Production and Trade Impacts of Tax Reform

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*The views expressed here are solely the authors' and do not necessarily reflect those of ERS, USDA, or the USITC

Abstract

Estimates of tax reform's impacts usually provide an economy-wide assessment, 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 tax reform. Focusing on agriculture, we use survey data to calculate the tax rates faced by primary agriculture producers; and IRS data to capture tax rates for all other producers. Conducting a tax reform scenario that lowers taxes for individuals and corporations, we find that impacts on investment weigh 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. These results highlight the demand saturation for products, especially for food, in the United States. As such, we provide an extension of the tax reform scenario, equalizing tariffs faced by U.S. agricultural producers with global tariffs. Those results indicate that foreign market access, coupled with tax reform, provides benefits to the entire economy, especially agriculture.

Things as certain as death and taxes, can be more firmly believ'd.
— Daniel Defoe, The Political History of the Devil, 1726.

Tax reform has been a subject of perennial interest both for its political economic 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 piece of legislation, rates have gradually risen and Congress has passed nearly 15,000 changes to the tax law (Birnbaum, 2006). None of these changes have been of the magnitude of the 1986 reform, as explained by the popular press.[1] Major tax reform has been proposed many times since then; in particular, corporate taxes and individual taxes are often discussed, with the change in taxes dependent on which political party is in power. The current political debate surrounding tax reform purposes to reduce taxes and streamline the process in filing taxes by reducing many deductions. Reducing tax rates could help businesses that pay something close to the 35 percent corporate rate.[2] However, several major industries that could lose out include those that deduct interest payments, expense their equipment and research, and transfer profits to foreign jurisdictions with lower rates. Agriculture is one such sector, as some farmers could end up paying higher taxes if certain deductions are eliminated in the current tax reform proposal (Fleming, 2017).

Alternative analytical methods have been employed to assess the impact of 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 effects of eliminating the corporate income tax altogether (Fehr et al., 2013) or 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 is not exactly

suitable for the political environment interested in short- to medium-term (no more than 8 year) impacts. Recognizing the inherent shorter 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., 5-8 years). Indeed, one of the earliest uses of these models was in the early 1970s to analyze the economic effects of changes in taxation (e.g., Keller, 1980; Shoven and Whalley, 1984). In a well-cited example, Ballard et al. (1985) investigate the marginal excess burden of U.S. taxes, providing information on several different types of taxes (e.g., corporate taxes, property taxes, social security taxes).

In terms of previous analysis of taxes and agriculture, Hanson and Bertselen (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 estimate the impacts of tax reform on agriculture. Boyd (1988) used a similar model as Ballard et al. (1985), but his 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; and 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 individual 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 individual level;[3] however, there are farms that are owned

by corporations. For non-corporate farms, lower individual tax rates are just one impact. Tax reform that lowers corporate taxes would affect producers such as agricultural processors, changes in their production and prices could transmit through the agricultural supply-chain to all producers. Clayton (2017) notes that non-corporate farmers could look at restructuring, because the proposed tax plans do not match lower individual income tax rates with the lower corporate rates. 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 in turn, U.S. agriculture.

To consider how 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. ARMS provides information on farm type (family farm, individual, corporations) and farm household income. With that information we calculate tax rates with distinctions for corporations versus non-corporate farms. To complete the entire economy, 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 then implement these rates into our CGE model, providing several data and modeling changes to improve the inner workings of the model. We then conduct a tax reform policy scenario. Our scenario is similar to those currently purposed, but with differences in the change in the corporate tax rate (15 percent versus 20 percent). The results of this reform indicate that agriculture could have production losses as resources are reallocated to other sectors. To illustrate how agriculture might gain from tax reform, we then present a scenario of tax reform and market access for U.S. agriculture

globally. Those results highlight the need to provide new markets for products, as demand is highly saturated for products, especially for food, in the United States.

CGE data and model

Computable general equilibrium models have been one of the main tools in analyzing tax reform, due to their ability to take into account inter-sectoral and global linkages in estimating economy-wide impacts. Although it is likely that most, if not all, of the CGE models mentioned in the literature have 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. Although one of its earliest uses was to model tax reform in the 1970s and 80s, the GTAP model has most recently been used for other topics such as trade policy analysis and climate change impacts. As such, work must be done to prepare the model for tax reform. In addition, the information for U.S. taxes is outdated (derived from U.S. tax statistics for the year 1997) and not inclusive of all taxes (Gurgel et al., 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 GTAP Database Version 10, which has a baseline of 2014. This database contain average tax information about primary factors, i.e., 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 personal income taxes fall on labor at the household level, i.e., theses taxes are viewed as income taxes. Corporate taxes fall on land, other natural resources and capital at the household level too. Social security contributions fall on labor at the sector level,

i.e., 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.

<insert table 1 here>

Our work validates those tax rates in GTAP by providing detailed information on tax incidences in the U.S., particularly for agriculture. We use ARMS,[4] which provides information on various tax components for our primary agricultural sectors (see Appendix A for the regional aggregation for the model. We keep all 57 GTAP sectors disaggregated, to provide richness for our modeling). Specifically, we utilize the total household income calculation that combines income from different sources (figure 1). On-farm incomes includes income, and other aspects that could be modified in the tax reform scenario (interest expense). 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.[5]

<insert figure 1 here>

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, wool, is shown later). Certain ARMS sectors needs to be aggregated to fit into our CGE database. For example, the GTAP sector 'coarse grains' is composed of barley, corn, oats, and sorghum. Average household incomes 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 in 2013. 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 tax rates listed in table 3 (we assume households filed as joint). The amount of tax applied is also a function of the type of farm for legal status.

<insert table 2 here>

<insert table 3 here>

The resulting tax rates for farm households are indicated in table 4. Our average tax rates for primary agriculture are in-line with those estimated by Williamson and Bawa (2018). Using data from 2015, and focusing on tax rates by farm size distribution, they calculate an average rate of 18.1 percent for all of primary agriculture. The rate calculated here is 19.1 percent (weighted by production value). The percent difference is likely due to higher farm income in 2013 ($123.8 billion) versus $81.4 billion in 2015 (ERS, 2017).

<insert table 4 here>

Table 2 also 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 et al., 2013). Like household income, there is also significant variation within this observation, 5 of the sectors have less than 1 percent of farms held by C-corporations, while 4 have more than 3 percent in C-corporations. To calculate the tax rate for agricultural corporations, and other non-agriculture sectors, we use aggregations of tax calculations and reforms in the non-agriculture and trade/investment side. The baseline tax rates for corporations are shown in Appendix B. These tax rates are derived from data from the Internal Revenue Service (IRS), specifically, the Returns of Active Corporations (i.e., 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 percent. 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 often cited 35 percent tax on corporations. Some sectors, in fact, have tax rates less than 10 percent. Processed agricultural products are taxed at a higher rate than primary agriculture, the tax rate calculated from IRS data is 24.83 percent.

Reallocating taxes

Once we arrive at the actual tax rates to be used in our baseline, work is done to change the structure of the taxes to more realistically portray 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 be specified on one factor to facilitate the specification of the tax reform scenario by being able to shock unique tax instruments (for example, personal income tax and social security contributions are not both taxed on labor income at the household level, otherwise the two taxes would have to be aggregates into a single tax).

First, the application of household income taxes is made to all factors other than labor; as 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. This shift is 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 percent) is the same for all sectors since we have no information on sector-specific differences. This 15.38 percent rate is essentially the baseline income tax rate in the GTAP database.

Next, we need to account for 'double taxation', i.e., individuals being taxed through corporations and individual 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 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 percent), which includes social security, medicare, and any other additional withholdings. The "all other factor taxes" portion of the initial tax setup (3.30 percent) are removed from the new tax setup since it is not clear what these taxes represented. The final group 'agricultural subsidies' are taken as given in the baseline. These subsidies can be applied to the same factors as taxes, since they have the opposite sign of taxes.

Model

Given the complex links and interactions between agricultural commodities, competition among these commodities (and non-agriculture commodities) for limited economic resources, and interactions between production, consumption, and trade activities, an economy-wide CGE modeling approach provides an appropriate framework to analyze the impacts of tax reform. Once we validate the tax rates in our baseline, we then consider a tax reform scenario. Changes in the tax system for our scenario include lowering the statutory corporate tax rate to 15 percent, from 35 percent, and eliminating interest deductions. We also consider reforms to individual tax

brackets, these rates are all shown in table 3. To introduce the new tax rates into the model, we must calculate the new tax rates that will be faced by primary agricultural producers. To do so, we remove the interest expense from table 2 (i.e., increasing farm household income) and recalculate tax rates based on the brackets shown in table 3. 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 remove the interest expense deduction and calculate a new tax rate based on that amount. Since we add this deduction back to taxable income, if the resulting tax rate is greater than 15 percent, we ultimately cap the rate at 15 percent.

The new household tax rates are presented in table 4 for primary agriculture, Appendix C shows the corporate tax rates. As shown, tax reform would lower tax rates for almost all sectors; in particular, the household tax rate for primary agriculture would decrease to an average of 14.05 percent. In this instance, only sugar cane/beet and plant fiber producers would pay over 20 percent. Most primary agricultural sectors would actually have a rate less than 15 percent, coarse grains is the only other commodity besides the two previously mentioned with a rate greater than 15 percent. The tax rate on processed agricultural products decreases to 15 percent, which should have an impact on demand for primary agricultural products. As mentioned, almost all sectors have a decrease in their tax rate, the only exception are those non-ag sectors with a very low initial tax rate. Secondary energy products (petroleum/coal products, electricity, and gas manufacturing/distribution), wood products, construction, business services, and dwellings have an increase in their tax rate due to the addition of the interest expense to their income.

<insert table 4 here>

As was discussed in the earlier section, we focus our tax reform scenario on primary agriculture taxes that are a part of personal and corporate income taxation. We do not change social security contributions and 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. Personal income tax rates were lowered from 15.38 percent to 11.01 percent. This calculation was derived by calculating the difference in taxes faced by primary agriculture (the tax reform compared to the baseline), and applying that difference to the initial personal income tax for all households embedded in GTAP (15.38 percent).

CGE results

We first review the macroeconomic results to understand the economy-wide results. In addition, these results provide insight into what we can expect in the sectoral impacts. Before delving into the results, we would like to point out that the results essentially hinge on what is assumed for investment.[6,7] 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 investment), the larger the investment community sees the investment opportunity in that country. Unfortunately, the parameter (known in GTAP as: RORFLEX) does not have an econometric basis. To provide confidence in our results, we calibrate the parameter to the change in household income resulting from tax reform. That is, the current tax reform proposal has cited a potential increase in income of $1,182 per household. According to the Census Bureau, average U.S. household income was

$59,000, which would give a change in income of 2 percent. Without any additional external data to base this parameter on, we tie the RORFLEX parameter to household income change.

Another point of concern is investment decisions. If the U.S. becomes an attractive option for foreign investment due to tax reform, resources would flow to certain sectors where investment occurs and away from others. It is possible that this pull from investment is even stronger than the demand-side benefits of lowering taxes. The results could be potentially devastating to sectors in which taxes and investments changes are relatively small as in the case of primary agricultural sectors. To prohibit resources from moving out of primary agriculture, we provide a modeling change that makes labor and capital movement across agricultural versus nonagricultural somewhat rigid, i.e., not perfectly mobile. This is akin to the segmentation of labor markets for farm versus non-farm sectors in Keeney and Hertel (2005).[8]

Macroeconomic impacts

The calibration of the model to the potential tax reform scenario induces a 2 percent change in U.S. household income (table 5). Other macroeconomic impacts are also shown in table 5. 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 -1.67 percent and the smallest decrease at -1.05 percent. U.S. GDP (in real terms) increases by almost a quarter of a percent, while 3 of the 14 other regions have no change; but most experience a modest decrease.[9] Interestingly, Canada is one of those regions with the largest decrease (-0.04 percent), while the other North American Free Trade Agreement (NAFTA) partner, Mexico, had no change in GDP. The U.S. dollar strengthens by 4.63 percent 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 1981 tax reform as an example of how exchange

rates can adjust after pro-growth tax reform.[10] Finally, we also report changes in welfare using the equivalent variation (EV) measure, with a decomposition allocating the change in welfare to three activities: 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 U.S., welfare increases by $58 billion under our tax reform scenario. About half of this is from terms of trade, while investment captures 30 percent of welfare and allocative efficiency the other 20 percent. Notice that welfare results for the ROW largely mirror the welfare changes in the U.S. (except with decreases), their total welfare loss is $60 billion.

<insert table 5 here>

Finally, our model tracks changes in tax spending. The results indicate that tax revenue would decrease by $633 billion. For comparisons, the Joint Committee on Taxation (JCT) projects that the House of Representatives tax reform proposal will increase the deficit by $1.487 trillion.[11] There are a handful of differences in our tax estimates, as we do not consider all the changes that JCT do (e.g., the elimination of the estate tax). The biggest difference, however, is in our time horizon. The JCT calculations project out until 2027, while our work is a static shock (i.e., no demand and income growth projections). Their shorter-term projection to 2022 ($921 billion) is more in-line with our estimate.

Sectoral impacts

The macro results highlighted the importance of investment to the U.S. economy. Here we provide micro-level results, with particular attention on agriculture and those commodities that that feature in investment.[12] The second half of table 5 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 normal and luxury goods, not for inferior goods such as primary agriculture; the majority of primary agriculture is used as inputs into production by processed agriculture sectors, whose production increase is very small. 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 ag increases the price of those goods (on average, a quarter of a percent), making imports more attractive (an increase of 1.95 percent).

The overall change in the price of land for primary agriculture is -2.19 percent (only primary agriculture uses land). The decrease in oilseeds production highlights the importance of the 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, the price of land used by oilseeds producers decreases by 5.10 percent. The main destination for oilseeds is vegetable oils, which is one of the sectors that actually has an increase in exports. These exports tend to be priced lower than domestic sales (note the change in price of vegetable oils is -1.63 percent), which decreases the attractiveness of oilseeds in agricultural production (hence the relative larger decrease in land prices). The price of labor (i.e., the wage rate) decreases for agriculture, as there is less of a demand for that resource. There are increases in the price of labor in all other sectors, due to competition. Labor use only increases in

the investment goods group; however, close competition with processed agriculture and all others leads to an overall increases in wages of about 2 percent.

The sectoral results show that investment goods have the largest production gains, despite a decrease in exports. First, investment goods have the smallest share of production allocated to exports (domestic consumption is large) and they are the most attractive to foreign investment. Table 6 provides detailed information on impacts across all sectors.[13] Of the four sectors that comprised the investment goods grouping in table 5, production slightly decreases for motor vehicles, machinery and equipment; but there are increases for trade, and construction. Indeed, the 4.77 percent increase in construction is essentially driving the result for investment goods. Construction is responsible for 50 percent of investment, thus the reduction in taxes leads to an increase in investment; in particular, 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 rate well below the proposed change in corporate tax rates.

<insert table 6 here>

Table 6 can also shed 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 who has a smaller decrease in exports and where imports are increased. For example, coarse grains (barley, corn, oats, and sorghum) have the smallest reduction in production (note that milk actually has an increase in production) as they also have the smallest

decrease in exports. Wheat has one of the largest decreases in production, which is because of an increase in imports, not necessarily taxes on that sector. Of the processed food products, meats and vegetable oils have an increase in production; while processed foods, rice, and sugar have decreases. This is, again, largely a result of increases in foreign demand, not domestic demand.

U.S. bilateral trade in primary agricultural products

This last set of results explores the trade changes discussed in the previous section. That is, we look at changes in U.S. bilateral trade in primary agricultural products. These results (shown in table 7) echo those aggregate changes for each sector. U.S. exports to all regions in the model for all primary agricultural commodities decrease. The decreases are smallest (in percentage change terms) for the NAFTA partners, especially for Mexico (which has more than $500 million of exports to the U.S. for several products, indicated by an asterisk). Regions that are further away, or that do not have a free trade agreement with the U.S. have the largest decreases in exports. On the other hand, the U.S. has an increase in imports of primary agricultural products from almost all regions. The exception is a decrease in oilseeds from several regions. These increases, however, tend to be of a smaller magnitude than the decreases in exports.

<insert table 7 here>

Market access with tax reform

The results of our tax reform analysis indicate that sectors which comprise investment have production gains, which pull resources for other sectors, in particular agriculture. Along with agriculture making up a small share of investment, agriculture is impacted by the fact that U.S. consumer demand is already highly saturated. Increasing incomes with tax reform does not stimulate demand if demand is inelastic with respect to income. Further, the appreciation of the dollar makes the U.S. relatively less competitive in the global market. Global agricultural trade

in primary commodities is characterized by markets that are highly competitive. The dollar appreciation could price U.S. products out of some countries. Earlier tax reform discussions (i.e., the border adjustment debate) centered around making the United States more competitive in the global market. For agriculture to gain the same macroeconomic benefits as other sectors (e.g., investment goods), increases in demand for U.S. goods, i.e. overseas market access, is critical. As such, we present a scenario that would make U.S. agriculture more competitive internationally: tax reform coupled with market access where the playing field is leveled for U.S. agriculture, globally. World Trade Organization (WTO) *World Trade Profiles* indicates that the simple average tariff on agricultural imports into the U.S. was 5.2 percent in 2016. The average for all other countries is 14.8 percent. This scenario considers the equalization of these two rates for primary agriculture plus meats and vegetable oils. We do not apply the shock to processed food products and beverages and tobacco since not all of those products are included in the standard definition of agricultural products.[14]

Table 8 shows the impacts to those agricultural sectors, with results given for production, prices, and trade. In addition, macroeconomic changes for the U.S. are presented. Starting with those results, there is an increase in U.S. household income (compared to only tax reform), as sectors that were likely losing jobs are now experiencing an increase in production. This leads to an increase in the wage rate (5 percent) greater than that from tax reform alone. U.S. agricultural production increases for all sectors. Many have increases of more than 5 percent, in total, U.S. agricultural production increases by 3.64 percent in this scenario. The increase in demand for agricultural products does pull resources from non-ag, all these other sectors have a decrease in production of 0.34 percent. There is a smaller increase in GDP compared to only tax reform, a result directly tied to a smaller increase in investment from this scenario. This occurs because the

increase in global demand for U.S. agricultural products (22.26 percent) increases the price of resources. This increase makes investment less attractive as it is relatively more expensive to produce these products. However, along with higher household income, the U.S. also has an increase in welfare of almost $30 billion compared to the tax reform scenario. The welfare decomposition indicates that this result is largely due to an increase in terms of trade for the U.S., as tariffs on agriculture products become level with the world.

<insert table 8 here>

Policy implications

Tax reform impacts have been found to be 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 proposed tax reform on agricultural sectors. Overall, GDP, household income, and welfare increase following tax reform, but at the sectoral level there are winners and losers. That is, households might have more income from paying less taxes, but they might not have employment. Although the focus is on agriculture, to properly model a country-wide tax reform, we must consider all economic agents. 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 manufacturing. 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

themselves, rather they are indirectly demand through consumer purchases of processed agriculture. Some processed agriculture products do have an increase in demand; however, reducing taxes in a wealthy country will lead consumers to spend less on food and more on manufacturing products. 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. Auerbach (1997) notes that financial innovation-new accounting, reclassification, was a major outcome of the 1986 tax reform.

This paper adds to the tax reform debate, but it should not be considered as representing exactly what will happen under reform. There are many intricacies in tax law that we could not consider due to the complex nature of CGE modeling. For example, we do not consider changes in the estate tax, nor do we consider taxes by income distribution since the CGE model only portrays average households. Further, most analysis of tax reform presents 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. Nevertheless, our model does incorporate information that has not been presented by others, namely the impacts to specific businesses. 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 has cautioned that certain households might pay more in taxes, we caution that some businesses will fail due to certain sectors paying less in corporate taxes. These are the sectors that tend to be highly sought after for investments. In addition, U.S. demand for certain (if not all) products is

saturated. An analysis by Page et al. (2017) found that tax legislation would increase aggregate demand, but we caution that demand might not increase by as much as they envision. For example, how many phones can one person have, or how much beef can one person eat? As such, we present an additional scenario that stimulates foreign demand for U.S. agricultural products. Agriculture was one of those sectors harmed by tax reform, due to low demand for products domestically and the reallocation of resources to non-agricultural sectors. However, by equalizing foreign tariffs with those in place in the U.S., agriculture would find new export opportunities and be one of the winners of tax reform.

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[1] E.g., Bloomberg: It's Been 31 Years Since the Last Tax Overhaul. Here's Why. Tax Foundation: A Lot Has Changed in the 27 Years Since the Last Major Tax Reform.

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

[3] Williamson et al. (2013) note that 96 percent of farms are taxed under the provisions of the individual income tax.

[4] 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).

[5] 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.

[6] 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.

[7] This is essentially the ongoing debate between Krugman and Gravelle. For an example, see New York Times: The Gravelle Geardown (Wonkish).

[8] They note that "if labor and capital were perfectly mobile between agriculture and non-agriculture, as is commonly assumed in applied general equilibrium models, then we would expect to see wages equalized at each point in time for farm and non-farm workers with comparable skills."

[9] This quarter of a percent is lower than what is predicted by the White House and other politicians. Wilbur Ross (Secretary of Commerce) is calling for a 1 percent increase, but notes that this will only occur if: the government can get tax reform "right". He also notes that Americans spend 6 billion hours on filing taxes, thus productivity could increase if taxes are simplified (CNBC, 2017). This potential boost in productivity is not modeled in our work.

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

[11] Estimated Revenue Effects Of H.R. 1, The "Tax Cuts And Jobs Act," Scheduled For Markup By The Committee On Ways And Means On November 6, 2017.

[12] The sectoral results in table 6 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 percent of investment: Machinery and equipment nec, motor vehicles and parts, construction, and trade. These four sectors are those represented by the 'investment goods' category.

[13] Not all can be shown due to space limitations. Those missing are: wool, fishing, forestry, and public administration, defense, education, health. Those results are available upon request from the authors.
[14] See Beckman et al. (2017) for a comparison of United States Department of Agriculture's (USDA) definition of agricultural products and the WTO definition.

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Table 1. U.S. factor taxes in GTAP database

Baseline

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
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		

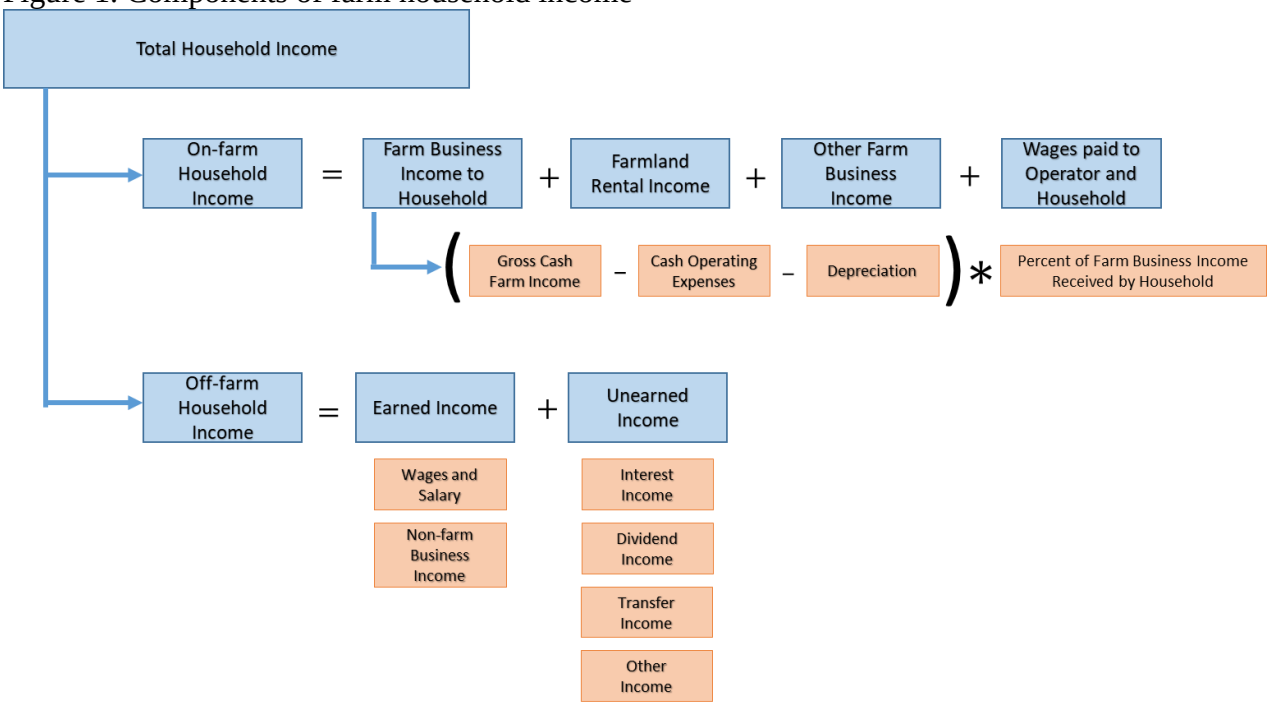
New tax structure for the CGE model

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
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 the modeling

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
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

	Interest expense	Average household income	Property & estate tax %	C-corporation	
				% of farms	% of value
paddy rice (pdr)	15,482	149,199	0.96	0.83	1.98
wheat (wht)	8,325	170,634	0.34	3.32	8.70
coarse grains[1] (gro)	12,751	217,286	0.43	3.19	5.37
veg & fruit (v_f)	6,813	152,584	0.67	3.45	16.04
oilseeds[2] (osd)	7,092	163,346	0.43	1.44	3.94
sugar cane/beet (c_b)	14,689	N/A	0.65	0.43	6.38
plant fibers[3] (pfb)	19,400	290,408	0.43	0.95	0.99
other crops[4] (ocr)	2,306	97,981	0.55	0.90	26.21
cattle[5] (ctl)	2,353	96,450	0.39	0.80	18.32
other animal products[6] (oap)	8,698	120,171	0.46	1.99	4.55
milk (rmk)	19,189	147,723	0.56	3.28	9.12

Source: Agricultural Resource Management Survey (ARMS)

Notes: 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 parenthesis.

Table 3. Tax rates used for the base and model experiment

2013 Tax rates		Model scenario	
Individuals		*Individuals*	Tax rate
$0 to $17,850:	10%	$0 to $146,400	12%
$17,850 to $72,500:	15%	$146,400-$223,050	25%
$72,500 to $146,400:	25%	$223,050+	33%
$146,400 to $223,050:	28%	*Corporate*	15%
$223,050 to $398,350:	33%	Eliminate interest expense for farm	
$398,350 to $450,000:	35%	households and increase standard	
$450,000+:	39.60%	deduction from $12,000 to $24,000	

Table 4. Initial tax rates and tax rates under the reform for primary agriculture

	Initial tax rate (%)	Reformed tax rate (%)
paddy rice (pdr)	19.48	12.58
wheat (wht)	20.04	13.72
coarse grains (gro)	21.76	16.20
veg & fruit (v_f)	18.78	12.55
oilseeds (osd)	20.06	13.07
sugar cane/beet (c_b)	28.58	25.30
plant fibers (pfb)	24.73	20.56
other crops (ocr)	15.86	12.79
cattle (ctl)	16.01	12.55
other animal products (oap)	18.01	12.14
milk (rmk)	18.95	12.92
wool (wol)*	13.54	15.00

Source: Tax calculations based on ARMS and IRS (2017)
Note: * = information is from IRS (2017); ' = calculations are based on their income subject to tax.

Table 5. CGE model results

Macro

	Household income (% change)	GDP (% change)	Exchange rate (% change)	Equivalent Variation ($ million)		
				Allocative efficiency	Terms of trade	Investment
U.S.	2.03	0.24	4.63	11,455.78	28,988.33	18,169.60
ROW	[-1.67,-1.05]	[-0.04,0]	[-1.63,-1.02]	-12,684.92	-29,265.48	-18,136.78

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	-0.88	0.17	1.74	-0.46	0.13	0.08	-0.31	0.17
X/P	18.21	7.87	3.63	6.36	Not reported			
Prices	0.23	-0.29	0.72	0.78	-1.31	-1.17	-1.31	-1.30
Exports	-3.05	-4.56	-10.23	-7.38	0.64	0.47	1.42	0.96
Imports	1.95	2.43	6.63	3.37	-0.12	-0.18	-0.59	-0.26
Endowments								
Land price	-2.19	No land used						
Labor use	-0.95	-1.51	1.40	-0.49	Not reported, but available upon request from the authors			
Labor price	-0.26	2.01	2.01	1.79				
Capital use	-2.00	3.03	3.84	0.13				

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

Table 6. Commodity specific results for the United States (percent change)

	Production	Prices	Exports	Imports
paddy rice	-1.23	-0.18	-4.20	6.37
wheat	-2.31	-0.44	-4.19	2.67
coarse grains	-0.37	0.62	-2.31	2.29
veg & fruit	-0.90	0.01	-3.18	1.64
oilseeds	-2.01	-0.44	-2.41	0.29
sugar cane/beet	-0.80	1.35	-7.99	6.55
plant fibers	-3.38	0.05	-3.80	2.32
other crops	-2.00	0.13	-6.99	2.75
cattle	-0.79	0.58	-5.30	2.46
other animal products	-0.66	0.15	-2.73	1.59
milk	0.29	0.51	-12.26	7.59
bovine meat	0.10	-1.47	0.99	-0.29
other meats	1.35	-1.67	3.79	-0.62
vegetable oils	1.27	-1.63	3.19	-1.95
dairy products	0.45	-0.69	-0.95	-0.60
processed rice	-0.52	0.38	-8.39	5.88
processed sugar	-0.87	0.36	-8.94	6.04
processed food products	-1.82	-0.27	-4.54	1.56
beverages & tobacco products	0.29	-0.18	-6.02	4.71
coal	-1.07	-0.25	-4.01	2.34
oil	-0.87	0.42	-5.75	2.81
gas	0.43	-0.47	-2.34	2.21
petroleum, coal products	1.16	-1.00	-0.60	1.47
electricity	-2.69	0.74	-10.17	5.30
minerals	-6.23	0.54	-12.77	2.91
textiles	2.57	1.46	-13.54	11.01
wearing apparel	-1.02	1.23	-9.55	6.27
leather products	0.18	-1.18	-0.11	-0.20
wood products	-3.67	0.76	-9.47	4.09
paper products	1.05	0.96	-10.19	6.96
chemical, rubber, plastic	-2.22	0.81	-8.48	4.56
mineral products	-2.10	-0.72	-3.86	-0.04
ferrous metals	-0.48	0.96	-11.88	8.92
metals nec	-1.40	0.73	-9.32	6.03
metal products	-5.52	0.30	-9.73	2.98
motor vehicles and parts	-3.24	0.73	-9.95	6.15
transport equipment	1.08	0.59	-12.39	10.58
electronic equipment	-5.06	0.66	-11.70	4.18
machinery and equipment nec	-0.05	0.77	-9.03	5.67
manufactures nec	-0.69	1.23	-12.48	6.83
water	0.28	0.07	-6.64	4.64
construction	4.77	1.42	-10.55	11.69
trade	0.78	0.34	-5.80	3.68
transport nec	-0.36	0.91	-6.72	3.63
water transport	0.80	-1.52	0.74	0.31
air transport	0.30	-1.29	0.15	0.01
communication	1.78	-1.82	1.81	0.64
financial services	0.18	1.03	-7.25	5.72
insurance	0.07	0.50	-5.57	3.57
business services	-0.12	1.45	-9.31	5.52
recreational & other services	-0.01	0.88	-6.89	4.19
dwellings	-1.83	3.29	-1.83	-1.83

Table 7. Percent change in U.S. bilateral trade in primary agricultural products

Exports	Canada	Mexico	Argentina	Brazil	RestOfAmerica	Australia	NewZealand	Japan	Korea	China	India	RestOfAsia	EU	Rest Of World
paddy rice	-9.51	-0.13	-8.35	-11.73	-6.88	-10.53	-10.77	-11.29	-10.92	-10.05	-10.05	-8.73	-10.14	-9.87
wheat	-4.26	-2.68*	-6.64	-3.46*	-3.06*	-6.77	-6.02	-2.84*	-4.19	-5.30*	-7.11	-5.00*	-6.26	-6.20*
coarse grains	-1.73	-1.08*	-3.37	-4.29	-2.29*	-3.96	-2.38	-1.30*	-3.18*	-2.85*	-4.52	-4.01*	-4.31	-4.29*
veg & fruit	-1.58*	-1.22*	-4.47	-4.20	-3.56*	-3.58	-3.74	-3.66*	-3.13*	-3.88*	-4.19*	-3.78*	-4.50*	-4.58*
oilseeds	-1.40	-1.12*	-2.51	-3.21	-2.16	-3.19	-2.93	-2.29*	-2.63	-2.36	-3.79	-2.77*	-3.25*	-3.35*
sugar cane/beet	-7.20	-10.65	-13.39	-13.67	-12.25	-13.19	-13.14	-13.33	-13.16	-13.29	-13.44	-12.73	-13.36	-13.50
plant fibers	-4.89	-0.73	-6.03	-5.17	-1.74	-5.07	-5.75	-3.98	-3.96	-4.45*	-4.52	-4.18*	-5.62	-5.67
other crops	-6.68	-7.40	-8.58	-8.97	-7.79	-8.64	-7.72	-6.71*	-5.76	-6.27	-8.25	-7.65	-8.39	-8.17
cattle	-3.69	-3.59	-6.22	-5.75	-7.08	-5.29	-4.80	-5.03	-4.25	-6.31	-6.34	-4.29	-6.87	-5.01
other animal products	-1.69*	-2.32	-2.74	-2.82	-2.64	-3.66	-2.92	-3.18	-2.05	-3.08*	-3.53	-2.98	-3.51	-3.28
milk	-11.11	-10.06	-13.06	-13.11	-12.65	-12.26	-11.49	-11.91	-12.22	-12.70	-12.35	-12.40	-12.66	-12.78

Imports	Canada	Mexico	Argentina	Brazil	RestOfAmerica	Australia	NewZealand	Japan	Korea	China	India	RestOfAsia	EU	Rest Of World
paddy rice	2.05	-1.86	5.67	7.81	4.87	7.56	5.30	6.22	4.94	5.49	6.29	5.16	5.76	6.69
wheat	2.56*	2.41	3.61	4.70	2.65	4.58	4.42	3.36	2.59	4.59	4.41	3.59	4.71	4.93
coarse grains	1.97*	1.38	2.83	3.34	2.45	2.95	2.61	2.43	2.10	2.61	2.99	2.60	2.87	3.10
veg & fruit	1.58*	0.73*	2.94	3.30	2.38*	3.27	2.54	2.73	2.03	2.40	2.82	2.27*	2.65	2.92*
oilseeds	-0.36*	-0.76	0.50	1.00*	0.13	0.86	0.59	0.77	-0.13	0.40	0.90	0.40	0.74	1.16
sugar cane/beet	6.64	4.11	7.79	7.52	6.81	6.93	5.93	6.86	5.71	6.42	7.10	6.35	6.50	7.02
plant fibers	1.63	0.05	3.05	3.16	1.69	3.39	2.93	2.60	1.42	1.78	1.55	1.54	2.51	2.91
other crops	1.53*	1.49	4.01	4.36*	2.51*	4.49	2.64	3.25	2.95	2.05	3.21	2.27*	3.06*	3.24*
cattle	2.45*	1.55*	4.79	4.89	4.31	3.13	3.19	3.57	2.43	3.12	3.75	3.70	3.87	4.19
other animal products	1.13*	0.62	1.99	2.29	1.90	2.30	1.79	1.82	1.38	1.91	2.05	1.76	1.96	2.09
milk	5.53	3.43	8.24	9.00	7.10	7.89	6.51	7.10	5.87	6.67	8.00	6.14	7.15	7.36

Note: * represents trade of more than $500 million in the baseline.

Table 8. Results of tax reform and U.S. agriculture market access (percent change)

	Production	Prices	Exports	Imports
paddy rice	6.12	4.35	18.74	37.30
wheat	9.03	5.80	20.80	33.03
coarse grains	2.71	3.09	7.88	6.94
veg & fruit	2.05	2.68	16.98	5.83
oilseeds	7.44	5.28	9.99	18.70
sugar cane/beet	2.09	4.51	13.54	18.94
plant fibers	8.30	5.94	11.48	13.11
other crops	0.23	2.94	36.79	9.04
cattle	2.08	2.93	20.90	10.86
other animal products	4.15	2.42	12.46	5.17
milk	2.72	2.74	44.96	22.30
wool	11.48	6.19	34.16	2.10
bovine meat	2.23	1.98	39.13	16.72
other meats	5.52	1.99	42.68	16.71
vegetable oils	7.73	2.75	31.63	9.88
dairy products	3.25	1.42	49.21	13.81
processed rice	6.96	1.07	34.68	6.38
processed sugar	2.33	1.82	28.45	9.68
all other sectors	-0.34	1.89	-12.89	6.15
U.S. macro indicators			household income	2.47
			GDP	0.03
			welfare ($ million)	87,424.92

Appendix A. Regional mapping for the CGE model

Model region	GTAP region
USA	usa
Canada	can
Mexico	mex
Argentina	arg
Brazil	bra
RestOfAmerica	xna, bol, chl, col, ecu, pry, per, ury, ven, xsm, cri, gtm, hnd, nic, pan, slv, xca, dom, jam, pru, tto, xcb
Australia	aus
NewZealand	nzl
Japan	jpn
Korea	kor
China	chn, hkg
India	ind
RestOfAsia	mng, twn, xea, brn, khm, idn, lao, mys, phl, sgp, tha, vnm, xse, bgd, npl, pak, lka, xsa, tur
EU	aut, bel, cyp, cze, dnk, est, fin, fra, deu, grc, hun, irl, ita, lva, ltu, lux, mlt, nld, pol, prt, svk, svn, esp, swe, gbr, bgr, hrv, rou
RestOfWorld	xoc, che, nor, xef, alb, blr, rus, ukr, xee, xer, kaz, kgz, tjk, xsu, arm, aze, geo, bhr, irn, isr, jor, kwt, omn, qat, sau, are, xws, egy, mar, tun, xnf, ben, bfa, cmr, civ, gha, gin, nga, sen, tgo, xwf, xcf, xac, eth, ken, mdg, mwi, mus, moz, rwa, tza, uga, xmb, zwe, xec, bwa, nam, zaf, xsc, xtw

Appendix B. Initial corporate tax rates

	Tax rate %	*Manufacturing*	Tax rate %	*Services*	Tax rate %
Primary agriculture	13.54	minerals (omn)	26.95	water (wtr)	22.90
Processed agriculture		textiles (tex)	17.36	construction (cns)	5.97
forestry (frs)	7.80	wearing apparel (wap)	17.20	trade (trd)	23.10
fishing (fsh)	3.64	leather products (lea)	17.02	transport nec (otp)	12.23
bovine meat (cmt)	24.83	wood products (lum)	7.15	water transport (wtp)	34.93'
other meats (omt)	24.83	paper products (ppp)	14.33	air transport (atp)	34.93'
vegetable oils (vol)	24.83	chemical, rubber, plastic (crp)	14.50	communication (cmn)	24.81
dairy products (mil)	24.83	mineral products (nmm)	15.06	financial services (ofi)	18.32
processed rice (pcr)	24.83	ferrous metals (i_s)	15.06	insurance (isr)	24.56
processed sugar (sgr)	24.83	metals nec (nfm)	34.89'	business services (obs)	3.70
processed food products (ofd)	24.83	metal products (fmp)	14.95	recreational & other services (ros)	11.32
beverages & tobacco products (b_t)	25.00	motor vehicles and parts (mvh)	13.11		
Energy products		transport equipment (otn)	18.38	public adminstration, defense, education, health (osg)	23.90
coal (coa)	26.95	electronic equipment (ele)	9.58		
oil (oil)	26.95	machinery and equipment nec (ome)	20.20	dwellings (dwe)	4.78
gas (gas)	26.95	manufactures nec (omf)	20.20		
petroleum, coal products (p_c)	5.76				
electricity (ely)	5.76				
gas manufacture, distribution (gdt)	5.76				

Source: Tax calculations IRS (2017)

Note: ' = calculations are based on their income subject to tax.

Appendix C. Corporate tax rates under the reform

	Tax rate %	*Manufacturing*	Tax rate %	*Services*	Tax rate %
Primary agriculture	15.00	minerals (omn)	15.00	water (wtr)	15.00
Processed agriculture		textiles (tex)	15.00	construction (cns)	7.33
forestry (frs)	12.33	wearing apparel (wap)	15.00	trade (trd)	15.00
fishing (fsh)	4.03	leather products (lea)	15.00	transport nec (otp)	15.00
bovine meat (cmt)	15.00	wood products (lum)	9.57	water transport (wtp)	15.00
other meats (omt)	15.00	paper products (ppp)	15.00	air transport (atp)	15.00
vegetable oils (vol)	15.00	chemical, rubber, plastic (crp)	15.00	communication (cmn)	15.00
dairy products (mil)	15.00	mineral products (nmm)	15.00	financial services (ofi)	15.00
processed rice (pcr)	15.00	ferrous metals (i_s)	15.00	insurance (isr)	15.00
processed sugar (sgr)	15.00	metals nec (nfm)	15.00	business services (obs)	5.60
processed food products (ofd)	15.00	metal products (fmp)	15.00	recreational & other services (ros)	15.00
beverages & tobacco products (b_t)	15.00	motor vehicles and parts (mvh)	15.00		
Energy products		transport equipment (otn)	15.00	public adminstration, defense, education, health (osg)	15.00
coal (coa)	15.00	electronic equipment (ele)	15.00		
oil (oil)	15.00	machinery and equipment nec (ome)	15.00	dwellings (dwe)	7.98
gas (gas)	15.00	manufactures nec (omf)	15.00		
petroleum, coal products (p_c)	6.84				
electricity (ely)	6.84				
gas manufacture, distribution (gdt)	6.84				

Supporting online material

To illustrate how we calculate tax rates, we provide an example using the taxes faced by wheat producers. The corporate rate, based on IRS data is applied in the model at the 'corporate income tax' level illustrated in table 1. The individual tax rates are based on income brackets, in much the same way as a person's effective tax rate is calculated. Table 2 indicates that the average household income for wheat farmers was $170,634. Applying the 2013 tax rates shown in table 3, we arrive at the effective tax rate:

Tax rate	Tax bracket	Share of income	Share-weighted tax
10%	$0-17,850	10.46	1.05
15%	$17,850-72,500	32.03	4.80
25%	$72,500-146,400	43.31	10.83
28%	$146,000-223,050	14.20	3.98
		Sum	20.65

For the new tax rates after our tax reform scenario, we apply the same methodology; however, we have to account for some items in the reform that could affect household income. Of the items shown in figure 1, our tax reform scenario changes the interest expense, the standard deduction, and the tax brackets. First, we calculate the change in farm household income as:

$170,634 + $8,325 - $12,000 = $166,959

Initial household income + interest expense – difference in standard deduction = new household income

Our new average effective tax rate is then computed as:

Tax rate	Tax bracket	Share of income	Share-weighted tax
12%	$0-146,400	87.69	10.52
25%	$146,400-223,050	12.31	3.08
		Sum	13.60