The Impacts of the North American Free Trade Agreement on Farm Profitability and Survival

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1 Introduction

U.S. agriculture has been experiencing increases in its exports to foreign markets in the last three decades with global trade liberalization. Specifically, the North American Free Trade Agreement (NAFTA) boosted agricultural trade between U.S., Canada, and Mexico through the elimination of barriers to trade between the three countries. As a consequence of better accessibility to global markets, U.S. agricultural producers gain or lose from trade. The potential benefits are particularly pronounced for exporters, who experience significant tariff reductions as a result of trade liberalization. On the other hand, if individual farm operators lose their comparative advantage in production, it would impact farm business decisions on input use, crop choice, or exit from the market. Consequently, it becomes important to understand the impact of export exposure on the profitability of farms and farm survival, with a keen focus on identifying the individualized effects that stand to gain from improved access to foreign markets.

The objective of this study is to examine how the export exposures from NAFTA affect the profitability of farms and as a result, and how changes in the profitability after the implementation of NAFTA have impacts on the survival of farms. To do so, we estimate the effects of export exposures on farm profit using farm-level panel data and employ a duration model to investigate the effects of export exposures on farm exit.

In this study, we study NAFTA for a couple of reasons. First, Canada and Mexico are major agricultural trade partners of the US. Second, since NAFTA has been enforced, the agreement eliminates almost all barriers to trade and investment between the three countries, resulting in increases in the size of US agricultural trade with members in NAFTA. In addition, due to the limitation of data, we focus on the farms that produced major field crops (corn, wheat, soybeans, sorghum) in Kansas from 1991 to 2022.

The literature on the impacts of trade finds negative correlations between imports (exports) and local labor markets (e.g., Autor et al., 2013; Dix-Carneiro and Kovak, 2017;

He, 2020), but less attention has been paid to the impact of better access to foreign markets on the profitability of agriculture across states. One exception is Yu et al. (2022), who showed that more export exposure improved the returns to U.S. agriculture. Their results indicate that the heterogeneous export effects on returns may come from the changes in profitability of crops that are exposed to greater accessibility, yet the direct estimation of trade exposure on individual profitability has not been documented.

Some studies analyze the effect of NAFTA on agriculture. Burfisher et al. (2001) find that the agricultural sectors in US farmers benefited from NAFTA by increasing demand for US products, and Prina (2013) find that Mexican small farmers tended to benefit from the agreement on balance. However, the empirical evidence on the effects of NAFTA on farm survival is limited.

While several studies have paid attention to the survival of firms in response to changing trade barriers, their theoretical and empirical findings imply the need for more empirical assessment. A seminal paper by Melitz (2003) argues and proves theoretically that relatively high-productive firms extend their market shares and use resources at the expense of low-productive firms, which are forced to exit. Hence, relatively productive firms may benefit from increased access to foreign markets as exporters, while low-productive firms may suffer lower profits due to increased market competition as non-exporters, resulting in a lower probability of survival. Findings from Baggs (2005), which studies the US-Canada free trade agreement, indicate that export partner's tariff reductions increase the likelihood of survival for firms in the exporting country.

Within the agricultural sector, literature on farm survival has found that agricultural support payments exhibit a negative impact on the farm exit rate (e.g., Key and Roberts, 2006; Kazukauskas et al., 2013; Storm et al., 2015). On the other hand, findings from other studies indicate that receiving more government payments leads to a faster rate of exits (e.g., Goetz and Debertin, 2001). In addition, several studies have explored other determinants of farm survival. These determinants include farm characteristics (e.g., Kimhi and Bollman, 1999), decoupled subsidies (e.g., Key and Roberts, 2006; Kazukauskas et al., 2013), neighboring interdependence (e.g., Storm et al., 2015), crop insurance (e.g., Kim et al., 2020; Santeramo et al., 2016), and cooperative extension (e.g., Goetz and Davlasheridze, 2017). However, there is a lack of empirical estimates on the impact of trade policy on farm survival.

The main contribution of this study is that we provide empirical estimates of the impact of changes in export exposures from NAFTA on farm survival. In addition, we contribute to the literature as it is the first to assess the effect of NAFTA on farm survival.

2 Data and variable descriptions

2.1 Farm production and trade data

To estimate the farm-level impacts of NAFTA, we consider the Kansas Farm Management Association (KFMA). The KFMA data contains detailed information on finance and production, including farm characteristics, crop and livestock production, farm income and expenses, farm assets, and non-farm income and expenses. Although other administrative data, such as the Census of Agriculture, provides comprehensive farm financial and crop production for farm population, the Census data is taken only once every five years, so it is unclear how to figure out the survival of farms in consecutive years. Thus, the data from KFMA is valuable for the analysis of farm exits in the sense that the periods of KFMA data are more than 40 years, and the KFMA collects detailed financial and production information.

Trade volume data are obtained from UN Commodity Trade (UN Comtrade) using the World Integrated Trade Solution (WITS) database. We extract the importer-exporter pair[1]

[1]Importers are Canada and Mexico, and their trade partners (exporters) are all countries including the

level data for the four field crops using 4-digit Harmonized Tariff Schedule (HS) codes[2] from 1991 to 2022. To construct the weights for aggregating trade value, that is, US exports to trade partner countries for each crop, we additionally utilize the annual national level of production values by crop obtained from the NASS survey.

2.2 Individualized trade exposure

Our explanatory variable of interest is individualized export exposure, which is a measure of how much export exposure individual farms are subject to. The key challenge is to construct an individualized variable from national-level export value from the U.S. to Canada and Mexico. Motivated by Autor et al. (2013), we define individualized trade exposure ($Trade_{it}$) for farm i in year t as

$$Trade_{it} = \sum_j \delta_{jt} \times Crop\ Share_{ijt}$$

where δ_{jt} an aggregated trade value, that is, US exports to Canada and Mexico for crop j in year t, and $Crop\ Share_{ijt}$ is the production share of farm i for crop j in year t, converts the trade value to localized exposure. We aggregate trade value using the following equation:

$$\delta_{jt} = \sum_d \theta_{jdt} \times US\ Market\ Share_{jdt} \quad (1)$$

where θ_{jdt} is the weight based on country d's import values of crop j from the US over US total production for crop j in year t, $US\ Market\ Share_{jdt}$ is the US's market share in country d for crop j in year t. Since δ_{jt} is based on the trade volumes in year t from country d, some might be concerned about endogeneity issues with contemporaneous trade variables aggregated by contemporaneous crop shares. Thus, we compute the trade exposure using contemporaneous export volumes and initial farm production shares in pre-NAFTA period

United States.

[2] 1001 (wheat), 1005 (corn), 1007 (Sorghum), 1201(soybeans)

(1991-1993), $Trade_{i0}$.

$$Trade_{i0} = \sum_{j} \delta_{jt} \times Crop\ Share_{ij0} \tag{2}$$

where initial crop shares are the average of crop acres for each farm, i.e., $Crop\ Share_{ij0} = Crop\ Acreage_{ij0}/Total\ Acreage_{i0}$.[3]

Table 1 provides the summary statistics for the key variables, including net farm income at the level, crop shares, individualized trade exposures, and covariates for the full sample. Figure 1 shows boxplots of the individualized trade exposures for the overall samples to illustrate the distribution across farms in each year using the different approaches. Since all tariffs on agricultural commodities were completely eliminated in 2008, the variance of individualized trade exposures from 2008 was smaller compared to that before 2008.

[3]Subscript 0 indicates the initial period, defined as the pre-NAFTA period (1991-1993).

Table 1: Descriptive statistics

	(1)	(2)	(3)	(4)	(5)	(6)
	1991-2022		1991-1993		2020-2022	
VARIABLES	Mean	SD	Mean	SD	Mean	SD
Net farm income (2020=$1)	70,940	184,274	24,069	35,960	275,533	453,807
Share of corn (%)	0.145	0.179	0.0838	0.137	0.219	0.199
Share of soybeans (%)	0.218	0.231	0.140	0.192	0.335	0.246
Share of wheat (%)	0.291	0.232	0.335	0.219	0.211	0.204
Share of sorghum (%)	0.114	0.141	0.149	0.151	0.0712	0.121
Contemp. export and Init. crop shares, ($Trade_{i0}$, %)	0.00427	0.00543	0.00451	0.00427	0.00179	0.00274
Number of operators	1.009	0.473	1.055	0.441	0.996	0.560
Number of workers	1.508	1.350	1.520	1.257	1.635	1.772
Number of family dependents	2.794	1.623	3.013	1.702	2.634	1.396
Operator's Age	54.23	19.83	49.70	13.51	59.28	14.25
Observations	52,638		6,481		2,696	

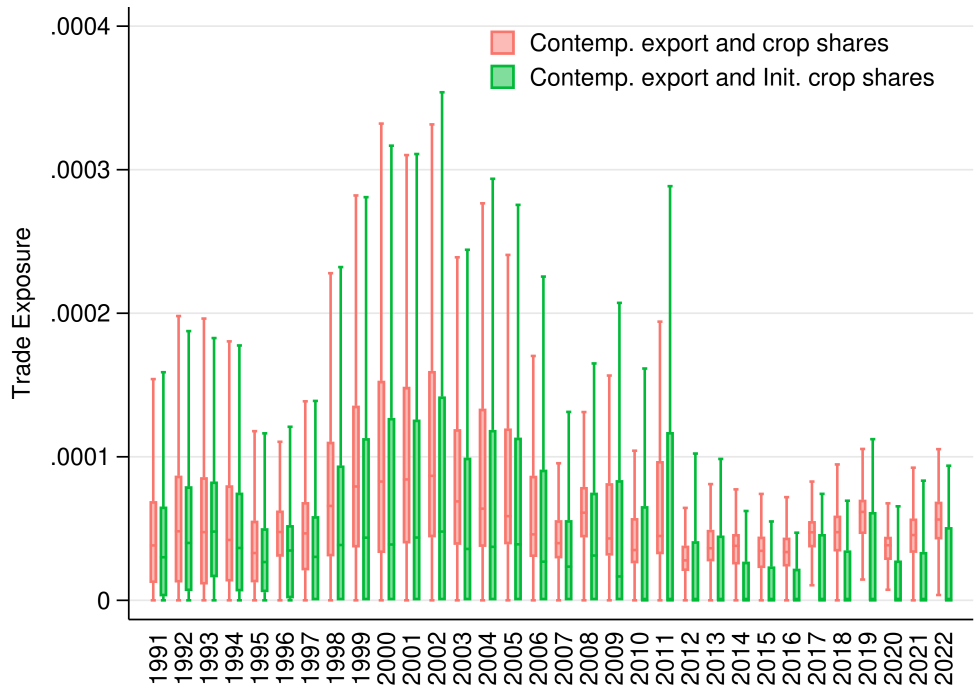

Figure 1: Boxplots of individualized trade exposure

2.3 Definition of farm exit

The key component of farm survival analyses is how to define farm exit. In earlier studies, farms are considered to have exited if they are no longer present in their dataset (e.g., Key and Roberts, 2006; Bontemps et al., 2013). However, in the case of KFMA data, some producers who participate in KFMA may not renew their annual membership while continuing to operate their farms.

Since farms voluntarily participate in KFMA, some may not renew their annual membership, and thus, it is possible for producers to be temporarily absent from the data even though they continue to operate their farms (Kim et al., 2020). Therefore, Kim et al. (2020) defined farm exit using the longest average length of consecutive missing years of farms. Following Kim et al. (2020), we also consider how long producers disappeared from the KFMA data. Table 2 presents the average consecutive missing years for farms that left KFMA and returned to KFMA for different starting years from 1991 to 1999. The average length of consecutive missing years was between 2.46 and 3.57. We assume that a farm does not exit despite not being observed in the KFMA data after 2019, taking into account the possibility of temporary absences of farms in the data

Table 2: Average length of the consecutive missing years

Initial year	Number of farms	Missing years
1991	812	2.92
1992	167	3.41
1993	78	2.82
1994	61	2.95
1995	61	2.64
1996	68	3.16
1997	52	2.46
1998	54	2.80
1999	37	3.57

Note: If a farm disappeared from the dataset more than once, the longest consecutive missing years are counted.

3 Empirical specification

3.1 Shift-share design

To examine the localized impact of NAFTA on crop acreage response, this study utilizes "shift-share" specifications, motivated by literature (e.g., Bartik, 1991; Autor et al., 2013). Shift-share instruments for trade exposure are the weighted averages of trade exposure, with weights reflecting heterogeneous shock exposure. This individualized exposure is constructed from shocks to crop sectors, with individual farms' crop production shares measuring the shock exposure. Since tariffs were gradually reduced in NAFTA, we define the pre-NAFTA periods of 1991-1993 as the "base period" and compute the annual trade shocks based on this definition to capture the gradual effects of tariff reductions.

Let i and t denote farm and time, respectively. The estimation model is as follows:

$$\Delta Profit_{it} = \alpha_0 + \alpha_1 \Delta Trade_{it} + B\Delta X_{it} + u_c + \epsilon_{it} \tag{3}$$

where Δ indicates $\Delta Profit_{it} = Profit_{it} - \overline{Profit_{i0}}$, i.e. the change in average profit for farm i in t from the average acreage from 1991 to 1993 (pre-NAFTA). The tariff shocks from NAFTA are measured by the weighted average of the changes in the tariffs for crop j in year t from the average tariffs in the pre-NAFTA weighted by the average export and crop shares in the pre-NAFTA period:

$$\Delta Trade_{it} = \sum_j \left(\sum_d \theta_{jd0} \times (US\ Market\ Share_{jdt} - US\ Market\ Share_{jd0}) \right) \times Crop\,Share_{ij0}$$

ΔX_{ijt} denote the changes in average covariates in the pre-NAFTA and u_c indicate county fixed effects.

3.2 Duration model

To estimate the impact of trade exposure due to NAFTA on farm survival, this study considers a duration model, i.e., Cox proportional hazard model (Cox, 1972) with sample restrictions to the farms observed in 1991-1994 and the base year is 1994. We select the year 1994 as the base year because NAFTA was enforced in 1994.

Due to the limitation of data, we do not observe the exit of farms that did not exit at the end of periods in our data and this may lead to the censoring problems. The Cox proportional hazard model can mitigate the standard right censoring problem. For a farm that survived until time t, the conditional probability of exiting after time t, a hazard function $h(\cdot)$ is as follows

$$h(t;\ Trade_i,\ X_i) = h_0(t)\exp(\gamma Trade_i + \Gamma X_i) \tag{4}$$

where $h_0(t)$ is the baseline hazard function, $Trade_i$ is a trade exposure for farm i, X_i is a vector of control variables.

The coefficient that we are interested in is γ, representing the treatment effect. It is interpreted as how the implementation of NAFTA impacts the likelihood of farms' survival through greater exposure to exports. The vector of control variables, X, includes individual operator's characteristics (e.g., the age of the operator, number of operators, number of workers, and number of family dependents).

4 Preliminary results

4.1 Effects of trade shock on farm profit

Figure 2 presents the distributions of the coefficients estimated from equation 3 by years using the shift-share variables, which are weighted by crop share over county production and crop share over national production, respectively. In the results, we find that trade shocks from NAFTA have mostly positive and significant impacts on farm profit in the beginning periods of the implementation of NAFTA (1994-2009). The shift-share results show negative effects of trade shocks after 2010 but most results are not statistically significant.

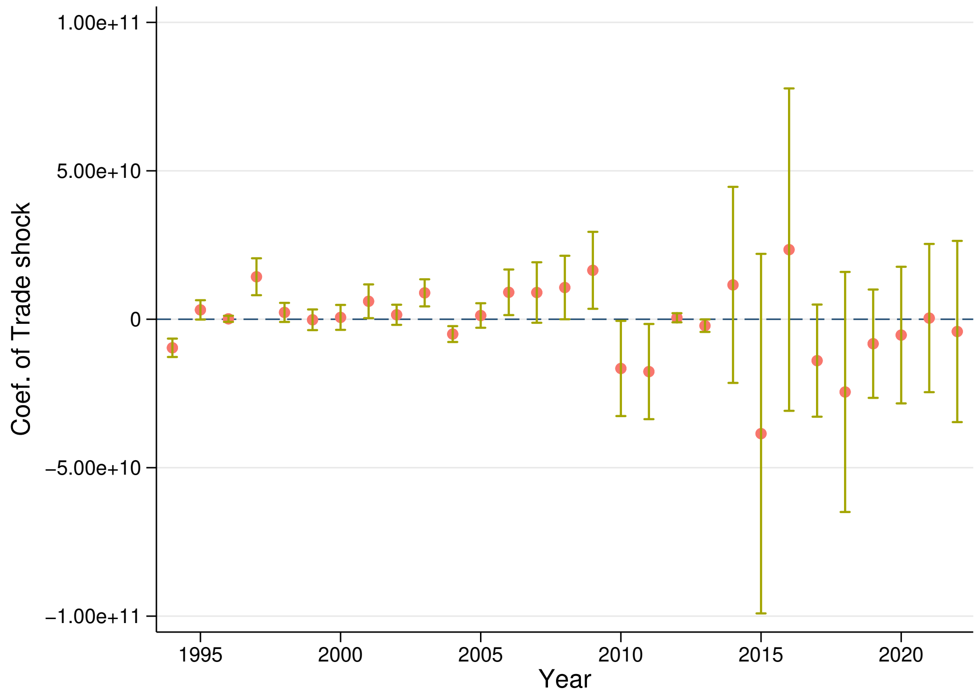

Figure 2: Effects of Trade Shock on Farm Profit (shift-share design, by year)

4.2 Effects of trade shock on farm exit

To examine the relationship between trade exposure and farm survival, we compare Kaplan-Meier survival function estimates for farm with quartiles of trade exposure. Figure 3 shows that farms in the low quartile (Q25) are less likely to survive than those in the top quartile (Q75). Table 3 provides the estimates of the Cox model, and we find that better access to foreign markets reduces the rate of farm exit.

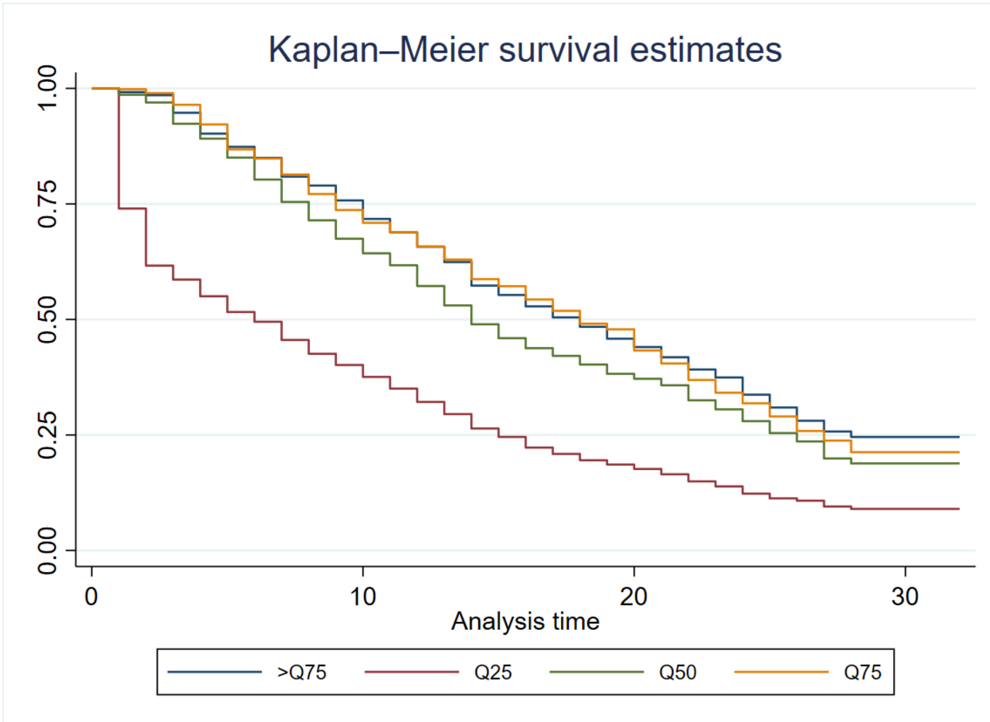

Figure 3: Kaplan–Meier survival curves by quartiles of trade exposure

Table 3: Cox proportional hazard model estimation

	(1)	(2)
Dependent variable: hazard rate		
Trade exposure	-4,603***	-106.0***
	(492.4)	(35.28)
Observations	37,429	37,429
Covariates	No	Yes

*** p<0.01, ** p<0.05, * p<0.1

5 Concluding Remarks

After the implementation of the North American Free Trade Agreement (NAFTA), one of the major trade agreements of the US, trade restrictions on some agricultural commodities were phased out over periods. Better accessibility to foreign markets provides opportunities for US agricultural producers to gain from trade, while producers who lose comparative advantage in production lose from trade resulting in exit from the market. Previous studies that examine the impacts of trade

Focusing on the field crop farms in Kansas, we study the impact of trade exposure on farm profitability and survival. Specifically, we focus on the North American Free Trade Agreement (NAFTA) case. Using the comprehensive dataset on farm production and export volumes from 1991 to 2022 and individualized trade shock, we find that the immediate effects of trade exposure are positive on farm profit, but the long-term effects are influenced by other than trade values. In addition, we estimate the impact of trade exposure on farm survival and find that greater export exposure reduced the rate of farm exit.

Since we restricted samples to the crop farms in Kansas, we cannot conclude that better accessibility to foreign markets has positive impacts on farm profit and survival generally. Further investigations would be needed to provide additional policy implications.

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References

Autor, D. H., Dorn, D., Hanson, G., Hanson, G. H., and Hanson, G. H. (2013). The china syndrome: Local labor market effects of import competition in the united states. *The American Economic Review*, 103:2121–2168.

Baggs, J. (2005). Firm survival and exit in response to trade liberalization. *Canadian Journal of Economics*, 38:1364–1383.

Bartik, T. J. (1991). *Who Benefits from State and Local Economic Development Policies?* W.E. Upjohn Institute.

Bontemps, C., Bouamra-Mechemache, Z., and Simioni, M. (2013). Quality labels and firm survival: some first empirical evidence. *European Review of Agricultural Economics*, 40:413–439.

Burfisher, M. E., Robinson, S., and Thierfelder, K. (2001). The impact of nafta on the united states. *Journal of Economic Perspectives*, 15:125–144.

Cox, D. R. (1972). Regression models and life-tables. *Journal of the Royal Statistical Society Series B: Statistical Methodology*, 34:187–202.

Dix-Carneiro, R. and Kovak, B. K. (2017). Trade liberalization and regional dynamics. *The American Economic Review*, 107:2908–2946. MAG ID: 2579648655 S2ID: 1915f50544f64da092210dcb7ad43ae3e153e535.

Goetz, S. J. and Davlasheridze, M. (2017). State-level cooperative extension spending and farmer exits. *Applied Economic Perspectives and Policy*, 39:65–86.

Goetz, S. J. and Debertin, D. L. (2001). Why farmers quit: A county-level analysis. *American Journal of Agricultural Economics*, 83:1010–1023.

He, X. (2020). Us agricultural exports and labor market adjustments. *Agricultural Economics*, 51:609–621. MAG ID: 3015252440 S2ID: 3776bb68b9f07d84ca948584034bffbd5d382803.

Kazukauskas, A., Newman, C., Clancy, D., and Sauer, J. (2013). Disinvestment, farm size, and gradual farm exit: The impact of subsidy decoupling in a european context. *American Journal of Agricultural Economics*, 95:1068–1087.

Key, N. and Roberts, M. J. (2006). Government payments and farm business survival. *American Journal of Agricultural Economics*, 88:382–392.

Kim, Y., Yu, J., and Pendell, D. L. (2020). Effects of crop insurance on farm disinvestment and exit decisions. *European Review of Agricultural Economics*, 47:324–347.

Kimhi, A. and Bollman, R. (1999). Family farm dynamics in canada and israel: the case of farm exits. *Agricultural Economics*, 21:69–79.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71:1695–1725.

Prina, S. (2013). Who benefited more from the north american free trade agreement: Small or large farmers? evidence from mexico. *Review of Development Economics*, 17:594–608.

Santeramo, F. G., Goodwin, B. K., Adinolfi, F., and Capitanio, F. (2016). Farmer participation, entry and exit decisions in the italian crop insurance programme. *Journal of Agricultural Economics*, 67:639–657.

Storm, H., Mittenzwei, K., and Heckelei, T. (2015). Direct payments, spatial competition, and farm survival in norway. *American Journal of Agricultural Economics*, 97:1192–1205.

Yu, J., Villoria, N. B., and Hendricks, N. P. (2022). The incidence of foreign market tariffs on farmland rental rates. *Food Policy*, 112:102343.