



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*



United States Department of Agriculture

Economic
Research
Service

Economic
Research
Report
Number 227

April 2017

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

Economic Research Service

www.ers.usda.gov

Access this report online: www.ers.usda.gov/publications/

Download the charts contained in this report:

- Go to the report's index page www.ers.usda.gov/publications/
- Click on the bulleted item "Download err2227.zip"
- Open the chart you want, then save it to your computer

Recommended citation format for this publication:

Zahniser, Steven, Tom Hertz, Peter Dixon, and Maureen Rimmer. *The Potential Effects of Increased Demand for U.S. Agricultural Exports on Metro and Nonmetro Employment*, ERR-227, U.S. Department of Agriculture, Economic Research Service, April 2017.

Cover image: iStock

Use of commercial and trade names does not imply approval or constitute endorsement by USDA.

To ensure the quality of its research reports and satisfy government-wide standards, ERS requires that all research reports with substantively new material be reviewed by qualified technical research peers. This technical peer review process, coordinated by ERS' Peer Review Coordinating Council, allows experts who possess the technical background, perspective, and expertise to provide an objective and meaningful assessment of the output's substantive content and clarity of communication during the publication's review. For more information on the Agency's peer review process, go to: <http://www.ers.usda.gov/about-ers/peer-reviews.aspx>

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at [How to File a Program Discrimination Complaint](#) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.



**Economic
Research
Service**

Economic
Research
Report
Number 227

April 2017

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

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.

Acknowledgments

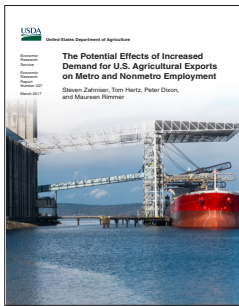
We thank Jeffrey Reimer, Oregon State University; Fahren Robb, USDA, Foreign Agricultural Service (FAS); Timothy Wojan, USDA, Economic Research Service (ERS); and a fourth individual for their peer review comments. We also thank Andrew Muhammad, John Pender, and Suresh Persaud (USDA/ERS) and Mike Dwyer (formerly USDA/FAS) for their comments and suggestions and Timothy Parker (USDA/ERS) for constructing the maps used in the report. Special thanks go to Dale Simms and Cynthia A. Ray (USDA/ERS) for their expert editing and design of the report.

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.

Contents

Summary	iv
Introduction	1
Modeling Approach	3
Model Structure and Macroeconomic Results	6
Sectoral Results	10
Regional Results	13
Research Caveats	22
Conclusions	23
References	25
Appendix Tables	29



Find the full report at
[www.ers.usda.gov/
publications](http://www.ers.usda.gov/publications)

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

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 sugar-beet 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

¹The 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.

²The 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).

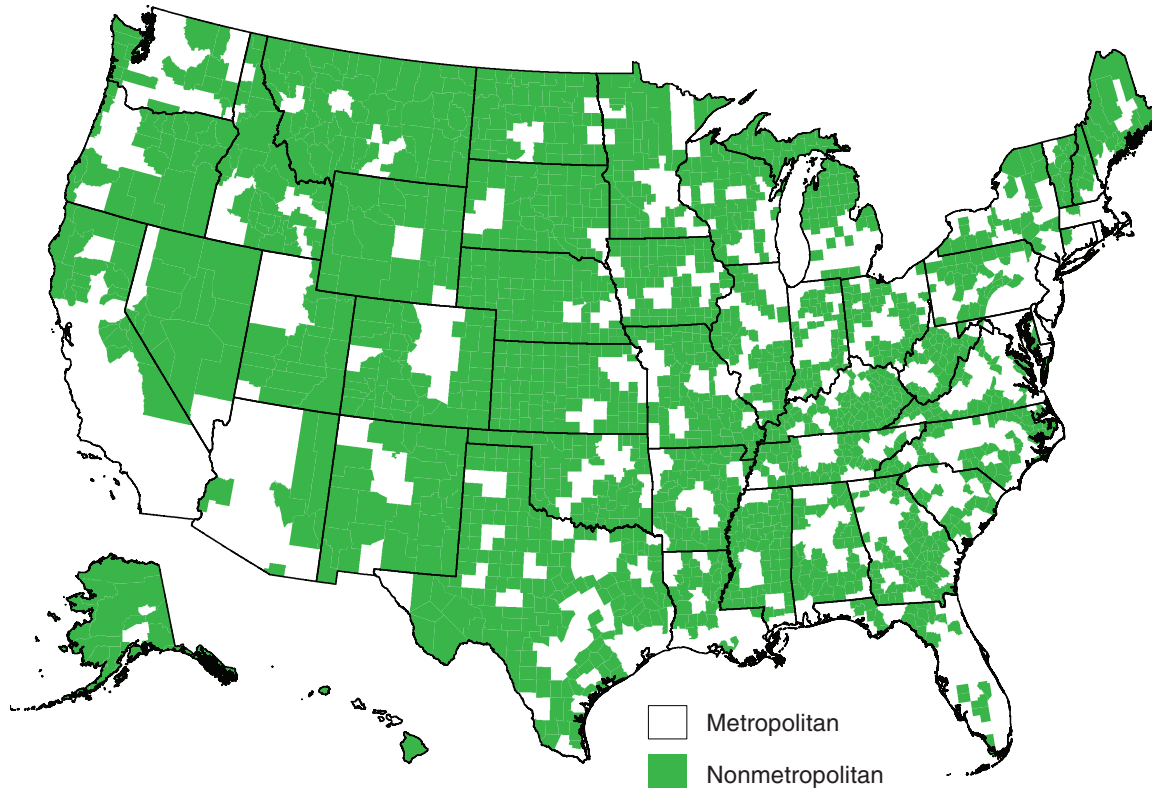
The distinction between metro and nonmetro regions is important to our study for two reasons. First, this analytical framework provides a means to consider the impact of agricultural exports on rural communities, as represented in our CGE model by nonmetro regions. Second, the agri-food sector accounts 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

³By 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.

⁴U.S. Department of Commerce, Census Bureau (2013) describes the OMB’s delineation of metropolitan and micro-politan 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 short-run 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

⁵The 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.

⁶Many 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.

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

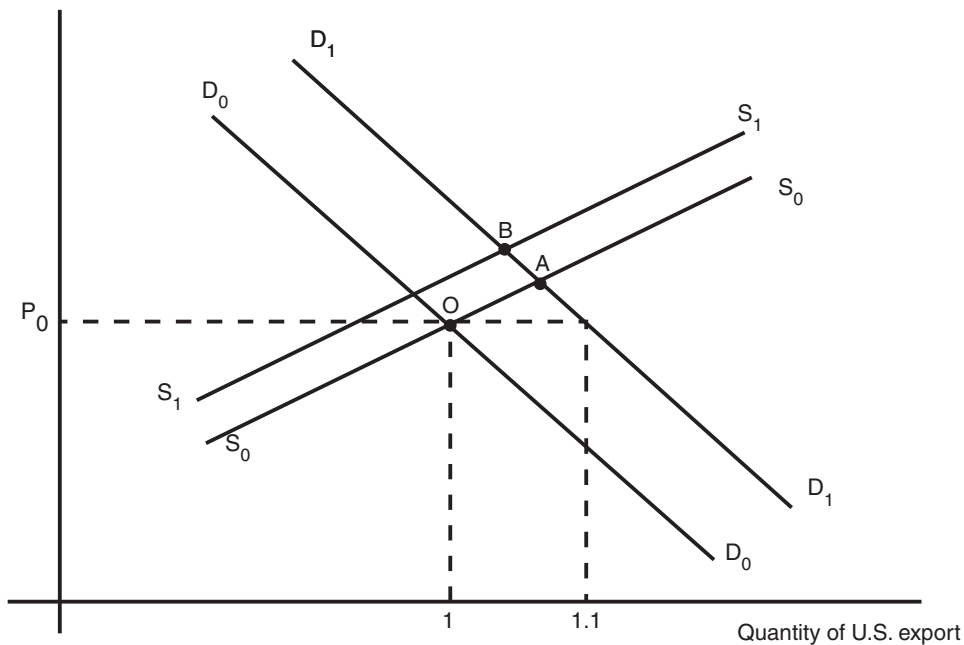
The modest GDP effect—an increase of 0.004 percent (about \$640 million)—accords with the result for labor input and the assumption of no change in aggregate capital. With labor contributing about two-thirds of GDP, the increase in labor input of 0.006 percent generates an increase in real GDP of 0.004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

Price in foreign currency



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 [$\approx 100 \times (1.01245 \times 1.06717 \div 1.00232 - 1)$], 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 ($41,493 \div 11.24 = 3,692$). 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.

⁸This 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.

⁹We 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
	<i>Number</i>			<i>Percent</i>		
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.

¹⁰To 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 industries¹² 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.

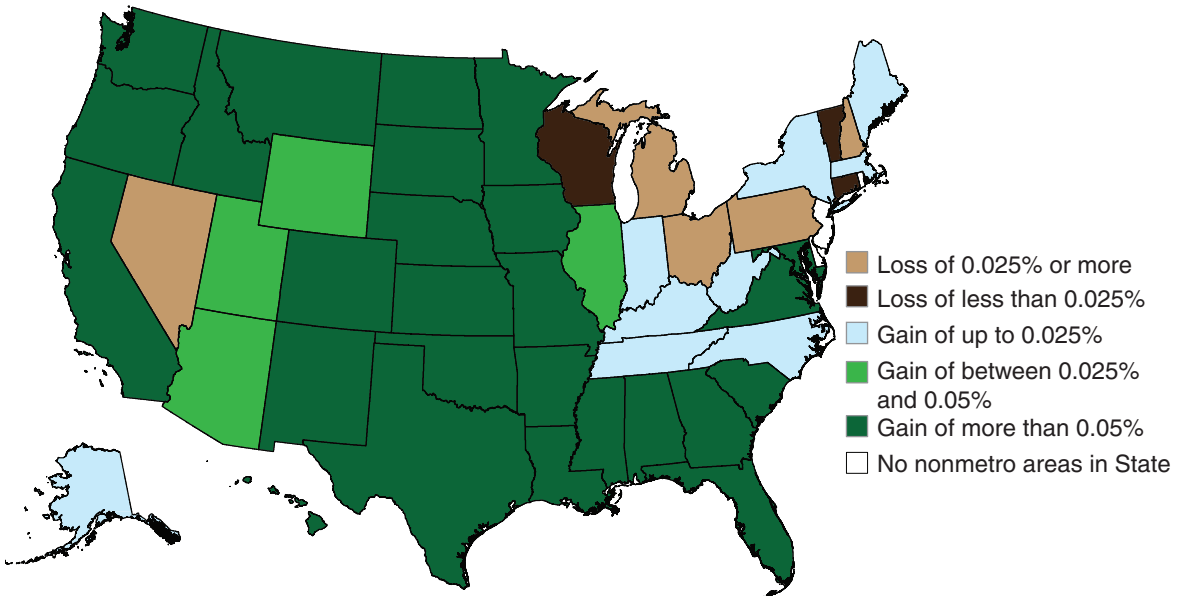
Figures 3-6 show the total and agri-food employment effects of a 10-percent increase in demand for U.S. agricultural exports in each State's nonmetro and metro regions. (The full set of State and regional results is reported in appendix table 2.) For total nonmetro employment, 39 of the 47 States with 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 Columbia 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

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

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

Figure 3

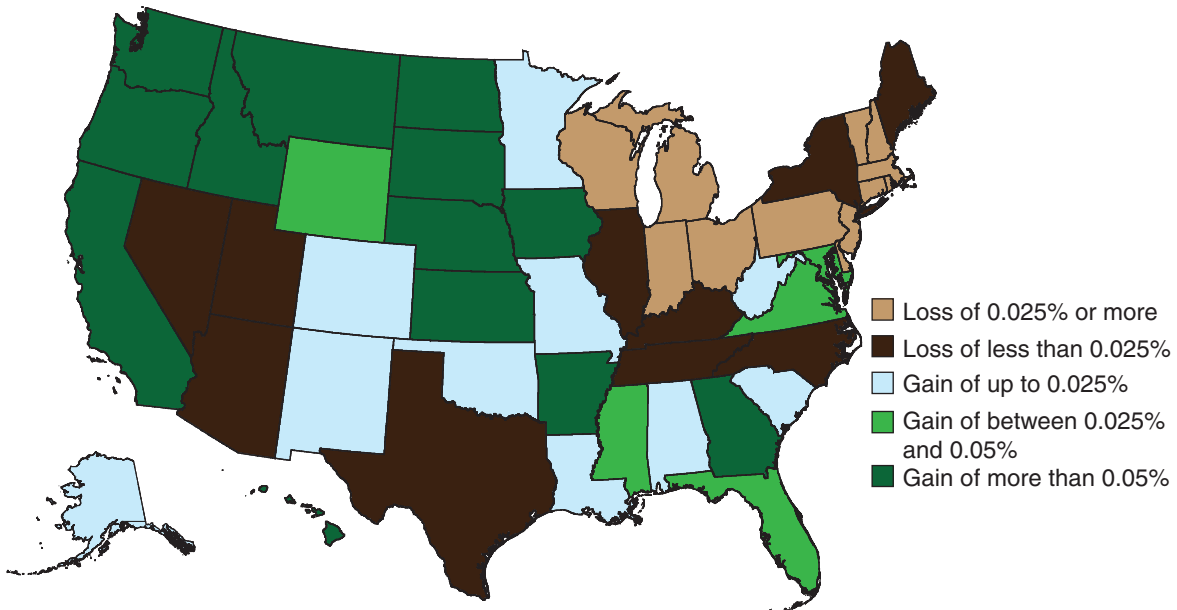
Change in nonmetro employment from a 10-percent increase in demand for U.S. agricultural exports



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.

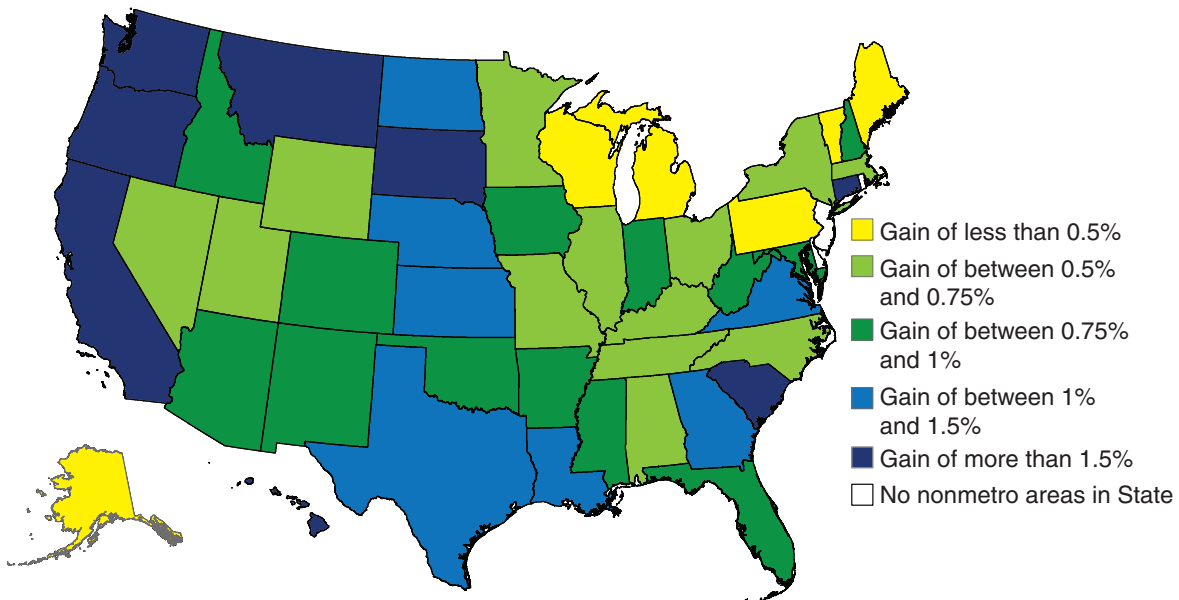
Figures 5 and 6 pertain to changes in agri-food employment, using a different scale than in figures 3 and 4 to reflect the larger proportionate effects. All regions, except for the District of Columbia, experience growth in agri-food employment. Eight nonmetro regions (Washington, Oregon, California, 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

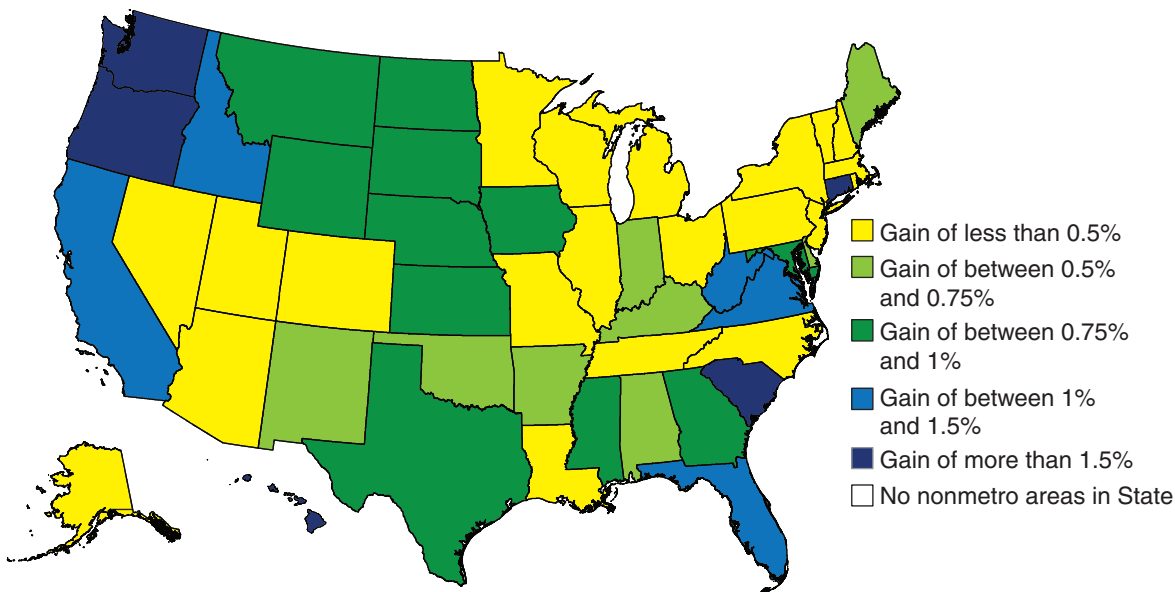
Figure 5
Change in nonmetro agri-food employment from a 10-percent increase in demand for U.S. agricultural exports



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:

$$AG_COMP_r = \sum_s SH_{s,r} \times NAT_PCT_CH_s$$

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

¹³The 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.

¹⁴The 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

Dependent variable = Percentage change in employment	Model 1		Model 2		Model 3		Model 4	
	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

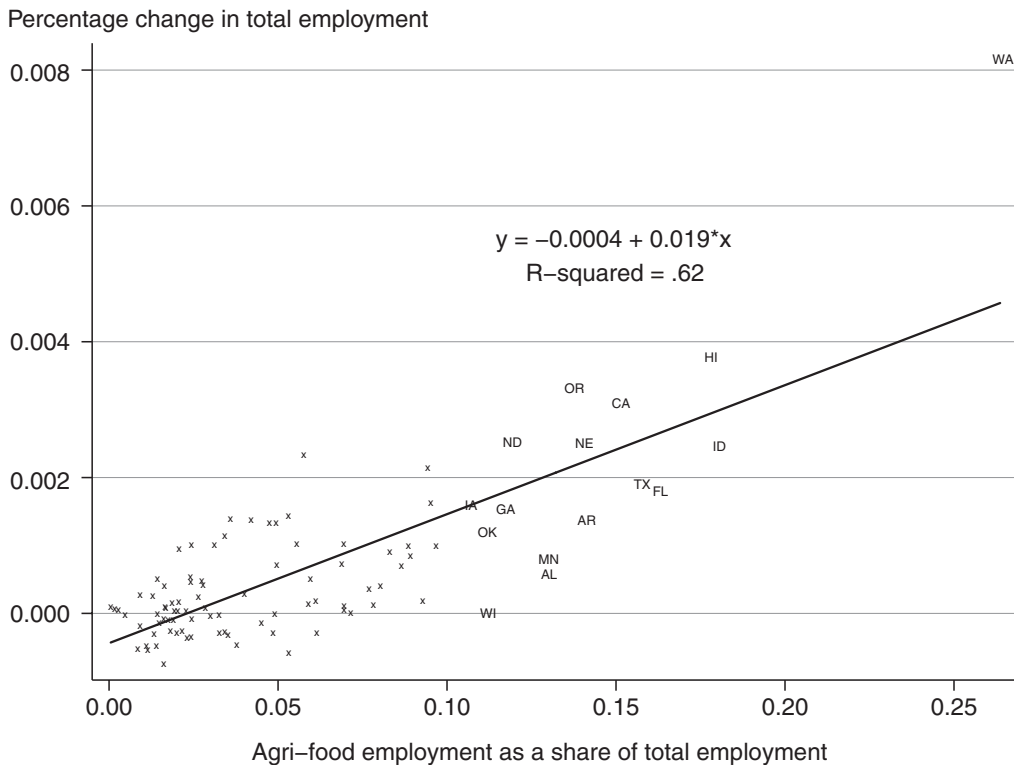
Robust standard errors in parentheses

*** 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 indispensable 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 macro-economic, 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.

References

Website addresses current as of February 14, 2017.

- Athukorala, Prema-chandra, and Fawad Khan. 2016. "Global Production sharing and the Measurement of Price Elasticity in International Trade," *Economics Letters* 139 (Feb.): 27-30. <http://www.sciencedirect.com/science/article/pii/S0165176515003961>.
- Burfisher, Mary E. 2011. *Introduction to Computable General Equilibrium Models*. New York: Cambridge University Press.
- Bussière, Matthieu. 2011. "Estimating Trade Elasticities: Demand Composition and the Trade Collapse of 2008-09." <http://www.parisschoolofeconomics.eu/IMG/pdf/Bussiere-Callegari-Ghironi-Sestieri-Yamano-oct2011.pdf>.
- Cooke, Bryce. 2015. "Foreign Agricultural Trade of the United States (FATUS): Questions & Answers." U.S. Department of Agriculture, Economic Research Service, June 9. <https://www.ers.usda.gov/data-products/foreign-agricultural-trade-of-the-united-states-fatus/questions-answers/>.
- Dixon, Peter B., and Maureen T. Rimmer. 2015. "CGE modelling as a framework for absorbing specialist information: linking an energy model and a CGE model to analyse U.S. energy policies," in G. Das (ed.), *Current Issues in International Trade: Methodologies and Development Implications for the World Economy* (Nova Science Publishers): 183-200.
- _____. 2014. "USAGE-Hwy: Creation and illustrative application." Report prepared for the U.S. Department of Transportation, Volpe Center. Feb.
- _____. 2013a. "Doubling U.S. Exports Under the President's National Export Initiative: Implications of successful implementation," *Contemporary Economic Policy* 31(2): 440-56.
- _____. 2013b. "Validation in CGE Modeling," in P.B. Dixon and D.W. Jorgenson (eds.) *Handbook of Computable General Equilibrium Modeling*. Elsevier, Amsterdam.
- _____. 2011. "You can't have a CGE recession without excess capacity," *Economic Modelling* 28(1-2, Jan.-Mar.): 602-13.
- _____. 2010. "Validating a detailed, dynamic CGE model of the USA," *Economic Record* 86 (Special issue, Sept.): 22-34.
- _____. 2004. "The US economy from 1992 to 1998: results from a detailed CGE model," *Economic Record* 80 (Special Issue, Sept.): S13-S23.
- _____. 2002. *Dynamic General Equilibrium Modelling for Forecasting and Policy: A Practical Guide and Documentation of MONASH*. Contributions to Economic Analysis, Vol. 256. Amsterdam: North-Holland Publishing Company.
- Dixon, P.B., J.A. Giesecke, M.T. Rimmer, and A. Rose. 2011a. "The economic costs to the U.S. of closing its borders: a computable general equilibrium analysis," *Defence and Peace Economics* 22 (1, Feb.): 85-97.

- Dixon, P.B., M. Johnson, and M.T. Rimmer. 2011b. "Economy-wide effects of reducing illegal immigrants in U.S. employment," *Contemporary Economic Policy* 29(1, Jan.): 14-30.
- Dixon, P.B., R.B. Koopman, and M.T. Rimmer. 2013. "The MONASH style of CGE modeling: a framework for practical policy analysis." Chapter 2 in P.B. Dixon and D.W. Jorgenson (eds.) *Handbook of Computable General Equilibrium Modeling*. Elsevier, Amsterdam.
- Dixon, P.B., B. Lee, T. Muehlenbeck, M.T. Rimmer, A.Z. Rose, and G. Verikios. 2010. "Effects on the U.S. of an H1N1 epidemic: Analysis with a quarterly CGE model," *Journal of Homeland Security and Emergency Management* 7(1), Article 75.
- Dixon, P.B., S. Osborne, and M.T. Rimmer. 2007. "The economy-wide effects in the United States of replacing crude petroleum with biomass," *Energy and Environment* 18(6): 709-722.
- Dixon, P.B., M.T. Rimmer, and B.W. Roberts. 2014. "Restricting employment of low-paid immigrants: a general equilibrium assessment of the social welfare implications for legal U.S. wage-earners," *Contemporary Economic Policy* 32(3): 639-52.
- Dixon, P.B., M.T. Rimmer, and M.E. Tsigas. 2007. "Regionalizing results from a detailed CGE model: macro, industry and state effects in the U.S. of removing major tariffs and quotas," *Papers in Regional Science* 86(1, March): 31-55.
- Fox, A., W. Powers, and A. Winston. 2008. "Textile and Apparel Barriers and Rules of Origin: What's Left to Gain after the Agreement on Textiles and Clothing?" *Journal of Economic Integration* 23(3): 656-84.
- Gehlhar, M., A. Somwaru, P.B. Dixon, M.T. Rimmer, and A.R. Winston. 2010. "Economywide Implications from US Bioenergy Expansion," *American Economic Review* 100(2, May): 172-77.
- Giesecke, J.A. 2011. "Development of a large-scale single U.S. region CGE model using IMPLAN data: A Los Angeles County example with a productivity shock application," *Spatial Economic Analysis* 6(3).
- Giesecke, J.A., W. Burns, A. Barrett, E. Bayrak, A. Rose, P. Slovic, and M. Suher. 2012. "Assessment of the regional economic impacts of catastrophic events: CGE analysis of resource loss and behavioral effects of an RDD attack scenario," *Risk Analysis* 32(4): 583-600.
- Jacobs, Elisabeth. 2015. "The Declining Labor Force Participation Rate: Causes, Consequences, and the Path Forward." Testimony before the United States Congress Joint Economic Committee on "What Lower Labor Force Participation Rates Tell Us about Work Opportunities and Incentives." July 15. http://www.jec.senate.gov/public/_cache/files/3d9668e5-804e-40da-bc6c-0f954b34f80e/jacobs-lfpr-testimony-for-jec-hearing-final.pdf.
- Kee, Hiau Looi, Alessandro Nicita, and Marcelo Olarreaga. 2008. "Import Demand Elasticities and Trade Distortions," *The Review of Economics and Statistics* 90(4, Nov.): 666-682. <http://www.mitpressjournals.org/doi/pdf/10.1162/rest.90.4.666>.
- Paggi, Mechel S., C. Parr Rosson, III, Flynn J. Adcock, and Daniel Hanselka. 2011. "National and Regional Impacts of U.S. Agricultural Exports," *Choices* 26(1).

- Persaud, Suresh. 2017. "Agricultural trade multipliers: effects of trade on the U.S. economy – 2015." U.S. Department of Agriculture, Economic Research Service. Jan. 30. <https://www.ers.usda.gov/data-products/agricultural-trade-multipliers/effects-of-trade-on-the-us-economy-2015/>.
- Rasmussen, Chris. 2016. *Jobs Supported by Exports 2014: Product and Industry*. U.S. Department of Commerce, International Trade Administration, Office of Trade and Economic Analysis. July 13. http://www.trade.gov/mas/ian/build/groups/public/@tg_ian/documents/webcontent/tg_ian_005506.pdf.
- Raza, Werner, Lance Taylor, Bernhard Tröster, and Rudi von Amim. 2016. "Modelling the Impacts of Trade on Employment and Development: A Structuralist CGE-model for the Analysis of TTIP and Other Trade Agreements." Austrian Foundation for Development Research (ÖFSE), Working Paper No. 57, April.
- Sablik, Tim. 2013. "Jargon Alert: Full Employment." Federal Reserve Bank of Richmond, *Econ Focus*, Second Quarter: 10. https://www.richmondfed.org/~media/richmondfedorg/publications/research/econ_focus/2013/q2/pdf/jargon_alert.pdf.
- Simonovska, Ina, and Michael E. Waugh. 2014. "The Elasticity of Trade: Estimates and Evidence," *Journal of International Economics* 92(1): 34-50. <http://www.sciencedirect.com/science/article/pii/S0022199613000986>.
- U.S. Department of Agriculture, Foreign Agricultural Service (USDA/FAS). 2017. *Global Agricultural Trade System*. Statistical database. <http://apps.fas.usda.gov/gats/Default.aspx>.
- _____. 2015. *Production, Supply, and Distribution Online*. Statistical database. <http://apps.fas.usda.gov/psdonline/psdhome.aspx>.
- U.S. Department of Agriculture, National Agricultural Statistics Service (USDA/NASS). 2017. "Charts and Maps: Prices Received: Indexes for Agricultural, Crop, and Livestock Production by Month, US." Jan. 31. http://www.nass.usda.gov/Charts_and_Maps/Agricultural_Prices/received.php.
- U.S. Department of Commerce, Bureau of Economic Analysis. 2016a. "CA6N Compensation of Employees by NAICS Industry: Metropolitan and Nonmetropolitan Portions." *Interactive Data: Regional Data: GDP & Regional Income*. Nov. 17. http://www.bea.gov/iTable/index_regional.cfm.
- _____. 2016b. "Value Added by Industry." *Interactive Access to Industry Economic Accounts Data: GDP by Industry*. Nov. 3. https://www.bea.gov/iTable/index_industry_gdpIndy.cfm.
- U.S. Department of Commerce, Census Bureau. 2013. "Metropolitan and Micropolitan." Website. May 6. <http://www.census.gov/population/metro/>.
- U.S. Department of Labor, Bureau of Labor Statistics. 2017a. "Household Data: Annual Averages: Table 18: Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity." <https://www.bls.gov/cps/cpsaat18.pdf>.
- _____. 2017b. *Top Picks: Labor Force Statistics from the Current Population Survey*. Statistical database. Sept. 26. <http://data.bls.gov/cgi-bin/surveymost?ln>.

- U.S. International Trade Commission (USITC). 2013. *The Economic Effects of Significant U.S. Import Restraints: Eighth Update*. Investigation No. 332-325. Publication No. 4440.
- _____. 2011. *The Economic Effects of Significant U.S. Import Restraints: Seventh Update*. Investigation No. 332-325. Publication No. 4253.
- _____. 2009. *The Economic Effects of Significant U.S. Import Restraints: Sixth Update*. Investigation No. 332-325. Publication No. 4094.
- _____. 2007. *The Economic Effects of Significant U.S. Import Restraints: Fifth Update*. Investigation No. 332-325. Publication No. 3906.
- _____. 2004. *The Economic Effects of Significant U.S. Import Restraints: Fourth Update*. Investigation No. 332-325. Publication No. 3701.
- Victoria University, Centre of Policy Studies (CoPS). 2016. “The USAGE Model.” <http://www.copsmodels.com/usage.htm>.
- Winston, Ashley. 2005. “The theory of tariff rate quotas: an application to the U.S. sugar program using MONASH-USA.” Working Paper No. IP-83, Centre of Policy Studies, Monash University. July. <http://www.copsmodels.com/ftp/workpapr/ip-83.pdf>.
- Zahniser, Steven, Sahar Angadjivand, Thomas Hertz, Lindsay Kuberka, and Alexandra Santos. 2015. *NAFTA at 20: North America’s Free-Trade Area and Its Impact on Agriculture*. Outlook Report No. WRS-15-01. U.S. Department of Agriculture, Economic Research Service, Feb. <https://www.ers.usda.gov/publications/pub-details/?pubid=40486>.
- Zahniser, Steven, Tom Hertz, Peter B. Dixon, and Maureen T. Rimmer. 2012. *The Potential Impact of Changes in Immigration Policy on U.S. Agriculture and the Market for Hired Farm Labor: A Simulation Analysis*. ERR-135. U.S. Department of Agriculture, Economic Research Service, May. <https://www.ers.usda.gov/publications/pub-details/?pubid=44983>.

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 Poultry and egg production Livestock production	Dairy farming Poultry and egg farming 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 Tree nut production Vegetable production Sugar crop production Greenhouse and nursery production	Fruit farming Tree nut farming Vegetable farming Sugar crop farming 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.