The Impacts of Tax Reform on Agricultural Households

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Estimates of tax reform's impacts usually concentrate on macroeconomic impacts, but attention at the industry or sectoral level is often limited. Our study uses a computable general equilibrium (CGE) model to estimate the disaggregated impacts of the Tax Cuts and Jobs Act (TCJA) of 2018, which lowered personal and corporate tax rates. Focusing on agriculture, we use survey data to calculate how the TCJA would change the tax rates faced by farmers at the sector level. We use Internal Revenue Service data to calculate tax rates for all other producers. We then simulate the economy-wide and sectoral effects of TCJA. We find that the TCJA would cause a reduction in agricultural output as resources would be reallocated to other sectors. Using our survey data, we extend the CGE results to measure the impacts to farm households—from changes in on- and off-farm income. We find that most farm households would have income gains from tax reform. Our tax reform scenario highlights the fact that investment weighs heavily on model results. That is, firms that are attractive to domestic and foreign investment have gains in demand for their products, while other sectors, such as primary agriculture, experience decreases in production. A sensitivity analysis that reduces the attractiveness of the United States in foreign investment shows smaller impacts of TCJA, especially for macroeconomic variables.

Key words: CGE, taxes, households, sectors.

JEL codes: K34, Q1.

Tax reform has been a subject of perennial interest both for its political economy underpinnings as well as alteration of incentives of economic agents. The last major reform (Tax Reform Act of 1986) lowered tax rates and simplified the tax code; but since that legislation, rates have gradually risen and Congress has passed nearly 15,000 changes to the tax law (Birnbaum 2006). However, none of these changes has been of the magnitude of the 1986 reform. Major tax reform has been proposed many times since then; in particular, corporate taxes and personal taxes are often discussed, with the change in taxes dependent on which political party is in power. Most recently, a new tax law was passed "Tax Cuts and Jobs Act (TCJA)" that reduces both personal and corporate tax rates. Reducing tax rates could help businesses that pay something close to the 35% corporate rate.[1] However, some industries could be negatively impacted by the reform, such as those that deduct interest payments, expense their equipment, and transfer profits to foreign jurisdictions with lower rates. Agriculture is one such sector where some farmers could end up paying higher taxes due to the removal of certain deductions (Fleming 2017).

Alternative analytical methods have been employed to assess the impact of past tax reform on an economy, with simulation models often used to estimate broad macroeconomic impacts. One type of simulation model, "a life-cycle model or overlapping generations," has been used to investigate the effects of eliminating the corporate income tax

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[1] As has been noted many times in the popular press, not all U.S. corporations pay the 35% rate due to deductions. Using IRS data, we will show that few sectors actually pay close to that rate.

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altogether (Fehr et al. 2013) or of implementing a consumption tax (Carroll et al. 2006). Auerbach (2002), in particular, has made extensive use of this modeling setup, with his work analyzing the 2001 tax cut. This type of model is useful for estimating very long-term impacts (e.g., 100 years or more), but it is not exactly suitable for the political environment interested in short- to medium-term impacts. Recognizing the inherent short-term political nature of tax reform, others have used static simulation models, such as a computable general equilibrium (CGE) model, with a medium-run time horizon (i.e., 5 to 8 years). Indeed, one of the earliest uses of these models was in the early 1970s, when it was used to analyze the economic effects of changes in taxation (e.g., Keller 1980; Shoven and Whalley 1984). In a well-cited example, Ballard, Shoven, and Walley (1985) investigate the marginal excess burden of U.S. taxes, providing information on several different types of taxes (e.g., corporate taxes, property taxes, and social security taxes).

In terms of previous analysis of taxes and agriculture, Hanson and Bertelsen (1987) discussed how the Tax Reform Act of 1986 might impact production and investment decisions of agricultural producers. LeBlanc and Hrubovcak (1986), Halvorsen (1991), and LeBlanc et al. (1992) used econometric techniques to estimate the effects of tax policy on agricultural investment. CGE models have also been used to estimate the impacts of tax reform on agriculture. Boyd (1988) used a model similar to Ballard, Shoven, and Walley (1985), but Boyd's work disaggregated agriculture to a finer degree. Again focusing on the 1986 tax reform, Boyd and Newman (1991) concluded that tax reform negatively impacted agriculture, both in field crop sectors as well as livestock sectors. Other research that has considered the impacts of taxes to agriculture include Hertel and Tsigas (1988), who used a CGE model to analyze the effects of eliminating farm and food tax preferences in 1977, as well as Canning and Tsigas (2000), who considered the implications of federal and state tax policy for the food and farm sectors.

Tax reform that changes both corporate and personal income tax rates would impact all agricultural producers. The majority of U.S. farm businesses are structured as non-corporate entities whose owners pay taxes at the personal level; however, a sizeable share of farms are owned by corporations. For non-corporate farms, lower personal tax rates are the direct impact. In addition, lowering corporate taxes would impact agricultural processors and suppliers, and the resulting changes in their production and prices could transmit through the agricultural supply-chain affecting all producers. Clayton (2017) notes that non-corporate farmers could look at restructuring, because the tax plan does not match lower personal income tax rates with the lower corporate rates (and the personal income tax changes are not permanent, like the corporate tax change). U.S. agriculture is a net exporter but subject to intense global competition. Thus, changes to the tax code could also impact the global economy and U.S. agriculture.

To consider how the recent U.S. tax reform might impact the economy, we use a CGE model that details industry (or sectoral impacts), as well as global impacts. Although we consider the impacts across all sectors, our focus is on agriculture. To that end, we use detailed information on agriculture from the Agricultural Resource Management Survey (ARMS) to calculate the current tax rates faced by agricultural producers. The ARMS provides information on farm type (family farm, individual, and corporations) and farm household income. With that information, we calculate tax rates with distinctions for corporations versus non-corporate farms. We use publicly available Internal Revenue Service (IRS) data to calculate the corporate tax rate for all other sectors. Once this data work is done, we update our CGE model by calibrating these rates into the model, and we provide several data and modeling changes to improve the inner workings of the model. We then conduct a tax reform policy scenario based on the TCJA. The results of this reform indicate that agriculture would have production losses as resources are reallocated to other sectors. However, extending these results to our farm household data, we find that most farm households have income gains from tax reform. The economy-wide CGE results highlight the importance of investment in generating macroeconomic gains. We then conduct a sensitivity analysis to explore the implications of investment behavior on our analysis.

CGE Data and Model

Given the complex linkages and interactions between producing sectors, the competition among these sectors for limited economic resources, and interactions between production, consumption, and trade activities, a CGE modeling approach provides an appropriate framework to analyze the impacts of tax reform. Thus, CGE models have been one of the main tools in analyzing tax reform. Although it is likely that most, if not all, of the CGE studies mentioned in the literature review discuss sectoral-specific impacts, most studies have focused on macroeconomic impacts. While we are also concerned about the overall effect, the main purpose of this work is to examine the impact on agriculture relative to other sectors of the economy. To make our work as transparent as possible, we use the publicly available Global Trade Analysis Project (GTAP) model (Hertel 1997). Unfortunately, the information for U.S. taxes in the model is dated (derived from U.S. tax statistics for 1997) and not inclusive of all taxes (Gurgel, Metcalf, and Reilly 2006); thus along with computing the changes in taxes from the reform, we first need to validate the baseline tax rates.

Validating Tax Rates in the Model

In this work we utilize the latest GTAP Database (Version 10), which has a baseline of 2014.[2] The GTAP database contains average tax information about primary factors, that is, labor, land, natural resources, and capital. Table 1 shows how factors taxes are organized in the GTAP database. The first row in the table shows that a personal income tax rate of 15.38% falls on labor at the household level, that is, theses taxes are viewed as income taxes. A corporate tax rate of 8.58% falls on land, other natural resources, and capital at the household level as well. Social security contributions (13.80%) fall on labor at the sector level, that is, these taxes are viewed as taxes on the use of labor by producing firms. All other factor taxes fall on land, other natural resources, and capital at the sector level. The final row "agricultural subsidies" are taken as given in this work, with no changes made to them.

Our work validates those tax rates in GTAP by providing detailed information on tax incidences in the United States, particularly for agriculture. We use ARMS, which provides information on various tax components for primary agricultural sectors (see online supplementary appendix A for the regional aggregation for the model; we retain all 57 GTAP sectors, to focus on sectoral effects).[3] Specifically, we utilize the total farm household income calculation that combines income from different sources (figure 1). Farm income is the sum of the operator household's share of farm business income (net cash farm income less depreciation), off-farm income comes from earned and unearned sources. To calculate the tax rate for each primary agricultural sector, we apply the tax rates for 2013 to the various income levels.[4] Many farms have different types of production (e.g., a corn farm also grows soybeans). We assume that the largest source of commodity sales determines the type of farm.

Information on tax components from ARMS is provided in table 2. There are 12 primary agricultural sectors in GTAP; ARMS provides information on 11 of those (the calculation for the 12th sector—wool—is shown later). Certain ARMS industries need to be aggregated to fit into our CGE sectoral specification. For example, the GTAP sector "coarse grains" is composed of the ARMS industries barley, corn, oats, and sorghum. Average household income varies across a broad spectrum for U.S. agriculture: it is less than $100,000 for cattle and other crops, while coarse grains and plant fibers (i.e., cotton) households had an average of more than $200,000 of income. The average household income for sugar is not reported due to disclosure issues (number of sampled farms is too small to disclose information). We apply the rates for tax brackets listed in online supplementary appendix B (we assume farm households as joint filers).

[2] This database is a pre-release, available to GTAP consortium members. It is distributed early as a means of detecting any anomalies. As such, it is possible that some aspects of the data can be adjusted in later releases. We accept these complications given that this is the latest database possible, and because we validate the tax rates with external data.

[3] ARMS is a large, nationally representative and comprehensive database, which is the U.S. Department of Agriculture's (USDA's) primary source of information on the financial condition of farm businesses and households and farm production practices (Beckman and Livingston 2012).

[4] The base year for our CGE model is 2014; however, the component that provides tax rates for all other sectors (discussed later) is from 2013. We use 2013 to be consistent across tax rates. The tax brackets listed in table 3 under the 2017 tax reform follow those of 2013, except for the last 3 brackets. The income brackets for those groupings have changed compared to 2013, thus we make an approximation.

Table 1. U.S. Factor Taxes in GTAP Database

Type of tax or subsidy	Factor taxes at household level		Factor taxes at sector level			
			Farm sectors		Non-farm sectors	
	Labor	Land, Capital, Natural resources	Labor	Land, Capital	Labor	Capital, Natural resources
Standard GTAP baseline data						
Personal income tax	15.38%					
Corporate income tax		8.58%				
Social security contributions			13.80%		13.80%	
All other factor taxes				3.30%		3.30%
Agricultural subsidies			Rates vary by sector	Rates vary by sector		
Revised tax structure in CGE model baseline						
Personal income tax		15.38%	Rates vary by sector (first column of table 4)		15.38%	
Corporate income tax				Rates same for primary agriculture (appendix B)		Rates vary by sector (appendix B)
Social security contributions	13.80%					
Agricultural subsidies			From GTAP version 10	From GTAP version 10		
Tax setup for modeling the TCJA scenario						
Personal income tax		11.01%	Rates vary by sector (second column of table 4)		10.10%	
Corporate income tax				Rates same for primary agriculture (appendix C)		Rates vary by sector (appendix C)
Social security contributions	13.80%					
Agricultural subsidies			From GTAP version 10	From GTAP version 10		

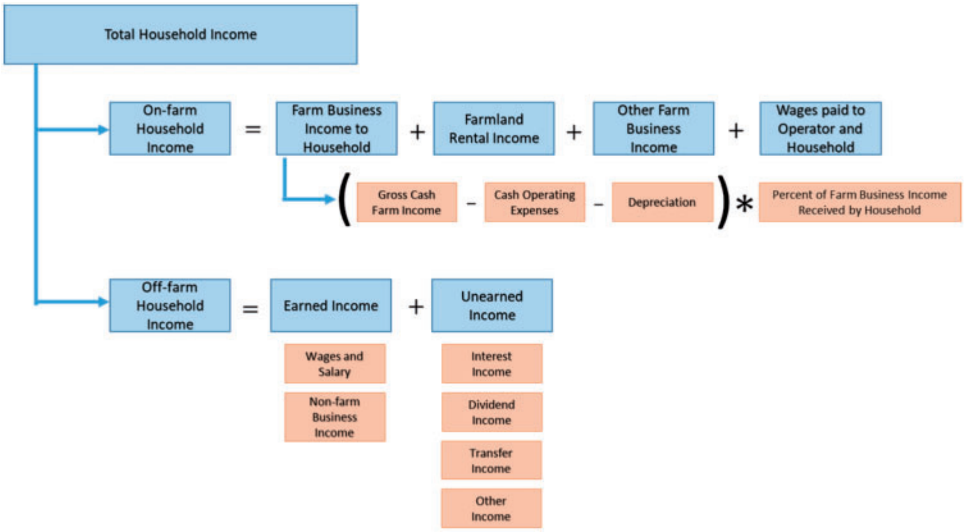

Figure 1. Components of farm household income.

Source: Key et al. 2017

Table 2. Information on Tax Components

	Average farm household income	Household income from off-farm sources	C-corporation	
			Percentage of farms	Percentage of value
paddy rice (pdr)	148,632	49,368	0.81	1.95
wheat (wht)	170,712	62,606	3.33	8.72
coarse grains[1] (gro)	217,288	95,949	3.19	5.37
veg & fruit (v_f)	151,554	102,579	3.53	16.77
oilseeds[2] (osd)	163,347	74,501	1.44	3.94
sugar cane/beet (c_b)	N/A	44,482	0.43	6.38
plant fibers[3] (pfb)	290,408	58,783	0.95	0.99
other crops[4] (ocr)	97,981	83,574	0.90	26.21
cattle[5] (ctl)	96,441	86,821	0.80	18.32
other animal products[6] (oap)	126,395	73,008	1.95	4.23
milk (rmk)	147,723	35,969	3.28	9.12

Source: USDA ERS (2017a).
Note: Superscripts indicate the following: [1] = barley, corn, oats, and sorghum; [2] = canola, other oilseeds, and soybeans; [3] = cotton; [4] = beans, hay, nursery, and tobacco; [5] = cattle; [6] = hogs, poultry, and eggs. N/A indicates that the number of farms sampled is too small to disclose income information. The GTAP sector name is given in parentheses.

The resulting tax rates for farm households are shown in table 3. Our average tax rates for primary agriculture are in line with those estimated by Bawa and Williamson (2018). Using data from 2015, and focusing on tax rates for farms of different size, they calculate an average rate of 18.1% for all of primary agriculture. The rate calculated here is 19.1% (weighted by production value). The percentagd difference is likely due to higher farm income in 2013 ($123.8 billion) versus $81.4 billion in 2015 (USDA ERS 2017c).

The amount of tax applied is also a function of the type of farm for legal status. Table 2 presents information on the number of C-corporations for each of the primary agricultural sectors. C-corporations are the type of farm that would pay corporate taxes (Williamson, Durst, and Farrigan 2013). Like household income, there is also significant variation within this observation; five of the sectors have less than 1% of farms held by C-corporations, while four sectors have more than 3% in C-corporations. To calculate the

Table 3. Baseline Personal Income Tax Rates and Tax Rates under the TCJA Scenario for Primary Agriculture

	Initial tax rate (%)	Reformed tax rate (%)
paddy rice (pdr)	19.48	16.40
wheat (wht)	20.04	17.03
coarse grains (gro)	21.76	18.58
veg & fruit (v_f)	18.78	16.10
oilseeds (osd)	20.06	16.93
sugar cane/beet (c_b)	28.58	25.13
plant fibers (pfb)	24.73	20.02
other crops (ocr)	15.86	13.26
cattle (ctl)	16.01	13.09
other animal products (oap)	18.01	14.90
milk (rmk)	18.95	16.14
wool (wol)[a]	13.54	13.54

Source: Tax calculations based on USDA ERS (2017a) and IRS (2017).
Note: Superscripts indicate the following: [a] = information is from IRS (2017); ' = calculations are based on their income subject to tax.

tax rate for agricultural corporations and other non-agricultural sectors, we use IRS data. The baseline tax rates for corporations are shown in supplementary appendix C. These tax rates are derived from data from IRS Returns of Active Corporations (i.e., SOI Stats table 6). As such, we are assuming that the share of Active Corporations in the total number of businesses in the off-farm sector is 100%. To calculate the tax rate, we divide the "total income tax after credits" by the "net income less deficit." The tax rates we calculate for all other sectors vary; however, only a few have tax rates close to the corporate tax rate before TCJA (35%). Some sectors, in fact, have tax rates less than 10%, due to deductions. Processed agricultural products are taxed at a higher rate (24.83%) than primary agriculture.

Developing the Baseline Applied Tax Rates

With the actual tax rates computed as noted above, the structure of the taxes in the standard GTAP database is altered to capture real-world behavior (changes are shown in the middle portion of table 1). In the CGE model, taxes can be applied at the household level (thus having the same effect for all producing sectors in an economy) and at the sector level (thus potentially introducing different tax effects across producing sectors). Our specification of taxes makes full use of our sectoral-level exposition. Each of the taxes is only specified on one factor or sector to facilitate modeling of individual as well as the aggregate impact of the tax reform (e.g., personal income tax and social security contributions are not both taxed on labor income at the household level, otherwise the two taxes would be aggregated into a single tax).

First, the application of income taxes at the household level is made to all factors other than labor, that is, land, capital, and natural resources; and we shift social security contributions from being sector-specific (since most farm and non-farm households pay a similar rate) to as being modeled on the labor income side at the household level. Because we have computed agricultural sector-specific income tax rates, our revised setup applies the tax on labor at the sectoral-level. Personal income taxes for labor employed in all other sectors (i.e., non-farming sectors) are also applied at the sector level but the tax rate (15.38%) is the same for all sectors since we have no information on sector-specific differences. This 15.38% rate is the baseline income tax rate in the GTAP database.

Next, we need to account for "double taxation," that is, individuals being taxed through corporations and personal income taxes, something not currently accounted for in the standard GTAP database. To incorporate this type of double taxation on income, we first apply a corporate income tax for the non-labor items (i.e., land, capital, and natural resources) at the sector level, since we computed sector-specific rates. This combination of the corporate income tax and the personal income tax reflects the double taxation of corporate income. Note that we are assuming that all individuals involved in corporations are getting double-taxed; however, the Tax Policy Center (2017) notes that in practice, not all corporate income is taxed and many corporate shareholders are exempt from income tax.

We keep the baseline GTAP rate for social security contributions (13.80%), which includes social security, Medicare, and any other additional withholdings. The "all other factor taxes" portion of the initial tax setup (3.30%) are removed from the new tax setup since it is not clear what these taxes represented.

Developing Applied Tax Rates under the TCJA

With the actual tax rates validated in the baseline, we consider the following tax reform scenario: lowering the statutory corporate tax rate to 21% from 35%, and reforming personal income tax brackets by applying TCJA, with rates shown in online supplementary appendix B. To introduce the new personal income tax rates into the model, we must calculate those that will be faced by primary agricultural producers. For that purpose, we calculate tax rates for incomes shown in table 2 based on the TCJA brackets shown in supplementary appendix B. Some aspects of the tax reform, such as deducting the cost of capital investments immediately, would provide an improvement to farm income; however, ARMS provides no information on how much capital investments are carried from year to year. To calculate the new corporate rates, we apply the less of the previous tax rate (before the reform), or 21% as specified in the TCJA.

The personal income tax rates levied on labor under the TCJA are presented in table 3 for primary agriculture. Supplementary appendix D shows the new corporate tax rates levied on land and capital income for farming sectors and on capital and natural resources for the rest of the sectors. As shown, the TCJA lowers tax rates for many sectors; in particular, the personal income tax rate levied on labor for primary agriculture declines to a simple average of 16.76% (table 3). In this instance, only sugar cane/beet and plant fiber producers would pay over 20%. The largest reductions in personal income taxes are to those sectors that have high household income and a small share of corporations holding production value, while the smallest reductions are for those with low household income and a large share of corporations (e.g., other crops). The effect from corporations is because the corporate rate on primary agriculture does not change. The corporate tax rate levied on capital employed by producers of processed agricultural products decreases to 21% (online supplementary appendix D).

As was discussed in the earlier section, we focus our tax reform scenario mostly on key changes to personal and corporate income taxes. We do not change tax rates for social security contributions or farm income supports. The third part of table 1 shows that our tax reform scenario changes personal and corporate income taxes at the household level, as well as at the sector level. For example, personal income tax rates levied on non-labor income were lowered from 15.38% to 13.74%. This calculation was derived by calculating the difference in taxes faced by primary agriculture (the TCJA scenario to the baseline), and applying that difference to the initial personal income tax for all households originally embedded in GTAP.

Investment Assumption

Before delving into the results, we would like to point out that the results essentially hinge on the behavioral assumptions underlying foreign investment in GTAP.[5,6] The allocation of investment demand across all regions is based on the attractiveness of each region in investment flows. The static GTAP model is not forward-looking, but seeks to maximize the current return on investment. The potential to maximize the return on investment is governed by a parameter in the model that hypothesizes that expected returns in a given region will fall as the amount of current investment rises. That is, the smaller the value of this parameter (it could also be turned off, effectively shutting off changes in investment), the larger the incentives in investment in that country or region. Unfortunately, the

[5] In the GTAP model, investors are represented by a single agent, known as the "global bank". This agent receives savings from households around the world, and invests those savings. Investment in each region is represented by the purchase of a commodity called "capital goods". This commodity is similar to the investment column on an input/output table. The capital goods sector is used to assemble the various inputs to investment expenditure (e.g., construction, machinery) into one composite sector, which is then purchased by the global bank. In each region, both imports and domestic goods can be used as inputs into the sector.

[6] This is essentially the ongoing debate between Krugman and Gravelle. For an example, see NYTimes 2017.

parameter (known in GTAP as RORFLEX) does not have an econometric basis. Since no literature exists on what this parameter should be, we calibrate the parameter results from two recent studies on TCJA impacts: the Tax Foundation (2017) and the Tax Policy Center (2017). In particular, these studies provide results for changes in household income, an element in our CGE model that is very responsive to investment changes. The Tax Policy Center estimates change in income across all households as 2.2% (changes in 2018) as the upper bound and 0.2% (changes in 2027) as the lower bound. The estimates by the Tax Foundation are 1.8% (static changes in 2018) as the upper bound, and -0.3% (static changes in 2027) as the lower bound. Without any additional external data to base the RORFLEX parameter on, we calibrate it to the largest change above (2.2%). We also consider the other end of the investment debate by conducting a sensitivity analysis where RORFLEX is calibrated to the lowest income change (-0.3%). Note that the default value for the RORFLEX parameter is 10 in the standard GTAP database. The income calibration of 2.2% gives a RORFLEX value of 26, while we assume that investment is allocated across regions maintaining the existing composition of capital stocks (i.e., RORFLEX is turned off) to calibrate to an income change of -0.3%. We first present the results using the first calibration, while the second calibration is our sensitivity analysis.

Results

We first review the macroeconomic results to understand the economy-wide results. In addition, these results provide insight into what we can expect at the sector level.

Macroeconomic Impacts

The macroeconomic impacts from the tax reform scenario with the first calibration are given in table 4. U.S. household income increases 2.2% (as calibrated), while household income declines for all other regions in this scenario. The table provides a range of impacts for the Rest of the World (ROW), with the largest decrease in household income at -1.58% and the smallest decrease at -0.82%. U.S. GDP (in real terms) increases by 0.05%, while most of the other regions experience a modest decrease. We can compare our estimates of U.S. GDP with those in the literature—the Tax Foundation and Tax Policy Center papers mentioned earlier, along with some work by Barro and Furman (2018) and the Joint Committee on Taxation (JCT; 2017). Those pieces show an initial (next year-2018) increase in GDP ranging between 0.4% and 0.8%, but the JCT and Tax Policy Center indicate that the long-run (to 2027) change in GDP is essentially zero. This is because almost all personal income tax provisions of the TCJA expire by that date. The Barro and Furman (2018) study has a year-to-year change of 0.04% over the next ten years, while the Tax Foundation has the largest long-run increase (1.7%). Our results are in line with those of the other three studies, and we note a main difference between our work and the Tax Foundation is that they get the result that domestic capital stock increases by 4.8%, that is, it is a dynamic model where capital can be created and carried over from year to year. Our static model does not have the capability to create capital, but we note that our model would estimate a GDP gain greater than 1% if we assume that capital grows by 4.8%. Note that the JCT paper assumes an increase in capital of 0.9% as well.

The U.S. dollar strengthens by 3.96% due to investment inflows. This link between rising capital investments and the strengthening of the dollar was pointed out by Entin (2017); who uses the period following the 1981 tax reform as an example of how exchange rates can adjust after pro-growth tax reform.[7] Finally, we also report changes in welfare using the equivalent variation (EV) measure, with a decomposition allocating the change in welfare to three components: allocative efficiency (the redistribution of resources); terms of trade (the ratio of an export price index to an import price index); and investment. The total welfare results indicate that for the United States, welfare increases by $73 billion under the TCJA scenario. More than half of the welfare gains are from improvements in the terms of trade, while improvements in the attractiveness of the U.S. economy to investors capture 32% of welfare,

[7] This reform reduced taxes on capital, and at the same time, the Federal Reserve allowed interest rates to rise. The U.S. dollar rose by more than 40% compared to major foreign currencies between 1980 and 1985.

Table 4. CGE Model Results

Macro

	Household income (Percentage change)	GDP (Percentage change)	Exchange rate (Percentage change)	Equivalent variation ($ million)			Trade balance ($ million)
				Allocative efficiency	Terms of trade	Investment	
U.S.	2.24	0.05	3.96	7,923.88	41,684.04	23,457.47	–288,997
ROW	[–1.58,–0.82]	[–0.06, 0]	[–1.52,–0.80]	–18,599.20	–42,253.01	–23,798.21	288,997

Sectoral (percentage change)

	U.S.				Rest of the World			
	Primary agriculture	Processed agriculture	Investment sectors	All others	Primary agriculture	Processed agriculture	Investment sectors	All others
Production	–1.60	–0.65	1.67	–0.86	0.17	0.15	–0.43	0.23
X/P	18.21	7.87	3.63	6.36	Not reported			
Prices	0.87	1.26	1.97	1.79	–0.99	–0.94	–1.10	–1.08
Exports	–4.14	–8.62	–14.62	–10.36	0.84	0.85	1.91	1.29
Imports	2.19	4.35	8.87	4.42	–0.14	–0.35	–0.87	–0.38
Endowments								
Land price	–2.04	No land used			Not reported, but available upon request from the authors			
Labor use	–2.56	–1.72	1.73	–0.60				
Labor price	3.00	2.40	2.40	2.30				
Capital use	–2.52	1.24	2.21	–0.44				

Note: X/P represents the share of production that is exported.

and allocative efficiency captures the other 11%. Notice that welfare results for the ROW largely mirror the welfare changes in the United States (except with decreases); their total welfare loss is $84.6 billion. Finally, the last column indicates that the U.S. trade balance (exports–imports) decreases by $289 billion. This is due to the reduction in exports of certain sectors (e.g., chemicals, rubber, plastic; motor vehicles and parts; transport equipment; and electronic equipment).

Finally, our model tracks changes in tax spending, and these results indicate that tax revenue would decrease by $374 billion. For comparisons, Barro and Furman (2018) estimate a reduction in tax revenue of $1.2 trillion over their 2018–2027 time period. The JCT paper indicates the yearly amount of their lost tax revenue, arriving at a final $1.071 trillion by 2027. Finally, the Tax Foundation estimates a loss of $1.47 trillion with their static assumption, and $448 billion with their dynamic assumptions. There are a handful of differences between our tax estimates and the others, as we do not consider all the changes that they do (e.g., the change in the estate tax). The biggest difference, however, is in our time horizon. The aforementioned estimates project out until 2027, while our work is a static shock (i.e., no demand and income growth projections).

Sectoral Impacts

The macro results highlighted the importance of investment to the U.S. economy. Here we provide sector-level results, with particular attention paid to agriculture and those commodities that feature in investment.[8] The second half of table 4 shows the results for our four aggregated groups. Although primary agriculture has the largest decrease in production, it has the smallest decrease in exports. Note that the share of exports in production (the 2nd main row of the table) is highest for primary agriculture compared with other sectors. The increase in export share of production from primary agriculture arises for a couple of reasons: the increase in household income leads to an increase in demand for services and manufactures, not for primary agriculture products; the majority of primary agriculture is used as inputs into production by processed agriculture sectors, which also has a decrease in production. Thus, any hope that a reduction in taxes for processed agriculture would lead to an increase in demand for primary agriculture does not materialize in this scenario. In fact, processed agriculture sectors actually have an increase in the amount of imported primary agriculture products that they use because of the terms of trade effects. The amount of labor and capital moving out of primary agriculture increases the price of those goods, making imports more attractive (an increase of 2.19%).

The overall change in the price of land for primary agriculture is -2.04% (only primary agriculture uses land). The decrease in *oilseeds* production (table 5) highlights the importance of land prices across primary agriculture products. *Oilseeds* actually had one of the largest decreases in the taxes they pay under the reform scenario; thus, we would expect them to be better off than other sectors. However, they are competing for land with all other primary agriculture sectors, and the price of land used by *oilseeds* producers increases by more than those for other producers. The main destination for *oilseeds* is *vegetable oils*, and 29% of *vegetable oils* are exported. Almost 60% of *oilseeds* are also exported; the reduction in exports of these two products decreases the attractiveness of *oilseeds* in agricultural production (hence the relatively larger decrease in land prices). Labor use only increases in the investment goods group; however, close competition with processed agriculture and all others leads to an overall increase in wages of 2.40%. Capital increases for the investment goods group as well, as resources flow from other sectors (although processed agriculture also has an increase in capital use).

The sectoral results show that investment goods have the largest production gains, despite a decrease in exports.[9] First, investment goods have the smallest share of production

[8] The sectoral results in table 4 aggregate the 57 sectors into 4 categories: primary agriculture, processed food and food manufacturing, investment goods, and all other sectors. The investment goods composite is constructed for those sectors that investment focuses on. There are four sectors that comprise 80% of investment: *machinery and equipment nec*, *motor vehicles and parts*, *construction*, and *trade*. These four sectors are those represented by the "investment goods" category.

[9] Not all sectors can be shown due to space limitations. Those missing are: *wool*, *fishing*, *forestry*, and *public administration*, *defense*, *education*, and *health*. Those results are available upon request from the authors.

Table 5. Commodity Specific Results for the United States (Percentage Change)

	Production	Prices	Exports	Imports
paddy rice	−2.12	0.32	−4.47	6.33
wheat	−3.93	0.32	−6.30	2.98
coarse grains	−0.78	0.75	−1.99	1.25
veg & fruit	−1.68	1.06	−4.88	2.06
oilseeds	−3.51	0.30	−3.65	−0.46
sugar cane/beet	−1.31	0.38	−3.55	2.51
plant fibers	−3.30	0.21	−3.51	2.12
other crops	−3.12	0.97	−9.29	3.20
cattle	−1.25	1.07	−5.79	2.26
other animal products	−1.21	1.09	−3.84	1.84
milk	−0.26	1.04	−13.42	7.59
bovine meat	−0.95	1.41	−12.04	8.47
other meats	−1.50	1.46	−13.12	9.02
vegetable oils	−4.09	0.92	−8.54	2.58
dairy products	−0.36	1.27	−12.12	8.77
processed rice	−2.60	1.28	−8.42	4.86
processed sugar	−1.44	1.15	−7.13	3.03
processed food products	−0.55	1.31	−6.80	4.47
beverages & tobacco products	0.19	1.20	−4.35	2.79
coal	−0.66	−0.39	−1.66	0.48
oil	−0.34	−0.87	0.10	−0.27
gas	−0.46	−1.03	1.37	−1.52
petroleum, coal products	−0.30	−0.54	−0.75	−0.31
electricity	−0.41	1.75	−11.98	7.62
minerals	−0.48	0.95	−2.61	−1.00
textiles	−4.00	1.84	−14.32	7.54
wearing apparel	−4.28	1.81	−17.84	6.85
leather products	−8.91	1.57	−17.80	4.05
wood products	3.09	2.49	−11.95	4.03
paper products	−1.56	0.86	−2.84	1.31
chemical, rubber, plastic	−5.10	1.69	−12.44	5.21
mineral products	0.79	1.98	−13.50	8.91
ferrous metals	−3.58	1.78	−11.28	5.37
metals nec	−6.02	0.63	−10.86	0.82
metal products	−1.12	1.86	−15.18	11.15
motor vehicles and parts	−2.05	1.57	−12.05	7.65
transport equipment	−8.12	1.18	−13.61	3.50
electronic equipment	−4.33	1.43	−12.37	7.43
machinery and equipment nec	0.36	1.98	−19.24	15.82
manufactures nec	−7.58	1.79	−16.68	5.94
water	−0.21	1.91	−13.82	9.01
construction	5.66	2.14	−12.50	13.92
trade	0.45	1.94	−10.36	5.96
transport nec	−1.12	2.46	−10.40	5.27
water transport	0.19	0.01	−1.08	1.81
air transport	−0.40	−0.10	−2.09	1.44
communication	0.48	1.14	−7.56	4.54
financial services	−0.03	2.23	−10.14	7.70
insurance	−0.35	1.89	−9.06	5.56
business services	−0.45	2.13	−10.86	6.13
recreational & other services	0.16	1.69	−8.66	5.39
dwellings	−0.32	2.71	−0.32	−0.32

allocated to exports (domestic consumption is large) and they are the most attractive to foreign investment. Of the four sectors that comprised the investment goods grouping in table 4, production slightly decreases for *motor vehicles*, *machinery*, *and equipment*; but

Table 6. Change in Farm Household Income from Tax Reform

	Change in farm sales (percentage)	Change in farm income ($)	Change in off-farm income ($)	Change in farm household income ($)	Reduction in household taxes paid ($)
paddy rice	−0.24	−805	1,007	202	4,578
wheat	−0.42	−1,678	1,277	−400	5,138
coarse grains	1.06	−894	1,957	1,064	6,910
veg & fruit	0.64	183	2,093	2,275	4,062
oilseeds	−2.30	−1,216	1,520	303	5,113
sugar cane/beet	−0.20	−2,264	907	−304	N/A
plant fibers	−3.04	−5,568	1,199	−4,368	13,678
other crops	−0.23	79	1,705	1,784	2,548
cattle	0.72	62	1,771	1,833	2,816
other animal products	0.55	−111	1,489	1,379	3,931
milk	1.51	420	734	1,154	4,151

there are increases for *trade* and *construction*. Indeed, the 5.66% increase in construction is essentially driving the result for investment goods. *Construction* is responsible for 50% of investment, thus the reduction in taxes leads to an increase in investment, particularly for *construction*. This result occurs for *construction* despite very little actual change coming in taxes from the tax reform scenario. Note that the *construction* sector was already paying a corporate tax rate well below the change in the tax rate.

Table 5 also sheds some light onto specific impacts for primary agriculture (the first 11 rows). All commodities have a decrease in production, although some are less affected. The primary agriculture commodities that had the largest decrease in taxes from the tax reform (*other animal products*, *oilseeds*, *paddy rice*) do not necessarily have the smallest decreases in production. Nor do the commodities with the smallest decrease in taxes (*sugar cane/beet*, *other crops*, *cattle*) have the largest decreases in production. Rather, the change in production is mainly derived from those who have a smaller decrease in exports and where imports increased. For example, *coarse grains* (barley, corn, oats, and sorghum) have the smallest reduction in production (other than *milk*) as they also have the smallest decrease in exports. *Wheat* has the largest decrease in production, which is because of an increase in imports, not necessarily taxes on that sector. Of the processed food products, *beverages and tobacco* have an increase in production, while all other processed foods have a decrease. This is, again, a result of higher-priced domestic goods as a result of higher factor prices. Almost all foreign primary and processed agricultural products have a decrease in price.

Changes in Farm Household Income

The CGE results provide estimates of macroeconomic impacts and production/trade impacts for each agricultural sector, and it also gives change in income for the representative household. But these pieces of information are not enough to determine what happens to farm household income. To calculate this measure, we combine results of the CGE model with information from ARMS. Table 2 presented information on the amount of total farm household income, and the amount of household income from off-farm sources. As indicated by the table, the amount off-farm household contributes to total farm household income varies widely. *Plant fibers* and *milk* households have only 20% and 24% of their income provided from off-farm sources, while 85% of *other crops* income and 90% of *cattle* household income are from off-farm sources.[10]

To determine the change in total farm household income we take the change in farm income as determined by the returns to primary factors (i.e., prices) and production. This calculation (prices * production) describes the amount of sales for each primary commodity. Table 6 presents information on the different components of the farm

[10] Note that if sugar farm household income was presented it would have had the lowest share of off-farm income contributing to farm income.

household calculation, with the change in farm income (the second column) and off-farm income (the third column) combining to determine the change in farm household income (fourth column). The change in off-farm income is determined by the change in wage rates across all sectors. Finally, the last piece of information in the table calculates the change (reduction) in taxes that a farm household would pay based on the tax brackets of TCJA.

The change in farm income in table 6 indicates that most commodities have a negative change in farm income; however, *veg & fruit*, *other crops*, *cattle*, and *milk* all have a slight increase (under $500) due to large price increases. The change in the wage rate is 2.40%; we multiply this amount by the share of farm household income occurring in off-farm sources. Combining the two sources gives the change in farm household income. Most commodities have an increase in farm household income; the exceptions are *wheat*, *sugar cane/beet*, and *plant fibers*. The decrease in *plant fiber* farm household income is $4,368 and is due to the 3.04% reduction in farm sales and the high percentage of farm household income derived from farm sources. The last column, however, shows that if the reduction in taxes paid by *plant fiber* farmers was considered, they would have the largest increase in after-tax income (adding the last two columns).

Sensitivity Analysis

This section explores the impacts of tax reform if foreign investment is limited. As mentioned earlier, we calibrate the investment parameter to the lowest household income estimate in the literature (–0.3%). This estimate is negative; thus, we expect that other macro impacts might be limited (e.g., GDP). Results for income and other macro factors are given in table 7. As expected, real GDP gains are less when investment into the United States is less attractive—0.01%—and the U.S. exchange rate does not strengthen by as much (1.36%). The welfare impacts also show a large difference compared to the initial scenario. U.S. welfare increases, but the $3.37 billion increase is almost $70 billion less than the initial scenario. The welfare breakdown indicates that the allocative efficiency change is similar across the two scenarios, but the terms of trade and changes from investment are very different. The change in investment is self-explanatory; the smaller terms of trade are caused by the United States receiving a lower price for their exports compared to the previous scenario. Online supplementary appendix E presents detailed sectoral results, where the second column indicates that U.S. prices are negative for most commodities. This compares to increases for most commodities in the initial scenario (table 5). Finally, the trade balance for the U.S. is positive, as the investment assumption keeps resources from flowing to investment activities, thereby negating the need for as much imports as in the initial scenario.

The lower panel of table 7 presents sectoral changes for the sensitivity analysis. Primary agriculture again has a reduction in production; however, at -0.09%, it is much smaller than the initial scenario. All other sectors have an increase in production, as the economy still grows despite the investment assumption. Processed agriculture has the largest increase in production, spurred by an increase in exports. Primary agriculture has an increase in imports, as the increase in production of processed agriculture draws resources away from primary agriculture (e.g., capital) causing production to fall and the need for more imports. The specific production changes for primary agriculture are mixed; there are increases for many commodities, but a decrease for *wheat*, *veg & fruit*, *oilseeds*, *other crops*, and *cattle*. Exports decrease for almost all primary agriculture commodities, as these products are needed domestically. Finally, note that the change in production for construction is zero, but overall, this scenario has a more equal distribution of impacts.

Summary and Conclusions

Tax reform impacts have been found to be largely beneficial in the aggregate, but sectoral or individual effects vary given the underlying heterogeneity in inputs, location, and organization. This study's findings highlight the later, differential impact of tax reform on agricultural sectors. Overall, GDP, household income, and welfare all increase following tax reform, but at the sectoral level there are winners and losers. That is, some households might have more income from paying less tax, but other households might

Table 7. CGE Sensitivity Results

Macro

	Household income (Percentage change)	GDP (Percentage change)	Exchange rate (Percentage change)	Equivalent variation ($ million)			Trade balance ($ million)
				Allocative efficiency	Terms of trade	Investment	
U.S.	−0.38	0.01	1.36	2,568.74	183.30	618.43	2,869
ROW	[-0.45,-0.36]	0	[-0.45,-0.36]	273.94	−183.75	−618.41	−2,869

Sectoral (percent change)

	U.S.				Rest of the World			
	Primary agriculture	Processed agriculture	Investment sectors	All others	Primary agriculture	Processed agriculture	Investment sectors	All others
Production	−0.09	0.23	0.02	0.02	0.01	−0.01	0.01	0.00
X/P	18.21	7.87	3.63	6.36	Not reported			
Prices	−0.17	−0.61	−0.41	−0.37	−0.38	−0.35	−0.39	−0.40
Exports	−0.54	0.64	−0.34	0.01	0.14	−0.05	0.04	−0.01
Imports	0.79	−0.22	0.11	−0.02	−0.03	0.02	−0.02	0.00
Endowments								
Land price	4.59	No land used			Not reported, but available upon request from the authors			
Labor use	−0.24	−0.72	−0.09	0.05				
Labor price	0.33	−0.39	−0.39	−0.40				
Capital use	−0.24	1.66	0.47	−0.15				

need to find employment outside of agriculture if jobs are lost to other sectors. Although the focus is on agriculture, we consider all economic agents to properly model a country-wide tax reform. Doing so highlights the fact that the impacts of lower taxes hinge on a couple of factors: how much foreign investment will take place, and who is able to capture limited resources.

Our results indicate that primary agriculture might face a decline in production following tax reform, as resources such as labor and capital move to other sectors. The agricultural-specific results indicate that producers who would pay lower taxes in the reform are not necessarily the ones who are harmed the least; rather, foreign demand seems to be one of the main determinants of the gains to any sector. Further, lowering taxes does not induce consumers to purchase agricultural products. Consumers do not purchase primary agricultural products; rather, they indirectly demand those products through consumer purchases of processed agriculture. But only *beverages & tobacco* has an increase in demand, as reducing taxes in a high income country will lead the average consumer to spend less on food and more on manufacturing and services. Corporations in agriculture are small in number, but they hold a large share of production value. Tax reform that benefits them more than individual owners could push agriculture (and other sectors) into more corporations. But it is difficult to ascertain just who would switch since personal income rates also come down in the tax reform simulation. Ultimately, the issue is a complicated legal decision as outlined by some advantages and disadvantages in Backman (2015). Auerbach and Slemrod (1997) note that financial innovation, that is, new accounting and reclassification, were major outcomes of the 1986 tax reform.

This study adds to the tax reform debate by teasing out the sectoral heterogeneity of impacts, albeit with some caveats. There are many intricacies in tax law that we do not consider because our CGE framework considers economic behavior in terms of representative producers and consumers. We do not consider changes in the estate tax due to the difficulty in ascertaining the number of farms that pay this penalty each year. Although the majority of farms will not pay an estate tax (USDA ERS 2017b notes the percentage for 2016 is 0.42%), those that do could potentially need to sell off assets (such as land). Doubling the exemption will exempt more farms, thus potentially freeing up assets that might have had to been sold. Unlike other work, our analysis does not present results using baseline projections of changes in the economy (e.g., GDP, population). The model we use here is a static model, which shows how the economy would be impacted at one reference point after tax reform. Nevertheless, our model does incorporate information that has not been presented by others, namely the impacts to specific sectors. We focus on the impacts to primary agricultural sectors, with detailed external survey data bringing richness to our modeling. Further work should strive to provide the same level of detail for non-primary agriculture sectors.

Finally, our results note some of the things not readily considered in the current tax debate. There will be winners and losers across sectors, as resources are finite. As some have cautioned that certain households might pay more in taxes, we caution that some businesses will be affected due to certain sectors paying less in corporate taxes. Our results also show that investment plays heavily in garnering macroeconomic gains, an issue highlighted by Paul Krugman and others (NYTimes 2017).

Supplementary Material

Supplementary material are available at *American Journal of Agricultural Economics* online.

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