HEDG
HEALTH, ECONOMETRICS AND DATA GROUP
THE UNIVERSITY of York

WP 16/18

Globalisation and national trends in nutrition and health - a grouped fixed effects approach to inter-country heterogeneity

Lisa Oberländer, Anne-Célia Disdier & Fabrice Etilé

August 2016

http://www.york.ac.uk/economics/postgrad/herc/hedg/wps/

Globalisation and national trends in nutrition and health - a grouped fixed effects approach to inter-country heterogeneity

Lisa Oberländer* Anne-Célia Disdier† Fabrice Etilé‡

July 15, 2016

*INRA-PSE, lisa.oberlander@psemail.eu
†INRA-PSE, Anne-Celia.Disdier@ens.fr
‡INRA-PSE, fabrice.etile@psemail.eu
We are grateful for financial support from the INRA Metaprogrammes Did'it and Glofoods.

Abstract

This paper estimates the effect of globalisation on nutritional composition of the diet and health outcomes using a panel dataset of 70 countries spanning 42 years (1970-2011). Our key methodological contribution is the application of the grouped fixed effects estimator developed by Bonhomme and Manresa (2015), which enables us to better control for unobserved time-varying heterogeneity. Our results indicate that a one standard deviation increase in the index of social globalisation is associated with an increase in the share of animal protein of about 12%. In contrast, economic globalisation has no effect on the composition of the diet. Moreover, we do not find significant effects on diabetes prevalence or mean Body Mass Index. Our findings indicate that social aspects of globalisation, such as food advertising, deserve greater attention in the nutrition transition discourse.

Keywords: nutrition transition, globalisation, overweight, grouped fixed effects

1 Introduction

Globalisation has substantially altered food systems around the world, yet consequences for nutrition and health are not well understood. This paper estimates the relationship between globalisation, food supply, and health outcomes for a large sample comprising 70 high and middle income countries between 1970 and 2011. Not only has food supply significantly increased over the past 50 years but the composition of the diet has been undergoing a profound shift.

Diets have become less dominated by carbohydrates[1] while intake of animal protein, animal fat, and free fat[2] have been rising. While this nutrition transition has advanced the most in high income countries, the transition speed is even faster in upper middle income countries. Figure 1 shows that the share of animal protein rose by 16% (from 6.4% to 7.4%) in high income countries and by 35% (from 3.6% to 4.8%) in upper middle income countries at the expense of vegetable proteins. Similarly, figure 2 reveals that vegetable fat is increasingly replaced by free fat and animal fat. Free fat rose by 18% (from 14.7% to 17.4%) in high income countries, by 60% (from 8.3% to 13.3%) in upper middle income countries, and by 46% (from 6.4% to 9.3%) in lower middle income countries. The share of animal fat also increased but to a smaller extent than free fat. Finally, although carbohydrates experience an overall decline, the share of sugar in total food supply has been slightly increasing in lower middle income countries (see figure 3).
The nutrition transition has been associated with augmenting consumption levels of ultra-processed foods[3] and studies document that middle and low income countries experienced the fastest growth in processed food consumption during the past 15 years (Monteiro et al., 2013; Stuckler et al., 2012).

The nutrition transition constitutes an important risk-factor for non-communicable diseases such as cardiovascular diseases and diabetes. High intakes of fat and sugar contribute to overweight, which in turn is an important risk factor for diabetes and cardiovascular diseases (CVD) (WHO, 2015b). In 2012 17.5 million people died from cardiovascular diseases ranking them as the number one cause of death globally. More than three quarters of CVD deaths take place in low- and middle-income countries causing substantial economic costs (WHO, 2015a). As a consequence, the World Health Organisation (WHO) regards obesity and related diseases as a

[1] Carbohydrates are sugars, fiber, and starches found in fruits, grains, and vegetables. Products rich in carbohydrates are cereals, pasta, rice, bread, corn, peas, and lentils.
[2] We classified oil, butter, and cream as free fats, as these are not part of a food item but individuals can choose the quantity of free fats in their diet.
[3] Ultra-processed foods are made from processed substances extracted from whole foods and contain a high share of unhealthy types of dietary fat, sugar, and salt (Monteiro et al., 2013)

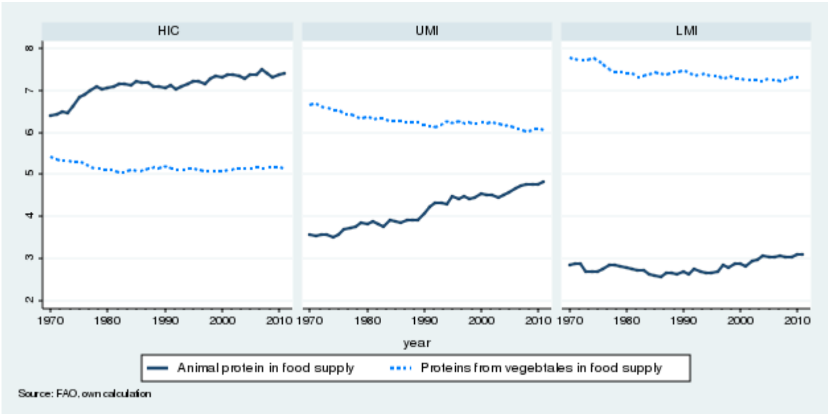

Figure 1: Composition of protein supply by income group, 1970-2011

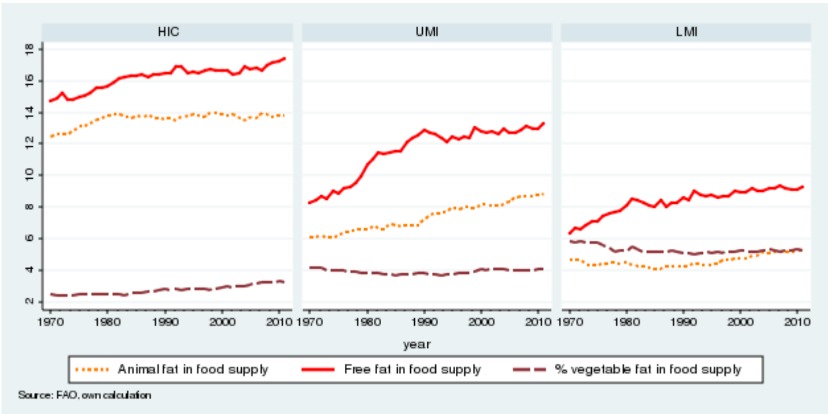

Figure 2: Composition of fat supply by income group, 1970-2011

growing threat all over the world replacing traditional public health concerns such as undernutrition and infectious diseases (WHO, 2000).

Globalisation has been held responsible for the nutrition transition (Hawkes, 2006; Popkin, 2006; Bishwajit et al., 2014). The existing evidence for this claim, however, consists mostly of case studies linking observed changes in diets to specific free trade agreements (Hawkes and Thow, 2008; Thow and Hawkes, 2009; Thow et al., 2011) and trends in foreign direct investments (FDI) in the food industry (Hawkes, 2006). These case studies typically solely focus on economic aspects of globalisation and fail to take into account the multifaceted nature of globalisation. However, theoretical work from Olivier et al. (2008) suggests that it is crucial to analyse economic and social facets of globalisation and its impact on nutritional behaviours separately. More precisely, their model predicts that social integration causes cultural convergence while economic integration causes cultural divergence.

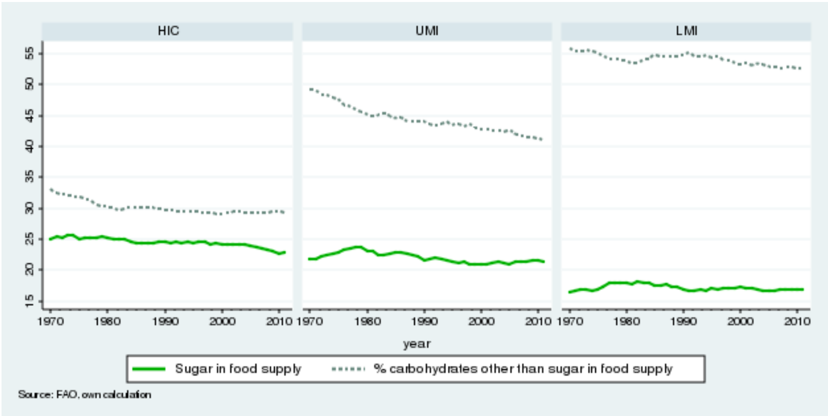

Figure 3: Composition of carbohydrates supply by income group, 1970-2011

The intuition behind this result is that economic integration allows countries to produce their own food at lowest costs while social integration triggers a shift in taste.

Considering model predictions of Olivier et al. (2008), we use the KOF Index of globalisation constructed in Dreher (2006) which allows us to separately analyse the effect of the social and economic dimension of globalisation. In order to better control for unobserved time-varying heterogeneity we use the Grouped Fixed Effects (GFE) estimator developed by Bonhomme and Manresa (2015). The GFE estimator endogenously groups countries together that share similar time profiles of food supply. Thereby, we can control for time-varying unobserved heterogeneity that is common within groups of countries. Furthermore, we test whether social and economic globalisation have heterogeneous impacts across country groups.

Our results suggest that social globalisation has a positive and significant effect on the share of animal protein in food supply. In contrast, economic globalisation has no significant effect on the composition of the diet. The magnitude of the effects is considerable, as a one standard deviation increase in the index of social globalisation is associated with an increase in the share of animal protein 12%. We further find a relatively strong convergence trend across groups for sugar and to a lesser extent for animal protein. Moreover, we find that the effect of social globalisation on animal protein is stronger for richer compared to poorer countries. Turning to health outcomes, we do not find significant effects of social and economic globalisation on diabetes prevalence or mean Body Mass Index (BMI).

Our paper contributes to the following strands of literature.
First, this paper is most closely related to a recent study from Costa-i-Font and Mas (2014) who estimated the effect of globalisation on calorie intake and obesity

using data from 26 mostly OECD countries from 1989 until 2004. Results of their pooled ordinary lest-squares (OLS) regression suggest that globalisation is positively associated with calorie intake.
We make a methodological contribution by applying the grouped fixed effects estimator, which allows us to better control for unobserved time-varying heterogeneity than pooled OLS. For example, food advertising expenditure is likely to be correlated with globalisation (e.g. number of households with television) and has been found to be positively associated with absolute calorie intake (Folkvord et al., 2016; Pettigrew et al., 2013). Moreover, we contribute to this literature by analysing the effect of globalisation on the composition of the diet instead of the absolute calorie intake. While undoubtedly excess calorie intake increases the risk of obesity, the changing composition of the diet has independent effects on morbidity and mortality.

Second, this paper relates to the literature on the relationship between overweight and globalisation at the country-level. Three studies (Costa-i-Font and Mas, 2014; Miljkovic et al., 2015; Vogli et al., 2014) use country-level data on BMI and overweight between 1980 and 2008. Goryakin et al. (2015) pooled Demographic Health Surveys and restricts its sample to women. Using country fixed effects regressions[4] these studies conclude that the effect of social globalisation is positive and significantly larger in magnitude than the effect of economic globalisation. Results on the effect of economic globalisation are mixed. Two studies (Vogli et al., 2014; Miljkovic et al., 2015) report a positive linear effect. But Goryakin et al. (2015) documents a small negative significant effect for women. These contradicting findings are likely to stem from different samples, time periods, and (non-)inclusion of individual covariates.
We add to the literature by better controlling for time-variant unobserved heterogeneity. Moreover, to the best of our knowledge this is the first study analysing the effect of globalisation on diabetes prevalence.

The rest of the paper is structured as follows. Section two describes data and section three the estimation strategy. Results and discussion are presented in sections four and five. Section six concludes.

[4] Costa-i-Font and Mas (2014) used pooled OLS

2 Data

2.1 Food supply data

Given that we observed the strongest trends for animal protein, free fat, and sugar, we restrict our attention to these three outcome variables. These dietary components are also particularly associated with negative health outcomes. High intake of sugar increases the risk of type two diabetes and overweight (Imamura et al., 2015; Te Morenga et al., 2013). Animal fat and free fats are associated with increased risk of coronary heart disease mortality (de Souza et al., 2015; Leren, 1968), and animal protein elevates the risk of type two diabetes (Malik et al., 2016).
The per capita food supply, expressed in kilocalories (kcal) per day, is a measure of the average number of calories available for human consumption, including all food groups. We obtained these data from the food balance sheets of the FAO for the time period of 1961 until 2011[5]. A food balance sheet indicates total supply by reporting the total quantity produced of each basic food item, adjusted for imports. On the utilisation side, a distinction is made between quantities exported, fed to livestock, used for seed, losses during storage and transportation, and food supply available for human consumption. However, the amount of food actually consumed may be lower depending on the degree of losses in the household.
In addition to the kilocalories available for human consumption of each food item, the dataset also contains the amount of fat and protein (grams/capita/day) of each food item, which we subsequently converted into kcal/capita/day.
In a second step, we determined for each food item its dominant type of fat and protein. More precisely, we divided proteins into vegetable and animal proteins according to their source. For fat, we differentiated between animal and vegetable origin and distinguished these from free fats that are not bound in a product. In particular, we classified vegetable oils, fish oil, butter, and cream as free fats. Finally, we separated sugar from other carbohydrates and subsequently calculated the shares of fat, protein, sugar, and their subgroups in total food supply.

2.2 Health outcomes

For health outcomes we focus on diabetes prevalence and BMI. Data was obtained from the Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborat-

[5] We drop data for the years 2012 and 2013 because they contain a large number of missing values. Access to FAO balance sheet data: http://faostat3.fao.org/download/FB/FBS/E

ing Group, which is a worldwide network of clinical and public health researchers[6]. The dataset covers the time period of 1980 to 2008 and is constructed by collecting data from health examination surveys and epidemiologic studies. The researchers used a Bayesian hierarchical model to estimate mean BMI and diabetes prevalence over time, by age group, sex, and country. Final data is age-standardised corresponding to the 2000-2025 world population (Finucane et al., 2011). The BMI is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2). Diabetes is defined as having a mean fasting plasma glucose value of 7.0 mmol/L or greater, or use of a glucose-lowering drug.

2.3 KOF Index of globalisation

Globalisation is a global process including "economic integration, transfer of policies across borders, transmission of knowledge, [and] cultural stability" (Al-Rodhan and Stoudmann, 2006). We use the KOF Index of globalisation developed by Dreher (2006)[7], as it allows us to distinguish between the social and economic dimension of globalisation. This is important in order to test the model predictions of Olivier et al. (2008).

The variables social and economic globalisation take values on a scale from 1 to 100 and higher values indicate a higher level of globalisation. Economic globalisation consists of two sub-dimensions: Data on actual flows (1) which includes trade, foreign direct investments, portfolio investment, and income payments to foreign nationals. The second sub-dimension consists of data on trade openness (2) measured by an index of hidden import barriers, mean tariff rate, taxes on international trade, and capital account trade openness.
Social globalisation is also constructed as a composite index with three sub-dimensions. It contains data on personal contacts (1) measured by telephone traffic, transfers, share of foreign population, and international letters. The second sub-dimension is data on information flows (2) including Internet users per day, television, and trade in newspapers. The final sub-dimension of social globalisation is data on cultural proximity (3) consisting of the number of McDonald's restaurants and Ikea stores as well as trade in books.

Over the past 40 years globalisation has intensified across the world. Figure 4 shows that while high income countries score highest on the globalisation index,

[6] We thank the research group for sharing their data. Access to data: https://www1.imperial.ac.uk/publichealth/departments/ebs/projects/eresh/majidezzati/healthmetrics/metabolicriskfactors/.

[7] We thank the KOF team for sharing their data. Access to data: http://globalisation.kof.ethz.ch/.

all countries experience a sharp upwards trend of globalisation since the 1990s. Economic and social globalisation has been converging in high income countries and their scores have been almost identical since the mid 1990s. Middle and low income countries still have a higher score in economic than in social globalisation and these two dimensions have evolved parallel over time.
Interestingly, we observe a parallel increasing trend for both dimensions of globlisation while the model of Olivier et al. (2008) predicts that economic and social globalisation have opposing effects on the diet.
Social and economic globalisation exhibit a high correlation of about 0.84 and the sub-dimensions cultural proximity and information flows are also strongly correlated (0.74). In order to rule out that coefficients are unstable because of multicollinearity, we checked the variance inflation factor (vif). All of our variables exhibit a vif substantially smaller than the rule of thumb of 10.

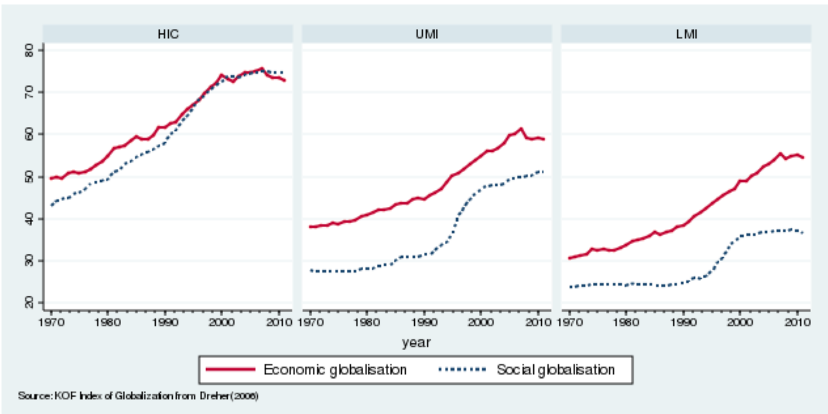

Figure 4: Social and economic globalisation by income group, 1970-2011

2.4 Descriptive Statistics

Our estimation sample includes 2940 observations from 70 countries. We dropped all countries containing missing values in any of the outcome variables or covariates. Consequently, this balanced sample contains 42 observations for every country, from 1970 until 2011 and covers 76% of the worldwide population. 40% of the countries in our sample are high income countries and 60% are middle income countries.

Table 1 reports the descriptive statistics for all variables. On average 25% of dietary energy is derived from fat, about 11% from protein, and 63% from carbohydrates. Free fat accounts for 12%, animal protein for about 5%, and sugar for about one

fifth of total food supply.
In our sample, the mean score of economic globalisation is 52 points and higher than social globalisation (44 points) on a scale from 0 to 100. Mean GDP per capita is about 10,000 USD.

In order to estimate the effect of globalisation on health outcomes, the sample has to be reduced to the time period 1980 to 2008 resulting in a sample size of $N = 2494$[8]. In our sample around 8% of the population suffer from diabetes. Mean BMI is 24.5, which is slightly lower than the cut-off point of $>= 25$ for overweight as defined by the WHO (WHO, 2015b).

Table 1: Summary Statistics, nutrition sample

	Mean	SD	Min	Max
Outcome variables				
Protein in food supply	11.11	1.50	7.68	16.89
Fat in food supply	25.64	8.26	7.37	45.25
Carbohydrates in food supply	63.25	9.27	41.78	82.43
Animal protein in food supply	4.95	2.37	1.05	13.68
Free fat in food supply	12.48	5.26	0.84	28.85
Sugar in food supply	21.52	6.15	3.85	40.82
Covariates				
Social globalisation	44.06	20.65	6.83	92.31
Personal contacts	48.61	19.43	8.81	90.61
Information flows	51.65	21.11	4.40	97.83
Cultural proximity	31.53	30.58	1.00	95.95
Economic globalisation	52.14	17.17	17.27	97.09
GDP per capita[a]	10.50	13.22	0.14	69.09
Income groups				
High income	0.41	0.49	0	1
Upper middle income	0.27	0.44	0	1
Lower middle income	0.31	0.46	0	1
Sample				
Number of countries	70			
Number of years	42			
N	2940			

[a] GDP per capita (constant 2005 in 1000 USD).

[8] see table 6 in the Appendix for summary statistics of the smaller health outcome sample.

3 Estimation strategy

3.1 Grouped Fixed Effects (GFE) estimator

Our objective is to estimate the relationship between globalisation, the composition of the diet, and health outcomes. The main challenge for our identification strategy are unobservable country characteristics that affect a country's level of globalisation as well as its food supply. For example, cultural norms and unobserved trends in food innovation may both affect a country's openness as well as its dietary habits. A common solution to this problem is the application of country and year fixed effects that control for time-invariant unobservable country characteristics as well as time trends common for all countries. This approach implies the relatively strong assumption that all unobserved country characteristics are constant over time and all countries follow the same time trend.

A less restrictive approach is the grouped fixed effects (GFE) estimator developed by Bonhomme and Manresa (2015). The GFE estimator relaxes the strict assumption that all countries follow the same time trend and it only requires that all countries within a group follow the same time pattern. Yet, different groups can have distinct time patterns.
Consequently, the GFE estimator is better suited to control for unobserved time-varying country characteristics that are correlated with globalisation as well as with composition of food supply. In contrast to the country fixed effects estimator, the GFE estimator can control for unobservable time-varying country characteristics that follow a group-specific time pattern. The main identifying assumption is that the number of distinct country-specific time patterns of unobserved heterogeneity is equal to the number of groups. In other words, all countries have to follow one of the group specific time-varying paths of unobserved heterogeneity.

For our research question, the GFE estimator constitutes an attractive alternative to a country fixed effects model. It allows for time-varying unobservables in a time period in which many countries have experienced a nutrition transition. Since transitions in the diet of societies are likely to be triggered by developments affecting several countries at the same time, it is plausible to assume that there are clusters of countries sharing a similar transition profile. For example, in the early 1990s, countries formerly belonging to the "Eastern Block" became independent, opened their countries and became exposed to "Western diet" at roughly the same time. Similarly, expansion of supermarkets in the developing world occurred in several waves starting in the 1990s. The first wave hit major cities in richer countries in Latin America, followed by East and South-east Asia, poorer countries in Latin America and Asia, and finally South Asia (Reardon et al., 2003).

The second important feature of the GFE estimator is that group membership of the countries in our sample is not pre-determined (e.g classification according to income groups) but that group membership is estimated according to a least-squares criterion. Countries whose time profiles of the outcome variable (food supply) - net of the effect of covariates - are most similar are grouped together. Assume that the countries in our sample are categorized in a number of groups indexed by $g = 1,...,G$. The number of groups g must be small compared to the number of countries. Our regression equation takes the following form:

$$y_{it} = \beta_1 globalisation_{it} + \beta_2 GDPpc_{it} + \beta_3 (GDPpc_{it})^2 + \alpha_{g_i t} + v_{it},$$

where y_{it} denotes the outcome variables for country i and year t. In particular, we have three outcome variables, the share of animal protein (1), free fat (2), and sugar (3) in total food supply.
Our coefficient of interest is β_1 indicating the effect of globalisation on food supply while controlling for GDP per capita and GDP per capita squared[9]. We use two main indicators for globalisation, namely social globalisation and economic globalisation. In addition, we further disentangle the social dimension and use the three sub-dimensions of social globalisation, personal contacts (1), information flows (2), and cultural proximity (3). $\alpha_{g_i t}$ denotes the group-specific time fixed effect which includes group fixed effects as well as time fixed effects. v_{it} denotes the error term.

3.2 Estimation procedure

Bonhomme and Manresa (2015) propose two algorithms for sorting the countries into groups. Algorithm 1 is a clustering algorithm and consists of two alternating steps.

Assignment step
In the beginning, a starting value of the parameter values (θ^0, α^0) is chosen. Countries are sorted into groups by minimizing the sum of residuals over all years for each country i:

$$g_i = \text{argmin}_{g \varepsilon \{1,...,G\}} \sum_{t=1}^{T} (y_{it} - x_{it}\theta - \alpha_{gt})^2$$

In the case of 42 years and 2 groups, for each country the residuals are computed 42 times while assuming the country is sorted into group 1 and hence using $\alpha_{g_1 t}$. The residuals across all 42 years are then summed and compared to the sum obtained

[9] The GDP per capita variable is obtained from the World Development Indicators database published by the World Bank. Access to data: http://data.worldbank.org/data-catalog/world-development-indicators.

when repeating this exercise using $\alpha_{g_2 t}$, that is assuming that this particular country had been sorted into group 2 instead of group 1. Finally, the country is sorted into that group in which it achieved the smallest sum of residuals over these 42 years. This step is called the assignment step and results in an initial grouping g_i^s where $s = 0$.

Update step
In the update step the initial grouping g_i^0 is used to estimate a new set of coefficients $(\theta^{s+1}, \alpha^{s+1})$. Then, s is set to $s = s + 1$ initializing a new assignment step. Algorithm 1 thus alternates between an assignment step and an update step. This loop stops when the difference between the old and the new coefficients is close to zero. The drawback of algorithm 1 is that the solution depends on the initial starting value. In order to ensure a reliable solution the entire exercise is simulated s times by choosing s different starting values to begin with. This can result in very long computation times.

Given this drawback of algorithm 1 Bonhomme and Manresa (2015) also propose the more efficient algorithm 2 that uses the variable neighbourhood search method. First, a starting value of the parameters (θ^0, α^0) is chosen and algorithm 1 is used to obtain an initial grouping of the countries γ_{init}. The key feature of algorithm 2 is the inclusion of a neighbourhood jump, where n countries are randomly reallocated to n randomly selected groups to obtain a new grouping γ'. These random jumps allow for an efficient exploration of the objective function and also avoid to get trapped in a local minimum. The newly obtained grouping γ' is then used to perform an update step to obtain new parameter values (θ', α'). Thus, algorithm 2 cycles over an update step, an assignment step, and a neighbourhood jump. This cycle is performed $neigh_{max}$ times where $neigh_{max}$ is set by the researcher. The entire exercise is simulated N_{sim} times by choosing N_{sim} different starting values. For each starting value, the cycle described above is repeated $iter_{max}$ times by setting n back to 1 once $neigh_{max}$ has been reached.

We use algorithm 2 for our main result and following Bonhomme and Manresa (2015) we set $neigh_{max}$, N_{sim}, and $iter_{max}$ all equal to 10. Group-specific coefficients are obtained with algorithm 1 with 500 simulations[10]. In order to account for the fact that group membership has been estimated the variance covariance matrix is computed by using bootstrapping with 25 replications[11]

[10] To this end we converted the Matlab code "Heterogenous_coeffB.m" provided by Bonhomme and Manresa (2015) into a Stata do file, which is shared on request.
[11] Bootstrapped standard errors are obtained by setting $neigh_{max} = 10$,$N_{sim} = 5$, and $iter_{max} = 5$.

3.3 Choice of the number of groups

Bonhomme and Manresa (2015) acknowledge that "optimal choice of G in practise is a notoriously difficult problem" (p.23 of the supplementary Appendix). While a high number of groups reduces the objective function it increases the potential for overfitting (Brusco et al., 2008). In order to find the optimal number of groups we estimated our main regression for $G = 1$ until $G = 10$. The objective function decreases steadily as G increases: by around 50% when $G = 2$ compared to OLS, and by more than 80% when $G = 8$. Figure 5[12] reports the coefficients of social and economic globalisation for different values of G. While the coefficients fluctuate with few groups they become stable from $G = 8$. Given this sizeable reduction of the objective function and the stability of the coefficients for higher numbers of groups, we chose $G = 8$ as our optimal specification. Interestingly, the second to last row of tables 7,8, and 9 show that the objective function of grouped fixed effects is lower than the one of country and year fixed effects as soon as $G \geq 6$ ($G \geq 7$ for sugar). This suggests that a substantial amount of cross-country heterogeneity is time-varying in our sample. The last row shows the objective function when grouping countries into high, upper middle and, lower middle income countries. The value of the objective function is substantially larger suggesting that grouping according to income does not capture much of unobserved time-varying heterogeneity.
We conducted the same analysis for our health outcome variables and chose $G = 10$. Figure 8 in the Appendix plots the coefficient for different number of groups.

4 Results

This section reports estimation results for nutrition and health outcomes.

4.1 Nutrition outcomes

We find that social globalisation has a positive and significant effect on the share of animal protein but no effect on free fat, and sugar in total food supply. We find no statistically significant effect of economic globalisation. These results are partly in line with the model predictions of Olivier et al. (2008). Our results confirm the model prediction of a positive relationship between social globalisation

[12] See tables 7,8, and 9 for the corresponding values.

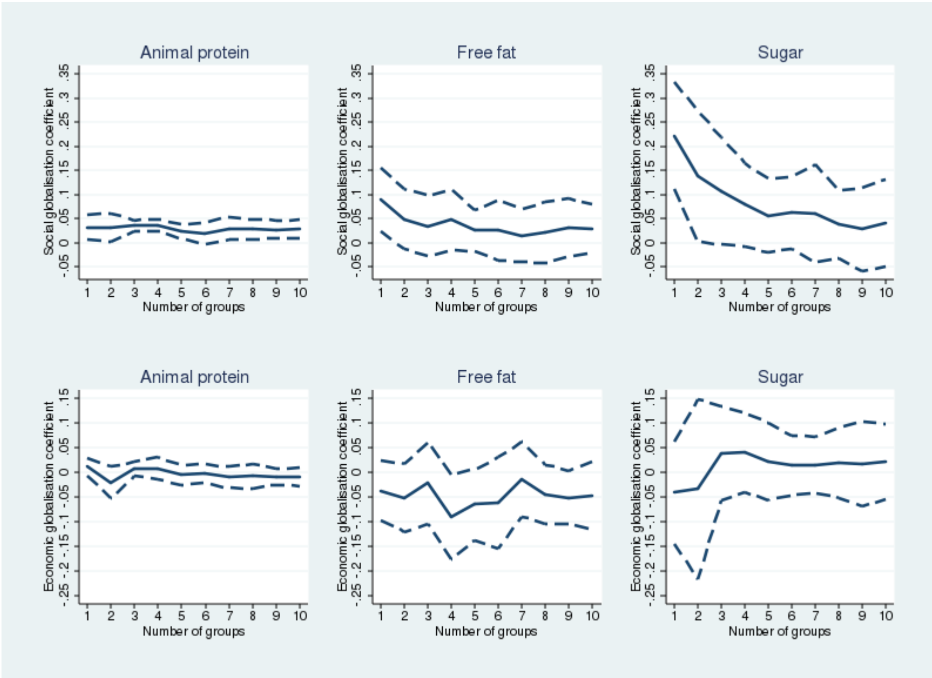

Figure 5: Coefficients of economic and social globalisation

and cultural convergence but our empirical analysis does not reveal a significant negative effect of economic globalisation on convergence.

Table 2 presents our main results for nutrition outcomes. Columns 1, 4, and 7 report results from a pooled OLS regression to facilitate comparison with Costa-i-Font and Mas (2014). Our analysis confirms findings of Costa-i-Font and Mas (2014). Social globalisation is positively associated with the share of animal protein, free fat, and sugar in total food supply and the coefficient is significant at the 5% or 1% level. In contrast, the coefficient of economic globalisation is never significant.
Results of country and year fixed effects regressions are presented in columns 2,5, and 7. The coefficient of social globalisation remains positive but loses its significance for the share of free fat and sugar. The coefficient of economic globalisation remains insignificant.
Controlling for grouped time effects (columns 3, 6, and 9) the coefficient of social globalisation is positive for all outcome variables but only significant at the 1% level for animal protein. Compared to OLS and FE specifications it slightly shrinks in magnitude but remains to be of economic significance. An additional point on the social globalisation index is associated with an increase in the share of animal protein by 0.028. A one standard deviation increase (20.65) on the index of social globalisation increases on average the share of animal protein by about 0.6, which is equivalent to an increase of about 12%.

The effect of economic globalisation is negative for animal protein and free fat but the coefficient is never significant for any of the outcome variables. The positive sign of coefficient of GDP per capita and the negative sign of the coefficient of its squared term suggests a inverted U-shape of the relationship between GDP and the outcome variables. The share of animal protein and free fat in the diet increases with increasing GDP up to a turning point beyond which increasing GDP reduces the share of these components in the diet.

Table 2: Globalisation and nutrition outcomes

Outcome variable	Animal protein			Free fat			Sugar		
	OLS	FE	GFE	OLS	FE	GFE	OLS	FE	GFE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Social	0.031**	0.030***	0.028***	0.081**	0.021	0.022	0.211***	0.017	0.039
globalisation	(0.012)	(0.007)	[0.010]	(0.032)	(0.021)	[0.032]	(0.054)	(0.027)	[0.035]
Economic	0.011	0.001	-0.008	-0.036	-0.028	-0.045	-0.041	-0.024	0.020
globalisation	(0.009)	(0.006)	[0.012]	(0.030)	(0.022)	[0.030]	(0.051)	(0.033)	[0.036]
GDP per capita[a]	0.193***	0.083**	0.174***	0.471***	0.102	0.454***	0.085	0.240	0.168
	(0.027)	(0.041)	[0.058]	(0.115)	(0.173)	[0.131]	(0.119)	(0.164)	[0.317]
$(\text{GDP per capita})^2$	-0.002***	-0.001**	-0.002**	-0.007***	-0.003	-0.007***	-0.003*	-0.004*	-0.003
	(0.000)	(0.001)	[0.001]	(0.002)	(0.002)	[0.002]	(0.002)	(0.002)	[0.006]
Constant	47.072***	1.605***	1.207***	-41.208	10.959***	8.981***	301.866***	16.906***	7.481***
	(11.837)	(0.215)	(0.184)	(50.957)	(0.749)	(0.687)	(52.040)	(1.261)	(1.112)
Country FE	no	yes	no	no	yes	no	no	yes	no
Group FE	no	no	yes	no	no	yes	no	no	yes
Year FE	no	yes	yes	no	yes	yes	no	yes	yes
Group-year FE	no	no	yes	no	no	yes	no	no	yes
Time trend	yes	no	no	yes	no	no	yes	no	no
N	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940	2,940
Adjusted R^2	0.700	0.950	0.959	0.524	0.879	0.899	0.301	0.893	0.901
Objective	4939	787.9	602.6	38657	9433	7274	77447	11439	9702

Robust standard errors in round brackets. Bootstrapped standard errors in square brackets. Results obtained with algorithm 2.
[a] GDP per capita (constant 2005 in 1000 USD).

4.2 Health outcomes

Results for nutrition outcomes are presented in table 3. We do not find significant effects of social or economic globalisation on diabetes prevalence and mean BMI. Pooled OLS results suggest a positive and significant association between social globalisation and diabetes prevalence and mean BMI. But applying country and year fixed effects (column 2) or grouped fixed effects (column 3) renders the coefficients of social globalisation insignificant.
Our results do not support findings of Miljkovic et al. (2015); Vogli et al. (2014);

Costa-i-Font and Mas (2014) and Goryakin et al. (2015) who report a positive and significant association between social globalisation and different measures of overweight.
The coefficient of economic globalisation is only significant in the fixed effects specification. It suggests a negative effect of economic globalisation on diabetes prevalence and mean BMI. The coefficient however loses significance when applying the GFE estimator.
The values of the objective function of the GFE estimation is lower than the values of the objective function of the OLS and fixed effects estimation. This suggests that some cross-country heterogeneity is time-varying in our sample.

Table 3: Globalisation and health outcomes

Outcome variable	Diabetes prevalence			Mean BMI		
	OLS	FE	GFE	OLS	FE	GFE
	(1)	(2)	(3)	(4)	(5)	(6)
Social globalisation	0.039**	0.003	-0.004	0.063***	-0.005	0.006
	(0.018)	(0.015)	[0.019]	(0.014)	(0.005)	[0.010]
Economic globalisation	-0.008	-0.038**	-0.005	0.008	-0.015***	0.013
	(0.012)	(0.015)	[0.013]	(0.012)	(0.005)	[0.010]
GDP per capita[a]	-0.159***	-0.080	-0.063	-0.029	0.001	-0.005
	(0.038)	(0.067)	[0.082]	(0.037)	(0.020)	[0.056]
(GDP per capita)^2	0.001**	0.001	0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	[0.001]	(0.001)	(0.000)	[0.001]
Constant	-121.998***	9.498***	7.963***	-32.201	24.738***	19.780***
	(24.616)	(0.272)	(0.224)	(25.502)	(0.154)	(0.277)
Country FE	no	yes	no	no	yes	no
Group FE	no	no	yes	no	no	yes
Year FE	no	yes	yes	no	yes	yes
Group-year FE	no	no	yes	no	no	yes
Time trend	yes	no	no	yes	no	no
N	2,494	2,494	2,494	2,494	2,494	2,494
Adjusted R^2	0.328	0.874	0.925	0.439	0.973	0.972
Objective	6681	1191	656.1	4398	198.6	193.3

Robust standard errors in round brackets. Bootstrapped standard errors in square brackets.
Results obtained with algorithm 2.
[a] GDP per capita (constant 2005 in 1000 USD).

4.3 Convergence across country groups

Moreover, we are addressing the question of whether countries are converging towards a homogeneous nutritional profile. Figures 1 and 2 already suggested that middle income countries have not yet reached the high levels of animal protein and free fat in the diet, which are prevalent in high income countries. But is the gap shrinking between middle and high income countries? Figure 6 shows the coefficient of variation[13] over time for the nutrition outcome variables. The share of sugar in the diet exhibits a strong convergence trend over time. The coefficient of variation moderately declines for animal protein, while it is increasing for free fat. This suggests that middle income countries are catching up to high income countries regarding the share of sugar in their diet, and to a smaller extent with respect to animal protein.

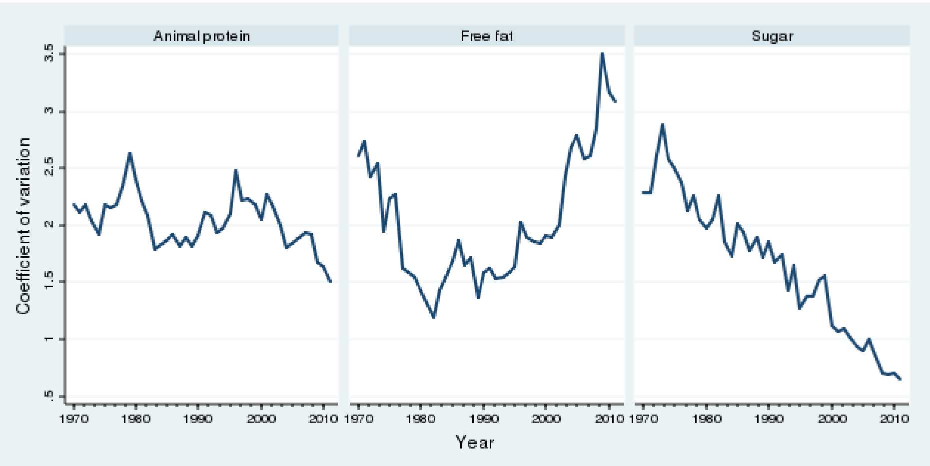

Figure 6: Coefficient of variation for nutrition outcomes, 1970-2011

The observed convergence for sugar and animal protein can be explained to a large degree by globalisation and GDP. Figure 7 plots the difference between groups over time. The difference is calculated as the sum of the group dummy and the grouped time effect[14]. We find that after controlling for globalisation and GDP, the difference across country groups appears stable for animal protein indicating that the moderate convergence process of animal protein can be explained by globalisation and GDP. But for sugar, we observe a small convergence trend after controlling for globalisation and GDP. This suggests that other factors partly explain the observed strong convergence of countries with respect to the share of sugar in their diet.

Finally, we investigate whether social globalisation has a different effect on the diet for different groups. To this end, we interacted the variable social globalisation with the group indicator variables.
Table 4 present the impact of social globalisation for different groups. For animal

[13] the coefficient of variation is defined as the ratio of the standard deviation to the mean.
[14] e.g. for group 3 and year 1971 it is the sum of $group_3$ and $group_3 * year_{1971}$ relative to the base group, group 1.

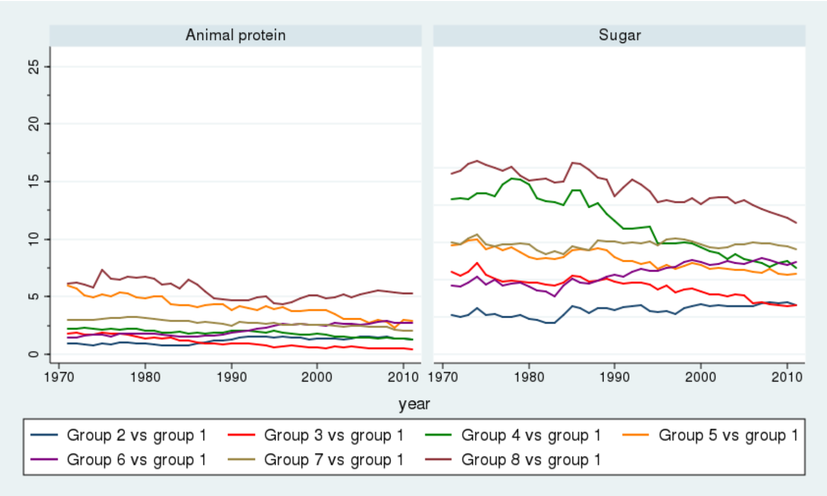

Figure 7: Convergence of groups for nutrition outcomes, 1970-2011

protein (column 1), the coefficient of the interaction term is positive and significant for four groups (groups 1,2,7, and 8). Group 2 exhibits the largest coefficient and this group consists of 14 mostly high income and upper middle income countries (Chile, Denmark, Portugal, China, Colombia, Costa Rica, Dominican Republic, Fiji, Malaysia, Mexico and the lower middle income countries Honduras, Kenya, Pakistan, and Senegal). In contrast, the coefficient of group 1 is much smaller and this group consists of 15 mostly lower middle income countries (Algeria, Tunisia, Turkey, Cameroon, Cote d'Ivoire, Egypt, El Salvador, Guatemala, India, Indonesia, Lesotho, Morocco, Nigeria, Zambia, and the high income country Saudi Arabia). Groups 7 and 8 each consists only of one country, namely Greece and Israel. These findings suggest that the effect of social globalisation on the share of animal protein in the diet is stronger for richer than for poorer countries. This corresponds to our hypothesis of a a moderate convergence process between middle and high income countries with respect to animal protein in the diet. For the outcome variables free fat and sugar we do not find any significant effects of the interaction terms.

One potential concern is that these results do not capture a different impact of social globalisation for different groups but simply reflect that different groups exhibit substantial differences in their median level of social globalisation. In other words the groups may just be at different stages of social globalisation. The box plot in figure 9 mitigates this concern, as group 1 and 2 do not exhibit a substantially different level of social globalisation compared to the other groups.

Table 4: Heterogeneous effects by group, grouped fixed effects

Outcome variable	Animal protein[a]	Free fat[a]	Sugar[a]
	(1)	(2)	(3)
Social globalisation*group 8	0.074***	0.072	-0.022
	(0.024)	(0.095)	(0.114)
Social globalisation*group 7	0.049**	0.096	0.347
	(0.023)	(0.105)	(0.252)
Social globalisation*group 6	0.031	0.057	-0.081
	(0.036)	(0.074)	(0.251)
Social globalisation*group 5	0.038	-0.006	0.174
	(0.024)	(0.094)	(0.371)
Social globalisation*group 4	0.042	0.006	0.101
	(0.142)	(0.12)	(0.104)
Social globalisation*group 3	0.006	-0.213	0.083
	(0.03)	(0.153)	(0.104)
Social globalisation*group 2	0.130***	0.022	0.011
	(0.05)	(0.123)	(0.119)
Social globalisation*group 1	0.023*	-0.131	-0.237
	(0.013)	(0.204)	(0.348)
Economic globalization	0.007	0.015	0.027
	(0.016)	(0.07)	(0.118)
GDP per capita[b]	0.179***	0.413*	0.144
	(0.052)	(0.242)	(0.184)
(GDP per capita)^2	-0.002***	-0.005	-0.002
	(0.001)	(0.004)	(0.003)
N	2940	2940	2940

Results obtained with algorithm 1 and 500 randomly generated starting values. Clustered standard errors based on the large-T normal approximation in parentheses. Regressions include group FE, year FE and, group-year FE.

[a] The dependent variable is the share of animal protein (free fat, sugar) in total food supply.

[b] GDP per capita (constant 2005 in 1000 USD).

5 Discussion

Our results suggest that social globalisation has a positive effect on the share of animal protein in the diet while economic globalisation has no effect on the nutrition composition. This result is only partly in line with the model developed by Olivier et al. (2008) predicting a positive effect of social globalisation but a negative effect of economic globalisation on cultural convergence.

The next step of our analysis consists of analysing the impact of the different sub-components of the globalisation index in order to better understand the underlying mechanisms.

Table 5 presents results from estimating the effect of different subcomponents of the globalisation index on the share of animal protein, free fat, and sugar in total food supply. We find that the positive effect of social globalisation seems to be mostly driven by information flows (e.g. number of Internet and telephone users per 1000 people), as this sub-component has the largest coefficient and is always positive and significant at the 1% level. Interestingly, personal contacts (e.g. tourism, telephone traffic, foreign population and transfers) have a positive effect on the share of animal protein in the diet but a negative effect on free fat and sugar. Countries with a high score on personal contacts are mostly small countries with a relatively large share of foreign populations (e.g. Ireland, Austria, Netherlands, Denmark, Norway). The foreigners may quickly adjust their meat consumption but only slowly alter their dietary habits with respect to free fat and sugar explaining the negative effect of personal contacts on the share of free fat and sugar in the diet.

Finally, cultural proximity (e.g. number of McDonald's restaurants and IKEA) has a small positive effect on free fat and a larger negative effect on the share of sugar in the diet. Countries scoring high on the cultural proximity index are high income countries such as Australia, United States, Austria, Denmark and the United Kingdom. One potential explanation is that we do not adequately account for sugar production made from corn in our food item classification. 80% of this so-called high-fructose corn syrup is produced in rich countries such as the US, Japan, the EU, and South Korea and is widely used as a sweetener in the food and beverage industry (Credit Suisse Research Institute, 2013).
Overall, the effects of the subcomponents for free fat and sugar carry positive as well as negative signs and thus are likely to cancel each other out in the composite social globalisation variable. This could explain why we do not find significant effects of social globalisation on the share of free fat and sugar in the diet.

Table 5: Subcomponents of social globalisation, grouped fixed effects

Outcome variable	Animal protein	Free fat	Sugar
	(1)	(2)	(3)
Personal contacts	0.008***	-0.027***	-0.040***
	(0.002)	(0.009)	(0.011)
Information flows	0.026***	0.035***	0.124***
	(0.002)	(0.009)	(0.012)
Cultural proximity	0.002	0.009*	-0.018***
	(0.001)	(0.005)	(0.006)
Economic globalisation	-0.000	-0.020	0.017
	(0.002)	(0.012)	(0.011)
GDP per capita[a]	0.172***	0.457***	-0.021
	(0.008)	(0.029)	(0.035)
(GDP per capita)^2	-0.002***	-0.006***	0.000
	(0.000)	(0.001)	(0.001)
Constant	0.557***	10.199***	6.242***
	(0.201)	(0.587)	(1.272)
N	2,940	2,940	2,940
Adjusted R^2	0.962	0.902	0.914

Bootstrapped standard errors in parentheses. Results obtained with algorithm 2.
Regressions include group FE, year FE and, group-year FE.
[a] GDP per capita (constant 2005 in 1000 USD).

6 Conclusion

This paper contributes to explaining the causes of changing nutrition patterns by estimating the effect of globalisation on the composition of the diet and health outcomes. Globalisation has often be held responsible for changing diets and associated negative health outcomes such as obesity, diabetes, and cardiovascular diseases. However, existing evidence concentrated on economic aspects of globalisation and mostly consisted of case studies about trade liberalisations and FDI.
We provide empirical evidence on the impact of globalisation on the share of animal protein, free fat, and sugar in food supply as well as on diabetes and mean BMI by using a panel of 70 high and middle income countries from 1970 until 2011. In order to better account for unobserved time-varying heterogeneity we apply a grouped fixed effects estimator developed by Bonhomme and Manresa (2015). This estimator endogenously groups countries together by minimizing a least-squares criterion and subsequently controls for group-specific time-varying unobserved heterogeneity.
Our results indicate that the social dimension of globalisation has a positive and significant effect on the share of animal protein in the diet while economic glob-

alisation has no impact on the composition of the diet. A one standard deviation increase on the index of social globalisation increases the share of animal protein on average by 12%. This finding is relevant for economies given the negative health consequences of a meat-intensive diet and associated healthcare costs as well as the environmental impact of meat production.

Moreover, we find that the gap between country groups has strongly converged over time for sugar and to a lesser extent for animal protein. For animal protein the observed convergence trend can be attributed to globalisation and GDP while in the case of sugar additional factors must play a role that require further analysis. We further show that the effect of social globalisation on animal protein is stronger for richer than for poorer countries, supporting the hypothesis of a moderate convergence trend between high and middle income countries with respect to the share of meat in their diet.

Given that social globalisation seems to be the main driver of changing diets, further research should focus on factors related to the social dimension of globalisation, such as food advertising on television and the Internet.

References

Al-Rodhan, N. R. and G. Stoudmann (2006). Definitions of globalization: A comprehensive overview and a proposed definition. *Program on the Geopolitical Implications of Globalization and Transnational Security*, 6.

Bishwajit, G., S. Ide, M. A. Hossain, and M. N. Safa (2014). Trade liberalization, urbanization and nutrition transition in asian countries. *Journal of Nutritional Health & Food Science*, 2(1).

Bonhomme, S. and E. Manresa (2015). Grouped patterns of heterogeneity in panel data. *Econometrica*, 83(3).

Brusco, M. J., J. D. Cradit, D. Steinley, and G. L. Fox (2008). Cautionary remarks on the use of clusterwise regression. *Multivariate Behavioral Research*, 43(1):29–49.

Costa-i-Font, J. and N. Mas (2014). 'Globesity'? The Effects of Globalization on Obesity and Caloric Intake. *CESifo Working Paper Series*, 4982.

Credit Suisse Research Institute (2013). Sugar - consumption at crossroads. Technical report, Credit Suisse.

de Souza, R. J., A. Mente, A. Maroleanu, A. I. Cozma, V. Ha, T. Kishibe, E. Uleryk, P. Budylowski, H. Schünemann, J. Beyene, and S. S. Anand (2015). Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ*, 351.

Dreher, A. (2006). Does globalization affect growth? evidence from a new index of globalization. *Applied Economics*, 38(10):1091–1110.

Finucane, M. M., G. A. Stevens, M. J. Cowan, G. Danaei, J. K. Lin, C. J. Paciorek, G. M. Singh, H. R. Gutierrez, Y. Lu, A. N. Bahalim, F. Farzadfar, L. M. Riley, and M. Ezzati (2011). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9Â·1 million participants. *The Lancet*, 377(9765):557 – 567.

Folkvord, F., D. J. Anschütz, E. Boyland, B. Kelly, and M. Buijzen (2016). Food advertising and eating behavior in children. *Current Opinion in Behavioral Sciences*, 9:26 – 31. Diet, behavior and brain function.

Goryakin, Y., T. Lobstein, W. P. T. James, and M. Suhrcke (2015). The impact of economic, political and social globalization on overweight and obesity in the 56 low and middle income countries. *Social Science & Medicine*, 133:67 – 76.

Hawkes, C. (2006). Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Globalization and Health*, 2(1):1–18.

Hawkes, C. and A. M. Thow (2008). Implications of the central america-dominican republic-free trade agreemeent for the nutrition in central america. *Pan American Journal of Public Health*, 24(5):345–360.

Imamura, F., L. O'Connor, Z. Ye, J. Mursu, Y. Hayashino, S. N. Bhupathiraju, and N. G. Forouhi (2015). Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic review, meta-analysis, and estimation of population attributable fraction. *BMJ*, 351.

Leren, P. (1968). The effect of plasma-cholesterol-lowering diet in male survivors of myocardial infarction. a controlled clinical trial. *Bulletin of the New York Academy of Medicine*, 44(8):1012.

Malik, V. S., Y. Li, D. K. Tobias, A. Pan, and F. B. Hu (2016). Dietary protein intake and risk of type 2 diabetes in us men and women. *American Journal of Epidemiology*, 183(8):715–728.

Miljkovic, D., S. Shaik, S. Miranda, N. Barabanov, and A. Liogier (2015). Globalisation and obesity. *The World Economy*, 38(8):1278–1294.

Monteiro, C. A., J.-C. Moubarac, G. Cannon, S. W. Ng, and B. Popkin (2013). Ultra-processed products are becoming dominant in the global food system. *Obesity Reviews*, 14:21–28.

Olivier, J., M. Thoenig, and T. Verdier (2008). Globalization and the dynamics of cultural identity. *Journal of International Economics*, 76(2):356–370.

Pettigrew, S., L. Tarabashkina, M. Roberts, P. Quester, K. Chapman, and C. Miller (2013). The effects of television and internet food advertising on parents and children. *Public health nutrition*, 16(12):2205–2212.

Popkin, B. M. (2006). Technology, transport, globalization and the nutrition transition food policy. *Food Policy*, 31(6):554 – 569.

Reardon, T., C. P. Timmer, C. B. Barrett, and J. Berdegué (2003). The rise of supermarkets in africa, asia, and latin america. *American Journal of Agricultural Economics*, 85(5):1140–1146.

Stuckler, D., M. McKee, S. Ebrahim, and S. Basu (2012). Manufacturing epidemics: The role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol, and tobacco. *PLoS Med*, 9(6):1–8.

Te Morenga, L., S. Mallard, and J. Mann (2013). Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ*, 346.

Thow, A. M. and C. Hawkes (2009). The implications of trade liberalization for diet and health: a case study from central america. *Globalization and Health*, 5(1):1–15.

Thow, A. M., P. Heywood, J. Schultz, C. Quested, S. Jan, and S. Colagiuri (2011). Trade and the nutrition transition: Strengthening policy for health in the pacific. *Ecology of Food and Nutrition*, 50(1):18–42.

Vogli, R. D., A. Kouvonen, M. Elovainio, and M. Marmot (2014). Economic globalization, inequality and body mass index: a cross-national analysis of 127 countries. *Critical Public Health*, 24(1):7–21.

WHO (2000). *Obesity: preventing and managing the global epidemic*, number 894. World Health Organization.

WHO (2015a). Cardiovascular diseases. *Fact Sheet*, 317.

WHO (2015b). Obesity. *Fact Sheet*, 311.

7 Appendix

Table 6: Summary statistics, health sample

	Mean	SD	Min	Max
Outcome variables				
Diabetes prevalence	8.39	2.00	3.18	21.82
Mean BMI	24.57	1.78	19.47	28.74
Covariates				
Economic globalisation	54.69	18.11	9.94	99.16
Social globalisation	46.92	21.28	6.85	93.68
GDP per capita[a]	11.75	14.80	0.22	86.13
Income groups				
High income	0.42	0.49	0.00	1.00
Upper middle income	0.29	0.45	0.00	1.00
Lower middle income	0.29	0.45	0.00	1.00
Sample				
Number of countries	86			
Number of years	29			
N	2494			

[a] GDP per capita (constant 2005 in 1000 USD).

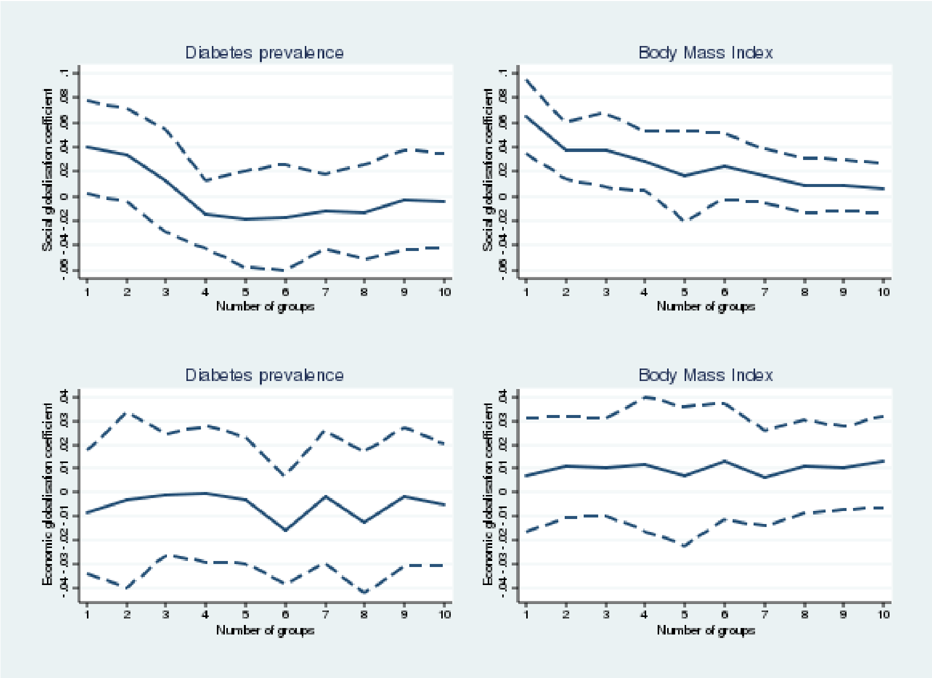

Figure 8: Coefficients of economic and social globalisation

Table 7: GFE estimates, animal protein

Number of groups	Objective	Social globalisation	Economic globalisation	GDP per capita[a]	(GDP per capita)^2
1	4918	0.033**	0.011	0.189***	-0.002***
		(0.013)	(0.009)	(0.029)	(0.000)
2	2506	0.032**	-0.021	0.193***	-0.002**
		(0.015)	(0.016)	(0.044)	(0.001)
3	1350	0.035***	0.007	0.204***	-0.003***
		(0.006)	(0.007)	(0.033)	(0.001)
4	1102	0.037***	0.008	0.214***	-0.003***
		(0.006)	(0.011)	(0.056)	(0.001)
5	868.2	0.024***	-0.006	0.157***	-0.002**
		(0.008)	(0.010)	(0.051)	(0.001)
6	764.9	0.020***	-0.003	0.156***	-0.002**
		(0.011)	(0.010)	(0.026)	(0.000)
7	699.7	0.030**	-0.011	0.164***	-0.002**
		(0.012)	(0.011)	(0.046)	(0.001)
8	602.6	0.028***	-0.008	0.174***	-0.002**
		(0.010)	(0.012)	(0.058)	(0.001)
9	547.4	0.028***	-0.009	0.172***	-0.002**
		(0.010)	(0.008)	(0.045)	(0.001)
10	516	0.029***	-0.01	0.171***	-0.002**
		(0.009)	(0.009)	(0.041)	(0.001)
Country & year FE	787.9	0.030***	0.001	0.083**	-0.001**
		(0.007)	(0.006)	(0.041)	(0.001)
Income groups[b]	4223	0.033**	0.003	0.080	-0.001
		(0.012)	(0.010)	(0.055)	(0.001)

The table reports the value of the objective function and the GFE coefficient for various number of groups. Computation using algorithm 2 (5;10;5) with 25 Bootstrap iterations.
[a] GDP per capita (constant 2005 in 1000 USD).
[b] Countries grouped into high income, upper middle, and lower middle income countries.

Table 8: GFE estimates, free fat

Number of groups	Objective	Social globalisation	Economic globalisation	GDP per capita[a]	(GDP per capita)^2
1	38110	0.090***	-0.037	0.447***	-0.007***
		(0.033)	(0.030)	(0.118)	(0.002)
2	17781	0.049	-0.052	0.431***	-0.007***
		(0.031)	(0.035)	(0.060)	(0.001)
3	14011	0.035	-0.022	0.399***	-0.006***
		(0.031)	(0.042)	(0.093)	(0.002)
4	11546	0.047	-0.092**	0.410***	-0.006**
		(0.032)	(0.043)	(0.147)	(0.002)
5	9739	0.026	-0.066*	0.432***	-0.006***
		(0.021)	(0.036)	(0.121)	(0.002)
6	8603	0.026	-0.063	0.427***	-0.006***
		(0.032)	(0.046)	(0.111)	(0.002)
7	7861	0.015	-0.013	0.450***	-0.006***
		(0.027)	(0.038)	(0.122)	(0.002)
8	7274	0.022	-0.045	0.454***	-0.007***
		(0.032)	(0.030)	(0.131)	(0.002)
9	6726	0.032	-0.052*	0.333***	-0.003
		(0.030)	(0.027)	(0.113)	(0.002)
10	6174	0.029	-0.047	0.333*	-0.003
		(0.025)	(0.034)	(0.144)	(0.003)
Country & year FE	9433	0.021	-0.028	0.102	-0.003
		(0.021)	(0.022)	(0.173)	(0.002)
Income groups[b]	35583	0.092***	-0.048	0.351**	-0.005**
		(0.034)	(0.031)	(0.137)	(0.002)

The table reports the value of the objective function and the GFE coefficient for various number of groups. Computation using algorithm 2 (5;10;5) with 25 Bootstrap iterations.
[a] GDP per capita (constant 2005 in 1000 USD).
[b] Countries grouped into high income, upper middle, and lower middle income countries.

Table 9: GFE estimates, sugar

Number of groups	Objective	Social globalisation	Economic globalisation	GDP per capita[a]	(GDP per capita)^2
1	76684	0.223***	-0.041	0.055	-0.003
		(0.056)	(0.052)	(0.124)	(0.002)
2	36924	0.138**	-0.034	0.373**	-0.006***
		(0.068)	(0.092)	(0.169)	(0.003)
3	24074	0.108**	0.038	0.378*	-0.006***
		(0.056)	(0.048)	(0.218)	(0.003)
4	17458	0.079*	0.04	0.607**	-0.009***
		(0.043)	(0.040)	(0.257)	(0.004)
5	13690	0.056	0.022	0.085	-0.001
		(0.038)	(0.039)	(0.213)	(0.003)
6	12085	0.063*	0.014	0.335**	-0.005***
		(0.037)	(0.031)	(0.164)	(0.003)
7	10727	0.06	0.015	0.319	-0.005
		(0.051)	(0.028)	(0.282)	(0.005)
8	9702	0.039	0.02	0.168	-0.003
		(0.035)	(0.036)	(0.317)	(0.006)
9	8747	0.028	0.016	0.134	-0.003
		(0.043)	(0.043)	(0.202)	(0.003)
10	7909	0.041	0.022	0.029	-0.000
		(0.046)	(0.038)	(0.312)	(0.005)
Country & year FE	11439	0.017	-0.024	0.240	-0.004*
		(0.027)	(0.033)	(0.164)	(0.002)
Income group[b]	69468	0.230***	-0.066	-0.117	0.000
		(0.050)	(0.052)	(0.133)	(0.002)

The table reports the value of the objective function and the GFE coefficient for various number of groups. Computation using algorithm 2 (5;10;5) with 25 Bootstrap iterations.
[a] GDP per capita (constant 2005 in 1000 USD).
[b] Countries grouped into high income, upper middle, and lower middle income countries.

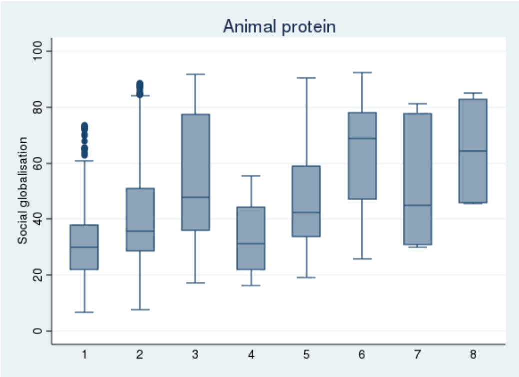

Figure 9: Distribution of social globalisation across groups