

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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1 **Abstract**

2 *Background*

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

6
7 *Methods*

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

15
16 *Results*

17 Liberal trade policy was not significantly associated with moderate/severe food insecurity
18 after covariate adjustment. However, among households in high-income countries with
19 incomes larger than \$25,430 per person per year, a unit increase in the trade policy index
20 (more liberal) corresponded to a 0.07 % (95% CI: -0.10% to -0.04%) reduction in the
21 predicted probability of reporting moderate/severe food insecurity. Among households in the
22 lowest income decile (<\$450 per person per year) in low-income countries, a unit increase in
23 the trade policy index was associated with a 0.35% (95% CI: 0.06% to 0.6%) increase in the
24 predicted probability of moderate/severe food insecurity.

25
26 *Interpretation*

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

31
32 *Funding*

33 Joseph Rowntree Foundation, ESRC

34 **Research in context**

35 *Evidence before this study*

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

47

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

55

56 *Added value of this study*

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

68 weighting procedure, and a series of additional tests to evaluate whether our results are
69 explained by other processes.

70

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

80

81 *Implications of all the available evidence*

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

94 **Introduction**

95 Food insecurity is a root cause of many of today's most pressing global health challenges and
96 prevents millions of individuals from reaching their full social and economic potential.¹ Food
97 insecurity has a profound scarring effect on health and can result in nutrient deficiencies,
98 malnutrition, wasting, and premature mortality.^{2,3} Even in contexts where these severe
99 outcomes are rare, food insecurity is associated with a higher risk of cardiovascular disease,
100 low mental health, and poor management of long-term health conditions.⁴⁻⁹ And yet, the
101 world is currently facing a series of challenges to eradicating food insecurity. The proportion
102 of the global population experiencing chronic food deprivation declined substantially in the
103 decade to 2015, falling from 14.5% in 2005 to 10.6% in 2015.¹⁰ However, this downward
104 trend has stalled, and climate change, population growth, and declining biodiversity may
105 undermine prior progress.

106

107 Eradicating food insecurity is therefore a key priority in the global health agenda. The United
108 Nation's Sustainable Development Goals (SDGs), adopted by 193 countries in September
109 2015, called on countries to 'end hunger' and 'achieve food security' (SDG 2) by 2030.¹¹
110 Food security exists 'when all people, at all times, have physical, social, and economic access
111 to sufficient, safe, and nutritious food' and is therefore essential to ensuring healthy lives for
112 all too (SDG 3).¹² Achieving this will require concerted action to address the complex
113 determinants of food insecurity, and international organizations have long promoted liberal
114 trade policy as one effective approach.¹³⁻¹⁵

115

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

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

138
139 Liberal trade policies spanning multiple sectors may therefore reduce food insecurity in some
140 contexts but the benefits may not accrue universally. Relatively affluent households – whose
141 wage-earners work in more competitive sectors – may experience increased access to diverse
142 and cheaper food supplies as well as increased food affordability via wage or job growth,
143 especially in high-income countries which are better able reap to trade's economic benefits.
144 In contrast, some argue that deteriorating economic circumstances could undermine food
145 affordability among poorer households who often work in less competitive sectors and lack
146 the resources to withstand income shocks.^{14,15}

147
148 Overall, the net direction of changes to food insecurity and the socio-economic groups
149 affected may partially depend on how the impact of different food prices in response to
150 liberal trade policy are exacerbated or offset by socio-economic circumstances that impact
151 food affordability. For example, declines in food affordability via changing incomes or
152 employment may offset the benefits of reduced food prices and increased food access,
153 resulting in no effect on food insecurity. One long-standing hypothesis is that liberal trade
154 policy could increase food insecurity among individuals lacking the resources, land rights, or
155 knowledge required to compete with subsidised, large-scale, multi-national producers.²⁵⁻²⁸ In
156 low- and lower-middle income countries, it is far more common for poor individuals to lack
157 these capacities, suggesting the world's poorest households could be among those exposed to
158 trade's deleterious economic effects, potentially leading to reductions in food affordability
159 and access.²⁵

160

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

168

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

176

177 **Methods**

178 *Data and measures*

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

190

191 Our trade policy measure is a sub-component of the KOF Globalisation Index.³⁴ We use the
192 'de jure' measure of trade integration, which captures policies that impede or promote trade
193 flows between countries and for which data are available across countries over several years.
194 This measures averages across sectors in order to capture the interacting and potentially

195 modifying influence of cross-sector trade liberality, and should not be interpreted as specific
196 to a particular sector, such as agriculture. Further, this measure captures different trade
197 regimes due to historic as well as recent policy changes.

198

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

203

204 *Statistical models*

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

212

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

221

222 We also re-weight observations using non-parametric Covariate Balancing Generalised
223 Propensity Scores (npCBGPS).³⁵ The non-parametric algorithm identifies country-weights
224 that, when applied to each unit, minimise the correlation between trade policy and its
225 covariates whilst simultaneously maximising treatment prediction. We then apply these
226 weights in the model fitting process. We subsequently build on these baseline models in
227 ‘doubly robust’ specifications incorporating individual- and macro-level controls as well as
228 npCBGPS weights.³⁵ All models testing for interactions with household income at the

229 individual-level incorporate individual-level controls: age, sex, education, employment
230 status, marital status. We conduct further tests to assess the robustness of our results.

231

232 *Role of funding source*

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

236

237 **Results**

238 Around 26·7% of respondents included in the sample reported moderate/severe food
239 insecurity. This varied from country-to-country. In low-income countries, 58·1% of
240 respondents reported moderate/severe food insecurity, compared with 35·9%, 23·2% and
241 7·8% in lower-middle, upper-middle, and high-income countries respectively. Food
242 insecurity also varied according to whether individuals were at the bottom or the top of the
243 global household income distribution. Among households in the highest income decile in
244 high-income countries, rates of moderate/severe food insecurity were less than 2% (1·9%),
245 while rates among those in the lowest income decile were above 70% (73·8%) in low-income
246 countries.

247

248 [Figure 1 about here]

249

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

257

258 [Figure 2 about here]

259 [Table 1 about here]

260

261 When we use these weights to correct for covariate imbalance, there is no clear association
262 between more liberal trade policy and an individual's odds of experiencing moderate/severe

263 (AOR = 1.01, 95% CI = 0.99 to 1.02) and severe (AOR = 1.01, 95% CI = 0.99 to 1.02) food
264 insecurity (Models B and C in Table 1).

265

266 To evaluate differences between country-income groups, we estimated an interaction model
267 and calculated the average difference in the predicted probability of food insecurity per unit
268 increase in trade liberality (the average marginal effect, 'AME') in each income group.³⁶

269 None of the AMEs was significantly different from zero (Figure 3) , although when
270 comparing the coefficients for high- and low-incomes countries, we find that the AME was
271 0.35% higher (95% CI: 0.34% to 0.36%) in low-income countries compared with high-
272 income countries.

273

274 [Figure 3 about here]

275

276 Next we explore within-country heterogeneity; once aggregated, this may account for the null
277 effects in Figure 3. Figure 4 shows that the correlation between liberal trade policy and food
278 insecurity varies both between countries and across the income distribution. A unit increase
279 in the trade policy index (indicating more liberal trade policy) was associated with a 0.35%
280 increase (95% CI: 0.06% to 0.6%) in the predicted probability of reporting moderate/severe
281 food insecurity among those in the lowest income decile (<450\$ per person per year) in low-
282 income countries. Moving up the income distribution, the AME declines in size but remains
283 positive among households earning up to \$2,760 per person per year; approximately 95%
284 respondents in low-income countries had incomes below this threshold. The AME was not
285 statistically significant at higher incomes.

286

287 [Figure 4 about here]

288

289 The pattern in low- and lower-middle income countries differs from upper-middle and high-
290 income countries (Figure 4). Among upper-middle income countries, none of AMEs are
291 statistically significant. In high-income countries, the AME was not statistically significant
292 among poor households earning up to \$4,300 per person per year; approximately 9.5%
293 respondents had incomes below this level. However, a unit increase in trade liberality was
294 associated with a reduction in food insecurity among households with a per capita annual
295 income of more than \$4,300 i.e. approximately 90.5% respondents in high-income countries.
296 For those with household incomes larger than \$25,430 per person per year (the highest decile

297 in the top left panel of Figure 4), a unit increase in the trade policy index corresponded to
298 0.07% reduction (95% CI: -0.10 % to -0.04%) in the predicted probability of reporting
299 moderate/ severe food insecurity.

300

301 *Robustness checks*

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

314

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

320

321 **Discussion**

322 Our analysis has identified distributional differences in the relationship between liberal trade
323 policy and food insecurity. Drawing on a global analysis of unique microdata spanning 132
324 countries, 2014-2017, we found that the negative association between trade policy and the
325 probability of reporting food insecurity was not robust to covariate adjustment. This global
326 estimate, however, masked significant variation. In high-income countries, more liberal trade
327 policy was associated with lower food insecurity among individuals who lived in households
328 earning more than \$4,300 per person per year (~90.5% respondents), but had no statistically
329 identifiable association among poorer households. In low-income countries, poor households
330 earning less than \$2,760 per person per year (~95% respondents) were more likely to

331 experience food insecurity where trade policy was more liberal, whereas trade liberality had
332 no statistically identifiable association among a minority earning higher incomes.

333

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

349

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

358

359 A third limitation concerns the generalisability of our findings to agricultural trade policy and
360 other sector-specific measures. Our results do not pertain to agricultural trade liberalization
361 specifically. Indeed, one interpretation of our paper is that any benefits from sector-specific
362 policies, including those affecting agriculture, may be offset by liberal policy in other sectors
363 that create socio-economic changes that serve to undermine food insecurity. Further, we were
364 unable to fully capture export taxes, and trade policy may also have different implications in

365 the context of ‘trade wars’. Industry-specific tariff increases in response to bilateral disputes
366 have escalated in recent years and may adversely impact some poor countries.³⁹ More
367 research is necessary to assess the impact of recent and ongoing trade disputes.

368

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

375

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

385

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

396

397 These limitations notwithstanding, what do our results imply about how to reduce food
398 insecurity and associated health outcomes in different contexts? Whilst our research is

399 observational and primarily assesses food insecurity outcomes under different trade regimes,
400 our results give policy makers grounds to consider how evenly shared the impact of trade
401 reforms on reduced food insecurity are likely to be in different contexts. Hence, more
402 research is certainly needed to estimate the causal effects of trade policy changes on food
403 insecurity. Our results are nevertheless important to take into account given the divergent
404 findings to-date and the paucity of evidence concerning the relationship between dynamic
405 changes in trade policy and multi-dimensional individual food insecurity indicators,
406 specifically.

407

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

419

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

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

Funding and acknowledgments

PB and AR were funded by the Joseph Rowntree Foundation. RL was supported by the Economic and Social Research Council (ES/N017358/1). We also thank Arjumand Siddiqui, Lant Pritchett, Paul Segal, and Jason Bell for their comments on an earlier version of this paper.

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

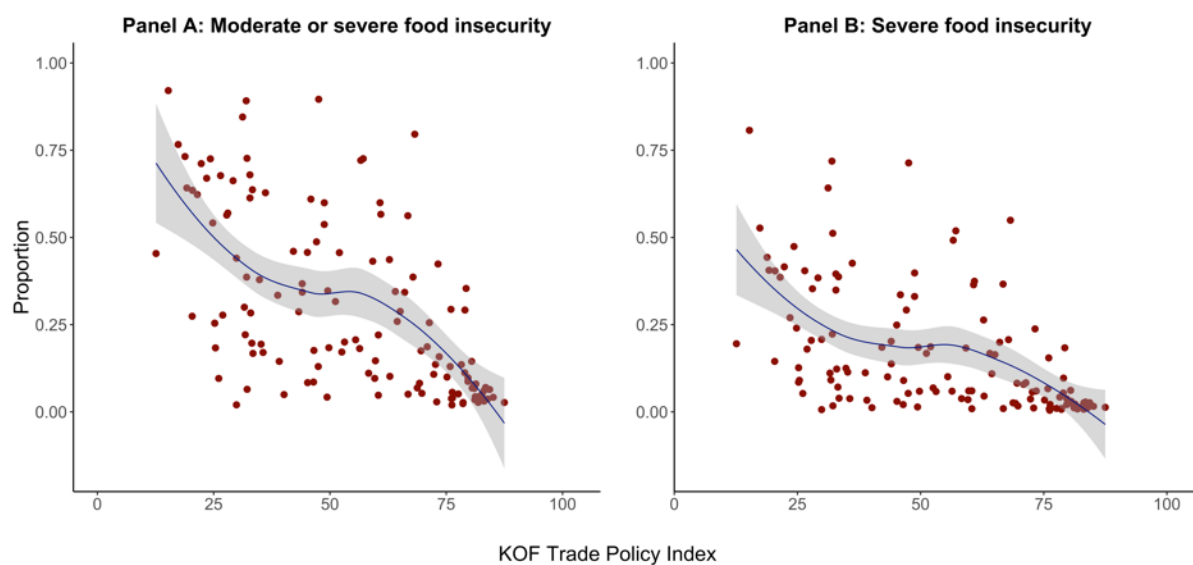
Table 1. Association between liberal trade policy and odds of reporting moderate/severe food insecurity

Model	OR^a Moderate/ severe FI	95% CI	OR^a Severe FI	95% CI
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: npCBGPS ^b 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.

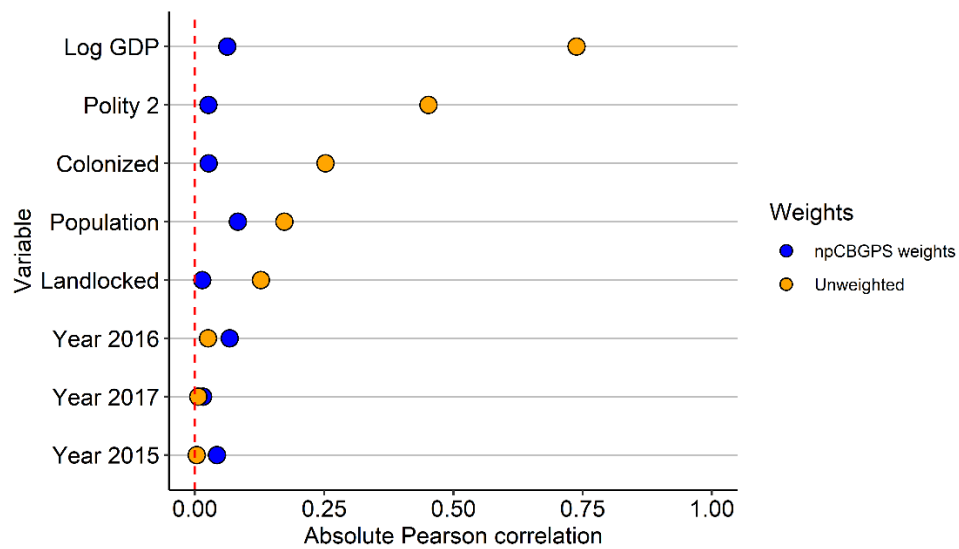
Figures

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



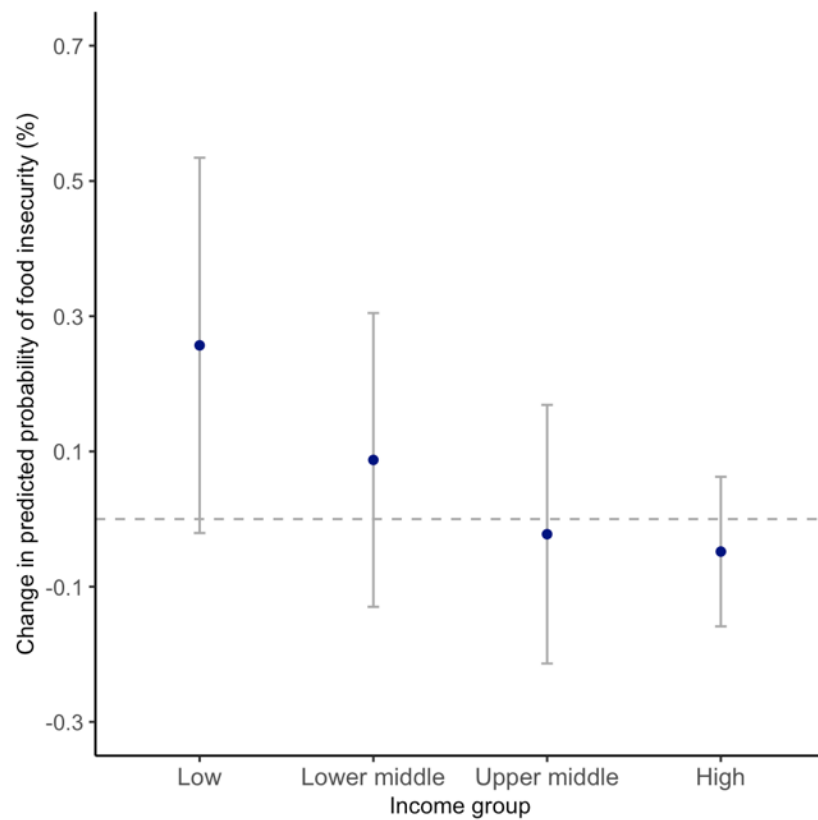
Notes: Lowess, unconditional association between country-average proportion of country respondents reporting food insecurity and country-average KOF trade policy index score in all years (bandwidth = 0.8). See methodological appendix for details of trade policy and food insecurity data sources and measurement.

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



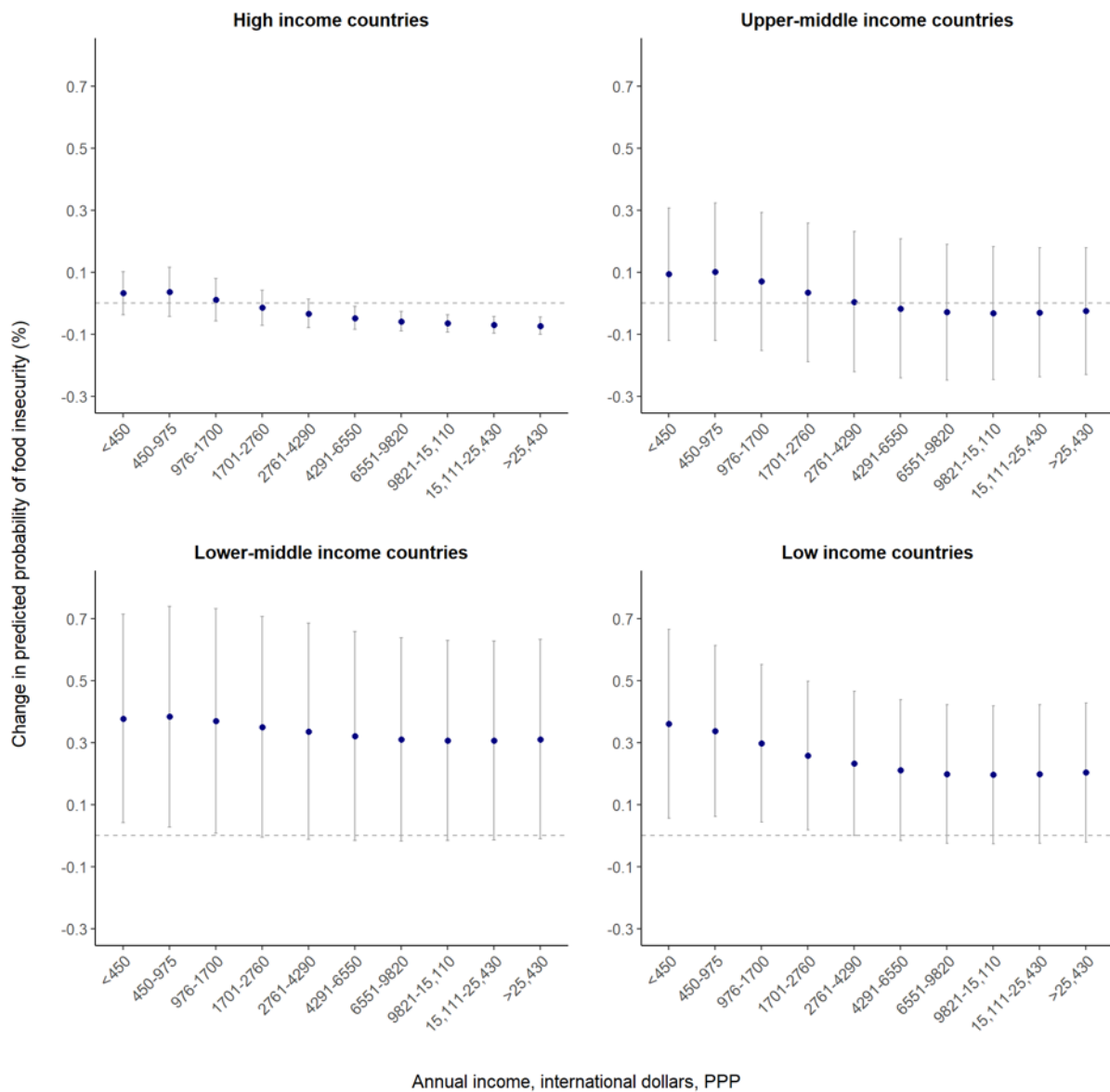
Notes: The non-parametric Covariate Balancing Propensity Score developed by Fong et al. (2018) is estimated such that it minimises the Pearson correlation between covariates and treatment assignment as well as maximising the prediction of treatment assignment, avoiding iterations between model fitting 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



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



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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