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# WEIGHT GAINS FROM TRADE IN FOODS: EVIDENCE FROM MEXICO

Osea Giuntella
Matthias Rieger
Lorenzo Rotunno

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**ABSTRACT**

In this paper, we investigate the effects of trade in foods on obesity in Mexico. To do so, we match data on Mexican food imports from the U.S. with anthropometric and food expenditure data. Our findings suggest that exposure to food imports from the U.S. explains four percent of the rise in obesity prevalence among Mexican women between 1988 and 2012. Pro-obesity effects are more pronounced in areas receiving more unhealthy food imports. We also find that food imports may widen health disparities between education groups. By linking trade flows to obesity, the paper sheds light on an important channel through which globalisation may affect health.

Osea Giuntella
University of Pittsburgh
Department of Economics
Posvar Hall
230 S Bouquet Street
Pittsburgh 15213
osea.giuntella@gmail.com

Matthias Rieger
International Institute of Social Studies (ISS)
Erasmus University
Kortenaerkade 12
The Hague
2518
The Netherlands
matthias.rieger@graduateinstitute.ch

Lorenzo Rotunno
Aix-Marseille University
Aix-Marseille School of Economics (AMSE)
CNRS & EHESS
Chemin du Chateau Lafarge
13290
Les Milles
France
lorenzo.rotunno@univ-amu.fr

# 1 Introduction

The prevalence of obesity, overweight and other diet-related chronic diseases has increased rapidly in the global south. Today, an estimated 62 percent of obese individuals live in developing countries (Ng and et al., 2014). And the number of overweight or obese people living in the developing world has tripled between 1980 and 2008 (Keats and Wiggins, 2014). Over the same period many emerging economies have opened up their food markets to international competition. In response, policy makers have paid more attention to the implications of globalisation and international trade for population health and diets. The World Health Organization (WHO, 2015), for instance, has adopted a clear mandate to help member states better align trade and health policies. Despite the perceived association between trade liberalisation and diet-related health outcomes (see the review by Barlow et al. (2017a)), the causal effects of trade in foods on obesity and their quantitative importance are not well established.[1]

The rise in obesity observed in emerging economies has been associated with a "nutrition transition" whereby diets become richer in animal fats, sugars, and processed foods as average income increases (Popkin and Gordon-Larsen, 2004). These nutritional changes are intertwined with an epidemiological transition in which populations suffer more from obesity, diabetes and cardiovascular diseases rather than infectious diseases and undernutrition (Omran, 1971).

Greater openness to trade in foods can affect the nutrition transition and hence obesity prevalence through changes in income, food prices, tastes and norms. By increasing average income, trade liberalisation can fuel the nutrition transition and contribute to the rise in obesity. Its effects through prices are however ambiguous as they depend on induced price changes and availability of unhealthy and healthy foods. Furthermore, globalisation and trade openness can affect norms and preferences by, for instance, heightening exposure to food advertising on television and the internet (Dragone and Ziebarth, 2017).

In this paper, we examine the effects of U.S. exports of foods and beverages (F&B or 'food' for short) on obesity in Mexico. Over the last decades, Mexico has recorded spectacular increases in diabetes and obesity rates, becoming a prime example of a country in the nutrition transition (Popkin et al., 2012). According to the latest WHO data from 2016, it ranks among the thirty most obese countries in the world, with an estimated 28.9 percent of the adult population being obese. Trade flows between the U.S. and Mexico

[1] A recent literature in public health has studied the association between trade liberalisation and availability of calories (Barlow et al., 2018), supply of products containing high-fructose corn syrup (Barlow et al., 2017b), and sugar-sweetened beverages (Lopez et al., 2017; Schram et al., 2015).

have also boomed since the 1980s and in particular following the North America Free Trade Agreement (NAFTA) in 1994 (Caliendo and Parro, 2015).[2] This is especially true for the F&B industry, where U.S. products represent around 80 percent of total Mexican imports (see section 4.1 for details). These concurrent trends beg the question that the U.S. might have 'exported' its high obesity prevalence (the highest among OECD countries (OECD, 2017)) to Mexico through trade in foods.

To identify the effect of U.S. food exports within Mexico, we allocate trade flows across Mexican states – i.e., the lowest spatial unit at which data are representative. We measure each state's 'exposure' with its historical expenditure by food product. The general idea is that national trade shocks affect regions and individuals differentially; depending on, for instance, their access to trade routes (Atkin and Donaldson, 2015) and their sectors of employment (Dix-Carneiro and Kovak, 2017; Autor et al., 2013). In our paper, the share of total national expenditure of a given food product in each state at baseline measures exposure to trade shocks. We thus use pre-determined and time-invariant food consumption and tastes to predict state-level food imports. This empirical approach implies that a Mexican state where expenditure in, say, processed foods, has been historically higher will receive a larger share of a given increase in U.S. exports of processed foods.

We document a positive and robust effect of U.S. food exports on obesity prevalence across Mexican states.[3] Our analysis is based on anthropometric data for adult women, as data for men were only collected in later surveys (2006 and 2012). The relationship between exposure to U.S. foods and obesity prevalence is statistically significant and robust to controlling for other state-level determinants of obesity. Its quantitative importance can however be inflated by the interaction of demand and supply shifters of food imports.

To bolster a causal interpretation of the least square (OLS) estimates, we follow Autor et al. (2013) and implement an instrumental variable (IV) strategy that nets out demand-side influences. Our instrument is based on the residuals from a regression of the log difference between U.S. and Mexican food exports on product and destination fixed effects, thus isolating supply-side drivers (such as comparative advantage and market access) of variation in U.S. food exports. The IV results are in line with the OLS ones and point to a sizeable causal effect of exposure to U.S. foods on the rise of obesity prevalence in Mexico. The supply-driven rise in U.S. food exports to Mexico can explain four percent of the spectacular

[2]A large literature has examined the implications of Mexican economic liberalisation for economic growth (Hanson, 2010), labour markets and wage inequality (e.g, Hanson, 2007; Verhoogen, 2008), and retail prices and household welfare (Atkin et al., 2018).

[3]Obesity status is derived from the Body-Mass Index (BMI, equal to weight (in kg) over height squared (in meters)), commonly used as a measure of body fat and weight.

increase in obesity prevalence among Mexican adult women observed between 1988 and 2012. In a further check on our causal interpretation, we find that an index of predictors of obesity at baseline does not significantly predict changes in exposure to food imports within states.

Counterfactual calculations illustrate the population dynamics suggested by the IV estimates. In the absence of food imports from the U.S. between 1988 and 2012, there would have been 422,000 fewer obese women in Mexico. These numbers point to a quantitatively important impact of food imports on obesity in Mexico, which is comparable to the effects of other changes in the local food environment found in the U.S. (see Courtemanche and Carden (2011) on obesity and Walmart supercenters expansions).

Our baseline findings survive a battery of robustness checks and extensions. The effect of (relatively low) food imports from other countries is smaller and not as robust, suggesting that U.S. food exports to Mexico are particularly obesity-inducing. Furthermore, results from a placebo test using imports of apparel as an alternative measure of states' exposure to trade rule out spuriousness due to overall trade with the U.S.. The findings are also robust to controlling for exposure to Mexican food exports and to the use of food imports statistics for final demand only.

The strong impact of American food (relative to the weak roles of imports from other sources and overall food expenditures) is suggestive of their inherent pro-obesity bias. To dissect the composition of U.S. food exports, we further categorize foods using the USDA Dietary Guidelines for Americans (DGA (2010); see also Handbury et al. (2017) and Volpe et al. (2013) for recent applications). Descriptive evidence indicates that U.S. producers indeed gained comparative advantage in less healthy foods. While U.S. food exports to Mexico increased more than seven-fold between 1989 and 2012, exports of unhealthy foods featured the highest increases (e.g., exports of "food preparations" are 23 times higher in 2012 than in 1989). This categorisation allows us to impute the unhealthy share of total food imports coming from the U.S.. Our estimates suggest that the unhealthy component of food imports from the U.S. may be driving our baseline findings.

The pro-obesity role of unhealthy food imports is robust to the use of instrumental variables as well as controlling for other state-level determinants of obesity, such as the unhealthy share of total food expenditure, relative prices of unhealthy foods and average income. To nuance the mediating role of these variables, we then estimate a household demand equation over healthy and unhealthy foods. We find that households tend to shift expenditure towards unhealthy foods in states that are more exposed to food imports from the U.S.. The correlation between household relative demand for unhealthy foods and exposure to U.S. foods does not change when we control for local prices and real household expenditure, hinting at a ‘taste’ channel (see also Atkin (2013)).

Finally, we investigate how the effect of exposure to U.S. foods varies with education. Our estimates from regressions at the individual level do not reveal any significant heterogeneity when it comes to total food imports. Instead, the adverse effect of trade in unhealthy foods is worsened by low levels of education. Our estimates further suggest that unhealthy food imports may widen the already large disparities in obesity risk between women with different levels of education. The average difference in the likelihood of being obese between women who have at least completed high school and less educated women increases by three percentage points (from five to eight percentage points) as states’ exposure to U.S. unhealthy foods rises from the average value to the highest one.

This paper provides the first causal evidence on trade in foods and obesity. It expands recent conceptual studies (WHO, 2015; Thow, 2009) linking trade liberalisation to the nutrition transition and to the related rise in obesity, diabetes and other cardiovascular diseases in the global south. Existing cross-country studies provide mixed evidence – Miljkovic et al. (2015) and Vogli et al. (2014) report a positive and significant effect of trade openness on obesity and BMI, whereas the findings in Oberlander et al. (2017) and Costa-Font and Mas (2016) suggest that social (rather than economic) globalisation matters. We use detailed data from a single country, Mexico, and contribute to this nascent line of empirical work by identifying the impact of trade in foods (rather than total trade flows).

Our study also complements recent work on the adverse effects of trade liberalisation on health through income and labour market channels (Colantone et al., 2018; Adda and Fawaz, 2017; Pierce and Schott, 2017; Hummels et al., 2016; Lang et al., 2016; McManus and Schaur, 2016). Our paper applies a comparable methodology to distribute trade shocks across regions within a single country, but it is the first one to focus on obesity and on a demand-side channel operating through the nutrition transition (Popkin and Gordon-Larsen, 2004; Rivera et al., 2004).

More broadly, we add to a large body of work on the economic determinants of obesity and dietary habits (Cawley, 2015). Courtemanche et al. (2016) find that the local economic environment (e.g., retailers and restaurants) explains a significant portion of the observed rise in obesity in the U.S..[4] Handbury et al. (2017), however, find that spatial differences in access to healthy foods explain only a small fraction of the differences in nutritional intake across people from different socioeconomic groups (e.g., across people with different levels of education). Our paper highlights the role of international trade in foods as a quantitatively important economic driver of obesity.

[4]See also Currie et al. (2010) on the effects of fast food restaurants on obesity.

The rest of the paper proceeds as follows. Sections 2 and 3 describe the empirical strategy and the data used in the analysis. Section 4 discusses the results, focusing on a descriptive analysis first (subsection 4.1), and then delving into the econometric results (subsections 4.2 to 4.4). Section 5 concludes.

# 2 Empirical strategy

The empirical analysis follows three steps. First, we present some descriptive patterns in obesity and U.S. food exports to Mexico. Second, we estimate the effect of greater exposure to food imports from the U.S. on obesity prevalence, and investigate the role of healthy and unhealthy foods. Finally, we examine the heterogeneity of the documented effects as a function of socioeconomic status.

Our baseline specification relates obesity prevalence to exposure to U.S. food exports allocated to the 32 Mexican states – the lowest level of aggregation at which the health surveys are representative. We estimate the following regression:

$$(1) \quad Obesity_{s,t} = \beta_1 USimp_{s,t} + \beta_2 X_{s,t} + \gamma_s + \gamma_s t + \theta_t + \epsilon_{s,t}$$

The *Obesity* variable equals the share of adult women living in state $s$ who have a BMI greater than or equal to 30 in $t$, the year of the health survey (1988, 1999, 2006, and 2012). The estimation sample is a four-period panel of Mexican states (the same individual is not followed over time). The main covariate of interest is $USimp$ – imputed food imports (in billions of current US$) coming from the U.S. at the state level at time $t$.[5]

The coefficient $\beta_1$ identifies the effect of U.S. food imports on obesity in 'reduced-form'. The variable $USimp$ measures states' exposure to food imports as predicted by historical expenditure specialisation in different food products. Specifically, imports from the U.S. for each Mexican state at the product level are imputed from national trade statistics – imports at the state level are available only starting from 2006.[6] We use the state's expenditure share for a given product (i.e., the state expenditure for a product relative to total national expenditure for the same product) to allocate imports across states. Total imputed food

[5] In our baseline specifications, we do not use import penetration ratios (imports from the U.S. over total food expenditure) at the state level because expenditure and imports flows are not directly comparable – we nonetheless show the country-level trend of this variable in Figure 2. Trade data may include purchases by firms (i.e. not for final consumption), and our constructed measure of imports for final demand has its own limitations, as discussed in Section 4. However, results tend in the same direction when using a metric of import penetration rather than the level of imports.

[6] We show below that there is a strong correlation between our imputed and actual Mexican state imports.

imports from the U.S. of state $s$ at time $t$ are defined as:

$$(2) \quad USimp_{s,t} = \sum_{g} \frac{E_{g,s,1984}}{E_{g,1984}} M_{g,t}$$

where the subscript $g$ identifies a product within the food & beverages (F&B) macro-category. The expenditure shares are computed using data from 1984 (the first year where such data are available), and hence before the beginning of our sample in 1988, and are held fixed throughout the period. The variable $M$ indicates actual Mexican imports of food $g$ at time $t$ from the U.S., measured in current billions of US$.

Variation in expenditures shares across states and products, as well as changes in trade flows over time identify our coefficient of interest, $\beta_1$, in the regression equation (1). If the food expenditure for each product is equally distributed across states and the $USimp$ variable also does not vary across states then $\beta_1$ cannot be identified separately from the time dummies $\theta_t$. Moreover, the time dummies absorb the influence of national food imports from the U.S. as well as of other national shocks. If there were no significant changes in food imports over time, the effect of the $USimp$ variable would be subsumed by the state fixed effects $\gamma_s$.

By using pre-determined expenditure shares to project variation in food imports over time, we are assigning more imports to states that were already on an upward trend in food consumption (and possibly in overweight prevalence). Linear state-specific time trends ($\gamma_s t$) control for such pre-existing patterns. The coefficient $\beta_1$ is thus identified off deviations in imputed food imports from states' trends in obesity. Its sign and size help assessing the role of exposure to U.S. foods in shaping the underlying and upward obesity trends observed in Mexico (and similar to those observed in other countries going through a nutrition transition). Standard errors in (1) are clustered at the state level and the state shares of total female population in the initial period (1990) are used as weights in the regressions to correct for sampling error in computing state-level variables.

Our empirical approach is borrowed from the literature on the local labour market impact of import competition (see, e.g., Autor et al., 2013), which has recently been applied to investigate the effects of imports on workers' health (Colantone et al., 2018). In this line of work, the objective is to investigate trade effects in the labour market and hence imports are allocated within countries according to sub-national and sectoral employment shares. In our analysis, we focus on a nutrition channel – expenditure shares are thus the relevant measure of trade exposure at the local level.[7]

[7] The coefficient $\beta_1$ in equation (1) could still capture the influence of labour market channels (e.g.,

The imputed import variable $USimp$ can be thought of as an instrument for the actual consumption of foods from the U.S. – which is unobserved until 2006 and likely to be endogenous to obesity prevalence. However, a causal interpretation of the $\beta_1$ coefficient further requires that U.S. exports to Mexico vary across food categories and over time ($M_{g,t}$ in equation (2)) with supply-side determinants of U.S. food production that are not affected by Mexican demand. We thus follow Autor et al. (2013) and exploit variation in U.S. food exports to the main upper middle-income destination countries (UMIC) (other than Mexico) to generate plausibly exogenous variation.[8] In particular, we use the residuals from panel regressions of U.S. exports on product and destination dummies as instruments for U.S. food exports to Mexico. And in a more demanding exercise, we use the (log) difference between U.S. and Mexican food exports to net out any remaining demand component. As Autor et al. (2013) argue, variation in these gravity residuals should only stem from changes in the patterns of U.S. comparative advantage relative to Mexico in the food sector, and from any differential changes in trade costs. Importantly, the product and destination fixed effects in the gravity regression control for dietary shifts during the nutrition transition that are common to UMIC and Mexico. In our instrumental variable strategy we replace $M_{g,t}$ in equation (2) with these gravity residuals.

Specification (1) also includes a set of other state variables $X$ that characterise the economic environment and can channel or confound the effect of food imports. We focus on demand channels through which greater availability of food imports can influence nutrition and obesity, operating through changes in income and prices. More specifically, we control for total household food expenditure to assess the distinct contribution of U.S. foods relative to overall food consumption. Relatedly, greater food imports can be associated with a price effect, whereby new and relatively cheaper U.S. food varieties displace domestic ones. This channel can reinforce the nutrition transition by encouraging shifts towards a less healthy diet. Faber (2014) finds strong evidence for an effect of NAFTA liberalisation on relative prices in Mexico, and Cravino and Levchenko (2017) find that the price of tradables rose after the Peso crisis. These recent studies work with very disaggregated data and, like the rest of the literature, do not focus on food varieties. In empirical specification (1), we control for the weighted average price of foods at the state level, where the weights equal the share of each food product in total spending. Moreover, trade liberalisation can increase average productivity and income, accelerating the nutrition transition and, more

changing physical activity due to import competition) if the pre-determined expenditure shares correlate with initial employment shares.

[8] We consider the ten largest destinations of U.S. food exports among UMIC (other than Mexico): China, Colombia, Costa Rica, Dominican Republic, Algeria, Malaysia, Russia, Thailand, Turkey and Venezuela.

generally, the abandoning of traditional life styles and behaviors. This demand channel is likely to affect the estimate of interest ($\beta_1$) if income-enhancing trade integration is biased towards consumption (and imports) of foods. In the empirical analysis, we proxy for this mechanism by adding the state GDP per capita (in logs) to our set of covariates. Finally, being more exposed to imports from the U.S. can be associated with other measures of economic and cultural proximity. To control for these influences, the term $X$ in our baseline regression includes also the state's stock of inward Foreign Direct Investments (FDI) (relative to the state's GDP) and the share of the state's population that migrated to the U.S. The confounding role of other time-invariant determinants of trade with the U.S. (e.g., distance to the border and touristic attractions) is captured by the state dummies ($\gamma_s$) in (1).

The obesity effect identified in our baseline regression framework is likely to depend on the nutritional composition of U.S food exports. In an extension of the empirical analysis, we thus concentrate on the share of US food exports that is considered 'unhealthy'. The objective is to have a closer look at the nutritional channel by investigating whether the overall impact of U.S. food exports is driven by specialisation in unhealthy foods. Specifically, we estimate the following regression:

$$(3) \quad Obesity_{s,t} = \beta_1 UnhealthyImp_{s,t} + \beta_2 X^{unh}_{s,t} + \gamma_s + \gamma_s t + \theta_t + \epsilon_{s,t}$$

where total imputed U.S. food exports to Mexico are replaced by their unhealthy share (more precisely: $UnhealthyImp \equiv \frac{USimp^{unh}_{s,t}}{USimp_{s,t}}$; with $USimp^{unh}_{s,t}$ being computed by restricting the summation in (2) to food categories $g$ that are classified as unhealthy). The other state-level determinants of obesity are adjusted to control for the relative importance of unhealthy foods. In particular, we include the unhealthy share of total household food expenditure and the relative weighted average prices of unhealthy and healthy foods. By controlling for the former, $\beta_1$ in (3) captures whether, within unhealthy categorisation, U.S. foods are more obesity-prone (e.g., because of different micro-nutrients that are not captured by the coarse healthy-unhealthy comparison).

# 3 Data

To implement our empirical analysis, we use data on anthropometrics, expenditure and trade. BMI information comes from the Encuesta Nacional de Nutricion (ENN, 1988 and 1999) which then became the Encuesta Nacional de Salud y Nutricion (ENSA, 2006 and

2012).[9] The survey changed structure and expanded its content over time. However and important for our study, all waves are representative at the state level[10]. The ENN only surveyed women between 20 and 49 years of age. For this reason, we restrict our analysis to this sample. In each survey year, the outcome variable at the state level is thus equal to the share of surveyed women between 20 and 49 years of age who are classified as obese.

These data also contain information on individual socioeconomic characteristics (education, employment status, household type) that may be linked to obesity. We employ these in individual-level extensions of our baseline model (estimated at the state level). In the absence of data on income, we proxy for the position of each household in the sample wealth distribution.[11]

Data on expenditure shares and prices (unit values) are drawn from different waves (from 1984 until 2012) of the Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH), the Mexican household-level survey on expenditure by detailed product categories. State expenditures in 1984 and hence before the beginning of the sample period are used to allocate food imports across states as shown in equation (2).

Mexican imports from the U.S. and other trade variables (in billions of current US$) starting from 1989 are from UN COMTRADE. After harmonizing the product classification of the trade (SITC, revision 3) and expenditure data, we obtain a sample of 152 foods and beverages with a full time series of expenditures and imports.[12]

To identify healthy and unhealthy products, we follow Volpe et al. (2013) (see also Hut and Oster (2018); Handbury et al. (2017); Oster (2017a) for recent applications) and aggregate food products in the 52 groups used by the Quarterly Food-at-Home Price Database (QFAHDP). We classify these as healthful/unhealthful following USDA Dietary

[9] We use these data rather than the individual panel data of the Mexican Family Life Survey (MXFLS) because the MXFLS is not representative at the state level (the smallest spatial unit at which the expenditure data are representative) and because it goes back only to 2002 and hence using it would miss the major changes in U.S. food exports to Mexico that occurred in the 1990's.

[10] The 1999 wave of the ENN survey does not include four states. We further drop the state of Chihuahua in 1999 because it includes only one woman between 20 and 49 years of age. All other state obesity rates are based on at least 15 individuals.

[11] We perform a principal component analysis of different household asset variables for each year (e.g., whether the house has walls made of concrete, a TV, a fridge) and use the first component as an index of household wealth – see Filmer and Pritchett (2001) for details on the methodology and Rutstein and Johnson (2004) for a commonly used application. We then allocate households to quintiles of the index in order to mitigate sampling error and use dummies for the first, the last and the middle quintiles in the regressions.

[12] We exclude 16 products for which the matching with the trade or health (USDA) classifications was highly problematic, because of imprecise definitions (e.g. "loose seeds", "packaged seeds", "packed chillis") or because there was no clear international (e.g., "Pueblan chillis for stuffing") or health (e.g., "Cinnamon") category. They represent, on average, 4.5 percent of state imputed imports from the U.S. and 2 percent of state household expenditure. Adding these flows to our import, expenditure and average price variables does not affect the empirical findings.

Guidelines for Americans (DGA, 2010; also in Volpe et al., 2013). Healthy foods are those recommended for increased consumption (e.g., "dark green vegetables"), whereas unhealthy foods are those recommended for limited consumption (e.g., "refined flour and mixes"). We assign the food items from the trade and expenditure data to the 52 USDA food categories on the basis of their text description, allowing us to construct the share of unhealthy imports (and expenditure) at the state level. Table A1 in the Appendix lists the food products and their USDA category. In the last column, we report a more conservative classification that restricts the healthy category to vegetables, fruits, fish and poultry.

# 4 Results

Before discussing the results of the econometric analysis, we provide some descriptive evidence on the evolution of obesity and U.S. food exports to Mexico in our sample, running from 1988 to 2012 and with data on obesity available at four points in time.

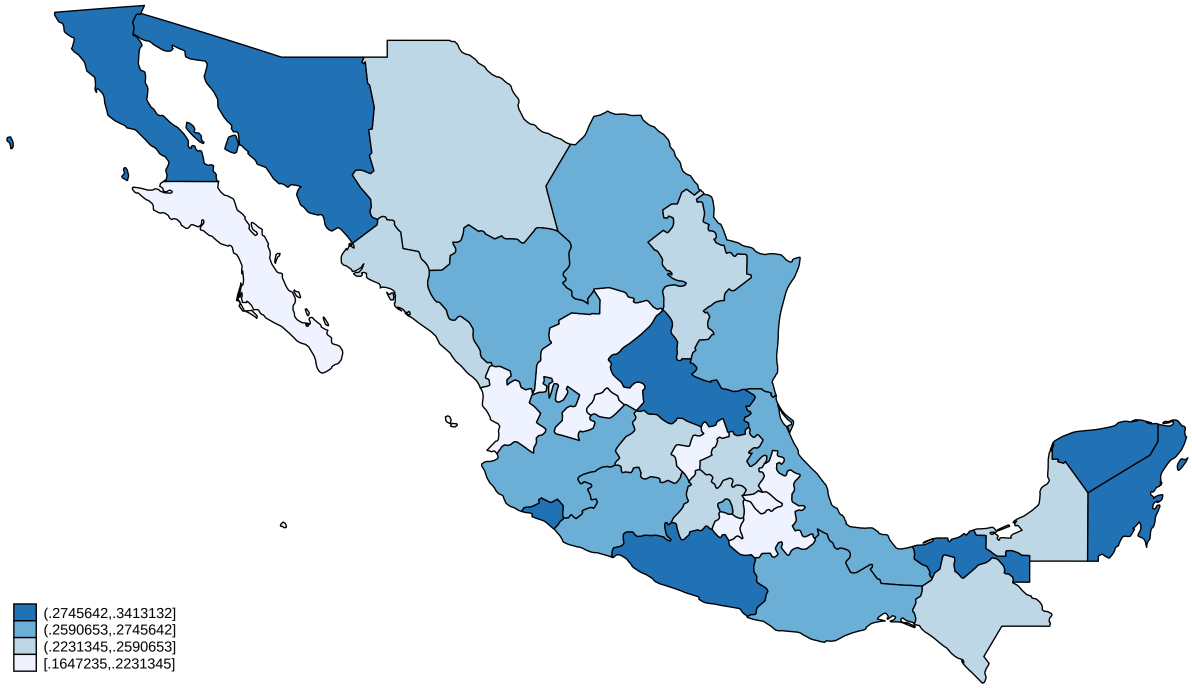
## 4.1 Descriptive evidence

Our anthropometric data replicate the spectacular rise in obesity that has been documented in other work on Mexico (see e.g. Rtveladze et al., 2014). Average BMI of women is 19 percent higher in 2012 than in 1988, and the rate of obesity prevalence dramatically increased during the same period, going from 10 to 35 percent.[13] The share of women who are overweight or obese (i.e. with a BMI of at least 25) doubled from 35 to 70 percent.

Obesity among adult women increased nationally, yet the rate of change varies across Mexican states as shown in Figure 1, which is necessary for our empirical approach. The state of Nayarit experienced the smallest increase (16 percentage points), while the biggest increase (34 percentage points) is recorded in Tabasco.

[13] Survey weights are used for the 1999, 2006 and 2012 waves. We use state-level weights equal to the number of adult women respondents divided by the relevant state population in 1990 for the 1988 survey, where survey weights are missing or have implausible values. Using an alternative measure of obesity based on the waist-to-height (WTH) ratio (women with a WTH over 0.58 are normally classified as obese), we find that obesity prevalence went from 18 to 48 percent between 1999 and 2012. We do not have have data on waist in 1988.

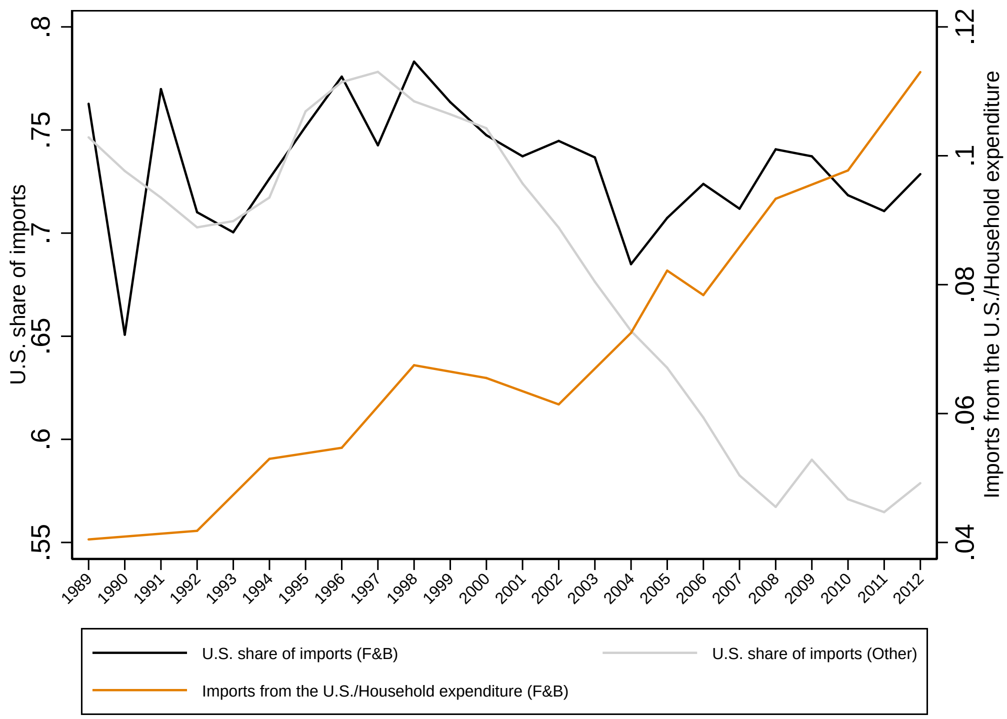
Figure 1: Changes in obesity prevalence across Mexican states between 1988 and 2012




At the same time, trade flows between Mexico and the U.S. have been rising steadily, following economic liberalisation policies adopted by the Mexican government and the formation of NAFTA in 1994. This trend is particularly strong in the food and beverage (F&B) sector. As shown in Figure 2, the U.S. are by far the largest source of Mexican imports of F&B, while U.S. importance in Mexican imports of other manufacturing goods has declined during the 2000s mainly because of heightened competition from emerging economies like China (Mendez, 2015). Figure 2 also shows that the share of imports from the U.S in total Mexican household expenditure in F&B ('import penetration') almost tripled between 1989 and 2012, going from 4 to 11 percent.[14]

[14]These shares are lower if we consider only imports classified for final consumption (see section 4). Under this alternative definition, import penetration in household food expenditure went from 3 to 7 percent between 1989 and 2012.

Figure 2: U.S. share of Mexican imports and U.S. import penetration in Mexican food expenditure




Notes: Mexican food imports are those under the one-digit categories 0 and 4, and the two-digit categories 11 and 22 of the SITC Revision 3 classification. Imports values in current US$ are converted in Mexican pesos using annual exchange rates. Mexican household food expenditures are imputed from the ENIGH surveys using the households' sampling weights.

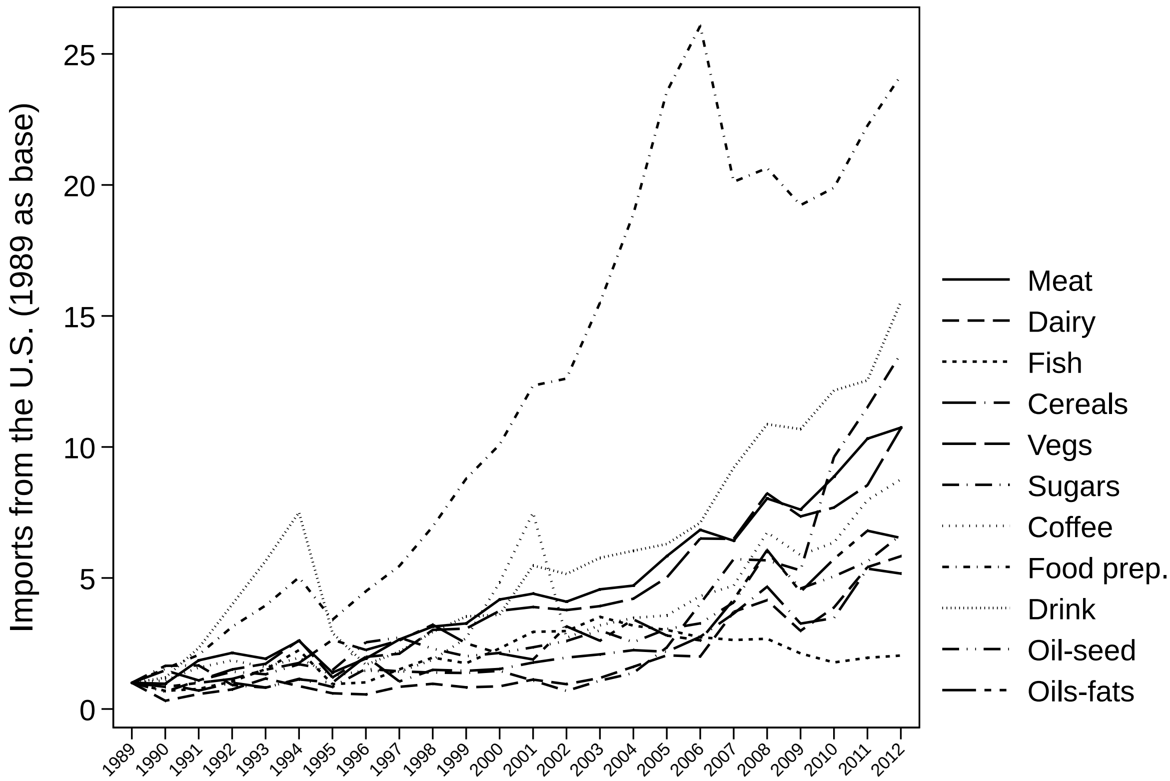
Our empirical strategy allocates U.S. food exports to Mexican states using expenditure shares by food product in 1984. The map in Figure A1 in the Appendix illustrates the geography of changes in imputed food imports (the variable $USimp$ in (2)) between 1988 and 2012, normalized by 1988 values (in current US$). While exposure to U.S. foods increased everywhere, states were exposed differentially so. Imputed imports were 5.5 times higher in 2012 than in 1988 in the state of Sonora (the smallest relative increase), while the state of Puebla experienced the largest (twelve-fold) relative increase in exposure during the same period. Table A2 dissects this variation further and reports values for each state and year used in the regression analysis.

Differences in how the $USimp$ variable changes across states and over time comes from the interaction of pre-determined expenditures shares and time-varying U.S. food exports to Mexico, as shown in equation (2). To verify that these imputed imports correlate with actual values, we use data from the TransBorder Freight Database, reporting U.S. exports by broad sector to each Mexican state starting from 2006. Results from annual panel regressions of total U.S. agricultural and food exports on the $USimp$ variable, reported in Table A3 in the Appendix, reveal a strong correlation between the two variables. Our $USimp$ variable explains around 55 percent of the total variation in actual Mexican imports, and 20 percent of the within-state variation.

The evolution of aggregate U.S. food exports to Mexico can mask important variation across different types of products. In Figure 3, we plot U.S. food exports by main F&B categories over time relative to their values in 1989. Products that are generally associated with an unhealthy and obese-prone diet have been driving the overall increase in Mexican food imports from the U.S.. More specifically, imports of "Food preparations" (including preparations of fats, sauces, soups, and homogenised foods) saw the highest relative increase among all food categories, going from 35.5 to 859 US$ millions.[15] "Drinks" and "sugars" also displayed large rates of change, recording fifteen-fold and fourteen-fold increases, respectively. While purely illustrative, these patterns suggest that the surge of Mexican imports from the U.S. is concentrated in generally 'bad' foods, which may have accelerated the spread of the obesity epidemic.

[15]Within the corresponding chapter "09 – Miscellaneous edible products and preparations", the product category "09893 – Food preparations for infant use" recorded the largest increase in imports relative to the base level in 1989 (a ninety-three-fold increase). "09899 – Miscellaneous food preparations" experienced the second largest relative increase (and the largest absolute one), followed by "09843 – Mustard preparations".

Figure 3: Mexican imports of F&B from the U.S. over time

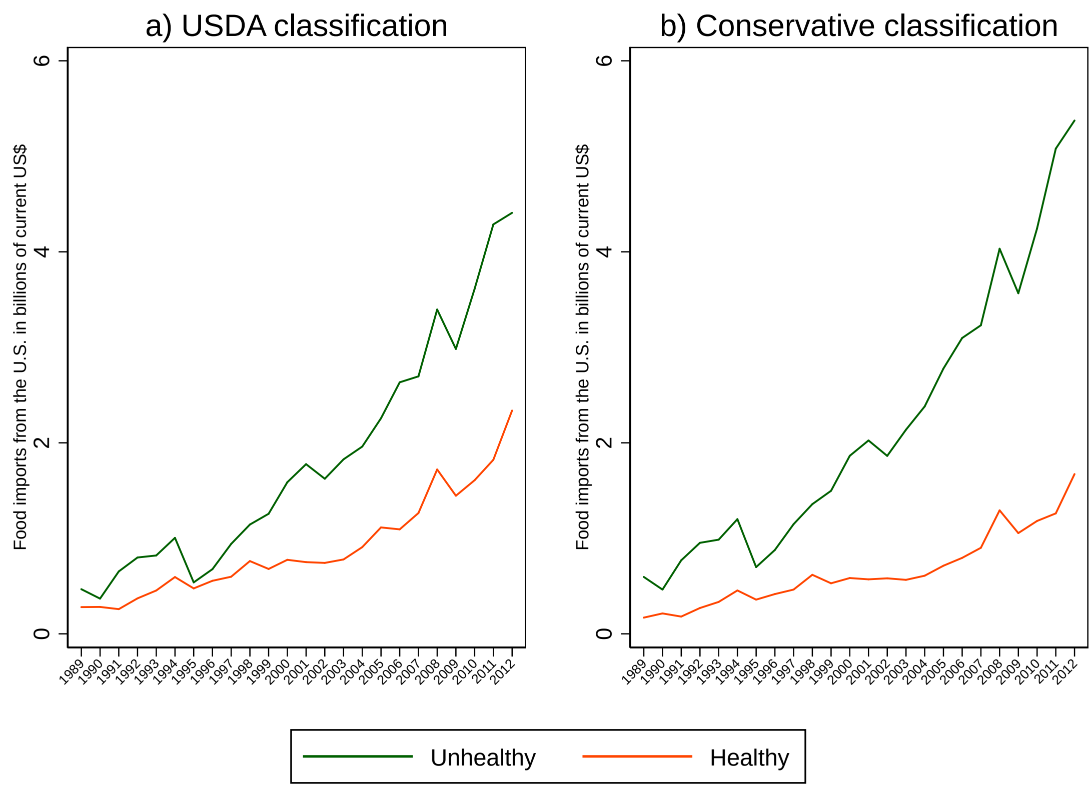



Notes: Food categories are defined following the SITC Rev. 3 product classification: 'Meat' is category "01 – Meat and meat preparations"; 'Dairy' is category "02 – Dairy products and birds' eggs"; 'Fish' is category "03 – Fish (not marine mammals), crustaceans, molluscs and aquatic invertebrates, and preparations thereof"; 'Cereals' is category "04 – Cereals and cereal preparations"; 'Vegs' is category "05 – Vegetables and fruit"; 'Sugars' is category "06 – Sugars, sugar preparations and honey"; 'Coffee' is category "07 – Coffee, tea, cocoa, spices, and manufactures thereof"; 'Food prep.' is category "09 – Miscellaneous edible products and preparations"; 'Drink' is category "11 – Beverages"; 'Oil-seed' is category "22 – Oil-seeds and oleaginous fruits"; and 'Oils-fats' is category "4 – Animal and vegetable oils, fats and waxes".

The bias towards unhealthy American foods is even clearer after we classify the SITC products according to the 'healthy' and 'unhealthy' categories of the USDA. As shown in panel (a) of Figure 4, the latter increased faster than the former, especially starting from the mid-1990's.[16] Trends (and regressions results) are similar when we use a more conservative classification that restricts the healthy category to vegetables, fruits, fish and poultry (see panel (b)).

[16]The absolute increase of U.S. food exports to Mexico is much larger if flows are converted into Mexican Pesos because of the large devaluation of the currency during our sample period – e.g., the ten-fold increase in U.S. food exports to Mexico between 1988 and 2012 as measured in US$ translates into a fifty-fold increase if we denominate exports in Mexican pesos. In the ensuing analysis, we will keep the trade variables in current US$ and highlight any implications this might have for the interpretation of the results.

Figure 4: Unhealthy and healthy Mexican F&B imports from the U.S.




Notes: The "conservative" classification considers only vegetables, fruits, fish and poultry.

As in the case of aggregate imports, Table A2 reveals strong heterogeneity across states in the exposure to unhealthy imports. While the share increased by 6 percentage points on average (but remained roughly constant between 2006 and 2012), it went down in nine Mexican states.

## 4.2 Effects of food imports on obesity

(a) Baseline results

Our benchmark specification allows us to assess the effect of exposure to food imports from the U.S. – computed using pre-determined expenditure shares at the product level – on obesity prevalence of adult women at the state level. The regressions span the four anthropometric surveys (1988, 1999, 2006, 2012).

The results reported in Table 1 point to a strong and positive relationship between exposure to foods coming from the U.S. and obesity. Columns (1) to (5) display least square results, while the remaining columns show the IV estimates. Column (1) considers the relationship between food imports from the U.S. (in billions of current US$) and obesity prevalence at the state level, conditional on state dummies, year dummies and state-specific linear time trends. The point estimate of 0.27 implies that a 190-million increase in food imports from the U.S. (i.e., the difference in the average of $USimp$ across states between 2012 and 1988) is associated with a five percentage-point increase in obesity prevalence. This effect remains stable when including state-level covariates. Adding total household food expenditure in column (2) does not affect the coefficient on the import variable, suggesting that trade exposure is not simply capturing the obesity effect of broader shifts in expenditure patterns (the correlation between the two variables is 0.57). Adding instead the average food price in column (3) also leaves our main coefficient of interest unchanged. In column (4), we include the states' GDP per capita to control for average income effects, and the estimated coefficient on food imports from the U.S. is again unaltered.[17] Controlling for other state-level confounders in column (5) gives the OLS baseline specification of equation (1). The results again point to a positive and significant effect of food imports on the risk of being obese.[18,19]

Our baseline finding is biased if within-state variation in U.S. food exports is driven by Mexican demand-side determinants that co-shape the obesity epidemic. In columns (6) to (9) of Table 1, we report the results of instrumental variable estimations that exploit residual variation in U.S. food exports to similar countries. The objective is to single out variation in U.S. food exports that is due to supply-side factors. Columns (6) and (7) report the results using residuals from a gravity regression of U.S. food exports on product and destination dummies to instrument the $USimp$ variable. The second-stage coefficient on the food imports variable is remarkably similar to the OLS one and the first-stage statistics reveal a strong explanatory power of the excluded instrument.

Identification can however remain problematic because the residuals of U.S. food exports to other upper middle-income countries might still be correlated with time-varying food preferences in those countries – which could be similar to the ones observed in Mexico. To alleviate such concerns, in column (8) and (9) of Table 1, we employ residuals from a gravity

[17] State GDP per capita partly controls for the possibility that our measure of 'estimated' import exposure at the state level correlates with the structure of local food production. By allocating imports of food products across states according to their share in national expenditures in 1984, we might be giving more imports of, say, foods that are both more consumed and produced locally – both in 1984 and in all subsequent years of our sample. If higher concentration of production in foods is associated with greater income per capita, the effect of our imputed food import variable might be mediated by GDP per capita.

[18] Results available upon request tend in the same direction when we divide the import variable by total household food expenditure held fixed at the beginning of the sample (see also footnote n.5).

[19] To investigate possible omitted variable bias, we also estimated how large should the selection on unobservables be relative to the selection on observables in order to explain away the results (Oster, 2017b). Reassuringly, we find that the selection on unobservables would have to be 1.14 times as large as the one on observables to produce a zero effect of the $USimp$ variable.

regression of the difference (in logs) between U.S. and Mexican food exports on product and destination fixed effects as instrument. This differencing nets out time-varying demand components in destination countries. The variation in the residuals is thus only due to changes in comparative advantage and market access for U.S. products relative to Mexican ones (see Appendix B of Autor et al. (2013) for further discussions). While weaker than the instrument used in columns (6) and (7), the first-stage results in columns (8) and (9) indicate that the supply-driven residuals are positively and significantly associated with U.S. food exports to Mexico. Crucially, the second-stage coefficient on food imports from the U.S. stays positive and statistically significant at conventional levels. By scaling down the overall changes in food imports by the partial $R^2$ in the first-stage (0.19), these estimates imply that the supply-driven component of a 190-million increase in food imports from the U.S. would cause a one percentage point higher obesity rate.[20] These estimates are conditional on state-specific time trends and hence suggest that greater exposure to U.S. foods has accelerated the generalised rise in obesity between 1988 and 2012 (see Figure 1).

To further investigate reverse causality going from obesity prevalence to changes in food imports, we conducted an unconfoundedness test. We constructed an index of obesity predictors using individual-level data from the first health survey in 1988. We regressed an obesity indicator on our main set of covariates at the individual and household levels (see subsection 4.4) and used the resulting state-level average of the predicted obesity probabilities as an index of obesity determinants at baseline. We then regressed the changes in the $USimp$ variable between 1988 and 2012 (also relative to 1988) on predicted obesity prevalence and find no evidence of a robust relationship. The point-estimate is positive (coef.=6.07; std.err.= 4.00), but poorly estimated – and the relationship is even weaker if changes in imports are relative to 1988. The relationship between obesity prevalence at baseline and changes in gravity residuals (the instrument used in columns (8) and (9) of Table 1) is also insignificant, suggesting that socioeconomic determinants of obesity do not predict exposure to supply-driven variation in exposure to U.S. foods.

[20] We obtain similar results when import values are converted into billions of current Mexican Pesos (MXN) – see Table A5 in the Appendix. The IV estimates of column (9) suggest that the increase in average state-level exposure to U.S. foods of 2.72 MXN billions observed between 1988 and 2012 would lead to a 0.8 percentage point increase in obesity prevalence.

Table 1: Food imports from the U.S. and obesity prevalence

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | | | OLS | | | | 2SLS | | |
| U.S. food imports | 0.271*** | 0.265*** | 0.263*** | 0.271*** | 0.266*** | 0.285*** | 0.283*** | 0.296** | 0.289* |
| | (0.0508) | (0.0534) | (0.0518) | (0.0515) | (0.0531) | (0.0550) | (0.0661) | (0.113) | (0.149) |
| Ln(food expenditure) | | 0.0225 | | | 0.0230 | | 0.0226 | | 0.0225 |
| | | (0.0249) | | | (0.0266) | | (0.0266) | | (0.0255) |
| Ln(food price) | | | 0.0470 | | 0.0341 | | 0.0324 | | 0.0318 |
| | | | (0.0659) | | (0.0612) | | (0.0622) | | (0.0580) |
| Ln(GDP per cap.) | | | | 0.00623 | 0.00161 | | 0.00139 | | 0.00132 |
| | | | | (0.0485) | (0.0507) | | (0.0506) | | (0.0490) |
| FDI/GDP | | | | | 0.228 | | 0.233 | | 0.234 |
| | | | | | (0.236) | | (0.237) | | (0.236) |
| Migrant share | | | | | 0.171 | | 0.153 | | 0.147 |
| | | | | | (1.016) | | (1.011) | | (1.000) |
| *First-stage results – Excluded instrument based on:* | | | | | | | | | |
| U.S. food exports | | | | | | 0.0022*** | 0.0022*** | | |
| | | | | | | (0.0002) | (0.0002) | | |
| U.S. - Mex. food exports | | | | | | | | 0.0086*** | 0.0103*** |
| | | | | | | | | (0.0025) | (0.0027) |
| F-stat excluded instr. | | | | | | 130.05 | 137.38 | 12.13 | 14.87 |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.970 | 0.971 | 0.970 | 0.970 | 0.971 | | | | |

Notes: All regressions include state dummies, state-specific linear trends, and year dummies. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

### (b) Benchmarking the impact of U.S. food exports on obesity in Mexico

The estimated effect of food imports from the U.S. can be assessed against the observed increase of 25 percentage points in obesity prevalence across states between 1988 and 2012. The positive and significant OLS coefficients from columns (1) to (5) of Table 1 could account for as much as 20 percent of the rise in obesity. That said, the combination of demand and supply factors driving variation in U.S. food exports to Mexico is likely biasing the OLS effects upwards.

When using the causal estimates from columns (8) and (9), U.S. food exports to Mexican states explain four percent of the increase in obesity prevalence. These magnitudes are comparable to the obesity effects found in other studies examining the role of changes in the food environment. Courtemanche and Carden (2011), for instance, find that the local penetration of Walmart Supercenters is responsible for 10.5 percent of the rise in obesity rates in the U.S. since the late 1980s.

Another way to interpret the estimated effects is to construct counterfactual changes in nation-wide obesity prevalence among adult women that would have occurred in the absence of increased U.S. food imports (see Acemoglu et al. (2016) for a similar exercise applied to the effects of import competition from China on labour markets in the U.S.). To this end we use the 2SLS estimates from column (9) of Table 1 ($\beta_1$=0.29 and partial $R^2$=0.19) to generate the changes in obesity rates mandated by the observed variation in instrumented food imports for each state. We compute these changes for each sub-period in our sample (e.g., $\widehat{Obesity}_{s,1999-1988} \equiv 0.19 \times \widehat{\beta}_1 \left(USimp_{s,1999} - USimp_{s,1988}\right)$), and multiply those by the number of women between 18 and 59 years of age (the closest demographic group to the 20-49 age range used in the estimations) for each state and sub-period. Summing these numbers across states, we back out the headcount of women who became obese as a result of food imports. Importantly, this counterfactual exercise assumes that all other covariates and the error term in equation (1) are unaffected by the exogenous changes in U.S. food exports to Mexico, and that the estimated effect ($\widehat{\beta}_1$) is constant over time. Because of the restrictiveness of these assumptions, we view these simulations as purely suggestive of economic magnitudes.

Table 2 reports the results of these back-of-the-envelope calculations. In the first row, we show the simulated changes in the number of obese women, computed using population data at the beginning of each period. Our estimates indicate that around 294,000 cases of obese women would have been averted with no further increases in food imports from the U.S. after 2006. Considering the full period, the rise in exposure to U.S. food can account for 422,000 additional obese women between 1988 and 2012. To put these numbers into perspective, we divide them by the observed increases in the number of Mexican obese women. As shown in the second row of Table 2, we replicate the share of the observed rise in obesity during the full sample period (four percent) that can be attributed to changes in food imports, with the effect being larger for 2006-2012 changes. In the third row, we divide the counterfactual changes in the number of obese women by the increases in obesity evaluated at start-of-the-period population levels. This enhances consistency with the way we constructed the counterfactual changes, but misses the comparison with overall changes in obesity rates. The imputed role of food imports from the U.S. is quantitatively more important – overall increases in food imports account for eight percent (rather than the four percent obtained using time-varying populations) of the total rise in obesity among adult women between 1988 and 2012 (holding total female population by state constant).[21]

[21] We repeated the counterfactual exercise using trade flows in billions of current Mexican Pesos together with estimates from column (9) of Table A5 (see footnote n.20). The magnitudes are slightly lower than the ones obtained from the baseline specification in current US$ – e.g., the imports-mandated increase in obese women over the 1988-2012 period is equivalent to 3.4 percent of the overall increase in the number of obese women.

Table 2: Obesity changes induced by changes in exposure to food imports from the U.S.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Period: | 1988-1999 | 1999-2006 | 2006-2012 | 1988-2012 |
| Implied changes in n. of obese women | 78 632 | 151 509 | 294 485 | 421 967 |
| - Divided by overall change in n. of obese women (at current pop., in %) | 2.04 | 4.03 | 14.70 | 4.39 |
| - Divided by overall change in n. of obese women (at pop. in start of period, in %) | 2.90 | 6.73 | 41.57 | 7.98 |

Notes: See the main text for a description of the estimation procedure. Food imports from the U.S. in billions of current US$. State female population data are in 1990 (1988), 2000 (1999), 2005 (2006), and 2010 (2012).

(c) Robustness checks and extensions

The baseline results show a robust and sizeable effect of exposure to U.S. foods on obesity rates in Mexico. In the following, we further investigate this finding by assessing the robustness of our results to alternative definitions of trade exposure, other BMI cutoffs, the role of American FDI and dropping specific states.

In Table 3 we experiment with different definitions of the trade exposure variable. Thus far we have focused on food imports from the U.S. as it is the main source of Mexican food imports (see Figure 2) and the forerunner in the obesity epidemic. In columns (1) and (2), we assess the influence of exposure to food imports coming from other countries than the U.S. (Rest of the World or RoW). While greater food imports from the RoW are associated with significantly higher obesity rates (column (1)), the estimated effect is lower than the one associated with food imports from the U.S.. The 56 million increase in food imports from the RoW observed on average across states between 1988 and 2012 would result in a 3 percentage point higher obesity prevalence (compared to the 5 percentage point OLS effect associated with food imports from the U.S.). Furthermore, this coefficient loses significance in a 'horse race' specification when we include food imports from the U.S. (and other state-level controls in column (2)). These results corroborate our focus on food imports from the U.S..

In columns (3) and (4), we single out food imports for final demand – and exclude imports for further industrial use that should not directly affect obesity. We use the Broad Economic Categories (BEC) classification for trade flows (matched with the more detailed SITC classification) to identify food products that are "mainly for household consumption" (BEC categories 112 and 122) and "other consumer goods" (BEC category 6). The matching between these BEC final demand categories and the SITC products is however not unique – some SITC products have multiple BEC categories –, and we thus take this exercise as a robustness test of the baseline results obtained using all SITC food products.[22] Using the revised food imports variable in columns (3) and (4) further strengthens the estimated

[22] SITC products are classified for final demand if more than half of the entries fall into the BEC categories for final use.

effect – the average increase in exposure to foods for final demand from the U.S. between 1988 and 2012 (133 millions) is associated with an additional 8 percentage points of obesity prevalence.

One possible concern with the baseline specification (1) is that the effect of food imports might capture the influence of overall exposure to imports from the U.S.. We thus regress obesity prevalence on apparel imports (computed applying the formula in equation (2) to data on apparel expenditure). This important tradable product should have no direct influence on diet and nutrition. The negative but imprecisely estimated coefficients in columns (5) and (6) suggest that, if anything, exposure to American apparel is correlated with lower obesity rates. Importantly, the coefficient on the $USimp$ variable remains positive and significant when controlling for this variable.

Columns (7) and (8) of Table 3 provide a final check on the relevant definition of trade exposure, assessing the influence of exposure to Mexican food exports to the U.S. as dictated by pre-determined expenditure specialization. We replace the import flow variable $M$ in equation 2 with export values to the U.S.. Mexican exports to the U.S. can correlate with Mexican imports from the U.S. in the presence of intra-product trade related, for instance, to export processing (*maquiladora*) food sector (Utar and Ruiz, 2013). Results however do not reveal any significant correlation between exposure to food exports and obesity prevalence, while exposure to food imports is consistently associated with higher obesity.[23]

The last two columns of Table 3 show results replacing obesity with overweight prevalence at the state-level. The OLS effect on overweight is considerably lower than the one on obesity (the 1988-2012 average increase in food imports from the U.S. is associated with 3.3 percentage-point higher overweight prevalence – or 10 percent of the observed rise during the same period), and vanishes in the IV specification (results not shown). The relevance of food imports to the obesity cutoff is confirmed in quantile regressions where BMI at the individual level is the dependent variable. Figure A2 in the Appendix shows that the coefficient rises with BMI and becomes statistically significant for BMI levels above the sample median, which is just above the overweight threshold of 25, and it is highest for levels that are above the obesity threshold of 30 (corresponding to BMI levels above the third quartile of the sample distribution).

Exposure to American FDI in the retail and food sector can confound the pro-obesity effect of food imports. While controlling for the stock of total FDI over GDP by state did not impact our baseline findings, this measure can miss the dynamics of the Mexican food retail

[23]Similar results are obtained if we use exposure to Mexican food exports to all countries rather than exports to the U.S. only.

sector. Walmart expanded into Mexico during our sample period and has become one of the biggest retailers in Latin America. This development can undermine the interpretation of our result, if Walmart expansion in Mexico is correlated with obesity prevalence (see Courtemanche and Carden (2011) for evidence on the pro-obesity effect of Walmart in the U.S.) and if states where Walmart expanded more aggressively also saw greater exposure to food import from the U.S.. We investigate this using data on the number of Walmart stores by Mexican state as of 2007 from Iacovone et al. (2015). Since Walmart entered the Mexican market in the early 90's and developed mainly in the 2000's (Atkin et al., 2018), the stock of Walmart stores in 2007 (per thousands of people) equates to the change in Walmart presence since the beginning of our sample in 1988. Panel (a) of Figure A3 in the Appendix plots the 1988-2006 changes in obesity prevalence against the Walmart measure by state. While purely suggestive, the regression line is negatively sloped, indicating that, if anything, obesity prevalence has increased less rapidly in Mexican states that received more Walmart stores. Panel (b) displays the percent change in food imports from the U.S. on the vertical axis. The positive but insignificant regression coefficient suggests a rather weak relationship between Walmart presence and penetration of U.S. foods. Overall, the increasing penetration of Walmart in Mexico does not seem to be driving the baseline pro-obesity effect of exposure to U.S. foods.

Finally, we check the robustness of our results to the exclusion of individual Mexican states. In Figure A4, we plot the coefficient on the $USimp$ variable from our baseline specification (column (5) of Table 1) dropping one of the 32 states state at a time. The estimated coefficients are close to the one obtained with the full sample and are always significantly larger than zero, indicating that the main findings are not entirely driven by the influence of single states.

Table 3: Food imports from the U.S. and obesity prevalence – Robustness checks

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Imports from RoW | | Final use imports | | Apparel imports | | Mex. exports | | Dep. var.: Overw. | |
| U.S. food imports | | 0.230*** | 0.604*** | 0.622*** | | 0.241** | | 0.267*** | 0.183** | 0.174** |
| | | (0.0729) | (0.124) | (0.107) | | (0.0927) | | (0.0537) | (0.0844) | (0.0843) |
| RoW food imports | 0.414* | 0.341 | | | | | | | | |
| | (0.211) | (0.296) | | | | | | | | |
| Apparel imports | | | | | -0.199 | -0.0691 | | | | |
| | | | | | (0.122) | (0.178) | | | | |
| Mex. food exports to U.S. | | | | | | | -0.0283 | 0.0438 | | |
| | | | | | | | (0.158) | (0.253) | | |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.964 | 0.972 | 0.971 | 0.973 | 0.965 | 0.972 | 0.962 | 0.971 | 0.975 | 0.976 |

Notes: Trade variables are in billions of current US$. All regressions include state dummies, state-specific linear trends, and year dummies. Even-numbered columns include state-level controls in column (5) of Table 1. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Columns (3) and (4) use trade data only on food products classified for final consumption according to the BEC classification. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

## 4.3 The role of unhealthy food imports

(a) Unhealthy imports and obesity prevalence

Our baseline results are robust to controlling for total food expenditure, suggesting a specific obesity-bias in the basket of foods imported from the U.S.. The descriptive evidence in Figures 3 and 4 underlines that U.S. food exports to Mexico have increasingly been specialised in unhealthy and possibly more obesity-prone foods. In this subsection, we investigate this presumption more formally and assess the relationship between obesity prevalence and imports of unhealthy foods from the U.S. with empirical specification (3). We distinguish between healthy and unhealthy foods by applying the USDA classification to our sample of foods (see section 3 and Table A1). Table 4 reports these results.

First consider columns (1) and (2), where we split the total food imports variable $USimp$ into its unhealthy and healthy components. The coefficient associated with the level of unhealthy imports from the U.S. is positive and significant even after controlling for the unhealthy composition of household food expenditure and for the relative price of unhealthy foods. While the coefficient on healthy imports is positive – proposing that also 'healthy' calories are correlated with higher weight – it is imprecisely estimated.

The other columns of Table 4 show the estimates of the unhealthy share specification (3). This share variable allows us to examine the role of unhealthy imports given total imputed food imports (the $USimp$ variable). The OLS estimates in column (3) and (4) show a positive and significant association between unhealthy imports and obesity prevalence.

The unhealthy expenditure and price variables come with the expected signs but are poorly estimated, which we attribute to little variation around the state-specific time trends. In particular, price effects might well be present at a much finer product level than what is available in the household expenditure surveys. Furthermore, the unit values that are reported in the expenditure surveys can incorporate quality effects (see also Faber, 2014), which have ambiguous implications for nutrition and obesity.

Column (5) and (6) report the results of our IV strategy, where residuals from a gravity regression of the (log) difference between U.S. and Mexico food exports on product and destination fixed effects are used as instrument for the unhealthy share of food imports from the U.S.. The first-stage results reveal a strong and positive link between the supply-side determinants of (overall) U.S. food exports and the unhealthy share, advancing the idea that U.S. exporters gained comparative advantage and expanded market access especially in unhealthy foods. The causal effect of the instrumented unhealthy share of imports on obesity prevalence is positive and larger than the OLS counterpart. The estimates imply that exposure to the exogenous component of the 1988-2012 increase in the average unhealthy share of imports across states (6 percentage points, marked down by a partial $R^2$ of 0.16) leads to a 0.4 percentage point increase in obesity prevalence. This pro-obesity effect is however not comparable to the one associated with total imports, which enter the unhealthy share variable in the denominator and push up obesity prevalence as shown in our baseline analysis. A more direct comparison is obtained by estimating a specification similar to the one in column (2) of Table 4, but without the healthy import variable and instrumenting the level of unhealthy imports with the gravity residuals. The results (available upon request) show that unhealthy foods drive the pro-obesity impact of exposure to food imports from the U.S.. The supply-driven rise in average exposure to U.S. unhealthy foods across states between 1988 and 2012 is responsible for the 'same' additional percentage point of average obesity prevalence that we found for the rise of *total* food imports. On the contrary, IV estimations using the healthy component of exposure delivers insignificant results and much smaller effects.

Table 4: Unhealthy imports and obesity prevalence

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | OLS | | | | IV | |
| U.S. Unhealthy imports | 0.308** | 0.312** | | | | |
| | (0.148) | (0.120) | | | | |
| U.S. Healthy imports | 0.210 | 0.173 | | | | |
| | (0.264) | (0.222) | | | | |
| U.S. unhealthy share of imports | | | 0.320* | 0.297* | 0.535** | 0.438* |
| | | | (0.175) | (0.171) | (0.233) | (0.228) |
| Unhealthy share of expenditure | | 0.160 | | 0.183 | | 0.137 |
| | | (0.233) | | (0.239) | | (0.276) |
| Ln(relative price of unhealthy foods) | | -0.0305 | | -0.0384 | | -0.0354 |
| | | (0.0503) | | (0.0612) | | (0.0673) |
| Ln(GDP per capita) | | 0.00322 | | -0.0132 | | -0.0229 |
| | | (0.0484) | | (0.0519) | | (0.0447) |
| FDI/GDP | | 0.226 | | 0.0889 | | 0.0492 |
| | | (0.242) | | (0.240) | | (0.262) |
| Migrant share | | 0.174 | | 0.275 | | 0.157 |
| | | (0.992) | | (0.991) | | (1.067) |
| *First-stage results – Excluded instrument based on:* | | | | | | |
| U.S. - Mex. food exports | | | | | 0.0047*** | 0.0060*** |
| | | | | | (0.0016) | (0.0014) |
| F-stat excluded instr. | | | | | 8.69 | 18.64 |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.970 | 0.971 | 0.967 | 0.968 | | |

Notes: All regressions include state dummies, state-specific linear trends, and year dummies. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

We successfully submit these findings to the same battery of checks adopted for the baseline analysis.[24] In addition, the effect of unhealthy food imports from the U.S. is not sensitive to the specific classification of foods. This is shown in Table A7, where we restrict the healthy category to vegetables, fruits, fish and poultry only (see Table A1).

(b) Household demand for unhealthy foods

The evidence thus far indicates that state-level GDP per capita and aggregate food prices do not influence obesity nor the pro-obesity effect of U.S. food imports. Such aggregate measures might not be ideal in capturing demand adjustments and other mechanisms like shifts in tastes may explain our findings. To further disentangle these demand-based mechanisms, we adapt the approach of Atkin (2013) and estimate the association between exposure to foods from the U.S. and household demand.

Using data from expenditure surveys between 1989 and 2012, we regress household expenditure shares on states' import shares controlling for local prices, household real expenditure and other household characteristics. After controlling for these factors, Atkin (2013) attributes any residual variation in household budget shares to differences in tastes across geographical areas. Likewise, we investigate whether any correlation between import shares and household expenditure shares is absorbed by the effects of prices, real household expenditure, other socioeconomic characteristics, and we interpret residual variation as changes in tastes. The demand specification stems from the linear approximation of the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) and takes the following form:[25]

$$(4) \quad bshare_{c,h,t} = \beta_{1,c} Impsh_{c,s,t} + \sum_{c'} \beta_{c,c'} \ln p_{c',m,t} + \beta_{2,c} \ln \frac{food_{h,t}}{P^*_{m,t}} + \Pi_c Z_{h,t} + \gamma_{c,s} + \lambda_{s,t} + \epsilon_{c,h,t}$$

The variable *bshare* denotes the share of household $h$'s expenditure on food group $c$ – that is, USDA healthy, unhealthy and the excluded category 'other' foods (see footnote

[24] Table A6 in the Appendix broadly confirms the positive association between unhealthy of imports from the U.S. and obesity prevalence, and qualifies the evidence from the robustness tests on total food imports. The insignificant coefficient on the unhealthy share of imports from the RoW (see columns (1) and (2)), for instance, supports our focus on American foods. The coefficient on the unhealthy share of imports remains positive and of similar size but loses significance when controlling for imputed imports of apparel. It is also less precisely estimated in predicting overweight prevalence, which underscores its specific importance in the upper portion of the BMI distribution.

[25] Huffman and Rizov (2010) apply a similar demand specification to assess the relationship between lifestyle, nutrition and obesity in Russia, while Dharmasena and Capps (2012) adopt a quadratic AIDS to study the obesity-reducing effect of a proposed tax on sugar-sweetened beverages in the U.S..

n.12).[26,27] Unit values from the expenditure surveys are used to compute local prices as median prices at the *municipio* level (subscript $m$ in (4), the smallest geographical unit recorded in the expenditure surveys) in order to attenuate endogeneity concerns (see also Atkin (2013)). Assuming weak separability between food consumption and consumption of other goods, we can use household food expenditure (the $food$ variable) instead of total household expenditure. A Stone price index, $\ln P^{*}_{m,t} = \sum_c \overline{bshare}_{c,s,t} \ln p_{c,m,t}$, makes the AIDS linear. We also control for household characteristics $Z$,[28] and allow their effect to vary across food groups. We follow the empirical specification of the obesity regression (1) and include state-food group ($\gamma_{c,s}$) and state-year ($\lambda_{s,t}$) fixed effects.[29]

Table 5 reports these demand estimations. The sign and significance of the $\beta_1$ coefficients in regression (4) provide an indication of how expenditure patterns in healthy and unhealthy foods relate to imports from the U.S. (relative to other foods). Our focus is on the difference $\beta_{1,unh} - \beta_{1,h}$ as it shows whether the correlation between household expenditures patterns and exposure to U.S. foods is stronger for unhealthy than for healthy foods. Going from column (1) to column (4) of Table 5, we add local prices, total food expenditure and other household characteristics to the regression equation.

The results are consistent with food consumption shifting towards less healthy foods, thus increasing obesity rates, in states with greater exposure to food imports from the U.S. The positive and significant difference between $\beta_{1,unh}$ and $\beta_{1,h}$ suggests that households spend a higher share of their food expenditure on unhealthy foods (relative to healthy ones) as their state's exposure to American foods increases. Importantly, price and real income adjustments do not drive this positive association.

Taken together, these results support the evidence from the baseline obesity regressions suggesting that price and income adjustments do not explain the pro-obesity effect of exposure to food imports. As in Atkin (2013), differences in tastes constitute a plausible source of residual variation in expenditure shares across states (and over time). Our findings

[26]The expenditure data for each survey are available at the individual level and, starting from the 1994 wave, they report the place of purchase (e.g., market, stores). Individual identifiers are however often missing. We thus perform the analysis at the household level and compute prices as weighted averages across individuals and places of purchase. We further aggregate prices across food categories using household expenditure shares as weights.

[27]We pool the household budget share data for the three food groups and estimate (4) by interacting each explanatory variable with food group indicators. The level effect of these indicators is absorbed by state-group dummies $\gamma_{c,s}$.

[28]Namely, age (and its square term), sex, occupation, education and sector of employment of the household head, as well as for household size (and its square term) and composition

[29]We use household survey weights and cluster standard errors at the state-year level because of the high number of parameters to be estimated with household controls (column (4)). The statistical significance of the reported coefficients does not change if we cluster standard errors at the state level instead

may bolster the idea that households living in states that became more exposed to food imports developed also stronger preferences for unhealthy foods (for given changes in prices and income). This shift in preferences towards unhealthy foods might well be behind the documented pro-obesity effect of food imports from the U.S..[30]

Table 5: Demand for healthy and unhealthy foods and imports

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $\beta_{1,unh} - \beta_{1,h}$ | 0.763* | 0.780* | 0.805* | 0.812* |
| | (0.450) | (0.455) | (0.442) | (0.434) |
| $\beta_{1,unh}$ | 0.322 | 0.321 | 0.326 | 0.328 |
| | (0.225) | (0.226) | (0.220) | (0.216) |
| $\beta_{1,h}$ | -0.441* | -0.458** | -0.479** | -0.484** |
| | (0.228) | (0.232) | (0.226) | (0.221) |
| Obs | 422,347 | 422,347 | 422,347 | 422,347 |
| $R^2$ | 0.105 | 0.107 | 0.120 | 0.173 |

Notes: All regressions include food-state and state-year fixed effects. Socioeconomic controls for the household head include age, age squared, and dummies for education and occupation (i.e. whether employed, employed with a salary, or entrepreneur). Controls for household composition include household size, household size squared, the number of kids, the number of females, and the number of adults older than 65. Household survey weights are used. Standard errors clustered at the state-year level are in parenthesis. Significant at: *10%, **5%, ***1% level.

## 4.4 Effects of food imports on inequalities in obesity prevalence

Local food environments and in our case exposure to U.S. foods can interact with socioeconomic determinants of obesity and thus exacerbate health inequalities (Handbury et al., 2017; Cawley, 2015). In this final part of our empirical analysis, we estimate a specification at the individual level where the outcome variable is an obesity dummy and investigate how the average effects of our import variables ($USimp$ and $Unhealthyimp$) vary with education, a key indicator of socioeconomic status. In particular, we compare women who have completed secondary or tertiary education ('high education') with those having at most primary education ('low education'). Individual and household characteristics such as age, work status and wealth from the health surveys (see section 3) are included as covariates. We absorb 'level' effects of state covariates by including state-year fixed effects.

[30]Preferences for U.S. foods might be correlated with preferences for physical activities – both affect obesity (see Bleich et al. (2008) for evidence on their relative importance). To explore this additional interpretation of our main findings, we regress an indicator for weekly physical activity at the individual level, available only in 2006 and 2012, on total food imports and on the unhealthy share of imports, controlling for individual and other state-level characteristics, state and year dummies. We find no significant effect of exposure to total food imports and a positive (albeit weak) effect of unhealthy food imports on the likelihood of being physically active, suggesting that the taste channel is mainly operating through food consumption.

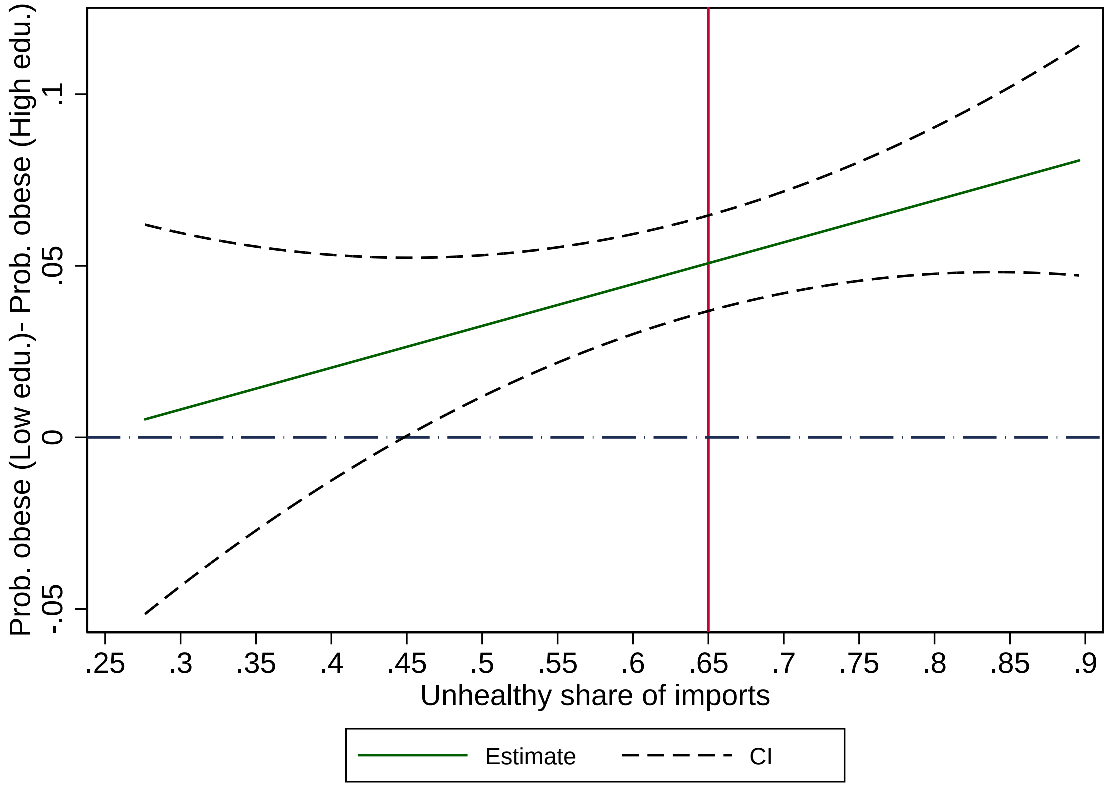
Exposure to total imports (column (1) of Table A8 in the Appendix) does not substantially magnify the existing schooling gradient (of about 5 percentage points) in obesity risk. The interaction effect associated with the high education indicator is small and insignificant. Conversely, the unhealthy component of U.S. food imports interacts significantly with education (column (2)). To better gauge the importance of this interaction effect consider Figure 5 where we plot the difference in the probability of being obese between women with low and high education against the unhealthy share of imports. The results imply that a highly educated woman is 5 percentage points less likely to be obese than a low educated one if they both live in a state with average exposure to unhealthy foods from the U.S. (0.65). If the unhealthy share of imports increases to the highest observed level (0.9), the gap grows by a further 3 percentage points. In states with exposure to unhealthy imports below the first decile, the difference in obesity risk between women from different education groups becomes insignificant.

Additional models in the rest of Table A8 show some statistically significant, but quantitatively weak,[31] heterogeneity in the effect of total food imports with respect to household income. Moreover, controlling for this socioeconomic aspect does not alter substantially the role of unhealthy food imports in shaping the education gradient in obesity risk.

The empirical patterns point to a significant but perhaps moderately sized interaction between exposure to unhealthy food imports and education in predicting the risk of being obese. The results are consistent with the well-known link between education and health: educated individuals may obtain a larger marginal return from any investment in health capital ("productive efficiency", Grossman, 1972; Michael and Becker, 1973; Fuchs, 1982 ) and may be more efficient at selecting inputs into health investment ("allocative efficiency", Rosenzweig and Schultz, 1983). This educational gradient may magnify in food environments where individuals are faced with more unhealthy food choices (Handbury et al., 2017; Mani et al., 2013; Mullainathan, 2011; Dupas, 2011). In our setting, highly educated women in Mexico may be better at assessing the nutritional content of or avoiding some imported foods.

[31] The negative coefficient on the interaction between the $USimp$ variable and the rich household dummy (i.e., women living in the top 20% of the household income distribution) suggests that rich women are less likely to become obese than poor women when exposed to more foods from the U.S.. Yet, rich women remain significantly more likely (up to 3 percentage points – see the coefficient on the $Highincome$ dummy) to be obese than women in poorest households for values of U.S. foods imports below 60 millions US$ (60th percentile of the $USimp$ distribution).

Figure 5: Inequality between education groups in obesity risk and unhealthy food imports




Notes: Vertical line indicates the sample average of the unhealthy share of imports. Estimates from column (2) of Table A8 are used to generate the graph.

# 5 Concluding remarks

A handful but growing set of studies has documented the adverse effects of trade liberalisation on health through income and labour market channels (Colantone et al., 2018; Adda and Fawaz, 2017; Pierce and Schott, 2017; Hummels et al., 2016; Lang et al., 2016; McManus and Schaur, 2016). We contribute to this literature by providing novel evidence on the effects of trade in foods on obesity in the case of Mexico.

Combining household survey and trade data, we assess the impact of greater exposure to American food exports on the risk of being obese across Mexican states. Our results advance the idea that the U.S. has exported some of its obesity epidemic to Mexico. Our causal estimates suggests that the plausibly exogenous part of the variation in U.S. food exports to Mexico explains four percent of the total rise in obesity prevalence among Mexican women observed between 1988 and 2012. This effect amounts to 422,000 additional obese women over the period. The magnitudes are comparable to the obesity effects found in other studies examining the role of changes in the food environment in different contexts (Courtemanche and Carden, 2011). Our results are driven by the imports of unhealthy U.S. foods and we document that exposure to these is associated with demand changes induced by shifts in preferences, rather than through price and income changes. Furthermore, evidence points to a magnifying effect of unhealthy food imports when it comes to existing inequalities in obesity rates across education groups.

These findings imply a significant and sizeable contribution of U.S. food exports to the ongoing nutrition transition and associated spread of the obesity epidemic in Mexico. Like other emerging economies, the country would have attained high levels of obesity prevalence even without increasing exposure to U.S. (unhealthy) foods. Our empirical analysis – which controls for upward linear trends in obesity prevalence across Mexican states – shows that the rising penetration of U.S. food exports has moved Mexican consumers on a steeper obesity trajectory.

The documented pro-obesity effects support the idea that health concerns should matter for the determination of trade policies, especially when it comes to unhealthy food products. Our paper accords well with anecdotal evidence of a positive link between trade and investment liberalisation and the observed rise in obesity in Mexico (Jacobs and Richtel, 2017; Clark et al., 2012). As the UN Special Rapporteur on the Right to Food stated in 2012, the widespread belief is that at least part of the obesity emergency could have been avoided if "the health concerns linked to shifting diets had been integrated into the design of the country's trade policies" (Guardian, 2015).

That said, future work should investigate further the health consequences of trade liberalisation in the food sector. Our findings suggest the existence of negative health externalities associated with trade integration, especially when trading partners have a comparative advantage in unhealthy foods. Yet, it remains unclear how these health externalities measure up to the much heralded consumers' welfare gains from trade due to access to new and less expensive varieties. More quantitative work in this area is needed to fully assess the combined health and welfare implications of trade liberalisation.

# References


Acemoglu, D., Autor, D., Dorn, D., Hanson, G.H., Price, B., 2016. Import Competition and the Great US Employment Sag of the 2000s. Journal of Labor Economics 34(S1), 141–198.

Adda, J., Fawaz, Y., 2017. The Health Toll of Import Competition. Technical Report. Mimeo.

Atkin, D., 2013. Trade, tastes, and nutrition in India. American Economic Review 103(5), 1629–1663.

Atkin, D., Donaldson, D., 2015. Who's Getting Globalized? The Size and Implications of Intra-national Trade Costs. Technical Report 21439. National Bureau of Economic Research.

Atkin, D., Faber, B., Gonzalez-Navarro, M., 2018. Retail globalization and household welfare: Evidence from mexico. Journal of Political Economy 126(1), 1–73.

Autor, D.H., Dorn, D., Hanson, G.H., 2013. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. American Economic Review 103(6), 2121–68.

Barlow, P., McKee, M., Basu, S., Stuckler, D., 2017a. The health impact of trade and investment agreements: a quantitative systematic review and network co-citation analysis. Globalization and Health 13(1), 13.

Barlow, P., McKee, M., Basu, S., Stuckler, D., 2017b. Impact of the North American Free Trade Agreement on high-fructose corn syrup supply in Canada: a natural experiment using synthetic control methods. Canadian Medical Association Journal 189(26), 881–887.

Barlow, P., McKee, M., Stuckler, D., 2018. The impact of u.s. free trade agreements on calorie availability and obesity: A natural experiment in canada. American Journal of Preventive Medicine 54(5), 637 – 643.

Bleich, S.N., Cutler, D., Murray, C., Adams, A., 2008. Why Is the Developed World Obese? Annual Review of Public Health 29(1), 273–295.

Caliendo, L., Parro, F., 2015. Estimates of the Trade and Welfare Effects of NAFTA. The Review of Economic Studies 82(1), 1–44.

Cawley, J., 2015. An economy of scales: A selective review of obesity's economic causes, consequences, and solutions. Journal of Health Economics 43, 244–268.

Clark, S.E., Hawkes, C., Murphy, S.M., Hansen-Kuhn, K.A., Wallinga, D., 2012. Exporting obesity: US farm and trade policy and the transformation of the Mexican consumer food environment. International Journal of Occupational and Environmental Health 18(1), 53–64.

Colantone, I., Crinò, R., Ogliari, L., 2018. Globalization and Mental Distress. Technical Report. mimeo.

Costa-Font, J., Mas, N., 2016. 'Globesity'? The effects of globalization on obesity and caloric intake. Food Policy 64, 121 – 132.

Courtemanche, C., Carden, A., 2011. Supersizing supercenters? The impact of Walmart Supercenters on body mass index and obesity. Journal of Urban Economics 69(2), 165–181.

Courtemanche, C.J., Pinkston, J.C., Ruhm, C.J., Wehby, G.L., 2016. Can Changing Economic Factors Explain the Rise in Obesity? Southern Economic Journal .

Cravino, J., Levchenko, A.A., 2017. The Distributional Consequences of Large Devaluations. American Economic Review (648), 3477 – 3509.

Currie, J., DellaVigna, S., Moretti, E., Pathania, V., 2010. The effect of fast food restaurants on obesity and weight gain. American Economic Journal: Economic Policy 2(3), 32–63.

Deaton, A., Muellbauer, J., 1980. An almost ideal demand system. American Economic Review 70(3), 312–326.

DGA, 2010. USDA Dietary Guidelines for Americans. Technical Report. Available at: https://health.gov/dietaryguidelines/dga2010/DietaryGuidelines2010.pdf.

Dharmasena, S., Capps, O., 2012. Intended and unintended consequences of a proposed national tax on sugar-sweetened beverages to combat the U.S. obesity problem. Health Economics 21(6), 669–694.

Dix-Carneiro, R., Kovak, B.K., 2017. Trade Liberalization and Regional Dynamics. American Economic Review 107(10), 2908–46.

Dragone, D., Ziebarth, N.R., 2017. Economic Development, Novelty Consumption, and Body Weight: Evidence from the East German Transition to Capitalism. Journal of Health Economics (51), 41–65.

Dupas, P., 2011. Health behavior in developing countries. Annu. Rev. Econ. 3(1), 425–449.

Faber, B., 2014. Trade Liberalization, the Price of Quality, and Inequality: Evidence from Mexican Store Prices. Technical Report. UC Berkeley.

Filmer, D., Pritchett, L.H., 2001. Estimating Wealth Effects without Expenditure Data-or Tears: An Application to Educational Enrollments in States of India. Demography 38(1), 115–132.

Fuchs, V.R., 1982. Time Preferences and Health: An Exploratory Study. University of Chicago Press.

Grossman, M., 1972. On the concept of health capital and the demand for health. Journal of Political Economy 80(2), 223–255.

Guardian, 2015. The Global South has free trade to thank for its obesity and diabetes epidemic. Technical Report. Article by Ramon Vera Herrera, Monday 6th April 2015.

Handbury, J., Rahkovsky, I., Schnell, M., 2017. Is the focus on food deserts fruitless? Retail access and food purchases across the socioeconomic spectrum. Technical Report. Working Paper.

Hanson, G.H., 2007. Globalization, Labor Income, and Poverty in Mexico, in: Globalization and Poverty. National Bureau of Economic Research, Inc. NBER Chapters, pp. 417–456.

Hanson, G.H., 2010. Why Isn't Mexico Rich? Journal of Economic Literature 48(4), 987–1004.

Huffman, S.K., Rizov, M., 2010. The Rise of Obesity in Transition: Theory and Empirical Evidence from Russia. The Journal of Development Studies 46(3), 574–594.

Hummels, D., Munch, J., Xiang, C., 2016. No Pain, No Gain: The Effects of Exports on Effort, Injury, and Illness. Technical Report 22365. National Bureau of Economic Research.

Hut, S., Oster, E., 2018. Diabetes and diet: Purchasing behavior change in response to health. Technical Report. Working Paper.

Iacovone, L., Javorcik, B., Keller, W., Tybout, J., 2015. Supplier responses to Walmart's invasion in Mexico. Journal of International Economics 95(1), 1–15.

Jacobs, A., Richtel, M., 2017. A nasty, nafta-related surprise: Mexico's soaring obesity. The New York Times .

Keats, S., Wiggins, S., 2014. Future diets: Implications for agriculture and food prices. Technical Report. Overseas Development Institute (ODI).

Lang, M., McManus, C., Schaur, G., 2016. The Effects of Import Competition on Health in the Local Economy. Technical Report. Mimeo.

Lopez, A.M., Loopstra, R., McKee, M., Stuckler, D., 2017. Is trade liberalisation a vector for the spread of sugar-sweetened beverages? A cross-national longitudinal analysis of 44 low- and middle-income countries. Social Science and Medicine 172, 21 – 27.

Mani, A., Mullainathan, S., Shafir, E., Zhao, J., 2013. Poverty impedes cognitive function. Science 341(6149), 976–980.

McManus, T.C., Schaur, G., 2016. The effects of import competition on worker health. Journal of International Economics 102, 160 – 172.

Mendez, O., 2015. The effect of chinese import competition on mexican local labor markets. The North American Journal of Economics and Finance 34(Suppl. C), 364 – 380.

Michael, R.T., Becker, G.S., 1973. On the new theory of consumer behavior. The Swedish Journal of Economics pp. 378–396.

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

Mullainathan, S., 2011. The psychology of poverty. Focus 28(1), 19–22.

Ng, M., et al., 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the global burden of disease study 2013. The Lancet 384(9945), 766 – 781.

Oberlander, L., Disdier, A.C., Etilé, F., 2017. Globalisation and national trends in nutrition and health: A grouped fixed-effects approach to intercountry heterogeneity. Health Economics 0, 1–16.

OECD, 2017. Obesity Update 2017. Technical Report. Organisation for Economic Cooperation and Development (OECD).

Omran, A.R., 1971. The epidemiologic transition: a theory of the epidemiology of population change. The Milbank Memorial Fund Quarterly 49(4), 509–538.

Oster, E., 2017a. Changes in Household Diet: Determinants and Predictability. Technical Report. American Economic Journal: Applied Economics (Forthcoming).

Oster, E., 2017b. Unobservable selection and coefficient stability: Theory and evidence. Journal of Business & Economic Statistics pp. 1–18.

Parente, P., Santos-Silva, J., 2016. Quantile Regression with Clustered Data. Journal of Econometric Methods 5(1), 1–15.

Pierce, J.R., Schott, P.K., 2017. Trade Liberalization and Mortality: Evidence from U.S. Counties. Technical Report 22849. National Bureau of Economic Research.

Popkin, B.M., Adair, L.S., Ng, S.W., 2012. Global nutrition transition and the pandemic of obesity in developing countries. Nutrition Reviews 70(1), 3–21.

Popkin, B.M., Gordon-Larsen, P., 2004. The nutrition transition: worldwide obesity dynamics and their determinants. International Journal of Obesity 28, S2–S9.

Rivera, J.A., Barquera, S., Gonzalez-Cossio, T., Olaiz, G., Sepulveda, J., 2004. Nutrition transition in Mexico and in other Latin American countries. Nutrition Reviews 62(suppl 2), S149–S157.

Rosenzweig, M.R., Schultz, T.P., 1983. Estimating a household production function: Heterogeneity, the demand for health inputs, and their effects on birth weight. Journal of Political Economy 91(5), 723–746.

Rtveladze, K., Marsh, T., Barquera, S., Romero, L.M.S., Levy, D., Melendez, G., Webber, L., Kilpi, F., McPherson, K., Brown, M., 2014. Obesity prevalence in mexico: impact on health and economic burden. Public Health Nutrition 17(1), 233–239.

Rutstein, O.S., Johnson, K., 2004. The DHS Wealth Index. Technical Report DHS Comparative Reports n. 6. ORC Macro.

Schram, A., Labonte, R., Baker, P., Friel, S., Reeves, A., Stuckler, D., 2015. The role of trade and investment liberalization in the sugar-sweetened carbonated beverages market: a natural experiment contrasting Vietnam and the Philippines. Globalization and Health 11(1), 41.

Thow, A.M., 2009. Trade liberalisation and the nutrition transition: mapping the pathways for public health nutritionists. Public Health Nutrition 12(11), 2150–2158.

Utar, H., Ruiz, L.B.T., 2013. International competition and industrial evolution: Evidence from the impact of chinese competition on mexican maquiladoras. Journal of Development Economics 105(Supplement C), 267 – 287.

Verhoogen, E.A., 2008. Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector. The Quarterly Journal of Economics 123(2), 489–530.

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

Volpe, R., Okrent, A., Leibtag, E., 2013. The Effect of Supercenter-format Stores on the Healthfulness of Consumers' Grocery Purchases. American Journal of Agricultural Economics 95(3), 568–589.

WHO, 2015. Trade and Health: Towards building a national strategy. Technical Report eds. R. Smith, C. Blouin, Z. Mirza, P. Beyer and N. Drager.. World Health Organization.

# Appendix

Figure A1: Changes in imputed food imports from the U.S. between 1988 and 2012 (relative to 1988)

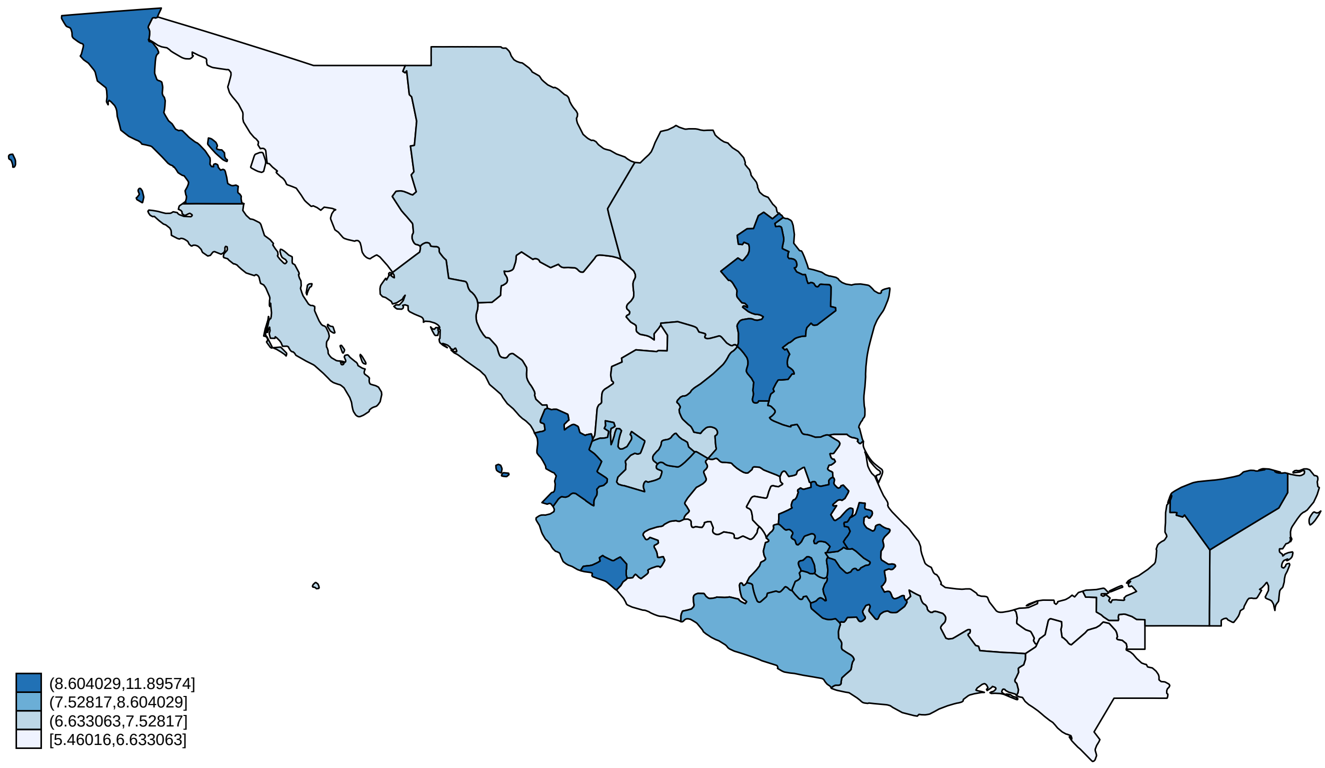
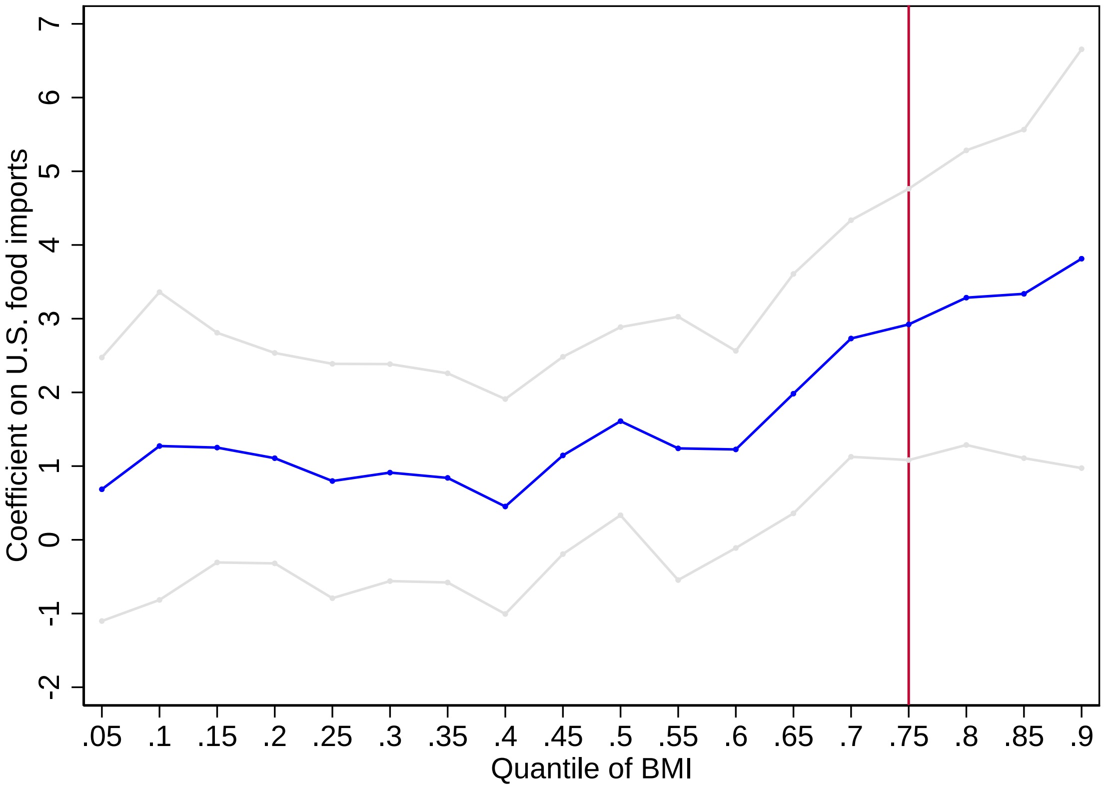


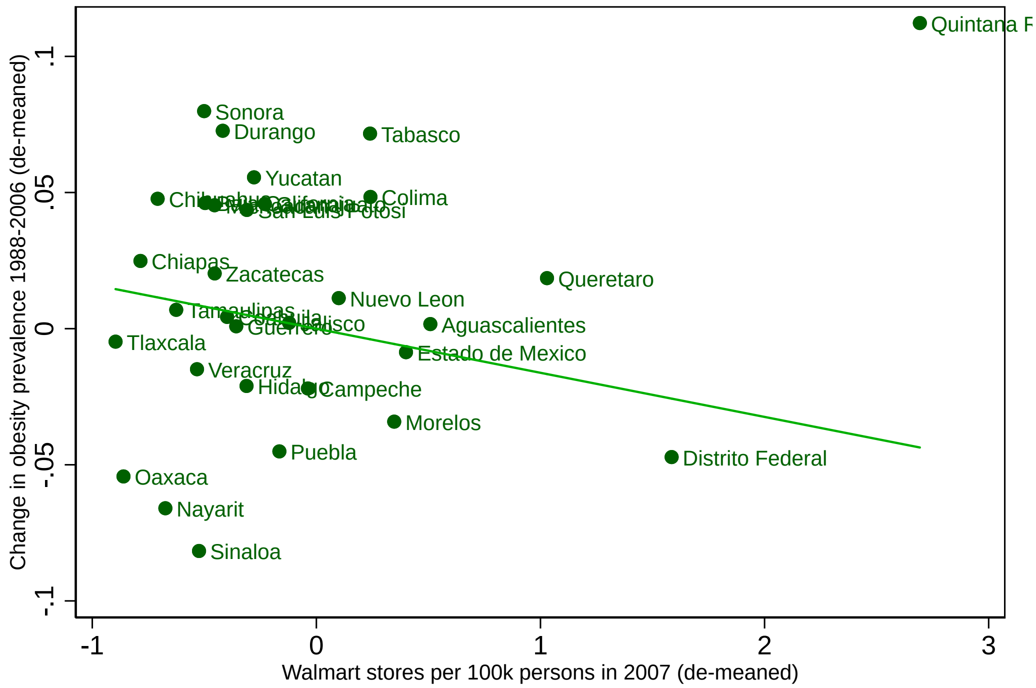
Figure A2: Quantile BMI regressions




Notes: Each dot gives the estimated coefficient (with 90% confidence interval in grey) on the $USimp$ variable in a quantile regression at the individual level, where the horizontal axis shows the corresponding quantile of BMI. The specification includes individual and household controls, state-level covariates, state fixed effects, state-specific linear trends and time dummies. Vertical line indicates BMI=30 – when BMI¿30 the woman is classified as obese. Confidence intervals computed using standard errors clustered at the state level (Parente and Santos-Silva, 2016).

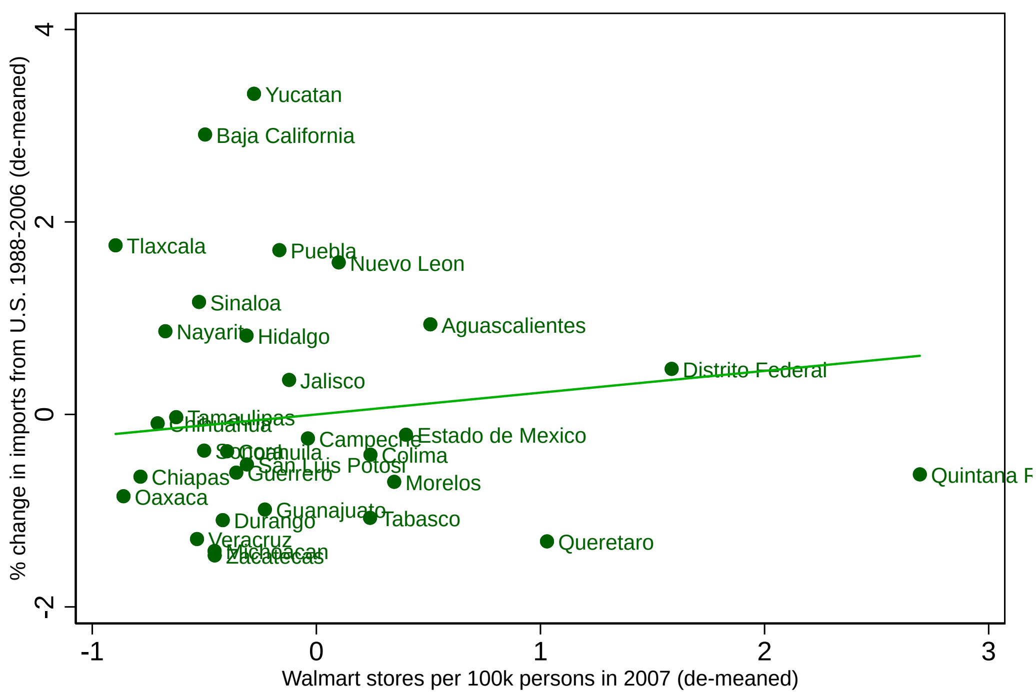
Figure A3: Walmart, obesity and food imports

Panel (a): Relationship between obesity prevalence and Walmart expansion



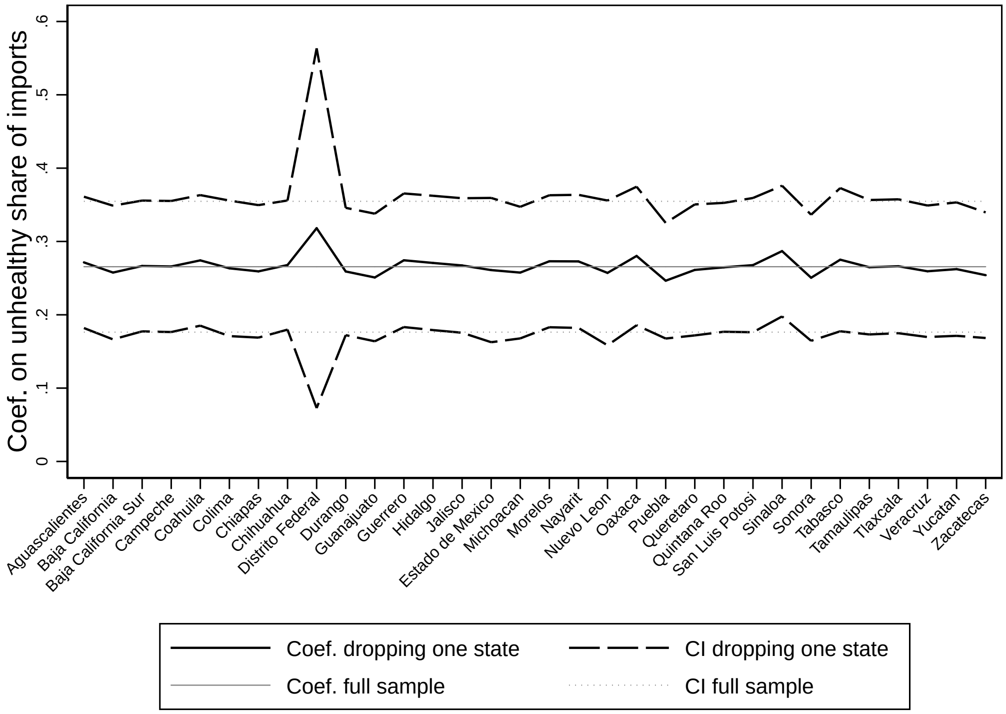

coef = -.0162, (robust) se = .0109, t = -1.49

Panel (b): Relationship between U.S. food imports and Walmart expansion




coef = .2262, (robust) se = .1649, t = 1.37

Figure A4: Unhealthy share of imports and obesity – Excluding one state at a time



## Table A1: List of Food and Beverages products

| Product | QFAHPD category | Healthy (USDA) | Healthy (Vegs+) |
|---|---|---|---|
| Pineapple | 1 | 1 | 1 |
| Apple | 1 | 1 | 1 |
| Lemon | 1 | 1 | 1 |
| Strawberry | 1 | 1 | 1 |
| Grape | 1 | 1 | 1 |
| Avocado | 1 | 1 | 1 |
| Peach and apricot | 1 | 1 | 1 |
| Tabascan banana | 1 | 1 | 1 |
| Orange | 1 | 1 | 1 |
| Mammee apple | 1 | 1 | 1 |
| Pear | 1 | 1 | 1 |
| Watermelon | 1 | 1 | 1 |
| Mango | 1 | 1 | 1 |
| Other citrus fruits: lime, grapefruit | 1 | 1 | 1 |
| Melon | 1 | 1 | 1 |
| Other: soursop, fig, coconut, tamarind | 1 | 1 | 1 |
| Papaya | 1 | 1 | 1 |
| Guava | 1 | 1 | 1 |
| Boxed juices | 3 | 1 | 0 |
| Cucumber | 4 | 1 | 1 |
| Coriander | 4 | 1 | 1 |
| Parsley | 4 | 1 | 1 |
| Mixed bagged vegetables | 4 | 1 | 1 |
| Cabbage | 4 | 1 | 1 |
| Lettuce | 4 | 1 | 1 |
| Courgette | 4 | 1 | 1 |
| Epazote, celery, papalo | 4 | 1 | 1 |
| Spinach, algae | 4 | 1 | 1 |
| Carrot | 6 | 1 | 1 |
| Sweetcorn | 8 | 1 | 1 |
| Corn | 8 | 1 | 0 |
| Potato | 8 | 1 | 0 |
| Other: yam, sweet potato, beetroot | 8 | 1 | 1 |
| Other bananas: plantain etc. | 8 | 1 | 1 |
| Pea | 8 | 1 | 1 |
| Nixtamal (boiled maize/corn) and others | 9 | 1 | 0 |
| Nopales | 10 | 1 | 1 |
| Serrano pepper and jalapeno | 10 | 1 | 1 |
| Dried and powdered chillis | 11 | 1 | 1 |
| Pepper | 12 | 1 | 1 |
| Green tomato | 12 | 1 | 1 |
| Red tomato | 12 | 1 | 1 |
| Garlic | 14 | 1 | 1 |
| Bean | 14 | 1 | 1 |
| Chickpea | 14 | 1 | 1 |
| Other: lentil, broad bean | 14 | 1 | 1 |
| Green bean | 14 | 1 | 1 |
| Onion | 14 | 1 | 1 |
| Chayote | 14 | 1 | 1 |
| Other: artichoke, radishes | 14 | 1 | 1 |
| Bean (tinned or boxed) | 15 | 1 | 1 |
| Grains of rice | 16 | 1 | 0 |
| Corn tortilla | 16 | 1 | 0 |
| Oats | 16 | 1 | 0 |
| Other cereals: barley, rye | 16 | 1 | 0 |
| Wheat tortilla | 16 | 1 | 0 |
| Corn dough | 16 | 1 | 0 |
| Corn flour | 17 | 1 | 0 |
| Other: yoghurt, sour cream | 17 | 0 | 0 |
| Sliced bread | 19 | 0 | 0 |
| Other wheat products: flakes, prepared | 19 | 0 | 0 |
| Other rice products: flour, toasted | 19 | 0 | 0 |
| Pasta for soup | 19 | 0 | 0 |
| White bread | 19 | 0 | 0 |
| Wheat flour (refined and wholemeal) | 20 | 0 | 0 |
| Evaporated milk | 22 | 1 | 0 |
| Formula milk | 22 | 1 | 0 |
| Manchego | 23 | 1 | 0 |
| Fresh cheese | 23 | 1 | 0 |
| Other milk: goat, donkey | 25 | 0 | 0 |
| Powdered milk (whole or skimmed) | 25 | 0 | 0 |
| Condensed milk | 25 | 0 | 0 |
| Pasteurised milk | 25 | 0 | 0 |
| Other: Chillied, Gruyere, Parmesan | 26 | 0 | 0 |
| Oaxaca | 26 | 1 | 0 |

*Continued in next column*

## Table A1: List of Food and Beverages products (*continued*)

| Product | QFAHPD category | Healthy (USDA) | Healthy (Vegs+) |
|---|---|---|---|
| Butter | 26 | 0 | 0 |
| Mature cheese | 26 | 0 | 0 |
| Cream | 27 | 0 | 0 |
| Goat | 28 | 1 | 0 |
| Mutton and lamb | 28 | 1 | 0 |
| Pork: mince, steak, piece | 29 | 0 | 0 |
| Beef: stew/stock with bone | 29 | 0 | 0 |
| Beef: chop and rib | 29 | 0 | 0 |
| Beef: fillet | 29 | 0 | 0 |
| Sausage | 29 | 0 | 0 |
| Other beef: offal (liver), tongue, heart | 29 | 0 | 0 |
| Lard | 29 | 0 | 0 |
| Beef: steak and breaded | 29 | 0 | 0 |
| Beef: round (piece or ground) | 29 | 0 | 0 |
| Other: rabbit, iguana, venison | 29 | 0 | 0 |
| Pork: chop and rib | 29 | 0 | 0 |
| Other pork: insides (liver, kidney), to | 29 | 0 | 0 |
| Pork: fillet and leg | 29 | 0 | 0 |
| Beef: special cuts: t-bone, roast | 29 | 0 | 0 |
| Other: chicken pie, salami, mortadella | 30 | 0 | 0 |
| Bacon | 30 | 0 | 0 |
| Chillied or smoked meats | 30 | 0 | 0 |
| Ham | 30 | 0 | 0 |
| Chorizo and longaniza | 30 | 0 | 0 |
| Dried beef, cured meat, machaca | 30 | 0 | 0 |
| Other birds: turkey, duck, pigeon | 31 | 1 | 0 |
| Whole hen or in pieces | 31 | 1 | 1 |
| Roast chicken | 31 | 1 | 1 |
| Chicken insides: heart, liver | 32 | 1 | 1 |
| Chicken in pieces | 32 | 1 | 1 |
| Sardines | 33 | 1 | 1 |
| Other: oyster, octopus, abalone | 33 | 1 | 1 |
| Dried: cod, prawn | 34 | 1 | 1 |
| Tuna | 34 | 1 | 1 |
| Jam, jelly, peanut butter | 36 | 1 | 1 |
| Hen egg | 37 | 1 | 1 |
| Vegetable oil | 38 | 1 | 1 |
| Vinegar | 38 | 1 | 1 |
| Other: olive oil | 38 | 1 | 1 |
| Mole | 39 | 0 | 0 |
| Margarine | 39 | 0 | 0 |
| Vegetable fat | 39 | 0 | 0 |
| Other condiments: dressings | 39 | 0 | 0 |
| Other: corn syrup, powdered brown sugar | 40 | 0 | 0 |
| Honey | 40 | 0 | 0 |
| Compote or conserve | 40 | 0 | 0 |
| White or brown sugar | 40 | 0 | 0 |
| Soft drinks (sparkling or still) | 41 | 0 | 0 |
| Mineral water (flavoured or unflavoured) | 41 | 0 | 0 |
| Beer | 42 | 0 | 0 |
| Tequila | 42 | 0 | 0 |
| Wine | 42 | 0 | 0 |
| Aguardiente, mescal, sotol | 42 | 0 | 0 |
| Other: cider, eggnog, sherry, vodka | 42 | 0 | 0 |
| Ron | 42 | 0 | 0 |
| Pulque | 42 | 0 | 0 |
| Brandy | 42 | 0 | 0 |
| Purified water | 43 | 1 | 0 |
| Ice creams and ices | 44 | 0 | 0 |
| Jellies, flans and puddings | 45 | 0 | 0 |
| Toffee and caramel | 45 | 0 | 0 |
| Sweet biscuits | 46 | 0 | 0 |
| Sweets and lollipops | 46 | 0 | 0 |
| Powdered chocolate or chocolate bar | 46 | 0 | 0 |
| Sweet bread | 47 | 0 | 0 |
| Savoury biscuits | 47 | 0 | 0 |
| Other: soup, salad, pizza, pie | 48 | 0 | 0 |
| Mayonnaise | 49 | 0 | 0 |
| Mustard | 49 | 0 | 0 |
| Other: soup and tinned vegetables, olives | 49 | 0 | 0 |
| Spicy sauces | 49 | 0 | 0 |
| Instant tea | 49 | 0 | 0 |
| Instant coffee | 49 | 0 | 0 |
| Chicken and tomato stock | 51 | 0 | 0 |
| Barbecued pork and pork rind (carnitas | 52 | 0 | 0 |
| Barbeque | 52 | 0 | 0 |

Notes: See Volpe et al. (2013), Table 1 for a list of the QFAHPD categories. The USDA healthy categorization is read from column (3) of their Table. The "Healthy (vegs+)" classification classifies all vegetables, fruits, fish and poultry products as healthy.

Table A2: Imputed food imports from U.S. and its unhealthy share

| State | Var | 1988 | 1999 | 2006 | 2012 | 2012 - 1988 |
|---|---|---|---|---|---|---|
| Aguascalientes | USimp | 0.002 | 0.006 | 0.013 | 0.019 | 0.017 |
| | Unhealthyimp | 0.549 | 0.650 | 0.704 | 0.605 | 0.056 |
| Baja California | USimp | 0.020 | 0.082 | 0.156 | 0.210 | 0.190 |
| | Unhealthyimp | 0.586 | 0.747 | 0.802 | 0.707 | 0.121 |
| Baja California Sur | USimp | 0.001 | 0.004 | 0.007 | 0.012 | 0.011 |
| | Unhealthyimp | 0.650 | 0.752 | 0.786 | 0.769 | 0.119 |
| Campeche | USimp | 0.013 | 0.030 | 0.060 | 0.101 | 0.088 |
| | Unhealthyimp | 0.754 | 0.801 | 0.837 | 0.808 | 0.054 |
| Chiapas | USimp | 0.024 | 0.053 | 0.101 | 0.164 | 0.140 |
| | Unhealthyimp | 0.494 | 0.625 | 0.730 | 0.619 | 0.126 |
| Chihuahua | USimp | 0.038 | 0.093 | 0.183 | 0.319 | 0.281 |
| | Unhealthyimp | 0.654 | 0.706 | 0.727 | 0.653 | -0.001 |
| Coahuila | USimp | 0.019 | 0.050 | 0.084 | 0.153 | 0.134 |
| | Unhealthyimp | 0.676 | 0.692 | 0.763 | 0.723 | 0.047 |
| Colima | USimp | 0.017 | 0.040 | 0.075 | 0.172 | 0.155 |
| | Unhealthyimp | 0.569 | 0.622 | 0.720 | 0.720 | 0.151 |
| Distrito Federal | USimp | 0.136 | 0.383 | 0.726 | 1.388 | 1.252 |
| | Unhealthyimp | 0.674 | 0.636 | 0.691 | 0.666 | -0.008 |
| Durango | USimp | 0.005 | 0.010 | 0.019 | 0.038 | 0.033 |
| | Unhealthyimp | 0.831 | 0.761 | 0.794 | 0.801 | -0.030 |
| Estado de Mexico | USimp | 0.087 | 0.215 | 0.402 | 0.768 | 0.682 |
| | Unhealthyimp | 0.674 | 0.636 | 0.707 | 0.667 | -0.007 |
| Guanajuato | USimp | 0.021 | 0.049 | 0.083 | 0.154 | 0.133 |
| | Unhealthyimp | 0.459 | 0.521 | 0.583 | 0.516 | 0.057 |
| Guerrero | USimp | 0.005 | 0.011 | 0.021 | 0.047 | 0.042 |
| | Unhealthyimp | 0.523 | 0.516 | 0.694 | 0.657 | 0.134 |
| Hidalgo | USimp | 0.003 | 0.009 | 0.017 | 0.034 | 0.031 |
| | Unhealthyimp | 0.351 | 0.379 | 0.369 | 0.276 | -0.075 |
| Jalisco | USimp | 0.041 | 0.106 | 0.214 | 0.364 | 0.323 |
| | Unhealthyimp | 0.732 | 0.785 | 0.821 | 0.784 | 0.052 |
| Michoacan | USimp | 0.018 | 0.035 | 0.060 | 0.121 | 0.103 |
| | Unhealthyimp | 0.667 | 0.646 | 0.661 | 0.637 | -0.030 |
| Morelos | USimp | 0.015 | 0.032 | 0.061 | 0.127 | 0.112 |
| | Unhealthyimp | 0.651 | 0.693 | 0.766 | 0.735 | 0.084 |
| Nayarit | USimp | 0.002 | 0.005 | 0.010 | 0.021 | 0.019 |
| | Unhealthyimp | 0.756 | 0.694 | 0.738 | 0.745 | -0.011 |
| Nuevo Leon | USimp | 0.024 | 0.083 | 0.153 | 0.230 | 0.206 |
| | Unhealthyimp | 0.735 | 0.782 | 0.842 | 0.786 | 0.051 |
| Oaxaca | USimp | 0.008 | 0.017 | 0.030 | 0.062 | 0.055 |
| | Unhealthyimp | 0.455 | 0.460 | 0.558 | 0.531 | 0.076 |
| Puebla | USimp | 0.046 | 0.140 | 0.301 | 0.591 | 0.545 |
| | Unhealthyimp | 0.361 | 0.397 | 0.398 | 0.291 | -0.070 |
| Queretaro | USimp | 0.008 | 0.018 | 0.030 | 0.060 | 0.052 |
| | Unhealthyimp | 0.343 | 0.359 | 0.446 | 0.404 | 0.061 |
| Quintana Roo | USimp | 0.018 | 0.034 | 0.077 | 0.146 | 0.128 |
| | Unhealthyimp | 0.643 | 0.719 | 0.751 | 0.788 | 0.145 |
| San Luis Potosi | USimp | 0.013 | 0.034 | 0.058 | 0.122 | 0.109 |
| | Unhealthyimp | 0.519 | 0.563 | 0.681 | 0.660 | 0.141 |
| Sinaloa | USimp | 0.024 | 0.074 | 0.143 | 0.200 | 0.177 |
| | Unhealthyimp | 0.590 | 0.753 | 0.821 | 0.733 | 0.143 |
| Sonora | USimp | 0.026 | 0.062 | 0.115 | 0.166 | 0.140 |
| | Unhealthyimp | 0.660 | 0.777 | 0.818 | 0.749 | 0.089 |
| Tabasco | USimp | 0.003 | 0.006 | 0.011 | 0.019 | 0.016 |
| | Unhealthyimp | 0.670 | 0.655 | 0.690 | 0.660 | -0.010 |
| Tamaulipas | USimp | 0.026 | 0.069 | 0.126 | 0.224 | 0.198 |
| | Unhealthyimp | 0.646 | 0.644 | 0.717 | 0.659 | 0.013 |
| Tlaxcala | USimp | 0.016 | 0.043 | 0.106 | 0.152 | 0.136 |
| | Unhealthyimp | 0.568 | 0.609 | 0.788 | 0.725 | 0.157 |
| Veracruz | USimp | 0.048 | 0.087 | 0.170 | 0.355 | 0.307 |
| | Unhealthyimp | 0.665 | 0.615 | 0.682 | 0.688 | 0.024 |
| Yucatan | USimp | 0.009 | 0.032 | 0.072 | 0.107 | 0.098 |
| | Unhealthyimp | 0.793 | 0.867 | 0.896 | 0.882 | 0.089 |
| Zacatecas | USimp | 0.013 | 0.025 | 0.044 | 0.100 | 0.087 |
| | Unhealthyimp | 0.609 | 0.599 | 0.674 | 0.693 | 0.084 |

Notes: *USimp* in billions of current US$.

Table A3: Actual and imputed food imports, 2006-2012

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Dep. var.: Food & agri. imports | | | Dep. var.: Food imports | | |
| *USimp* | 1.845*** | 1.844*** | 1.142*** | 0.573*** | 0.576*** | 0.376*** |
| | (0.357) | (0.366) | (0.203) | (0.0991) | (0.101) | (0.132) |
| Year FE | N | Y | Y | N | Y | Y |
| State FE | N | N | Y | N | N | Y |
| Obs | 224 | 224 | 224 | 224 | 224 | 224 |
| $R^2$ | 0.514 | 0.515 | 0.221 | 0.573 | 0.574 | 0.188 |

Notes: State-year panel regressions. The dependent variable in columns (1) to (3) equals the sum of imports from the U.S. by Mexican state and year under commodity codes from 02 to 22 (see description **??**here of the North America TransBorder Freight Database. Its overall mean is 347.5 US$ millions. The dependent variable in columns (4) to (6) include only food preparations and beverages classified under commodity codes from 16 to 22. Its overall mean equals 77.5 US$ millions. The overall mean of the *USimp* variable in the estimation sample is 164.2 US$ millions. The $R^2$ in columns (3) and (6) is the within-state $R^2$. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table A4: Summary statistics for state-level variables

| | (1) | (2) | (3) | (4) | (5 ) |
|---|---|---|---|---|---|
| | Obs | Mean | Std. Dev. | Min | Max |
| BMI | 123 | 27.15 | 2.10 | 22.34 | 30.38 |
| Obesity | 123 | 0.27 | 0.12 | 0.04 | 0.47 |
| Overw. | 123 | 0.61 | 0.16 | 0.20 | 0.87 |
| U.S. food imports | 123 | 0.11 | 0.17 | 0.00 | 1.39 |
| Ln(food expenditure) | 123 | 22.51 | 1.45 | 17.82 | 25.50 |
| Ln(food price) | 123 | 2.94 | 0.83 | 1.38 | 3.97 |
| LN(GDP per cap.) | 123 | 10.51 | 1.45 | 7.60 | 13.75 |
| FDI/GDP | 123 | 0.02 | 0.04 | 0.00 | 0.41 |
| Migrant share | 123 | 0.01 | 0.01 | 0.00 | 0.06 |
| RoW food imports | 123 | 0.04 | 0.07 | 0.00 | 0.52 |
| Apparel imports | 123 | 0.03 | 0.04 | 0.00 | 0.25 |
| U.S. food imports for fin. demand | 123 | 0.08 | 0.13 | 0.00 | 0.98 |
| Mex. food exports to U.S. | 123 | 0.19 | 0.34 | 0.00 | 2.51 |
| U.S. unhealthy share of imports | 123 | 0.66 | 0.13 | 0.28 | 0.90 |
| Unhealthy share of expenditure | 123 | 0.53 | 0.07 | 0.37 | 0.68 |
| Ln(relative price of unhealthy foods) | 123 | 0.71 | 0.13 | 0.47 | 1.20 |
| RoW unhealthy share of imports | 123 | 0.62 | 0.20 | 0.15 | 0.98 |
| U.S. unhealthy share of imports for fin. dem. | 123 | 0.63 | 0.15 | 0.21 | 0.89 |
| Unhealthy share of Mex. exports | 123 | 0.39 | 0.17 | 0.10 | 0.80 |

Notes: Trade flow variables are in billions of current US$.

Table A5: Food imports from the U.S. (in billions of MXN) and obesity prevalence

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| | OLS | | | | | 2SLS | | | |
| U.S. food imports | 0.0153*** | 0.0149*** | 0.0148*** | 0.0153*** | 0.0151*** | 0.0165*** | 0.0166*** | 0.0203** | 0.0191* |
| | (0.00289) | (0.00299) | (0.00300) | (0.00294) | (0.00307) | (0.00324) | (0.00397) | (0.00822) | (0.00989) |
| Ln(food expenditure) | | 0.0208 | | | 0.0215 | | 0.0209 | | 0.0199 |
| | | (0.0255) | | | (0.0271) | | (0.0271) | | (0.0260) |
| Ln(food price) | | | 0.0435 | | 0.0304 | | 0.0274 | | 0.0224 |
| | | | (0.0687) | | (0.0633) | | (0.0645) | | (0.0611) |
| Ln(GDP per cap.) | | | | 0.00414 | -0.000956 | | -0.00156 | | -0.00254 |
| | | | | (0.0494) | (0.0515) | | (0.0512) | | (0.0476) |
| FDI/GDP | | | | | 0.251 | | 0.261 | | 0.277 |
| | | | | | (0.245) | | (0.248) | | (0.251) |
| Migrant share | | | | | 0.166 | | 0.138 | | 0.0925 |
| | | | | | (1.041) | | (1.030) | | (1.006) |
| *First-stage results – Excluded instrument based on:* | | | | | | | | | |
| U.S. food exports | | | | | | 0.038*** | 0.038*** | | |
| | | | | | | (0.0039) | (0.0036) | | |
| U.S. - Mex. food exports | | | | | | | | 0.125*** | 0.155*** |
| | | | | | | | | (0.0420) | (0.0451) |
| F-stat excluded instr. | | | | | | 92.54 | 114.58 | 8.88 | 11.86 |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.969 | 0.970 | 0.970 | 0.969 | 0.971 | | | | |

Notes: U.S. food imports are converted into billions of current MXN using the annual US$/MXN exchange rate. All regressions include state dummies, state-specific linear trends, and year dummies. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table A6: Unhealthy imports and obesity prevalence – Robustness checks

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Imports from RoW | | Final use imports | | Apparel imports | | Mex. exports | | Dep. var.: Overw. | |
| U.S. unhealthy share of imports | | 0.304* | 0.275** | 0.258** | | 0.237 | | 0.313* | 0.303 | 0.293 |
| | | (0.172) | (0.116) | (0.114) | | (0.184) | | (0.171) | (0.194) | (0.200) |
| RoW unhealthy share of imports | 0.0325 | -0.0213 | | | | | | | | |
| | (0.0853) | (0.0827) | | | | | | | | |
| U.S. apparel imports | | | | | -0.199 | -0.115 | | | | |
| | | | | | (0.122) | (0.132) | | | | |
| Unhealthy share of Mexican exports | | | | | | | 0.112 | 0.235 | | |
| | | | | | | | (0.194) | (0.213) | | |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.963 | 0.968 | 0.967 | 0.969 | 0.965 | 0.969 | 0.963 | 0.969 | 0.975 | 0.976 |

Notes: All regressions include state dummies, state-specific linear trends, and year dummies. Even-numbered columns include state-level controls in Table 4. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Columns (3) and (4) use trade data only on food products classified for final consumption according to the BEC classification. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table A7: Unhealthy imports and obesity prevalence – alternative classification

| | OLS | | | | IV | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| U.S. Unhealthy imports | 0.526*** | 0.607** | | | | |
| | (0.182) | (0.263) | | | | |
| U.S. Healthy imports | -0.331 | -0.528 | | | | |
| | (0.371) | (0.561) | | | | |
| U.S. unhealthy share of imports | | | 0.394* | 0.417** | 0.876** | 0.627* |
| | | | (0.196) | (0.188) | (0.370) | (0.320) |
| Unhealthy share of expenditure | | 0.396 | | 0.372 | | 0.367 |
| | | (0.344) | | (0.350) | | (0.368) |
| Ln(relative price of unhealthy foods) | | -0.0132 | | -0.0453 | | -0.0450 |
| | | (0.0474) | | (0.0582) | | (0.0637) |
| Ln(GDP per capita) | | 0.0319 | | -0.0296 | | -0.0474 |
| | | (0.0553) | | (0.0529) | | (0.0475) |
| FDI/GDP | | 0.0666 | | 0.0115 | | -0.0398 |
| | | (0.221) | | (0.236) | | (0.250) |
| Migrant share | | 0.0383 | | 0.219 | | 0.222 |
| | | (0.929) | | (0.936) | | (0.919) |
| *First-stage results – Excluded instrument based on:* | | | | | | |
| U.S. - Mex. food exports | | | | | 0.0027** | 0.0046*** |
| | | | | | (0.0010) | (0.0013) |
| F-stat excluded instr. | | | | | 6.74 | 11.79 |
| Obs | 123 | 123 | 123 | 123 | 123 | 123 |
| $R^2$ | 0.971 | 0.973 | 0.968 | 0.969 | | |

Notes: Unhealthy are not vegetables, fruits, fish and poultry (see Table A1). All regressions include state dummies, state-specific linear trends, and year dummies. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.

Table A8: Unhealthy share of imports and health disparities

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| U.S. food var.: | Tot. | Unh. | Tot. | Unh. | Tot. | Unh. |
| U.S. foods × High educ. | 0.000503 | -0.122* | | | 0.0169 | -0.0947 |
| | (0.0135) | (0.0624) | | | (0.0167) | (0.0589) |
| High educ. | -0.0518*** | 0.0284 | -0.0520*** | -0.0520*** | -0.0553*** | 0.0104 |
| | (0.00768) | (0.0414) | (0.00652) | (0.00659) | (0.00816) | (0.0380) |
| Middle inc. | 0.0523*** | 0.0513*** | 0.0612*** | 0.0917** | 0.0619*** | 0.0746** |
| | (0.00788) | (0.00794) | (0.00877) | (0.0386) | (0.00889) | (0.0346) |
| High inc. | 0.0136 | 0.0129 | 0.0299** | 0.105** | 0.0314*** | 0.0694 |
| | (0.0153) | (0.0154) | (0.0121) | (0.0498) | (0.0113) | (0.0454) |
| U.S. foods × Middle inc. | | | -0.0496 | -0.0615 | -0.0531 | -0.0358 |
| | | | (0.0388) | (0.0575) | (0.0411) | (0.0518) |
| U.S. foods × High inc. | | | -0.0860** | -0.138* | -0.0930* | -0.0852 |
| | | | (0.0417) | (0.0710) | (0.0460) | (0.0660) |
| Obs | 56,713 | 56,713 | 56,713 | 56,713 | 56,713 | 56,713 |
| $R^2$ | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 |

Notes: All regressions include state-year fixed effects and the following individual level covariates: age and age squared; dummies for employment in retail, agriculture or other sectors, students, and disabled persons; an indicator for women who speak indigenous languages; a dummy for chronic diseases, and one for being the household head. The variable "U.S. foods" equals $USimp$ in "Tot." columns and $Unhealthyimp$ in "Unh." columns. The state share of national female population between 18 and 59 years of age in 1990 is used as weight. Standard errors clustered at the state level are in parenthesis. Significant at: *10%, **5%, ***1% level.