U.S. Employment Exposure to Agricultural Trade Policy

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Abstract

Literature examining the effects of changes in trade agreements and import competition on U.S. employment and wages has focused solely on non-farm industries, and the agricultural sector has mostly been ignored. In this paper, we propose a method for measuring worker exposure to changes in agricultural tariffs using a newly developed county-level dataset of employment shares by crop and livestock type. As an example, we apply the method to illustrate the spatial concentration of U.S. county-level employment-weighted exposure to changes in agricultural and non-agricultural tariffs caused by the North American Free Trade Agreement (NAFTA). These detailed data permit investigation of crop-, livestock-, and non-farm product-specific natural and market-driven shocks on employment and wage outcomes across U.S. counties. We show that reductions in U.S. tariffs imposed on imports from Mexico and Canada were much larger for crops than non-farm goods on average, and worker exposure to declines in foreign import tariffs on U.S. crops and livestock were even larger in magnitude. Based on these findings, we suggest that research should consider both exposure to farm and non-farm tariffs on imports that increase competition in domestic markets and exposure to foreign import tariffs that increase U.S. competitiveness in foreign export markets.

I. Introduction

There is renewed demand for economists to examine the efficiency and distributional implications of trade policies on labor markets. Globally, barriers to trade increased in recent years (Constantinescu et al., 2019). This includes increased tariffs from trade wars and barriers to the movement of people and goods implemented in response to Covid-19 (Beckman and Countryman, 2021; Beckman, Baquedano, and Countryman, 2021; World Trade Organization, 2020). Previous literature examines the effects of trade liberalization on employment and wages in non-farm industries of the United States (Autor, Dorn, and Hanson, 2013; Autor et al., 2014; Hakobyan and McLaren, 2016). However, the omission of agricultural sectors from this literature has important implications, especially for rural communities where agricultural exports are a significant source of income. This paper proposes a method for measuring worker exposure to changes in agricultural tariffs using a newly developed county-level dataset of employment shares by crop and livestock type. As an example, we apply the method to illustrate the spatial concentration of US county-level exposure to changes in agricultural and non-agricultural tariffs caused by the North American Free Trade Agreement (NAFTA). These detailed data permit investigation of crop-, livestock-, and non-farm product-specific natural and market-driven shocks on employment and wage outcomes across U.S. counties.

Neoclassical economic theory implies that labor will migrate across industries in response to trade liberalization, from industries or locations where the country does not have a comparative advantage to industries or locations where the country does. However, empirical studies show that there are high frictions to labor mobility. For example, Autor et al. (2014) find heterogeneous labor mobility across workers of different initial skills and wages in the United States. They find that low-wage workers initially employed in industries that experience high import competition tend to migrate to firms within the same sector, thus experiencing multiple employment disruptions due to increasing exposure to import competition over time. In contrast, high-wage workers are better able to migrate to higher performing industries over the long run. High-wage workers experience greater wage growth and are less likely to take public disability benefits than low-wage workers following an influx in import competition. Findings from other countries indicate that wage depression and low employment resulting from trade liberalization can persist for many years. For example, trade liberalization in Brazil led to large declines in formal sector employment and wages up to 20 years after a cut in tariffs (Dix-Carneiro and Kovak, 2017). While capital responded relatively rapidly to changes in profitability across sectors and regions, labor was largely immobile after trade liberalization, even in the long run. Additional research to understand how trade liberalization or protectionist policies affect labor markets in urban and rural communities across different industries is imperative for informing policy and anticipating changes in labor migration.

Previous literature examining the effects of NAFTA on worker wages in the United States shows that NAFTA depressed the wages in industries that experienced large declines in tariff protection from 1990-2000. Service sector workers also had depressed wages if they were employed in locations where a large share of the workforce in 1990 was employed in industries that had large declines in protection during the roll-out of NAFTA (Hakobyan and McLaren, 2016). These findings affirm that labor is not perfectly mobile across industries or geographic locations and labor markets do not adjust immediately to changes in global competition when trade is liberalized. However, the agricultural sector was deliberately excluded from Hakobyan and McLaren (2016)'s analysis due to lack of detailed data on labor employment by crop and location. While their findings are robust to the inclusion of the aggregate agricultural industry, agricultural tariffs changed substantially during NAFTA and this may have had unintended consequences across agricultural sectors. Canned, Frozen, and Preserved Fruits and Vegetables was the third most protected industry in the United States in 1990. After adjusting for Mexico's Revealed Comparative Advantage[1] in production of goods in each industry, it is only the fifth most protected industry, and Agricultural Crop Production is the eighth most protected industry (Hakobyan and McLaren, 2016). In rural communities, where agriculture is a more dominant employer, changes in agricultural tariffs could have important labor market implications that are not fully understood when only controlling for effects of aggregate agricultural labor exposure to tariffs that mask variation across individual crops and livestock. Furthermore, although much of the previous literatures has focused on

[1]Mexico's Revealed Comparative Advantage is Mexico's share of trade with the rest of the world in the select industry divided by Mexico's share of trade with the rest of the world in all goods. A Revealed Comparative Advantage greater than 1 means that Mexico exports more of the good than the average product (Hakobyan and McLaren, 2016).

diminished tariff protection during trade liberalization, improved access to foreign export markets also needs to be explored. The United States is a major exporter of agricultural goods. Even though some crops lost protection with implementation of NAFTA, others gained access to important foreign markets. Net effects of NAFTA on employment and wages in agricultural industries and rural communities is hitherto unknown.

We create a unique dataset that combines trade data detailed to the 6-digit Harmonized System (HS) product code with county-level acreage and production data for specific crops and livestock in the U.S. Census of Agriculture, labor inputs by crop from Crop Enterprise Budgets, and wage and employment data from the Quarterly Census of Employment and Wages (QCEW). Our methods are similar to those of Topalova (2007) and Topalova (2010), additionally weighting tariffs by the trading partner's Revealed Comparative Advantage (RCA) as in Hakobyan and McLaren (2016). We show that U.S. tariffs on Mexican and Canadian agricultural goods declined more than those on non-farm goods during NAFTA. However, the decrease in U.S. tariff protection was much smaller in magnitude than the decrease in tariffs that Canada and Mexico imposed on imports of U.S. crops and livestock. The decrease in Mexican import tariffs on crops and livestock was larger in magnitude than its decrease in non-farm import tariffs. There was little change in Canadian import tariffs on U.S. crops and non-farm goods, but Canada reduced import tariffs on U.S. livestock substantially. Furthermore, we show that the employment weighted workforce exposure to reduced foreign import tariffs on U.S. crops and livestock was larger in magnitude and more geographically spread than changes in workforce exposure to reductions in U.S. or foreign import tariffs on non-farm goods following the roll-out of NAFTA. Given the relatively large declines in foreign import tariffs that U.S. crop and livestock producers were exposed to, NAFTA might have benefited many industries and workers in nearby locations if there were substantial spillovers. This contrasts with previous literature that has focused solely on losses in non-farm employment protection from U.S. tariffs on imports and merits further empirical investigation.

Little research has been devoted to understanding the effects of trade liberalization on employment and wages in rural communities of developed countries with a large agricultural presence. Our focus on rural communities is an important distinction from previous literature since the United States was a net exporter of agricultural products during the roll-out of NAFTA, and employment and wages in agricultural communities might benefit from reduced tariffs on U.S. goods even as employment and wages declined in non-farm industries that were exposed to more foreign competition. Empirical investigation that accounts for changes in workforce exposure to U.S. and foreign import tariffs is necessary to understand the full implications of trade agreements like NAFTA. Our findings suggest that the effects might be more complex than previous literature implies.

II. Data

We create a unique dataset of county-level tariff exposure. We combine data from the World Integrated Trade Solution (WITS), the U.S. Agricultural Census, the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW), and farm-level crop enterprise budgets published by various U.S. universities. We create the first national dataset to our knowledge with county labor employment shares by individual crops, and we combine this with labor shares by non-farm and livestock products, and U.S., Canadian, and Mexican import tariffs by product and year.

II - I Trade and Tariff Data Construction

We obtain trade and tariff data from the World Integrated Trade Solution (WITS) database, which accesses major international trade databases—the United Nations (UN) Comtrade database for trade and the United Nations Conference on Trade and Development (UNCTAD) Trade Analysis Information System (TRAINS) database for tariffs. From the WITS database, we derive annual bilateral trade flow at the Harmonized System (HS) 6 product level from 1993 to 2010. We use the HS6 product code level because we can more precisely match tariffs to specific crops and livestock. We use bilateral import and export trade values in US dollars from Canada, Mexico, the U.S., and the rest of the World. We examine bilaterally applied import tariffs at the HS6 level, which we merge with trade flows. We focus on changes in employment weighted import tariff exposure by

U.S. county from 1996 to 2006, since the WITS data appear more complete in 1996 than in previous years (data are sparse prior to 1996 as though countries did not report trade or tariffs for all goods (see figures 1-2)), and there was little change in applied import tariff rates between the U.S., Canada, and Mexico past 2006.

We weight import tariffs by the comparative advantage of the trading partners to place greater weight on tariffs of goods that the trading partner specializes in exporting. We do this using the Revealed Comparative Advantage (RCA) as in Hakobyan and McLaren (2016). The RCA is a measure of how much a country exports a good relative to total world exports of that good as a share of the country's share of total world exports in all goods. Specifically, let $k \in 1, ..., K$ be the index of goods for which we have employment data. Some index numbers will match to multiple HS6 codes. To aggregate multiple HS6 products to the index k, we sum trade flows within each industry k and take an average of import tariffs, weighted by 1992 import value. The RCA is then calculated at the country-by-product k level using global trade data from 1992 as follows:

$$RCA_k^c = \frac{\frac{x_{kt}^c}{x_{kt}^{ROWc}}}{\sum_n \frac{x_{nt}^c}{x_{nt}^{ROWc}}} \quad (1)$$

where x_{kt}^c is country c's exports of good k to the rest of the world (ROW) excluding exports to the trading partner of interest (e.g. when calculating Mexico's Revealed Comparative Advantage for trade with the United States, we exclude Mexico's exports of good k to the United States), and x_{kt}^{ROWc} is total exports of good k from countries excluding bilateral trade between the two countries of interest to one another. Thus the numerator is country c's share of world trade of good k excluding trade with the trading partner of interest. The denominator is country c's share of total ROW exports in all goods $n \in 1, 2, ..., k, ..., N$. Thus the RCA is country c's share of ROW exports of good k divided by country c's share of total ROW exports. If $RCA > 1$, then this is indicative that country c specializes in production and trade of good k.

Let $j \in \{crop, livestock, non-farm\}$ index the three labor sectors of interest, and each industry k belongs to a sector j. We map crop and livestock products that involve minimal processing to crops and livestock, respectively. For example, both wheat and flour are mapped to crops. Both live cattle and beef are mapped to livestock. (We describe this mapping in more detail in the next section.) We calculate the weighted mean import tariff that the United States imposes on country $c \in \{MX, CA\}$ for goods in sector j as follows:

$$\tau_{jt}^{US-c} = \frac{\sum_{k\in j} \tau_{kt}^{US-c} \cdot RCA_k^c}{\sum_{k\in j} RCA_k^c} \tag{2}$$

where τ_{kt}^{US-c} is the tariff that the United States imposes on imports of goods in industry k from country c in year t, and RCA_k^c is country c's Revealed Comparative Advantage in global exports of goods from industry k.

We similarly calculate the weighted mean tariff that each country c imposes on the United States for goods in sector j as follows:

$$\tau_{jt}^{c-US} = \frac{\sum_{k\in j} \tau_{kt}^{c-US} \cdot RCA_k^{US}}{\sum_{k\in j} RCA_k^{US}} \tag{3}$$

We plot the weighted mean tariffs by sector over time in figures 1-2. Import tariffs seem to peak around 1996, which we believe is due to incomplete reporting in prior years. There is some noise from year to year, but overall we find substantial drops in mean tariffs following implementation of NAFTA. Mean U.S. import tariffs were relatively small from the start with all mean tariffs below 10% throughout the time period and ending near zero by 2005. Mean Mexican tariffs on U.S. crops and livestock were over 20% in 1996 and dropped below 10% by 2005. Canada reduced tariffs on U.S. livestock and related products from nearly 50% to only 25% from 1996-2006. There was little change in weighted mean crop and non-farm tariffs that Canada imposed on the United States, which were both low from the start.

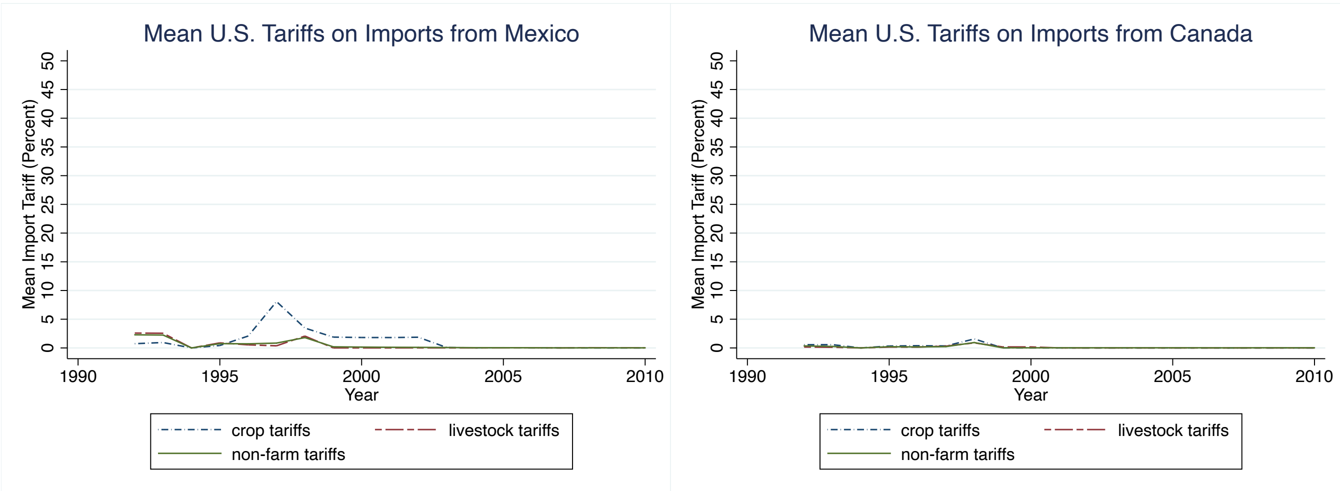

Figure 1: Weighted Mean U.S. Import Tariffs on Mexico and Canada

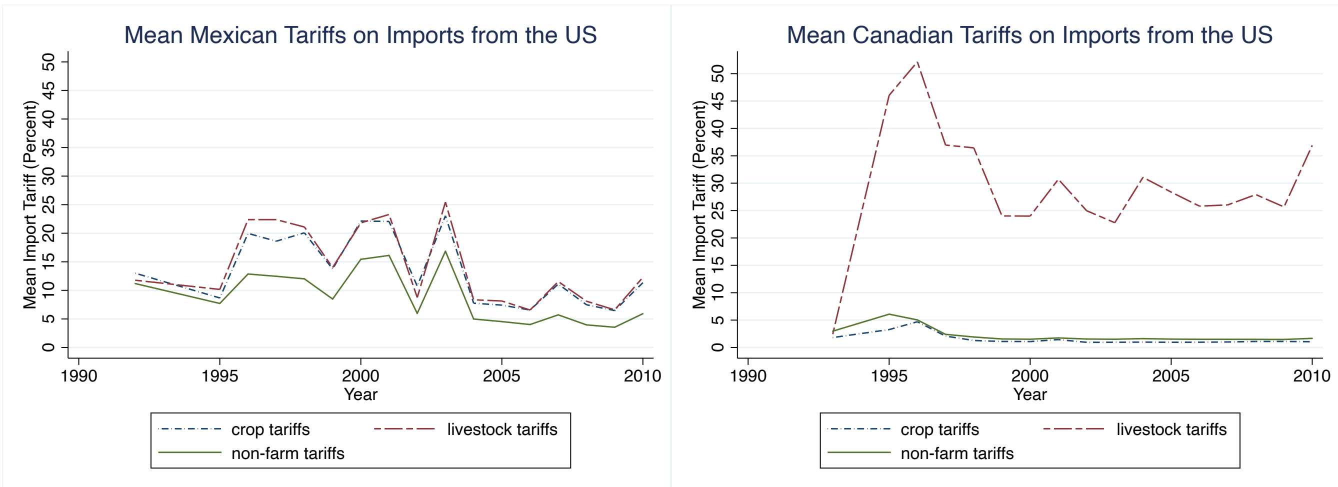

Figure 2: Weighted Mean Mexican & Canadian Import Tariffs on the U.S.

II - II Labor Share Data and Construction

To find employment share by crop of type k, we take detailed acreage data by crop from the 1992 U.S. Census of Agriculture. Although, the Census of Agriculture does not record labor employment per crop, we can impute labor hours per crop by multiplying acreage by the approximate labor hours per acre required to produce each crop. We take hours per acre from crop enterprise budgets published at various universities. Since many of the tasks performed on farm are hired through custom operations, the budgets do not always contain detailed labor input data. We spoke with authors of the reports to approximate percentages of costs for agricultural production activities like discing or spraying that can be attributed to labor, so that we can include these activities in total labor inputs even when they are written only as total custom line items. These budgets are based on production inputs reported for representative farms and do not reflect labor inputs on every farm. Nevertheless, they provide proxies for labor inputs per acre and generate substantial variation in labor inputs across crops. Labor-intensive crops like strawberries, for instance, have many more hours per acre than a crop, like soybeans, which is highly mechanized. We do this for every crop k and compute the total implied crop labor hours in the county by taking the product of acreage of crop k in the county and labor hours per acre for production of crop k, summed across all crops. We then find crop k share of total county crop labor hours by crop type. Finally, the QCEW records employment by industry using North American Industry Classification System (NAICS). NAICS 111 is crop employment and 115115 farm labor contractors and crew leaders. We sum these to find the total number of crop workers in a county and then find the crop employment share of total employment in the county in 1992. We multiply this share by crop k share of total crop hours to find proxies for crop k employment share of total county employment.

For livestock employment shares, since we lack proxies of employment per animal, we approximate livestock employment shares by taking the share of total livestock value in the county for each animal (cattle, dairy, sheep, goats, dairy, hogs, poultry) in the 1992 Census of Agriculture. We then multiply this livestock k share of total livestock value in the county by animal production and aquaculture (NAICS 112) share of total employment (NAICS 10) in the 1992 QCEW. For the non-farm sector, we take employment shares using the 3-digit NAICS codes and we include Forestry and Logging (NAICS 113) and Fishing, Hunting and Trapping (NAICS 114) and the remainder of Support Activities for Agriculture and Forestry (NAICS 115) in the non-farm sector.

The QCEW includes data for all workers who worked during, or received pay, during the pay period including the 12th day of the month and who were covered by the state unemployment insurance (UI) laws (and federal workers covered by the Unemployment Compensation for Federal Employees program). In some states, farms below a threshold size might be exempt, and workers who receive pay off the books will be excluded. Nevertheless, even unauthorized workers frequently borrow a social security number to receive pay on the books, and we do not expect these measurement errors to be systematically correlated with variation in county exposure to trade liberalization after controlling for county fixed effects.

In order to merge employment share data with trade and tariff data, we map HS codes to NAICS 3 codes and map HS codes to crops and livestock by hand. Since we expect tariffs on minimally processed goods to impact farmers, we map crops and animals to goods with some processing. For example, an import tariff on beef affects not only meat processing facilities but also feedlot and cow-calf operations in other locations. We do not want to include high levels of processing in the crop and livestock tariffs, but we want to include minimal downstream linkages. For example, tomatoes are mapped to the following HS codes in table 1.

Table 1: Harmonized System Mapping to Tomatoes

HS Code	**Definition**
70200	Vegetables; Tomatoes, fresh or chilled
200210	Vegetable preparations; tomatoes, whole or in pieces, prepared or preserved otherwise than by vinegar or acetic acid
200290	Vegetable preparations; tomatoes (other than whole or in pieces) prepared or preserved otherwise than by vinegar or acetic acid
200950	Juice; tomato, unfermented, not containing added spirit, whether or not containing added sugar or other sweetening matter
210320	Sauces; tomato ketchup and other tomato sauces

III. Calculating County Employment Exposure to Domestic and Foreign Import Tariffs

We calculate county employment exposure to foreign import tariffs for each county i and for countries $c \in \{MX, CA\}$ as follows:

$$\tau_{it}^{cj} = \frac{\sum_{k \in j} L_{ikt} RCA_k^{US} \tau_{kt}^{c-US}}{\sum_{k \in j} L_{ikt} RCA_k^{US}} \tag{4}$$

where L_{ikt} is employment in industry k in county i in year t, RCA_k^{US} is the U.S.'s Revealed Comparative Advantage in world exports of product k, and τ_{kt}^{c-US} is the tariff that country c imposes on its imports of good k from the United States in year t.

We similarly calculate the U.S. county employment-weighted tariffs on imports from Mexico and Canada as follows:

$$\tau_{it}^{USj} = \frac{\sum_{k \in j} L_{ikt} RCA_k^{c} \tau_{kt}^{US-c}}{\sum_{k \in j} L_{ikt} RCA_k^{c}} \tag{5}$$

IV. Changes in County Import Tariff Exposure During NAFTA Implementation

Figures 3- 4 show the changes within counties in employment-weighted mean exposure to tariffs that Mexico and Canada imposed on imports of U.S. crops and lightly processed related goods. There were large reductions in average crop import tariffs imposed by Mexico across U.S. counties. Reduced exposure to Canadian import tariffs were more concentrated in wheat growing regions of the United States. Figures 5- 6 show the changes within counties in employment-weighted mean exposure to tariffs that the United States imposed on crop imports from Mexico and Canada. There was very little change in the average tariffs that the United States imposed on its crop imports since U.S. crop import

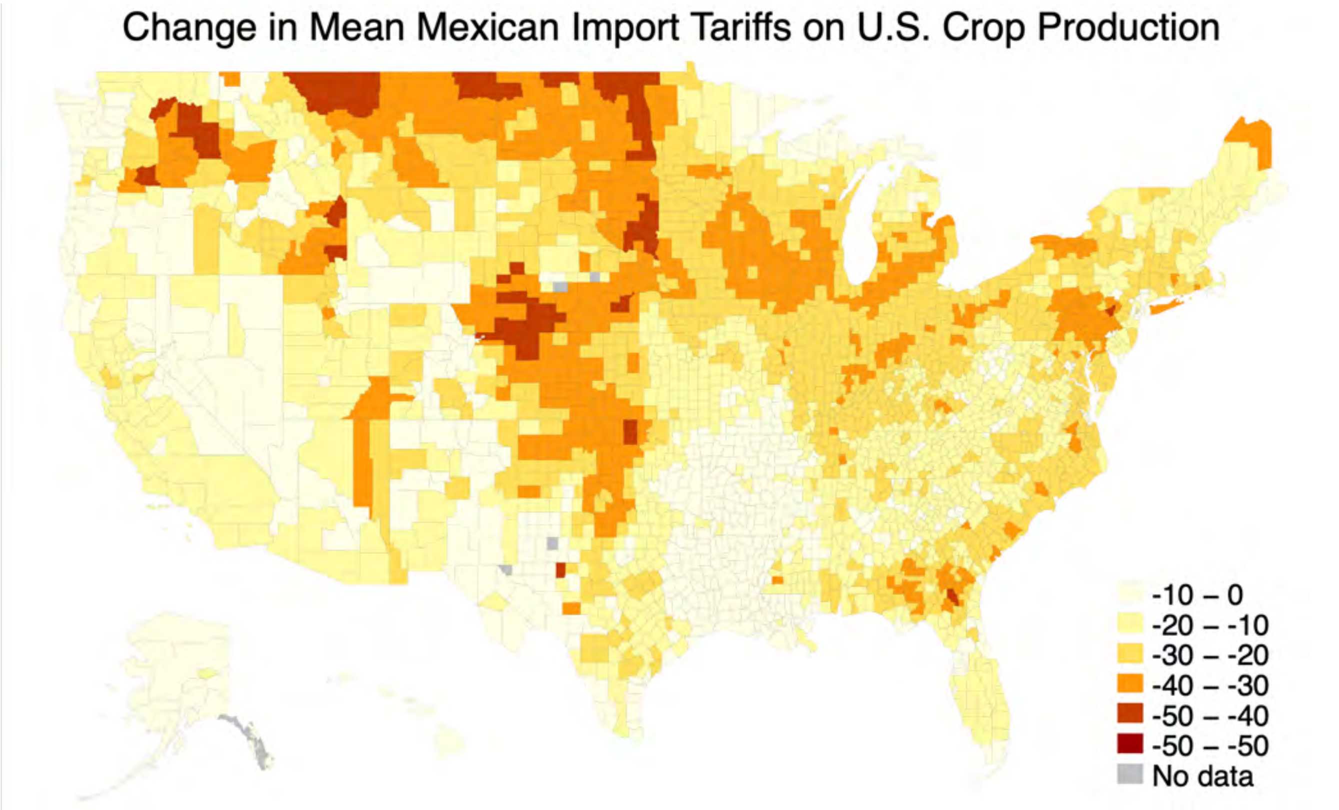

Figure 3: Change in Weighted Mean Mexican Import Tariffs on U.S. Crops Produced in County

tariffs were initially low (mean U.S. import tariffs on Canadian crops were less than 1% at the start of the period).

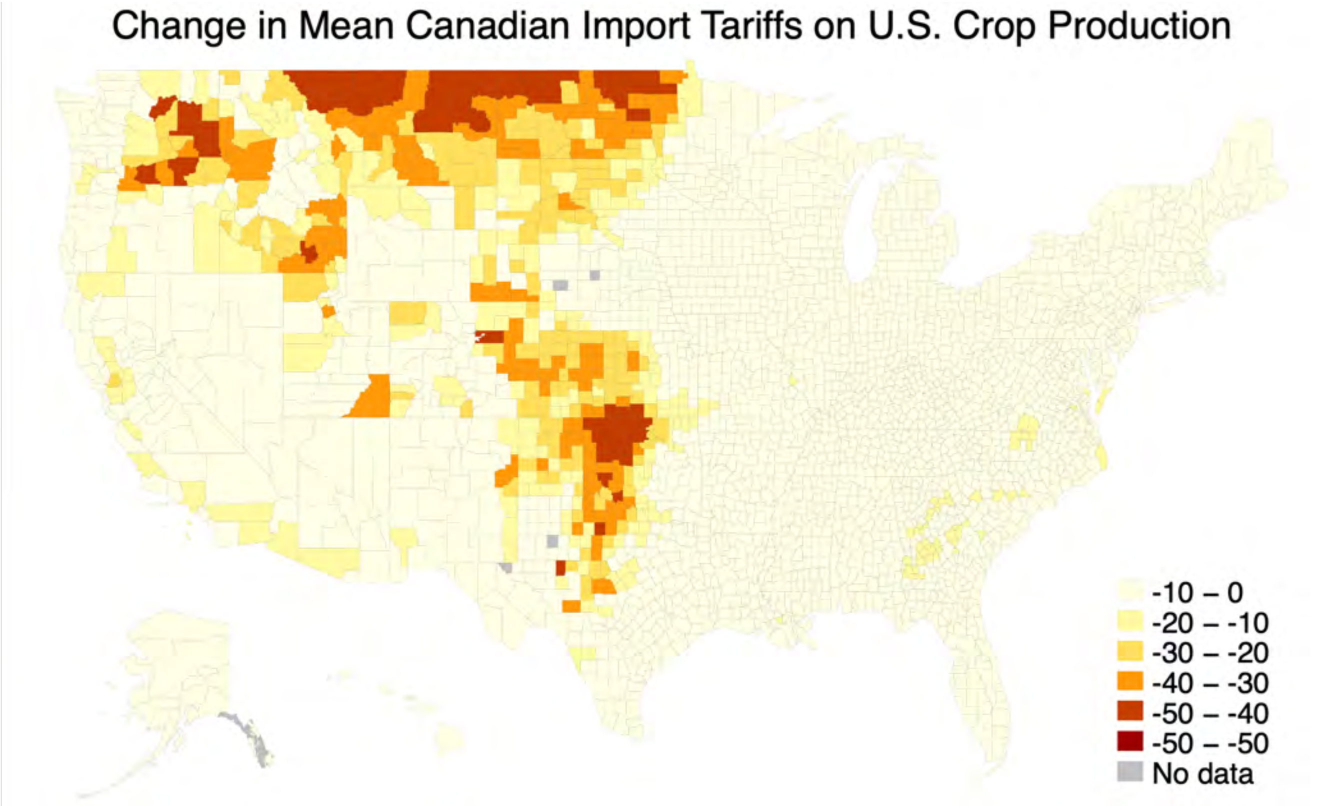

Figure 4: Change in Weighted Mean Canadian Import Tariffs on U.S. Crops Produced in County

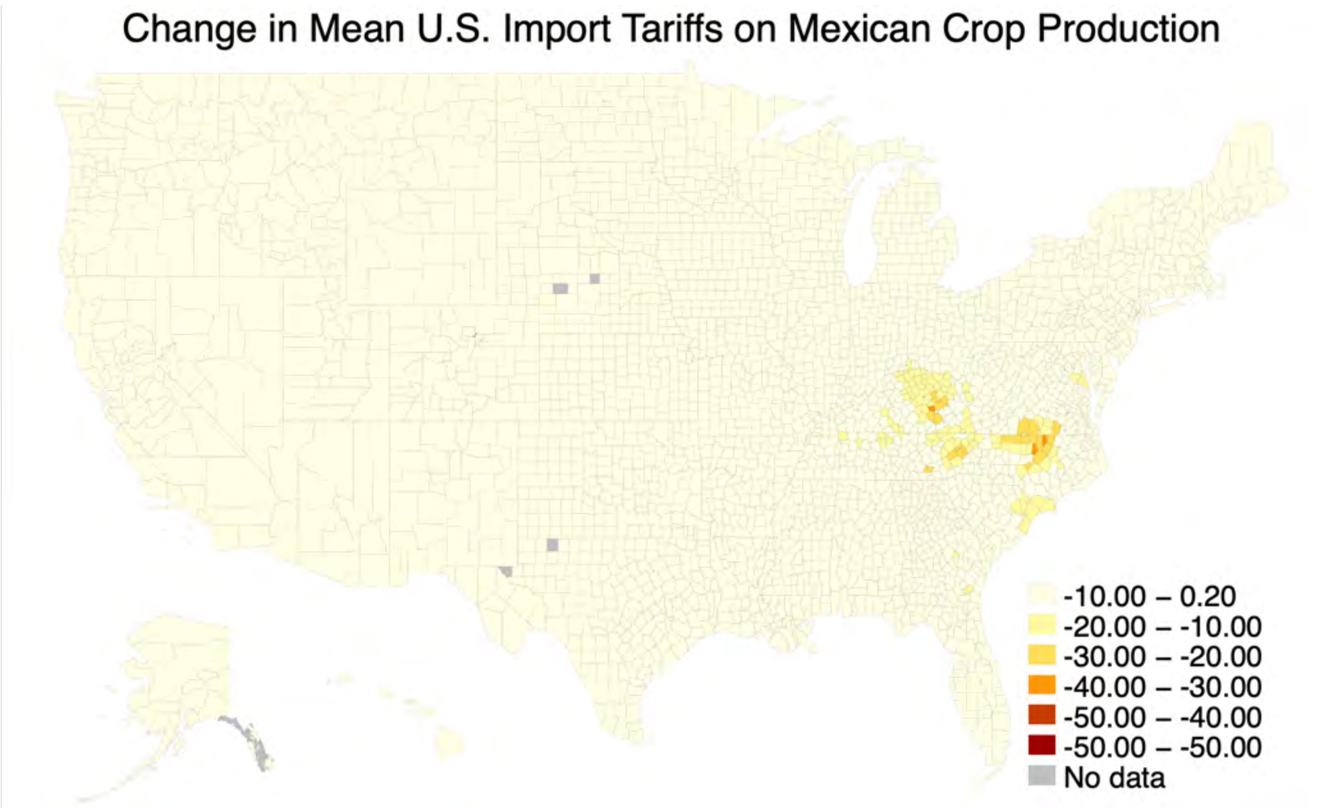

Figure 5: Change in Weighted Mean U.S. Import Tariffs on Mexican Crops Produced in County

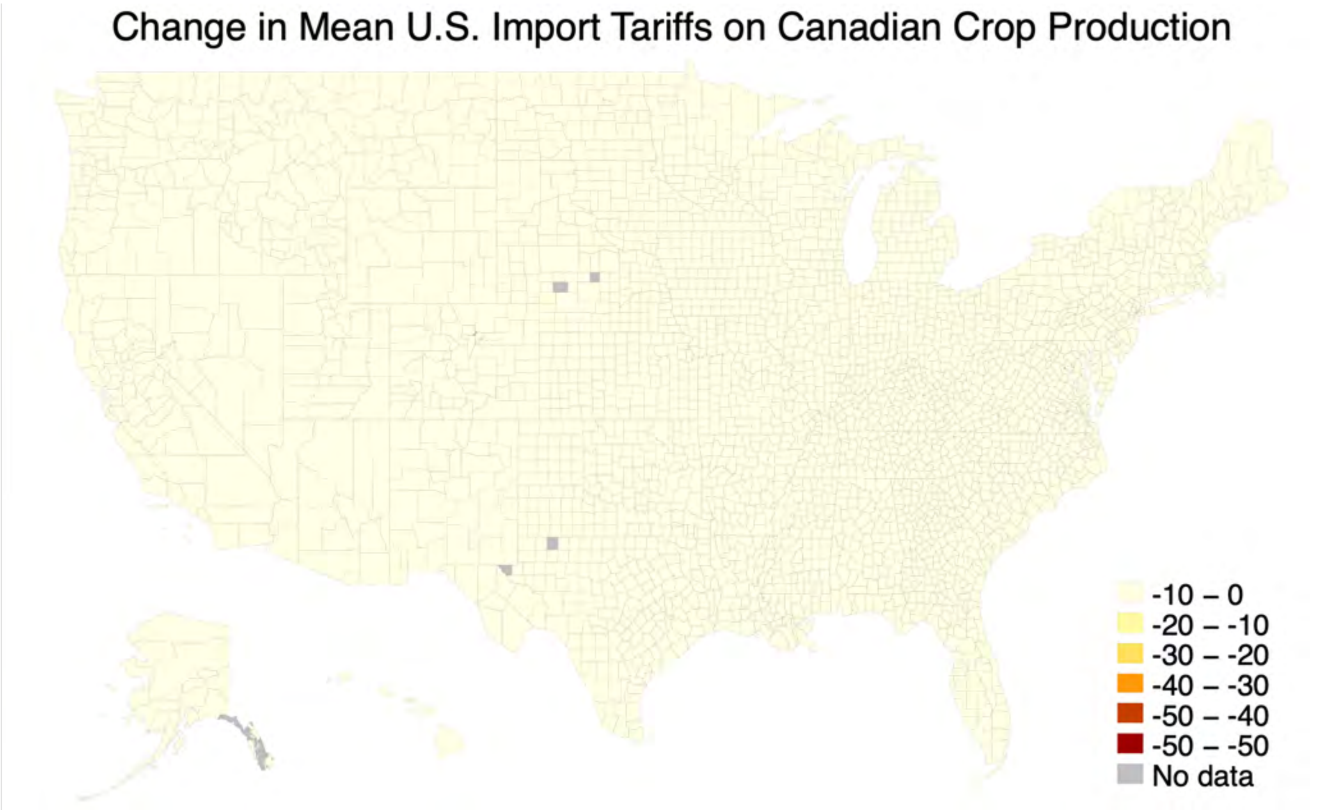

Figure 6: Change in Weighted Mean U.S. Import Tariffs on Canadian Crops Produced in County

Figures 7- 9 map county shares of crop acreage for wheat, corn, and soybeans. Reduced exposure to Canadian import tariffs on U.S. crop products is highly correlated with the share of wheat production in a county. Reduced exposure to Mexican import tariffs on U.S. crop products is highly correlated with county-level share of crop acreage in corn, wheat, and soybeans. There also appears to be moderate reductions in exposure to Mexican import tariffs in California, Florida, Oregon, and other regions that produce a wide variety of fruits, vegetables, and specialty crops.

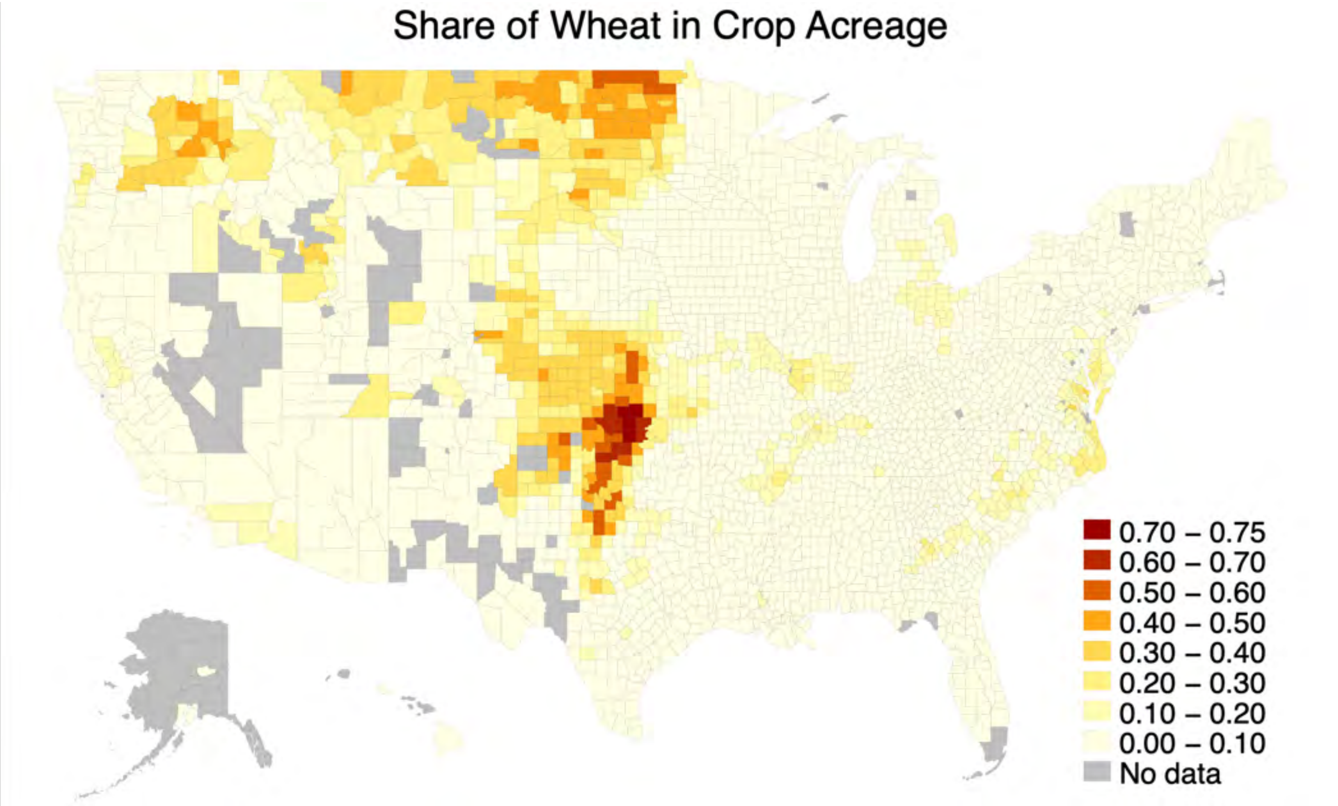

Figure 7: U.S. County Crop Acreage in Wheat (1992 Census of Agriculture)

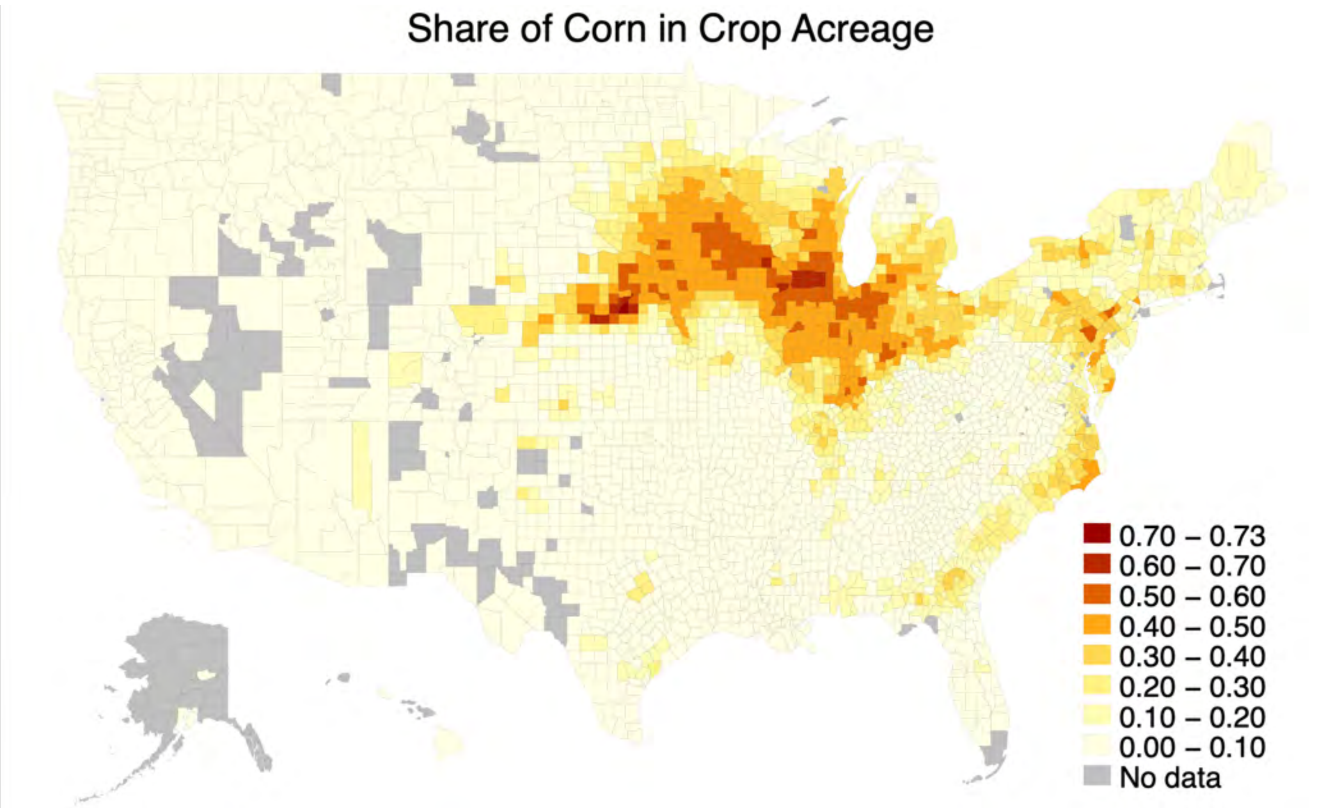

Figure 8: U.S. County Crop Acreage in Corn (1992 Census of Agriculture)

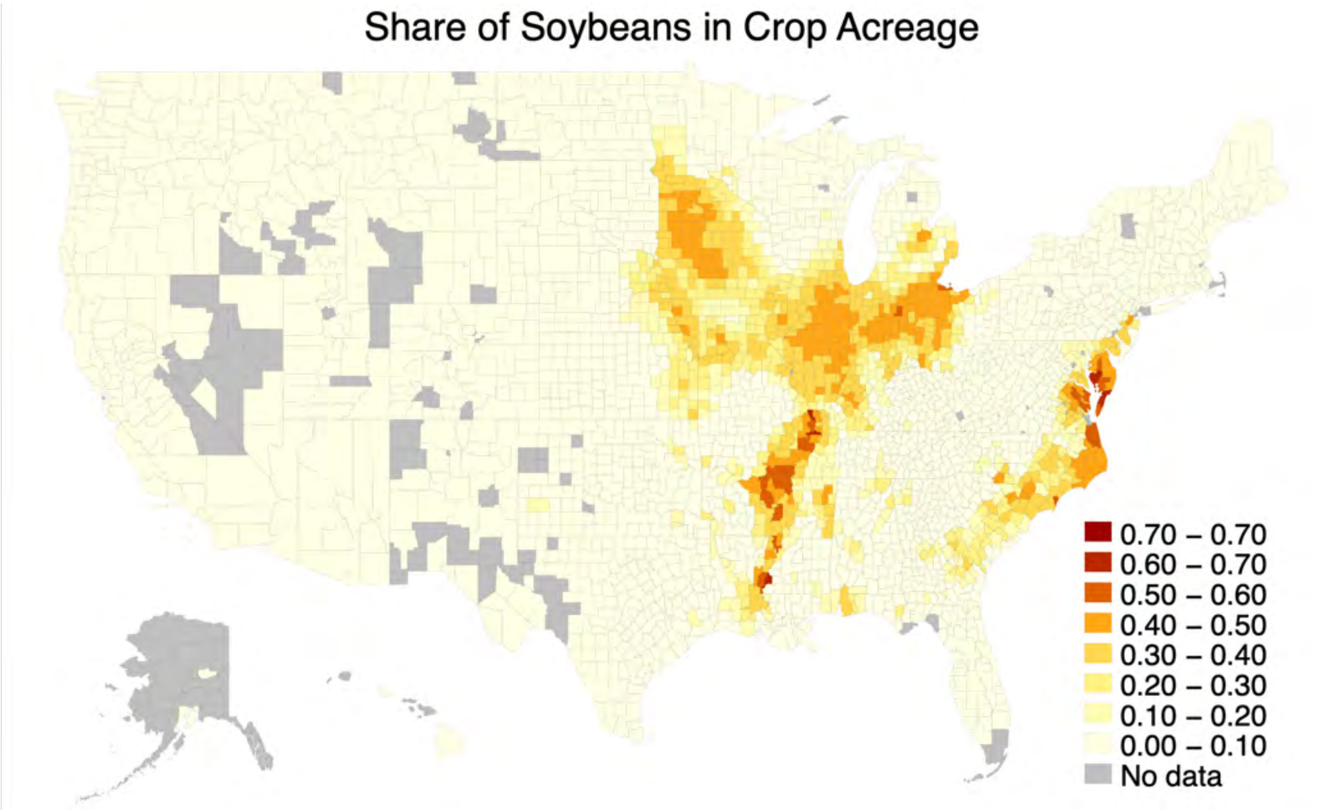

Figure 9: U.S. County Crop Acreage in Soybeans (1992 Census of Agriculture)

Figures 10- 13 shows the changes within counties in employment-weighted mean tariffs that Mexico and Canada imposed on imports of U.S. livestock and animal products and that the United States imposed on imports of livestock and animal products from Mexico and Canada. Much of the United States saw relatively large declines in exposure to Mexican and Canadian livestock import tariffs. However, counties experienced very little change in protection from U.S. tariffs on livestock imports because the United States had relatively low pre-NAFTA import tariffs.

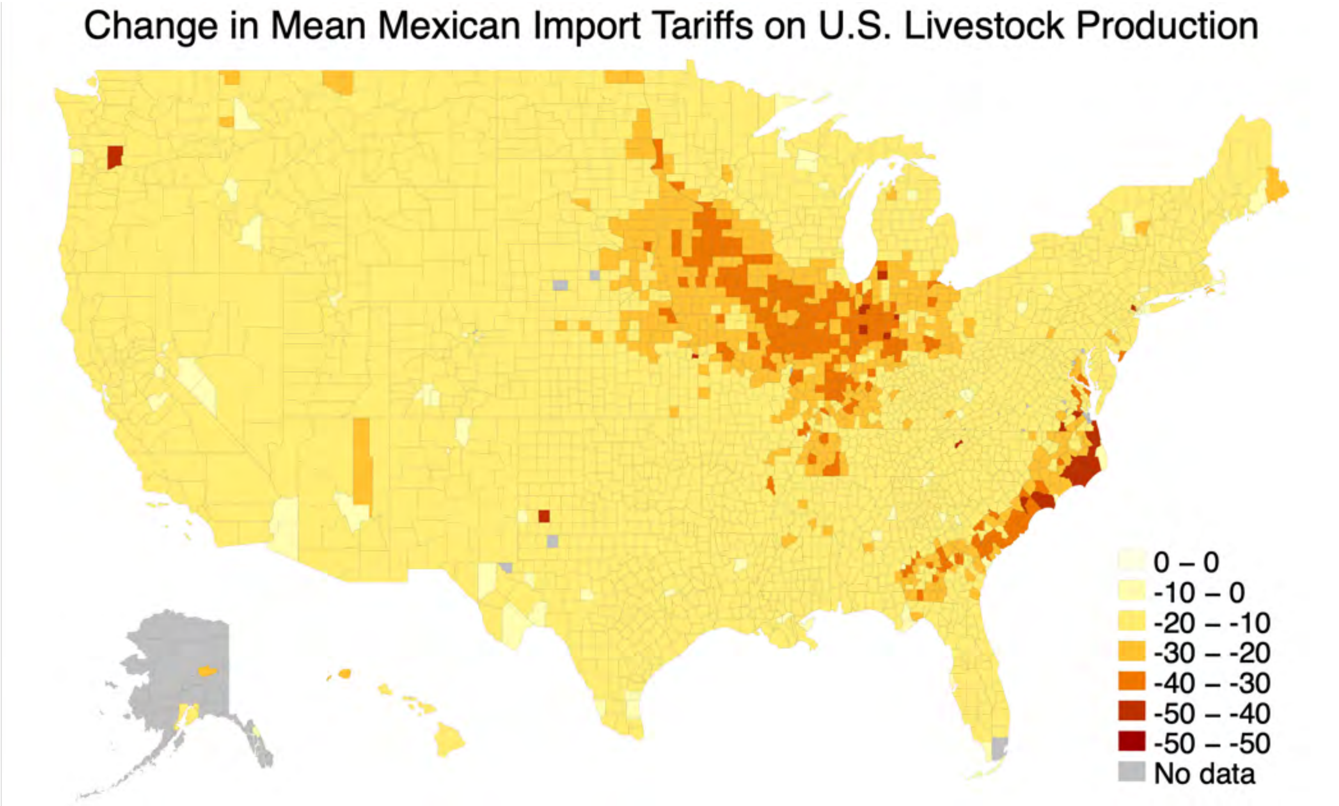

Figure 10: Change in Weighted Mean Mexican Import Tariffs on U.S. Livestock Produced in County

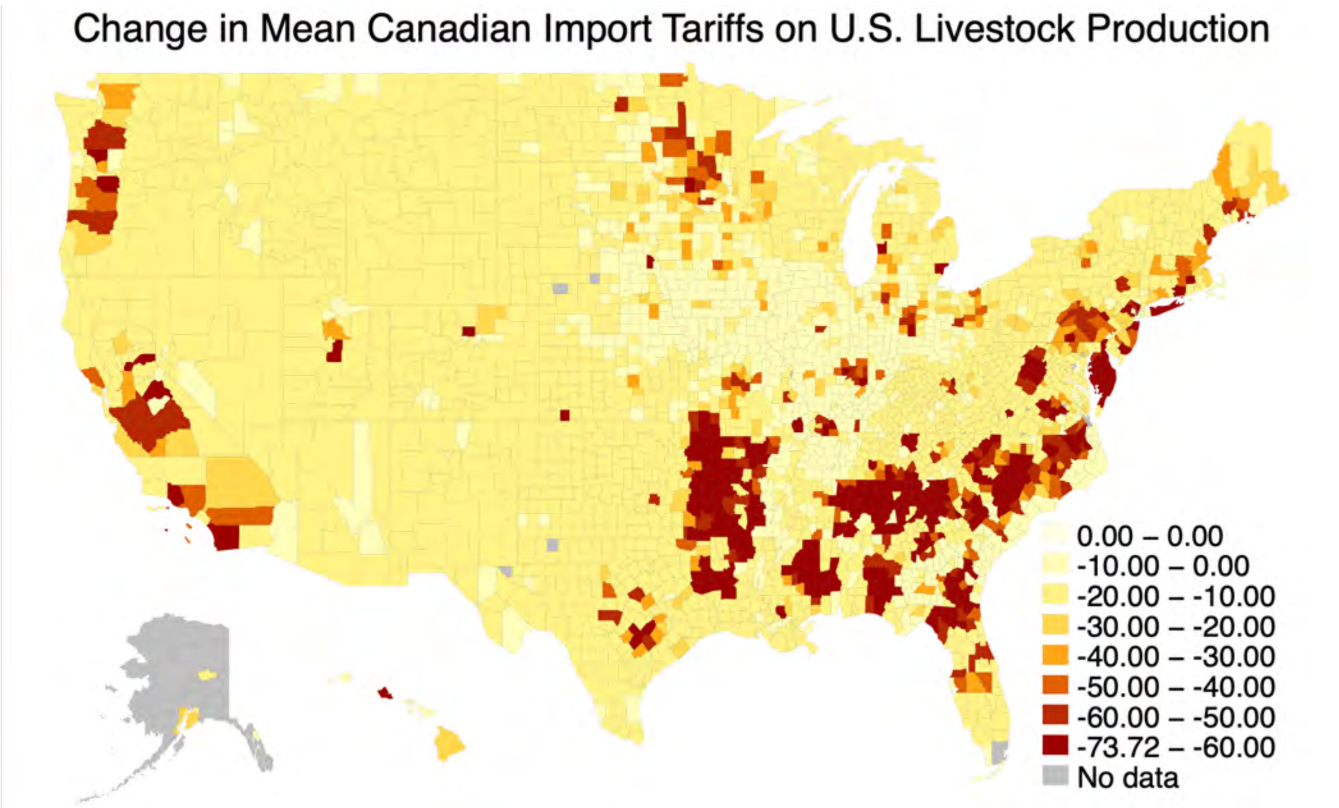

Figure 11: Change in Weighted Mean Canadian Import Tariffs on U.S. Livestock Produced in County

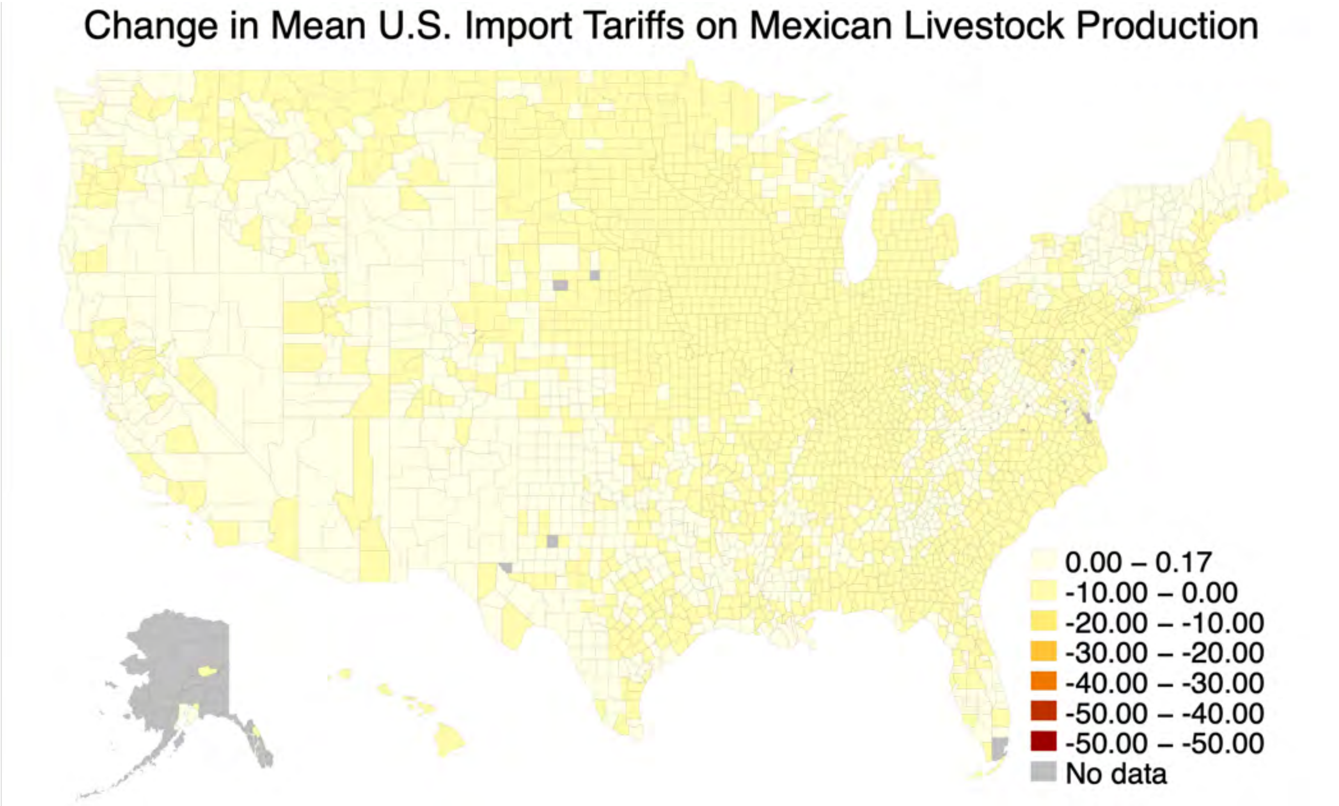

Figure 12: Change in Weighted Mean U.S. Import Tariffs on Mexican Livestock Produced in County

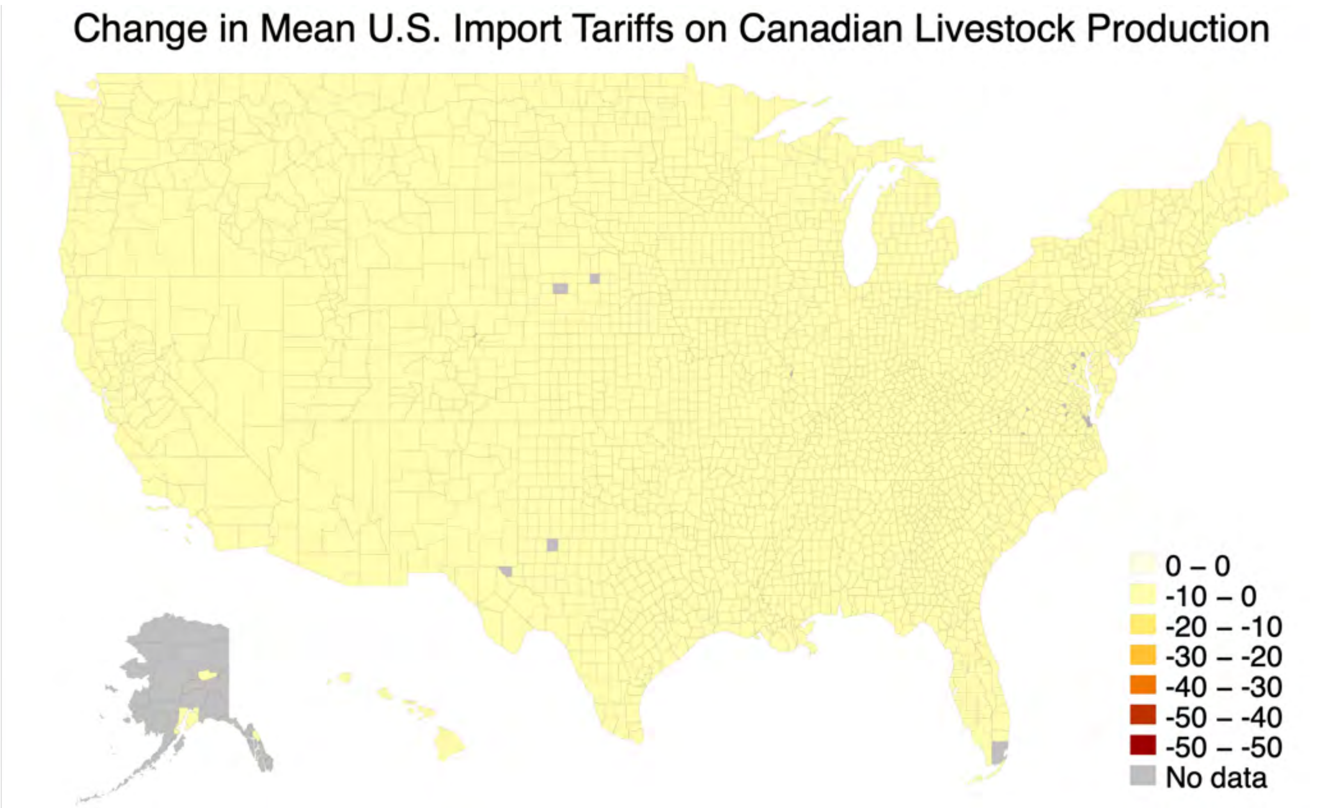

Figure 13: Change in Weighted Mean U.S. Import Tariffs on Canadian Livestock Produced in County

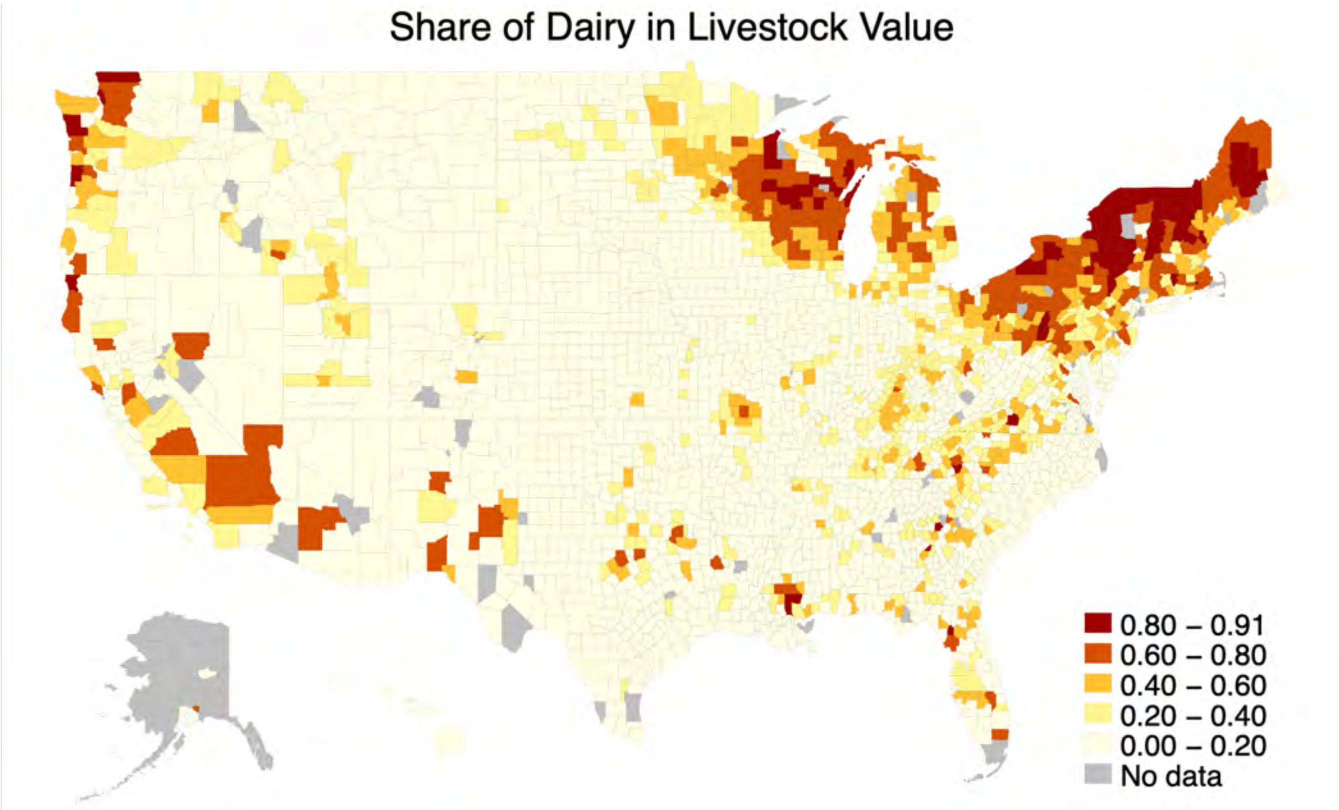

Figure 14: Share of U.S. County Livestock Value in Dairy (1992 Census of Agriculture)

Figures 14- 17 map the livestock value shares of dairy, cattle, hogs, and poultry. The greatest reductions in exposure to Mexican tariffs on imports of U.S. livestock appear most concentrated in hog producing counties. Canadian tariff reductions are most concentrated in poultry producing counties. Cattle producing counties also appeared to gain access to Mexican and Canadian export markets during this time as cattle production is scattered throughout much of the Western half of the United States.

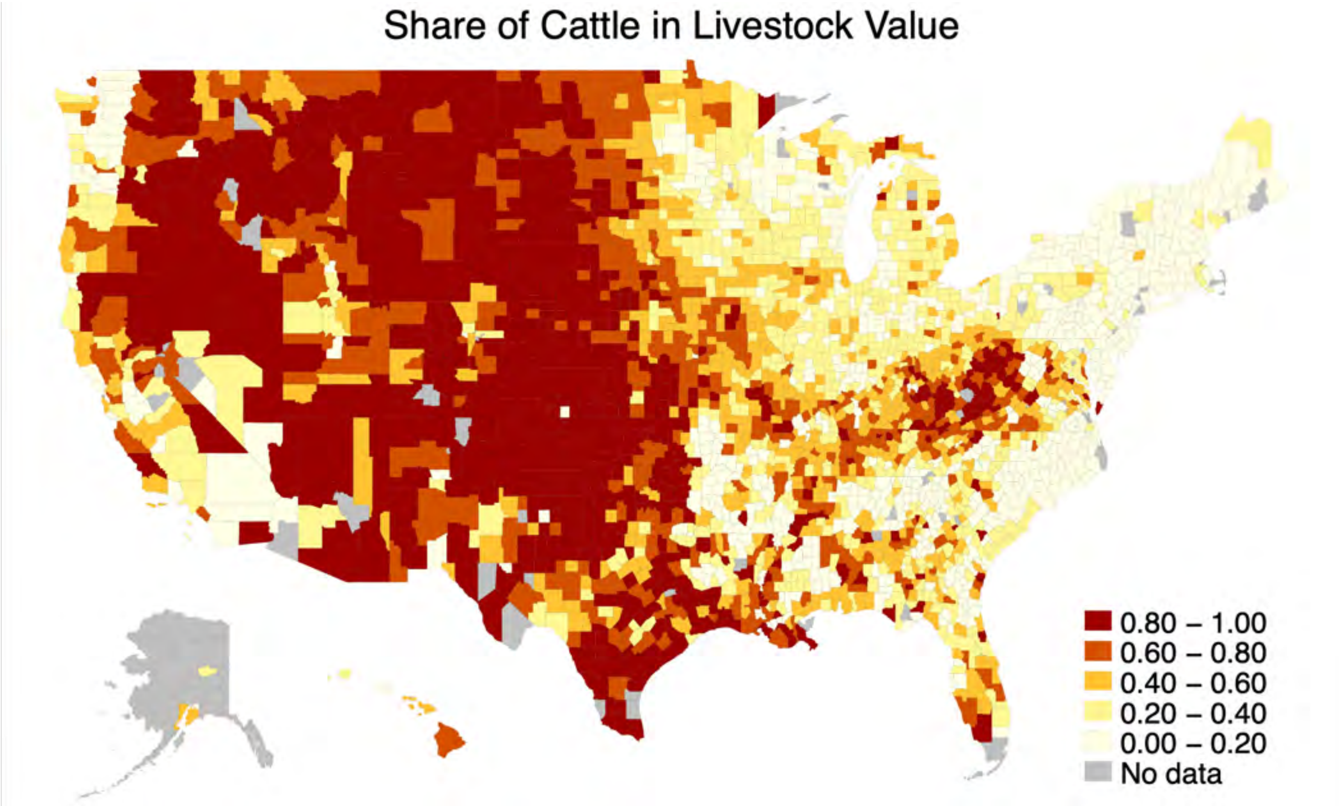

Figure 15: Share of U.S. County Livestock Value in Cattle (1992 Census of Agriculture)

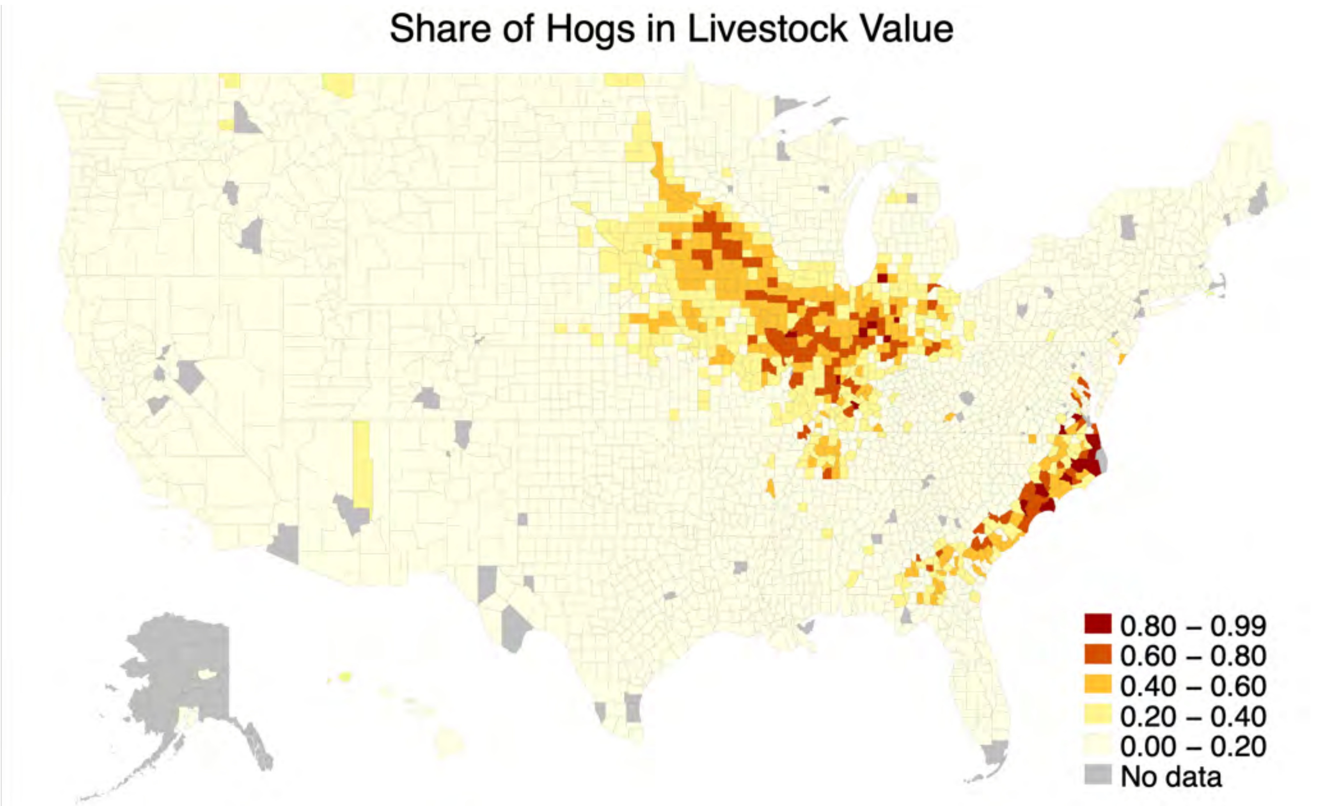

Figure 16: Share of U.S. County Livestock Value in Hogs (1992 Census of Agriculture)

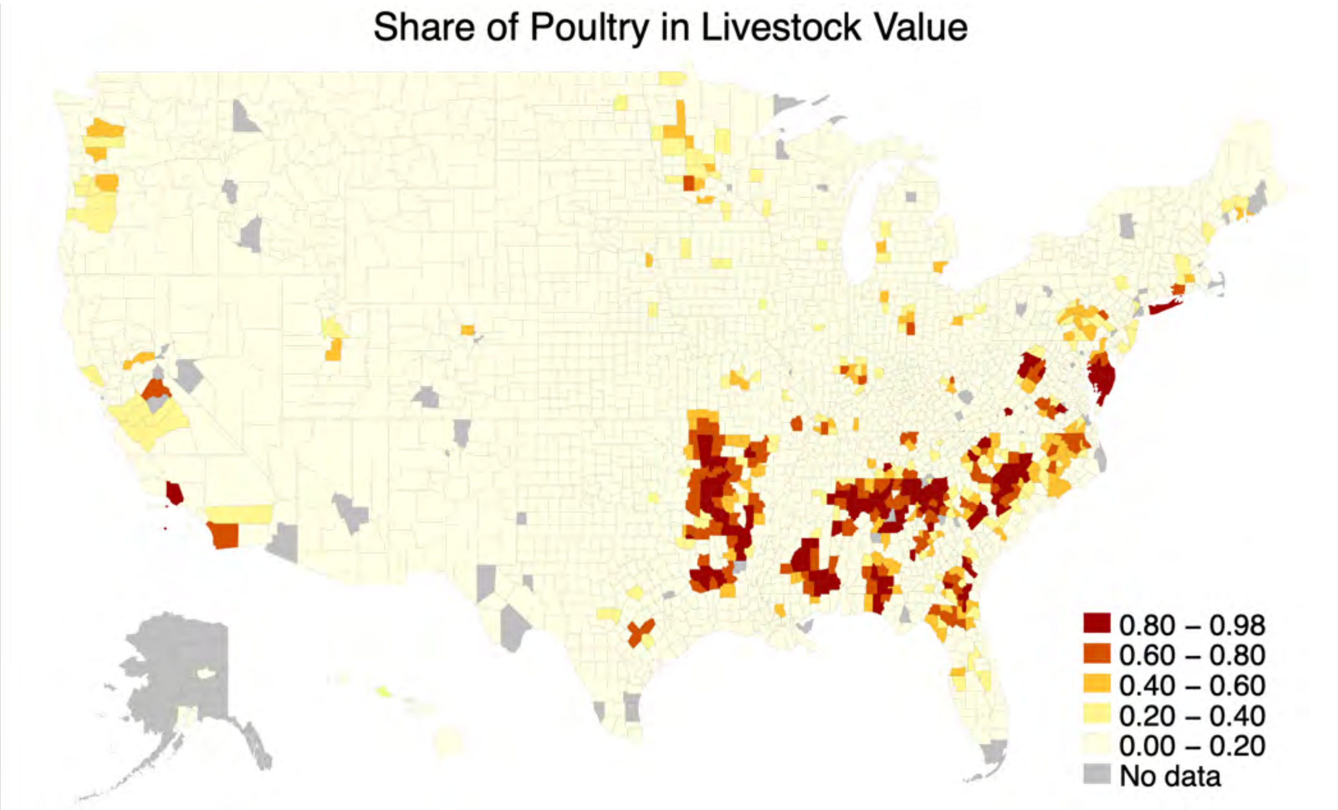

Figure 17: Share of U.S. County Livestock Value in Poultry (1992 Census of Agriculture)

Figures 18- 21 show the changes within counties in employment-weighted mean exposure to tariffs that Mexico and Canada imposed on imports of U.S. non-farm goods and employment-weighted tariffs that the United States imposed on non-farm imports from Mexico and Canada. There is some substantive spatial variation in U.S. employment exposure to changes in Mexican import tariffs on U.S. non-farm goods. Workers in non-farm industries would theoretically benefit from improved access to export markets. The reduction in U.S. tariffs on non-farm imports from Mexico or Canada are much smaller in magnitude, less than a 10 percent change over the period.

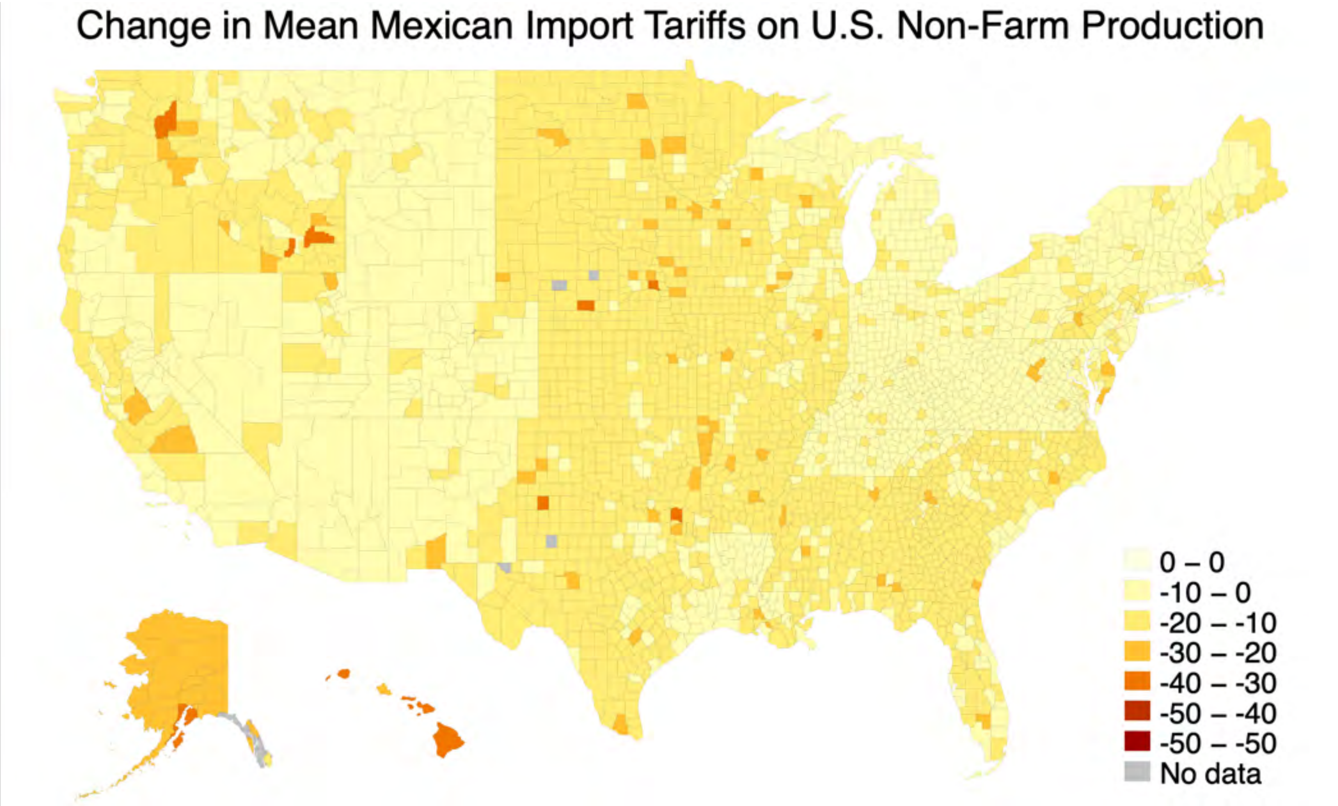

Figure 18: Change in Weighted Mean Mexican Import Tariffs on U.S. Non-Farm Produced in County

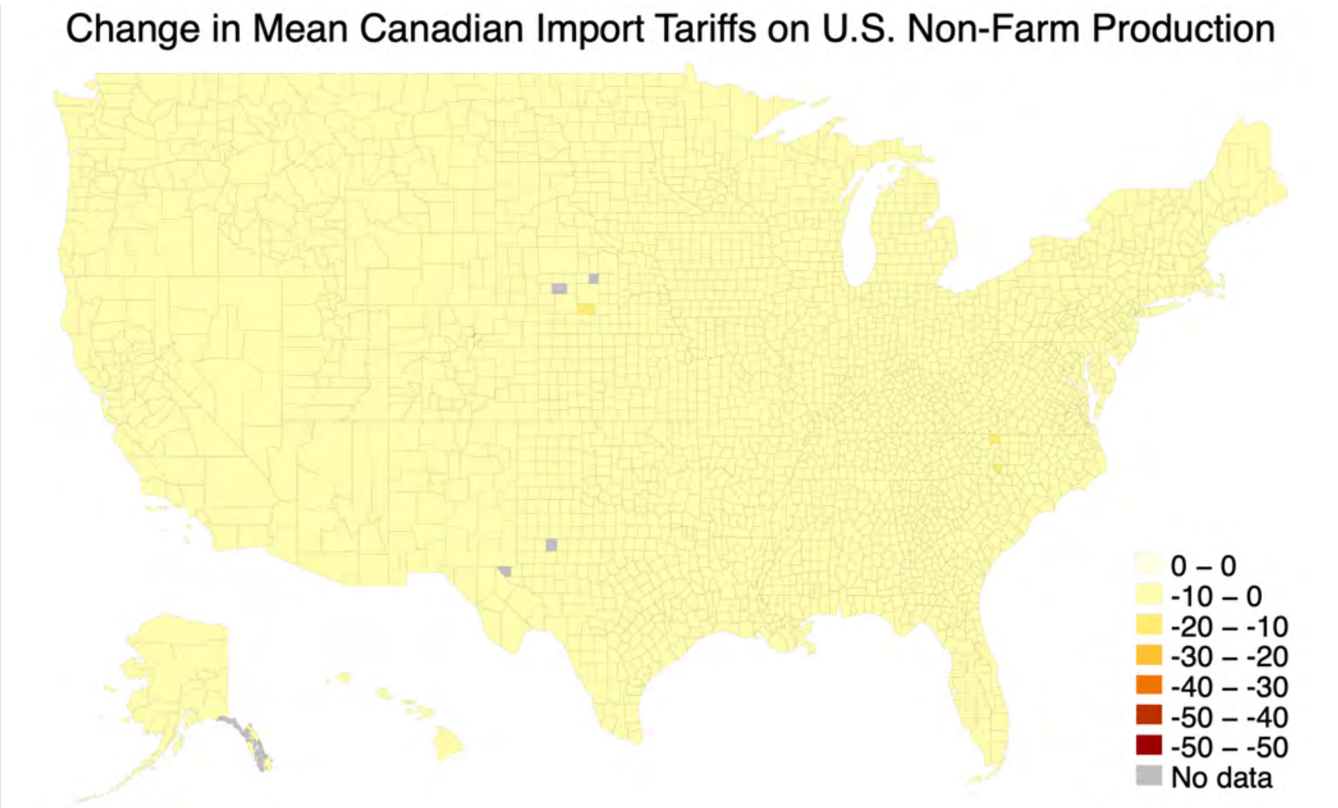

Figure 19: Change in Weighted Mean Canadian Import Tariffs on U.S. Non-Farm Produced in County

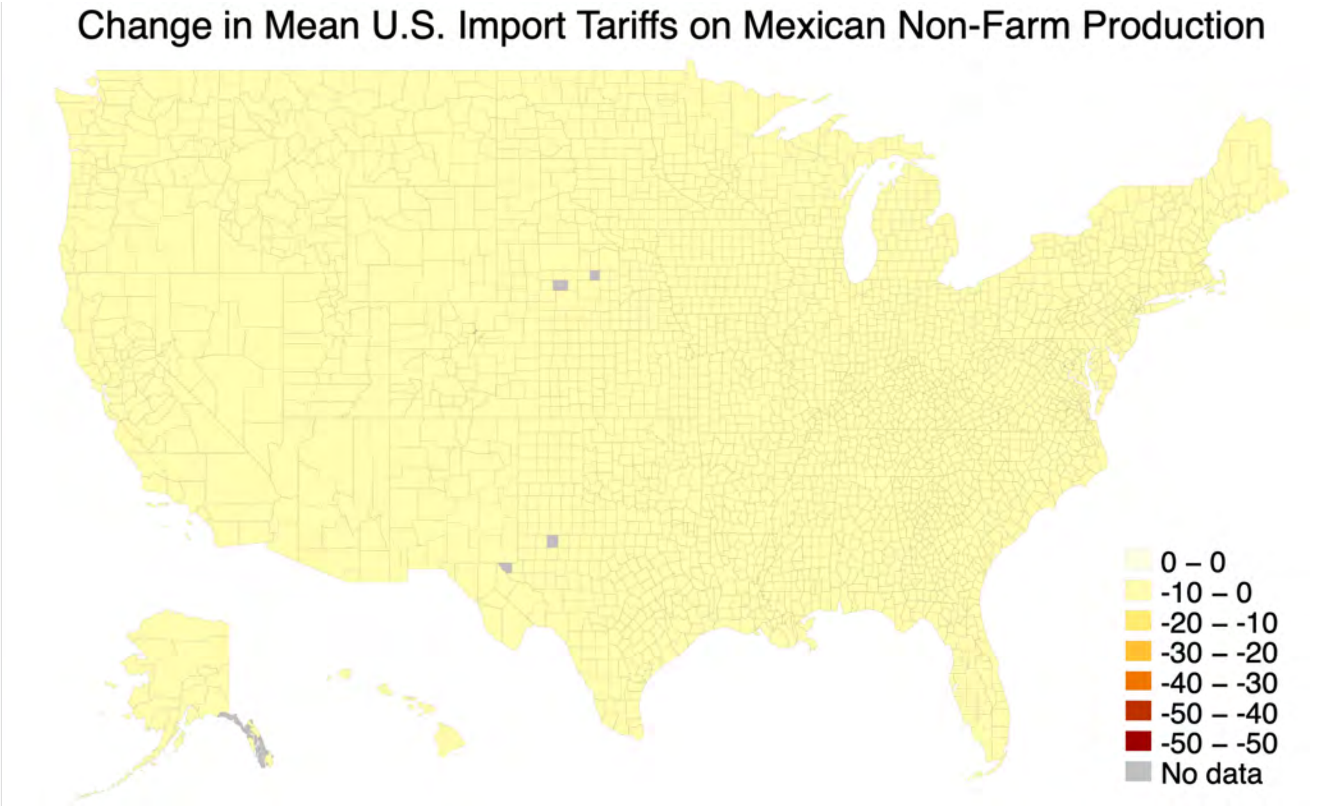

Figure 20: Change in Weighted Mean U.S. Import Tariffs on Mexican Non-Farm Produced in County

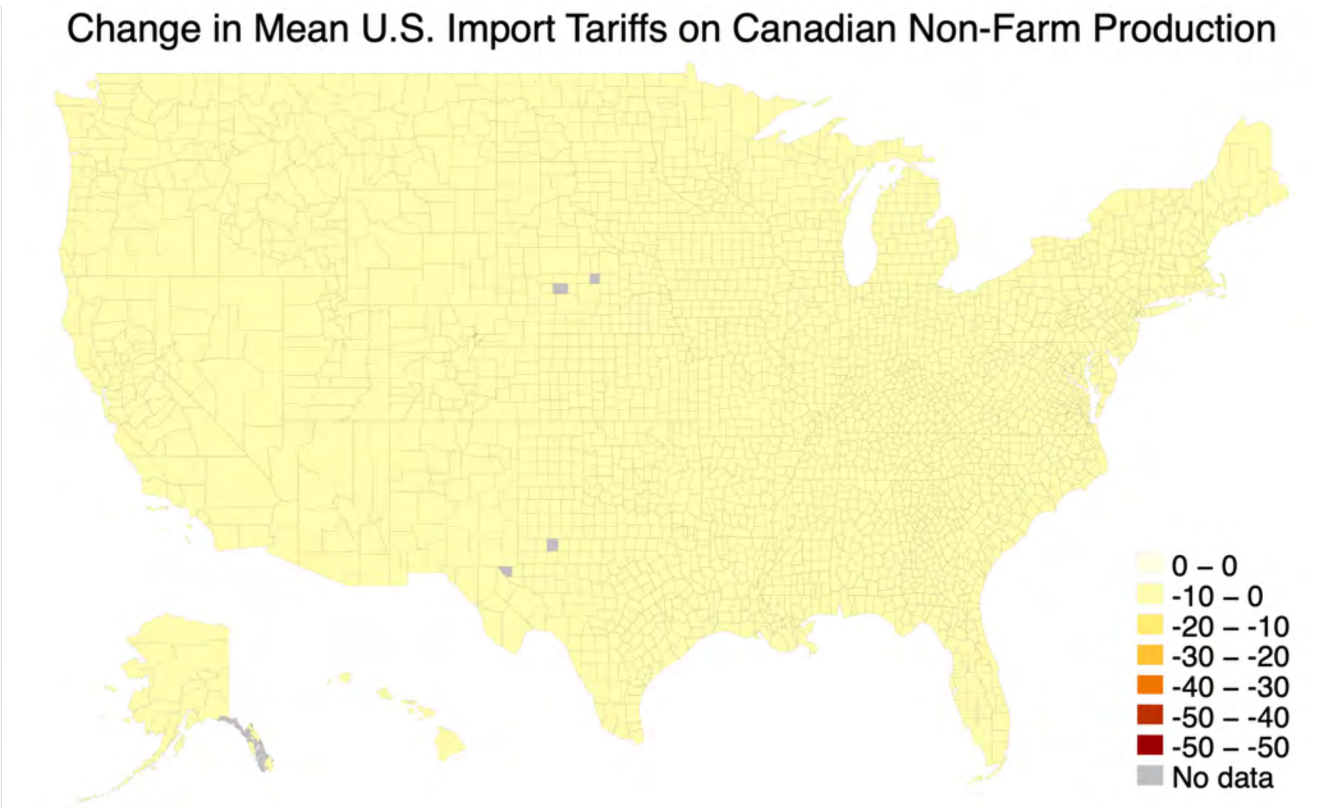

Figure 21: Change in Weighted Mean U.S. Import Tariffs on Canadian Non-Farm Produced in County

V. Conclusion

While the field of economics consistently demonstrates that workers are not perfectly mobile across industries or geographic space (Autor, Dorn, and Hanson, 2013; Autor et al., 2014; Hakobyan and McLaren, 2016; Topalova, 2007, 2010), there has been little research on the effects of trade liberalization or protectionism on employment and wages in communities with a large presence of agricultural production in developed countries like the United States. Although the share of the U.S. population employed in agriculture and related industries is relatively small (10.4% of U.S. employment in 2022 (USDA Economic Research Service, 2023)), agriculture is still an important part of rural communities. The findings in this paper show that reductions in U.S. tariffs imposed on imports from Mexico and Canada were much larger for crops than non-farm goods on average even though previous literature has focused almost exclusively on the labor market impacts of reduced non-farm import tariffs. Furthermore, we suggest that research should consider both exposure to tariffs on imports that increase competition in domestic markets and exposure to import tariffs in export markets that increase competitiveness in foreign markets. NAFTA reduced foreign tariffs imposed on imports of U.S. goods by a larger magnitude than the U.S. reduced its tariffs on imports of Mexican and Canadian goods. Finally, we show that employment-weighted exposure to reduced foreign import tariffs on U.S. crops and livestock was larger in magnitude and more geographically spread than exposure to reduced foreign import tariffs on U.S. non-farm goods. There is much yet to investigate regarding the effects of agricultural trade and tariff changes on employment and wages. This paper develops crop- and livestock-specific employment weights to further explore changes in tariff exposure to NAFTA and other trade policies. These additional data will enable new and timely investigation of crop- and livestock-specific natural and market-driven shocks on employment and wage outcomes across U.S. counties.

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