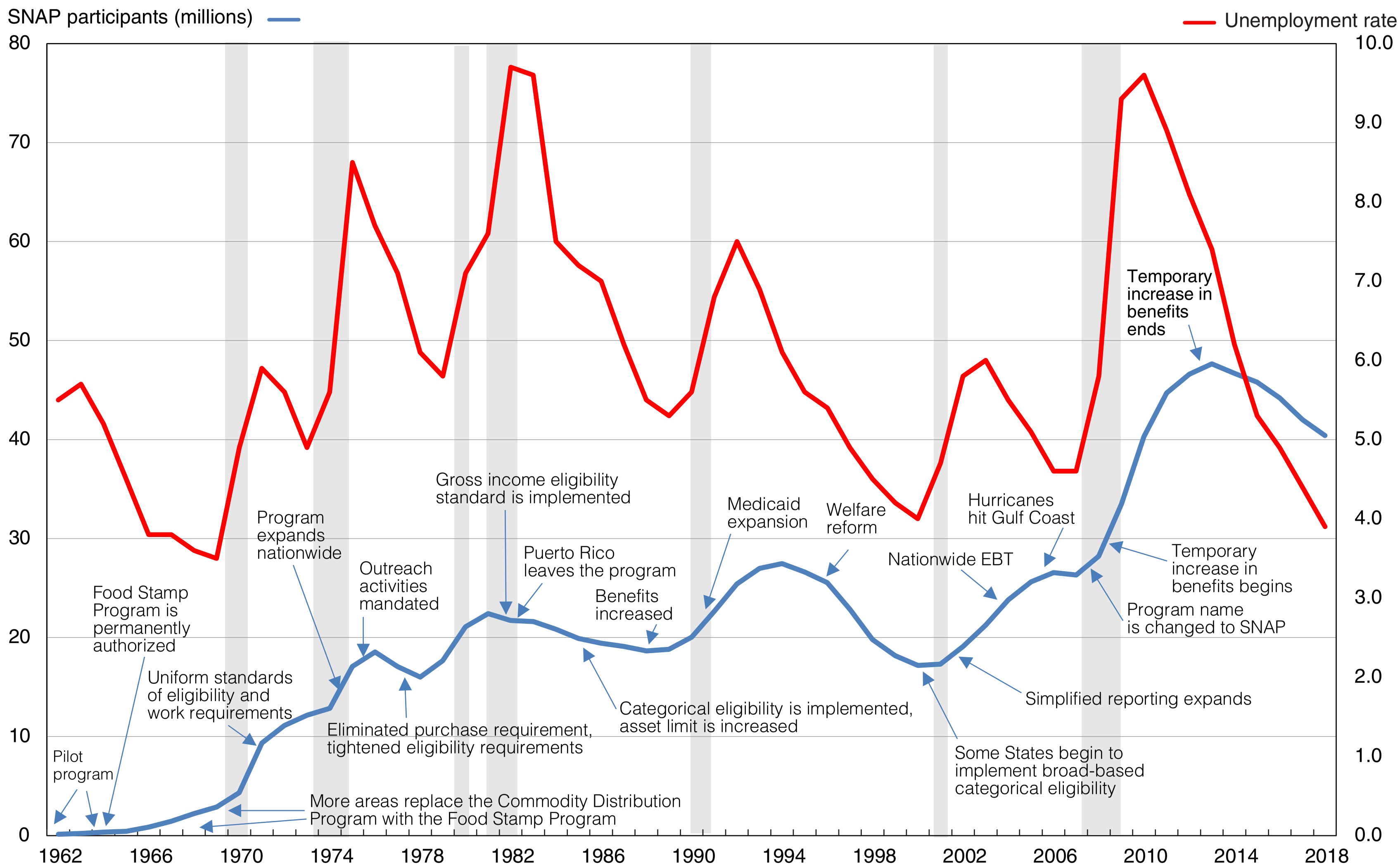
We develop the FEDS-SAM (Food Environment Data System–Social Accounting Matrix) model to produce current estimates of the multiplier for SNAP. Our modeling approach improves upon Hanson in several ways. As discussed in Hanson, the FANIOM model makes several simplifying assumptions in conducting the analysis, including using average relationships between SNAP benefit levels and the amount spent on goods and services, rather than using more-relevant marginal spending relationships. Using these new marginal spending estimates, we can get a more accurate prediction of the effects of SNAP spending on the economy. We also use a more comprehensive Social Accounting Matrix modeling approach and update the data used to calculate the FANIOM multipliers to the latest data produced by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) and U.S. Department of Labor, Bureau of Labor Statistics (BLS).

In the remainder of the report, we provide a detailed literature review of recent articles on the impact of Government spending as a stimulus measure generally and the impact of SNAP specifically. Additionally, using our FEDS-SAM model, we examine a hypothetical $1 billion increase in SNAP spending on national gross domestic product (GDP), employment, and income across U.S. industries, including agriculture. The hypothetical $1 billion increase in SNAP spending was also analyzed by Hanson, and we discuss differences between our models.

[3]Legislation in 1981 and 1982 introduced gross income eligibility tests and a freeze on the shelter reduction cap and standard deduction; changed household composition rules; prohibited Federal funds for outreach; counted retirement accounts as resources; and modified rules on job search and for job quitters.

See http://www.fns.usda.gov/SNAP/short-history-SNAP.

Figure 1
Food stamp participation and the unemployment rate, 1962-2018



Notes: SNAP = Supplemental Nutrition Assistance Program. EBT = Electronic Benefits Transfer.
The number of SNAP participants is reported in fiscal years; the unemployment rate is reported in calendar years. There is often a lag between the time a legislative act is passed and its implementation. There can be an additional lag between implementation of an act and measurable effects on participation. Gray vertical bars indicate recessions.

Source: U.S. Department of Agriculture, Food and Nutrition Service data, and U.S. Department of Labor, Bureau of Labor Statistics data.

Literature on the General Effectiveness of Stimulus Programs

Following the Great Recession of December 2007 to June 2009 and the large policy response that followed, a number of recent studies have attempted to estimate the impact of fiscal spending on the economy. We next detail several recent studies that have examined the effectiveness of fiscal stimulus generally and discuss new research on the effectiveness of the SNAP expansion, in particular, that has taken place since the recession.

The effects of Government spending on the economy at large are usually discussed in terms of multipliers. For our purposes, we discuss multipliers in the context of temporary, deficit-financed Government purchases. The definition we follow in this report for a multiplier for Government spending is the short-run change in total GDP resulting from a $1 increase in that type of spending, where "short-run" means roughly within 1 year of the spending increase. Fundamentally, as discussed in Ramey (2011), a positive multiplier is produced when the additional Government spending is able to induce job offers to supply more goods to the economy. This assumes that the additional Government spending does not "crowd out" other economic activity that would have taken place, for instance, by increasing interest rates, affecting exchange rates, or discouraging work through distortionary taxes (taxes that alter market- determined prices unequally across markets). As Ramey (2011) notes, in Neoclassical and New Keynesian models that factor in these effects, the multipliers tend to be smaller, with some Neoclassical models actually suggesting a negative multiplier in cases where temporary spending is paid for immediately by distortionary taxes.[4]

Theoretical work in Woodford (2011), using a New Keynesian dynamic, stochastic, general equilibrium (DSGE) model, suggests when interest rates are near the zero lower bound, and there is an expectation that interest rates near zero will persist for years into the future, the Government spending multiplier may be larger than 1 and could potentially be substantially larger. These conditions are most likely to occur during a large-scale economic contraction. The large spending multiplier is due, in part, to the fact that the Federal Reserve is unable to offset higher fiscal spending by increasing interest rates. Woodford, however, notes that in cases where interest rates are near zero but there is an expectation that they will not be so for long, the spending multiplier is more likely to be near 1 than substantially above 1. And when interest rates are not binding at zero, (i.e., above zero), Woodford suggests that economic stabilization is best handled using monetary policy, such as the Federal Reserve taking action to lower interest rates. Similar to Woodford, who found relatively large multiplier effects when interest rates are expected to remain near zero, Christiano, Eichenbaum, and Rebelo (2011) examine the size of spending multipliers at the zero interest lower bound using a DSGE model and also find multiplier effects substantially larger than 1. Their estimates suggest a 12-quarter increase in Government spending at the lower bound produces an overall multiplier of 1.6 and a peak multiplier of 2.3. Using a New Keynesian model, Hall (2009) estimates

[4]New Keynesian dynamic, stochastic, general equilibrium (DSGE) models are distinct from alternative neoclassical DSGE models in that neoclassical models typically assume wages and prices to be perfectly flexible, while New Keynesian models typically introduce some type of friction. The costs of fiscal spending increases and how they are paid for is an important issue. Burnside, Eichenbaum, and Fisher (2004) and Ramey (2011) note that increases in distortionary taxes do typically follow increases in Government spending. DeLong and Summers (2012) argue that in the presence of nominal interest rates near zero and unemployed resources (including labor and capital), temporary fiscal stimulus measures may pay for themselves under plausible conditions by increasing the long-term tax base of the economy and avoiding "hysteresis," which is a loss of the long-term potential of the economy through decreases in laborforce participation and productivity. The authors argue that in the presence of interest rates near zero, the fiscal policy multiplier is likely to be relatively high and that the Federal Reserve is unlikely to raise interest rates to offset the effects of the fiscal policy. The authors also argue that even if the conditions they lay out do not hold, expansionary fiscal policy is likely to pass a cost-benefit test.

that at the zero lower bound, the fiscal spending multiplier is 1.7 and between 0.5 and 1.0 during normal conditions.[5]

Besides theoretical work, multiple empirical studies have tried to assess the size of the multiplier. In a survey of recent literature on Government spending multipliers, Ramey (2011) suggests the range of plausible values for the multiplier is between 0.8 and 1.5. New empirical research also indicates that the size of the multiplier may depend on the context, including what the money is spent on, whether there are underemployed resources (slack) in the economy, and whether nominal interest rates are near the zero lower bound.

One approach to estimating the effects of fiscal spending on the economy is to use buildups and drawdowns in military spending during wartime, which are arguably unrelated to underlying economic circumstances. Barro and Redlick (2011) use data on buildups and drawdowns from 1913 to 2006. The authors find that, after controlling for average marginal tax rates, the Government spending multiplier is 0.6 for changes in military spending. Nakamura and Steinsson (2014) use differences across regions in the amount of money spent on military buildups and drawdowns in the United States as a way to identify the effects of Government spending on economic output. For instance, as the authors note, when U.S. military spending increases by 1 percent overall, spending in California increases by 3 percent, while it only increases by .5 percent in Illinois. The authors find that in States that see military spending increase by 1 percent, economies expand by around 1.4 to 1.9 percent, implying a multiplier between 1.4 and 1.9. They note that this may not necessarily match what would be expected for a national expansion in spending, because the comparison between States does not account for changes in monetary policy or tax policy that might occur at the national level. The authors also note that their results imply that the Government spending multiplier is likely to be higher when nominal interest rates are at the zero lower bound.

Auerbach and Gorodnichenko (2012) find that spending during recessions produces a relatively large multiplier. The authors use a structural vector autoregression technique to estimate Government spending multipliers that allows the multiplier to depend on the state of the economy and the type of spending that takes place. They find estimates of spending multipliers that are much larger in recessions (a maximum multiplier of 2.48) than in economic expansions (a maximum multiplier of 0.57). The authors also find that military spending in recessions has a larger multiplier (maximum multiplier in recession of 3.56) than nondefense spending (maximum multiplier in recession of 1.12). The authors do not break down nondefense spending into spending targeting low-income individuals, as SNAP would.

New research also suggests that spending targeted toward low-income individuals may result in a particularly large multiplier, possibly because low-income individuals have a relatively high marginal propensity to consume (MPC), where MPC measures the share of new income that is spent on consumption as opposed to saved or invested. Surveys show low-income households tend to spend a larger share of their income than high-income households (BLS, 2018b). Parker et al. (2013) examine the economic stimulus payments during 2008 that took place as part of the Economic Stimulus Act (ESA) of 2008. The ESA resulted in payments to 130 million U.S. tax filers of $300-$600 for single individuals, $600-$1,200 for couples, and additional payments of $300 per

[5]See also Cogan, Cwik, Taylor, and Wieland (2010), who also examine the size of the multiplier in the context of a New Keynesian model. The authors calibrate a New Keynesian model that assumes the Federal Reserve keeps interest rates set at zero for 2 years and then applies the "Taylor Rule" for raising interest rates. The authors find that estimates of the fiscal spending multiplier are smaller than those assumed in Romer and Bernstein (2009) under these conditions, but this result seems to hinge on how quickly the Federal Reserve raises interest rates after a downturn.

child who qualified for the child tax credit. The authors exploit random variation in timing of the payments, which was based on the last two digits of a recipient's Social Security number, to identify the marginal propensity to consume resulting from the payments. Recipients spent 50 to 90 percent of the payments within 3 months, with particularly large propensities for low-income families earning under $32,000.

Feyrer and Sacerdote (2011) use State- and county-level variation in the amount of money allocated in the American Recovery and Reinvestment Act (ARRA) stimulus plan as a way to identify variation in spending that is exogenous to economic conditions. The authors argue that the seniority of an area's representatives in the U.S. Congress is likely to be unrelated to underlying economic conditions and use the fact that regions with relatively high congressional seniority tended to receive more spending than regions with less seniority. Estimates show a spending multiplier between 0.5 and 1.0, but also show that multipliers are higher for certain types of spending. Spending coming from agencies focused on low-income support (HHS, HUD, and USDA) produces multipliers of 1.96. The spending from USDA and the other agencies includes all agency spending, but the authors note that the majority of USDA spending went to covering the expansion of food stamps (SNAP). The majority of HUD spending went to rental assistance and public housing support, and the majority of HHS spending went to Medicaid. The authors also find that money spent in agencies that focus on building projects (Department of Transportation, Department of Energy, Environmental Protection Agency) also have high spending multipliers close to 1.85.

Chodorow-Reich, Feiveson, Liscow, and Woolston (2012) examine the expansion of the Medicaid program resulting from the passage of the ARRA to estimate Government spending multipliers. The Government spending multiplier is estimated to be around 2.0 in its analysis. This is above the range seen across a number of studies in Ramey (2011) for a generic Government spending multiplier that is between 0.8 and 1.5 as reported and again suggests spending on low-income programs may be a particularly effective stimulus measure.

Wilson (2012) examines the overall impact of the ARRA legislation on jobs using variation in stimulus receipts across States and the fact that funds were allocated using a formula based on factors such as the number of highway miles and youth share of the population. These factors are arguably unrelated to economic conditions for a State at the onset of the Great Recession. The analysis focuses on spending by the Departments of Transportation, Education, and Health and Human Services. Wilson (2012) estimates that ARRA spending for these departments generated about one job per $125,000 spent.

Blinder and Zandi (2015) estimate that without the countercyclical policy responses, both monetary and fiscal, that were implemented in 2008 and 2009, the economy would have lost 17 million jobs, roughly twice the number actually lost, and GDP would have dropped by 14 percent, peak to trough, rather than the 4 percent actually lost. The authors examine 22 different multipliers for different types of fiscal spending measures. These include tax cuts (multipliers between .32 and 1.38), temporary increases in food stamps (1.74), temporary financing of work-share programs (1.69), extensions of unemployment benefits (1.61), defense spending (1.53), and infrastructure (1.57), among others types of spending (ranging from 1.13 to 1.41). Out of all of the spending multipliers considered, the multiplier for SNAP spending was the highest. All of the previously reported spending multipliers were for the first quarter (Q1) of 2009. Estimated spending multipliers for 2015 Q1 are reported to be much smaller, which the authors explain as driven by less economic slack in the economy in 2015 Q1 compared to 2009 Q1.

Table 1

Estimated multipliers for Federal spending in recent empirical studies

Study	Identification	Type of spending	Economic environment	Estimated spending multiplier
Ramey (2011)	Various from 17 published studies	Various	Various	0.8 – 1.5
Barro and Redlick (2011)	Military buildups and drawdowns	Military spending	Various	0.6
Zero Interest Rate/Economic Recession Environment				
Nakamura and Steinsson (2014)	Between-State variation in military buildups and drawdowns	Military spending	No change in Fed. Reserve policy between States	1.4-1.9
Auerbach and Gorodnichenko (2012)	Structural VAR that allows for multiplier to depend on economy	Military/ nonmilitary	Recessions and expansions	Recession: 2.48, expansion: 0.57, military in recession: 3.56, nonmilitary in recession: 1.12
Spending on low-income programs				
Feyrer and Sacerdote (2011)	State/county-level variation in ARRA Spending using congressional seniority	HHS, HUD, and USDA	Great Recession	1.96
Chodorow-Reich et al. (2012)	Medicaid expansion in ARRA	Medicaid	Great Recession	2.0
Wilson (2012)	ARRA spending changes based on funding formula	DOT, DOE, HHS	Great Recession	1 job/$125,000 spent
Blinder and Zandi (2015)	Moody's Macroeconomic Model	SNAP	Great Recession	1.74
Hanson (2010)	FANIOM Model	SNAP	Unspecified	1.79 1 job/$112,360

HHS = Health and Human Services; HUD = Housing and Urban Development; ARRA = American Recovery and Reinvestment Act.
Source: U.S. Department of Agriculture, Economic Research Service.

Literature on the Effectiveness of SNAP Specifically

The literature suggests that fiscal spending is most effective in times where there are underemployed resources and monetary policy is set at the zero lower bound and may be particularly effective for low-income support (SNAP, unemployment insurance, Medicaid), military spending, and infrastructure spending. One interpretation of these facts is that spending is best directed toward projects where money is likely to be spent quickly, while there is still slack in the economy and/or where a large share of the money is likely to be spent in the near future rather than saved.[6] Blinder (2016) notes that SNAP may fit both conditions. As noted in Blinder (2016) and Bernstein and Spielberg (2016), 97 percent of SNAP benefits are redeemed within 1 month of issuance.[7] Additionally, in an

[6]As discussed in Ramey (2011), when interest rates are held constant, the Keynesian multiplier is equal to $1/(1- mpc)$, where mpc is the marginal propensity to consume. This implies that spending directed toward projects with a high marginal propensity to consume will tend to have larger multipliers.

[7]See the USDA FNS report titled, "Benefit Redemption Patterns in the Supplemental Nutrition Assistance Program". http://www.fns.usda.gov/sites/default/files/ARRASpendingPatterns_Summary.pdf

economic contraction, more people automatically become eligible because of falling incomes, and no congressional legislation is needed to approve increases in the SNAP caseload.

Blinder and Zandi (2015), using Moody's Analytics model of the U.S. economy, examine specific provisions of the ARRA and find that increased spending on food stamps had the highest multiplier of any of the stimulus programs.[8] The authors find that an additional dollar of SNAP spending increased GDP over 1 year by $1.74, implying a multiplier of 1.74 as of the first quarter of 2009.[9] This is closely followed by temporary Federal financing of work-share programs, with a multiplier of 1.69, and the extension of unemployment insurance benefits, with a multiplier of 1.61.

Pender et al. (2019) used data on county-level SNAP payments and employment to empirically estimate the impacts of SNAP spending on employment. The authors find that a $10,000 increase in SNAP expenditures at the county level translated into an increase of between 0.4 and 0.5 jobs during 2001-2014, equivalent to an increase of 40,000 to 50,000 jobs per billion spent, with greater impacts during the Great Recession (2008-2010).

Hanson (2010), using the Food Assistance National Input-Output Multiplier (FANIOM) model, estimates that a $1 billion increase in SNAP expenditures leads to a $1.79 billion increase in GDP, implying a multiplier of 1.79. Hanson estimates suggest that a $1 billion increase would lead to between 8,900 and 17,900 full-time equivalent jobs.

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[8]See Zandi and Hoyt (2015) for details on the Moody's Analytics model. The ARRA increased the maximum allotments for all SNAP participants.

[9]The Moody's macroeconomic model predicts relatively large multiplier effects in times of greater economic slack compared to times of full employment. As the economy has improved, the multiplier predicted in the Moody's model has fallen. The authors report that the multiplier for SNAP as of 2015 Q1 is 1.22. The authors report that when the economy is at full employment, the model predicts a multiplier near zero, because the increased Government spending crowds out private-sector spending.

Modeling SNAP and the Economy With FEDS-SAM

Our focus is on the stabilizer role of SNAP during a slowing economy when SNAP benefit payouts typically increase. The appropriate model to study this scenario is arguably different than for periods of accelerating economic growth when payouts typically decrease. With this in mind, table 2 outlines the types of models that can be used.

Table 2
Strengths, limitations, of four model frameworks for SNAP multiplier analysis

Model framework	Recent SNAP application	Strengths	Limitations
Macroeconometric	Blinder and Zandi (2015)	Gold standard for estimating multipliers	Very little economic market structure precludes distributional analysis
Computable general equilibrium	Reimer, Weerasooriya, and West (2015)	Detailed economic structure; full macro-economic closure; allows 'crowding-out' effects	Full employment and fixed (or tight) capital market assumptions not representative of a slowing economy
Accounting multiplier	Hanson (2010)	Detailed economic structure; simple to calibrate; assumes slack factor markets	Assume APC/APS behaviors; upward bias multiplier
Fixed price multiplier	FEDS-SAM (2019)	Detailed economic structure; models MPC/MPS; assumes slack factor markets	No 'crowding-out'; requires extensive econometric calibration

Notes: MPC/MPS = Marginal Propensity to Consume/Marginal Propensity to Save; APC/APS = Average Propensity to Consume/Average Propensity to Save. SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service.

Macroeconometric model applications, such as in Blinder and Zandi (2015), are the gold standard for estimating multipliers from different types of fiscal stimulus, including SNAP. By design, macroeconometric models isolate and measure the influences of a fiscal stimulus using a statistical representation of the economy based on historical relationships and an array of current and historical macroeconomic data. Model equations that specify broad behavioral and market relationships are informed by economic theory, whereas the directions and intensities of these relationships in response to fiscal stimulus are informed by the current and historical data. Distributional analysis at the sector level, including representation of agriculture and the food-value chain (food processing, food services, food retailing, and supporting food system industries) are not captured in these models. The importance of relationships between SNAP, food markets, and agricultural production is well established, and the goal of our research in this report is to better understand that relationship. For this reason, macroeconometric models are not well suited for the goals of the study, beyond their use as a source for validation of the overall multiplier estimates produced and used in the analysis.

SNAP analysis from computable general equilibrium models (CGE), such as Reimer, Weerasooriya, and West (2015), provide a detailed accounting of behavioral and market relationships down to the household and sector levels, including an accounting of agriculture and the food-value chain. Their accounting of the flow of funds from industry (in the form of sales proceeds) to factor owners (e.g., labor, business partners, and stockholders) allows for an explicit accounting of the multiplier mechanism. CGE models also capture nonlinear substitution possibilities, both for primary production factors (labor, land, and capital), and for household consumer expenditures. A key feature of CGE models that distinguishes them from SAM multiplier models (discussed below) is the assumption that total factor supplies are fixed in the static (short-run) model. This feature is a strength in the context of studying a fiscal stimulus during a period of full employment and/or rising interest rates, since under these conditions, it is more likely that a fiscal stimulus will lead to increasing labor costs and/or increased competition for scarce capital resources. As discussed, our focus in this report is on the stabilizer role of SNAP during a slowing economy when SNAP benefit payouts typically increase. Although refinements in the specification of a CGE model can be made to relax the price pressures in factor markets following a fiscal stimulus, SAM multiplier models represent an attractive alternative. This is particularly the case for a SNAP analysis, since without factor price effects SNAP is not likely to otherwise affect consumer prices. This scenario leaves only income effects as the driving force affecting the size of the various multipliers under study.

A social accounting matrix (SAM) is a fully integrated economic accounting system that summarizes all transactions and transfers between economic agents, such as business establishments, Government entities, and private households. It is the data platform of both CGE models and SAM multiplier models. Two types of SAM multiplier models are accounting multiplier models and fixed-price multiplier models (Pyatt and Round, 1979). The FANIOM model (Hanson, 2010) is an accounting multiplier model, since income-induced household demands for consumer products and for savings are all assumed to change by the same percentage as the change in household disposable incomes. A fixed-price multiplier model allows for use of unique expenditure and savings elasticity parameters for each consumer good and for savings by households. With income effects as the driving force affecting the size of the various multipliers under a SNAP expansion, we view it as the preferred approach in the present context, particularly when expenditure and savings elasticities can be calibrated with historical and recent data. The FEDS-SAM model introduced in this report is a fixed-price multiplier model.

FEDS-SAM represents an annual summary of the entire U.S. economy in the year 2016. FEDS-SAM stands for the Food Environment Data System, Social Accounting Matrix. It is compiled from the most recent annual *Make* and *Use* tables published by the U.S. Department of Labor, Bureau of Labor Statistics (BLS, 2017). We embed the BLS 2016 *Make* and *Use* tables into a macroeconomic SAM compiled from the 2016 annual National Income and Product Accounts (NIPA) published by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA, 2018). In reconciling the data from BLS and BEA, we also reorganize the data in order to more fully represent salient attributes of the U.S. food system (see discussions of this reorganizing approach in Canning, 2011 and Canning et al., 2017). FEDS-SAM can in some ways be thought of as an extension of the work done in the FANIOM model (Hanson, 2010), although the methodology differs in important ways [See box “A Comparison of FEDS-SAM and FANIOM”].

A Comparison of FEDS-SAM and FANIOM

This report introduces FEDS-SAM—a social accounting matrix multiplier model—in order to study macroeconomic implications of changes to Supplemental Nutrition Assistance Program (SNAP) benefits. A 2010 ERS report (Hanson, 2010) introduced FANIOM—an input-output multiplier model used for the same purpose. Both models are addressing the same question in different time periods, so it is worthwhile to compare them.

Both FEDS-SAM and FANIOM use published Government *Make* and *Use* tables to model industry production and commodity outputs. FANIOM used the latest (2002 at the time) benchmark accounts published by BEA. This data partitions the national economy into 426 industries and 428 commodities. FEDS-SAM uses the latest (2016) annual tables published by BLS. This data partitions the national economy into 202 industries and 201 commodities. *Use* tables report all commodity purchases of each industry for use as production inputs. *Use* tables also report gross domestic income for each industry. *Make* tables report the commodities produced by each industry. Incorporation of *Make* and *Use* tables in both models are similar.

There are three key differences in the two models. First, FANIOM accounts for domestic industry income broken out into four categories (salaries and wages, proprietor incomes, output taxes, operating surplus) and allocates these incomes between Government and a single representative household. FEDS-SAM breaks out domestic industry income into eight primary factor categories (see Appendix table A.2) plus two external factors (output plus corporate taxes and direct industry savings/investment). Each of the primary factor incomes are allocated between three endogenous owners (two household groups and international) and two exogenous owners (Government and capital). A second difference is that FANIOM bases households' expenditure and saving behaviors on their annual average budget shares (except for the initial SNAP household food marginal propensity to consume (MPC)), and FEDS-SAM bases SNAP and non-SNAP household expenditure and savings behaviors on their estimated marginal budget shares. A third difference is that FANIOM treats imports and exports of commodities plus the international flows of incomes and savings as exogenous, whereas FEDS-SAM internalizes these international flows. FANIOM does an outside-the-model adjustment that accounts for changes in commodity imports only.

In the same hypothetical SNAP spending increase scenario, the first above-cited difference has an indeterminate effect, the second is expected to substantially reduce all FEDS-SAM multipliers compared to FANIOM, and the third is expected to marginally increase the FEDS-SAM multipliers compared to FANIOM. The table below compares the Type III multipliers from FANIOM with FEDS-SAM and with a model from a sensitivity analysis of FEDS-SAM that eliminates a key difference with FANIOM by using average savings rates. The results confirm expectation: FEDS-SAM lowers gross domestic product (GDP) and output, and FEDS-SAM based on average propensity to save (APS) is slightly higher than FANIOM. The employment comparison is imperfect since FEDS-SAM adds unpaid workers to full-time equivalent (FTE) jobs and FANIOM uses FTE.

In summary, the key conclusions related to national multipliers from both model applications are similar, but with predictable differences. Most of the changes implemented in FEDS-SAM are discussed in Hanson (2010) as potential future refinements.

Comparison of multipliers between FANIOM and two FEDS-SAM models

Model	GDP multiplier	Output multiplier	Employment multiplier (x1,000)
FANIOM Type III	1.8	3.3	16.1*
FEDS-SAM	1.5	2.8	13.6
FEDS-SAM based on APS	2.0	3.6	16.9

*Published value (17.9) adjusted to reflect 2008 benefits in 2016 dollars based on the food and beverage at home personal consumption expenditures price index (BEA, 2018).

Source: U.S. Department of Agriculture, Economic Research Service.

Table 3 depicts the macroeconomic SAM, which is the high-level summary of economic flows within and between all sectors of the U.S. economy. It comprises four main partitions, each having one or more subaccounts. These partitions are **production** (with subaccounts 1 to 4), **consumption** (with subaccounts 5 to 7), **capital** (subaccount 8), and **international** (subaccount 9). In addition, there is an **external** account that summarizes all the predetermined (as opposed to the variable) household expenditures, as identified during estimation of household expenditure systems (discussed below). In table 3, all subaccounts are represented in both a row and a corresponding column. Reading across any subaccount row, we can identify all sources of revenue flowing into the account, and reading down its corresponding column we can identify destinations of all outlays from the account. The SAM must balance, meaning summing across any row (inflows) equals the same total as summing down its corresponding column (outflows).

Table 3
Macroeconomic SAM of the United States, 2016

Partition	Subaccount	Account number	A* (1)	C* (2)	P* (3)	F* (4)	S* (5)	N* (6)	G* (7)	SI* (8)	IE* (9)	E* (10)	Total
			$ trillion										
Production	Activities	(1)		18.6									18.6
	Commodities	(2)			12.8				2.7	3.7	1.9	10.0	21.0
	Products	(3)					<0.05	2.8					12.8
	Factors	(4)	13.9					<0.05	<0.05	<0.05	0.4		14.3
Current Consumption	SNAP Households	(5)				0.3			0.3		<0.05	-0.7	<0.05
	Non-SNAP Households	(6)				13.2			3.0		0.2	-11.2	5.1
	Government	(7)	1.6			0.3	<0.05	0.7	0.1		<0.05	2.6	5.3
Capital	Save/Invest	(8)	3.1			0.3		1.6	-0.9	<0.05	0.5	-0.9	3.7
International	Import/Export	(9)		2.4		0.1			0.2			0.2	3.0
External	Exogenous Households Outlays	(10)											
		Total	18.6	21.0	12.8	14.3	<0.05	5.1	5.3	3.7	3.0	0.0	

Notes: SAM = Social Accounting Matrix. SNAP = Supplemental Nutrition Assistance Program.
*Column abreviations are as follows: Activities, Commodities, Products, Factors, SNAP Households, Non-SNAP Households, Government, Save/Invest, Import/Export, Exogenous Household Outlays.

Source: U.S. Department of Agriculture, Economic Research Service.

Production

The four **production** subaccounts are the *activity*, *commodity*, *product*, and *factor* accounts. All domestic production is measured in the *activity* account, which is comprised of 202 distinct industry groups such as agricultural crops, bakeries, food retailers, and the airline industry, to name a few (see Appendix table A.1 for a list of all industry groups in the activity subaccount). Each industry contributes to the production of one or more commodities, so that collectively the commodity account aggregates domestic industry outputs and is the source of $18.6 trillion in gross domestic income (GDI) by industry, as reported in the commodity column (2) of the Activities row in table 3.[10] In order to produce, each activity employs the services of primary factors such as labor, land, buildings, equipment, and other property, and most of the GDI proceeds ($13.9 trillion) are allocated to this *factor* account. Other accounts with claims on industry GDI are the Government account in

[10]Our source for industry GDI is BLS (2017), and the $18.6 trillion figure is equal to the same measure as the NIPA's (BEA, 2018) through one decimal but differs from the NIPA's over two or more decimals.

the form of output, corporate and excise taxes and fees ($1.6 trillion), and the capital account in the form of retained corporate earnings, capital depreciation allowances, and inventory value adjustments ($3.1 trillion).

The 201 commodity groups in the *commodity* account, such as dairy products and electric power (see Appendix table A.1 for a list of all commodity groups in the commodity subaccount), sell their outputs to consumer product aggregators ($12.8 trillion) and Government agencies ($2.7 trillion) and put an additional $3.7 and $1.9 trillion in investment and export sales, respectively. To facilitate these sales, the purchases from domestic industries are augmented by import commodity purchases from the international account ($2.4 trillion).

The *products* account is another aggregator—this time of commodities—selling exclusively to domestic households ($12.8 trillion) and meeting both predetermined and variable household demand. The products account aggregates a subset of the 201 commodities into 15 consumer products (see Appendix table A.3 for a list of the 15 products).

The final subaccount of the production partition is the *factor* account (see Appendix table A.2 for the list of factors). Factor incomes come primarily from domestic industries, with lesser amounts from the ownership of international assets ($0.4 trillion) and Government transfers (<$0.1 trillion). This account distributes the proceeds to factor owners such as hired labor, property owners, stockholders, sole proprietors, and business partners. The largest share of ownership is the non-SNAP households ($13.2 trillion), with the next-largest share directed to capital ($0.3 trillion), followed by SNAP households ($0.3 trillion), Government ($0.3 trillion), and international claimants ($0.1 trillion).

Consumption

The three **consumption** subaccounts are *SNAP households*, *non-SNAP households*, and *Government*. In 2016, SNAP households accounted for 11 percent of the U.S. population (BLS, 2018) and derived income mostly from ownership of primary factors, principally wages and self-employed income, and from Government sources ($0.3 trillion). Most of this income is allocated to the external account to cover committed expenditures, with the remainder split between marginal personal consumption expenditures and marginal Government payments, including personal income taxes and contributions to social insurance funds (<$0.1 trillion).

Non-SNAP households also derived income from ownership of primary factors and from Government sources ($3.0 trillion), plus lesser amounts of income from international sources ($0.2 trillion). Non-SNAP households also allocate income to the external account to cover committed expenditures ($11.2 trillion). This allocation of both SNAP and non-SNAP household incomes between committed and marginal spending is estimated from a nested demand system statistical analysis, discussed below and reported in Appendix B.

Government (Federal, State, and local) derives revenues from personal and business taxes across activities, households (including for committed expenditures), and international sources ($1.6 trillion), and claims income from ownership of primary factors. Much of this income is for consumption expenditures on commodities and transfer payments to households. A considerable allocation is also made to the capital account for Government investment expenditures; however, this allocation is more than offset by substantial budget deficits (combined Federal, State, and local), recorded as a negative transfer from the capital account and representing Government borrowing (-$0.9 trillion).

Capital, International and External

The **capital** account consolidates all savings, principally from domestic industry and households, as discussed above. In addition, international investors direct their trade surplus with the United States to this account ($0.5 trillion). All savings above those covering current account deficits are invested through the purchase of commodities from both domestic production and international imports.

The **international** account derives funds principally from import commodity sales in the United States, with smaller amounts derived from claims on factor incomes of U.S. industries and transfers from Government. A lesser amount of international purchases from U.S. commodity exports is augmented by U.S. claims on foreign factor and interest incomes. The remaining deficit in U.S. international trade (inflows - outflows) is directed to the capital account in the form of international savings in the United States.

The **external** account draws funds from SNAP and non-SNAP households, plus from the capital account through the accumulation of debt. These transfers exactly offset the committed expenditures and the associated payments to Government.

Modeling Household Consumption and Savings

Observations of household spending behaviors consistently reveal differences between average propensities to consume (APC) and marginal propensities to consume (MPC). The average propensity to consume measures the share of annual disposable household income spent on consumption, while the marginal propensity to consume measures the share that this same household spent on consumption from the last dollar of annual income. For example, Engel's Law (Houthakker, 1957) states that as income rises, the proportion of income spent on food falls, suggesting that households with rising incomes are likely to have a lower MPC than APC for food. This result is observed in the latest annual statistics on consumer expenditures from BLS (table 1101 in BLS, 2018b), where the data shows that the lowest 20 percent of households, when ordered by pre-tax annual household income, spent 33 percent of their annual 2016 after-tax income on food, whereas the second through the highest 20 percent of households spent 17, 13, 11, and 8 percent of their annual after-tax incomes on food, respectively. The same pattern is observed in tracking expenditures of individual households over time as their incomes change. This pattern of different APC and MPC is also observed in different categories of spending, such as on housing, entertainment, and automobiles, but in some cases the share spent on a category increases as incomes rise.

Since we are studying how newly enrolled SNAP households will spend their SNAP benefits and how this outcome will induce new production and spending economywide, the APC versus MPC distinction is informative. For households enrolling in the program, SNAP payouts add to existing incomes, so their responses will reflect marginal, as opposed to average, behaviors. Our approach to incorporating these behaviors is to study historical data from the same source used to compile our SAM (BLS, 2017) in order to measure average and marginal behaviors of both SNAP and non-SNAP households. For this purpose, we estimate a nested linear expenditure system (LES) in two steps.

The LES demand system has long been widely used in aggregate data analysis (e.g., Eastwood and Craven, 1981; Reimer et al., 2015), and it has consistently exhibited strong explanatory properties for the analysis of household expenditure data, particularly when the analysis is across aggregate consumer commodity groupings. This is shown to be the case in the present stage 1 analysis, in which a regression model of 1993 to 2016 aggregate household expenditure and price data across the 15 product categories produced highly significant demand-system parameter estimates over all 14 independent LES demand equations of the 15-equation system (a detailed summary of the regression analysis is reported in Appendix B).

In the second stage, a constrained maximum likelihood (CML) model is used to estimate separate demand system parameters for (1) households receiving SNAP benefits in 2016 (representing 11 percent of the population) and (2) all other households (representing 89 percent of the population). Our assumption is that the average newly enrolled SNAP household exhibits the same spending and saving behavior as the average existing SNAP household. Additional BLS data and analysis are used for this identification. The data are from the BLS 2016 Consumer Expenditure Survey (BLS, 2018), and it tells us both the total and the average per capita annual spending on each of the 15 product groups under study for SNAP and non-SNAP households. The 2016 Consumer Expenditure Survey data is also our source for the share of the population in SNAP and non-SNAP households.

Marginal propensity to consume or purchase (MPC) food with SNAP benefits is measured as the ratio of (1) the amount of new food spending at grocery stores and other food retailers in response to receiving a SNAP benefit, over (2) the value of the SNAP benefit. For example, benefit recipients can only use their SNAP benefits to purchase food, but they are not prohibited from repurposing other funds (e.g., salary or savings) they intended to use for food purchases to nonfood purchases. Should a new recipient who receives a $100 monthly SNAP benefit decide to repurpose $70 of that month's salary that was intended for food purchases in the same month, the recipient's net increase in food spending would be $30 ($100–$70), and the recipient's food MPC from SNAP benefits would be 0.3 ($30/$100).

We estimate an MPC on food at home among SNAP households in preparation for the second stage of our household consumption model. In the CML model of stage 2, we constrain the value of the MPC on food at home among SNAP households to this estimate. This is necessary due to the importance of this parameter to our overall analysis. For this purpose, we draw on the previous literature as well as our own econometric estimates to derive values for the parameter. Our econometric approach is described in the appendix and makes use of data from two natural experiments: the SNAP benefit increase following the passage of the ARRA and the Economic Stimulus Payment of 2008 in which tax refunds of $300-$600 for individuals and $600-$1,200 for couples were issued. Both natural experiments are ideal for investigating marginal spending patterns from a hypothetical SNAP enrollment increase, because both involve a temporary, deficit-financed change in either SNAP benefit levels or income from which we can examine how households respond.

Our analysis, reported in table 4, produced a marginal propensity to consume food from SNAP benefits of 0.30. This is near the middle of the distribution of estimates from the literature, with estimates ranging from 0.163 to 0.65 among recent studies, but on the lower end of recent estimates of the marginal propensity to consume food at home, which find estimates near 0.5 or above (described in table 5).[11]

[11]We also conduct a sensitivity check, discussed in the next section, where our full model is compiled with food MPC parameters of SNAP households equal to 0.15 and 0.45.

Table 4
Key model parameters for the FEDS-SAM model

Parameter	SNAP households	Non-SNAP households
Marginal propensity to consume food at home	0.30 (0.05)	0.03 (0.03)
Marginal propensity to save	0.078 (0.06)	0.367 (0.02)

Note: FEDS-SAM = Food Environment Data System-Social Accounting Matrix. Standard errors in parentheses.

Source: U.S. Department of Agriculture, Economic Research Service calculations.

Results from the stage 2 CML model produce the 2016 per capita personal consumption expenditure estimates of an average SNAP and non-SNAP household individual, as reported in table 6.[12] Lines 1 to 15 of columns (a) and (d) in table 6 are summarized from the values for the *Product* rows of the household columns in our full SAM, and line 0 is summarized from the household columns (columns 5 and 6) in the macro SAM of table 3. As table 6 shows, marginal food-at-home expenditures for SNAP recipients represent 30 percent (0.73/2.44) of marginal disposable income (marginal expenditures + savings)—a substantial share compared with the 2-percent share (7.07/341.5) for non-SNAP households. It is also substantial compared to the overall food-at-home share of disposable income, which is 13 percent for SNAP households (132.36/1000). This result reflects the very high propensity to increase food spending from SNAP benefits relative to food spending increases induced from non-SNAP income sources—a finding that portends a substantial benefit to farmers from new SNAP spending.

Table 5
Estimated marginal propensities to consume food at home from nutrition assistance benefits in recent empirical studies

Study	Time period	Identification	Experiment	Estimated SNAP MPC for food at home
Hoynes and Schanzenbach (2009)	1960-1970s	Diff-in-Diff	Initial food stamp program rollout	0.163
Breunig and Dasgupta (2005)	Late 1980s	RCT	SNAP cash-out experiment	0.297
Fraker, Martini, and Ohls (1995)	Late 1980s	RCT	SNAP cash-out experiment in late 1980s	0.2-0.35
Beatty and Tuttle (2014)	2007-2010	Diff-in-Diff	SNAP benefit increases associated with ARRA	0.48
Hastings and Shapiro (2018)	2004-2016	Panel event study	Rhode Island Admin Records	0.5-0.6
Collins et al. (2014)	2011-2014	RCT	Summer electronic benefit transfer for children (SEBTC) demonstration	0.54-0.65

Note: MPC is additional food-at-home spending generated from an additional dollar in nutrition assistance.
SNAP = Supplemental Nutrition Assistance Program. RCT = Estimates from a Randomized Control Trial.
Diff-in-Diff = Difference-in-differences estimation technique.

Source: U.S. Department of Agriculture, Economic Research Service.

[12]Consumer Expenditure Survey data (BLS, 2018) is used to inform the stage 2 model household partitions of aggregate consumption data in the NIPA accounts; however, due to discrepancies in total expenditures across the two data sources, table 6 reports (in lieu of totals) the disposition of expenditures and savings per $1,000 of disposable income, as estimated in the stage 2 model.

Household savings per $1,000 of disposable income are reported in line 17 of table 6. The marginal propensity to save (MPS) for SNAP households is set to 0 based on econometric estimates of this measure that were not significantly different than 0 (table 4). The MPS per dollar of non-SNAP household disposable income is an estimated $0.367 (125.3/341.5). These MPS values come from econometric estimates reported in Appendix B and are in line with previous literature. For example, Parker et al. (2013) find that between 50 and 90 percent of the Economic Stimulus Payments of 2008 were spent immediately, meaning between 10 and 50 percent of the marginal income provided by the payments were saved. Our estimate of 0.367 for the MPS of Non-SNAP households is thus in the middle of these estimates. Parker et al. also find some evidence that low-income households spend relatively more of marginal income. Additionally, Mahedy and Wilson (2018) note that numerous studies show that liquidity-constrained households, which include many SNAP households, tend to have relatively high marginal propensities to consume, and therefore relatively low marginal propensities to save. Both are consistent with our finding that, on average, savings for SNAP recipients are not affected by a change in SNAP benefits.

As reported on the bottom row of table 6, on a per capita basis the average non-SNAP household disposable income is about 150 percent higher than for average SNAP households (246.4/100.0).

Table 6

Disposition of per capita expenditures and savings per $1,000 of disposible income, 2016

		SNAP Recipient Households			Non-SNAP Recipient Households		
	Line ↓ /	Marginal	Committed	Total	Marginal	Committed	Total
Item	Column →	(a)	(b)	(c)	(d)	(e)	(f)
Total expenditures	0	2.44	1,007.26	1,009.65	216.16	730.14	946.33
Food at home	1	0.73	131.64	132.36	7.07	57.94	65.01
Food away from home	2	0.07	46.72	46.78	7.92	46.62	54.55
Clothing and footwear	3	0.11	43.97	44.08	9.37	18.39	27.76
Other nondurable goods	4	0.22	150.91	151.13	21.48	79.95	101.43
Motor vehicles and parts	5	0.03	45.83	45.86	6.78	28.01	34.79
Furnishings and durable household equipment	6	0.15	26.66	26.81	12.77	10.61	23.39
Recreational goods	7	0.24	36.55	36.79	22.00	4.30	26.30
Other durable goods	8	0.10	17.72	17.81	8.61	10.15	18.76
Housing and utilities	9	0.23	255.61	255.84	25.14	143.77	168.92
Health care	10	0.29	107.36	107.65	45.18	120.51	165.69
Recreation services	11	0.07	14.03	14.09	7.71	29.41	37.12
Accommodations	12	0.03	1.73	1.76	2.89	6.70	9.59
Financial services and insurance	13	0.04	44.79	44.82	9.65	62.95	72.60
Other services	14	0.10	72.41	72.51	18.23	95.17	113.40
Nonprofit institutions serving households	15	0.03	11.33	11.36	11.36	15.66	27.02
Savings	17	0.0	-9.7	-9.7	125.3	-71.7	53.7
Disposible income	18	2.4	997.6	1,000.0	341.5	658.5	1,000.0
Per capita disposible income index (SNAP average + 100)				100.0			246.4

SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service.

This ratio is larger than the 112 percent measured by the Consumer Expenditure Survey (CES). The non-SNAP to SNAP household expenditure ratio for each of the 15 consumer products and for savings are the same as measured by the CES. The discrepancy with respect to disposable income is attributed to the fact that total NIPA expenditure data for each of the 15 consumer products are higher than in CES, but not uniformly so across consumer products. As a result, adopting the measured expenditure shares of SNAP and non-SNAP households of the CES and the national disposable income measure in the NIPA produces the disposable income discrepancy between FEDS-SAM and the CES. This discrepancy does not affect the outcomes of the analysis we report.

The SAM Multiplier Model

To conduct a SNAP scenario analysis, we develop a SAM multiplier model. This approach is widely used and is an effective framework for exploring the impact of changes in certain categories of Government expenditures on economywide measures of economic performance (Thorbecke, 1998; Hewings and Madden, 1995). Three important assumptions about the economic setting for the period of analysis facilitate the multiplier approach. They are that: (1) both the supply of labor and the production capacity of industry capital exceed the demand for these inputs, (2) any additional labor and industry capacity brought into production in response to new Government spending is indistinguishable from (as equally productive as) labor and capacity already in use, and (3) the new scenario being studied does not change existing relative prices in factor, commodity, and product markets.

In the context of an expanding SNAP enrollment scenario, each of these assumptions is reasonable. First, SNAP expansion occurs during economic downturns when primary production factors are underemployed, so it is not likely to impact wages or interest rates. In addition, SNAP benefits represent a transfer payment to eligible households and are not directly tied to any offsetting revenue sources—distortionary or otherwise—so commodity and product prices should not be impacted by changes in the level of SNAP benefits.

Under these conditions we can trace through all the direct, indirect, and induced effects to U.S. gross domestic income by industry, as well as output and employment by industry, from a hypothetical new SNAP benefit payout. We can also measure changes to both SNAP and non-SNAP household incomes and expenditures from the same hypothetical new SNAP payout.

To develop the multiplier matrix, we must first identify which economic sectors we allow to adjust to the new SNAP scenario based on their own technical or behavioral attributes. Each sector, represented by a SAM subaccount, which is allowed to adjust is called an endogenous sector in the multiplier model. The criteria for inclusion as an endogenous sector is empirical evidence that the sector adjusts in the short term—usually considered to be about 1 year—to a new fiscal stimulus.

Strong candidates for inclusion as endogenous sectors are domestic industry production and the aggregation of industry output into commodities and products. Further, new SNAP benefits will induce new spending among SNAP households, and with the industry response, payments to factor owners will include U.S. households, inducing a more widespread household response. Empirical evidence of these responses is found in the macroeconometric research summarized above in tables 1 and 5.

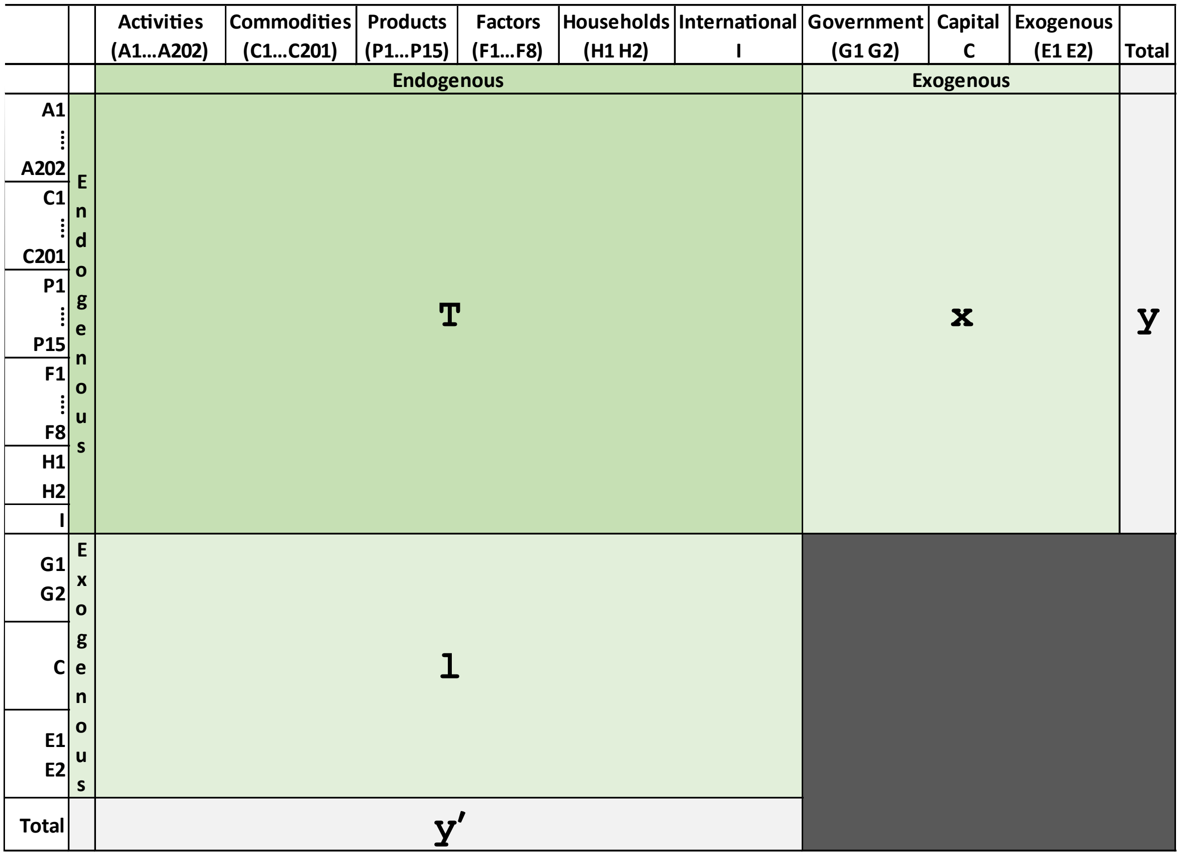
Strong candidates for exclusion, thus treated as exogenous, are the Government sector and capital markets. We treat Government as exogenous because there is no compelling evidence that indicates new SNAP enrollment will automatically lead to further Government policy measures. Concerning capital markets, Hall and Jorgenson (1996) find a strong positive relationship between tax expenditures and investment. Alesina et al. (2015) find that fiscal policy may "crowd out" business investment and point to investor confidence in the predictability of cumulative fiscal policy over time as a driver of real investment. Research on the impacts of deficit spending suggest higher deficits increase real interest rates and discourage new investment (Huntly, 2014; Gale and Orszag, 2003). The totality of research on this topic suggests an indeterminate relationship in the short run, making capital markets a strong candidate as an exogenous sector in the model. Households, by the nature of their estimation in our empirical model of household expenditure behaviors, are also partly treated as exogenous in the model. Specifically, the portion of expenditures empirically estimated as committed expenditures are, by definition, independent of changes in prices and incomes.

The last area to consider is the international sector. Two factors to take into account for this determination are (1) the role of commodity imports in meeting new consumer demand induced by a change in SNAP enrollment, and (2) the impact of a change in SNAP enrollment on the size of the overall U.S. trade deficit. Findings reported in table 6 clearly indicate that the direct effect of a change in SNAP enrollment will be most pronounced in new spending on food and beverages. As reported by Saksena (2018), the share of U.S. food and beverage spending supplied from imports was 12.7 percent in 2016, with an additional 4.7 percent to cover costs of imported inputs to domestic food and beverage production. To treat these imports as exogenous would imply that all new spending on food and beverages would be supplied entirely by domestic production. To address this problematic assumption, Hanson (2010) treated the international sector as exogenous in the FANIOM model simulations of new SNAP benefits but deducted the import share of new gross industry output. Making the international sector exogenous while deducting direct imports increases the trade deficit by the full amount of the import deduction, since no new exports are induced. We are aware of no evidence to support a causal relationship between SNAP enrollment levels and the size of the U.S. trade deficit. Our approach is to make the international sector endogenous in our multiplier model. Doing so will maintain the role of imports in meeting both direct and induced new consumption expenditures and will maintain the size of the overall U.S. trade deficit relative to the total volume of international trade.

With these designations of endogenous and exogenous model sectors, the FEDS-SAM multiplier model structure is depicted in figure 2. The endogenous sector block, **T**, captures all endogenous transactions in the model. These comprise 429 rows and columns representing 202 industries, 201 commodities, 15 consumer products, 8 primary factor groups, 2 households, and 1 aggregate international sector. The exogenous injections block, **x**, is a vector that consolidates exogenous inflows into the endogenous accounts, and the five consolidated columns represent two Government entities and one aggregate capital sector (see Appendix table A.2 for descriptions of these subaccounts). Block **x** also includes the two exogenous household accounts. The exogenous leakage block, **l**, is a vector that consolidates outflows from the endogenous sectors flowing to these same exogenous sectors.

From the FEDS-SAM schematic in figure 2, total inflows are measured using matrix algebra, where '**i**' is a matrix row summation vector, by summing across the endogenous rows—**T**×**i**—and adding the exogenous inflows vector, **x**. This produces the total inflows vector, **y**. Recalling that SAM accounts must balance inflows and outflows, it must be the case that summing down the endogenous columns, where '**i′**' is a matrix column summation vector—**i′**×**T**—and adding the exogenous outflows row vector, **l**, produces the total outflows that must equal the transpose of the **y** vector, or **y′**.

Figure 2
FEDS-SAM schematic



Note: FEDS-SAM = Food Environment Data System-Social Accounting Matrix.

Source: U.S. Department of Agriculture, Economic Research Service.

If we convert the endogenous block into a technical and behavioral parameters matrix,[13] **A**, through dividing all elements in the matrix by its corresponding column total (**y′**), we can derive the SAM multiplier model as follows:

$$(1)\quad \mathbf{A} \times \mathbf{y} + \mathbf{x} = \mathbf{y} \Leftrightarrow \mathbf{x} = (\mathbf{I}\text{-}\mathbf{A}) \times \mathbf{y} \Leftrightarrow (\mathbf{I}\text{-}\mathbf{A})^{-1} \times \mathbf{x} = \mathbf{y}$$

$$\Leftrightarrow \mathbf{M} \times \mathbf{x} = \mathbf{y}$$

In (1), inversion of the matrix containing technical and behavioral coefficients, $(\mathbf{I}\text{-}\mathbf{A})^{-1}$, produces the multiplier matrix **M**. Because behavioral coefficients in **M** reflect different MPC's across households and consumer products, **M** is called a fixed-price multiplier matrix (Pyatt and Round, 1979), which allows for any nonnegative expenditure elasticity of demand for all products.

To conduct a SNAP analysis, the final step is to develop our inflow vector, $\mathbf{x}^{p1}$, where 'p1' is a hypothetical SNAP enrollment change that leads to an additional $1 billion in SNAP benefit payouts. In our hypothetical increase scenario, the $1 billion represents new benefits to households that

[13]These include household MPC's and MPS's, along with production coefficients within the 'Activities' block and the various income and commodity flow parameters between the different subaccounts.

were previously not participating in SNAP (assuming eligible, nonparticipating households have same average income and expenditure profiles as current participants[14]).

Table 7 reports all relevant elements of the $\mathbf{x}^{p1}$ inflow scenario vector. The calculation for gross output, GDI, employment by industry, and new household consumption expenditures for SNAP and non-SNAP households, from implementation of scenario $\mathbf{x}^{p1}$, are presented in Appendix C. Results and analysis of these calculations are reported in the next section.

Table 7
SNAP-induced household expenditures and savings of new SNAP households

Product	New SNAP households
	$million
Food and beverages at home	300.0
Food services	27.3
Clothing and footwear	44.8
Other nondurable goods	89.4
Motor vehicles and parts	12.5
Furnishings and durable household equipment	60.1
Recreational goods and vehicles	100.1
Other durable goods	39.7
Housing and utilities	94.5
Healthcare	121.3
Recreation services	28.6
Accommodations	13.5
Financial services and insurance	15.1
Other services	39.8
Nonprofit institutions serving households (NPISHs)	13.1
Personal savings	0.0

SNAP = Supplemental Nutrition Assistance Program.
Source: U.S. Department of Agriculture, Economic Research Service.

[14]A case could be made that marginal participants would be drawn from the upper part of the (SNAP-eligible) income distribution since they may be among the newly eligible. Assuming average MPC's, MPS's, and income sources for this group may potentially bias the model results, but effects would be far less than those captured below in sensitivity analysis.

Estimated Impact of a $1 Billion Expansion in SNAP Payouts

Using our FEDS-SAM model, we calculate the impacts of the hypothetical SNAP expansion on overall GDP, income, output, and employment by broad industry groups, including agriculture, and by both total and per capita food and other spending by SNAP and non-SNAP households. The model calculations of these measures are outlined in Appendix C.

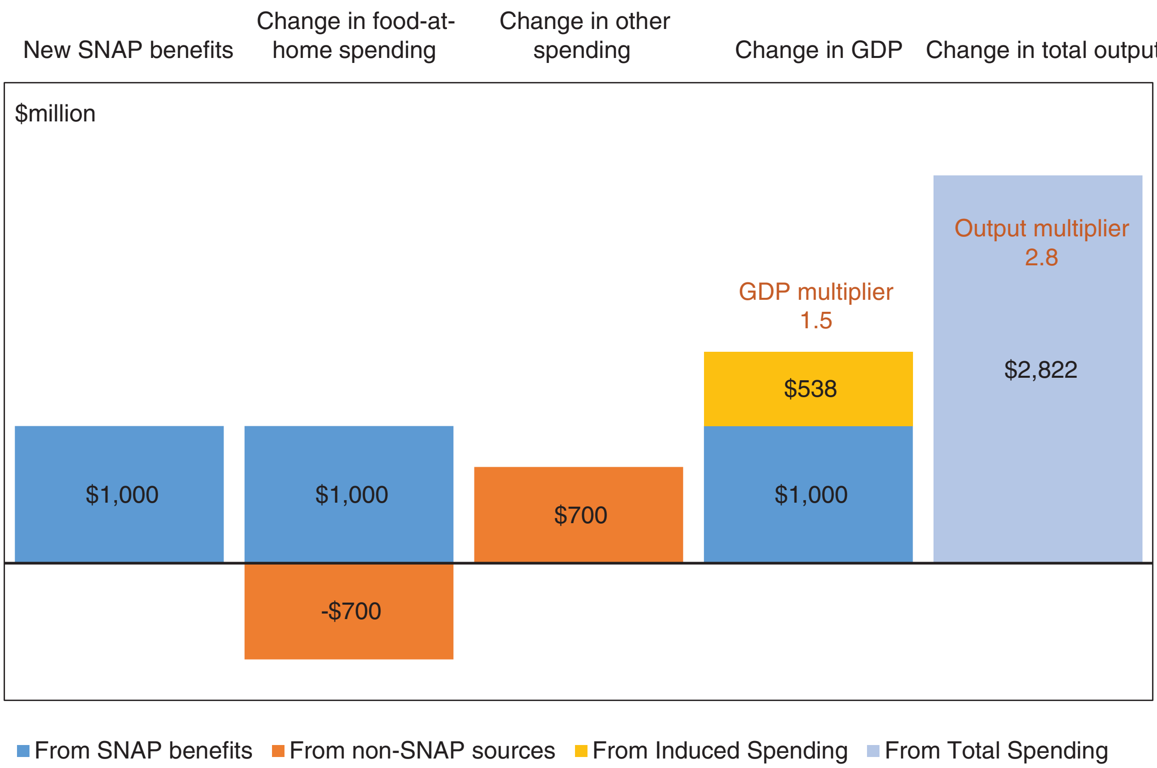
To understand the intuition behind the mechanisms that generate multiplier effects of new SNAP benefit payouts, consider the following scenario.

GDP and Industrial Output

Figure 3 shows the impact on GDP of an additional $1 billion SNAP payout to new enrollees during an economic downturn. Column 1 shows the $1 billion increase in SNAP payouts to new enrollees. In column 2, we show the impact of the new $1 billion SNAP payout on food-at-home expenditures. New SNAP households can increase their food purchases by the full amount of the new SNAP benefit, or they can redirect some of the cash that was previously spent on food at home to other products or to savings, so that their increased food expenditures total less than the $1 billion in new SNAP benefits. We estimate a marginal propensity to consume food at home from SNAP benefits to be 0.30 (see table 4). SNAP benefits must be spent on food, but 70 cents of beneficiary non-SNAP disposable income is redirected from food spending to other consumer products and so there is a net 30-cent increase in food-at-home spending ($1 from SNAP minus $0.7 from non-SNAP disposable income). This implies a $300 million increase in food-at-home spending caused by the new $1 billion SNAP payout.

This leaves $700 million remaining to be spent by new SNAP households on other goods and services or saved, as reported in column 3 of figure 3. Then, after aggregating income generated in response to the $1 billion increase in SNAP, our FEDS-SAM model estimates that $1.54 billion of total GDP is produced from the $1 billion SNAP payout, implying a multiplier of 1.5. Total industry output, from which industry incomes and GDP are derived, increased by an estimated $2.82 billion, implying a multiplier of 2.8. Total output is the sum of GDP and the value of intermediate inputs into production, so output multipliers are usually substantially higher then GDP multipliers. For example, consider the sale of beef at a grocery store. The retail price of the purchased beef is the sum total of value added by all establishments involved in supplying this product. If we assume for this example that no imported products were used at any point along this beef supply chain, then if this sale is for $100, it equals $100 in GDP. But in terms of output produced to facilitate the sale, note that a beef cattle feedlot sold the animal to a meatpacking plant, which in turn processed the packaged beef product. In the output multiplier, the animal sale by the feedlot is counted twice; first as an output of the feedlot, and next by the output of the meatpackers, since they will charge a price that includes the cost they paid to the feedlot plus the value they've added to produce the packaged meat product.

Figure 3
Economywide impacts of $1 billion in new SNAP benefits, 2016



Notes: Induced Spending refers to spending occurring after the initial $1 billion SNAP expenditure, which is derived from income that is generated for all involved in the production, distribution, marketing, and sales of the final goods and products sold. Total Output is the sum of Gross Domestic Product (GDP) and the value of intermediate inputs into production. SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service.

Household Expenditures and Savings

Table 8 reports changes to per capita and total household expenditures and savings linked to the $1 billion in new SNAP benefits. Although our scenario analysis assumes benefits go to newly enrolled households, the per capita measures in table 8 average this new benefit across all enrollees, including all those who were already enrolled. These changes encompass the direct impacts reported in table 7 plus the allocations of additional disposable incomes to both non-SNAP and SNAP households, induced by these direct expenditures.[15] The same calculation is made for all non-SNAP households, although these changes only represent induced spending since non-SNAP households receive no direct benefits. The top three expenditure increases on a per capita basis among SNAP households are food, durable goods, and nondurable goods. Each of these consumer goods relies heavily on the transportation and trade (wholesaling and retailing) industries for the marketing of these products. Although SNAP-payout-induced per capita expenditures of non-SNAP households are substantially lower, overall new spending of these households is more than half as large as for SNAP households since non-SNAP households represent almost 90 percent of the population in the model, which is based on the 2016 economy. If we factor in new personal savings, increases in total disposable

[15]Technically, this average per capita calculation represents increases induced by the last $1 billion in new 2016 enrollee benefits that lead to the observed 2016 enrollment levels.

incomes of non-SNAP households are almost on par with total SNAP household increases, which include the full value of the new $1 billion SNAP payout.[16]

Table 8
Change in annual per capita and total consumer expenditures due to $1 billion in SNAP benefits

Item	SNAP recipient	Non-SNAP recipient
	$ per capita*	
Durable goods	6.1	0.5
Food	9.4	0.1
Healthcare	3.5	0.4
Housing and utilities	2.7	0.2
Nondurable goods	3.9	0.3
Other services	3.2	0.5
	$ million	
Durable goods	217.9	137.4
Food	335.7	41.1
Healthcare	124.4	123.7
Housing and utilities	97.0	68.8
Nondurable goods	137.7	84.5
Other services	113.0	136.5

Notes: *Per capita measure assumes number of SNAP enrollees remains constant.
SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service.

Incomes and Employment by Industry

Figure 4 reports impacts of the hypothetical new $1 billion SNAP payout on gross domestic income (GDI) and employment by major industry group. The bottom horizontal column of figure 4 reports the increase in GDI and jobs going to agriculture, forestry, fishing, and hunting, combined as *agriculture* for short. The additional $32 million in GDI and 480 full-time equivalent jobs going to *agriculture* are substantial and are attributable to two causes. First, as shown in table 7, a SNAP expenditure is associated with a relatively high marginal propensity to consume food at home from new benefits (0.30). Second, the new SNAP payouts are targeted toward households that spend the full new benefit, compared to the average non-SNAP household that will save more than a third of its marginal income (table 6).

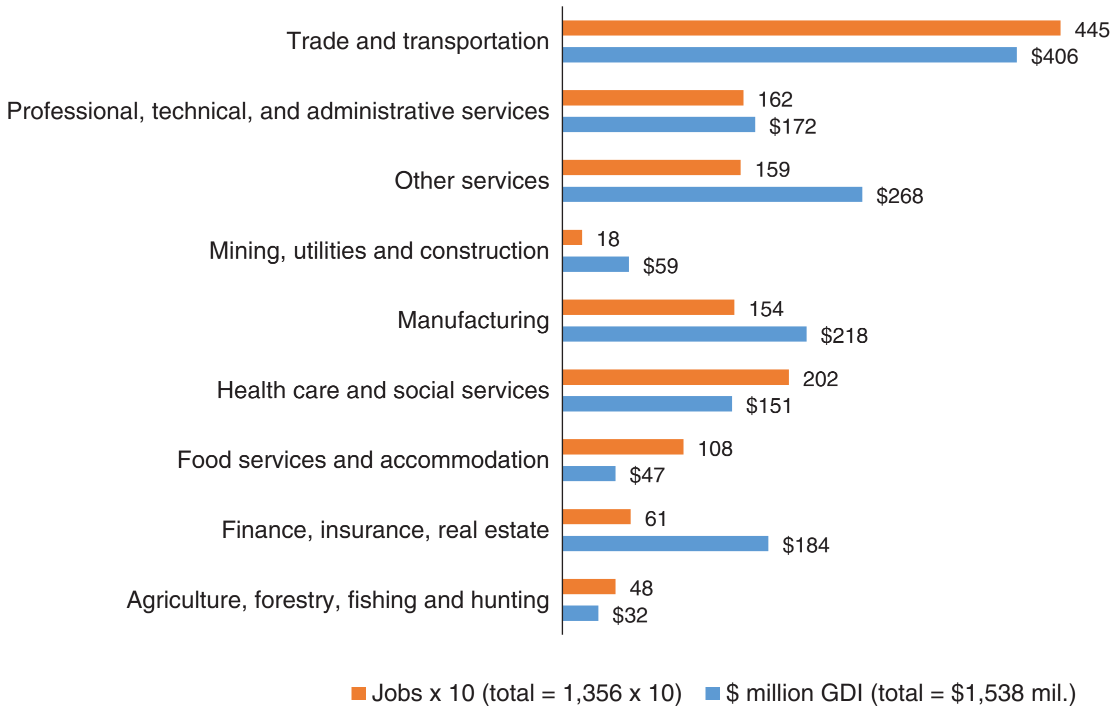
Perhaps surprisingly, a new SNAP payout has a relatively large effect on the manufacturing and trade and transportation sectors. Over $200 million in GDI and 1,500 full-time equivalent jobs are generated for the manufacturing sector from the new SNAP expenditure. This sector includes food and beverage processors, as well as packaging manufacturers. For the trade and transportation sector, new income totaling around $400 million and nearly 4,500 jobs are generated. The sector includes grocery stores, food, and other wholesalers, plus the trucking and rail freight industries, among others. These results can be understood by considering the new household expenditures summarized above in table 8. Recall that the two largest areas of new spending are on food and durable goods, both of which rely on transportation and trade (wholesaling and retailing) services to market these products.

[16]New personal savings and taxes, plus new payments for social insurance, are part of the pooled exogenous sector in the model, so we cannot pinpoint the share going to savings. However, based on the MPS, this would put the increase in non-SNAP household disposable income at $933 million compared to $1,020 million for SNAP households.

Overall, around $1.54 billion in GDI and around 13,560 jobs are supported by the $1 billion SNAP expenditure. For comparison, Hanson (2010) estimates $1.79 billion in income and 16,100 jobs per $1 billion in new SNAP payouts (after adjusting to 2016 SNAP dollars) with the FANIOM model. Both figures are larger than those produced using FEDS-SAM.

Figure 4

Change in annual gross domestic income (GDI) and employment by major industry group per $1 billion in new SNAP benefits, 2016



SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service.

Sensitivity Analysis

Two key behavioral parameters in the model can have important impacts on the model results. These are the MPC for food-at-home purchases by SNAP households and the MPS for non-SNAP households. The food MPC is important because empirical evidence that SNAP recipients substantially increase their food-at-home spending from new SNAP benefits contrasts with their own average food-spending behaviors—about 16 percent of total consumption expenditures of SNAP households in 2016 was food-at-home spending according to BLS (2018). This also contrasts with the food MPC of non-SNAP households—we estimate this to be 2 percent of disposable income (table 6). These contrasts would indicate that new SNAP benefits will disproportionately increase new food spending compared to other types of expenditure inducements such as an employee bonus. Domestic food spending in the United States is the most important final market for U.S. farm production. The MPS for non-SNAP households is important because the size of GDP, output, and employment multiplier effects are driven by induced new spending from domestic households, and new savings represent a leakage to the exogenous sector that limits the size of these multipliers.

Because of their importance, we compiled five alternative models that, when combined with our “preferred” model, collectively represent six combinations of food MPC and MPS parameter assumptions. Specifically, we consider models using our econometrically estimated non-SNAP household MPS value of 0.367 and models using the observed APS value of 0.054 based on BLS data (2018). For each of these parameters, we consider three alterative SNAP household food MPC parameters, starting with our econometrically estimated value of 0.3 and values that are plus and minus 50 percent of this value, or 0.45 and 0.15. This range encompasses most of the empirical estimates in the recent literature, as reported in table 5.

Table 9 summarizes the results for the analysis of a hypothetical $1 billion SNAP payout to new enrollees from each of the six models, with the preferred model (model using the most statistically significant empirical estimates of key parameters) in the first (gray-shaded) data column. The first three data columns utilize results from models based on the Non-SNAP household MPS parameter of 0.367. These three models represent the food MPC parameter values of 0.30, 0.45 and 0.15, respectively. This same sequence of MPC parameters is reported in the next three data columns in table 9 for models based on the Non-SNAP household APS parameter of 0.054. Results are reported by major industry sector and for U.S. totals. Data rows 1 to 10 report measures for industry employment, data rows 11 to 20 report measures for gross industry output (market value of productions), and data rows 21 to 30 report gross domestic industry income.

Focusing first on U.S. totals, results reported in data rows 10, 20, and 30 show that the preferred model results (shaded data column 1) are all near the low end of the range across all models (low values by row in green font, high values by row in blue font). For example, as reported previously, total employment impacts of a $1 billion new SNAP benefit are around 13,600 in the preferred model, which is slightly higher than the low estimate of around 13,400 for the model with the same MPS and the lowest food MPC. All three models based on the APS show substantially higher employment impacts. This is not surprising, since the savings leakage discussed above is lower, which drives up the multipliers. Gross output and GDI estimates show similar patterns.

The pattern of preferred model results being close in value to models with minimum impact also applies across most industrial sectors. The most notable exceptions are in the agriculture, forestry, fishing, and hunting sectors, or Agriculture for short (data rows 1, 11, and 21). For Agriculture, the preferred model results are at least 50 percent higher than the minimum impact model, even showing higher impacts than the APS model with the low food MPC. This is a clear demonstration of the finding that fiscal spending that induces higher food expenditures benefits Agriculture far more than all other sectors relative to new spending that does not induce higher food spending. For example, when going from a policy that directs all its benefits to households having a food MPC of 0.15 to a policy where all benefits are directed to households having a food MPC of 0.30, results reported in table 9 show that total domestic employment, output, and income would increase by 1, 2, and 0 percent respectively (compare rows 10, 20, and 30 of data column 3 with the same rows in data column 1). But this same policy change would increase agricultural employment, output, and income by 51, 52, and 50 percent, respectively (compare rows 1, 11, and 21 of data column 3 with the same rows in data column 1). In general, changing model parameters does not have equal impacts on the three multiplier effects, due to the changing mix of consumer products purchased in the model solutions. Each industry group in the model has its own ratio of income and jobs supported per dollar of output, so a different mix of domestic industries in the various model solutions produces varying percentage impacts on the output, income, and jobs multiplier effects.

Table 9

Sensitivity analysis: employment, gross output, and gross domestic income impacts of a $1 billion SNAP benefit increase under alternative household behavior assumptions

	Models based on MPS (0.367)			Models based on APS (0.054)		
SECTOR	SNAP Food MPC = 0.30	SNAP Food MPC = 0.45	SNAP Food MPC = 0.15	SNAP Food MPC = 0.30	SNAP Food MPC = 0.45	SNAP Food MPC = 0.15
	Employment					
Agriculture, Forestry, Fishing and Hunting	475	635	315	570	730	410
Finance, Insurance, Real Estate	610	587	632	926	900	951
3.Food Services and Accommodation	1,080	1,020	1,136	1,671	1,606	1,732
4.Health Care and Social Services	2,023	1,536	2,484	2,528	2,033	2,996
5.Manufacturing	1,536	1,710	1,368	1,744	1,917	1,576
6.Mining, Utilities and Construction	176	171	181	246	240	252
7.Other Services	1,592	1,459	1,717	2,137	1,998	2,266
8.Prof., Tech., and Admin. Services	1,616	1,581	1,650	2,064	2,025	2,102
9.Trade and Transportation	4,450	4,983	3,936	5,037	5,568	4,524
10.Total	13,558	13,680	13,417	16,923	17,017	16,807
	Gross Output ($ million)					
11.Agriculture, Forestry, Fishing and Hunting	92	123	61	111	142	79
12.Finance, Insurance, Real Estate	317	304	329	470	456	483
13.Food Services and Accommodation	84	79	88	125	120	130
14.Health Care and Social Services	248	185	308	307	243	367
15.Manufacturing	640	729	554	762	851	677
16.Mining, Utilities and Construction	85	84	87	118	116	120
17.Other Services	455	414	494	632	589	672
18.Prof., Tech., and Admin. Services	278	275	280	353	349	356
19.Trade and Transportation	623	679	570	715	771	662
20.Total	2,822	2,873	2,771	3,591	3,637	3,546
	Gross Domestic Income ($ million)					
21. Agriculture, Forestry, Fishing and Hunting	32	43	21	39	49	28
22.Finance, Insurance, Real Estate	184	177	191	272	264	279
23.Food Services and Accommodation	47	45	50	70	67	73
24.Health Care and Social Services	151	113	188	187	148	224
25.Manufacturing	218	240	198	260	281	240
26.Mining, Utilities and Construction	59	58	60	82	81	83
27.Other Services	268	243	291	391	365	415
28.Prof., Tech., and Admin. Services	172	170	175	219	216	222
29.Trade and Transportation	406	444	369	465	503	429
30.Total	1,539	1,532	1,543	1,985	1,975	1,993

Note– Grey shaded column indicates preferred model results; numbers in green font indicate a minimum row value; numbers in blue font indicate a maximum row value. MPC/MPS = Marginal Propensity to Consume/Marginal Propensity to Save. APS = Average Propensity to Save. SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Agriculture, Economic Research Service

Conclusions

Recently published research and data are available for understanding SNAP's impact on the economy. We build on this literature and produce estimates of multiplier effects from a hypothetical SNAP expenditure increase, using a newly compiled Social Accounting Matrix (SAM) multiplier model. We find that a $1 billion increase in SNAP benefits due to new enrollment during an economic downturn increases GDP by $1.54 billion, implying a GDP multiplier of 1.5, supporting around 13,600 jobs and about $32 million of farm income.

We conducted a sensitivity analysis to examine how key behavioral parameters in the model impacted model results from the same SNAP scenario simulation. Five alternative models are compiled that, when combined with our "preferred" model, collectively represent six combinations of food MPC and personal MPS parameter assumptions. A comparison of results across these models reinforced our expectations. First, it confirmed our expectation that modeling consumer marginal savings behavior, which was empirically found to be substantially higher than their average savings behavior, will accelerate the leakage effect in our multiplier model analysis and thus substantially dampen the size of our multipliers. We find this scenario to be more realistic and largely instrumental in producing multipliers that are in line with those reported in current macroeconometric literature. Second, the sensitivity analysis confirmed expectations that higher food MPC values will direct greater benefits to the agricultural sector, since domestic food expenditures represent the most important final market for U.S. agricultural products. The strength of this relationship was noteworthy. Our analysis showed that the same hypothetical SNAP expansion scenario had a 50-percent higher impact on agricultural employment, output, and income under conditions where SNAP household food MPC was 0.30 instead of 0.15, even though these alternative parameter values produced roughly the same economywide impacts. Further, going from the preferred model with a 0.3 food MPC to a model that assumes a 0.45 food MPC produced about a 33-percent higher impact on agricultural employment, outputs, and income, while again producing very little change on economywide impacts. The explanation for this is that overall spending of SNAP households does not change due to changes in the food MPC parameter, but the product mix of commodities purchased by these households is skewed further toward food commodity purchases as the food MPC parameter increases. Domestic food expenditures represent the most important market for U.S. agricultural producers.

It is important to review the appropriate economic settings for use of a SAM multiplier model such as FEDS-SAM. They are (1) that both the supply of labor and the production capacity of industry capital exceed the demand for these inputs; (2) that any additional labor and industry capacity brought into production in response to new Government spending is indistinguishable from (as equally productive as) labor and capacity already in use; and (3) the new scenario being studied does not change/distort existing relative prices in factor, commodity, and product markets. The first, and possibly the third, of these three conditions do not reflect the current economy or even the 2016 economy whose data are used in the FEDS-SAM model. Current employment statistics indicate the economy is at or near full employment (BLS, 2018c), and with the effective Federal funds rate climbing from 0.1 percent in June 2014 to 1.8 percent in June 2016 (Board of Governors of the Federal Reserve System, 2018), the assumption that slackness in the economy will keep prices unaffected by new SNAP spending is questionable. This implies that crowding out in labor and capital markets may occur, whereby new SNAP spending could adversely affect the availability of both labor and financing for SNAP-affected businesses and other businesses not directly benefiting from new SNAP spending. In conditions like this, results from the FEDS-SAM model could be interpreted as an upper bound. For example, Blinder and Zandi (2015) reported a SNAP spending GDP multiplier of 1.74 for the fourth quarter of 2009, but report a lower 1.22 multiplier for the first quarter of 2015. So while FEDS-SAM is an appropriate model to inform impacts of fiscal spending during economic downturns, its use for analysis of spending increases or decreases in an economy characterized by full employment, and increasing interest rates should be interpreted as an upper-bound economic response.

A promising area of future research on this topic is to close the FEDS-SAM model by moving the capital account into the endogenous sectors and imposing a full employment assumption for both labor and capital (all primary factors). This type of model is referred to as a computable general equilibrium model, or CGE, and it is an effective tool for capturing tradeoffs of changes in SNAP payouts when an economy is at or near full employment (Robinson, 2006; Robinson and Roland-Holst, 1988)—for example, the potential crowding-out effects of new SNAP spending or the potential easing of such effects brought on by reduced spending. Based on findings in this study regarding agriculture's strong linkage to domestic food spending, a CGE analysis could inform on tradeoffs between potential benefits to an economy in full employment brought on by a reduction in SNAP benefits versus possible adverse effects of this policy on the farm economy brought on by reduced domestic food spending.

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Appendix A: Underlying Detailed Tables

Appendix table A.1
FEDS-SAM activities and commodities

Sequence	NAICS 2012[1]	Description	Activity	Commodity
1	111	Crop production	yes	yes
2	112	Animal production	yes	yes
3	1131, 1132	Forestry	yes	yes
4	1133	Logging	yes	yes
5	114	Fishing, hunting and trapping	yes	yes
6	115	Support activities for agriculture and forestry	yes	yes
7	211	Oil and gas extraction	yes	yes
8	2121	Coal mining	yes	yes
9	2122	Metal ore mining	yes	yes
10	2123	Nonmetallic mineral mining and quarrying	yes	yes
11	213	Support activities for mining	yes	yes
12	2211	Electric power generation, transmission and distribution	yes	yes
13	2212	Natural gas distribution	yes	yes
14	2213	Water, sewage and other systems	yes	yes
15	23	Construction	yes	yes
16	3111	Animal food manufacturing	yes	yes
17	3112	Grain and oilseed milling	yes	yes
18	3113	Sugar and confectionery product manufacturing	yes	yes
19	3114	Fruit and vegetable preserving and specialty food manufacturing	yes	yes
20	3115	Dairy product manufacturing	yes	yes
21	3116	Animal slaughtering and processing	yes	yes
22	3117	Seafood product preparation and packaging	yes	yes
23	3118	Bakeries and tortilla manufacturing	yes	yes
24	3119	Other food manufacturing	yes	yes
25	3121	Beverage manufacturing	yes	yes
26	3122	Tobacco manufacturing	yes	yes
27	313, 314	Textile mills and textile product mills	yes	yes
28	315, 316	Apparel, leather, and allied product manufacturing	yes	yes
29	3211	Sawmills and wood preservation	yes	yes
30	3212	Veneer, plywood, and engineered wood product manufacturing	yes	yes
31	3219	Other wood product manufacturing, including wood TV, radio and sewing machine cabinet manufacturing	yes	yes
32	3221	Pulp, paper, and paperboard mills	yes	yes
33	3222	Converted paper product manufacturing	yes	yes
34	323	Printing and related support activities	yes	yes
35	324	Petroleum and coal products manufacturing	yes	yes
36	3251	Basic chemical manufacturing	yes	yes
37	3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing	yes	yes

Continued—

Sequence	NAICS 2012[1]	Description	Activity	Commodity
38	3253	Pesticide, fertilizer, and other agricultural chemical manufacturing	yes	yes
39	3254	Pharmaceutical and medicine manufacturing	yes	yes
40	3255	Paint, coating, and adhesive manufacturing	yes	yes
41	3256	Soap, cleaning compound, and toilet preparation manufacturing	yes	yes
42	3259	Other chemical product and preparation manufacturing	yes	yes
43	3261	Plastics product manufacturing	yes	yes
44	3262	Rubber product manufacturing	yes	yes
45	3271	Clay product and refractory manufacturing	yes	yes
46	3272	Glass and glass product manufacturing	yes	yes
47	3273	Cement and concrete product manufacturing	yes	yes
48	3274, 3279	Lime, gypsum, and other nonmetallic mineral product manufacturing	yes	yes
49	3311	Iron and steel mills and ferroalloy manufacturing	yes	yes
50	3312	Steel product manufacturing from purchased steel	yes	yes
51	3313	Alumina and aluminum production and processing	yes	yes
52	3314	Nonferrous metal (except aluminum) production and processing	yes	yes
53	3315	Foundries	yes	yes
54	3321	Forging and stamping	yes	yes
55	3322	Cutlery and handtool manufacturing	yes	yes
56	3323	Architectural and structural metals manufacturing	yes	yes
57	3324	Boiler, tank, and shipping container manufacturing	yes	yes
58	3325	Hardware manufacturing	yes	yes
59	3326	Spring and wire product manufacturing	yes	yes
60	3327	Machine shops; turned product; and screw, nut, and bolt manufacturing	yes	yes
61	3328	Coating, engraving, heat treating, and allied activities	yes	yes
62	3329	Other fabricated metal product manufacturing	yes	yes
63	3331	Agriculture, construction, and mining machinery manufacturing	yes	yes
64	3332	Industrial machinery manufacturing	yes	yes
65	3333	Commercial and service industry machinery manufacturing, including digital camera manufacturing	yes	yes
66	3334	Ventilation, heating, air-conditioning, and commercial refrigeration equipment manufacturing	yes	yes
67	3335	Metalworking machinery manufacturing	yes	yes
68	3336	Engine, turbine, and power transmission equipment manufacturing	yes	yes
69	3339	Other general purpose machinery manufacturing	yes	yes
70	3341	Computer and peripheral equipment manufacturing, excluding digital camera manufacturing	yes	yes
71	3342	Communications equipment manufacturing	yes	yes

Continued—

Sequence	NAICS 2012[1]	Description	Activity	Commodity
72	3343	Audio and video equipment manufacturing	yes	yes
73	3344	Semiconductor and other electronic component manufacturing	yes	yes
74	3345	Navigational, measuring, electromedical, and control instruments manufacturing	yes	yes
75	3346	Manufacturing and reproducing magnetic and optical media	yes	yes
76	3351	Electric lighting equipment manufacturing	yes	yes
77	3352	Household appliance manufacturing	yes	yes
78	3353	Electrical equipment manufacturing	yes	yes
79	3359	Other electrical equipment and component manufacturing	yes	yes
80	3361	Motor vehicle manufacturing	yes	yes
81	3362	Motor vehicle body and trailer manufacturing	yes	yes
82	3363	Motor vehicle parts manufacturing	yes	yes
83	3364	Aerospace product and parts manufacturing	yes	yes
84	3365	Railroad rolling stock manufacturing	yes	yes
85	3366	Ship and boat building	yes	yes
86	3369	Other transportation equipment manufacturing	yes	yes
87	3371	Household and institutional furniture and kitchen cabinet manufacturing, excluding wood TV, radio and sewing machine cabinet manufacturing	yes	yes
88	3372	Office furniture (including fixtures) manufacturing	yes	yes
89	3379	Other furniture-related product manufacturing	yes	yes
90	3391	Medical equipment and supplies manufacturing	yes	yes
91	3399	Other miscellaneous manufacturing	yes	yes
92	42	Wholesale trade	yes	yes
93	441	Motor vehicle and parts dealers	yes	no
94	445	Food and beverage stores	yes	yes
95	452	General Merchandise stores	yes	no
96	442-4, 446-8, 451, 453-4	All other retail	yes	yes[2]
97	481	Air transportation	yes	yes
98	482	Rail transportation	yes	yes
99	483	Water transportation	yes	yes
100	484	Truck transportation	yes	yes
101	485	Transit and ground passenger transportation	yes	yes
102	486	Pipeline transportation	yes	yes
103	487, 488	Scenic and sightseeing transportation and support activities for transportation	yes	yes
104	492	Couriers and messengers	yes	yes
105	493	Warehousing and storage	yes	yes
106	5111	Newspaper, periodical, book, and directory publishers	yes	yes
107	5112	Software publishers	yes	yes
108	512	Motion picture, video, and sound recording industries	yes	yes

Continued—

Sequence	NAICS 2012[1]	Description	Activity	Commodity
109	5151	Radio and television broadcasting	yes	yes
110	5152	Cable and other subscription programming	yes	yes
111	5171	Wired telecommunications carriers	yes	yes
112	5172	Wireless telecommunications carriers (except satellite)	yes	yes
113	5174, 5179	Satellite, telecommunications resellers, and all other telecommunications	yes	yes
114	518	Data processing, hosting, and related services	yes	yes
115	519	Other information services	yes	yes
116	521, 522	Monetary authorities, credit intermediation, and related activities	yes	yes
117	523, 525	Securities, commodity contracts, fund, trusts and other financial investments and vehicles and related activities	yes	yes
118	5241	Insurance carriers	yes	yes
119	5242	Agencies, brokerages, and other insurance related activities	yes	yes
120	531	Real estate	yes	yes
121	5321	Automotive equipment rental and leasing	yes	yes
122	5322, 5323	Consumer goods rental and general rental centers	yes	yes
123	5324	Commercial and industrial machinery and equipment rental and leasing	yes	yes
124	533	Lessors of nonfinancial intangible assets (except copyrighted works)	yes	yes
125	5411	Legal services	yes	yes
126	5412	Accounting, tax preparation, bookkeeping, and payroll services	yes	yes
127	5413	Architectural, engineering, and related services	yes	yes
128	5414	Specialized design services	yes	yes
129	5415	Computer systems design and related services	yes	yes
130	5416	Management, scientific, and technical consulting services	yes	yes
131	5417	Scientific research and development services	yes	yes
132	5418	Advertising and related services	yes	yes
133	5419	Other professional, scientific, and technical services	yes	yes
134	55	Management of companies and enterprises	yes	yes
135	5611	Office administrative services	yes	yes
136	5612	Facilities support services	yes	yes
137	5613	Employment services	yes	yes
138	5614	Business support services	yes	yes
139	5615	Travel arrangement and reservation services	yes	yes
140	5616	Investigation and security services	yes	yes
141	5617	Services to buildings and dwellings	yes	yes

Continued—

Sequence	NAICS 2012[1]	Description	Activity	Commodity
142	5619	Other support services	yes	yes
143	562	Waste management and remediation services	yes	yes
144	6111	Elementary and secondary schools	yes	yes
145	6112, 6113	Junior colleges, colleges, universities, and professional schools	yes	yes
146	6114-7	Other educational services	yes	yes
147	6211	Offices of physicians	yes	yes
148	6212	Offices of dentists	yes	yes
149	6213	Offices of other health practitioners	yes	yes
150	6214	Outpatient care centers	yes	yes
151	6215	Medical and diagnostic laboratories	yes	yes
152	6216	Home healthcare services	yes	yes
153	6219	Other ambulatory healthcare services	yes	yes
154	622	Hospitals	yes	yes
155	623	Nursing and residential care facilities	yes	yes
156	6241	Individual and family services	yes	yes
157	6242, 6243	Community and vocational rehabilitation services	yes	yes
158	6244	Child day care services	yes	yes
159	7111	Performing arts companies	yes	yes
160	7112	Spectator sports	yes	yes
161	7113, 7114	Promoters of events, and agents and managers	yes	yes
162	7115	Independent artists, writers, and performers	yes	yes
163	712	Museums, historical sites, and similar institutions	yes	yes
164	7131	Amusement parks and arcades	yes	yes
165	7132	Gambling industries (except casino hotels)	yes	yes
166	7139	Other amusement and recreation industries	yes	yes
167	721	Accommodation	yes	yes
168	722 3/	Food services and drinking places (food, excluding services)	yes	yes
169	8111	Automotive repair and maintenance	yes	yes
170	8112	Electronic and precision equipment repair and maintenance	yes	yes
171	8113	Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	yes	yes
172	8114	Personal and household goods repair and maintenance	yes	yes
173	8121	Personal care services	yes	yes
174	8122	Death care services	yes	yes
175	8123	Drycleaning and laundry services	yes	yes
176	8129	Other personal services	yes	yes
177	8131	Religious organizations	yes	yes
178	8132, 8133	Grantmaking and giving services and social advocacy organizations	yes	yes

Continued—

Sequence	NAICS 2012[1]	Description	Activity	Commodity
179	8134, 8139	Civic, social, professional, and similar organizations	yes	yes
180	814	Private households	yes	yes
181	491	Postal Service	yes	yes
182	NA	Federal electric utilities	yes	no
183	NA	Federal enterprises except the Postal Service and electric utilities	yes	yes
184	NA	Federal defense government compensation	yes	yes
185	NA	Federal defense government consumption of fixed capital	yes	yes
186	NA	Federal defense government except compensation and consumption of fixed capital	yes	yes
187	NA	Federal non-defense government compensation	yes	yes
188	NA	Federal non-defense government consumption of fixed capital	yes	yes
189	NA	Federal non-defense government except compensa-tion and consumption of fixed capital	yes	yes
190	NA	Local government passenger transit	yes	no
191	NA	Local government enterprises except passenger transit	yes	yes
192	NA	Local government hospitals compensation	yes	yes
193	NA	Local government educational services compensation	yes	yes
194	NA	Local government, other compensation	yes	yes
195	NA	State government enterprises	yes	yes
196	NA	State government hospitals compensation	yes	yes
197	NA	State government educational services compe nsation	yes	yes
198	NA	State government, other compensation	yes	yes
199	NA	State and local government consumption of fixed capital	yes	yes
200	NA	State and local government except compensation and consumption of fixed capital	yes	yes
201	NA	Owner-occupied dwellings	yes	yes
202	NA	Noncomparable imports	no	yes
203	NA	Scrap	no	yes
204	NA	Used and secondhand goods	no	yes
205	NA	Rest of the world adjustment	no	yes
206	722 3/	Food services and drinking places (services, exclud-ing food)	yes	yes

[1]NAICS = North American Industry Classification System, 2012. [2]As a commodity, this comprises all nonfood retailing, including motor vehicle and general merchandise retailing. [3]Food service activity and commodity is split between the services of a food service establishment (number 206) and the food and beverages prepared and served (number 168). FEDS-SAM=Food Environment Data System-Social Accounting Matrix.

Source: Adapted from U.S. Department of Labor, Bureau of Labor Statistics (2017).

Appendix table A.2
Gross domestic income by subaccount and dispersal category

Subaccount	Industry GDI dispersal category	Data sources
Capital	Consumption of fixed capital, all industries	BEA, 2018; BLS, 2017
Capital	Inventory value adjustment, corporate	BEA, 2018; BLS, 2017; IRS, 2018
Capital	Capital consumption adjustment, corporate	BEA, 2018; BLS, 2017; IRS, 2018
Factor 1	Wages and salaries	BEA, 2018; BLS, 2017
Factor 2	Employer contributions to Government social insurance	BEA, 2018; BLS, 2017
Factor 2	Employer contributions to pensions and private insurance	BEA, 2018; BLS, 2017
Factor 3	Capital consumption adjustment, noncorporate	BEA, 2018; BLS, 2017
Factor 3	Farm proprietor income with inventory value adjustment	BEA, 2018; BLS, 2017; IRS, 2018
Factor 3	Inventory value adjustment, noncorporate	BEA, 2018; BLS, 2017
Factor 3	Nonfarm proprietors income	BEA, 2018; BLS, 2017; IRS, 2018
Factor 3	Rental income of persons without capital consumption adjustment	BEA, 2018; BLS, 2017
Factor 4	Net interest	BEA, 2018; BLS, 2017
Factor 5	Net dividends, corporate	BEA, 2018; BLS, 2017; IRS, 2018
Factor 6	Miscellaneous payments	BEA, 2018; BLS, 2017
Factor 7	Business current transfer payments	BEA, 2018; BLS, 2017
Factor 8	Undistributed profits, corporate	BEA, 2018; BLS, 2017; IRS, 2018
Government 1	Taxes on production and imports	BEA, 2018; BLS, 2017
Government 1	Taxes on income, corporate	BEA, 2018; BLS, 2017; IRS, 2018
Government 2	Subsidies	BEA, 2018; BLS, 2017
Government 2	Current surplus of Government enterprises	BEA, 2018; BLS, 2017

Source: U.S. Department of Agriculture, Economic Research Service.

Appendix table A.3
Product to PCE category concordance

Product	PCE category
Food and beverages purchased for off premises consumption	Food and nonalcoholic beverages purchased for off-premises consumption
	Alcoholic beverages purchased for off-premises consumption
	Food produced and consumed on farms
Food services	Purchased meals and beverages
	Food furnished to employees (including military)
Clothing and footwear	Men's and boys' clothing
	Women's and girls' clothing
	Children's and infants' clothing
	Other clothing materials and footwear
Other nondurable goods	Motor vehicle fuels, lubricants, and fluids
	Fuel oil and other fuels
	Pharmaceutical and other medical products
	Recreational items
	Household supplies
	Personal care products
	Tobacco
	Magazines, newspapers, and stationery
	Net expenditures abroad by U.S. residents
Motor vehicles and parts	New motor vehicles
	Net purchases of used motor vehicles
	Motor vehicle parts and accessories
Furnishings and durable household equipment	Furniture and furnishings
	Household appliances
	Glassware, tableware, and household utensils
	Tools and equipment for house and garden
Recreational goods and vehicles	Video, audio, and photographic equipment and media
	Information processing equipment
	Sporting equipment, supplies, guns, and ammunition
	Sports and recreational vehicles
	Musical instruments
Other durable goods	Jewelry and watches
	Therapeutic appliances and equipment
	Books, educational and recreational
	Luggage and similar personal items
	Telephone and facsimile equipment
Housing and utilities	Rental of tenant-occupied nonfarm housing
	Imputed rental of owner-occupied nonfarm housing
	Rental value of farm dwellings
	Group housing
	Water supply and sanitation
	Electricity

Continued—

Product	PCE category
Healthcare	Natural gas Physician services Dental services Paramedical services Hospitals Nursing homes
Recreation services	Membership clubs, sports centers, parks, theaters, and museums Audio-video, photographic, and information processing equipment services Gambling Other recreational services
Accommodations Financial services and insurance	Accommodations Financial services furnished without payment Financial service charges, fees, and commissions Life insurance Net household insurance Net health insurance Net motor vehicle and other transportation insurance
Other services	Motor vehicle maintenance and repair Other motor vehicle services Ground transportation Air transportation Water transportation Telecommunication services Postal and delivery services Internet access Higher education Nursery, elementary, and secondary schools Commercial and vocational schools Professional and other services Personal care and clothing services Social services and religious activities Household maintenance Foreign travel by U.S. residents Expenditures in the United States by nonresidents
Nonprofit institutions serving households (NPISHs)	Final consumption expenditures of nonprofit institutions serving households

Source: PCE (Personal Consumption Expenditures) categories are based on U.S. Department of Labor, Bureau of Labor Statistics, 2017; Product categories are based on U.S. Department of Commerce, Bureau of Economic Analysis, 2018.

Appendix B: Measuring Household Expenditures and Savings

In FEDS-SAM, expenditures among U.S. households are characterized using the linear expenditure system (LES) framework (Stone, 1954; Deaton and Muellbauer, 1980) as follows[17]:

(B.1) $$\hat{\mathbf{p}}\mathbf{q} = \hat{\mathbf{p}}\boldsymbol{\gamma} + \boldsymbol{\beta}\left(\nu - \mathbf{p}'\boldsymbol{\gamma}\right) \leftrightarrow \hat{\mathbf{p}}\mathbf{q} = \hat{\mathbf{p}}\boldsymbol{\gamma} + \boldsymbol{\beta}\theta,$$

where,

(B.2) $$\mathbf{i}'\boldsymbol{\beta} = 1,\ \nu > \mathbf{p}'\boldsymbol{\gamma},\ \beta_n > 0, q_n > \gamma_n \geq 0 \quad \forall n \in N.$$

In equations (B.1) and (B.2), $\mathbf{q} = \{q_n\}$ is a commodity demand vector, $\mathbf{p} = \{p_n\}$ a commodity price vector, $\boldsymbol{\gamma} = \{\gamma_n\}$ a committed commodity demand vector, $\boldsymbol{\beta} = \{\beta_n\}$ an expenditure share vector, ν a scalar representing total expenditures, and **i** a unit (summation) vector. All vectors have N elements, coinciding with the number of consumer products. Total expenditures is made up of committed expenditures ($\mathbf{p}'\boldsymbol{\gamma}$) and supernumerary expenditures (θ) such that $\nu = \mathbf{p}'\boldsymbol{\gamma} + \theta$. For any given commodity 'n', committed expenditures are the product of the commodity retail price (p_n) and a fixed parameter representing a committed household per annum demand quantity (γ_n) that is not dependent on prices or the expenditure budget. Supernumerary expenditures represent the remaining expenditure budget after committed expenditures for all commodities, $n \in N$, are paid.

Features of the LES include the well-known demand system properties of *additivity, homogeneity, symmetry*, and *negativity* (Stone, 1954; Deaton and Muellbauer, 1980). Three key restrictive properties of the LES are the ruling out of inferior goods and gross substitution ($dq_n/d\nu > 0$ and $dq_n/dp_{n''} > 0$ for $n'' \neq n$), plus the existence of a linear Engel curve ($0 < dq_n/d\nu < 1$, $d^2q_n/d\nu^2 = 0$). But these are less problematic when looking at aggregate expenditure categories such as the 15 groupings of this study. There are two key advantages to using the LES framework in the FEDS-SAM model. First, it allows for flexibility in the representation of expenditure elasticities across key consumer goods, in comparison to the Cobb-Douglas system implicit in a typical SAM or IO multiplier model (Rose, 1995). Second, the linear properties of marginal behaviors make it routine to implement in SAM multiplier analysis.

Our approach is to estimate two complete expenditure systems, representative of both SNAP households and non-SNAP households calibrated to the calendar year 2016 data in FEDS-SAM. This is done in two stages. First, a single national household LES system is estimated from BLS time series data on national personal consumption expenditures (PCE) from 1993 to 2016 (BLS, 2017; BLS, 2013). In the second stage, a constrained maximum likelihood model is developed to estimate the two calendar year 2016 household LES equations.

Stage 1: Estimation of a National Household LES Demand System

Data for estimation of equations B.1, subject to constraints in equations B.2, come from BLS. The 2017 release of the data product, *Inter-industry relationships* (BLS, 2017) includes total annual household expenditures broken out into the 76 PCE categories reported above in Appendix table

[17]Notation convention is to represent vectors as bold lowercase letters, matrices with bold uppercase letters, and scalars in lowercase italics. Letters are either Roman or Greek. Use of ^ denotes a diagonalized vector, and ′a vector or matrix transposition.

A.3. This data is for the years 1997 to 2016 and is reported in both nominal (current year) prices and real (year 2009) prices, so that dividing the real series into the nominal series produces an index of annual consumer prices. The 2013 release of the same BLS data product (BLS, 2013) provides the same data back to 1993. Once the real price series for the earlier years is converted from constant 2005 prices to 2009 prices, the combined dataset provides observations for vectors **p** and **q** and the scaler ν for the years 1993 to 2016. The 76 PCE categories are aggregated to the 15 product categories according to the concordances reported in Appendix table A.3. Annual data are converted to per capita measures using population data from the NIPA accounts (BEA, 2018).

With this data, we estimate the system of equations in (B.1) subject to constraints (B.2). Because of the constraints in (B.2), we must omit one of the 15 demand equations. The 14-equation system is estimated as an *SUR* with the *Model* procedure in SAS (version 9.4) using the full dataset. All equation residual errors were analyzed separately using OLS with the REG procedure in SAS and were found to have an AR(2) process. The original data was adjusted to account for the AR(2) finding and the LES equations were reestimated. Results are reported in table B.1.

All estimated coefficients are significant and adjusted R-squares are high on all 14 endogenous equations. With one marginal exception (recreational goods and vehicles), autocorrelation is not present in 13 of the 14 endogenous equations. Expenditure elasticities are highest for recreational goods and vehicles (4.385) and lowest for food-at-home (FAH) spending (0.450). By way of comparison, Eastwood and Craven (1981) estimate a comparable FAH expenditure elasticity of 0.356 from an LES model. Among disaggregated food demand system studies, Park et al. (1996) also produce comparable expenditure elasticity estimates across five FAH categories that range from 0.43 to 0.65, whereas Okrent and Alston (2012) produce lower estimates that range from 0.01 to 0.11 and Huang and Lin (2000) produce higher estimates that range from 0.63 to 1.07.

Appendix table B.1

Estimated parameters of the Linear Expenditure System

Category	Parameter γ (ρ)	Std. error σ_γ (σ_ρ)	Parameter β	Std. error σ_β	adj R-Sq	Durbin Watson	Expenditure elasticity
Food at home	2478.300	6.970*	0.0314	0.00176*	0.943	2.038	0.450
Food away from home	1707.550	5.837*	0.0253	0.00128*	0.938	1.907	0.552
Clothing and foot-wear	942.570	7.369*	0.0530	0.00125*	0.990	1.911	1.560
Other nondurable goods	3503.020	14.604*	0.0840	0.00223*	0.988	2.204	0.916
Motor vehicles and parts	1174.100	12.255*	0.0299	0.00495*	0.603	1.762	0.807
Furnishings and durable household equipment	746.627	9.810*	0.0706	0.00126*	0.994	2.130	2.556
Recreational goods and vehicles	608.643	18.606*	0.1706	0.00462*	0.993	1.345	4.385
Other durable goods	561.136	6.500*	0.0421	0.00089*	0.991	2.353	2.073
Housing and utilities	5874.090	20.512*	0.1104	0.00318*	0.982	2.163	0.637
Healthcare	4925.550	33.742*	0.1762	0.00538*	0.976	1.578	1.186
Recreation services	1189.540	5.726*	0.0294	0.00119*	0.971	1.871	0.858
Accommodations	252.342	2.297*	0.0106	0.00058*	0.945	1.928	1.291
Financial services and insurance	2287.130	20.494*	0.0423	0.00623*	0.610	2.684	0.463
Other services	3855.840	15.567*	0.0617	0.0039*	0.919	1.719	0.594
Nonprofit institutions serving households	726.335	13.577*	0.0627	0.01243*	na	na	2.232
roe_1 (autocorrela-tion coefficient)	(-1.122)	(0.056*)	na	na	na	na	na
roe_2 (autocorrela-tion coefficient)	(-0.367)	(0.055*)	na	na	na	na	na
* Probability > ǀtǀ < .001; na = not applicable.							

Note: Nonprofit institutions serving households is omitted equation subject to Engle aggregation constraint.

Source: U.S. Department of Agriculture, Economic Research Service.

Stage 2: Estimate LES Equations for 2016 SNAP and Non-SNAP Households

The second-stage regression analysis applies a constrained maximum likelihood model to estimate LES equations separately for 2016 SNAP and non-SNAP households. For this, we must obtain separate per capita observations of **q** for SNAP households ($\mathbf{q}^s$) and all other households ($\mathbf{q}^o$). We assume both face the same price vector so we also obtain observations $\mathbf{v}^s$ and $\mathbf{v}^o$.

Our approach is to develop share vectors representing SNAP household percentages of total expenditures on each of the 15 consumer products in 2016. These shares are applied to the total expenditure data from FEDS-SAM (and used in the stage 1 regressions), and resulting total SNAP household expenditures are divided by the population residing in SNAP households in 2016. For other households, we divide remaining 2016 expenditures not allocated to SNAP households by the 2016 non-SNAP household population. Our 2016 expenditure and population share estimates are discussed in the next section.

Due to the importance of the SNAP household MPC for food-at-home (β_{fah}) spending in studying SNAP benefit policy, we estimate this parameter separately (discussed below) and add this to the model constraints listed in equation (B.2). If we use tilde '~' above expressions to denote stage one parameter estimates reported in data columns 1 and 3 of table B.1, the constrained maximum likelihood model for SNAP households is:

(B.3) $$\text{Max } Z = -0.5 \times \left[\left(\boldsymbol{\gamma}^s - \tilde{\boldsymbol{\gamma}}\right)' \times \left(\widehat{\boldsymbol{\sigma}_\gamma^2}\right)^{-1} \times \left(\boldsymbol{\gamma}^s - \tilde{\boldsymbol{\gamma}}\right) + \left(\boldsymbol{\beta}^s - \tilde{\boldsymbol{\beta}}\right)' \times \left(\widehat{\boldsymbol{\sigma}_\beta^2}\right)^{-1} \times \left(\boldsymbol{\beta}^s - \tilde{\boldsymbol{\beta}}\right) \right]$$

subject to equations (B.1) and (B.2) as applied to SNAP households ($\mathbf{q}^s$), plus:

(B.4) $$\beta_{fah}^s = 0.3.$$

Equation (B.3) represents the variance-weighted least square differential between stage 1 and stage 2 parameter estimates. With a null hypothesis that both parameters are equal to their stage 1 values, Byron (1996) demonstrates constrained maximum likelihood properties of this model. If a solution exists, it also meets the four demand system properties and exactly fits the observed 2016 expenditure statistics. The same model is applied to the non-SNAP households. We implemented this model in GAMS 24.7.4 and used CONOPT3 3.17A as the NLP solver. Results are represented in table 6 of this report.

Measuring the 2016 SNAP Population and Its Total Expenditures

Using data from the 2016 Consumer Expenditure (CEX) Survey (BLS, 2018), which includes a survey question on SNAP participation, we are able to characterize SNAP household expenditures.[18] The CEX survey collects detailed spending information from participant households, along with demographic, socioeconomic, tax, and public assistance program information. The spending information includes detailed data on food purchases, including food at home and food away from home, apparel, entertainment, transportation, shelter, taxes, and other types of purchases. Each round of the CEX survey includes roughly 7,000 households and consists of 5 interviews of each household that take place on a quarterly basis. Data on total expenditures, as well as APCs, for SNAP and Non-SNAP households are reported in table B.2.

[18]A common problem with survey data is misreporting of SNAP participation (See Meyer, Mok, and Sullivan, 2015). We acknowledge this problem as a source of estimation error, and future study should examine how misreporting affects estimates using consumer expenditure survey data.

Appendix table B.2

Total quarterly expenditures per capita and APCs of key categories by SNAP use using 2016 Consumer Expenditure Survey data

	All	APC	Not on SNAP	APC Not on SNAP	On SNAP	APC On SNAP
SNAP participation rate	11.0%		0.0%		100.0%	
SNAP benefit amount	$73.64		$0.00		$668.93	
Quarterly after tax income	$16,526.43		$17,736.57		$6,743.86	
Food at home	$1,355.36	0.08	$1,381.76	0.08	$1,141.93	0.17
Food away from home	$685.06	0.04	$738.02	0.04	$256.94	0.04
Clothing and footwear	$268.83	0.02	$279.78	0.02	$180.32	0.03
Other nondurable goods	$921.35	0.06	$963.26	0.05	$582.62	0.09
Motor vehicles and parts	$1,117.27	0.07	$1,177.55	0.07	$629.98	0.09
Furnishings and durable household equipment	$255.56	0.02	$271.54	0.02	$126.36	0.02
Recreational goods and vehicles	$413.81	0.03	$434.48	0.02	$246.69	0.04
Other durable goods	$125.99	0.01	$135.13	0.01	$52.09	0.01
Housing and utilities	$3,938.28	0.24	$4,112.67	0.23	$2,528.53	0.37
Healthcare	$1,103.04	0.07	$1,200.33	0.07	$316.58	0.05
Recreation services	$285.65	0.02	$314.98	0.02	$48.55	0.01
Accommodations	$204.89	0.01	$228.13	0.01	$17.03	0.00
Financial services and insurance	$2,243.58	0.14	$2,445.31	0.14	$612.89	0.09
Other services	$435.72	0.03	$474.39	0.03	$123.12	0.02
Nonprofit institutions serving households (NPISHs)	$530.10	0.03	$583.36	0.03	$99.57	0.01
Total expenditures	$13,884.49	0.84014	$14,740.68	0.83	$6,963.19	1.03

APC = Average Propensity to Consume. SNAP = Supplemental Nutrition Assistance Program.

Source: U.S. Department of Labor, Bureau of Labor Statistics, 2018a.

Measuring the Food MPC and MPS of SNAP and Other Households

In order to calculate separate marginal spending relationships, we use recent estimates of marginal spending patterns from the literature and two large-scale policy changes that took place in 2008 and 2009, namely the Economic Stimulus Payment of 2008, which sent tax rebates to 130 million U.S. tax filers and the ARRA stimulus package, which increased the maximum monthly SNAP benefits by 13.6 percent. From the Economic Stimulus Payment of 2008, which issued refunds of $300-$600 for individuals and $600-$1,200 for couples, we estimate the marginal spending patterns for the average U.S. household. We assume that households treat income received from the stimulus payments the same as income that would be received in the later rounds of the hypothetical SNAP increase multiplier process. From the ARRA SNAP increase, we estimate the marginal spending pattern for SNAP households, which we can use to model the spending patterns in the first round of a hypothetical SNAP spending increase. Our methods closely follow the work of Parker et al. (2013), in the case of the 2008 tax rebates, and Beatty and Tuttle (2014) and Tuttle (2016) in the case of the SNAP expansion.

Our data include the 2007 to 2010 rounds of the Consumer Expenditure (CEX) Survey. The CEX survey collects detailed spending information from participant households, along with demographic, socioeconomic, tax, and public assistance program information, including information on the size of their tax rebate during the Economics Stimulus Payment of 2008 and information on the amount of SNAP benefits received. The spending information includes detailed data on food purchases, including food at home and food away from home, apparel, entertainment, transportation, shelter, taxes, and other types of purchases. Each round of the CEX survey includes roughly 7,000 households and consists of 5 interviews of each household that take place on a quarterly basis. The longitudinal design of the survey allows for tracking of household spending decisions across time. Summary statistics are reported in table B.3. Our sample includes 96,485 observations from Non-SNAP households and 7,209 observations from SNAP households.[19]

Appendix table B.3

Summary statistics of key variables by SNAP use for CEX survey data from 2007-2009

	All	Not on SNAP	On SNAP	Difference
SNAP usage	7.0	0.0	100.0	-100.0
Age	48.9	49.1	45.8	3.4***
Female	52.3	51.0	69.9	-18.9***
Black	11.9	10.9	26.3	-15.4***
White	81.6	82.6	67.5	15.1***
Family size	2.53	2.49	2.96	-0.47***
Children under age 18	0.64	0.60	1.18	-0.58***
Annual salary	64,747.81	67,872.28	22,930.00	44,942.28***
SNAP amount	29.75	0.00	427.95	-427.95***
2008 tax rebate amount	956.27	964.17	784.71	179.46***
Total quarterly expenditure	11,982.74	12,404.92	6,332.32	6,072.60***
Quarterly food-at-home expenditure	1,221.87	1,231.18	1,097.24	133.94***
Observations	103,694	96,485	7,209	

Note: .01 - ***; .05 - **; .1 - *

SNAP = Supplemental Nutrition Assistance Program. CEX = Consumer expenditure.

Source: U.S. Department of Labor, Bureau of Labor Statistics, 2018a.

[19]Expenditure, salary, and benefits are adjusted for inflation using the Consumer Price Index for All Urban Consumers (January 2010=100). CPI information was gathered from the St. Louis FED FRED data system. https://fred.stlouisfed.org/series/CPIAUCSL.

Following Parker et al. (2013), we drop observations with expenditures greater than the 99th percentile and below the 1st percentile, after adjusting for family size and quarter of interview. We also drop observations that are under 21 or over 85 years old, and we drop observations that saw abnormally large changes in family size or age during the interview span.

Empirical Approach

Similar to Beatty and Tuttle (2014), Tuttle (2016), and Parker et al. (2013), we use the panel nature of the CEX survey to produce estimates based on a household fixed-effects estimator, which eliminates time-constant unobservable heterogeneity, including tastes and fixed assets, which could be a source of bias in estimation. Our estimating equation is

$$C_{itj} = \beta_{0j} + \beta_{1j} Pay_{it} + \beta_{2j} X_{it} + \delta_{tj} + \mu_{ij} + \epsilon_{itj}$$

where C_{itj} is household i's expenditure in time t on some good j, that is food at home or total expenditures on all goods. Pay_{it} is either the economic stimulus payment amount or the SNAP benefit payment amount for household i in time period t, where t indicates a specific year and quarter. β_{1j}, the coefficient of interest, is the marginal propensity to spend on good j. X_{it} includes average age of the respondent and the spouse, if applicable; the number of individuals in the household; and the number of children in the household under 18. δ_t is an indicator for the year and quarter in which the interview took place. μ_i is a household fixed effect capturing time-constant household heterogeneity, and ϵ_{it} is a strictly exogenous error term.

Our estimation approach also relies on quasi-experimental policy changes to identify the impact of the stimulus or SNAP payments on expenditure. In the case of the economic stimulus payments of 2008, we use the random timing of the issuance of the stimulus payments to separately identify the impact of the payment from the macroeconomic volatility captured in the time effect, δ_t. As described in greater detail in Parker et al. (2013), the timing of the stimulus payments was based on the last two digits of the taxpayer Social Security number, which is plausibly randomly assigned. In the case of the ARRA SNAP increase, we use a difference-in-differences technique to separate the SNAP benefit increase from δ_t following Beatty and Tuttle (2014) and Tuttle (2016). The difference-in-difference approach combines matching treatment and control groups on family size, age, race, marital status, income, and employment with including indicators for SNAP participation, a pre-ARRA indicator variable, and a SNAP*Post-ARRA indicator variable, which represents the impact of the SNAP ARRA benefit increase on expenditures.

Following Parker et al., we use household fixed-effects instrumental variables (FE IV) method, which uses indicators for either the period that the economic stimulus payments were issued (late April to July 2008) or the period that the ARRA SNAP benefit increase went into effect (April 2009) as instruments for the economic stimulus payment amount or SNAP benefit payment amount, as the case may be. As described in Parker et al., this FE IV method only uses variation in the timing of the stimulus or SNAP payments within households, and not the size of the payments, which may be endogenous. Regressions are done separately for each of the 78 spending categories.

Finally, because some estimates of the marginal propensity to spend were estimated imprecisely, we form a precision-weighted average between the average expenditure and the marginal expenditure based on our FE IV estimates. Intuitively, if an MPS is estimated imprecisely, more weight is put on the average expenditure rather than on the noisily estimated marginal expenditure. If it is estimated precisely, then more weight is put on the estimated marginal expenditure. The precision-weighted estimate, $\tilde{\beta}_j$, is:

$$\tilde{\beta}_j = \overline{\beta_j} \frac{\sigma_{\hat{\beta}}^2}{\tau^2 + \sigma_{\hat{\beta}}^2} + \hat{\beta}_j \frac{\tau^2}{\tau^2 + \sigma_{\hat{\beta}}^2}$$

where $\tilde{\beta}_j$ is the APC for good j, and $\tilde{\beta}_j$ is the estimated marginal propensity to consume good j using the FE IV estimator. We take a reasonable estimate of the APC to be 0.90.[20] For food-at-home spending for SNAP participants, we assume an average expenditure per dollar of .26, which is the value used in Hanson (2010), was based on prior research. For Non-SNAP participants, we assume an APC for food at home of 0.08, which is derived from our Consumer Expenditure Survey data. $\sigma^2_{\hat{\beta}}$ is the squared standard error from the FE IV estimator for good j. τ is a weight given to the average expenditure per dollar and is equal to .25 for all goods and services.[21] Estimates of the MPC for food at home and for expenditures overall can be found in table B.4.

One noteworthy item is that the precision-weighted MPC for expenditures overall for SNAP households is very similar to the APC. This is because the marginal estimate, based on using the ARRA SNAP benefit increase, was highly imprecise. From the marginal propensity to consume, we can derive the marginal propensity to save, which is 1 minus the marginal propensity to consume. Final estimates used in the report for the marginal propensity to consume food at home and the marginal propensity to save are shown in table 4 of the main body of the report.

[20]We arrive at this number from considering both the APC drawn from our 2016 Consumer Expenditure Survey data in table B.2, which implies an APC of 0.84, and from data on personal savings from the St. Louis FRED, which showed the personal savings rate, based on BEA data, of 0.067 in 2016. See https://fred.stlouisfed.org/series/PSAVERT.

This personal savings rate implies an APC of 0.933 (0.933=1-0.067). Because both of these sources provide reasonable estimates, we average the two. For simplicity, we round the average of the two to 0.90. Additionally, we assume an APC of 0.90 for both SNAP and Non-SNAP households. While the 2016 Consumer Expenditure Survey suggests an APC greater than 1 in table B.2., we do not want to put too much weight on it, since it is estimated somewhat imprecisely.

[21]This precision-weighted estimator can be viewed as a Bayes estimator with a Normally distributed conjugate prior. If we assume a prior distribution for the MPS for good j that is , then the minimum mean square error Bayes estimator is equal to $\tilde{\beta}_j$. With τ =.25, we assume a prior distribution that would have the MPS be within ±.50 of $\tilde{\beta}_j$ with 95-percent confidence.

Appendix table B.4

Estimates of the marginal propensity to consume for food at home and total expenditures overall using CEX survey data from 2007-2009

Parameter	Final precision-weighted estimate	APC estimate	Marginal estimate	MPC estimate standard error
	SNAP households			
Marginal propensity to consume food at home	0.30	0.26	0.56	(0.63)
Marginal propensity to consume	0.92	0.90	5.82	(3.73)
	Non-SNAP households			
Marginal propensity to consume food at home	0.03	0.08	0.03	(0.02)
Marginal propensity to consume	0.63	0.90	0.51	(0.17)

CEX = Consumer expenditure. APC = Average Propensity to Consume. MPC = Marginal Propensity to Consume.

Source: U.S. Department of Agriculture, Economic Research Service.

Appendix C: FEDS-SAM Data Sources and Model Calculations

From the notation introduced in figure 2 and for the model statement in equation 1, the following notation conventions will facilitate a statement of data sources and model calculations. The three main FEDS-SAM sub-matrices are **T** (endogenous transactions), **X** (exogenous inflows) and L (exogenous outflows, or leakages). Matrices **X** and **L** are related to the vectors in figure 2 as follows; **x = Xi, l = i′L**. Using the italicized first letter of each subaccount name (substitute K for C in Capital account) to identify row sets and column sets, subsections of any matrix can be identified in brackets with rows first and columns second, as follows: **T**[C, A]. In this example, the sub-matrix identified includes all activity outlays (columns A1 to A202) directed to the *commodity* account (rows C1 to C201) within the **T** matrix.

Data Sources

With this notation convention, consider the just-referenced data block, **T**[C, A]. This data comes directly from the 2016 interindustry transaction section of the *Use* table published by BLS (BLS, 2017). It was modified to split the food services activity (A168—see Appendix table A.1) into two activities—*food, excluding services* or A168, and *services, excluding food* or A206.

Next, consider **T**[A,C]. These data come directly from the 2016 *Make* table published by BLS (BLS, 2017). Aside from accommodating the food services split described above, all the nonfood retail trade commodities (C93, C95, C96—see Appendix table A.1) are consolidated into the ‘All other retail’ commodity (C96).

Next, jointly consider **T**[F,A] and **L**[G+K,A]. This combined data block represents gross domestic income by industry. Several data sources are used to develop this block. First, there is GDI broken out into three categories (salary and benefits, output taxes less subsidies, and operating surplus) for each of the 202 industries, obtained from the 2016 Use table published by BLS (BLS, 2017). Second, industry GDI by each of the 20 dispersal categories listed in Appendix table A.2 is available in varying industry detail levels from the 2016 NIPA tables (BEA, 2018). Third, corporate, sole proprietor and partnership statistics by industry are used from the Internal Revenue Service (IRS, 2018). These disparate data sources inform initial estimates of industry GDI across the 20 dispersal categories for each of the 202 industries. A mathematical programming model was developed to minimize the change in initial estimates subject to the replication of the first data source from BLS.

The product aggregation data block, **T**[C,P], comes directly from BLS (BLS, 2017), where they are aggregated based on the product to PCE category concordances reported in Appendix table A.3. Initial factor dispersal estimates, **T**[H+I,F] and **L**[*G+K,F*], are based on the NIPA tables (BEA, 2018). GDI in FEDS-SAM is based on the BLS Use table, which creates a statistical discrepancy with the GDI dispersal data in the NIPA tables. In addition, other imbalances inherent in the NIPA tables are published as statistical discrepancies. Both discrepancy sources are dealt with in a final matrix balancing procedure discussed below.

Total personal consumption expenditures are from BLS (2017), and these data are allocated to households, **T**[*P***,***H*] and **X**[*P***,***E*], following the procedures laid out in Appendix B. The disposition of remaining household disposable incomes, $\mathbf{L}[G{+}K{,}H]$ and $\mathbf{X}[G{+}K{,}H]$, comes from the NIPA tables, and they are allocated following procedures laid out in Appendix B.

With the exception of Government and private direct investment, X[C,G+K], whose data come directly from BLS (2018), all remaining data entries compiled in an initial unbalanced SAM come directly from the NIPA tables. Remaining subaccount imbalances in this initial unbalanced SAM were small in percentage terms and existed exclusively in the exogenous subaccounts. This fact, combined with the predetermined result that combined subaccount imbalances summed to 0, lead to a simple matrix-balancing procedure, whereby the *miscellaneous payment* factor row (factor 6—see Appendix table A.2) served as a balancing row through new inflows (summing to 0) into this account from all unbalanced subaccounts.

FEDS-SAM Model Calculations

In our presentation of the SAM multiplier model, the policy inflow vector was denoted $\mathbf{x}^{p1}$, where 'p1' is a hypothetical SNAP payout increase. The fixed price multiplier matrix was denoted **M**, and the endogenous direct requirement matrix was denoted **A**. Here, we introduce the normalized leakage vector (**w**) and the employment multiplier (**j**):

$$\mathbf{w} = \mathbf{l} \bullet \hat{\mathbf{y}}^{-1}$$

$$\mathbf{j} = \mathbf{e} \bullet \hat{\mathbf{y}}^{-1}$$

Model results presented in this report are produced from the following calculations ('*' denotes all columns or rows, depending on its placement within brackets):

Gross industry output and the output multiplier for SNAP policy:

$$\mathbf{y}^{p1}[A] = \mathbf{M}[A,*] \bullet \mathbf{x}^{p1}$$

$$y\_m^{p1} = (\mathbf{i}'[A] \bullet \mathbf{y}^{p1}[A]) / (\mathbf{i}' \bullet \mathbf{x}^{p1})$$

Gross domestic income by industry and the gdp multiplier for SNAP policy:

$$\mathbf{gdi}^{p1}[A] = (\mathbf{i}'[F] \bullet \mathbf{A}[F,A] + \mathbf{w}[A]) \bullet \hat{\mathbf{y}}^{p1}[A]$$

$$gdi\_m^{p1} = (\mathbf{i}'[A] \bullet \mathbf{gdi}^{p1}[A]) / (\mathbf{i}' \bullet \mathbf{x}^{p1})$$

Employment by industry and the employment multiplier for SNAP policy:

$$\mathbf{e}^{p1}[A] = \mathbf{j}[A] \bullet \hat{\mathbf{y}}^{p1}[A]$$

$$e\_m^{p1} = \mathbf{i}'[A] \bullet \mathbf{e}^{p1}[A]$$

Personal consumption expenditures by type of household for SNAP policy:

$$\mathbf{pce}^{p1}[H] = \mathbf{A}[P,H] \bullet \hat{\mathbf{y}}^{p1}[H] + (\mathbf{x}^{p1}[P] \,\|\, 0[P]),$$

where '||' denotes a concatenation and '0[*P*]' denotes a *P* element null vector.