

The freer the fatter?
**A cross-country panel study of the relationship between
changes in body-mass index and economic freedom**

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Abstract

This study examines whether there is a relationship between economic freedom, as measured by the Economic Freedom of the World Index, and the large increases in obesity that have been observed worldwide. Using a panel of 82 middle- and high-income countries, the study finds that the level of economic freedom is related to increases in mean adult body-mass index. The effect is observed in both middle- and high-income countries, and is robust to controls for GDP per capita, education structure, and the fraction of females in the labor force. This suggests that, in a context of expanded personal choice and free markets, consumers make worse decisions from an obesity perspective.

1. Introduction

1.1 Background

The purpose of this study is to investigate the relationship between economic freedom and increases in adult body-mass index. Figure 1 depicts the mean level of economic freedom and mean adult body-mass index among 82 middle- and high-income countries between 1980 and 2008. These raw data at the aggregate level suggest that the increase in obesity around the world closely mirrors the development of economic freedom.

[Figure 1 here]

The technological and economic progress that has taken place in modern times implies many improvements to individual welfare. For example, individuals have access to more advanced products, and a larger variety of them, and diseases that used to imply death or a low quality of life can now be treated.

However, whereas many diseases and previous public health concerns have decreased in significance, and people are living longer, obesity is an increasing problem that is now internationally recognized as a serious threat to public health. Obesity is a significant risk factor for chronic diseases such as cardiovascular diseases, diabetes, and some cancers, which in turn are the most important causes to death and disability in the world (Sassi, 2010, p. 26). Obesity does not exist only in affluent countries. Lower-income developing countries are also affected, and under-nourishment sometimes exists parallel to, or even hand in hand with, obesity (WHO, 2011; Popkin, 2002; Chopra, Galbraith & Darnton-Hill, 2002). Despite major research efforts and awareness among health professionals, there is still no good recipe for policy interventions that would cure the “obesity epidemic.”

In many developed countries there is evidence of significant socioeconomic disparities in obesity. Lower socioeconomic groups are more likely to be obese than other groups, in particular among women (Sassi, 2010, pp. 79-103; Zhang & Wang, 2004; Molarius, Seidell, Sans, Tuomilehto & Kuulasmaa, 2000; Ljungvall & Gerdtham, 2010). However, empirical individual-level studies report evidence of a large common time trend after controlling for individual-specific factors such as age, education, income, and marital status (Cutler, Glaeser & Shapiro, 2003a; Truong & Sturm, 2005). In other words, over time there is something that increases the risk of obesity also after controlling for key individual characteristics. Due to this result, the literature increasingly points towards contextual rather than individual factors as important explanations to the increases in obesity (Zhang & Wang, 2004; Cummins & Macintyre, 2006; Wang & Beydoun, 2007).

Along these lines, the current study shifts focus from individual-level characteristics to environmental, or contextual, factors. The purpose is to investigate whether there is an actual relationship between average body size and economic freedom in middle- and high-income countries.

To measure economic freedom, the definition from the *2010 Annual Report of Economic Freedom of the World* (Gwartney, Hall & Lawson, 2010a) is used. It broadly defines economic freedom as protection of people and their property, and as individuals' right to choose for themselves (Gwartney et al., 2010a). The concept is centered around the idea of "self-ownership" and emphasizes the role of the individual. Personal choice, voluntary exchange coordinated by markets, freedom to enter and compete in markets, and protection of persons and their property are fundamental characteristics of economic freedom (Gwartney et al., 2010a). The Economic Freedom of the World index (EFW) has been constructed to reflect these aspects (Gwartney, Hall & Lawson, 2010b).

1.2 Four hypotheses about the link between economic freedom and obesity

Cutler, Glaeser, and Shapiro (2003b) suggest that mass production is driving the increases in obesity around the world. In brief, the argument is that instant and continuous access to food has increased. This development has been made possible by technological innovations that allow packaging, storage, and transportation of foods in ways that have led to a shift from individual to mass preparation of food and decreased time costs of food for consumers.

An implication of this mass production theory is that in countries where technological progress related to food production is less widespread, and where food manufacturers have more restricted access to these food production technologies, obesity should be less prevalent (Cutler et al., 2003b). Because the spread of new technologies, trade with new products, and food market regulations are related to economic freedom, the mass production theory suggests a positive relationship between the degree of economic freedom and increases in obesity.

Another potential mechanism linking market freedom and body size is related to the effect of ease of market entry and lack of regulations. When market entry is relatively easy, competition increases. Increased competition is generally thought to lower prices and increase product differentiation, thereby increasing the variety of products for consumers to choose from. Because food variety tends to increase consumption (Chandon & Wansink, 2011), a possible result is increased total eating. Bleich, Cutler, Murray, and Adams (2008) find evidence for such a view in that the supply of calories tends to be larger in countries where market entry is relatively easy.

Marketing, which is arguably more pronounced and developed where markets are less regulated, may also be important. Marketers influence consumption, and marketing is proposed to be an important cause of the rise in obesity (Chandon and Wansink, 2011; Zimmerman 2011). It may be more difficult to make healthier choices and acquire healthy food habits in an

environment with smart marketing and many cheap and unhealthy products, leading to a positive relationship between economic freedom and obesity.

A third potential mechanism for a relationship between economic freedom and obesity is the role of the government. A larger public sector means a lower degree of economic freedom. To the extent that a larger government is related to publicly financed health insurance, the public sector has a stronger incentive to encourage prevention and promote policies that improve public health (Kenkel, 2000, pp. 1691-1694), and such preventive policies may also be easier to carry out where the public sector is larger. There are several mechanisms through which this encouragement and prevention may take place. First, well-functioning public transportation, parks, and other facilities for physical activities, and safe roads for walking and bicycling are examples of potentially obesity-preventing public goods that are likely to attract more resources in countries where the public sector is large. Second, a large public sector usually means that services such as schools, health care, and care of the elderly are paid for by the government, which may facilitate health-promoting changes, for example, through the type of food served in schools. Third, to the extent that marketing matters, advertising and promotions are likely to be absent from government-funded schools.

On the other hand, theoretically, moral hazard may lead individuals to be less careful with their health, and this phenomenon could be more important in public health insurance systems (Kenkel, 2000, pp. 1691-1694).

A fourth potential mechanism for a relationship between economic freedom and obesity is through economic insecurity. Smith, Stoddard, and Barnes (2009) argue that perception of (economic) insecurity, such as risk of unemployment or other income loss, creates stress, which in turn leads to overeating. Offer, Pechey, and Ulijaszek (2010) also hypothesize that economic insecurity creates stress that leads to higher obesity prevalence, and they further argue that

economic insecurity is more prominent in “market-liberal” countries. One specific possible mechanism between insecurity and economic freedom is through social safety nets. If countries with larger public sectors have larger social safety nets, which increase the individual’s perception of security, the economic insecurity hypothesis implies a negative relationship between government size and obesity. However, insecurity may also be reflected in other dimensions of economic freedom than through social safety nets, such as through less regulated labor markets.

In sum, we may conclude that there are (at least) four a priori theoretical arguments for a positive relationship between the degree of economic freedom and obesity. These four hypotheses are:

- i. *The mass production theory* (Cutler et al., 2003b). Obesity should be more common where new food technologies are more widely accessible. Economic freedom implies weaker regulations for food manufacturers and less restricted trade, which has a positive impact on the spread of new food technologies, and thereby also on obesity.
- ii. *Ease of market entry and lack of regulations*. Lower prices, unhealthy products, and more intensive marketing may obstruct healthy choices.
- iii. *A larger public sector*. Through a publicly financed health insurance, the government has a stronger incentive to encourage policies that prevent obesity. Furthermore, a large public sector may facilitate health-promoting changes.
- iv. *The economic insecurity hypothesis* (Smith et al., 2009). Obesity increases as economic insecurity increases, and economic freedom may increase insecurity.

1.3 Previous empirical evidence

The literature on the relationship between economic freedom and obesity is scarce. A couple of studies test single sub-components of economic freedom, primarily in the context of the mass production theory or the economic insecurity hypothesis. In light of the mass production theory,

Cutler et al. (2003b) test whether obesity prevalence is larger in countries where access to new technology is greater. Controlling for the rate of female labor force participation and GDP per capita, they regress national obesity prevalence on a number of proxies for food industry regulation. With a single cross-section of only 22 observations at most, the results are not definite, but they indicate that obesity prevalence indeed tends to be higher in less regulated countries.

Bleich et al. (2008) test whether there is any association between national caloric supply and two proxies for technological innovation related to economic freedom: freedom for businesses to set their own prices and easy entry to markets – both taken from the Economic Freedom of the World index. Based on OLS country and year fixed effects for OECD countries in the 1995 to 2002 period, and controlling for GDP per capita, they find a significant and positive association between ease of market entry and national supply of calories. The association with the freedom to set prices is insignificant, but positive.

Offer et al. (2010) analyze cross-country national aggregate data consisting of 96 surveys undertaken in 11 OECD countries between 1994 and 2004. OLS regressions show that greater economic insecurity and market liberalism (where four countries are classified as market liberal) are related to higher obesity prevalence.

Smith et al. (2009) test the economic insecurity hypothesis on US individual-level longitudinal data. Using IV regressions, they find a significant effect of three different measures of economic insecurity (probability of unemployment, volatility of income, and access to safety nets) on body weight, controlling for height and other key individual characteristics.

The current analysis adds to the existing literature in that it takes a broader approach and focuses on overall economic freedom as well as different dimensions of it. The current study also

extends previous results by exploring a panel of countries, examining a longer time period, and including countries other than OECD members. Moreover, the present study uses newly released internationally comparable data on body sizes (see section 2a), whereas the previous studies use a mix of self-reported and measured information that comes from country-specific surveys, sometimes based on different age groups.

2. Data and methods

2.1 Data

The empirical analysis uses an unbalanced panel of 82 middle- and high-income countries and six points in time over a period of 25 years: 1983, 1988, 1993, 1998, 2003, and 2008. The countries are selected and labeled according to the World Bank classification of countries into income groups for each year (World Bank, 1983; 1988; 1993; 1998; 2003; 2008), excluding countries with populations of less than 250 000 in 2008. Table 1 lists the included countries. The data come from various sources and are described below.

[Table 1 here]

2.1.1 Body-mass index

To measure cross-country differences and changes in body size over time, cross-country comparable age-standardized data on average body-mass index (BMI, calculated as weight in kilos divided by the square of height in meters) for adults 20 years and older per country are used. The BMI data have been elaborated by *The Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group* with the specific aim of producing worldwide comparative estimates of BMI (and other risk factors). The group has made a large effort to collect and standardize available information on BMI for 200 countries between 1980 and 2008 (Finucane et al., 2011). These data constitute an important improvement over earlier available international data on BMI and obesity across countries. In earlier available datasets, data for

different countries correspond to different age groups, are sometimes nationally but sometimes only regionally representative, and are based on objectively measured height and weight for some countries, but on self-reports for other countries. As a result, differences across countries based on unadjusted data may partly stem from the fact that the data are not comparable. In other words, the data used in the current study provide a greatly enhanced foundation for cross-country analyses.

The Finucane et al. (2011) BMI data are reported for men and women separately. To produce an overall measure for the present analysis, an average between the male and female averages is calculated, weighted by the fraction of each gender for each year. The gender proportion information comes from the World Development Indicators (World Bank, various years).

2.1.2 The Economic Freedom of the World index

To measure the degree of economic freedom the (chain-linked) Economic Freedom of the World index, EFW (Gwartney et al., 2010b), is used. The index assigns a value between zero and ten to each country, where a higher value corresponds to more economic freedom. Observed changes in the index over time are not driven by inclusion of new variables, because the chain-linked version of the index takes into account that the definition of the index (i.e., the exact components) has changed over time, and adjusts the degree of the freedom accordingly.

Between 1970 and 2000 the EFW is available on a five-year basis only. To produce estimates for 1983, 1988, 1993, and 1998, the values for the indices from the nearest years before and after with available data are used to calculate a weighted average.

The EFW consists of five sub-indices that can be used as measures of economic freedom in five dimensions (all included variables are listed in Table A1 in the appendix):

1. *size of government*, including measures of expenditure, taxes and enterprises;

2. *legal structure and security of property rights*, including measures of judicial independence, military interference, and contract enforcement;
3. *access to sound money*; including measures of money growth, inflation, and foreign bank account access;
4. *freedom to trade internationally*, including measures of taxes, tariffs, and international credit market controls; and
5. *regulation of credit, labor, and business*, including measures of minimum wages, hiring regulations, and price controls.

The four potential mechanisms for a relationship between BMI and economic freedom (Section 1b) can each be linked to one or more of these sub-indices. If the mass production theory is at work, economic freedom in the trade and regulation dimensions (4 and 5 in the list above) ought to be the most relevant measures. The trade and regulation components are also likely to capture the marketing and competition channel. The government size mechanism ought to be captured by the government sub-index (1). To the extent that economic insecurity is reflected and relieved through the social security safety nets, the government sub-index also captures the insecurity mechanism. However, insecurity may be broader and could potentially be reflected in other dimensions of the society as well. For example, since the regulation dimension (5) partly reflects labor market regulations, this dimension may also capture part of the insecurity mechanism.

2.1.3 Other controls

Control variables include purchasing power adjusted GDP per capita in constant prices (2005 international dollars), the percentage of females in the labor force, and the percentage of the population 25 years and older having completed secondary and tertiary education, respectively. The GDP data come from the Penn World Table (Heston, Summers & Aten, 2011). Information about females in the labor force is taken from the World Development Indicators (World Bank,

various years). The education data come from Barro and Lee (2010), who use multiple sources to estimate comparable levels of education across countries.

At the individual level, education and income are likely to be important BMI determinants, but the effect, and the direction of the effect, is unclear at the aggregate level. Using individual data, there tends to be a negative relationship between BMI and level of education and income, at least among women (Section 1a), and the same relationship could be expected at the aggregate level. On the other hand, if obesity is related to development, and the education and income variables reflect this aggregate effect, a negative relationship could instead be expected. The fraction of females in the labor force is included as a potential driver to the increases in BMI via altered time allocations and food consumption, and is expected to be positively related to BMI, if anything.

Previous studies find mixed results and not very strong relationships between obesity-related measures on the one hand and GDP per capita and/or female labor force measures on the other (Cutler et al., 2003b; Loureiro & Nayga, 2005). Hence, despite a plausible contextual relationship, these variables seem to be weak predictors of differences in obesity across countries.

2.2 Model specification

To empirically assess the relationship between economic freedom and increases in BMI, the following time and country fixed effects model is estimated:

$$\begin{aligned}
 BMI_{it} - BMI_{it-1} &= \Delta BMI_{it} & (1) \\
 &= \alpha + \beta_1 EFW_{it-1} + \beta_2 \ln(GDP\ cap)_{it-1} + \beta_3 \ln(GDP\ cap)_{it-1}^2 + \beta_4 fem_part_{it-1} \\
 &\quad + \beta_5 educ2_{it-1} + \beta_6 educ3_{it-1} + \gamma_1 1993 + \gamma_2 1998 + \gamma_3 2003 + \gamma_4 2008 + \mu_i + \varepsilon_{it}
 \end{aligned}$$

The subscript i refers to country, and t refers to year where $t=1983, 1988, 1993, 1998, 2003, \text{ or } 2008$. EFW represents the economic freedom variable, and is either the aggregate index, one of

the sub-indices, or a vector of all the five sub-components. GDP_cap is the PPP adjusted GDP per capita, fem_part is the fraction of females in the labor force, $educ2$ and $educ3$ correspond to the percentage of the population 25 years or older with completed secondary and tertiary education, respectively. 1993, 1998, 2003, and 2008 are year dummies. μ is a country fixed effect and captures observed and unobserved country-specific factors that are constant over time. ε is a time-varying error and includes unobserved factors that affect the dependent variable, and is assumed to be random with $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$. All explanatory variables, including the country and time fixed effects, are assumed to be independent of the error term.

BMI is the standardized national mean BMI among adults for each country. Similar to models used to assess the effect of economic freedom on changes in GDP per capita (e.g., De Haan & Sturm 2000; Dawson, 2003; Carlsson & Lundström, 2002), Equation 1 relates the *level* of economic freedom in the earlier period to the *change* in BMI between two periods (i.e., over five years in this case). Hence, the model tests whether the degree of economic freedom in period t is related to the size of the (absolute) change in BMI during the subsequent five years, and thereby tests whether the level of freedom is linked to the change in BMI, irrespective of the level of it. A one-unit increase in the economic freedom index implies a β_1 BMI points change in the absolute BMI level during the next five years.

To allow for different effects in countries with different levels of income, Equation 1 is modified to include indicator variables for high- (*high*) and upper-middle- (*upper middle*) income countries, keeping lower-middle-income countries as reference, and interaction terms between country classification and the economic freedom variable(s):

$$\begin{aligned}
 BMI_{it} - BMI_{it-1} &= \Delta BMI_{it} & (2) \\
 &= \alpha + \beta_1 EFW_{it-1} + \beta_2 fem_part_{it-1} + \beta_3 educ2_{it-1} + \beta_4 educ3_{it-1} + \gamma_1 1993 + \gamma_2 1998 \\
 &+ \gamma_3 2003 + \gamma_4 2008 + \delta_1 high_{it-1} + \delta_2 upper\ middle_{it-1} + \delta_3 high * EFW_{it-1} \\
 &+ \delta_4 upper\ middle * EFW_{it-1} + \mu_i + \varepsilon_{it}
 \end{aligned}$$

where notation is the same as in Equation 1. The sign, size, and statistical significance of δ_3 and δ_4 reveal whether the relationship between economic freedom and the change in BMI differs across income groups.

3. Results

3.1 Descriptive statistics

Table 2 reports final sample summary descriptive statistics per year and as (unweighted) averages of the 1983-2003 period. Between 1983 and 2008, national mean BMI increased by 2.1 BMI points, and economic freedom increased by one index point. Over the full period, the (absolute) increase in freedom in the sound money dimension is largest, followed by the government dimension. Cross-country average economic freedom in the legal structure dimension decreased slightly between 1983 and 2008. The *Min*, *Max*, and *Std. Dev.* columns reflect that there is cross-country variation in all variables. For example, five-year changes in BMI vary between -0.1 and 0.7 in 1983 and between -0.1 and 1.2 in 2003. Regarding changes in economic freedom, the average within-country five-year change in overall economic freedom is 0.25 index points (not shown in the table).

[Table 2 here]

Table 3 reports the pair-wise correlations between the variables included in the analysis. The grey area highlights the correlations between economic freedom sub-indices, which are included simultaneously in some specifications. In particular, freedom in the legal structure, sound money, trade, and regulation dimensions are correlated. The GDP variable is also correlated with these variables, as well as with the aggregate economic freedom index. These correlations reflect the issue of how these variables are related to each other, and whether they should be included simultaneously in the regressions. However, the correlations are not high enough to cause any multicollinearity concerns.

[Table 3 here]

3.2 Baseline results: The aggregate index

Table 4 reports the baseline results, which are estimations of Equation 1. Controlling only for economic freedom (in addition to time and country fixed effects) gives a positive and statistically significant relationship between the level of economic freedom and the change in national mean adult BMI during the next five years. Hence, the greater the reliance on free markets and individual choices, the more weight individuals seem to put on. Adding the logarithm of PPP adjusted GDP per capita and its square (column 2), the fraction of females in the labor force (column 3), and education (column 4) does not alter the size or significance level of the economic freedom variable. Thus, the potential and complex interrelationship between these variables does not seem to be too serious a problem for estimating the relationship between economic freedom and changes in BMI. Based on the results in column 4, a one-unit increase in EFW (which roughly corresponds to a standard deviation, see Table 2) implies a 0.09 index points larger increase in BMI in the next five years. This corresponds to 45 percent of the standard deviation of the average five-year increase in BMI, and to about 20 percent of the mean increase in BMI between two periods. GDP, female labor force, and education are all statistically insignificantly related to increases in BMI.

[Table 4 here]

Column 5 in Table 4 includes an indicator variable for high-income countries instead of the GDP variables. Increases in BMI are smaller in high-income countries than in middle-income countries. Separation of the middle-income countries into upper- and lower-middle-income countries in column 6 reveals that five-year changes in BMI are step-wise becoming smaller with economic development. However, column 7 shows that the effect of economic freedom does not

differ across income groups, and the main result of a positive and statistically significant effect of overall economic freedom remains unchanged.

The results in Table 4 are based on fixed effect models where equations are first transformed to remove time-invariant country effects. Consequently, only countries that change income classification over time contribute to the estimated effect of *high* and *upper middle* in columns 5 to 7, which may explain why there seems to be an effect of income classification but not of GDP per se (columns 2-4). About five percent of the observations change to or from being classified as high-income. The corresponding numbers for upper- and lower-middle-income countries are 11 and seven percent.

3.3 Baseline results: Decomposition of the aggregate index

Table 5 presents the results from the decomposition of the aggregate economic freedom index into its sub-components, controlling for income classification, female labor force, and education. Including the sub-indices one at a time gives a positive and statistically significant effect of economic freedom in the government, sound money, trade, and regulation dimensions. The effect is the largest for the regulation sub-index.

Because of the high correlation between freedom in the different dimensions, it is likely that the sub-index included when controlling for only one of them, as in columns 1 to 5, captures part of the effect that stems from other sub-indices. In line with this argument, including all sub-indices in the same model (column 6) reduces the size of the effect of economic freedom in some dimensions. The effect of freedom in the government, sound money, and regulations dimensions decreases, but it remains positive and statistically significant. Freedom in the trade dimension loses both size and statistical significance. Hence, the positive and statistically significant effect of freedom in the trade dimension that appears in column 4 may actually be a result of the effect of freedom in the sound money or trade dimension instead, which are omitted from the model.

Freedom in the regulation dimension remains the strongest driver to the observed overall effect of economic freedom on increases in BMI. This result could be interpreted in favor of the mass production or marketing and competition link. However, as the government and sound money dimensions also remain positive and statistically significant, although with smaller effects, these results do not exclude any of the hypotheses proposed in Section 1b as a relevant explanation.

[Table 5 here]

3.4 Baseline results: Stratification by income group

Table 6 reports summary results for the estimations of the aggregate economic freedom index and for the decomposition of it, separately by income group (high-, upper-middle-, and lower-middle-income countries). Although not reported, all models control for GDP per capita, female labor force, and education. Clearly, splitting the sample into three sub-samples reduces the number of observations and countries in each sample, possibly resulting in somewhat less precise estimates. Column 1 confirms that there is a positive and statistically significant effect of overall economic freedom in all three income groups.

Among high-income countries, including the sub-indices one at a time (columns 2-6) results in a positive and statistically significant effect of economic freedom in the sound money, trade, and regulations dimensions. As in the full sample, the largest effect is for the regulations dimension. When all sub-indices are included in the same model, the positive and statistically significant effect of freedom in the regulation dimension remains (column 7). The size of the regulation effect is not negligible. For example, the difference between the most and least free high-income countries in the sample in this particular dimension in 2003 is about 3.5 index points. All else being equal, this difference would imply a difference of 0.24 BMI points in the increase in BMI between 2003 and 2008, which corresponds to about 70 percent of the mean increase, and to

about 27 percent of the amplitude of changes in BMI between these years among high-income countries.

[Table 6 here]

Among upper-middle-income countries, freedom in the government dimension results in a positive and statistically significant effect, implying that when the size of the government decreases (i.e., more freedom), increases in national mean adult BMI in the subsequent five years are larger. This result is in line with the hypothesis that a larger government provides a more secure economic environment and has a greater interest in and impact on health-promoting policies, both of which could prevent increases in BMI to some extent. However, when controlling for economic freedom in the other four dimensions, the government effect decreases in size and loses its significance. Among upper-middle-income countries, none of the other four sub-indices appears related to increases in BMI. Hence, although the aggregate index is related to increases in BMI in upper-middle-income countries as well, it is unclear what lies behind this overall effect, and none of the sub-indices appears as a dominant driver.

Among lower-middle-income countries, including the sub-indices one at a time results in a positive and statistically significant effect of economic freedom in the government, sound money, trade, and regulation dimensions. As for high-income countries, the regulation dimension has the largest effect, but the government and trade dimensions are non-negligible in size. When including all sub-indices in the same model, the size of the effects decreases somewhat, but freedom in both the government and regulation dimensions remains statistically significant.

3.5 Summary results

The main result of this study is that the level of economic freedom is related to increases in national mean adult BMI. The effect is observed in high-income as well as in both upper- and lower-middle-income countries, and the result is robust to controls for GDP per capita, income classification, education structure, and the fraction of females in the labor force. The decomposition into sub-indices gives a less uniform picture. In lower- and upper-middle-income countries, freedom in the government dimension appears to be a relevant driver for the overall effect, although the significance of this effect disappears in upper-middle-income countries when controlling for freedom in the other dimensions. In lower-middle-income countries, the effect remains significant both statistically and economically. In high-income and lower-middle- (but not in upper-middle) income countries, freedom in the regulations dimension is the strongest contributor to the overall effect. Freedom in the sound money and trade dimensions also appears relevant in high-income and lower-middle-income countries, although this effect disappears once controlling for freedom in the other dimensions, likely because of the correlation between the different sub-indices.

4. Sensitivity analysis: Alternative specifications

The main analysis relates the *level* of economic freedom in period t to the *change* in BMI between period t and $t+1$. An alternative would be to estimate the relationship in first differences:

$$\begin{aligned} \Delta BMI_{it} &= BMI_{it} - BMI_{it-1} \\ &= \alpha + \beta_1 \Delta EFW_{it} + \beta_2 \Delta high_{it} + \beta_3 \Delta upper\ middle_{it} + \beta_4 \Delta fem_{part_{it}} + \beta_5 \Delta educ2_{it} + \beta_6 \Delta educ3_{it} \\ &\quad + \gamma_1 1993 + \gamma_2 1998 + \gamma_3 2003 + \gamma_4 2008 + r_{it} \end{aligned} \tag{3}$$

or in levels:

$$\begin{aligned} BMI_{it} &= \alpha + \beta_1 EFW_{it-1} + \beta_2 high_{it-1} + \beta_3 upper\ middle_{it-1} + \beta_4 fem_{part_{it-1}} + \beta_5 educ2_{it-1} \\ &\quad + \beta_6 educ3_{it-1} + \gamma_1 1993 + \gamma_2 1998 + \gamma_3 2003 + \gamma_4 2008 + \mu_i + \varepsilon_{it} \end{aligned} \tag{4}$$

where the same notation as in Equation 1 applies. In Equation 4, the lag of the regressors is used to avoid part of the potential problem with reversed causality, but perhaps more importantly to allow the explanatory variables to operate for some time before the effect is notable in the society. Because BMI changes slowly, this is a plausible specification from a theoretical point of view.

As we shall see, the results seem sensitive to model specification, but an analysis of the potential sources of these differences suggests that the baseline model is to be preferred.

Table 7 reports the results from Equation 3 (columns 2 and 5) and Equation 4 (columns 3 and 6), together with the results from the baseline specification (columns 1 and 4). Regarding the aggregate economic freedom index (columns 1-3), the model in levels gives a similar result as the main analysis, although the effect is statistically insignificant. The first difference model results in a *negative*, but insignificant, effect. When decomposing the aggregate index (columns 4-6), contrary to the main analysis, there is a *negative*, although statistically insignificant, effect of freedom in the regulation dimension when estimating both the levels and first difference models. Also contrary to the main analysis, there is a small but significant *negative* effect of freedom in the sound money dimension based on the first difference model. Finally, both the model in first differences and levels identify a positive and statistically significant effect of freedom in the legal structure dimension, whereas this dimension appears unrelated to changes in BMI in the baseline model.

Overall, the results appear rather sensitive to model specification. Judging by the models in first differences or levels, one would conclude that there is basically no relationship between BMI and economic freedom, except from a positive effect of freedom in the legal structure dimension.

[Table 7 here]

The only difference between the baseline specification and the model in levels is how the dependent variable is constructed, and this difference alters the estimated relationship. Consequently, different results from the two different models may spring from the nature of the relationship more than from a non-robust relationship. The baseline specification relates the level of economic freedom to the (absolute) change in BMI in the next five years, *irrespective of the level of BMI*, and captures the development of BMI. The model in levels, on the other hand, relates the level of economic freedom in period t to the level of BMI in period $t+1$, and does not distinguish economies that are growing (in physical terms, i.e., increasing in BMI) from those that are not. A relatively large increase in BMI accompanied by a high level of economic freedom would not be captured by the model in levels if this increase occurred in a country with a relatively low level of BMI.

Bloom, Canning, and Fink (2009) explain why a first difference model (similar to Equation 3) and a model with a difference as the dependent variable and the level of the explanatory variable (similar to the baseline model, Equation 1) produce different results. The key reason is that there is a strong negative relationship between the level and difference of the explanatory variable of interest. Bloom et al. (2009) discuss the effect of life expectancy on growth (which, by definition, is a difference between two periods). To exemplify the reasoning in the context of the current study, Figure 2 illustrates the (unconditional) positive relationship between the change in BMI and economic freedom in the regulation dimension, separately by income group. Further, Figure 3 shows that there is a negative relationship between the level of economic freedom and the change in it: countries with relatively small economic freedom experienced relatively large increases over the next five years.

[Figure 2, 3 and 4 here]

If the relationships in Figures 2 and 3 are true and causal, combining them leads to an expectation of a *negative* relationship between the change in BMI and the change in economic freedom (Bloom et al., 2009). Accordingly, Figure 4 illustrates such a negative relationship, and represents the relationship modeled in Equation 3. Hence, if Figures 2 and 3 illustrate a true and causal relationship, the one in Figure 4 is a statistical artifact: Figure 2 shows that where economic freedom is relatively high in, for example, 2003, the increase in BMI between 2003 and 2008 is relatively large. At the same time, Figure 3 shows that where economic freedom is relatively high in 2003, the increase in freedom between 2003 and 2008 is relatively small. Consequently, countries with relatively large increases in economic freedom are countries with a relatively low degree of freedom in the beginning of the period, and thereby experience a low increase in BMI between 2003 and 2008 according to Figure 2. Hence, failing to control for either the level or the difference of the economic freedom variables may result in relationships that are difficult to interpret (Bloom et al., 2009).

The baseline model (Equation 1) controls for levels, but not for differences, whereas the first difference model fails to control for levels, which may be the reason for the different results. Adding differenced versions of the freedom variable(s) to the baseline model results in the following specification (similar to models used in the growth and economic freedom literature, see for example Dawson, 1998; 2003; Gwartney, Lawson & Holcombe, 1999):

$$\begin{aligned}
 BMI_{it} - BMI_{it-1} &= \Delta BMI_{it} & (5) \\
 &= \alpha + \beta_1 EFW_{it-1} + \beta_2 \Delta EFW_{it} + \beta_3 high_{it-1} + \beta_4 upper\ middle_{it-1} + \beta_5 fem_part_{it-1} \\
 &\quad + \beta_6 educ2_{it-1} + \beta_7 educ3_{it-1} + \gamma_1 1993 + \gamma_2 1998 + \gamma_3 2003 + \gamma_4 2008 + \mu_i + \varepsilon_{it}
 \end{aligned}$$

where again the same notation as before applies. Columns 7 and 8 in Table 7 report the results based on this model. The differenced versions of the freedom variables are insignificant, and the estimated influence of the economic freedom variables in levels is very similar to the ones estimated in the baseline model. Hence, the contrary results found in the first difference model,

compared to the basic specification, seem to depend on the assumption that the level of economic freedom is unrelated to the change in it. Although not reported here, adding the differences of the female labor force, education variables, and income classification variables does not affect the results. Overall, these results justify the baseline specification that relates the *level* of economic freedom to the *change* in BMI, which is also theoretically plausible. The empirical investigation suggests that this relationship exists and is rather robust, whereas relationships in pure levels or first differences are weaker and less significant.

5. Discussion and conclusions

The main empirical analysis concludes a statistically significant relationship between the level of economic freedom, as defined by the Economic Freedom of the World index, and increases in national adult mean BMI, as suggested by the theoretical arguments presented in the introduction. Decomposition into sub-components of the aggregate index suggests that freedom in various dimensions contributes to this effect, and the results do not exclude any of the suggested links between freedom and obesity. Freedom in the legal structure dimension is the only sub-component that is unrelated to increases in BMI throughout. Unfortunately, the current data do not allow a more careful and detailed investigation of exactly which mechanism lies behind the result. To accurately disentangle the proposed links and to further explore the exact mechanisms, more detailed data on factors such as product differentiation, money spent on advertising, promotions, and sponsorships would be needed.

The overall finding of a positive relationship between measures of obesity and economic freedom is also found in two previous and related studies. Cutler et al. (2003b) find a negative relationship between obesity prevalence and frequency of price controls among 21 OECD countries in a single cross-section. Also among OECD countries, Bleich et al. (2008) find that national caloric supply increases with ease of market entry. Both of these measures are sub-components of the regulation index. Similar to these studies, the current study observes an

effect of freedom in the regulation dimension among high-income countries, but the extension to also investigate other dimensions of economic freedom shows that freedom in multiple dimensions is related to BMI. Further, Offer et al. (2010) use two different measures of economic security (Osberg's index and the ILO index of security) and find a negative relationship with obesity prevalence. If security decreases with economic freedom, the results from the current study are in line with these results.

However, the current study also extends the analysis to include non-OECD countries, and shows that economic freedom has an effect in middle-income countries as well. The study could be extended further to include low-income countries. It would be interesting to see whether the same relationship between economic freedom and increased BMI appears in the least developed countries. The BMI data used in this study include information about the development in low-income countries. However, the uncertainty in the BMI information varies across countries; the uncertainty is generally greatest in low-income countries and the lowest in high-income countries. This difference is driven by the amount of available primary information in the different countries and thereby the extent to which the data rely on estimates and imputation (see the appendix to Finucane et al. (2011) for details).

The research question in focus in this study raises the question of reversed causality and endogeneity. Reversed causality would appear if BMI, or changes in BMI, affected the level of economic freedom. This potential problem is somewhat reduced through the model specification that relates lagged economic freedom (and other variables) to increases in BMI. Perhaps more importantly, it is unclear what the mechanisms to such a reversed effect would be. However, even if reversed causality is excluded due to theoretical reasons, endogeneity emerges if the assumption of no correlation between the error term and the regressors fails to hold, for example due to omitted variables. This potential problem of omitted variable bias is partly reduced by the country fixed effects included in the regressions. These fixed effects control for

otherwise omitted variables that are constant over time, but not for factors that are time-varying. It is not obvious what such a time-varying omitted variable could be, and how it is related to economic freedom. Perhaps “norms” towards market liberalism could be a potential candidate if these norms also affect changes in BMI other than through the level of economic freedom. The issue of norms is complex, and one would need to consider where such potential norms would come from. If they are a result of the level of economic freedom, then norms would not be an omitted variable, but rather a mechanism through which the observed relationship operates. Nevertheless, it should be kept in mind that the observed relationship between economic freedom and increases in BMI could potentially be spurious rather than direct and causal.

As emphasized in the introduction, the economic and technological progress, to a large extent accompanied by more economic freedom, experienced in modern times has many positive effects on individual welfare. Economic freedom is related to growth (Berggren, 2003; de Haan & Sturm, 2000; Dawson, 1998; 2003; Gwartney & Lawson, 2004), and there is some evidence that economic freedom is related to improved health. Owen and Wu (2007) find that increased openness is associated with lower infant mortality and higher life expectancy in developing countries, whereas the effects are insignificant in developed countries. Stroup (2007) finds that greater economic freedom, as measured by the Economic Freedom of the World index, is related to increased life expectancy and lower child mortality. Tracy, Kruk, Harper, and Galea (2010) also use the Economic Freedom of the World index to explore a potential economic freedom and child mortality relationship. They find no statistically significant effect of the aggregate freedom index on child mortality, but a negative and statistically significant effect of two of the sub-components: legal structure and access to sound money. The results from these studies signal a positive effect of economic freedom on health, which is in contrast to the findings in the present study. If the results from the main analysis in this study are true, then economic freedom also has some unhealthy effects.

Because there are positive effects of economic freedom on welfare and health in other dimensions than BMI, the conclusion to be drawn from this study is not necessarily that the increasing freedom trend should be reversed – the net effect on overall welfare and utility may well be positive despite the potential negative effect on welfare from increasing BMI. If freedom in different dimensions, or if different sub-components of freedom, affect growth, life expectancy, and obesity, or if the effects on these different variables are not counteracting each other, there is scope for interventions that could have a positive effect on overall welfare. Moreover, policies that extend economic freedom could be accompanied by strong health-promoting policies that counteract the harmful effects of increased freedom suggested by the results in this study.

The changes in BMI over time spring from changes in individual behavior and an altered relation between energy intake and output. The results from this study suggest that in a context of expanded personal choice and free markets, worse decisions are made from an obesity perspective. More detailed mechanisms behind this result are worth exploring if we want to understand the causes of the large increases in obesity and the universal spread of this phenomenon.

References

- Barro, R. J., & Lee, J.-W. (2010). A new data set of educational attainment in the world, 1950–2010. *National Bureau of Economic Research Working Paper Series*, no. 15902.
- Berggren, N. (2003). The benefits of economic freedom: a survey. *The Independent Review*, 8(2), 193-212.
- 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.
- Bloom, D., Canning, D., & Fink, G. (2009). Disease and development revisited. *PGDA Working Paper*, no. 44.
- Carlsson, F., & Lundström, S. (2002). Economic freedom and growth: Decomposing the effects. *Public Choice*, 112(3), 335-344.
- Chandon, P., & Wansink, B. (2011). Is food marketing making us fat? A multi-disciplinary review. *Foundations and Trends in Marketing*, 5(3), 113-196.
- Chopra, M., Galbraith, S., & Darnton-Hill, I. (2002). A global response to a global problem: The epidemic of overnutrition. *Bulletin of the World Health Organization*, 80(12), 952-958.
- Cummins, S., & Macintyre, S. (2006). Food environments and obesity—neighbourhood or nation? *International Journal of Epidemiology*, 35(1), 100 -104.
- Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003a). Why have Americans become more obese? *National Bureau of Economic Research Working Paper Series*, no. 9446.
- Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003b). Why have Americans become more obese? *Journal of Economic Perspectives*, 17(3), 93-118.
- Dawson, J. W. (1998). Institutions, investment, and growth: New cross-country and panel data evidence. *Economic Inquiry*, 36(4), 603-619.
- Dawson, J. W. (2003). Causality in the freedom–growth relationship. *European Journal of Political Economy*, 19(3), 479-495.
- Finucane, M. M., Stevens, G. A., Cowan, M. J., Danaei, G., Lin, J. K., Paciorek, C. J., ... Ezzati, M. (2011). National, regional, and global trends in body-mass index since 1980: Systematic

- analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *The Lancet*, 377(9765), 557-567.
- Gwartney, J. D., Hall, J. C., & Lawson, R. (2010a). *Economic freedom of the world: 2010 annual report*. Vancouver, BC: The Fraser Institute.
- Gwartney, J. D., Hall, J. C., & Lawson, R. (2010b). *Economic freedom of the world: 2010 annual report*, Vancouver, BC: The Fraser Institute. Data retrieved from www.freetheworld.com.
- Gwartney, J. D., & Lawson, R. (2004). *Economic freedom of the world: 2004 annual report*. Vancouver, BC: The Fraser Institute.
- Gwartney, J. D., Lawson, A., & Holcombe, R. G. (1999). Economic freedom and the environment for economic growth. *Journal of Institutional and Theoretical Economics*, 155(4), 643-663.
- de Haan, J., & Sturm, J-E. (2000). On the relationship between economic freedom and economic growth. *European Journal of Political Economy*, 16(2), 215-241.
- Heston, A., Summers, R., & Aten, B. (2011). *Penn World Table Version 7.0*. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.
- Kenkel, D. S. (2000). Prevention. In A. J. Culyer & J. P. Newhouse (Eds.), *Handbook of Health Economics: Vol. 1B* (1st. ed., ch. 31, pp. 1675-1720). Amsterdam: Elsevier.
- Ljungvall, Å., & Gerdtham, U-G. (2010). More equal but heavier: A longitudinal analysis of income-related obesity inequalities in an adult Swedish cohort. *Social Science and Medicine*, 70(2), 221-231.
- Loureiro, M. L., & Nayga, R. (2005). International dimensions of obesity and overweight related problems: An economics perspective. *American Journal of Agricultural Economics*, 87(5), 1147-1153.
- Molarius, A., Seidell, J. C., Sans, S, Tuomilehto, J., & Kuulasmaa, K. (2000). Educational level, relative body weight, and changes in their association over 10 years: An international perspective from the WHO MONICA project. *American Journal of Public Health*, 90(8), 1260-1269.

- Offer, A., Pechey, R., & Ulijaszek, S. (2010). Obesity under affluence varies by welfare regimes: The effect of fast food, insecurity, and inequality. *Economics & Human Biology*, 8(3), 297-308.
- Owen, A. L., & Wu, S. (2007). Is trade good for your health? *Review of International Economics*, 15(4), 660-682.
- Popkin, B. M. (2002). An overview on the nutrition transition and its health implications: The Bellagio meeting. *Public Health Nutrition*, 5(1A), 93-103.
- Sassi, F. (2010). *Obesity and the Economics of Prevention: Fit not fat*. Paris: OECD Publishing .
- Smith, T. G., Stoddard, C., & Barnes, M. G. (2009). Why the poor get fat: Weight gain and economic insecurity. *Forum for Health Economics & Policy*, 12(2).
- Stroup, M. D. (2007). Economic freedom, democracy, and the quality of life. *World Development*, 35(1), 52-66.
- Tracy, M., Kruk, M. E., Harper, C., & Galea, S. (2010). Neo-liberal economic practices and population health: A cross-national analysis, 1980-2004. *Health Economics, Policy and Law*, 5(02), 171-199.
- Truong, K. D., & Sturm, R. (2005). Weight gain trends across sociodemographic groups in the United States. *American Journal of Public Health*, 95(9), 1602-1606.
- Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States - Gender, age, socioeconomic, racial/ethnic, and geographic characteristics: A systematic review and meta-regression analysis. *Epidemiologic Reviews*, 29(1), 6-28.
- WHO. (2011). Obesity and overweight. *WHO Factsheet*, no. 311, version updated March 2011.
- World Bank. (1983). *WDR: Management in development*. New York: Oxford University Press.
- World Bank. (1988). *WDR: Public finance in development*. New York: Oxford University Press.
- World Bank. (1993). *WDR: Investing in health*. New York: Oxford University Press.
- World Bank. (1998). *WDR 1998/99: Knowledge for development*. New York: Oxford University Press.

World Bank. (2003). *WDR 2003: Sustainable development in a dynamic world: Transforming institutions, growth, and quality of life*. Washington, D.C.: World Bank, and New York: Oxford University Press.

World Bank. (2008). *WDR: Agriculture for development*. Washington, D.C.: World Bank

World Bank. (various years). World Development Indicators Database. Data retrieved from <http://databank.worldbank.org/ddp/home.do>

Zhang, Q., & Wang, Y. (2004). Trends in the association between obesity and socioeconomic status in US adults: 1971 to 2000. *Obesity, 12*(10), 1622–1632.

Zimmerman, F. J. (2011). Using marketing muscle to sell fat: The rise of obesity in the modern economy. *Annual Review of Public Health, 32*(1), 285-306.

Appendix

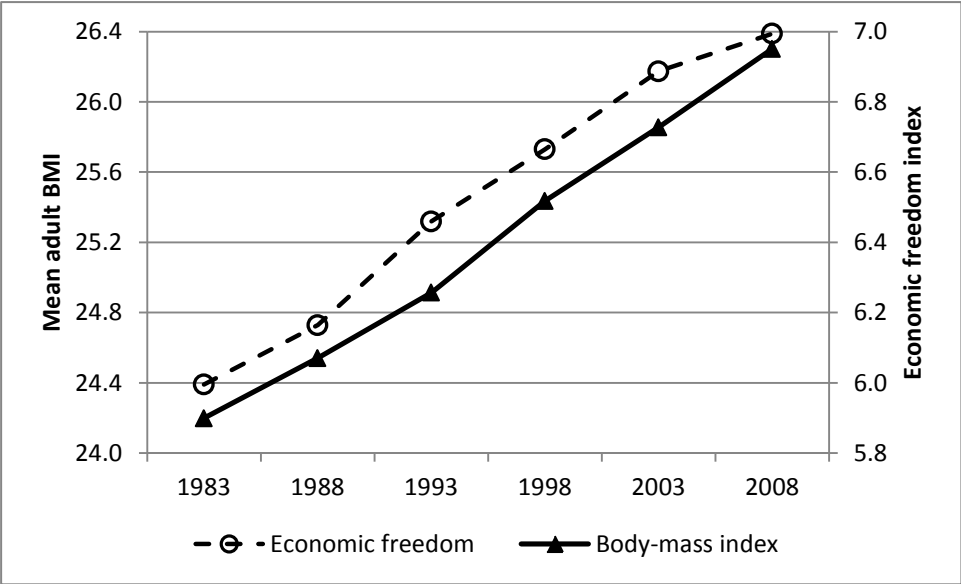
Table A1. Components of the Economic Freedom of the World Index.

1	Size of Government: Expenditures, Taxes, and Enterprises	
	A	General government consumption spending (% of total consumption)
	B	Transfers and subsidies (% of GDP)
	C	Government enterprises and investment
	D	Top marginal tax rate
		i Top marginal income tax rate
		ii Top marginal income and payroll tax rates
2	Legal Structure and Security of Property Rights	
	A	Judicial independence
	B	Impartial courts
	C	Protection of property rights
	D	Military interference in rule of law and the political process
	E	Integrity of the legal system
	F	Legal enforcement of contracts
	G	Regulatory restrictions on the sale of real property
3	Access to Sound Money	
	A	Money growth
	B	Standard deviation of inflation
	C	Inflation: Most recent year
	D	Freedom to own foreign currency bank accounts
4	Freedom to Trade Internationally	
	A	Taxes on international trade
		i Revenues from trade taxes (% of trade sector)
		ii Mean tariff rate
		iii Standard deviation of tariff rates
	B	Regulatory trade barriers
		i Non-tariff trade barriers
		ii Compliance cost of importing and exporting
	C	Size of trade sector relative to expected
	D	Black-market exchange rates
	E	International capital market controls
		i Foreign ownership / investment restrictions
		ii Capital controls
5	Regulation of Credit, Labor, and Business	
	A	Credit market regulations
		i Ownership of banks
		ii Foreign bank competition
		iii Private sector credit
		iv Interest rate controls / negative real interest rates
	B	Labor market regulations
		i Hiring regulations and minimum wage
		ii Hiring and firing regulations
		iii Centralized collective bargaining
		iv Hours regulations
		v Mandated cost of worker dismissal
		vi Conscription
	C	Business regulations
		i Price controls
		ii Administrative requirements (GCR)
		iii Bureaucracy costs
		iv Starting a business
		v Extra payments / bribes
		vi Licensing restrictions
		vii Cost of tax compliance

Note: Reproduced from Exhibit 1.1 in Gwartney et al. (2010a).

TABLES AND FIGURES

Figure 1. Time trends in mean of national average adult BMI and overall economic freedom between 1983 and 2008 for 82 high- and middle-income countries.



Sources: Economic freedom is taken from the Economic Freedom of the World index (Gwartney, Hall & Lawson, 2010b) and BMI data, for men and women separately, are from Finucane et al. (2011). Average of male and female BMI is calculated by the author, using information on gender fractions from the World Development Indicators database (World Bank, various years).

Figure 2. Relationship between the level of economic freedom (regulation dimension, time t) and the five-year change in adult mean BMI ($BMI(t+1)-BMI(t)$). $t=1983, 1988, 1993, 1998, 2003,$ and 2008.

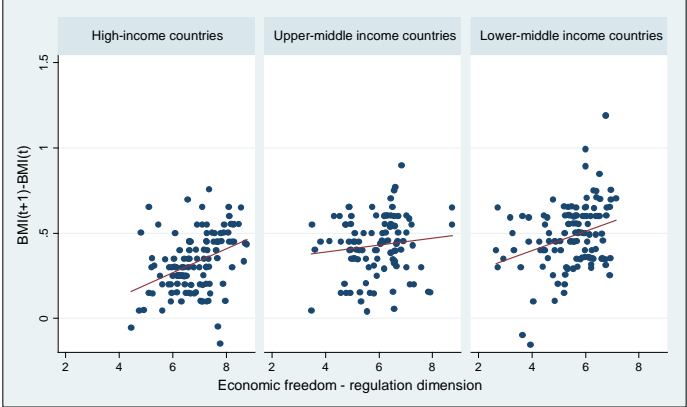


Figure 3. Relationship between the level of economic freedom (trade dimension) and five-year changes therein. $t=1983, 1988, 1993, 1998, 2003,$ and 2008.

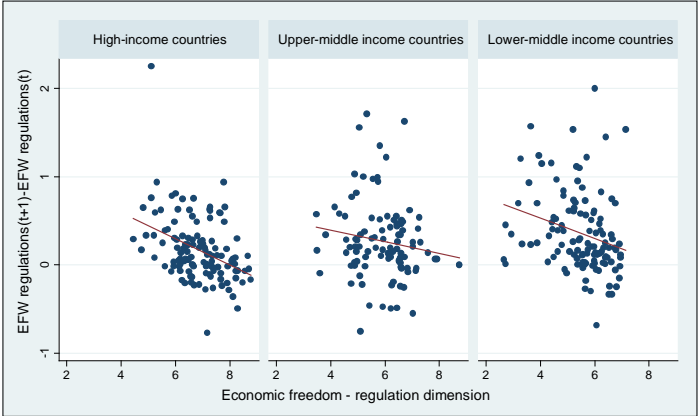


Figure 4. Relationship between five-year changes in economic freedom and contemporaneous changes in adult mean BMI. $t=1983, 1988, 1993, 1998, 2003,$ and 2008.

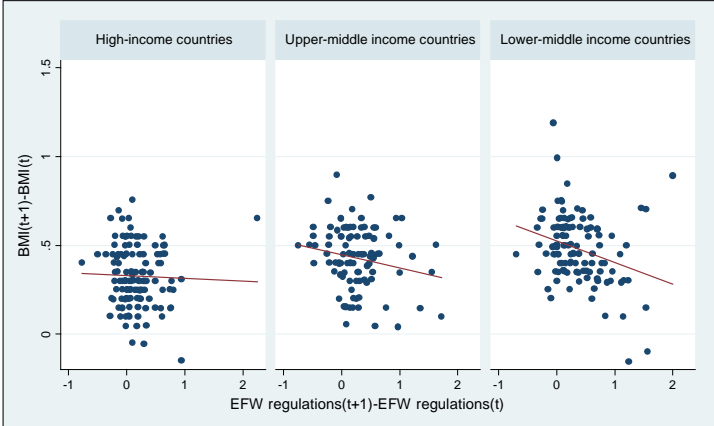


Table 1. List of countries included in the analysis.

Algeria	Chile	France	Korea	Panama	Sri Lanka
Argentina	Colombia	Germany	Kuwait	Pap. New Guinea	Sweden
Australia	Costa Rica	Greece	Latvia	Paraguay	Switzerland
Austria	Croatia	Guatemala	Lithuania	Peru	Syria
Bahrain	Cyprus	Hong Kong	Luxembourg	Philippines	Thailand
Barbados	Czech Rep.	Hungary	Malaysia	Poland	Trinidad & Tob.
Belgium	Denmark	Iceland	Malta	Portugal	Tunisia
Belize	Dominican Rep.	Iran	Mauritius	Romania	Turkey
Bolivia	Ecuador	Ireland	Mexico	Russia	United Kingdom
Botswana	Egypt	Israel	Morocco	Singapore	United States
Brazil	El Salvador	Italy	Namibia	Slovak Rep	Uruguay
Bulgaria	Estonia	Jamaica	Netherlands	Slovenia	Venezuela
Cameroon	Fiji	Japan	New Zealand	South Africa	
Canada	Finland	Jordan	Norway	Spain	

Table 2. Summary descriptive statistics per year.

Variable	1983 (n=54)				1988 (n=63)				1993 (n=68)				1998 (n= 80)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
BMI	24.2	1.2	21.2	26.4	24.5	1.2	21.7	27.0	24.9	1.1	22.1	27.3	25.4	1.2	21.9	28.6
BMI(t+1)-BMI(t)	0.4	0.2	-0.1	0.7	0.4	0.2	0.0	0.7	0.4	0.2	-0.2	0.8	0.4	0.2	0.0	1.0
EFW aggregate	6.0	1.3	3.5	9.0	6.2	1.2	3.6	8.8	6.5	1.1	4.1	8.9	6.7	1.0	4.4	9.0
EFW government	5.0	1.4	2.0	9.3	5.4	1.4	2.6	9.1	5.8	1.7	2.2	9.4	5.8	1.7	2.8	9.4
EFW legal structure	6.5	2.3	2.0	9.8	6.5	2.4	2.0	9.9	6.6	2.0	2.9	9.6	6.5	1.7	3.2	9.4
EFW sound money	6.6	2.2	0.9	9.6	6.8	2.3	0.1	9.7	7.2	2.2	0.1	9.8	7.6	2.0	1.7	9.8
EFW trade	6.2	1.7	2.7	9.8	6.4	1.6	3.2	9.8	6.8	1.3	3.7	9.8	7.2	1.0	4.8	9.8
EFW regulations	5.8	1.3	2.7	8.7	5.9	1.2	2.7	8.7	6.0	1.2	2.7	8.7	6.2	1.0	3.2	8.7
real GDP/cap PPP	12794	8610	2022	29506	13980	9938	1958	38020	14377	10720	2016	48294	15763	12003	2097	54618
ln(real GDP/cap)	9.2	0.8	7.6	10.3	9.2	0.8	7.6	10.5	9.3	0.8	7.6	10.8	9.4	0.8	7.6	10.9
female labor force (%)	34.7	8.0	13.8	47.1	36.3	8.3	14.6	48.0	37.8	7.9	17.9	48.4	39.0	7.5	19.9	48.3
educ: comp. secondary (%)	14.4	10.6	2.5	43.3	16.0	9.9	2.4	39.4	18.7	9.9	2.3	41.1	22.7	11.3	2.0	50.6
educ: comp. tertiary (%)	10.0	7.3	1.7	34.8	11.1	7.0	2.2	32.4	12.8	6.8	2.9	29.7	15.5	7.2	4.2	32.5
Variable	2003 (n=80)				2008 (n=80)				Mean 1983-2003 (n=345)							
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max				
BMI	25.9	1.3	22.2	29.2	26.3	1.4	22.6	30.0	25.1	1.4	21.2	29.2				
BMI(t+1)-BMI(t)	0.4	0.2	-0.1	1.2					0.4	0.2	-0.2	1.2				
EFW aggregate	6.9	0.9	4.1	8.8	7.0	0.8	4.4	9.0	6.5	1.1	3.5	9.0				
EFW government	6.2	1.4	3.3	9.0	6.3	1.3	3.1	9.3	5.7	1.6	2.0	9.4				
EFW legal structure	6.2	1.9	1.4	9.5	6.4	1.4	2.9	9.0	6.5	2.1	1.4	9.9				
EFW sound money	8.4	1.4	4.3	9.8	8.5	1.2	5.3	9.8	7.4	2.1	0.1	9.8				
EFW trade	7.1	1.1	4.4	9.7	7.0	1.0	3.5	9.6	6.8	1.4	2.7	9.8				
EFW regulations	6.5	1.0	3.9	8.8	6.8	0.9	4.1	8.7	6.1	1.2	2.7	8.8				
real GDP/cap PPP	17540	13303	2245	65537	20916	15710	2961	89814	15111	11313	1958	65537				
ln(real GDP/cap)	9.5	0.8	7.7	11.1	9.7	0.8	8.0	11.4	9.3	0.8	7.6	11.1				
female labor force (%)	40.0	7.4	19.5	49.8	40.8	7.4	18.2	49.6	37.9	8.0	13.8	49.8				
educ: comp. secondary (%)	25.2	12.5	1.8	64.1	27.9	13.5	1.5	69.1	19.9	11.6	1.8	64.1				
educ: comp. tertiary (%)	16.9	7.6	4.0	34.6	18.6	8.2	4.1	39.3	13.6	7.6	1.7	34.8				

Table 3. Pair-wise correlations between variables included in the analysis.

	a	b	c	d	e	f	g	h	i	j	k
a BMI	1										
b BMI(t)-BMI(t-1)	0.28	1									
c EFW aggregate	0.07	-0.08	1								
d EFW government	-0.06	0.37	0.16	1							
e EFW legal structure	0.04	-0.29	0.70	-0.41	1						
f EFW sound money	0.13	-0.08	0.81	-0.06	0.50	1					
g EFW trade	-0.01	-0.20	0.83	-0.01	0.59	0.62	1				
h EFW regulations	0.12	0.01	0.83	0.20	0.55	0.53	0.62	1			
i ln(real GDP/cap)	0.24	-0.31	0.65	-0.31	0.76	0.53	0.56	0.53	1		
j female labor force (%)	-0.12	-0.31	0.42	-0.12	0.43	0.28	0.38	0.47	0.48	1	
k educ: comp. secondary (%)	0.14	-0.19	0.39	-0.23	0.37	0.42	0.36	0.33	0.47	0.36	1
l educ: comp. tertiary (%)	0.15	-0.21	0.48	-0.20	0.45	0.47	0.43	0.41	0.55	0.43	0.92

Table 4. Results from the baseline model. Aggregate economic freedom index.

Dependent variable: Δ BMI							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EFW aggregate (t-1)	0.09*** (0.019)	0.09*** (0.019)	0.09*** (0.019)	0.09*** (0.020)	0.09*** (0.019)	0.09*** (0.019)	0.09*** (0.022)
ln(GDP cap) (t-1)		-0.16 (0.467)	0.06 (0.510)	0.03 (0.511)			
ln(GDP cap)^2 (t-1)		0.01 (0.026)	-0.01 (0.028)	-0.00 (0.029)			
female labor force (t-1)			0.80 (0.732)	0.81 (0.744)	1.14 (0.759)	1.04 (0.706)	0.98 (0.724)
educ: comp. secondary (t-1)				0.13 (0.364)	-0.08 (0.357)	-0.14 (0.343)	-0.16 (0.333)
educ: comp. tertiary (t-1)				-0.19 (0.630)	0.18 (0.547)	0.23 (0.532)	0.24 (0.533)
high (t-1)					-0.11*** (0.037)	-0.19*** (0.071)	-0.16 (0.180)
EFW aggregate * high (t-1)							-0.00 (0.026)
upper middle (t-1)						-0.08* (0.048)	-0.17 (0.153)
EFW aggregate * upper middle (t-1)							0.01 (0.023)
Observations	345	345	345	345	345	345	345
R-squared (within)	0.200	0.204	0.214	0.214	0.247	0.267	0.270
Number of countries	82	82	82	82	82	82	82

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

All models include country and time fixed effects.

Fraction females in the labor force and education are measured in decimal numbers.

Table 5. Results from decomposition of the aggregate economic freedom index. All countries.

Dependent variable: Δ BMI						
	(1)	(2)	(3)	(4)	(5)	(6)
EFW government (t-1)	0.04*** (0.012)					0.03** (0.011)
EFW legal structure (t-1)		0.01 (0.012)				0.00 (0.013)
EFW sound money (t-1)			0.03*** (0.006)			0.02*** (0.007)
EFW trade (t-1)				0.04** (0.016)		0.01 (0.020)
EFW regulations (t-1)					0.09*** (0.021)	0.05** (0.026)
high (t-1)	-0.18** (0.079)	-0.18** (0.075)	-0.23*** (0.074)	-0.18** (0.079)	-0.18** (0.074)	-0.20*** (0.073)
upper middle (t-1)	-0.08 (0.053)	-0.08 (0.049)	-0.10** (0.049)	-0.08 (0.054)	-0.08 (0.051)	-0.09* (0.048)
female labor force (t-1)	0.98 (0.717)	0.71 (0.712)	1.09 (0.702)	0.68 (0.763)	0.96 (0.692)	1.23* (0.713)
educ: comp. secondary (t-1)	-0.12 (0.342)	-0.23 (0.380)	-0.23 (0.345)	-0.36 (0.344)	-0.07 (0.324)	-0.06 (0.352)
educ: comp. tertiary (t-1)	0.49 (0.582)	0.58 (0.604)	0.43 (0.543)	0.69 (0.533)	0.19 (0.550)	0.12 (0.573)
Observations	345	345	345	345	345	345
R-squared (within)	0.202	0.152	0.222	0.193	0.233	0.289
Number of countries	82	82	82	82	82	82

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
All models include country and time fixed effects.

Table 6. Results from decomposition of the aggregate economic freedom index. Separated by income group.

<i>High-income countries</i>							
Dependent variable: Δ BMI	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EFW aggregate (t-1)	0.08*** (0.026)						
EFW government (t-1)		0.01 (0.015)					-0.00 (0.012)
EFW legal structure (t-1)			0.01 (0.024)				0.01 (0.019)
EFW sound money (t-1)				0.03*** (0.009)			0.02 (0.010)
EFW trade (t-1)					0.05* (0.027)		0.02 (0.027)
EFW regulations (t-1)						0.08** (0.031)	0.07*** (0.024)
Observations	124	124	124	124	124	124	124
R-squared (within)	0.254	0.157	0.155	0.236	0.190	0.249	0.303
Number of countries	31	31	31	31	31	31	31
<i>Upper-middle-income countries</i>							
Dependent variable: Δ BMI	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EFW aggregate (t-1)	0.06* (0.030)						
EFW government (t-1)		0.05** (0.023)					0.03 (0.023)
EFW legal structure (t-1)			0.03 (0.025)				0.02 (0.023)
EFW sound money (t-1)				0.01 (0.012)			0.01 (0.012)
EFW trade (t-1)					0.03 (0.034)		0.01 (0.043)
EFW regulations (t-1)						0.02 (0.043)	-0.02 (0.055)
Observations	101	101	101	101	101	101	101
R-squared (within)	0.380	0.379	0.351	0.346	0.359	0.332	0.398
Number of countries	35	35	35	35	35	35	35
<i>Lower-middle-income countries</i>							
Dependent variable: Δ BMI	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EFW aggregate (t-1)	0.13*** (0.039)						
EFW government (t-1)		0.07*** (0.025)					0.05** (0.022)
EFW legal structure (t-1)			0.00 (0.023)				0.03 (0.023)
EFW sound money (t-1)				0.02* (0.011)			-0.00 (0.012)
EFW trade (t-1)					0.06** (0.022)		0.03 (0.024)
EFW regulations (t-1)						0.14*** (0.034)	0.11*** (0.032)
Observations	120	120	120	120	120	120	120
R-squared (within)	0.303	0.271	0.127	0.162	0.189	0.349	0.448
Number of countries	38	38	38	38	38	38	38

Robust standard errors in parentheses

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

All models include country and time fixed effects, and controls for the logarithm of PPP-adjusted GDP per capita, the fraction of females in the labor force, and education.

Table 7. Sensitivity analysis: results from alternative specifications.

Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Δ BMI	Δ BMI	BMI	Δ BMI	Δ BMI	BMI	Δ BMI	Δ BMI
	Eq. 1	Eq. 3	Eq. 4	Eq. 1	Eq. 3	Eq. 4	Eq. 5	Eq. 5
EFW aggregate (t-1)	0.09*** (0.019)		0.08 (0.057)				0.10*** (0.021)	
Δ EFW aggregate		-0.04 (0.032)					0.02 (0.026)	
EFW government (t-1)				0.03** (0.011)		0.04 (0.033)		0.03** (0.013)
Δ EFW government					-0.02 (0.016)			0.01 (0.013)
EFW legal structure (t-1)				0.00 (0.013)		0.06** (0.031)		0.01 (0.015)
Δ EFW legal structure					0.03** (0.014)			0.01 (0.013)
EFW sound money (t-1)				0.02*** (0.007)		-0.01 (0.017)		0.02*** (0.008)
Δ EFW sound money					-0.01* (0.008)			0.01 (0.008)
EFW trade (t-1)				0.01 (0.020)		0.06 (0.042)		0.00 (0.021)
Δ EFW trade					0.01 (0.026)			0.00 (0.014)
EFW regulations (t-1)				0.05** (0.026)		-0.06 (0.057)		0.03 (0.027)
Δ EFW regulations					-0.05 (0.032)			-0.03 (0.021)
high (t-1)	-0.19*** (0.071)		-0.26* (0.145)	-0.20*** (0.073)		-0.18 (0.140)	-0.20*** (0.072)	-0.21*** (0.076)
Δ high		0.03 (0.046)			0.07 (0.046)			
upper middle (t-1)	-0.08* (0.048)		-0.04 (0.090)	-0.09* (0.048)		-0.00 (0.079)	-0.08 (0.050)	-0.09* (0.051)
Δ upper middle		0.06*** (0.020)			0.08*** (0.023)			
female labor force (t-1)	1.04 (0.706)		3.67** (1.726)	1.23* (0.713)		3.06* (1.764)	1.03 (0.713)	1.18* (0.660)
Δ female labor force		0.87 (1.106)			0.34 (1.125)			
educ: comp. secondary (t-1)	-0.14 (0.343)		1.62 (1.112)	-0.06 (0.352)		1.50 (1.170)	-0.18 (0.345)	-0.12 (0.338)
Δ comp. secondary		-0.04 (0.671)			-0.01 (0.679)			
educ: comp. tertiary (t-1)	0.23 (0.532)		-5.15*** (1.518)	0.12 (0.573)		-4.95*** (1.532)	0.27 (0.540)	0.23 (0.588)
Δ comp. tertiary		-1.45** (0.560)			-1.56*** (0.578)			
Constant	-0.47 (0.288)	0.37*** (0.035)	23.17*** (0.799)	-0.59* (0.310)	0.38*** (0.037)	23.28*** (0.822)	-0.51* (0.291)	-0.51* (0.277)
Observations	345	345	345	345	345	345	345	345
R-squared	0.267	0.061	0.888	0.289	0.089	0.894	0.271	0.308

Robust standard errors in parentheses. Regressions include all (n=82) countries.

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