**The relationship between cross-sector liberal trade policy and individual food insecurity by household- and country-income: an observational analysis of 460,102 persons in 132 countries, 2014-2017**

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## Abstract

*Background*

Eradicating food insecurity is necessary for achieving global health goals. Liberal trade policies may increase food supplies but how these policies influence individual-level food insecurity remains uncertain.

*Methods*

We combined Food and Agricultural Organization data from 460,102 persons in 132 countries, 2014-2017, with a country-level trade policy index from the Konjunkturforschungsstelle (KOF) Swiss Economic Institute. We examined the association between a country’s trade policy score and the probability of reporting ‘moderate/severe’ food insecurity using regression models and algorithmic weighting procedures. We control for multiple covariates, including GDP, democratization, and population size. We further examined heterogeneity by country- and household-income.

*Results*

Liberal trade policy was not significantly associated with moderate/severe food insecurity after covariate adjustment. However, among households in high-income countries with incomes larger than $25,430 per person per year, a unit increase in the trade policy index (more liberal) corresponded to a 0·07 % (95% CI: -0·10% to -0·04%) reduction in the predicted probability of reporting moderate/severe food insecurity. Among households in the lowest income decile (<$450 per person per year) in low-income countries, a unit increase in the trade policy index was associated with a 0·35% (95% CI: 0·06% to 0·6%) increase in the predicted probability of moderate/severe food insecurity.

*Interpretation*

The relationship between liberal trade policy and food insecurity varies across countries and households. Liberal trade policy is predominantly associated with lower food insecurity in high-income countries but corresponds to increased food insecurity among some very poor households in low-income countries.

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## Research in context

*Evidence before this study*

To identify studies investigating the relationship between liberal trade policy and food insecurity we searched Scopus, Google Scholar, and PubMed for all articles with “trade policy”, “trade reforms”, “trade liberalization” and “food insecurity” in the abstract or title, without date restrictions. We also examined the bibliographies of existing reviews of trade policy, nutrition, and health. Our searches identified divergent hypotheses about the nature and expected direction of trade policy impacts on food insecurity. Furthermore, varying operationalizations of trade policy and food insecurity have produced different findings. Studies have predominantly used country-level food insecurity proxies (e.g. food supply, famines) or did not correct for potential covariates (e.g. GDP). Other studies identified increased food supplies and reduced food price volatility in response to agricultural trade liberalization.

These studies may not capture food insecurity outcomes in response to cross-sector trade liberality, as availability, supplies, and prices at the local or aggregate level may not translate into consumption. Furthermore, the socio-economic consequences of liberal trade policy can have varying effects on food budgets and access across different country- and household-income groups. We did not identify any studies that conducted a systematic global analysis of the relationship between cross-sector liberal trade policy and individual-level food insecurity outcomes in different household- and country-income groups.

*Added value of this study*

We combined novel data and methods to conduct the first systematic analysis of the relationship between ‘liberal’ trade policies and individuals’ probabilities of reporting food insecurity across country- and household- income groups. We use a global dataset of individual-level food insecurity indicators, measured through the Food Insecurity Experience Scale developed by Food and Agriculture Organisation (FAO) and collected in the Gallup World Poll (GWP). These data created a unique opportunity to analyse individual-level food insecurity by providing the first survey protocol to measure people’s direct experiences of food insecurity at the individual level on a global scale. We combine these rich microdata from 460,102 people across 132 countries with country-level data on the degree of liberal trade policy across multiple sectors from the Konjunkturforschungsstelle (KOF) Swiss Economic Institute, 2014-2017. We use cross-national regression models, an algorithmic weighting procedure, and a series of additional tests to evaluate whether our results are explained by other processes.

Our results advance current debates about food insecurity under different trade regimes by revealing marked distributional complexities in this relationship. More liberal trade policy was, on average, associated with a lower probability of reporting moderate/severe food insecurity, but this association was not robust once we adjusted for potential covariates. In high-income countries, greater trade liberality was associated with a lower probability of reporting moderate/severe food insecurity among individuals with household incomes of more than $4,300 per person per year. However, trade liberality corresponded to a higher probability of food insecurity among individuals in the lowest income decile (<$450 per person per year) in low-income countries.

*Implications of all the available evidence*

Our results corroborate previous suggestions that food insecurity is lower among most income groups in high-income countries with more liberal trade regimes. Yet, we find liberal trade policy corresponds to lower food affordability and access among some of the world’s poorest households in low-income countries. Our results are therefore cause for both optimism and concern among policymakers, donors, international institutions, and medics worried about food insecurity, and have particular relevance for those developing trade and food insecurity policies. Our results highlight the need to consider the distributional complexities in the impact of trade reforms on food insecurity. Complementary measures may be necessary in order to ensure widespread improvements in food security under liberal trade regimes. Furthermore, our results point toward a critical and urgent need for research that evaluates the impacts of trade policy changes on food insecurity among different socio-economic groups.

## Introduction

Food insecurity is a root cause of many of today’s most pressing global health challenges and prevents millions of individuals from reaching their full social and economic potential.1 Food insecurity has a profound scarring effect on health and can result in nutrient deficiencies, malnutrition, wasting, and premature mortality.2,3 Even in contexts where these severe outcomes are rare, food insecurity is associated with a higher risk of cardiovascular disease, low mental health, and poor management of long-term health conditions.4–9 And yet, the world is currently facing a series of challenges to eradicating food insecurity. The proportion of the global population experiencing chronic food deprivation declined substantially in the decade to 2015, falling from 14·5% in 2005 to 10·6% in 2015.10 However, this downward trend has stalled, and climate change, population growth, and declining biodiversity may undermine prior progress.

Eradicating food insecurity is therefore a key priority in the global health agenda. The United Nation’s Sustainable Development Goals (SDGs), adopted by 193 countries in September 2015, called on countries to ‘end hunger’ and ‘achieve food security’ (SDG 2) by 2030.11 Food security exists ‘when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food’ and is therefore essential to ensuring healthy lives for all too (SDG 3).12 Achieving this will require concerted action to address the complex determinants of food insecurity, and international organizations have long promoted liberal trade policy as one effective approach.13–15

However, theoretical and empirical studies to date have reached divergent conclusions about the relationship between liberal trade policy and food insecurity.14,15 Liberal trade policy typically affects multiple sectors and can positively or negatively influence individual food insecurity via changes to food supplies, prices, and affordability. For example, research indicates that liberal trade policy in the food and agricultural sectors can increase access to food imports, lower food prices, smooth domestic food supply volatility, and expand domestic food production.16–18 Liberal policy in other sectors may also reduce food insecurity via increased wages and employment.14 Yet a resurgence of anti-trade politics in the United States and Europe has generated renewed interest in which socio-economic groups benefit from liberal trade policy and whether disadvantaged socio-economic groups suffer long-term losses.19 However, little is known about distributional differences in trade policy’s impacts on food insecurity (see ‘Research in Context’).20,21

Socio-economic conditions exert a strong influence on food security and so some argue that liberal trade policies spanning multiple sectors may have varying impacts on food insecurity among different groups according to whether and how their socio-economic circumstances change. For example, research indicates that high-income countries generally benefit economically from liberal trade policies, but some poorer countries do not experience higher trade flows and income growth due to labour market rigidities, weak property rights, and poor infrastructure.22 Trade’s economic impacts can also vary within countries. Increased competition and falling prices for certain goods has resulted in increased wages for some individuals but lower wages and job losses for others working in the least competitive firms or sectors.23,24

Liberal trade policies spanning multiple sectors may therefore reduce food insecurity in some contexts but the benefits may not accrue universally. Relatively affluent households – whose wage-earners work in more competitive sectors – may experience increased access to diverse and cheaper food supplies as well as increased food affordability via wage or job growth, especially in high-income countries which are better able reap to trade’s economic benefits. In contrast, some argue that deteriorating economic circumstances could undermine food affordability among poorer households who often work in less competitive sectors and lack the resources to withstand income shocks.14,15

Overall, the net direction of changes to food insecurity and the socio-economic groups affected may partially depend on how the impact of different food prices in response to liberal trade policy are exacerbated or offset by socio-economic circumstances that impact food affordability. For example, declines in food affordability via changing incomes or employment may offset the benefits of reduced food prices and increased food access, resulting in no effect on food insecurity. One long-standing hypothesis is that liberal trade policy could increase food insecurity among individuals lacking the resources, land rights, or knowledge required to compete with subsidised, large-scale, multi-national producers.25–28 In low- and lower-middle income countries, it is far more common for poor individuals to lack these capacities, suggesting the world’s poorest households could be among those exposed to trade’s deleterious economic effects, potentially leading to reductions in food affordability and access.25

Demand for countries’ food exports and the extent to which land is used for non-food resources can also vary under different trade regimes.25,29 According to this view, trade integration may lead to higher staple food prices and reduce food affordability. Others argued that food-price and supply volatility can also occur in more integrated markets due to fluctuating demand and crises elsewhere.30 Again, the world’s poorest households are said to be most acutely affected as they spend a higher proportion of their income on food and lack the surplus income required to absorb price shocks.10

The existing literature has yet to explore these complexities because the necessary data were not available. Hence, the links between trade liberality and food insecurity remain disputed, despite recognition of the need to assess how outcomes vary in different conditions using indicators that capture food insecurity’s multiple dimensions.14,15 Here we expand on prior work by conducting the first empirical test – to our knowledge – of whether individuals living in countries with more ‘liberal’ trade policies are less likely to experience food insecurity, and whether this association varies across country- and household-income groups.

## Methods

*Data and measures*

We used individual-level data on household food insecurity and socio-demographic characteristics from the Gallup World Poll (GWP) for the years 2014-2017, made available via a license from FAO. The GWP is a stratified random sample conducted in over 140 countries since 2005.31 In 2014, the FAO funded the inclusion of its Food Insecurity Experience Scale (FIES), a new global measure of individual food insecurity. It contains 8 ‘Yes/No’ questions spanning food insecurity’s multiple dimensions. Several studies have assessed the validity of the FIES and concluded that it is the only internationally comparable micro-level food insecurity measure that has internal and construct validity.32 We re-coded responses across the 8 questions into two binary categories of food insecurity: at least moderate food insecurity, i.e. ‘moderate/severe’, capturing a ‘Yes’ response to at least 4 questions, and ‘severe’ food insecurity, capturing ‘Yes’ responses to at least 7 questions.33

Our trade policy measure is a sub-component of the KOF Globalisation Index.34 We use the ‘de jure’ measure of trade integration, which captures policies that impede or promote trade flows between countries and for which data are available across countries over several years. This measures averages across sectors in order to capture the interacting and potentially modifying influence of cross-sector trade liberality, and should not be interpreted as specific to a particular sector, such as agriculture. Further, this measure captures different trade regimes due to historic as well as recent policy changes.

After merging the GWP and KOF data with additional covariate data we excluded cases with missing individual-level and country-level data. Our final analytic sample comprised 460,102 individuals spanning up to 132 countries, 2014-2017. Appendices 1.1-1.4 provide additional details.

*Statistical models*

Full details of all statistical procedures are provided in Appendix 1.5. We estimated separate logistic regression models examining the association between the liberal trade policy index and the two binary outcomes: ‘moderate/ severe’ and ‘severe’ food insecurity. We tested for heterogeneity by incorporating interaction terms between trade policy and country-income classification, and a 3-way interaction between trade policy, country-income classification, and household-income per person per year (net of welfare support, adjusted for differences in purchasing power).

Both food insecurity and trade policy may be caused by a third factor, e.g., Gross Domestic Product (GDP), and valid instruments for liberal trade policy are difficult to identify. Briefly, we aim to reduce potential measurable sources of bias using two statistical procedures. We incorporated potential country-level confounders as controls: GDP per capita, degree of democracy, population size, being a landlocked country, whether a country was colonized, and year dummies capturing unobserved period differences. We estimated pooled ordinary least squares (OLS) models as we have an insufficient number of repeat observations and within-unit variation to estimate panel GMM or fixed-effects models.

We also re-weight observations using non-parametric Covariate Balancing Generalised Propensity Scores (npCBGPS).35 The non-parametric algorithm identifies country-weights that, when applied to each unit, minimise the correlation between trade policy and its covariates whilst simultaneously maximising treatment prediction. We then apply these weights in the model fitting process. We subsequently build on these baseline models in ‘doubly robust’ specifications incorporating individual- and macro-level controls as well as npCBGPS weights.35 All models testing for interactions with household income at the individual-level incorporate individual-level controls: age, sex, education, employment status, marital status. We conduct further tests to assess the robustness of our results.

*Role of funding source*

The funders of the study had no role in study design, data collection, data analysis, interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Results

Around 26·7% of respondents included in the sample reported moderate/severe food insecurity. This varied from country-to-country. In low-income countries, 58·1% of respondents reported moderate/severe food insecurity, compared with 35·9%, 23·2% and 7·8% in lower-middle, upper-middle, and high-income countries respectively. Food insecurity also varied according to whether individuals were at the bottom or the top of the global household income distribution. Among households in the highest income decile in high-income countries, rates of moderate/severe food insecurity were less than 2% (1·9%), while rates among those in the lowest income decile were above 70% (73·8%) in low-income countries.

[Figure 1 about here]

Figure 1 shows that there is a clear negative association between liberal trade policy and the proportion of a country’s respondents reporting moderate/severe (Panel A) and severe (Panel B) food insecurity. This association, however, is quite plausibly explained by trade policy and food insecurity covariates. Re-weighting observations using npCBGPS weights substantially reduces covariate imbalance (see Figure 2), reducing the mean absolute Pearson correlation between covariates and trade policy from 0·22 (pre-weighting) to 0·05 (post-weighting).

[Figure 2 about here]

[Table 1 about here]

When we use these weights to correct for covariate imbalance, there is no clear association between more liberal trade policy and an individual’s odds of experiencing moderate/severe (AOR = 1·01, 95% CI = 0·99 to 1·02) and severe (AOR = 1·01, 95% CI = 0·99 to 1·02) food insecurity (Models B and C in Table 1).

To evaluate differences between country-income groups, we estimated an interaction model and calculated the average difference in the predicted probability of food insecurity per unit increase in trade liberality (the average marginal effect, ‘AME’) in each income group.36 None of the AMEs was significantly different from zero (Figure 3) , although when comparing the coefficients for high- and low-incomes countries, we find that the AME was 0·35% higher (95% CI: 0·34% to 0·36%) in low-income countries compared with high-income countries.

[Figure 3 about here]

Next we explore within-country heterogeneity; once aggregated, this may account for the null effects in Figure 3. Figure 4 shows that the correlation between liberal trade policy and food insecurity varies both between countries and across the income distribution. A unit increase in the trade policy index (indicating more liberal trade policy) was associated with a 0·35% increase (95% CI: 0·06% to 0·6%) in the predicted probability of reporting moderate/severe food insecurity among those in the lowest income decile (<450$ per person per year) in low-income countries. Moving up the income distribution, the AME declines in size but remains positive among households earning up to $2,760 per person per year; approximately 95% respondents in low-income countries had incomes below this threshold. The AME was not statistically significant at higher incomes.

[Figure 4 about here]

The pattern in low- and lower-middle income countries differs from upper-middle and high-income countries (Figure 4). Among upper-middle income countries, none of AMEs are statistically significant. In high-income countries, the AME was not statistically significant among poor households earning up to $4,300 per person per year; approximately 9·5% respondents had incomes below this level. However, a unit increase in trade liberality was associated with a reduction in food insecurity among households with a per capita annual income of more than $4,300 i.e. approximately 90·5% respondents in high-income countries. For those with household incomes larger than $25,430 per person per year (the highest decile in the top left panel of Figure 4), a unit increase in the trade policy index corresponded to a 0·07% reduction (95% CI: -0·10 % to -0·04%) in the predicted probability of reporting moderate/ severe food insecurity.

*Robustness checks*

Appendices 2.3-2.9 present a series of additional tests to explore whether our results are stable across model specifications, including a ‘placebo’ test which examines an outcome we would not expect to be affected by trade policy: whether people would help a stranger. We find no significant association, giving our results more face validity.37 We also estimated ‘doubly robust’ models incorporating both macro-level controls and npCBGPS weights. In addition, we originally estimated pooled ordinary least squares (OLS) models as we have an insufficient number of repeat observations and within-unit variation to estimate panel GMM or fixed-effects models. However, as a further check we re-estimated our models incorporating country fixed-effects to test whether the broad pattern of our results was generally consistent. Furthermore, our original models did not incorporate a country’s arable land area as a control since data is only available for approximately half of the countries. We conducted an additional test in which we included this variable and re-estimated our models.

Appendices 2.4-2.9 show that the precise income groups which experience a predicted rise and fall in food insecurity in low- and high-income countries vary in some specifications. As expected, the results from the fixed-effects models have wider confidence intervals due to the reduced sample size. However, the pattern of the results was broadly consistent with our main models.

## Discussion

Our analysis has identified distributional differences in the relationship between liberal trade policy and food insecurity. Drawing on a global analysis of unique microdata spanning 132 countries, 2014-2017, we found that the negative association between trade policy and the probability of reporting food insecurity was not robust to covariate adjustment. This global estimate, however, masked significant variation. In high-income countries, more liberal trade policy was associated with lower food insecurity among individuals who lived in households earning more than $4,300 per person per year (~90·5% respondents), but had no statistically identifiable association among poorer households. In low-income countries, poor households earning less than $2,760 per person per year (~95% respondents) were more likely to experience food insecurity where trade policy was more liberal, whereas trade liberality had no statistically identifiable association among a minority earning higher incomes.

Our study has important limitations, some reflecting data availability and the inability to conduct randomized experiments. First, some trade policy covariates are difficult to measure, such as privatization reforms. We have attempted to control for and minimise the risk that our results are explained by alternative processes by estimating models addressing different sources of bias, including covariate confounding (OLS regression), covariate imbalance (npCBGPS weights), and time-invariant heterogeneity (fixed-effects). However, we were unable to identify a suitable instrument for liberal trade policy and rule out all confounders, and our data do not allow for definitive causal conclusions. Future quasi-experimental studies should further investigate our study findings, and our results highlight the need for future research in this area. Our findings nevertheless provide new evidence of significant and clear complexities in the association between trade policy and food insecurity using detailed microdata. This improves our understanding of the nature of the relationship between trade policy and presents an important finding for policy makers and practitioners to consider – alongside context-specific information and existing evidence – when developing trade and food insecurity policies.

Second, our analysis uses a unique dataset of individual-level food insecurity that captures outcomes within a limited time period and it remains unclear whether our results are representative in the long-run. Short-run outcomes may vary over time due to changing industry structure and labour mobility.38 Furthermore, our results show differences in food insecurity levels under different trade regimes and that these may reflect policy changes in previous periods as well as contemporaneous reforms. More longitudinal and quasi-experimental research is necessary to assess the impact of trade reforms and associated mechanisms, including prices.

A third limitation concerns the generalisability of our findings to agricultural trade policy and other sector-specific measures. Our results do not pertain to agricultural trade liberalization specifically. Indeed, one interpretation of our paper is that any benefits from sector-specific policies, including those affecting agriculture, may be offset by liberal policy in other sectors that create socio-economic changes that serve to undermine food insecurity. Further, we were unable to fully capture export taxes, and trade policy may also have different implications in the context of ‘trade wars’. Industry-specific tariff increases in response to bilateral disputes have escalated in recent years and may adversely impact some poor countries.39 More research is necessary to assess the impact of recent and ongoing trade disputes.

Fourth, it is necessary to understand how liberal trade policies affect nutrient intake and associated outcomes. Consumption of unhealthy products such as sugar has increased in response to liberal trade policy in some contexts, and this can occur even if households remain food insecure.40 Our results together with previous findings suggest that liberal trade policy could be an institutional driver of food consumption patterns related to both under- and over-nutrition in low-income countries.

More research is also necessary to identify precisely which of the mechanisms we have discussed explains our results, why certain groups experience increased food insecurity in countries with more liberal trade regimes whilst others experience reductions, whether there are additional sources of variation, and how benefits may be equalized. As we have shown elsewhere, these questions are under-explored in the trade literature more broadly and are an important priority for future research.21,41 It may be fruitful to examine specific case studies, such as Togo, Argentina and Sri Lanka, which had approximately 5% higher food insecurity rates than predicted given their trade policy scores, and Slovenia, Ecuador, and Bahrain, which had approximately 5% lower food insecurity rates than predicted.

There may also be important variation between high-income countries according to their welfare system. Indeed, liberal trade policy may best enable food insecurity reductions where policies serve to mitigate harms and ensure shared benefits, as social transfers may minimise some of the social and economic dislocation that occurs as a result of trade. Potentially effective complementary policies include infrastructural investment and active re-employment programs, in addition to instruments specifically targeting food insecurity such as food subsidies. The rules and agreements which govern trade conditions may also be an important target for intervention by, for example, removing subsidies in high-income countries which render poor countries unable to compete with imports, or by ensuring labour market protections remain adequate.25

These limitations notwithstanding, what do our results imply about how to reduce food insecurity and associated health outcomes in different contexts? Whilst our research is observational and primarily assesses food insecurity outcomes under different trade regimes, our results give policy makers grounds to consider how evenly shared the impact of trade reforms on reduced food insecurity are likely to be in different contexts. Hence, more research is certainly needed to estimate the causal effects of trade policy changes on food insecurity. Our results are nevertheless important to take into account given the divergent findings to-date and the paucity of evidence concerning the relationship between dynamic changes in trade policy and multi-dimensional individual food insecurity indicators, specifically.

Thus, our findings may be cause for both optimism and concern for policymakers and medics concerned with reducing food insecurity. We find that liberal trade policy is, in the right conditions, associated with lower food insecurity and so may also help to alleviate associated health consequences. According to our results, these conditions are predominantly observed in high-income countries, as we find that among individuals in wealthy countries who live in relatively affluent households by global standards, food insecurity is lower under more liberal trade regimes. The exceptions in high-income countries are people who are on low incomes by global standards – such as those living on less than $5-10 per day in the United States, for example.42 We find that these individuals do not necessarily benefit from liberal trade regimes in terms of food insecurity, suggesting that benefits from food price declines may be offset by material losses, or that some of these individuals gain but others lose out.

Furthermore, when we look at low-income countries and focus on the world’s poorest households, we find that food insecurity is higher where trade policy is more liberal. Although trade liberality, especially in the agriculture sector, may well yield increases in food access via increasing food imports, our findings suggest these improvements do not extend to the poorest households, or are offset by deteriorating economic circumstances that undermine food affordability. What makes this particularly salient is that these are also the households where the most severe health consequences of food insecurity are likely to be felt.11 Hence, policy-makers may need to work across sectors to ensure policies in different areas serve to reinforce – rather than undermine – possible benefits of trade integration.

Liberal trade policy has been cited as an ‘engine’ for reducing food insecurity (SDG 2) and so improving health (SDG 3). Our study suggests there is a need for policymakers to consider the complexities in whether liberal trade policies yield widespread benefits. Developing inclusive approaches to liberal trade policy may be crucial to ensuring that trade liberality yields the benefits we identify whilst avoiding food insecurity and hunger among the world’s poorest households.

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## Contributions

PB and AR conceptualized and designed the study. AR, RL and VT obtained the study data. PB developed the statistical models, conducted the statistical analysis, and synthesized the statistical results. AR contributed to developing the statistical models, reviewed the study methodology, and validated the statistical results. PB and AR wrote the original drafts of the manuscript. PB, AR, RL and VT contributed to editing and revising the manuscript.

## Declaration of interests

Authors declare no competing interests.

## Tables

**Table 1. Association between liberal trade policy and odds of reporting moderate/ severe food insecurity**

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| --- | --- | --- | --- | --- |
| Model | ORa | 95% CI | ORa | 95% CI |
|  | **Moderate/ severe FI** |  | **Severe FI** |  |
| A: No controls or weights | 0.96 | 0.96 to 0.98 | 0.97 | 0.96 to 0.98 |
| B: Covariate controls | 1.00 | 0.98 to 1.01 | 1.00 | 0.98 to 1.01 |
| C: npCBGPSb weights | 1.00 | 0.99 to 1.02 | 1.00 | 0.99 to 1.02 |

*Notes:* \* p<0.10 ; \*\* p<0.05; \*\*\* p<0.01.N=460,102. A – Odds Ratio. b – Model with non-parametric Covariate Balancing Generalised Propensity Score (npCBGPS) weights adjusts for covariates of trade policy and food insecurity by re-weighting observations to minimise the association between trade policy and GDP per capita, Polity 2 score, being a former colony, being a landlocked island, population size, and survey year. See methodological appendix for additional details of covariate measurement, sample composition, and statistical procedures.

**Figures**

**Figure 1. Association between KOF trade policy index and proportion reporting food insecurity**

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*Notes:* Lowess, unconditional association between country-average proportion of country respondents reporting food insecurity and country-average KOF trade policy index score in all years (bandwidth = 0.8). See methodological appendix for details of trade policy and food insecurity data sources and measurement.

**Figure 2. Absolute Pearson correlation between trade policy covariates and trade policy pre- and post-weighting**

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*Notes:* The non-parametric Covariate Balancing Propensity Score developed by Fong et al. (2018) is estimated such that it minimises the Pearson correlation between covariates and treatment assignment as well as maximising the prediction of treatment assignment, avoiding iterations between model fitting and balance checking. See methodological appendix (section 1.5) for additional details.

**Figure 3. Change in predicted probability of reporting moderate/ severe food insecurity per unit increase trade policy index (more liberal policy) across country income classifications**

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*Notes:* Figure shows change in predicted probability of reporting moderate or severe food insecurity per unit increase in trade policy index (indicating more liberal trade policy) among countries in different income groups. See Appendix 2.1 for figure showing probability of reporting severe food insecurity.

**Figure 4. Predicted change in the probability of reporting either moderate/ severe food insecurity per unit increase trade policy score (more liberal policy) by country- and household- income group**

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*Notes:* Figure shows change in predicted probability of reporting moderate/ severe food insecurity per unit increase in trade policy index (indicating more liberal trade policy) among households of different income levels, in different income groups. See Appendix 2.2 for figure showing changes in predicted probability of reporting severe food insecurity only.

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