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# The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment

Steven Zahniser, Tom Hertz, Peter Dixon, and Maureen Rimmer

United States Department of Agriculture

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## Abstract

This report uses a computable general equilibrium (CGE) model to explore the economic effects of a hypothetical 10-percent increase in foreign demand for U.S. agricultural exports. This demand shift was found to result in a 6.7-percent increase in the volume of such exports, worth $9.7 billion at 2013 prices, and a net increase in total U.S. employment (all economic sectors) of about 41,500 jobs—above and beyond the nearly 1.1 million full-time civilian jobs that U.S. agricultural exports currently support. Some 40 percent of these new jobs are created in rural (nonmetropolitan) counties. Most parts of the agri-food sector (i.e., production agriculture plus food and beverage manufacturing) would see an increase in employment, while employment in other trade-exposed industries—most notably non-food-and-beverage manufacturing and mining—would decrease. The agri-food sector's share of regional employment is the main determinant of the percentage change in total regional employment in our simulation. Since the agri-food sector accounts for a larger share of nonmetro employment than of metro employment, growth in U.S. agricultural exports is of greater relative importance to the economic prosperity of nonmetro communities.

**Keywords:** Employment, trade, CGE, computable general equilibrium model.

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## About the authors

Steven Zahniser is an agricultural economist and Tom Hertz is an economist at USDA's Economic Research Service. Peter Dixon is a professor and principal researcher, and Maureen Rimmer is a professor, both at the Centre of Policy Studies at Victoria University in Melbourne, Australia.

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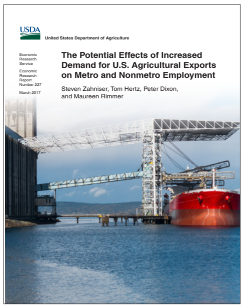


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# The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment

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## What Is the Issue?

ERS estimates that U.S. agricultural exports supported about 1.1 million full-time, civilian jobs in 2015. Yet, the economic linkages between U.S. agricultural exports and rural employment are not fully understood, particularly in the metro and nonmetro regions of each State and among production agriculture, food and beverage manufacturing, and other sectors of the economy. In this report, ERS researchers use a model of the U.S. economy to explore the possible economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports, including in those various regions and economic sectors.

## What Did the Study Find?

A hypothetical 10-percent increase in foreign demand for U.S. agricultural exports results in a 6.7-percent increase in the volume of U.S. agricultural exports, worth $9.7 billion at 2013 prices. (This increase in export volume (6.7 percent) is smaller than the increase in export demand (10 percent) because the demand stimulus is partially offset by an increase in the prices of agricultural exports.)

In addition, total employment in all sectors of the U.S. economy (agricultural and nonagricultural) increases by about 41,500 jobs, above and beyond the approximately 1.1 million jobs currently supported by U.S. agricultural exports.

At the regional level, our analysis shows employment increases in 32 of the 50 States and in the District of Columbia. The proportionate increase in nonmetro employment is about four times larger than the corresponding increase in metro employment (0.09 percent versus 0.02 percent).

Regions whose share of total employment is greater in the agri-food sector exhibit a stronger positive change in total employment due to the hypothetical 10-percent increase in foreign demand for U.S. agricultural exports. However, regions with a greater share of both mining and non-food-and-beverage manufacturing exhibit a strong negative change in total employment. A region's commodity mix in agri-food production and the presence of an international port also influence the regional employment results, but to a far lesser extent.


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

In our simulation, the expansion of export demand also leads to an increase in the exchange rate, which makes U.S. goods more expensive and reduces the competitiveness of products in trade-exposed industries. While employment would increase in some sectors, especially in export-oriented agricultural production and food and beverage industries, it would decrease in other trade-exposed industries, such as mining and manufacturing. On the other hand, an increase in the price of exports relative to the price of imports stimulates U.S. employment overall due to the increase in gross national expenditures. But, even within the agri-food sector, not all industries would expand. For example, land-intensive, non-export-oriented industries such as sugarcane and sugarbeet production would contract slightly.

## How Was the Study Conducted?

This report relies upon the U.S. Applied General Equilibrium (USAGE) model, a computable general equilibrium (CGE) model of the U.S. economy. The study focuses on employment effects at the economic sector and metro and nonmetro regional levels—a type of analysis for which the USAGE model is well suited. The model provides detail on over 500 economic sectors, both agricultural and nonagricultural. However, we concentrate on the agricultural and food and beverage sectors that produce agricultural exports, as defined by USDA.

The model includes a regional extension that allows the national results to be disaggregated into State- and county-level results. We then reaggregate the county-level results into groups of nonmetro and metro counties within each State in order to form a model with 98 regions—94 regions for the 47 States that have both metro and nonmetro counties, 3 regions for the States with only metro counties, and 1 region for the District of Columbia.

# The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment

## Introduction

The U.S. agri-food sector—defined in this report to encompass production agriculture and food and beverage manufacturing—accounted for 4.2 million jobs in 2016, or about 3 percent of total U.S. employment (U.S. Department of Labor, Bureau of Labor Statistics, 2017a). The agri-food sector is responsible for a larger share of employment in nonmetropolitan (nonmetro) than in metropolitan (metro) counties; in 2015, the agri-food sector accounted for 4 percent of the compensation of nonmetro employees, versus 1 percent for metro employees (U.S. Department of Commerce, Bureau of Economic Analysis, 2016a).

Exports, in turn, are an important component of U.S. agricultural sales. In 2015, U.S. agricultural exports to all countries (including bulk, high-value intermediate, and consumer-oriented agricultural products) totaled just over $133 billion (USDA/FAS, 2017), compared with $394 billion in value added to the U.S. economy by the agri-food sector (U.S. Department of Commerce, Bureau of Economic Analysis, 2016b).[1]

Economists have a pretty good idea of the number of jobs that U.S. agricultural exports currently support. For some years, USDA's Economic Research Service (ERS) has used input-output (I-O) modeling to construct agricultural trade multipliers. That research indicates that the number of jobs supported by U.S. agricultural exports rose from just over 800,000 full-time, civilian jobs in 2009 to about 1.1 million jobs in 2015 (Persaud, 2017). Rasmussen (2016) arrives at a similar result using similar methods. Paggi and colleagues (2011) use the IMPLAN I-O model to conclude that agricultural exports supported a total of 1.6 million jobs nationwide in 2009. These I-O models measure the total amount of labor required to produce the observed level of agricultural exports, counting those employed directly on farms and in food processing operations, as well as those employed in the industries that supply the necessary inputs to agriculture and food processing operations.

What we seek to estimate in this report is not the total level of employment supported by agri-food exports, but how this total would change in response to an increase in foreign demand. Such stimulus could arise from an increase in foreign population or income, a contraction in foreign supply of agricultural products, free-trade agreements that improve the access of U.S. agricultural products to foreign markets, or a successful U.S. promotion campaign for such products. Whatever the underlying cause, we have in mind a shock that uniformly moves the foreign demand curve for each type of U.S. agricultural product horizontally 10 percent to the right, without changing the position of foreign

[1] The statistics in this paragraph for employee compensation and value added cover tobacco manufacturing as well as the agri-food sector. USDA's definition of agricultural trade does not include tobacco manufactures, but it does include food manufactures and many types of beverages, such as soft drinks, beer, and wine, as well as milk and juice. In 2014, U.S. agricultural exports totaled $150 billion. The year-to-year reduction in exports between 2014 and 2015 was due in part to lower commodity prices. Also, one should be careful when comparing U.S. agricultural exports to the agri-food sector's value added, since exports are not a measure of value added.

demand curves for other U.S. products. This means that at a given price, the quantity demanded by foreign buyers of a specific agricultural product will rise by 10 percent.

To estimate the effects of this demand stimulus, we move beyond basic I-O modeling to a full computable general equilibrium (CGE) model. A CGE model is "a system of equations that describe an economy as a whole and the interactions of its parts" (Burfisher, 2011: 3); this system of equations includes an I-O matrix that relates inputs and outputs across industries. Unlike I-O models, however, CGE models can also capture the effects of competition for scarce resources, such as labor in different skill categories, capital, land, foreign currency, and public sector budget capacity. CGE models can show how the stimulation of one industry affects other industries by changing the availability of workers in different occupations, the availability and cost of financing for investment projects, the availability and rental of land for different uses, the exchange rate, the availability of public funds, and the relative prices of all goods and services, including most importantly the agricultural exports themselves. The CGE model also accounts for the effects of the re-spending of the additional income that accrues to the producers of agricultural exports and their suppliers, sometimes known as "induced demand."

Each of the model's 20 agri-food sectors produces a unique agricultural output—fruit or dairy farm products, for instance. The additional details of our CGE model make it possible to understand how the demand shift would result in both higher prices for exports and an increase in their volume, to quantify the resulting competition for resources between the agri-food sector and other industries, and to allocate economic changes resulting from the demand stimulus across States and between the nonmetro and metro regions of each State. Thus, the primary contribution of this report is to extend ERS's agricultural trade multiplier model by adding CGE dynamics and by disaggregating the results regionally.

The 10-percent shift in the foreign demand curves is not intended to represent the effects of any specific policy or policy proposal. Instead, it provides an opportunity to consider the economic impacts of a marginal change in export demand. To be sure, a 10-percent increase in the quantity demanded of U.S. agricultural exports by foreign buyers would be a sizable increase, but it is not outside the realm of possibility. Sometimes, trade agreements can contribute to an even larger increase in demand. For instance, with the elimination of Mexico's restrictions on corn imports from the United States as part of the North American Free Trade Agreement (NAFTA), the volume of U.S. corn exports to Mexico increased from an annual average of 27 kilograms per Mexican inhabitant during 1984-93 to 79 kilograms per inhabitant during 2013-15—an increase of 188 percent.[2] Moreover, given the model's fundamentally linear structure, the effects of smaller demand shocks can be estimated by assuming that they would be proportional to the effects reported here.

[2]The per capita consumption figures in this sentence were calculated by dividing average trade volumes for the periods in question (using trade data from USDA/FAS, 2016) by Mexico's population during the middle year of each period (using population estimates from U.S. Department of Commerce, Bureau of the Census, 2015). For more detail on NAFTA's impact on North American agriculture, see Zahniser et al. (2015).

## Modeling Approach

To estimate the effects of stimulating U.S. agricultural exports, we use the U.S. Applied General Equilibrium (USAGE) model—a 534-industry, CGE model of the U.S. economy. This model was developed at the Centre of Policy Studies at Victoria University in Melbourne, Australia, in collaboration with the U.S. International Trade Commission (USITC). The theoretical structure of the USAGE model is similar to that of the MONASH CGE model of Australia. Dixon and Rimmer (2002) provide complete technical documentation of the Australia model, and Victoria University, Centre of Policy Studies (2016) offers a reference library of technical information and working papers concerning the U.S. model. As is the case for all CGE models, at the heart of the USAGE model is a social accounting matrix (SAM), which describes the monetary flows within an economy between buyers and sellers—including industries that buy intermediate inputs from each other—and quantifies the public, private, and foreign sources of demand for national output.

The USAGE model explicitly represents the markets for labor, capital, farmland, and output as endogenous variables, and we make several simplifying assumptions (discussed below) that allow us to focus on the economic linkages between agricultural exports and employment. Of particular interest are linkages between the markets for various factors of production, between different economic sectors (production agriculture, food manufacturing, and other industries), and between the U.S. economy and the rest of the world. On the input side, farmers, growers, and ranchers affect the rest of the economy by purchasing or renting fuel, fertilizer, equipment, land, and the services provided by hired farmworkers and other agricultural professionals. The sale, transportation, processing, and marketing of agricultural production—some of which is destined for export—generates further demand for employment in downstream industries, including the food manufacturing sector. Labor is assumed to be mobile across sectors, while land is assumed to be an input only in agricultural production but not in other sectors of the economy, including food processing. Land prices are flexible, and land can be reallocated from one agricultural sector to another.

The USAGE model has been applied by the USITC and the U.S. Departments of Commerce, Agriculture, Homeland Security, Energy, and Transportation in studies concerned with international trade policy (Dixon et al., 2007; Fox et al., 2008; USITC, 2004, 2007, 2009, 2011, 2013), bioenergy (Dixon et al., 2007b; Gehlhar et al., 2010), immigration (Dixon et al., 2011a; Dixon et al., 2011b; Zahniser et al., 2012; Dixon et al., 2014), the Great Recession of 2007-09 (Dixon and Rimmer, 2011), the National Export Initiative (NEI) (Dixon and Rimmer, 2013a), climate change policies (Dixon and Rimmer, 2015), the economic dimensions of national security threats (Dixon et al., 2010; Giesecke, 2011; Giesecke et al., 2012), and highway infrastructure (Dixon and Rimmer, 2014).

Among these works, Dixon and Rimmer (2013a) use the USAGE model to explore the likely impacts of four types of export promotion policies implemented under the National Export Initiative and other Government initiatives: (1) policies that shift the foreign demand curves for U.S. exports, (2) policies that shift the supply curves for U.S. exports, (3) efforts to pursue trade-expanding policies in international forums, and (4) efforts to improve the macro competitiveness of the U.S. economy by cutting public expenditure. The authors find that these policies, if successfully implemented, would lower the job losses associated with the Great Recession for the period 2008-20 from about 70 million to 45 million job-years. This research, however, does not provide specific analysis for the agri-food sector, nor does it allow for an examination of separate impacts in nonmetro and metro parts of the country. The version of the USAGE model employed here addresses these limitations.

The agricultural products we identify correspond to the definition used by the U.S. Department of Agriculture (USDA) in its Foreign Agricultural Trade of the United States (FATUS) data system (USDA/FAS, 2017). USDA has maintained FATUS in accordance with a congressional directive since about 1926. FATUS is an aggregation of the several thousand 10-digit U.S. Harmonized Tariff Schedule (HTS) codes that USDA considers to be "agricultural" into usable groupings of agricultural products that encompass both farm and nonfarm products (Cooke, 2015). These products consist of both agricultural commodities and food and beverages manufactured using such commodities as inputs.

To facilitate the presentation of our modeling results, we combine a number of industries into larger categories in order to focus on 20 agricultural or food and beverage manufacturing sectors, and we use the term "agri-food" to refer to these 20 sectors as a group. Appendix table 1 lists these 20 sectors and the industries from the USAGE model that make up these sectors. The agri-food sector encompasses all the industries whose output falls into the category of products considered to be agricultural in USDA's definition of agricultural trade. According to the model's base data for 2013, the agri-food sector generated $144 billion in exports (6.4 percent of U.S. exports), contributed $381 billion in value added (2.4 percent of U.S. gross domestic product, GDP), and provided employment for 4.9 million people (3.4 percent of total U.S. employment).[3] Although both the USAGE model and the ERS agricultural trade multipliers rely upon USDA's official definition of agricultural trade, the 20 agri-food sectors analyzed in this report do not conform precisely to the individual commodity groups examined using the ERS multipliers.

The USAGE model generates results for a wide range of variables at different levels of analysis. In this study, we employ a variant of the model that provides results not only at the macroeconomic and industry levels, but also at the regional level. For our regional analysis, we use the distinction between metropolitan and nonmetropolitan counties, as defined by the Office of Management and Budget (OMB) in February 2013, as our guide for disaggregating the United States into regions.[4] We divide each State into two regions—metro counties and nonmetro counties (fig. 1). Three States (Delaware, New Jersey, and Rhode Island) and the District of Columbia do not have any nonmetro counties, so our model contains a total of 98 regions (47 States, each with a metro and nonmetro region, plus Delaware, New Jersey, Rhode Island, and the District of Columbia).

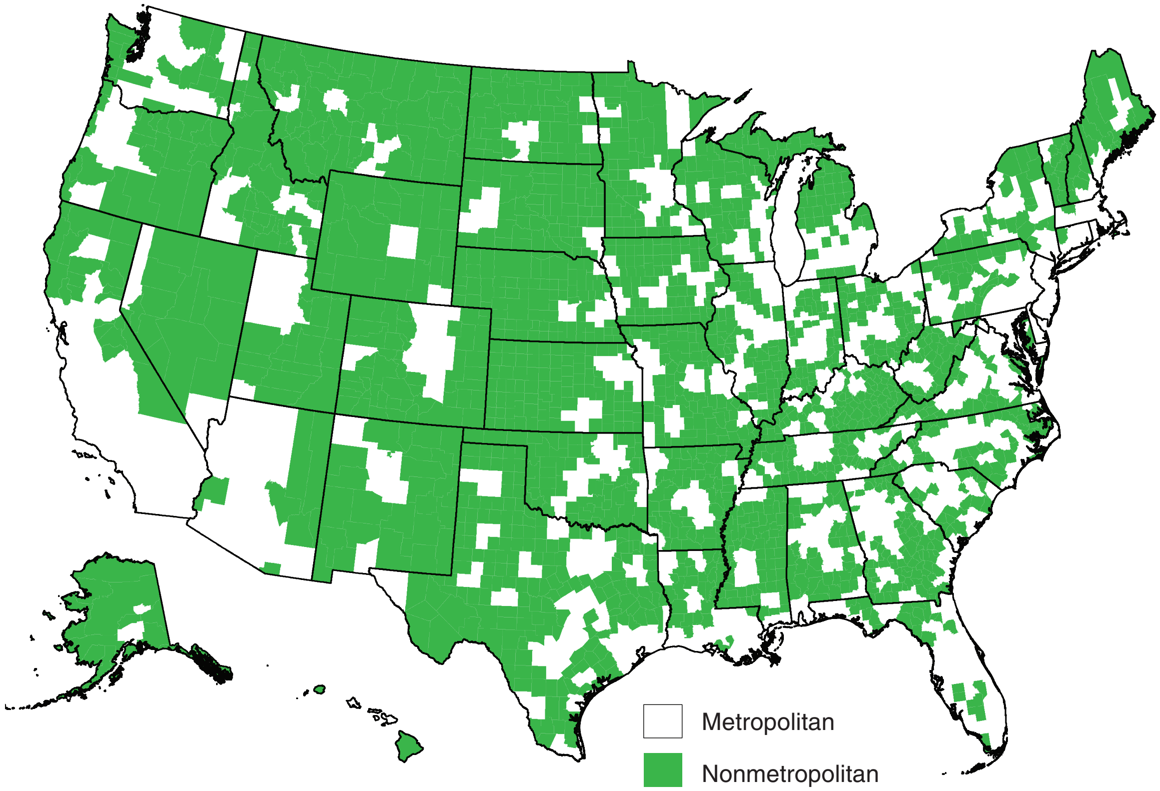
The distinction between metro and nonmetro regions is important to our study for two reasons. First, this analytical framework provides a means to consider the impact of agricultural exports on rural communities, as represented in our CGE model by nonmetro regions. Second, the agri-food sector accounts for a larger share of total employment in nonmetro counties than in metro counties—9 percent versus 2 percent—according to our model's base data. Thus, the effects of stimulating agricultural exports are likely to be larger in nonmetro than metro regions. This is not to say that the agri-food sector consistently plays a small role in the economic activities of metro regions. In absolute terms, some metro regions have large levels of agri-food employment—particularly in populous States. For instance, agri-food employment in metro California (about 904,000 jobs) is larger than total employment in 14 individual States and the District of Columbia. Moreover, some metro regions are distinguished by the agri-food sector's large share of total employment. In metro Arkansas, for instance, this share is 7 percent; in metro Washington and metro California, it is 6

[3]By region, the agri-food sector's share of the number of jobs tends to be higher than its share of compensation (as described on page 1) because earnings in the agri-food sector are relatively low.

[4]U.S. Department of Commerce, Census Bureau (2013) describes the OMB's delineation of metropolitan and micropolitan areas.

percent. But the largest shares of agri-food employment are, not surprisingly, located in nonmetro regions, such as nonmetro Washington (26 percent), nonmetro Idaho (18 percent), and nonmetro Hawaii (18 percent).

Figure 1
**Metro and nonmetro counties of the United States, 2013**




Source: USDA, Economic Research Service.

## Model Structure and Macroeconomic Results

The USAGE model can be run under different sets of assumptions. For this study, we assume that real wage rates in each U.S. industry are unaffected by the stimulation of agricultural exports. This assumption, which is also a feature of I-O models, is appropriate for showing the effects of an export-demand shock amid slack labor markets (relatively high rates of unemployment). As the U.S. economy recovered from the Great Recession of 2007-09, the U.S. unemployment rate (seasonally adjusted) gradually declined from a high of 10.0 percent in October 2009 to 4.8 percent in January 2017 (U.S. Department of Labor, Bureau of Labor Statistics, 2017b). Estimates of the full-employment level of unemployment—the minimum unemployment level that the economy can sustain without generating additional inflation—vary between 4.2 percent and 5.3 percent.

More comprehensive measures of labor underutilization that address both unemployment and underemployment indicate the persistence of considerable slack in the U.S. labor market. When the calculation includes people who are either marginally attached to the labor force or employed part-time for economic reasons, the rate of labor underutilization rises to 9.4 percent in January 2017, compared with 17.1 percent in October 2009 (U.S. Department of Labor, Bureau of Labor Statistics, 2017b).[5] Given this current context, our assumption of fixed real wages allows us to answer the following question: How many extra jobs could be sustained at current real wage rates if foreign demand curves for U.S. agricultural exports shifted to the right by 10 percent? [6]

The model also contains several simplifying assumptions that focus our analysis on the linkage between increased demand for exports and employment. First, we assume that the increase in export demand does not affect the U.S. balance of trade, which is maintained via adjustment of the U.S. exchange rate. This assumption has two important implications for our modeling results. First, any increase in U.S. exports of agricultural products resulting from the increase in foreign demand will lead to an appreciation of the U.S. dollar, causing either an increase in U.S. imports, a decrease in U.S. exports of other products (agricultural or nonagricultural), or some combination of the two. This assumption is equivalent to assuming that the demand shift has no effect on the U.S. capital account, which is assumed to be primarily determined by factors in financial markets. This constraint virtually ensures a decrease in U.S. exports and/or increased U.S. imports of trade-exposed, nonagricultural products as a result of the demand shift.

Second, the stimulation to export demand is assumed not to affect the total size of the U.S. capital stock. This is a shortrun assumption, as is the assumption that industry-specific real wage rates do not change. A final simplifying macroeconomic assumption is that export stimulation does not affect the broad composition of gross national expenditure (GNE). GNE is defined as the sum of public

[5]The marginally attached are defined as people "who currently are neither working nor looking for work but indicate that they want and are available for a job and have looked for work sometime in the past 12 months" (U.S. Department of Labor, Bureau of Labor Statistics, 2015). Some researchers have found that the Great Recession increased the percentage of people who are marginally detached from the labor force, although this increase is challenging to disentangle from the long-term decline in the labor-force participation rate resulting from such structural factors as the aging of the population and increased schooling among younger adults. See Jacobs (2015) for a discussion of this issue.

[6]Many CGE models rely on an alternative assumption, namely that full employment is continually maintained via adjustments in real wage rates. Under that assumption, no demand shocks or policies have any effect on total employment in the short run: any employment gains in one sector must be exactly offset by losses in another. Our opposite assumption (fixed real wages) may be closer to reality given the current state of the economy but may result in a slight overstatement of the employment effects.

consumption, private consumption, and investment, and we assume equal percentage movements in these three components.

With respect to price elasticities in international trade, the USAGE model has the capacity to allow the price elasticity of export demand (and import demand) to vary by sector and by trading partner. In this application of the model, however, we allow the elasticities to vary only by sector and not by trading partner. For all sectors in production agriculture except fruit, vegetable, and greenhouse and nursery production, the price elasticity of export demand is assumed to equal -2. For all other industries—including fruit, vegetable, and greenhouse and nursery production, all the food manufacturing sectors, and all non-agri-food sectors—this elasticity is assumed to equal -3. The assumption that the price elasticity of export demand is around -2 to -3 is broadly consistent with trade elasticities estimated by other researchers over the past decade.[7]

### *Macroeconomic Results*

The projected effect of a 10-percent increase in demand for U.S. agricultural exports on the number of people employed in all U.S. industries is an increase of 0.029 percent (about 41,500 jobs). However, the projected effect on labor input—the total amount of wages paid by employers (also known as the U.S. wage bill)—is just 0.006 percent (table 1). The projected effect on labor input weights the percentage effects on employment in each industry by that industry's share of the total labor input. This means that if people in one industry have wage rates that are twice those of people in another industry, then the employment of an extra person in the first industry contributes twice as much to the increase in labor input as the employment of an extra person in the second industry. The discrepancy between the two employment measures in table 1 reflects the relatively low earnings of workers in the agri-food sectors. The shock (agricultural export stimulation) creates lower paying jobs and therefore stimulates labor input less than total employment.

Table 1
**Macroeconomic effects of a 10-percent increase in demand for U.S. agricultural exports, in percent**

| | |
|---|---|
| Employment (people) | 0.029 |
| Labor input (total wage bill) | 0.006 |
| Real GDP | 0.004 |
| Capital stock | 0.000 |
| Gross national expenditure | 0.042 |
| Real exports (all industries) | -0.010 |
| Real imports (all industries) | 0.231 |
| Terms of trade | 0.240 |
| Exchange rate | 0.232 |
| Agricultural exports, volume | 6.717 |
| Agricultural exports, price in foreign currency | 1.245 |
| Agricultural exports, value in U.S. currency | 7.796 |

Source: Simulation results using the USAGE model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports.

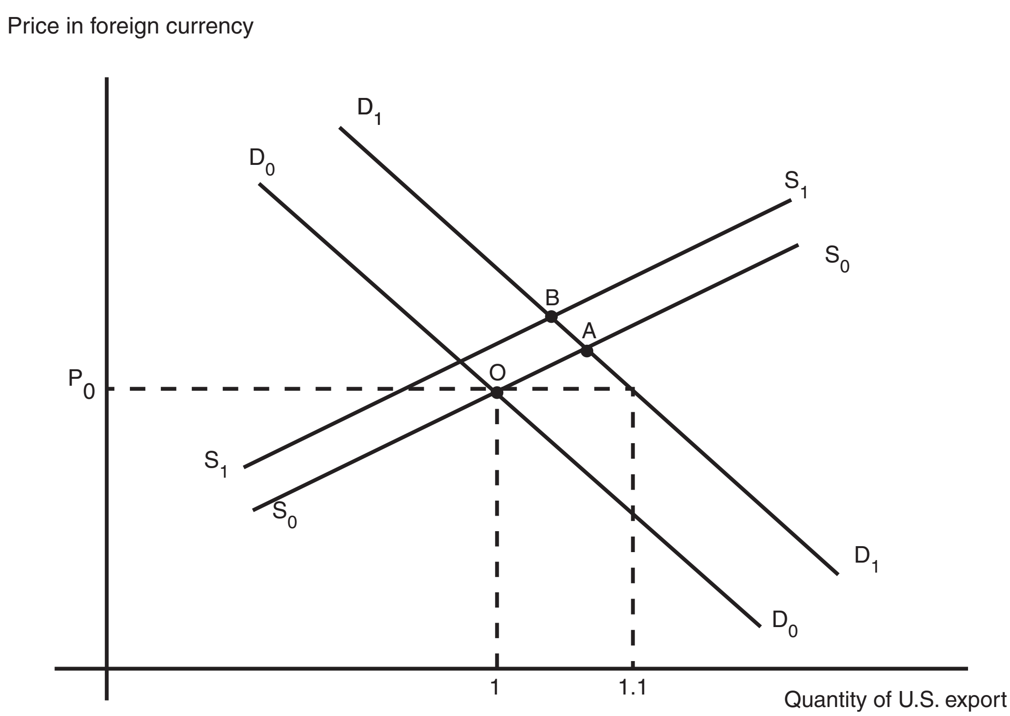
[7]To make comparisons between the existing empirical estimates and our assumptions, see Athukorala and Khan (2016), Kee et al. (2008), and Raza et al. (2016).

The modest GDP effect—an increase of 0.004 percent (about $640 million)—accords with the result for labor input and the assumption of no change in aggregate capital. With labor contributing about two-thirds of GDP, the increase in labor input of 0.006 percent generates an increase in real GDP of 0.004 percent.

Unlike with GDP, there is a significant increase in GNE (0.042 percent, or about $6.7 billion). The increase in GNE is a measure of the total welfare effect of the assumed export stimulation. GNE provides a broad measure of domestic spending in the economy (consumption, investment, and government) without accounting for the trade balance, which we assume to be constant. The increase in GNE relative to GDP is made possible by an increase in the price of U.S. exports relative to the price of imports—that is, an improvement in the terms of trade (0.240 percent). With an improvement in the terms of trade, the United States receives more imports for a given volume of exports and is therefore able to increase its consumption and investment (GNE) relative to its output (GDP) without deterioration in its balance of trade.

The source of the improvement in terms of trade can be seen in figure 2. The original demand curve is $D_0D_0$, and the original supply curve is $S_0S_0$, with the intersection of the two curves (Point O) indicating the initial equilibrium $S_0S_0$. Under the assumption of a fixed exchange rate, the demand curve shifts to $D_1D_1$, which moves the equilibrium to point A, the intersection of $D_1D_1$, and $S_0S_0$. However, the exchange rate also moves. With more agricultural exports and no increase in the reliance of the United States on foreign borrowing (fixed balance of trade), the exchange

Figure 2
**Foreign demand and export supply curves for a U.S. agricultural product**




Source: USDA, Economic Research Service.

rate appreciates by 0.232 percent (table 1).[8] In figure 2, this moves the export supply curve for agricultural products ($S_1S_1$), measured in foreign currency, to the left. The final equilibrium is at point B, the intersection of $D_1D_1$, and $S_1S_1$, indicating that the foreign currency prices of U.S. agricultural exports have increased. By contrast, there is no direct effect on the foreign currency prices of imports. Consequently, there is improvement in the terms of trade. The improvement emanating from the agricultural sector is reinforced by exchange-rate-induced movements in the export-supply curves for nonagricultural exports. While the exchange rate movement reduces nonagricultural exports, it increases their foreign-currency prices.

The upward-sloping supply curve for agricultural products and its exchange-rate-induced shift explain why the increase in the volume of agricultural exports is 6.72 percent, not 10 percent, and why the foreign-currency price of these exports increases by 1.25 percent (table 1). In combination, the foreign-currency price increase, the volume increase, and the exchange rate increase imply an increase in the domestic currency value of agricultural exports of 7.8 percent [≈ 100 x (1.01245 x 1.06717 ÷ 1.00232 – 1)], or $11.24 billion. Thus, our model indicates that a $1-billion increase in the nominal value of agricultural exports generates about 3,700 additional jobs in the U.S. economy (41,493 ÷ 11.24 = 3,692). This equates to an increase of about 4,600 jobs per $1 billion of additional exports measured in real (volume) terms, at 2015 prices.[9]

This employment effect is smaller than ERS's most recent estimate of the average number of U.S. full-time, civilian jobs currently supported by $1 billion of U.S. agricultural exports (Persaud, 2017). That research, obtained through I-O analysis, calculates an agricultural trade multiplier of about 8,000 jobs per $1 billion in real agricultural exports, using data for 2015. The main reason for this difference is that our scenario involves an increase in foreign demand, which leads to an appreciation of the U.S. dollar, which in turn leads to a reduction in net exports in trade-exposed industries outside the agri-food sector. By contrast, the I-O analysis looks only at the number of jobs currently supported by U.S. agricultural exports and does not consider the macroeconomic effects of hypothetical changes in foreign demand or any other alternative scenario.

Despite the increase in the volume of agricultural exports, total U.S. exports (agricultural and nonagricultural) decline by 0.01 percent. The exchange-rate effect reduces nonagricultural exports sufficiently to cause this result. To understand how this can happen, we need to consider imports. With an increase in GNE of 0.042 percent, we might expect a proportionate increase in imports. However, the exchange-rate appreciation stimulates imports (an increase of 0.231 percent, table 1). With terms of trade improved by 0.24 percent, this increase in imports can be paid for (recall the assumption of a fixed trade balance) with only a slight reduction in real exports.

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[8]This is not only the nominal appreciation but also the real appreciation. We assume that the export stimulation has no effect on U.S. inflation relative to that of its trading partners.

[9]We adjust for changing agricultural prices using the USDA National Agricultural Statistics Service (NASS) index for prices received by crop and livestock producers (USDA/NASS, 2017).

## Sectoral Results

Table 2 shows the change in export values for each agri-food sector associated with a 10-percent increase in foreign demand for U.S. agricultural exports. In our model, the base level of U.S. agricultural exports (in the base year of 2013) is $144.15 billion, compared with $144.36 billion in the latest official tally of U.S. agricultural exports for that year (USDA/FAS, 2017). Across agri-food sectors, the changes in export values in absolute terms range from a mere $1 million (sugar crop production, where output is usually refined in the source country and thus is rarely traded internationally) to $4.0 billion (field crop production, the agri-food sector with the most exports by far in the model). Among agri-food sectors, the animal slaughtering and processing sector shows the second largest absolute change in exports, with an increase in export sales of $1.6 billion.

The percentage increases in the export values of the agri-food sector range from 5.6 percent (sugar crop production) to 9.1 percent (greenhouse and nursery production). Interestingly, the three agri-food

Table 2

**Nominal change in U.S. agricultural exports in response to a 10-percent increase in foreign demand for those exports, by agri-food sector**

| Agri-food sector | Base year export value | Change due to 10-percent increase in export demand | |
|---|---|---|---|
| | *$ Million* | *$ Million* | *Percent* |
| Dairy farm products | 96 | 8 | 8.71 |
| Poultry and egg production | 768 | 59 | 7.73 |
| Livestock production | 2,674 | 226 | 8.45 |
| Field crop production | 51,321 | 4,028 | 7.85 |
| Fruit production | 6,558 | 450 | 6.87 |
| Tree nut production | 2,560 | 191 | 7.47 |
| Vegetable production | 6,129 | 374 | 6.10 |
| Sugar crop production | 11 | 1 | 5.61 |
| Greenhouse and nursery production | 1,289 | 118 | 9.15 |
| Animal slaughtering and processing | 20,338 | 1,573 | 7.74 |
| Dairy product manufacturing | 4,297 | 362 | 8.43 |
| Fruit and vegetable preserving and specialty food manufacturing | 9,642 | 842 | 8.73 |
| Grain and oilseed milling | 14,284 | 1,003 | 7.02 |
| Animal food manufacturing | 3,970 | 327 | 8.24 |
| Bakeries and tortilla manufacturing | 1,439 | 131 | 9.10 |
| Sugar manufacturing | 908 | 52 | 5.74 |
| Chocolate and confectionery manufacturing | 2,704 | 228 | 8.42 |
| Nuts and snack food manufacturing | 4,606 | 326 | 7.07 |
| Beverage manufacturing | 2,973 | 270 | 9.09 |
| Other food manufacturing | 7,584 | 668 | 8.80 |
| **Total** | 144,150 | 11,238 | 7.80 |

Source: Simulation results using the USAGE model.

sectors that see the largest proportionate change in export values—greenhouse and nursery production, bakeries and tortilla manufacturing, and beverage manufacturing—account for just 4 percent of total U.S. agri-food exports, using the base values in the model. Sugar crop production and sugar manufacturing experience the two smallest percentage increases in exports—a result that reflects the comparative advantages of the U.S. economy in other sectors. Overall, the United States is a large net importer of sugar (about $1.4 billion in 2013).

Table 3 shows the employment effects of our hypothetical 10-percent increase in foreign demand for U.S. agricultural exports. The additional demand leads to a 0.029-percent increase in total U.S. employment (table 1), or about 41,500 additional jobs. Some labor is drawn into agri-food employment from other sectors of the economy in response to the export stimulus. Total agri-food employment increases by 0.969 percent (about 47,200 jobs), while employment in other sectors decreases by 0.004 percent (about 5,700 jobs). While all sectors of the economy are stimulated by the increase in GNE, non-agri-food employment generally declines due to the decrease in total exports and increase

Table 3

**Change in employment in response to a 10-percent increase in foreign demand for U.S. agricultural exports: by sector and by nonmetro/metro counties**

| Sector | Nonmetro | Metro | Total | Nonmetro | Metro | Total |
|---|---|---|---|---|---|---|
| | | *Number* | | | *Percent* | |
| **Total** | 17,539 | 23,954 | 41,493 | 0.09 | 0.02 | 0.03 |
| **Sectors other than agriculture and food manufacturing** | -690 | -5,035 | -5,725 | -0.004 | -0.004 | -0.004 |
| **Agriculture and food manufacturing** | 18,229 | 28,989 | 47,218 | 1.00 | 0.95 | 0.97 |
| Dairy farm products | 561 | 925 | 1,486 | 0.32 | 0.44 | 0.39 |
| Poultry and egg production | 1,423 | 992 | 2,415 | 0.46 | 0.57 | 0.50 |
| Livestock production | 3,127 | 1,822 | 4,949 | 0.84 | 1.01 | 0.90 |
| Field crop production | 10,362 | 11,329 | 21,691 | 2.57 | 3.04 | 2.80 |
| Fruit production | 619 | 4,306 | 4,925 | 0.87 | 1.01 | 0.99 |
| Tree nut production | 773 | 3,565 | 4,338 | 3.23 | 3.26 | 3.26 |
| Vegetable production | -230 | -93 | -322 | -0.19 | -0.03 | -0.08 |
| Sugar crop production | -185 | -249 | -434 | -1.45 | -1.43 | -1.44 |
| Greenhouse and nursery production | 69 | 581 | 651 | 0.38 | 0.59 | 0.55 |
| Animal slaughtering and processing | 675 | 1,327 | 2,002 | 0.58 | 0.71 | 0.66 |
| Dairy product manufacturing | 132 | 362 | 495 | 0.32 | 0.33 | 0.33 |
| Fruit and vegetable preserving and specialty food manufacturing | 233 | 1,258 | 1,491 | 0.66 | 0.84 | 0.81 |
| Grain and oilseed milling | 302 | 802 | 1,104 | 1.20 | 0.94 | 1.00 |
| Animal food manufacturing | 230 | 240 | 470 | 1.17 | 1.36 | 1.26 |
| Bakeries and tortilla manufacturing | 10 | 284 | 295 | 0.03 | 0.12 | 0.11 |
| Sugar refining | -70 | -74 | -144 | -0.72 | -0.62 | -0.66 |
| Chocolate and confectionery manufacturing | 26 | 200 | 227 | 0.25 | 0.42 | 0.39 |
| Nuts and snack food manufacturing | 86 | 353 | 439 | 0.83 | 0.74 | 0.76 |
| Beverage manufacturing | 32 | 294 | 327 | 0.16 | 0.18 | 0.18 |
| Other food manufacturing | 51 | 764 | 816 | 0.47 | 0.85 | 0.81 |

Source: Simulation results using the USAGE model.

in total imports induced by the appreciation of the exchange rate. A few non-agri-food sectors—such as agricultural services, pesticides, and farm machinery—benefit from increased sales of inputs to the agri-food sector. For almost all of the trade-exposed sectors outside of agri-food, however, the negative exchange-rate effects dominate the positive effects emanating from the increase in GNE and linkages to the agri-food sector.

The effect on employment is positive for 17 of the 20 agri-food sectors in our analysis. Of these, the three with the largest proportionate increase in employment are tree nuts (3.26 percent), field crops (2.80 percent), and animal food (food for dogs, cats, and other animals) processing (1.26 percent), while the three sectors with the largest absolute increase in employment are field crops (about 22,000 jobs), livestock (5,000 jobs), and fruit (5,000 jobs). Field crops account for 46 percent of the total increase in agri-food employment.

Employment in three agri-food sectors decreases: sugar crops (-1.44 percent), sugar refining (-0.66 percent), and vegetables (-0.08 percent). In the cases of sugar crops and sugar refining, the negative effect is not surprising since the United States is a net importer of sugar, with imports accounting for about one-fourth of total use (USDA/FAS, 2015). Moreover, land accounts for a high share of the cost of production for sugarcane and sugarbeet cultivation. With the agri-food sector's expansion in response to export demand, land prices rise, causing significant increases in the cost of production. This land-price effect, together with the appreciation of the dollar, causes imported raw and refined sugar to displace a portion of U.S. sugarcane and sugarbeet production. Currency appreciation also increases imports and reduces employment in sugar refining. In the model's base year (2013), refined sugar accounted for a small portion of total U.S. sugar imports: 4 percent in 2012/13 and 9 percent in 2013/14 (USDA/FAS, 2015).[10]

The vegetable sector faces strong competition from imports, even though the sector has a high export share (26 percent). Although the United States is a major exporter of fresh vegetables and a net exporter of some fresh vegetables such as onions, it imports far more fresh vegetables than it exports. In the model's base year, U.S. net imports of vegetables equaled $4.3 billion (USDA/FAS, 2017). Households constitute the main customer for vegetables, with a 59-percent share of total sales. Although demand from households expands when export demand is stimulated, this expansion is small (recall that private consumption rises by only 0.042 percent) and competition from imported vegetables is sufficient to offset the gains to output and employment in the vegetable sector from expanded exports.

[10]To facilitate our discussion of the results, we aggregate the sugar-related sectors in the USAGE model into two sectors: sugar crops (i.e., sugarcane and sugar beets) and sugar refining. While the model used in this report does not include a representation of U.S. sugar policy, Winston (2005) uses the USAGE model to evaluate the tariff-rate quotas (TRQs) that regulate the U.S. supply of sugar.

## Regional Results

To obtain detailed results for metro and nonmetro regions, we first apportion the national results from our CGE model across the 50 States and the District of Columbia; then, we apportion the State-level results across individual counties, as described below. Finally, we aggregate the county-level results into groups of metro and nonmetro counties within each State, which we call regions. This aggregation means that any errors in the allocation of economic activity to particular counties within a given region will not affect the allocation at the regional level.

This State and county extension of the model takes three factors into account.[11] The most important factor is the sectoral composition of economic activity in each region. If a region's employment is heavily concentrated in sectors that are favored by the economic shock under consideration (in our case, the stimulation of agricultural exports), then the model will assign larger positive results to that region.

The second factor is interstate and international trade. If a region relies heavily on sales either to other regions or to international markets where expenditures grow strongly due to the shock under consideration, then the model will again generate positive effects for that region. These sales include both intermediate goods used as inputs in the production of other goods and final goods directly consumed by households.

Finally, the model encompasses local multiplier effects. If employment in the traded-goods industries[12] of a particular region benefits from the first two factors (composition and trade), then employment in non-traded-goods industries such as retail trade will also benefit.

Both metro and nonmetro counties experience an increase in total agri-food employment as a result of the 10-percent increase in foreign demand for U.S. agricultural exports (table 3). In percentage terms, the increases in agri-food employment in nonmetro and metro counties are comparable (1.00 percent versus 0.95 percent, respectively), but in absolute terms, the increase is much larger in metro counties than in nonmetro counties (about 29,000 jobs versus 18,000) because more agri-food jobs are located in metro than in nonmetro counties (3.0 million versus 1.8 million in 2013). However, because agri-food employment makes up a larger *share* of total employment in nonmetro counties, the proportionate increase in *total* employment is larger in nonmetro counties (0.09 percent) than in metro counties (0.02 percent). Thus, the promotion of agricultural exports would disproportionately benefit rural areas.

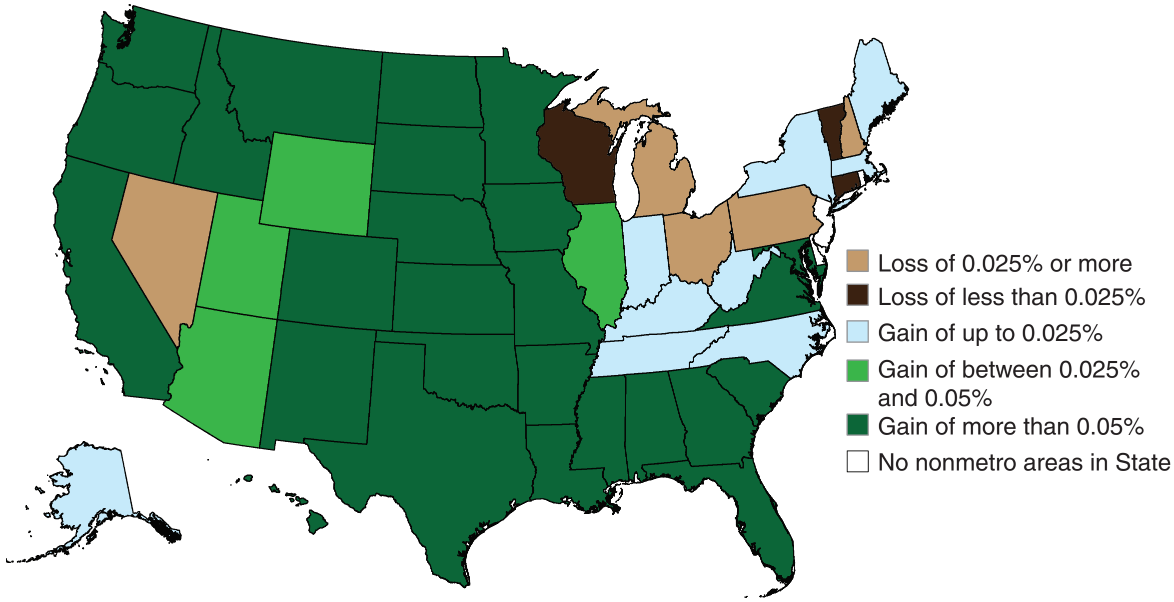
Figures 3-6 show the total and agri-food employment effects of a 10-percent increase in demand for U.S. agricultural exports in each State's nonmetro and metro regions. (The full set of State and regional results is reported in appendix table 2.) For total nonmetro employment, 39 of the 47 States with nonmetro counties experience nonmetro job growth in the simulation (fig. 3). Nonmetro job growth above 0.05 percent occurs in 26 States, mostly along the Pacific Ocean, in the Great Plains, and in the Southeast. For total metro employment, 28 States plus the District of Colombia see an increase in metro employment from greater agricultural exports (fig. 4). The largest proportionate metro job growth (again, in excess of 0.05 percent) occurs in 13 States. Some States that see high rates of nonmetro job growth see more modest increases (or even decreases) in total metro employment. These

[11]Dixon et al. (2007) explain the theory underlying the regional extension in greater detail.

[12]These are sectors that produce goods traded across regional, State, or international boundaries.

Figure 3

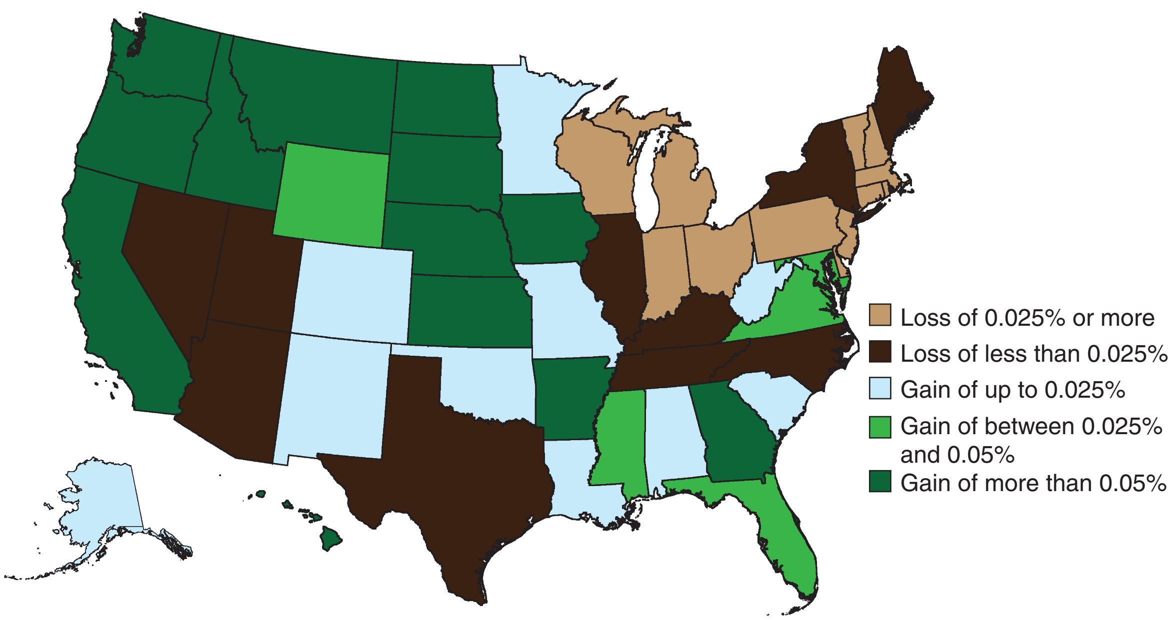
**Change in nonmetro employment from a 10-percent increase in demand for U.S. agricultural exports**




Source: Simulation results using the USAGE model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports, as allocated among the nonmetro counties of each State.

Figure 4

**Change in metro employment from a 10-percent increase in demand for U.S. agricultural exports**




Source: Simulation results using the USAGE model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports, as allocated among the metro counties of each State.

States tend to be located in the southern Great Plains and Southeast. Eight States see a decrease in total nonmetro employment, and 22 States experience a decrease in total metro employment.

Figures 5 and 6 pertain to changes in agri-food employment, using a different scale than in figures 3 and 4 to reflect the larger proportionate effects. All regions, except for the District of Colombia, experience growth in agri-food employment. Eight nonmetro regions (Washington, Oregon, California, Hawaii, Montana, South Dakota, South Carolina, and Connecticut) and five metro regions (Washington, Oregon, Hawaii, South Carolina, and Connecticut) experience agri-food job growth in excess of 1.5 percent.

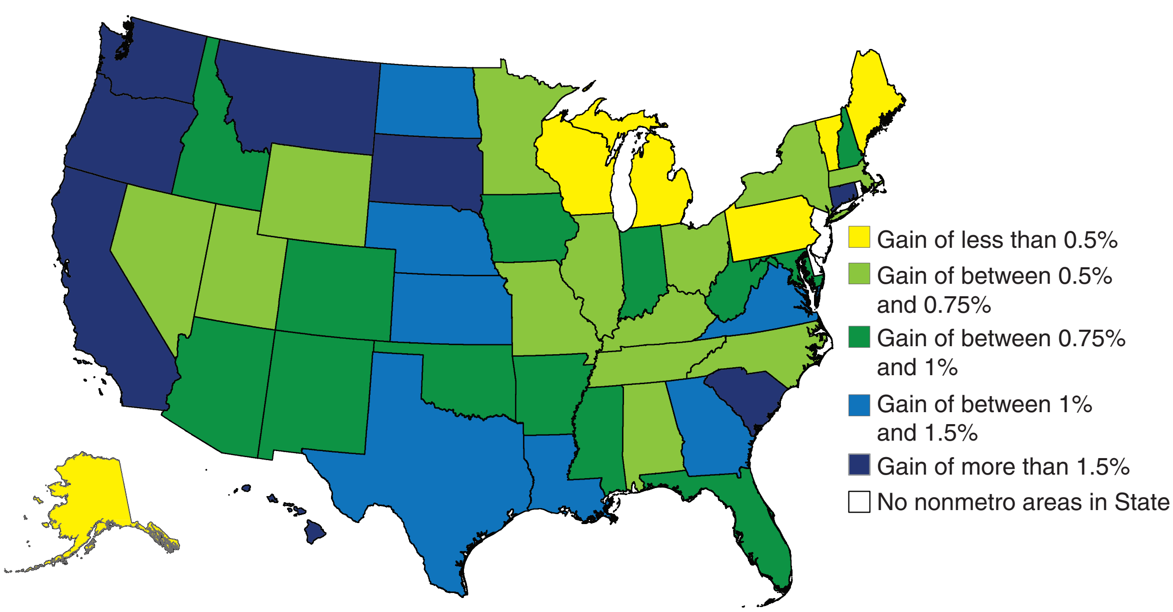
The range of effects on total employment across all 98 regions is from -0.07 percent (metro Michigan) to 0.81 percent (nonmetro Washington, see appendix table 2). The regional effects for agri-food employment range from -0.09 percent (District of Columbia) to 2.79 percent (nonmetro Washington State). In our regression analysis of the regional modeling results, we evaluate the importance of several possible determinants of the total employment effect.

## *Regression Analysis*

Simple regression analysis can be used to explore the heterogeneity of the regional results—in particular, which regional attributes are most strongly associated with positive employment outcomes from the export stimulus. For example, metro Michigan has several attributes that are negative determinants of employment growth: a low share of employment in the agri-food sector, a high share of employment in mining and non-food-and-beverage manufacturing, and the presence of international ports engaged in imports. In contrast, nonmetro Washington has several attributes that

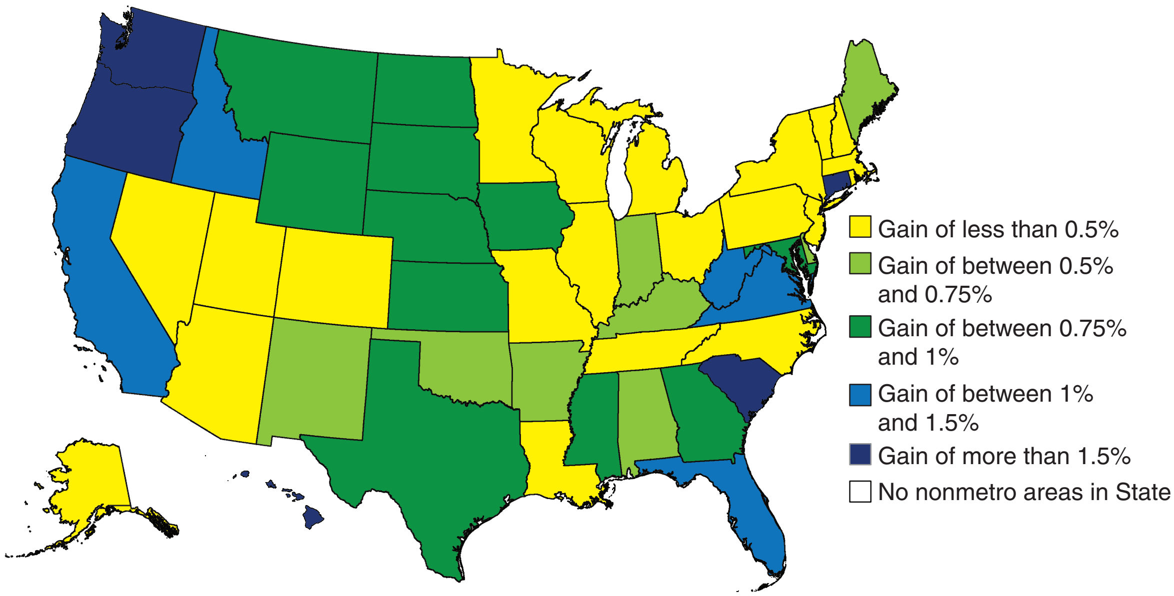
Figure 5

**Change in nonmetro agri-food employment from a 10-percent increase in demand for U.S. agricultural exports**




Source: Simulation results using the USAGE model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports, as allocated among the nonmetro counties of each State.

Figure 6
**Change in metro agri-food employment from a 10-percent increase in demand for U.S. agricultural exports**




Source: Simulation results using the USAGE model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports, as allocated among the metro counties of each State.

are positive determinants: a high share of employment in the agri-food sector, a favorable composition of agri-food employment, and international ports engaged in agricultural exports.

To examine these relationships, we estimate a series of regressions in which a region's percentage change in total employment ($PCT\_CH\_EMP_r$, where $r$ indexes regions) is posited to be a function of a region's sectoral composition of employment and the presence of one or more international ports in a region:

$$PCT\_CH\_EMP_r = \beta_0 + \beta_1 AG\_SHARE_r + \beta_2 AG\_COMP_r + \beta_3 MM\_SHARE_r + \beta_4 AGX\_PORT\_INDEX_r + \beta_5 M\_PORT\_INDEX_r + u_r$$

We consider the impact of three explanatory variables describing the sectoral composition of a region's employment:

- $AG\_SHARE_r$ —the agri-food sector's share of employment in region *r;*
- $AG\_COMP_r$ —the extent to which the sectoral composition of agri-food employment in region *r* is weighted toward sectors that benefit most strongly from the export demand shock; and
- $MM\_SHARE_r$ —the mining and non-food-and-beverage manufacturing sectors' combined share of employment in region *r*; calculated as defined below.

The first variable indicates the relative size of a region's agri-food sector, according to the USAGE model's base data. In our simulation results for the country as a whole, agri-food employment expanded as a result of increased foreign demand for U.S. agricultural exports. Thus, a region with a larger proportion of agri-food employment is also expected to experience a higher percentage change in total employment as a result of the simulation.

The second variable describes a region's composition of employment, $AG\_COMP_r$. This variable is defined as the sum of the products of each agri-food sector's share of total employment in the region, $SH_{s,r}$, times the percentage employment effect in the simulation for that sector at the national level, $NAT\_PCT\_CH_s$, where $s$ identifies sectors:

$$AG\_COMP_r = \Sigma_s SH_{s,r} \times NAT\_PCT\_CH_s$$

The employment effects in our export simulation vary from one agri-food sector to another. For any given share of agri-food employment, a region's percentage change in employment is likely to depend on whether its agri-food employment is concentrated in activities with strongly positive effects—such as tree nuts, field crops, animal food manufacturing, grain and oilseed milling, and fruit—or in activities with negative or weakly positive effects, such as sugar crops, sugar refining, vegetables, bakeries and tortilla manufacturing, and beverage manufacturing (table 3). Thus, a region where export-oriented, agri-food sectors account for a larger share of employment is expected to have a higher percentage change in total employment in the simulation. Similarly, a region where agri-food sectors subject to heightened competition from imports account for a larger share of employment is expected to have a lower percentage change in total employment.

The mining and non-food-and-beverage manufacturing sectors are of interest because of their pronounced exposure to import competition and/or because exports account for a high share of their output. In addition to competing with the agri-food sector in input markets, the mining and non-food-and-beverage manufacturing sectors are under further pressure to contract due to the real appreciation of the exchange rate that occurs in the simulation. With this in mind, a region with a larger proportion of employment in these sectors is expected to see a lower percentage change in total employment.

We also consider the impact of two explanatory variables measuring the relative level of international port activity in a given region:

- $AGX\_PORT\_INDEX_r$ —the ratio of the share of total agricultural exports departing the United States through the international ports located in region $r$ and region $r$'s share of total U.S. employment; and

- $M\_PORT\_INDEX_r$ —the ratio of the share of total imports entering the United States through the international ports located in region $r$ and region $r$'s share of total U.S. employment.[13]

These variables capture both the direct employment effect of international port activity occurring in a region and the indirect employment effect of such activity on firms located in that region in sectors not directly involved in port activity. In our export simulation, we would expect the percentage change in total employment for a region with a strong specialization in export-oriented agricultural products to be higher if that region has a port through which agricultural exports depart the country. Proximity to a port reduces transport costs and gives the region a competitive advantage in export markets. This is the indirect employment effect that the agricultural

[13]The port indexes are weighted in the denominator by the region's share of total U.S. employment so that the variables measure the proportionate impact of port activity on a region's total employment.

export port index ($AGX\_PORT\_INDEX_r$) aims to capture. Conversely, we would expect that the percentage change in employment for a region with a strong specialization in the production of trade-exposed, non-agricultural goods (i.e., mining and non-food-and-beverage manufacturing) will be lower due to the presence of a port. This is the indirect employment effect that the import port index ($M\_PORT\_INDEX_r$) is intended to measure.

Ports of entry include seaports, border-crossing points for vehicular traffic and railroads, and airports. The vast majority of U.S. agricultural trade enters or departs the United States by land (truck or rail) or by sea. International ports engaged in the export of agricultural products are located in both metro and nonmetro regions. The five regions with the highest values for the agricultural export port index are:

- metro Louisiana (14.61), with the Ports of New Orleans and Gramercy, near where the Mississippi River enters the Gulf of Mexico;
- nonmetro Arizona (10.50), with the Port of Nogales on the U.S.-Mexico border;
- nonmetro North Dakota (9.88), with the Ports of Portal and Pembina on the U.S.-Canada border;
- metro Washington (6.15), with the Ports of Seattle, Tacoma, Kalama, and Longview on various-bodies of water leading to the Pacific Ocean and the Port of Blaine along the U.S.-Canada border; and
- nonmetro Montana (3.74), with the Port of Sweetgrass on the U.S.-Canada border.

Thirty of the CGE model's 98 regions have no international ports where agricultural exports leave the United States.[14]

Ports of entry where the importation of products occurs are also located in both metro and nonmetro regions. The five regions with the highest values for the import port index are:

- metro Alaska (12.92), with the Port of Anchorage;
- nonmetro Arizona (11.57);
- nonmetro Louisiana (6.50), with the Port of Morgan City, near the Atchafalaya River and the Gulf of Mexico;
- nonmetro North Dakota (5.78); and
- metro Vermont (3.66), with the Port of Highgate Springs-Alburg on the U.S.-Canada border and the Port of Burlington on Lake Champlain.

Twenty-two of the CGE model's regions lack an international port where imports enter the United States.

[14]The weighting of agricultural exports by employment in the agricultural export port index is crucial to capturing the relative importance of ports located in less populated regions, as the two regions with the highest values for this variable illustrate. In 2013, $28.1 billion in agricultural exports departed the United States through the international ports in metro Louisiana, where total employment equaled about 1.9 million. By contrast, $872 million in agricultural exports departed through the ports in nonmetro Arizona, where employment totaled about 82,000.

### *Regression Results*

Table 4 reports the parameter estimates and their standard errors from four alternative specifications of our regression model, all of which are estimated using ordinary least squares. To compare the relative importance of the explanatory variables, we report the standardized coefficients in addition to the regular coefficients. The standardized coefficients measure the estimated impact of one standard deviation in an explanatory variable in terms of standard deviations of the dependent variable.

Our first specification is a simple model in which the percentage change in total employment ($PCT\_CH\_EMP_r$) is regressed on the agri-food sector's share of employment ($AG\_SHARE_r$). The results of this regression reveal that the agri-food sector's share not only has a strong, positive influence on the total employment effect, but that it is also a major determinant of that effect. The coefficient of determination ($R^2$) measures how well the model fits the data—that is, how close the data are to the fitted regression line. The value of $R^2$ for our first specification (0.62) indicates that about 62 percent of the variance across regions in the total employment effect is explained by the variance in a region's direct dependence on agri-food employment.

One way of further emphasizing this relationship is to look at the employment gains in regions where the agri-food sector accounts for more than 10 percent of employment. Figure 7 identifies the 16 regions where this is the case, using a plot of the data points and fitted regression line from our first specification. The 16 regions with this characteristic are all nonmetro, ranging from nonmetro Iowa (11 percent) to nonmetro Washington State (26 percent). As a group, these regions account for just 5 percent of U.S. employment but 32 percent of the total employment gain for the United States resulting from the simulated increase in agricultural exports.

Table 4

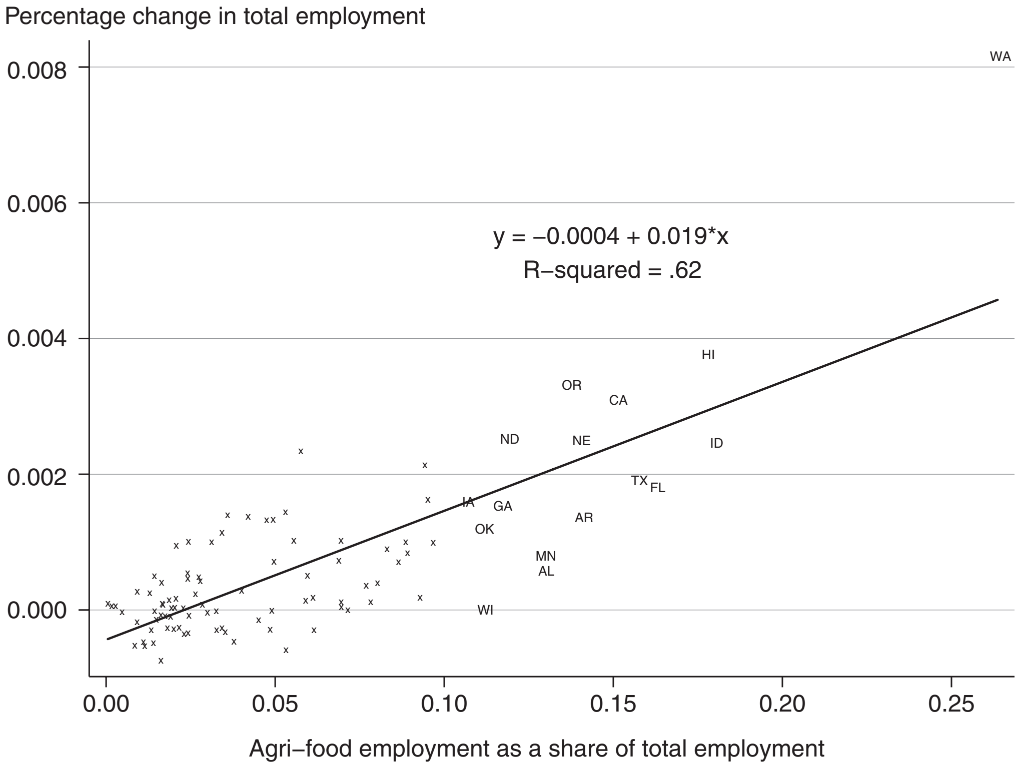
**Regression analysis of regional results from the export demand simulation**

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| Dependent variable = Percentage change in employment | Coefficient | Standard-ized coefficient | Coefficient | Standard-ized coefficient | Coefficient | Standard-ized coefficient | Coefficient | Standard-ized coefficient |
| Agri-food sector's share of employment | 0.0190*** (0.00348) | 0.786 | 0.0170*** (0.00311) | 0.705 | 0.0172*** (0.00277) | 0.711 | 0.0170*** (0.00275) | 0.701 |
| Composition of agri-food industries | | | 0.0712*** (0.0254) | 0.202 | 0.0770*** (0.0185) | 0.218 | 0.0760*** (0.0179) | 0.216 |
| Non-food manufactur-ing and mining's share of employment | | | | | -0.00770*** (0.000805) | -0.387 | -0.00777*** (0.000820) | -0.391 |
| Port index: imports | | | | | | | -4.59e-05** (2.05e-05) | -0.077 |
| Port index: agri-food exports | | | | | | | 5.44e-05** (2.32e-05) | 0.100 |
| Constant | -0.000438*** (0.000162) | | -0.00103*** (0.000292) | | 4.03e-06 (0.000189) | | 3.63e-05 (0.000197) | |
| Observations | 98 | | 98 | | 98 | | 98 | 98 |
| R-squared | 0.62 | | 0.65 | | 0.80 | | 0.81 | 0.81 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05
Source: Authors' regression results.

Figure 7

**A region's employment outcomes following the export demand increase depend strongly on its agri-food employment share**




Note: Each of the 16 nonmetro regions where the agri-food sector accounts for more than 10 percent of total employment is labeled with the postal abbreviation of the State to which it belongs. These sixteen regions account for nearly one-third of the total employment gain.
Source: USDA, Economic Research Service.

Our second specification incorporates the extent to which a region's sectoral composition of agri-food employment is weighted toward the sectors that expand most rapidly at the national level ($AG\_COMP_r$). As was hypothesized, this new variable exerts a positive influence on the percentage change in total employment. Inclusion of this variable marginally improves the regression model's explanatory power, as indicated by the slightly higher value for $R^2$ (0.65 versus 0.62). Still, the standardized coefficient for the variable (0.202) indicates that the sectoral composition of agri-food employment has an appreciable impact on total employment.

Our third specification incorporates the mining and non-food-and-beverage manufacturing sectors' combined share of total employment ($MM\_SHARE_r$) as an additional regressor. This new variable has a strong, negative effect on the percentage change in total employment, and its inclusion in the regression model considerably improves the regression's explanatory power, raising the value of $R^2$ from 0.65 to 0.80. Thus, the variance across regions in the three variables describing the sectoral composition of employment explains 80 percent of the variance in the percentage change in total employment.

Our fourth and final specification incorporates the two port indices, $AGX\_PORT\_INDEX_r$ and $M\_PORT\_INDEX_r$, as additional regressors. Both of these variables have the hypothesized direction of influence on the percentage change in employment—positive in the case of $AGX\_PORT\_INDEX_r$ and negative in the case of $M\_PORT\_INDEX_r$—but again, they only slightly improve the model's explanatory power, raising the value of $R^2$ to 0.81. Of the five explanatory variables, the two port indices have the smallest standardized coefficients in absolute value: 0.0999 for $AGX\_PORT\_INDEX_r$ and -0.0771 for $M\_PORT\_INDEX_r$. The limited impact of the port indices may be linked to how we construct the regions in our CGE model. While the direct employment effects of international port activity are likely to be focused on the communities where ports are located, the regions in our model cover far more extensive geographic areas. Thus, even though the direct employment effect on a port community may be large, this effect becomes diffused at a regional level. The fact that the overall impact of the port indices is small suggests that both the direct and indirect employment effects of port activity resulting from our simulation are small at the regional level.

The absolute values of the standardized coefficients from the fourth specification indicate the relative importance of the five explanatory variables. In order of importance from highest to lowest, the variables are: (1) the agri-food sector's share of employment, (2) the mining and non-food-and-beverage manufacturing sectors' share of employment, (3) the index comparing the composition of agri-food employment at the regional and national levels, (4) the agricultural export port index, and (5) the import port index.

## Research Caveats

The USAGE model accounts for many of the important linkages between agricultural exports and agri-food employment; however, there are some aspects of the U.S. economy and the relationship between exports and employment that the model does not fully capture:

- First, the simulation focuses exclusively on the impact of an increase in foreign demand for a very specific set of products: U.S. agricultural exports. This narrow focus allows us to evaluate the economic effects of such an increase. In reality, such an increase would almost certainly not occur in isolation, and the precise effects of the increase on employment would be difficult to distinguish from other changes in the economy.

- Second, the USAGE model is not intended to provide a complete representation of the foreign exchange market, even though this market plays an important role in the model by linking the simulated increase in foreign demand to the U.S. economy. Within the model's framework, the purchase of foreign exchange is an indispenable requirement for the exportation of goods, just as land, labor, and capital are necessary inputs for the production of those goods. In real life, foreign exchange serves the additional purposes of being stores of value and instruments of speculation—functions that are not represented by the USAGE model.

- Third, while the extension of the national CGE results to the county level takes many important local economic attributes into account, this mapping cannot capture the full heterogeneity of U.S. counties. Aggregating to the State metro/nonmetro level mitigates this concern and should provide a fair approximation of the rural versus urban outcomes in each State.

## Conclusions

This report explores the linkages between U.S. agricultural exports and employment at the macroeconomic, sectoral, and regional levels. Using a CGE model, we evaluate the economic effects of a hypothetical scenario in which foreign demand for U.S. agricultural exports increases by 10 percent. Such a stimulus could arise from free-trade agreements that improve the access of U.S. agricultural products to foreign markets or from a successful U.S. promotion campaign for its agricultural products. As a result of this demand shift, agricultural exports expand by about $11.24 billion (7.8 percent in 2013), and the U.S. economy gains an additional 41,493 jobs (full-time equivalents)—above and beyond the approximately 1.1 million full-time, civilian jobs currently supported by U.S. agriculture. Thus, our model indicates that a $1-billion increase in the nominal value of agricultural exports generates about 3,700 jobs. This equates to an increase of about 4,600 jobs per $1 billion of additional exports measured in real (volume) terms, at 2015 prices.

This employment effect is smaller than the estimate obtained from ERS's most recent research on this subject using I-O analysis. That research calculates an agricultural trade multiplier of about 8,000 jobs per $1 billion in real agricultural exports, using data for 2015. We obtain smaller estimates of employment effects relative to the I-O analysis because we model the effects of an increase in foreign demand, which in our CGE model leads to a stronger U.S. dollar and a consequent reduction in net exports and employment in trade-exposed industries outside the agri-food sector, such as mining and non-food-and-beverage manufacturing. On the other hand, an employment-stimulating factor captured by our CGE model and not the I-O analysis is the effect of improved terms of trade on employment via expansion of gross national expenditure, as well as the employment effects resulting from the re-spending of additional export earnings.

The demand stimulus has a positive impact on employment in 17 of the 20 agri-food sectors in our analysis, with the largest proportionate increases in jobs occurring in tree nuts, field crops, and animal food processing. In percentage terms, the increases in agri-food employment in nonmetro and metro counties are comparable (roughly 1 percent each), but in absolute terms, the increase is much larger in metro counties than in nonmetro counties (about 29,000 jobs versus 18,000). This latter outcome is due to the fact that more agri-food jobs are located in metro counties than in nonmetro counties.

At the regional level, the simulation's effects on total employment range from -0.073 percent (metro Michigan) to 0.815 percent (nonmetro Washington), compared with an employment effect of 0.029 percent for the United States as a whole. Of the model's 98 regions, 68 regions (29 metro and 39 nonmetro) see positive effects for total employment, and 30 regions (22 metro and 8 nonmetro) see negative effects.

Further analysis of the regional results indicates that the agri-food sector's share of employment is the main determinant of the percentage change in total employment in our export simulation. Indeed, a group of 16 nonmetro regions accounting for just 5 percent of U.S. employment obtain 32 percent of the job gains resulting from our hypothetical increase in foreign demand for U.S. agricultural exports. These regions are distinguished by high shares of agri-food employment, with such jobs accounting for over 10 percent of regional employment.

Agri-food jobs are present in both metro and nonmetro counties, but the agri-food sector accounts for a larger share of nonmetro employment than of metro employment (9 percent versus 2 percent). Thus, while growth in U.S. agricultural exports is important to people throughout the country, it takes on greater relative importance to the economic prosperity of nonmetro communities. The economic base of these communities, however, varies from one county to the next—with some engaged in crop or livestock production, some engaged in food processing, and some engaged in both—and their geographic location also differs—with some nonmetro communities located proximate to international ports and others relying on the Nation's transportation system to get their product to the international market.

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Appendix table 1

**The 20 agricultural production and food manufacturing sectors defined as agri-food and the industries from the USAGE Model that make up those sectors**

| Agri-food sector | USAGE Model industry |
|---|---|
| Dairy farm products | Dairy farming |
| Poultry and egg production | Poultry and egg farming |
| Livestock production | Meat-oriented livestock farming |
| | Miscellaneous livestock farming |
| Field crop production | Cotton farming |
| | Food grain farming |
| | Feed grain farming |
| | Grass seed farming |
| | Tobacco farming |
| | Miscellaneous crop farming |
| | Oil-bearing crop farming |
| Fruit production | Fruit farming |
| Tree nut production | Tree nut farming |
| Vegetable production | Vegetable farming |
| Sugar crop production | Sugar crop farming |
| Greenhouse and nursery production | Greenhouse and nursery production |
| Animal slaughtering and processing | Meat processing |
| | Sausage production |
| | Poultry processing |
| | Animal fats and oils |
| Dairy product manufacturing | Creamery butter manufacturing |
| | Cheese manufacturing |
| | Dry, condensed, and evaporated dairy product manufacturing |
| | Ice cream and frozen dessert manufacturing |
| | Fluid milk manufacturing |
| Fruit and vegetable preserving and specialty food manufacturing | Specialty canning |
| | Fruit and vegetable canning |
| | Dried and dehydrated fruit manufacturing |
| | Fruit and vegetable pickling |
| | Frozen fruit, juice, and vegetable manufacturing |
| | Frozen specialty food manufacturing |
| Grain and oilseed milling | Flour milling |
| | Breakfast cereal manufacturing |
| | Prepared dough manufacturing |
| | Rice milling |
| | Wet corn milling |
| | Malt manufacturing |
| | Cottonseed milling |
| | Soybean milling |
| | Fats and oils refining and blending |
| | Edible fats and oils |

Continued—

Appendix table 1

**The 20 agricultural production and food manufacturing sectors defined as agri-food and the industries from the USAGE Model that make up those sectors—continued**

| Agri-food sector | USAGE Model industry |
|---|---|
| Animal food manufacturing | Dog and cat food manufacturing |
| | Other animal food manufacturing |
| Bakeries and tortilla manufacturing | Retail and commercial bakeries |
| | Cookie and cracker manufacturing |
| | Frozen cakes, pies, and other pastries manufacturing |
| | Dry pasta, dough, and flour mixes manufacturing from purchased flour |
| Sugar manufacturing | Sugar manufacturing |
| Chocolate and confectionery manufacturing | Chocolate and confectionery manufacturing |
| | Nonchocolate confectionery manufacturing |
| Nuts and snack food manufacturing | Roasted nuts and peanut butter manufacturing |
| | Other snack food manufacturing |
| Beverage manufacturing | Breweries |
| | Wineries |
| | Soft drink manufacturing |
| Other food manufacturing | Flavoring syrup and concentrate manufacturing |
| | Coffee and tea manufacturing |
| | All other food manufacturing |

Source: USDA, Economic Research Service.

Appendix table 2

**Change in employment in response to a 10-percent increase in foreign demand for U.S. agricultural exports: by State and by nonmetro/metro counties**

| State/ Nonmetro or metro | Agri-food | | | Non-agri-food | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg |
| **United States** | 4,871,797 | 47,218 | 0.97% | 137,360,793 | -5,725 | -0.00% | 142,290,600 | 41,493 | 0.03% |
| Nonmetro | 1,829,807 | 18,229 | 1.00% | 17,660,793 | -690 | -0.00% | 19,490,600 | 17,539 | 0.09% |
| Metro | 3,041,989 | 28,989 | 0.95% | 119,700,000 | -5,035 | -0.00% | 122,800,000 | 23,954 | 0.02% |
| **Alaska** | 851 | 2 | 0.23% | 358,662 | 22 | 0.01% | 359,513 | 24 | 0.01% |
| Nonmetro | 209 | 0 | 0.14% | 129,208 | 9 | 0.01% | 129,418 | 9 | 0.01% |
| Metro | 642 | 2 | 0.27% | 229,453 | 13 | 0.01% | 230,095 | 15 | 0.01% |
| **Alabama** | 106,963 | 567 | 0.53% | 1,968,741 | -155 | -0.01% | 2,075,704 | 413 | 0.02% |
| Nonmetro | 61,427 | 324 | 0.53% | 412,773 | -59 | -0.01% | 474,200 | 265 | 0.06% |
| Metro | 45,536 | 243 | 0.53% | 1,555,968 | -95 | -0.01% | 1,601,504 | 148 | 0.01% |
| **Arkansas** | 120,558 | 812 | 0.67% | 1,137,718 | 406 | 0.04% | 1,258,276 | 1,218 | 0.10% |
| Nonmetro | 66,638 | 518 | 0.78% | 407,839 | 124 | 0.03% | 474,478 | 641 | 0.14% |
| Metro | 53,919 | 294 | 0.55% | 729,879 | 283 | 0.04% | 783,798 | 577 | 0.07% |
| **Arizona** | 44,474 | 207 | 0.47% | 2,254,956 | -356 | -0.02% | 2,299,430 | -149 | -0.01% |
| Nonmetro | 2,294 | 21 | 0.91% | 80,177 | 15 | 0.02% | 82,470 | 36 | 0.04% |
| Metro | 42,181 | 186 | 0.44% | 2,174,779 | -371 | -0.02% | 2,216,960 | -185 | -0.01% |
| **California** | 946,080 | 12,155 | 1.28% | 15,627,078 | 5,501 | 0.04% | 16,573,158 | 17,655 | 0.11% |
| Nonmetro | 41,716 | 707 | 1.69% | 235,158 | 146 | 0.06% | 276,874 | 853 | 0.31% |
| Metro | 904,364 | 11,448 | 1.27% | 15,391,920 | 5,354 | 0.03% | 16,296,284 | 16,802 | 0.10% |
| **Colorado** | 63,959 | 384 | 0.60% | 2,405,446 | 111 | 0.00% | 2,469,405 | 495 | 0.02% |
| Nonmetro | 28,343 | 233 | 0.82% | 289,764 | 38 | 0.01% | 318,107 | 271 | 0.09% |
| Metro | 35,616 | 151 | 0.42% | 2,115,682 | 73 | 0.00% | 2,151,298 | 224 | 0.01% |
| **Connecticut** | 35,526 | 604 | 1.70% | 1,868,725 | -1,071 | -0.06% | 1,904,252 | -467 | -0.02% |
| Nonmetro | 2,292 | 44 | 1.92% | 68,063 | -45 | -0.07% | 70,355 | -0 | -0.00% |
| Metro | 33,235 | 560 | 1.68% | 1,800,663 | -1,026 | -0.06% | 1,833,897 | -466 | -0.03% |
| **District of Columbia** | 363 | -0 | -0.09% | 716,684 | 76 | 0.01% | 717,047 | 76 | 0.01% |
| **Delaware** | 15,291 | 114 | 0.74% | 431,590 | -229 | -0.05% | 446,880 | -115 | -0.03% |
| **Florida** | 207,441 | 2,154 | 1.04% | 7,036,509 | 1,593 | 0.02% | 7,243,950 | 3,748 | 0.05% |
| Nonmetro | 38,389 | 379 | 0.99% | 198,029 | 44 | 0.02% | 236,418 | 423 | 0.18% |
| Metro | 169,052 | 1,775 | 1.05% | 6,838,480 | 1,549 | 0.02% | 7,007,532 | 3,325 | 0.05% |
| **Georgia** | 159,867 | 1,697 | 1.06% | 3,892,073 | 1,204 | 0.03% | 4,051,940 | 2,900 | 0.07% |
| Nonmetro | 78,624 | 945 | 1.20% | 596,177 | 81 | 0.01% | 674,801 | 1,026 | 0.15% |
| Metro | 81,243 | 751 | 0.92% | 3,295,896 | 1,123 | 0.03% | 3,377,139 | 1,874 | 0.06% |
| **Hawaii** | 51,350 | 947 | 1.84% | 655,285 | 310 | 0.05% | 706,635 | 1,257 | 0.18% |
| Nonmetro | 22,814 | 436 | 1.91% | 105,659 | 46 | 0.04% | 128,473 | 482 | 0.38% |
| Metro | 28,536 | 510 | 1.79% | 549,626 | 264 | 0.05% | 578,162 | 775 | 0.13% |
| **Iowa** | 98,896 | 803 | 0.81% | 1,458,078 | 1,152 | 0.08% | 1,556,974 | 1,955 | 0.13% |
| Nonmetro | 71,167 | 594 | 0.83% | 596,189 | 461 | 0.08% | 667,355 | 1,055 | 0.16% |
| Metro | 27,729 | 210 | 0.76% | 861,890 | 691 | 0.08% | 889,619 | 900 | 0.10% |
| **Idaho** | 61,416 | 617 | 1.00% | 569,686 | 490 | 0.09% | 631,102 | 1,107 | 0.18% |
| Nonmetro | 42,747 | 410 | 0.96% | 194,651 | 171 | 0.09% | 237,398 | 580 | 0.24% |
| Metro | 18,669 | 208 | 1.11% | 375,034 | 320 | 0.09% | 393,704 | 527 | 0.13% |

Continued—

Appendix table 2

**Change in employment in response to a 10-percent increase in foreign demand for U.S. agricultural exports: by State and by nonmetro/metro counties—continued**

| State/ Nonmetro or metro | Agri-food | | | Non-agri-food | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg |
| **Illinois** | 136,767 | 648 | 0.47% | 6,221,677 | -1,139 | -0.02% | 6,358,444 | -491 | -0.01% |
| Nonmetro | 52,758 | 392 | 0.74% | 633,618 | -138 | -0.02% | 686,376 | 254 | 0.04% |
| Metro | 84,009 | 256 | 0.30% | 5,588,059 | -1,001 | -0.02% | 5,672,068 | -745 | -0.01% |
| **Indiana** | 95,247 | 732 | 0.77% | 2,972,812 | -1,345 | -0.05% | 3,068,058 | -612 | -0.02% |
| Nonmetro | 47,630 | 382 | 0.80% | 637,373 | -346 | -0.05% | 685,003 | 37 | 0.01% |
| Metro | 47,617 | 350 | 0.73% | 2,335,439 | -999 | -0.04% | 2,383,055 | -649 | -0.03% |
| **Kansas** | 64,190 | 732 | 1.14% | 1,481,453 | 650 | 0.04% | 1,545,643 | 1,381 | 0.09% |
| Nonmetro | 49,603 | 618 | 1.25% | 471,893 | 237 | 0.05% | 521,496 | 855 | 0.16% |
| Metro | 14,586 | 114 | 0.78% | 1,009,561 | 413 | 0.04% | 1,024,147 | 527 | 0.05% |
| **Kentucky** | 81,410 | 483 | 0.59% | 1,876,319 | -375 | -0.02% | 1,957,729 | 109 | 0.01% |
| Nonmetro | 44,628 | 250 | 0.56% | 685,160 | -110 | -0.02% | 729,787 | 140 | 0.02% |
| Metro | 36,783 | 234 | 0.64% | 1,191,159 | -265 | -0.02% | 1,227,942 | -31 | -0.00% |
| **Louisiana** | 55,106 | 501 | 0.91% | 2,186,134 | 15 | 0.00% | 2,241,240 | 516 | 0.02% |
| Nonmetro | 23,119 | 342 | 1.48% | 309,947 | 3 | 0.00% | 333,066 | 345 | 0.10% |
| Metro | 31,987 | 160 | 0.50% | 1,876,187 | 12 | 0.00% | 1,908,174 | 171 | 0.01% |
| **Massachusetts** | 42,905 | 208 | 0.49% | 3,571,026 | -1,857 | -0.05% | 3,613,931 | -1,649 | -0.05% |
| Nonmetro | 3,726 | 24 | 0.64% | 43,916 | -17 | -0.04% | 47,642 | 6 | 0.01% |
| Metro | 39,180 | 184 | 0.47% | 3,527,110 | -1,839 | -0.05% | 3,566,289 | -1,655 | -0.05% |
| **Maryland** | 40,841 | 344 | 0.84% | 2,611,873 | 409 | 0.02% | 2,652,714 | 752 | 0.03% |
| Nonmetro | 7,679 | 73 | 0.96% | 71,725 | 6 | 0.01% | 79,404 | 80 | 0.10% |
| Metro | 33,162 | 270 | 0.81% | 2,540,148 | 402 | 0.02% | 2,573,310 | 672 | 0.03% |
| **Maine** | 20,288 | 97 | 0.48% | 618,970 | -88 | -0.01% | 639,259 | 9 | 0.00% |
| Nonmetro | 13,700 | 57 | 0.42% | 218,562 | -22 | -0.01% | 232,263 | 35 | 0.02% |
| Metro | 6,588 | 40 | 0.60% | 400,408 | -66 | -0.02% | 406,996 | -26 | -0.01% |
| **Michigan** | 104,744 | 123 | 0.12% | 4,728,967 | -3,553 | -0.08% | 4,833,710 | -3,430 | -0.07% |
| Nonmetro | 38,225 | 66 | 0.17% | 681,191 | -481 | -0.07% | 719,416 | -415 | -0.06% |
| Metro | 66,519 | 57 | 0.09% | 4,047,775 | -3,072 | -0.08% | 4,114,294 | -3,015 | -0.07% |
| **Minnesota** | 123,723 | 587 | 0.47% | 2,682,343 | -57 | -0.00% | 2,806,066 | 530 | 0.02% |
| Nonmetro | 72,536 | 395 | 0.54% | 488,312 | 43 | 0.01% | 560,848 | 438 | 0.08% |
| Metro | 51,187 | 192 | 0.38% | 2,194,031 | -100 | -0.00% | 2,245,218 | 92 | 0.00% |
| **Missouri** | 114,465 | 663 | 0.58% | 2,836,250 | 353 | 0.01% | 2,950,714 | 1,016 | 0.03% |
| Nonmetro | 52,708 | 368 | 0.70% | 556,882 | 68 | 0.01% | 609,590 | 436 | 0.07% |
| Metro | 61,757 | 295 | 0.48% | 2,279,368 | 285 | 0.01% | 2,341,125 | 580 | 0.02% |
| **Mississippi** | 78,192 | 733 | 0.94% | 1,205,710 | 263 | 0.02% | 1,283,903 | 996 | 0.08% |
| Nonmetro | 62,319 | 609 | 0.98% | 641,419 | 101 | 0.02% | 703,737 | 710 | 0.10% |
| Metro | 15,874 | 124 | 0.78% | 564,292 | 162 | 0.03% | 580,165 | 286 | 0.05% |
| **Montana** | 18,759 | 278 | 1.48% | 431,703 | 298 | 0.07% | 450,462 | 575 | 0.13% |
| Nonmetro | 15,477 | 249 | 1.61% | 276,481 | 175 | 0.06% | 291,959 | 424 | 0.15% |
| Metro | 3,282 | 29 | 0.89% | 155,222 | 123 | 0.08% | 158,504 | 152 | 0.10% |

Continued—

Appendix table 2

**Change in employment in response to a 10-percent increase in foreign demand for U.S. agricultural exports: by State and by nonmetro/metro counties—continued**

| State/ Nonmetro or metro | Agri-food | | | Non-agri-food | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg |
| **North Carolina** | 126,052 | 683 | 0.54% | 3,921,485 | -1,389 | -0.04% | 4,047,537 | -706 | -0.02% |
| Nonmetro | 56,317 | 353 | 0.63% | 754,078 | -252 | -0.03% | 810,395 | 100 | 0.01% |
| Metro | 69,735 | 331 | 0.47% | 3,167,407 | -1,137 | -0.04% | 3,237,142 | -806 | -0.02% |
| **North Dakota** | 29,530 | 343 | 1.16% | 345,248 | 397 | 0.12% | 374,778 | 740 | 0.20% |
| Nonmetro | 23,052 | 290 | 1.26% | 171,234 | 197 | 0.11% | 194,286 | 486 | 0.25% |
| Metro | 6,478 | 53 | 0.82% | 174,014 | 201 | 0.12% | 180,492 | 254 | 0.14% |
| **Nebraska** | 69,206 | 720 | 1.04% | 925,330 | 869 | 0.09% | 994,536 | 1,589 | 0.16% |
| Nonmetro | 46,589 | 542 | 1.16% | 286,906 | 287 | 0.10% | 333,494 | 829 | 0.25% |
| Metro | 22,617 | 178 | 0.79% | 638,425 | 582 | 0.09% | 661,041 | 760 | 0.11% |
| **New Hampshire** | 10,334 | 70 | 0.67% | 629,699 | -357 | -0.06% | 640,033 | -288 | -0.04% |
| Nonmetro | 5,766 | 50 | 0.86% | 232,571 | -128 | -0.06% | 238,337 | -78 | -0.03% |
| Metro | 4,568 | 20 | 0.43% | 397,128 | -229 | -0.06% | 401,696 | -209 | -0.05% |
| **New Jersey** | 55,733 | 220 | 0.39% | 4,131,727 | -1,415 | -0.03% | 4,187,460 | -1,195 | -0.03% |
| **New Mexico** | 34,300 | 296 | 0.86% | 811,468 | 55 | 0.01% | 845,768 | 351 | 0.04% |
| Nonmetro | 23,934 | 233 | 0.97% | 264,349 | 29 | 0.01% | 288,283 | 262 | 0.09% |
| Metro | 10,366 | 63 | 0.61% | 547,119 | 26 | 0.00% | 557,485 | 89 | 0.02% |
| **Nevada** | 7,587 | 38 | 0.51% | 907,174 | -97 | -0.01% | 914,761 | -58 | -0.01% |
| Nonmetro | 3,759 | 27 | 0.71% | 95,794 | -72 | -0.07% | 99,554 | -45 | -0.05% |
| Metro | 3,828 | 12 | 0.31% | 811,380 | -25 | -0.00% | 815,207 | -13 | -0.00% |
| **New York** | 115,456 | 571 | 0.49% | 9,213,843 | -2,049 | -0.02% | 9,329,300 | -1,478 | -0.02% |
| Nonmetro | 34,785 | 202 | 0.58% | 452,124 | -197 | -0.04% | 486,909 | 5 | 0.00% |
| Metro | 80,671 | 369 | 0.46% | 8,761,720 | -1,853 | -0.02% | 8,842,391 | -1,484 | -0.02% |
| **Ohio** | 131,796 | 709 | 0.54% | 5,683,877 | -3,266 | -0.06% | 5,815,673 | -2,557 | -0.04% |
| Nonmetro | 65,695 | 410 | 0.62% | 1,003,597 | -711 | -0.07% | 1,069,293 | -301 | -0.03% |
| Metro | 66,101 | 298 | 0.45% | 4,680,279 | -2,555 | -0.05% | 4,746,380 | -2,257 | -0.05% |
| **Oklahoma** | 87,192 | 759 | 0.87% | 1,695,842 | -38 | -0.00% | 1,783,034 | 721 | 0.04% |
| Nonmetro | 62,422 | 620 | 0.99% | 499,824 | 45 | 0.01% | 562,246 | 664 | 0.12% |
| Metro | 24,770 | 140 | 0.56% | 1,196,018 | -82 | -0.01% | 1,220,788 | 57 | 0.00% |
| **Oregon** | 100,575 | 1,950 | 1.94% | 1,690,892 | 1,051 | 0.06% | 1,791,467 | 3,000 | 0.17% |
| Nonmetro | 36,633 | 713 | 1.95% | 231,310 | 172 | 0.07% | 267,943 | 885 | 0.33% |
| Metro | 63,942 | 1,237 | 1.93% | 1,459,582 | 879 | 0.06% | 1,523,524 | 2,116 | 0.14% |
| **Pennsylvania** | 150,145 | 519 | 0.35% | 5,753,924 | -2,523 | -0.04% | 5,904,069 | -2,004 | -0.03% |
| Nonmetro | 27,114 | 122 | 0.45% | 532,472 | -275 | -0.05% | 559,586 | -153 | -0.03% |
| Metro | 123,031 | 397 | 0.32% | 5,221,451 | -2,248 | -0.04% | 5,344,483 | -1,851 | -0.03% |
| **Rhode Island** | 4,129 | 1 | 0.03% | 484,657 | -253 | -0.05% | 488,786 | -252 | -0.05% |
| **South Carolina** | 52,050 | 851 | 1.63% | 1,883,714 | -396 | -0.02% | 1,935,763 | 455 | 0.02% |
| Nonmetro | 18,619 | 317 | 1.70% | 294,289 | -156 | -0.05% | 312,908 | 162 | 0.05% |
| Metro | 33,431 | 533 | 1.60% | 1,589,424 | -240 | -0.02% | 1,622,855 | 293 | 0.02% |
| **South Dakota** | 24,120 | 351 | 1.45% | 371,367 | 287 | 0.08% | 395,487 | 637 | 0.16% |
| Nonmetro | 19,547 | 307 | 1.57% | 187,899 | 139 | 0.07% | 207,446 | 446 | 0.21% |
| Metro | 4,573 | 44 | 0.96% | 183,468 | 148 | 0.08% | 188,041 | 192 | 0.10% |

Continued—

Appendix table 2

**Change in employment in response to a 10-percent increase in foreign demand for U.S. agricultural exports: by State and by nonmetro/metro counties—continued**

| State/ Nonmetro or metro | Agri-food | | | Non-agri-food | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg | Base | Change | Pcnt Chg |
| **Tennessee** | 108,562 | 530 | 0.49% | 2,728,073 | -573 | -0.02% | 2,836,636 | -43 | -0.00% |
| Nonmetro | 53,249 | 307 | 0.58% | 520,415 | -196 | -0.04% | 573,664 | 111 | 0.02% |
| Metro | 55,313 | 223 | 0.40% | 2,207,659 | -377 | -0.02% | 2,262,972 | -154 | -0.01% |
| **Texas** | 326,915 | 3,481 | 1.06% | 10,455,671 | -1,220 | -0.01% | 10,782,585 | 2,261 | 0.02% |
| Nonmetro | 190,008 | 2,308 | 1.21% | 1,020,690 | -17 | -0.00% | 1,210,699 | 2,291 | 0.19% |
| Metro | 136,906 | 1,173 | 0.86% | 9,434,981 | -1,203 | -0.01% | 9,571,887 | -30 | -0.00% |
| **Utah** | 28,369 | 151 | 0.53% | 1,118,271 | -177 | -0.02% | 1,146,640 | -26 | -0.00% |
| Nonmetro | 10,763 | 76 | 0.71% | 123,399 | -21 | -0.02% | 134,162 | 55 | 0.04% |
| Metro | 17,606 | 74 | 0.42% | 994,873 | -156 | -0.02% | 1,012,479 | -82 | -0.01% |
| **Virginia** | 79,863 | 1,007 | 1.26% | 3,824,505 | 766 | 0.02% | 3,904,368 | 1,773 | 0.05% |
| Nonmetro | 23,716 | 311 | 1.31% | 454,470 | 37 | 0.01% | 478,186 | 347 | 0.07% |
| Metro | 56,147 | 696 | 1.24% | 3,370,035 | 729 | 0.02% | 3,426,182 | 1,426 | 0.04% |
| **Vermont** | 13,939 | 62 | 0.45% | 322,470 | -130 | -0.04% | 336,409 | -68 | -0.02% |
| Nonmetro | 9,569 | 44 | 0.46% | 202,704 | -73 | -0.04% | 212,273 | -29 | -0.01% |
| Metro | 4,370 | 19 | 0.43% | 119,766 | -58 | -0.05% | 124,136 | -39 | -0.03% |
| **Washington** | 247,998 | 6,093 | 2.46% | 2,976,469 | 3,238 | 0.11% | 3,224,467 | 9,330 | 0.29% |
| Nonmetro | 79,817 | 2,230 | 2.79% | 222,913 | 236 | 0.11% | 302,730 | 2,466 | 0.81% |
| Metro | 168,181 | 3,863 | 2.30% | 2,753,556 | 3,001 | 0.11% | 2,921,737 | 6,864 | 0.23% |
| **Wisconsin** | 144,937 | 336 | 0.23% | 2,679,232 | -950 | -0.04% | 2,824,169 | -614 | -0.02% |
| Nonmetro | 74,562 | 153 | 0.20% | 594,016 | -161 | -0.03% | 668,578 | -9 | -0.00% |
| Metro | 70,375 | 183 | 0.26% | 2,085,216 | -788 | -0.04% | 2,155,591 | -606 | -0.03% |
| **West Virginia** | 24,632 | 230 | 0.93% | 776,627 | -208 | -0.03% | 801,259 | 22 | 0.00% |
| Nonmetro | 15,157 | 131 | 0.86% | 294,518 | -130 | -0.04% | 309,675 | 1 | 0.00% |
| Metro | 9,475 | 99 | 1.04% | 482,109 | -78 | -0.02% | 491,584 | 21 | 0.00% |
| **Wyoming** | 8,703 | 58 | 0.66% | 270,776 | 25 | 0.01% | 279,479 | 82 | 0.03% |
| Nonmetro | 7,966 | 51 | 0.64% | 191,055 | 9 | 0.00% | 199,021 | 60 | 0.03% |
| Metro | 737 | 7 | 0.95% | 79,721 | 16 | 0.02% | 80,458 | 23 | 0.03% |

Source: Simulation results using the USAGE Model to evaluate the economic effects of a 10-percent increase in foreign demand for U.S. agricultural exports.