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## The Freer the Fatter? A Panel Study of the Relationship between Body-Mass Index and Economic Freedom

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Working Paper 2013:23

Department of Economics  
School of Economics and Management

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## A Panel Study of the Relationship between Body-Mass Index and Economic Freedom

Åsa Ljungvall

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# The freer the fatter?

## A panel study of the relationship between body-mass index and economic freedom

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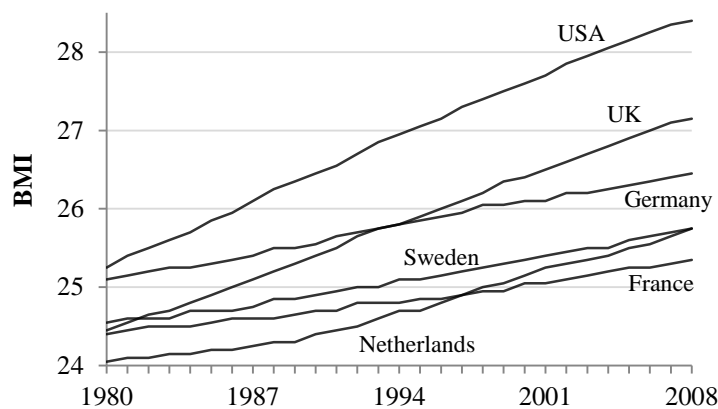
### **Abstract**

Along with the economic and technological developments of the past decades, obesity has become a growing public health problem. This study empirically investigates whether the large and widespread increases in body-mass index (BMI) that have been observed around the world are related to economic freedom, as measured and defined by the Economic Freedom of the World Index. Economic freedom is part of the environment in which individuals make choices about food intake and physical activity, and may encourage unhealthy behavior and affect body weight by changing the opportunity sets. It may for example affect the quality and quantity of foods available to consumers, the access to safety nets, and the access to environments for physical activity. The empirical analysis is based on a panel of 31 high-income countries and data for the period 1983 to 2008. It finds a positive and statistically significant relationship between the level of economic freedom and both the level of, and five-year change in, BMI. Decomposing the freedom index into sub-indices measuring economic freedom in five sub-areas (government, legal structure, sound money, trade, and regulations) shows that freedom in the regulations dimension is the most consistent contributor to this result.

## 1. Introduction

In modern times, technological and economic developments have increased individual welfare in many ways. However, whereas improvements have certainly taken place in many dimensions, obesity is an increasing problem and internationally recognized as a serious threat to public health with large economic impacts on society. Figure 1 shows the development in adult mean body-mass index (BMI, calculated as weight in kilos divided by squared height in meters,  $\text{kg}/\text{m}^2$ ), which is the most widely used indicator of body fat, for six selected OECD countries between 1980 and 2008. As can be seen, the level of BMI differs across countries, but increases are observed in all countries, with some countries experiencing larger increases than others.

**Figure 1. Trends in adult mean BMI for six selected countries.**



*Source:* Finucane et al. (2011). Average of female and male BMI calculated by author.

Obesity is not a problem that is unique to affluent countries. Also affected are lower-income developing countries, where obesity and undernourishment sometimes exist side by side (WHO 2012; Popkin 2002; Chopra et al. 2002). Global obesity prevalence has more than doubled since 1980; nowadays more than ten percent of the adult world population is obese, and overweight ranks fifth in the list of risks of death globally (WHO 2012). The simple explanation to this development is clear: energy intake is larger than energy use. The technological development, allowing for more sedentary lifestyles and more industry produced foods, is a quite uncontroversial condition for this fact, but there are different viewpoints about the individual decision processes behind the development. From a traditional economics point of view, changed relative prices, increased budget constraints, and decreased time costs of food preparation, all of which are enabled by the technological development, are reasonable explanations to the increasing obesity rates. However, given that obesity and its health consequences can be considered quite unpleasant, it is somewhat difficult to understand why a rational utility maximizing individual chooses to be obese if all information is taken into account. The presence of weight-loss programs, which tend to attract a lot of people, and the willingness to undergo surgery, can be interpreted as evidence that the chosen weight status is not a fully considered and

desirable decision after all. Hyperbolic discounting (Cutler et al. 2003; Redden 2007), the tendency to keep with default options (Thaler and Sunstein 2003; Wisdom et al. 2010), sub-optimal choice environments produced by so-called inappropriate opportunity market failures (Anand and Gray 2009), social norms (Oswald and Powdthavee 2007; Etilé 2007; Burke and Heiland 2007), and a dual decision model where an affective system interacts with the standard economic rational decision process (Ruhm 2012) are alternative, or complementary, approaches to the individual decision process behind the increases in obesity.

In developed countries there are well-documented socioeconomic disparities, particularly among women, where lower socioeconomic groups are more likely to be obese than other groups (Sassi 2010, chap. 3; Zhang and Wang 2004; Molarius et al. 2000; Ljungvall and Gerdtham 2010; Ljungvall and Zimmerman 2012). One interpretation of this result is that economic resources, neighborhood differences, health knowledge, and other *individual-level* characteristics are important explanations for the risk of obesity. However, different socioeconomic groups share a large part of the *increasing time trend*, and large increases in obesity and BMI are observed in all groups (Truong and Sturm 2005; Devaux and Sassi 2011; Ljungvall and Zimmerman 2012). Hence, the increases illustrated in Figure 1 are not limited to lower socioeconomic groups. As a result, the literature increasingly points towards social, contextual, or environmental factors, rather than individual-level characteristics, as important explanations for the widespread increases in obesity (Zhang and Wang 2004; Cummins and Macintyre 2006; Wang and Beydoun 2007).

Accordingly, this study focuses on contextual factors. The purpose is to investigate whether the large and widespread increases in BMI that have been observed around the world are related to economic freedom. Like BMI, economic freedom has increased considerably in recent times. Factors related to economic freedom are part of the environment in which individuals make decisions. An environment with more economic freedom may encourage unhealthy behavior by affecting the quality and quantity of foods available to consumers, by affecting access to safety nets, and by affecting access to environments for physical activity, leading to increases in BMI.

## **2. Economic Freedom and BMI**

To measure and define economic freedom, this study uses the definition from the *2010 Annual Report of Economic Freedom of the World* (Gwartney et al. 2010), where economic freedom is broadly defined as protection of people and their property, and as individuals' right to choose for themselves. Hence, it clearly emphasizes the role of the individual. Personal choice, voluntary exchange coordinated by markets, freedom to enter and compete in markets, and protection of people and their property are fundamental characteristics of economic freedom. The Economic Freedom of the World Index (EFW) (Gwartney et al. 2010) has been constructed to reflect these aspects. It consists of five sub-indices that, in addition to the aggregate measure of overall economic freedom, can be used as measures of economic freedom in five dimensions:

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.

Eating and physical activity – two fundamental determinants of body size – are behaviors where habits and norms are likely to play important roles in the decision making process. Different environments may create different norms and habits, and different levels of economic environments may thereby shape different behaviors. Swinburn et al. (2011) discuss changes in the food system as key drivers of the increases in BMI. Their framework recognizes what they call *systemic drivers*, such as taxation regimes, regulations, and social and economic policies, i.e. factors related to economic freedom, as important underlying drivers. By affecting the food system, these systemic drivers also affect the development in BMI. One example of a food system driver is food marketing, which influences consumption and is regarded as being an important cause of the rise in obesity (Chandon and Wansink 2011; Zimmerman 2011). Food marketing is arguably more pronounced where markets are less regulated and where there is more competition, i.e. when there is more economic freedom. Hence, through different types of regulations, the degree of economic freedom may affect the intensity of marketing actions, which in turn may be an important driver of increases in BMI.

Swinburn et al. (2011) further consider the increased supply of cheap calorie and energy-dense products, and improved distribution systems as part of the global food system. Similarly, Cutler et al. (2003) suggest that “mass production” is driving the increases in obesity around the world. They argue that technological innovations, which facilitate packaging, storage, and transportation of foods, have led to a shift from individual to mass preparation of food, allowing us to eat more through decreased time costs of food and increased, instant, and continuous access to food. An implication of this argument is that when and where technological progress related to food production is more widespread, and where food manufacturers have better and easier access to new production technologies, obesity should be more prevalent (Cutler et al. 2003). The degree of economic freedom, through trade and regulations, may affect the spread of new technologies, which in turn may affect food intake and thereby BMI.

Another example of how economic freedom may be related to increases in BMI is through the role of the government. According to the definition of economic freedom, a larger public sector means a lower degree of economic freedom, because increasing government spending takes place instead of

choices by individuals, households and businesses, and thereby it restricts individual choice (Gwartney et al. 2010). However, a larger public sector may facilitate encouragement of healthy behavior and implementation of preventive policies by offering more instruments for communication and implementation. Well-functioning public transportation, parks and other facilities for physical activities, and safe roads for walking and cycling are examples of potentially obesity-preventing public goods that are likely to attract more resources when the public sector is larger. Further, a large public sector usually means that services such as day care and schools are paid for by the government, which may facilitate health-promoting changes, for example through the type of food served in schools. Hence, economic freedom, in terms of the size of the government, may affect norms and habits regarding food and physical activity, which in turn affect BMI.

A fourth potential link between economic freedom and increases in BMI springs from the so-called economic insecurity hypothesis. Smith et al. (2009) argue that perception of economic insecurity, such as risk of unemployment or other income loss, creates stress, which leads to overeating. Further, Offer et al. (2010) argue that economic insecurity is more pronounced in “market-liberal” countries. Hence, economic freedom may affect the perception of insecurity, which then affects BMI. One possible mechanism between economic freedom and insecurity is social safety nets: A larger public sector may imply larger social safety nets, which increase the individual’s perception of security. However, insecurity may be reflected in additional dimensions of economic freedom, such as through less regulated labor markets that may increase the perception of insecurity for workers.

To summarize, the overall argument of a link between economic freedom and the large and widespread increases in BMI is that an environment with more economic freedom in general, and in particular sub-components like regulations, trade, or the size of government, affect how people behave. Regulations and trade may affect the quantity and quality of food available to consumers through new food technologies, marketing, and competition. With a larger public sector there may be more channels through which public health can be promoted, and health-promoting public goods are likely to attract more resources. More economic freedom may also increase the perception of insecurity. With time, factors like these create habits, norms, or a culture of unhealthy behavior leading to increases in BMI. The examples in this section are primarily related to regulations, trade, and the government. Consequently, based on this discussion, of the sub-indices of EFW, the government, trade, and regulation indices should have the largest impact on increases in BMI.

### **3. Previous empirical evidence**

A couple of previous 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. (2003) 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) use absence of price controls and ease of market entry, both taken from the EFW, as two proxies for technological innovation and explore whether these are related to the total number of calories supplied in the country. Controlling for time and country fixed effects, they find a positive and significant association between caloric supply and ease of market entry among OECD countries in the 1995 to 2002 period. The relationship between caloric supply and absence of price controls is also positive, but insignificant.

Smith et al. (2009) test the economic insecurity hypothesis on U.S. individual-level longitudinal data. Using an instrumental variables approach, 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. Offer et al. (2010) analyze national aggregate data from eleven OECD countries for the period 1994 to 2004, and find that greater economic insecurity, as measured by Lars Osberg’s index of economic well-being, and “market liberalism” (where four countries are classified as market liberal) are related to higher obesity prevalence. They conclude that the effects of increasing the supply of cheap and more accessible food have been larger in “market liberal” countries.

This analysis extends previous results by exploring a panel of countries and/or by examining a longer time period. It also adds to the existing empirical evidence in that it uses internationally comparable data on BMI, whereas previous studies use a mix of self-reported and measured information that comes from country-specific surveys, sometimes based on different age groups. At the conceptual level it takes a broader approach by focusing on economic freedom as a measure of the environment in which individuals make decisions, arguing that this environment affects choices and contribute to the creation of norms and habits.

#### 4. Methods

The empirical analysis is based on an unbalanced panel of countries observed up to six points in time over a period of 25 years: 1983, 1988, 1993, 1998, 2003, and 2008. Similar to previous studies (Cutler et al. 2003; Bleich et al. 2008; Offer et al. 2010), the focus is on high-income countries. 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). Appendix Table A1 lists the countries included in the final sample.

The following model is used to estimate the relationship between economic freedom and increases in BMI:

$$BMI_{it} - BMI_{it-1} = \Delta BMI_{it} = \alpha + \beta * EFW_{it-1} + \mathbf{x}_{it-1} * \boldsymbol{\gamma} + \mu_i + \varepsilon_{it} \quad (1)$$



*BMI* is the measure of national adult mean BMI for country  $i$  in year  $t$ . Hence,  $\Delta BMI$  is the five-year change in BMI. *EFW* is the measure of economic freedom, and is either the aggregated index or a vector of the five sub-indices.  $\mathbf{x}_i$  is a row vector of additional controls.  $\mu$  is a time-invariant country-specific effect, and  $\varepsilon$  is a time-varying error that includes unobserved factors affecting the dependent variable, assumed to be random with  $\varepsilon_{it} \sim IID(0, \sigma_\varepsilon^2)$ .

Equation 1 is estimated using the random effects (RE) and fixed effects (FE) estimators. The former assumes that the  $\mu$ 's are uncorrelated with the regressors, whereas the latter allows for such correlation and controls for unobserved variables which are time-invariant. A Hausman-like test is used to test the plausibility of the assumption underlying the RE model.<sup>1</sup>

Whereas equation 1 relates the *level* of economic freedom to *changes* in BMI during the subsequent five years, equation 2 explores whether economic freedom is related to the *level* of BMI:

$$BMI_{it} = \alpha + \beta * EFW_{it-1} + \mathbf{x}_{it-1} * \boldsymbol{\gamma} + \mathbf{t}_i * \boldsymbol{\delta} + \mu_i + \varepsilon_{it} \quad (2)$$

where notation is as before. As Figure 1 illustrated, there is a clear increasing trend in the level of BMI, and equation 2 therefore adds a flexible time trend: the row vector  $\mathbf{t}$  consists of four binary time variables. Equation 2 is also estimated using both the RE and FE estimators, and their difference is tested by the Hausman-like test. The lag of all 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 becomes detectable. Because BMI changes slowly, this is a plausible specification from a theoretical point of view.<sup>2</sup>

There are important differences between the models expressed in equations 1 and 2. Equation 1 relates economic freedom to BMI *irrespective of the level of BMI*, and captures the development of BMI. In contrast, the model in equation 2 does not distinguish economies that are growing (in physical terms) from those that are not. A relatively large increase in BMI accompanied by a high level of economic freedom would not be captured by equation 2 if this increase occurred in a country with a relatively low level of BMI. In this sense the model in equation 2 captures past relationships

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<sup>1</sup> More specifically, the difference between RE and FE is tested by the *xtoverid* command in Stata. *xtoverid* is a command for testing overidentifying restrictions, and the no-correlation assumption made in the RE model can be seen as an overidentifying restriction. An advantage of the *xtoverid* command over the Hausman test command in Stata is that country clustered standard errors can be dealt with. Hence, the reported test results take country clustering of standard errors into account.

<sup>2</sup> A third alternative specification would be to include lagged levels of BMI in equation 2. This alternative does not change the conclusions based on equation 1 and 2, and the full results from this specification are available from the author upon request. Adding a lagged dependent variable as explanatory variable in a RE or FE model necessarily introduces bias, because this variable is correlated with the error term (e.g. Baltagi 2008, pp. 147-148). Therefore, two alternative estimators were used: ordinary pooled OLS, where  $\mu$  is ignored and treated as part of the random error term, and, to also allow for  $\mu$ , the bias-corrected least square dummy variable estimator (LSDV-c, implemented in Stata by the *xtlsdv* command), which is adjusted for and considered to work well for unbalanced panels with a small number of individuals (Bruno 2005). Note that if the coefficient of the lagged dependent variable equals 1, the specification reduces to equation 1. For the LSDV-c estimations, the coefficient of the lagged dependent variable varied between 0.92 and 0.98, which t-tests could not distinguish from unity. For the pooled OLS model, the coefficient of the lagged dependent variable varied between 1.06 and 1.09.

that have been going on for longer times, whereas the model in equation 1 can be considered to capture more short-term current effects that are occurring within the period captured by the sample.

## 5. Data

To measure changes and cross-country differences in BMI, cross-country comparable data on average BMI for adults 20 years and older from *The Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group* (Finucane et al. 2011) are used. These data have been elaborated with the specific aim of producing worldwide comparative estimates of BMI (and other risk factors), constituting an important improvement over earlier available international data on BMI and obesity. In other datasets, data for different countries correspond to different age groups, are sometimes nationally and sometimes only regionally representative, as well as based on objectively measured height and weight for some countries, but on self-reports for other countries. These issues have been adjusted for in the data used in this study, thereby providing a greatly enhanced foundation for cross-country analyses.

The BMI data are reported for men and women separately. To produce joint BMI, the average between the male and female averages is calculated, weighted by the fraction of each gender for each year, using information from the World Development Indicators.

The chain-linked version of the Economic Freedom of the World index (EFW) from the 2010 dataset (Gwartney et al. 2010) is used to measure economic freedom.<sup>3</sup> EFW assigns a value between zero and ten to each country, where a higher value corresponds to more economic freedom. For the period 1970 to 2000, it is available on a five-year basis only. Estimates for 1983, 1988, 1993, and 1998 are linearly interpolated based on the values from the nearest years before and after with available data.

Control variables in  $x$  include purchasing power adjusted GDP per capita in constant prices (2005 international dollars), and five-year growth rates calculated from this information. Further control variables include the percentage of females in the labor force, and the percentage of the population 25 years and older with completed secondary and post-secondary education, respectively. The GDP data come from the Penn World Table (Heston et al. 2011). Information on females in the labor force is taken from the World Development Indicators, and the education data come from Barro and Lee (2010).

At the individual level, education and income tend to be negatively related to BMI, and the same relationship could therefore be expected at the aggregate level. However, if obesity is related to development and higher income levels, and the education and income variables reflect this aggregate effect, a positive relationship could instead be expected. The fraction of females in the labor force is

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<sup>3</sup> 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. Hence, observed changes in the index over time are not driven by the inclusion of new variables.

included as a potential driver of 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. 2003; Loureiro and Nayga, 2005; Egger et al. 2012).

Table 1 shows descriptive statistics per year and (unweighted) averages of the 1983-2003 period for the final sample. Between 1983 and 2003, national mean BMI increases by 1.3 BMI points, and economic freedom by 0.6 index points. Over the full period, the (absolute) increase in freedom in the government and sound money dimensions are largest, whereas cross-country average economic freedom in the legal structure dimension decreases by one index point. 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 0.8 in 2003. Regarding changes in economic freedom, the average within-country five-year change in overall economic freedom is 0.13 index points, ranging from -0.56 to 1.04 (not shown in the table).

## 6. Results

### 6.1. Aggregate economic freedom index

#### 6.1.1 Change in BMI (equation 1)

Table 2 reports the results from estimating equation 1 with the RE and FE estimators. In columns 1 and 2, without controlling for any additional variables, there is a positive and statistically significant relationship between economic freedom and changes in BMI. According to the RE model, a one unit increase in the freedom index implies a 0.07 larger increase in BMI the next coming five years, which corresponds to about 23 percent of the average five-year change in BMI, and to about 35 percent of the corresponding standard deviation (see Table 1).

Columns 3 and 4 add GDP per capita and its square, and columns 5 and 6 add the log of GDP per capita instead. In both cases, higher levels of income are unrelated to changes in BMI, indicating that the observed relationship between economic freedom and increases in BMI in columns 1 and 2 is not mediated by higher incomes. Adding the five-year contemporaneous growth (columns 7-8) shows that high growth rates are also not a channel through which higher levels of economic freedom are related to increases in BMI. Further, adding the fraction of females in the labor force in columns 9-10 and education in columns 11-12 has no impact on the relationship between economic freedom and increases in BMI.

In all specifications reported in columns 1-12, the RE and FE results are similar, but with a tendency for the FE model to give a somewhat stronger relationship. The p-values from the Hausman test are reported at the bottom of the table. In five of the six specifications, the test does not reject the assumptions underlying the RE model. However, in the specification with the full set of control variables (columns 11-12), the test suggests that the FE model is preferred.

Columns 13-16 include squared EFW, without additional control variables in columns 13-14, and with the full set of controls in columns 15-16. In both the FE and RE models, the EFW variables are jointly significant, suggesting a non-linear relationship where the effects are larger for higher values of EFW. The turning point, reported at the bottom of the table, is at low levels of economic freedom and, hence, the effect is positive for all levels of economic freedom in the sample. To illustrate the non-linearity, Figure 2 depicts the predicted effect on  $\Delta BMI$  of a one unit increase in the freedom index, based on the specifications reported in columns 13-16, for different in-sample levels of EFW. The FE model predicts larger effects than the RE model. Compared to the model with a linear effect, marked with dots in Figure 2, the models with non-linear relationships predict larger effects for values of EFW above 6.5, which includes about 90 percent of the sample. Hence, in most cases the model with a linear relationship tends to understate the size of the effect rather than overstate it.

**Table 1. Descriptive statistics.**

	1983 (n=19)				1988 (n=20)				1993 (n=24)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
BMI	24.6	0.8	21.8	25.6	24.9	0.8	21.9	26.2	25.1	1.0	22.1	26.8
BMI(t+1)-BMI(t)	0.3	0.2	-0.1	0.7	0.3	0.2	0.0	0.7	0.3	0.2	0.0	0.6
EFW aggregate	7.0	0.8	5.6	8.2	7.3	0.6	6.1	8.3	7.5	0.8	5.3	8.9
EFW government	4.3	1.1	2.1	6.7	4.6	1.2	2.6	6.6	5.0	1.7	2.6	9.4
EFW legal structure	8.9	0.7	7.0	9.8	9.2	1.0	5.7	9.9	8.8	0.9	6.0	9.6
EFW sound money	7.9	1.8	2.7	9.6	8.6	1.1	5.0	9.7	9.2	0.9	5.7	9.8
EFW trade	7.4	0.9	5.6	8.8	7.6	0.8	5.7	8.8	7.9	0.9	6.3	9.8
EFW regulations	6.6	0.8	4.5	8.1	6.7	0.9	4.7	8.3	6.9	1.0	4.8	8.7
real GDP/cap PPP (1000s of \$)	23.0	2.9	18.4	29.5	26.3	4.4	18.2	38.0	27.0	6.2	18.0	48.3
ln(real GDP/cap)	3.1	0.1	2.9	3.4	3.3	0.2	2.9	3.6	3.3	0.2	2.9	3.9
five-year growth (%)*	15.8	5.6	7.8	34.3	5.6	8.1	-11.0	27.0	14.7	8.7	2.0	45.2
female labor force (%)	40.6	4.0	33.6	47.1	40.7	6.9	16.1	47.7	42.1	3.7	36.2	47.6
education: comp. secondary (%)	23.7	11.4	2.5	43.3	24.9	10.0	2.4	39.4	25.5	10.0	2.3	41.1
education: comp. tertiary (%)	16.3	8.0	4.5	34.8	17.3	6.9	4.7	32.4	18.3	6.6	5.0	29.7
	1998 (n=30)				2003 (n=31)				Mean 1983-2003 (n=124)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
BMI	25.5	1.2	22.4	28.6	25.9	1.4	22.5	29.2	25.3	1.2	21.8	29.2
BMI(t+1)-BMI(t)	0.3	0.2	0.0	0.7	0.4	0.2	-0.1	0.8	0.3	0.2	-0.1	0.8
EFW aggregate	7.4	0.8	5.6	9.0	7.6	0.6	6.6	8.8	7.4	0.7	5.3	9.0
EFW government	5.1	1.7	2.8	9.4	5.8	1.3	3.4	9.0	5.0	1.5	2.1	9.4
EFW legal structure	8.2	1.1	5.8	9.4	7.9	1.2	5.6	9.5	8.5	1.1	5.6	9.9
EFW sound money	9.2	1.0	5.3	9.8	9.4	0.4	8.2	9.8	8.9	1.2	2.7	9.8
EFW trade	8.0	0.9	5.7	9.8	7.8	0.8	5.5	9.7	7.8	0.9	5.5	9.8
EFW regulations	6.7	1.0	5.1	8.7	7.1	0.9	5.3	8.8	6.8	0.9	4.5	8.8
real GDP/cap PPP (1000s of \$)	29.0	8.3	15.7	54.6	31.9	9.3	17.7	65.5	28.0	7.6	15.7	65.5
ln(real GDP/cap)	3.3	0.3	2.8	4.0	3.4	0.3	2.9	4.2	3.3	0.2	2.8	4.2
five-year growth (%)*	11.8	8.1	-0.4	35.5	14.8	9.2	0.9	39.6	12.7	8.8	-11.0	45.2
female labor force (%)	42.3	4.7	23.2	47.4	42.8	5.8	21.5	47.9	41.9	5.1	16.1	47.9
education: comp. secondary (%)	26.4	10.0	2.0	44.6	28.6	11.2	1.8	49.1	26.1	10.5	1.8	49.1
education: comp. tertiary (%)	19.6	6.7	5.7	32.5	21.0	6.5	6.4	32.6	18.8	7.0	4.5	34.8

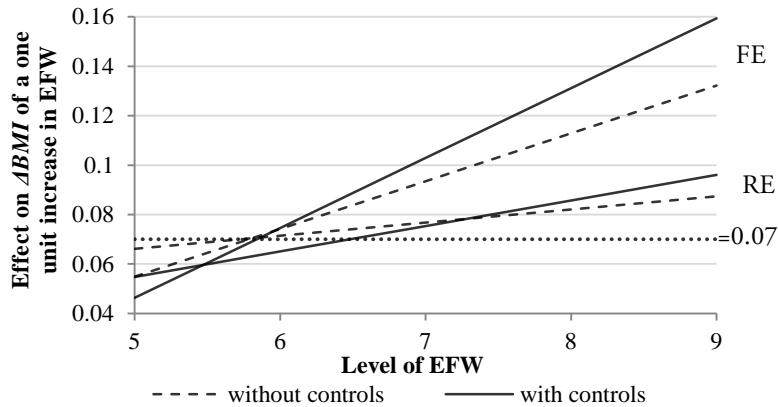
**Note:** \* five-year growth (t)=(GDP/cap(t+1)-GDP/cap(t))/(GDP/cap(t)), where GDP/cap refers to PPP-adjusted GDP per capita in constant prices.

**Table 2. Regression results based on equation 1.**

Estimator:	Dependent variable: $\Delta\text{BMI} = \text{BMI}(t) - \text{BMI}(t-1)$															
	RE 1	FE 2	RE 3	FE 4	RE 5	FE 6	RE 7	FE 8	RE 9	FE 10	RE 11	FE 12	RE 13	FE 14	RE 15	FE 16
EFW (t-1)	0.07*** (0.017)	0.08*** (0.016)	0.07*** (0.023)	0.08*** (0.024)	0.07*** (0.020)	0.09*** (0.020)	0.07*** (0.020)	0.09*** (0.021)	0.07*** (0.021)	0.09*** (0.021)	0.07*** (0.022)	0.09*** (0.022)	0.04 (0.202)	-0.05 (0.220)	-0.00 (0.205)	-0.11 (0.219)
EFW squared (t-1)													0.00 (0.014)	0.01 (0.016)	0.01 (0.014)	0.01 (0.016)
GDP/cap (t-1)			0.00 (0.006)	-0.00 (0.007)												
GDP/cap squared (t-1)			-0.00 (0.000)	-0.00 (0.000)												
ln(GDP/cap) (t-1)					0.00 (0.059)	-0.01 (0.063)	-0.00 (0.064)	-0.01 (0.068)	0.06 (0.076)	0.03 (0.102)	0.03 (0.085)	0.01 (0.111)			0.03 (0.085)	-0.00 (0.108)
five-year growth rate (t-1)							-0.00 (0.001)	-0.00 (0.001)	0.00 (0.001)	-0.00 (0.001)	-0.00 (0.001)	-0.00 (0.001)			-0.00 (0.001)	-0.00 (0.001)
female labor force (t-1)									-0.01 (0.005)	-0.00 (0.008)	-0.01** (0.005)	-0.01 (0.007)			-0.01** (0.005)	-0.01 (0.007)
educ: comp. 2nd (t-1)											-0.00 (0.003)	-0.00 (0.003)			-0.00 (0.003)	-0.00 (0.003)
educ: comp. 3rd (t-1)											0.01* (0.005)	0.00 (0.007)			0.01* (0.005)	0.00 (0.007)
Constant	-0.21 (0.138)	-0.29** (0.121)	-0.21 (0.139)	-0.30** (0.121)	-0.21 (0.179)	-0.27 (0.166)	-0.20 (0.189)	-0.26 (0.175)	-0.13 (0.196)	-0.24 (0.184)	0.04 (0.211)	-0.15 (0.233)	-0.08 (0.730)	0.17 (0.763)	0.29 (0.771)	0.55 (0.838)
Hausman-like test (p-value)	0.129		0.215		0.316		0.444		0.387		0.039		0.346		0.004	
Joint significance (p-value)													0.000	0.000	0.001	0.001
Turning point														2.669	0.195	3.862

*Notes:* Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Number of observations: 124. Number of countries: 31.

**Figure 2. Illustration of the non-linear effect (equation 1).**



*Note:* Illustration of the non-linear effect of a one unit increase in EFW on  $\Delta BMI$  (equation 1) for different levels of EFW as predicted by the estimations in columns 13-16 in Table 2.

### 6.1.2 Level of BMI (equation 2)

Table 3 shows the results based on equation 2 for a selection of specifications. In columns 1 and 2, the linear relationship between BMI and lagged levels of economic freedom is positive, but insignificant. The non-linear relationship in columns 3 and 4 fits the data better with joint significance of the freedom index variables as found at the bottom of the table. The model suggests a U-shaped relationship that turns into a positive effect when EFW is larger than about 6.5, which includes about 90 percent of the observations in the sample.

Regarding control variables, there is a positive relationship between BMI and GDP per capita. A ten percent higher GDP per capita implies a 0.08-0.10 index point higher BMI, which is similar in size to the effect of a one unit increase in EFW according to columns 1 and 2. Adding the five-year growth rate does not have any additional effect in columns 7-10. Columns 9 and 10 suggest that BMI increases with the fraction of females in the labor force, which is in line with the hypothesis that reallocation of labor within and outside the household might play a role. A larger fraction of adults with post-secondary education has a negative impact on the level of BMI. The EFW variables remain jointly significant throughout.

Following the results of the Hausman tests reported at the bottom of Table 3, Figure 3 illustrates the size of the effect of a one unit increase in EFW for the in-sample range of freedom, for the FE model without controls (column 4) and for the FE model with the full set of control variables (column 10). First, adding controls to the model has only a small effect on the estimated relationship between economic freedom and BMI as illustrated by the similarity between the dashed and solid lines in Figure 3. Second, compared to the insignificant effect in the model with a linear relationship, the models with a non-linear relationship predict rather large effects of economic freedom on BMI for a large part of the EFW range.

In sum, estimating equations 1 and 2 using the aggregate economic freedom index consistently results in a positive and significant relationship. Hence, the level of economic freedom appears related

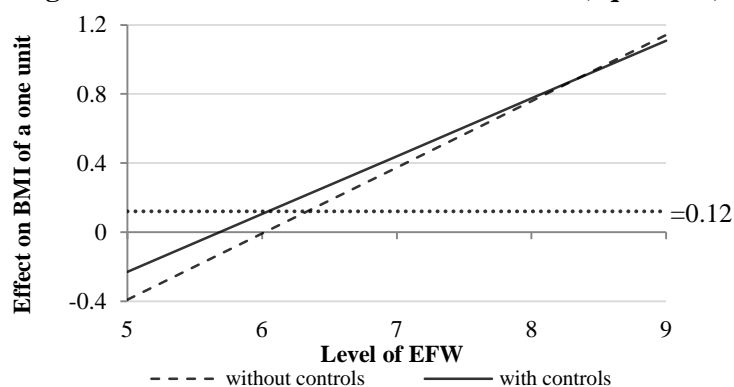
to both increases in BMI, signifying on-going effects, and the level of BMI, indicating that the economic freedom variable also captures relationships with BMI that have been going on for longer times and which have spilled over in a relationship also with the level of BMI.

**Table 3. Regression results based on equation 2.**

Estimator:	Dependent variable: BMI(t)									
	RE 1	FE 2	RE 3	FE 4	RE 5	FE 6	RE 7	FE 8	RE 9	FE 10
EFW (t-1)	0.10 (0.115)	0.12 (0.126)	-2.26** (0.982)	-2.50** (0.969)	-2.21** (1.022)	-2.47** (1.004)	-2.19** (1.015)	-2.45** (0.998)	-1.86* (0.982)	-2.07** (1.005)
EFW squared (t-1)			0.17** (0.068)	0.19*** (0.067)	0.17** (0.071)	0.19*** (0.069)	0.17** (0.070)	0.19*** (0.069)	0.15** (0.068)	0.17** (0.071)
ln(GDP/cap) (t-1)					0.77** (0.323)	0.89** (0.365)	0.84* (0.462)	1.02** (0.491)	0.87* (0.466)	0.91* (0.484)
five-year growth rate (t-1)							0.00 (0.005)	0.00 (0.005)	0.00 (0.004)	0.00 (0.004)
female labor force (t-1)									0.05** (0.025)	0.08*** (0.027)
educ: comp. 2nd (t-1)									0.02 (0.015)	0.03* (0.014)
educ: comp. 3rd (t-1)									-0.06*** (0.018)	-0.07*** (0.018)
Hausman-like test (p-value)	0.00		0.00		0.00		0.00		0.00	
Joint significance (p-value)			0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Turning point			6.58	6.52	6.51	6.43	6.52	6.43	6.30	6.19

**Notes:** \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Robust standard errors in parentheses. All specifications time variables (not reported). Number of observations: 124. Number of countries: 31.

**Figure 3. Illustration of the non-linear effect (equation 2).**



**Note:** Illustration of the non-linear effect of a one unit increase in EFW on the level of BMI (equation 2) for different levels of EFW as predicted by the estimations in columns 4 and 10 in Table 3, together with the effect predicted by the FE models with a linear relationship (column 2).

## 6.2. Sub-indices of economic freedom

### 6.2.1 Change in BMI (equation 1)

Table 4 contains the results based on equation 1, controlling for the five sub-indices of EFW instead of the aggregate index, for four different specifications, using the FE estimator, which is the preferred model according to the Hausman test. The regulation dimension is the main driver of the overall effect that was observed previously. The sound money dimension is also positive and significant, but the effect is smaller. As for the aggregate index, the effect of freedom is basically unaffected by the inclusion of more controls, and these additional covariates are generally both small and insignificant.

**Table 4. Regression results based on equation 1.  
Sub-indices of economic freedom.**

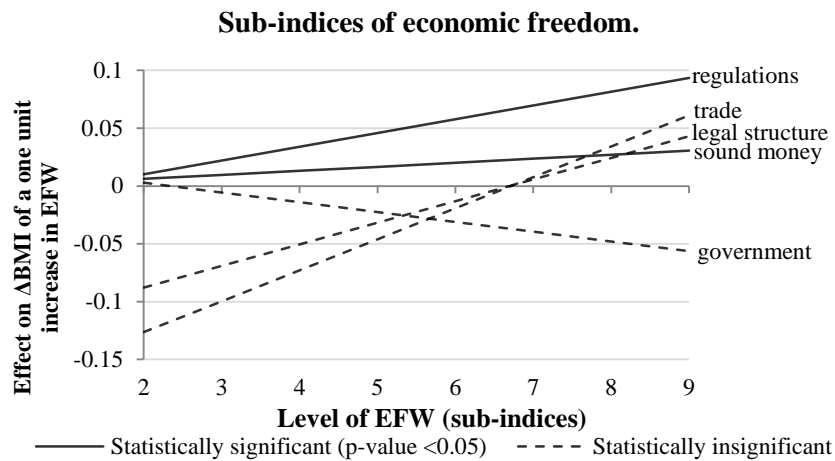
Estimator:	Dependent variable: $\Delta BMI = BMI(t) - BMI(t-1)$				
	FE	FE	FE	FE	FE
	1	2	3	4	5
EFW government (t-1)	-0.01 (0.012)	-0.01 (0.011)	-0.01 (0.011)	-0.01 (0.011)	-0.01 (0.011)
EFW legal structure (t-1)	0.02 (0.020)	0.02 (0.020)	0.02 (0.020)	0.02 (0.020)	0.02 (0.019)
EFW sound money (t-1)	0.02** (0.008)	0.02** (0.008)	0.02** (0.008)	0.02** (0.009)	0.02** (0.009)
EFW trade (t-1)	0.01 (0.019)	0.01 (0.019)	0.01 (0.021)	0.02 (0.022)	0.02 (0.023)
EFW regulations (t-1)	0.05** (0.018)	0.05** (0.020)	0.05** (0.021)	0.06** (0.021)	0.06** (0.021)
ln(GDP/cap) (t-1)		-0.02 (0.065)	-0.03 (0.074)	0.02 (0.108)	0.01 (0.113)
five-year growth rate (t-1)			-0.00 (0.001)	-0.00 (0.001)	-0.00 (0.001)
female labor force (t-1)				-0.00 (0.007)	-0.01 (0.008)
educ: comp. secondary (t-1)					0.00 (0.004)
educ: comp. tertiary (t-1)					0.00 (0.007)
Hausman-like test (p-value)	0.001	0.000	0.000	0.000	0.000

*Note:* Number of observations: 124. Number of countries: 31.

As in the case of the aggregate index, there is some evidence of non-linearities in the effects. Figure 4 illustrates the results based on the FE model, including squared terms of the five sub-indices without additional controls, by depicting the estimated effect on  $\Delta BMI$  of a one unit increase in the particular freedom index for different levels of freedom. Similar to the linear effect reported in Table 4, the regulation and access to sound money dimensions are positive and significant. The effect of freedom in the regulation dimension increases with the level of freedom, and ranges from around 0.05 for relatively low levels of freedom to around 0.08 for relatively high levels. The effect of freedom in the sound money dimension is smaller and almost linear. Adding control variables does not affect the results in Figure 4 markedly, and none of the control variables are significant (results not shown).



**Figure 4. Illustration of the non-linear effect (equation 1).**



*Notes:* Illustration of the non-linear effect of a one unit increase in EFW sub-indices on  $\Delta BMI$  (equation 1) for different levels of EFW, based on the FE model without control variables. Statistical significance refers to joint significance of the two sub-index variables (level and squared term). p-value for regulation sub-index: 0.01. p-value for sound money sub-index: 0.03.

### 6.2.2 Level of BMI (equation 2)

Table 5 reports the results based on equation 2, where the level of BMI is regressed on lagged values of the five sub-indices and their squares, with and without control variables, using the FE estimator. The RE and FE results are very similar, but the p-values from the Hausman test of the RE and FE models suggest that the FE model fits the data better. Figure 5 illustrates the non-linear effects.

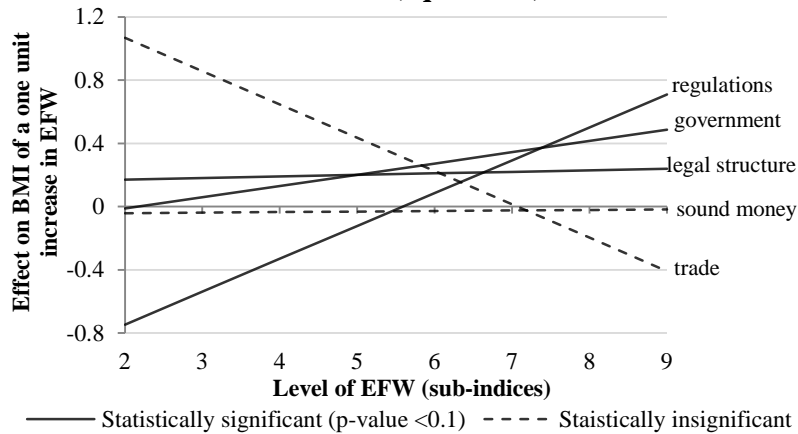
For most of the in-sample range of freedom in the regulation dimension (4.5-8.8, see Table 1), there is a positive effect on BMI. However, in contrast to the results based on equation 1, there is no apparent relationship between freedom in the sound money dimension and the level of BMI, but there is an additional positive and statistically significant effect of freedom in both the government and legal structure dimensions. Hence, freedom in the regulation dimension is positive and significantly related to the *level* of, and to within-the-sample-period on-going *increases* in, BMI. Freedom in the sound money dimension appears related to, for the period, on-going increases in BMI, but this effect does not spill over to a relationship with the level of BMI. On the other hand, freedom in the legal structure and government dimensions appears un-related to increases in BMI during the period of study, but are related to higher BMI. Thus, although there are factors related to freedom in the government and legal structure dimensions that are related to higher levels of BMI, more freedom in these two dimensions does not appear to be related to larger five-year increases between 1983 and 2008.

**Table 5. Regression results based on equation 2 using the FE estimator.  
Sub-indices of economic freedom.**

Dependent variable: BMI(t)		
Estimator: FE	1	2
EFW government (t-1)	-0.30 (0.192)	-0.19 (0.126)
squared	0.05** (0.020)	0.04** (0.013)
EFW legal structure (t-1)	0.63 (0.456)	0.15 (0.338)
squared	-0.03 (0.032)	0.00 (0.023)
EFW sound money (t-1)	0.02 (0.150)	-0.05 (0.106)
squared	-0.00 (0.010)	0.00 (0.007)
EFW trade (t-1)	-0.21 (1.317)	1.60 (0.972)
squared	0.01 (0.086)	-0.11 (0.064)
EFW regulations (t-1)	-1.17** (0.520)	-1.27** (0.558)
squared	0.09** (0.040)	0.10** (0.044)
ln(GDP/cap) (t-1)		1.30** (0.482)
five-year growth rate (t-1)		0.00 (0.003)
female labor force (t-1)		0.07*** (0.019)
educ: comp. secondary (t-1)		0.03** (0.013)
educ: comp. tertiary (t-1)		-0.06*** (0.017)
Hausman-like test (p-value)	0.00	0.00
<b>Joint significance (p-value):</b>		
EFW government	0.01	0.00
EFW legal structure	0.00	0.00
EFW sound money	0.98	0.66
EFW trade	0.72	0.27
EFW regulations	0.10	0.07
<b>Turning points:</b>		
EFW government	3.29	2.68
EFW legal structure	11.12	
EFW sound money	5.70	14.77
EFW trade	12.29	7.57
EFW regulations	6.54	6.09

*Notes:* Robust standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. All specifications include time variables (not reported). Number of observations: 124. Number of countries: 31.

**Figure 5. Illustration of the non-linear effect (equation 2). Sub-indices of economic freedom.**



**Notes:** Illustration of the non-linear effect of a one unit increase in EFW sub-indices on the level of BMI (equation 2) for different levels of EFW. Based on the FE model with the full set of control variables reported in column 2 of Table 5. Statistical significance refers to joint significance of the two sub-index variables (level and squared term).

### 6.3. Robustness

#### 6.3.1 Non-liberal countries

One concern is that the results in the previous sections are driven by only a few Anglo-Saxon countries that are known to have a high degree of economic freedom, and also to have experienced large increases in BMI or have high mean adult BMI. Table 6 summarizes the results from the analysis excluding the U.S., the U.K., Canada, and Australia (columns marked “excl.”), which are the four countries that Offer et al. (2010) define as “market-liberal” in their study. To facilitate comparison, columns marked “all” repeat the corresponding results from the main analysis including all countries. The reported values in the table are the predicted effects of a one unit increase in the freedom index (aggregate or sub-indices) for different in-sample levels of EFW. Numbers in italics indicate that the effect is insignificant, i.e. that the freedom variable and its square are jointly insignificant in the regression. Estimations of both equations 1 and 2 are based on the FE estimator, as suggested by the Hausman tests. Equation 1 is estimated without additional controls, as these are insignificant and do not alter the effect of freedom. However, because the control variables have a larger impact on the level of BMI, equation 2 includes time variables and the full set of control variables (i.e.  $\ln(\text{GDP}/\text{cap})$ , the five-year growth rate, the percentage of females in the labor force, and the fraction with completed secondary and tertiary education).

For the aggregate freedom index, columns 1 and 2 show that the relationship between freedom and increases in BMI (equation 1) remains, and is stronger, when excluding the U.S., the U.K., Canada, and Australia. The association with the level of BMI (equation 2) is very similar in both samples. Decomposition into sub-indices in columns 3-12 shows that the same sub-indices are driving the overall effect in both samples (sound money and regulations in equation 1; government, legal structure, and regulations in equation 2). For equation 2, freedom in the government dimension

appears less related, and particularly freedom in the regulations dimension appears more related, to the level of BMI in the restricted sample.

**Table 6. Summary of results based on sample that excludes the U.S., the U.K., Canada, and Australia.**

		EFW aggregate		EFW sub-index										
				government		legal structure		sound money		trade		regulations		
		all	excl.	all	excl.	all	excl.	all	excl.	all	excl.	all	excl.	
		1	2	3	4	5	6	7	8	9	10	11	12	
<b>Equation 1 - dependent variable: <math>\Delta BMI</math></b>														
Level of EFW		2		<i>0.00</i>	<i>-0.01</i>			0.01	-0.02					
		3		<i>-0.01</i>	<i>-0.01</i>			0.01	-0.01					
		4			<i>-0.01</i>	<i>0.00</i>			0.01	0.00			0.03	0.01
		5	0.05	0.01	<i>-0.02</i>	<i>0.00</i>	<i>-0.03</i>	<i>-0.01</i>	0.02	0.01	<i>-0.05</i>	<i>0.01</i>	0.05	0.03
		6	0.07	0.07	<i>-0.03</i>	<i>0.01</i>	<i>-0.01</i>	<i>0.00</i>	0.02	0.01	<i>-0.02</i>	<i>0.01</i>	0.06	0.05
		7	0.09	0.13	<i>-0.04</i>	<i>0.02</i>	<i>0.01</i>	<i>0.01</i>	0.02	0.02	<i>0.01</i>	<i>0.00</i>	0.07	0.08
		8	0.11	0.19	<i>-0.05</i>	<i>0.02</i>	<i>0.02</i>	<i>0.03</i>	0.03	0.03	<i>0.03</i>	<i>0.00</i>	0.08	0.10
		9	0.13	0.25	<i>-0.06</i>	<i>0.03</i>	<i>0.04</i>	<i>0.04</i>	0.03	0.04	<i>0.06</i>	<i>0.00</i>	0.09	0.12
		<b>Equation 2 - dependent variable: BMI</b>												
Level of EFW		2		<i>-0.01</i>	<i>0.04</i>			<i>-0.04</i>	<i>-0.07</i>					
		3		<i>0.06</i>	<i>0.07</i>			<i>-0.04</i>	<i>-0.06</i>					
		4			0.13	0.09			<i>-0.03</i>	<i>-0.05</i>			-0.33	-0.39
		5	-0.23	-0.10	0.20	0.12	0.20	0.14	<i>-0.03</i>	<i>-0.03</i>	<i>0.44</i>	<i>0.50</i>	-0.12	-0.10
		6	0.11	0.20	0.27	0.15	0.21	0.18	<i>-0.03</i>	<i>-0.02</i>	<i>0.22</i>	<i>0.29</i>	0.09	0.19
		7	0.44	0.50	0.34	0.18	0.22	0.22	<i>-0.02</i>	<i>0.00</i>	<i>0.01</i>	<i>0.09</i>	0.29	0.48
		8	0.77	0.80	0.41	0.20	0.23	0.27	<i>-0.02</i>	<i>0.01</i>	<i>-0.20</i>	<i>-0.12</i>	0.50	0.76
		9	1.11	1.10	0.49	0.23	0.24	0.31	<i>-0.02</i>	<i>0.03</i>	<i>-0.41</i>	<i>-0.32</i>	0.71	1.05

**Notes:** The table reports the effect of a one unit increase in EFW on i)  $\Delta BMI$  in the upper part of the table, estimating equation 1 by the FE estimator without additional controls; and ii)  $BMI$  in the lower part of the table, estimating equation 2 by the FE estimator, including the full set of controls and time variables. Columns marked “all” report the main results from the previous sections, and are illustrated in Figures 2-5. Italics refer to joint insignificance of the two freedom variables (level and square). Results are reported for in-sample levels of EFW only.

### 6.3.2 Male and female BMI

Table 7 draws attention to whether the relationship between economic freedom and BMI differs across gender. Similarly to Table 6, Table 7 reports the effects of a one unit increase in the freedom index for different levels of EFW. Again, numbers in italics indicate that the effect is insignificant, equation 1 is based on the FE estimator without additional controls, and equation 2 is based on the FE estimator including time variables and the full set of controls.

For the aggregate index, columns 1 and 2 show that the effect of economic freedom on changes in BMI (equation 1) is insignificant for female BMI. Hence, the result of a relationship between the level of economic freedom and increases in BMI in the main analysis seems to be driven mainly by an effect of economic freedom on changes in male BMI. Accordingly, the decomposition into sub-indices in column 3-12 shows that freedom in the sound money and regulation dimensions, which are the primary drivers in the main analysis, is positive and significant for male BMI only, and essentially

zero for female BMI. For female BMI there is a positive and significant effect of freedom in the legal structure dimension which did not appear in the main analysis.

The relationship between economic freedom and the *level* of BMI (equation 2) is significant for both female and male BMI, and appears stronger for female BMI. Freedom in the government and legal structure dimensions are positive and significant for both male and female BMI, although the effect of freedom in the government dimension is particularly stronger for female BMI. Freedom in the regulation dimension is significant only for female BMI, but still mostly positive for male BMI as well.

**Table 7. Summary results for male and female BMI.**

		EFW aggregate		EFW sub-index									
		female	male	government		legal structure		sound money		trade		regulations	
		1	2	female	male	female	male	female	male	female	male	female	male
Equation 1 - dependent variable: $\Delta BMI$													
Level of EFW	2			<i>-0.01</i>	<i>0.01</i>			<i>0.04</i>	<i>-0.03</i>				
	3			<i>-0.01</i>	<i>0.00</i>			<i>0.04</i>	<i>-0.02</i>				
	4			<i>-0.02</i>	<i>-0.01</i>			<i>0.03</i>	<i>-0.01</i>			<i>0.08</i>	<i>-0.01</i>
	5	<i>0.07</i>	<i>0.04</i>	<i>-0.02</i>	<i>-0.02</i>	<i>-0.01</i>	<i>-0.05</i>	<i>0.02</i>	<i>0.01</i>	<i>-0.04</i>	<i>-0.04</i>	<i>0.06</i>	<i>0.03</i>
	6	<i>0.04</i>	<i>0.10</i>	<i>-0.02</i>	<i>-0.04</i>	<i>0.01</i>	<i>-0.03</i>	<i>0.02</i>	<i>0.02</i>	<i>-0.02</i>	<i>-0.01</i>	<i>0.04</i>	<i>0.08</i>
	7	<i>0.02</i>	<i>0.17</i>	<i>-0.03</i>	<i>-0.05</i>	<i>0.03</i>	<i>-0.01</i>	<i>0.01</i>	<i>0.04</i>	<i>0.01</i>	<i>0.01</i>	<i>0.02</i>	<i>0.12</i>
	8	<i>-0.01</i>	<i>0.23</i>	<i>-0.03</i>	<i>-0.06</i>	<i>0.05</i>	<i>0.00</i>	<i>0.00</i>	<i>0.05</i>	<i>0.03</i>	<i>0.04</i>	<i>0.00</i>	<i>0.16</i>
	9	<i>-0.03</i>	<i>0.30</i>	<i>-0.04</i>	<i>-0.07</i>	<i>0.07</i>	<i>0.02</i>	<i>0.00</i>	<i>0.06</i>	<i>0.06</i>	<i>0.06</i>	<i>-0.02</i>	<i>0.20</i>
	Equation 2 - dependent variable: BMI												
Level of EFW	2			<i>-0.02</i>	<i>0.00</i>			<i>-0.07</i>	<i>-0.02</i>				
	3			<i>0.07</i>	<i>0.05</i>			<i>-0.06</i>	<i>-0.02</i>				
	4			<i>0.16</i>	<i>0.09</i>			<i>-0.05</i>	<i>-0.02</i>			<i>-0.56</i>	<i>-0.10</i>
	5	<i>-0.34</i>	<i>-0.11</i>	<i>0.26</i>	<i>0.14</i>	<i>0.28</i>	<i>0.11</i>	<i>-0.04</i>	<i>-0.02</i>	<i>0.47</i>	<i>0.41</i>	<i>-0.25</i>	<i>0.00</i>
	6	<i>0.12</i>	<i>0.09</i>	<i>0.35</i>	<i>0.19</i>	<i>0.28</i>	<i>0.13</i>	<i>-0.03</i>	<i>-0.02</i>	<i>0.27</i>	<i>0.19</i>	<i>0.07</i>	<i>0.10</i>
	7	<i>0.58</i>	<i>0.29</i>	<i>0.44</i>	<i>0.24</i>	<i>0.28</i>	<i>0.16</i>	<i>-0.03</i>	<i>-0.02</i>	<i>0.06</i>	<i>-0.03</i>	<i>0.38</i>	<i>0.21</i>
	8	<i>1.05</i>	<i>0.49</i>	<i>0.53</i>	<i>0.29</i>	<i>0.28</i>	<i>0.18</i>	<i>-0.02</i>	<i>-0.03</i>	<i>-0.15</i>	<i>-0.25</i>	<i>0.69</i>	<i>0.31</i>
	9	<i>1.51</i>	<i>0.69</i>	<i>0.62</i>	<i>0.34</i>	<i>0.28</i>	<i>0.21</i>	<i>-0.01</i>	<i>-0.03</i>	<i>-0.36</i>	<i>-0.47</i>	<i>1.00</i>	<i>0.41</i>

**Notes:** The table reports the effect of a one unit increase in EFW on i)  $\Delta BMI$  in the upper part of the table, estimating equation 1 by the FE estimator without additional controls; and ii) *BMI* in the lower part of the table, estimating equation 2 by the FE estimator, including the full set of controls and time variables. Italics refer to joint insignificance of the two freedom variables (level and square). Results are reported for in-sample levels of EFW only.

## 7. Conclusions

This study explores a potential relationship between BMI and economic freedom at the national level, defined and measured by the Economic Freedom of the World Index, focusing on high-income countries. It takes its starting point in the failure of individual-level characteristics such as education, income, and race/ethnicity to explain the large and widespread increases in adult BMI, and takes the view that the environment in which individuals make decisions shapes norms and habits, and thereby affects behavior. Economic freedom may affect individual behavior through for example the quality and quantity of food, access to social safety nets, and urban planning.

Summarizing the results of the empirical analysis, there is a statistically significant relationship between the level of economic freedom and *increases* in national adult mean BMI, as well as between economic freedom and the *level* of BMI. In both cases there is evidence of non-linearities. For the relationship with five-year changes in BMI, the effect increases with the level of economic freedom, and the different models suggest that a one unit increase in the economic freedom index has an effect of 0.07 to 0.16. For the relationship with the level of BMI, the effect also increases with the level of freedom, going from a negative effect of -0.2 for low degrees of freedom to about 1.1 for the most free. Controlling for income level and growth generally has only minor effects on the estimated effect of economic freedom. Hence, more economic freedom leading to higher incomes and growth does not seem to explain the observed relationships between economic freedom and BMI.

Decomposition into sub-components of the aggregate index suggests that freedom in the regulation dimension contributes significantly to the relationship between economic freedom and increases in, as well as the level of, BMI. In addition, freedom in the sound money dimension contributes to the relationship with increases in BMI, but to a quantitatively smaller extent. For the relationship between economic freedom and the level of BMI, freedom in the government dimension plays a role, and legal structure contributes to a smaller extent.

Excluding the four “market-liberal” and the Anglo-Saxon countries, the U.S., the U.K., Canada, and Australia, does not affect the results substantially, and hence the results are not driven by any peculiar situation that is unique to these countries. Separating male and female BMI indicates that the effect of freedom on *increases* in BMI is primarily driven by changes in male BMI. Economic freedom is related to the *level* of both male and female BMI. However, it is stronger for female BMI, and the effect of freedom in the regulation dimension is significant for female BMI only.

Taken together, this study suggests that there is a relationship between economic freedom and BMI in high-income countries. Freedom in the regulation dimension is the sub-index that most consistently appears to play a role. Perceived insecurity, via regulations of the labor market, and the structure, power, and functioning of food markets, potentially affecting the quality and quantity of food available to consumers, via regulations of food technologies, marketing, and competition, are potential explanations, but more research is needed to explore the underlying mechanisms in more detail. To accurately disentangle potential mechanisms and to further and more carefully explore the drivers, more detailed data on factors such as food industry regulations, product differentiation, and advertising are needed. Moreover, further research is needed to explore the relationship and development also in less affluent countries. As many of these countries are undergoing economic progress and becoming more involved in the world economy, it is important to investigate how this progress is related to the increasing obesity rates and dietary changes taking place in these countries.

The technological and economic progress, to a large extent accompanied by more economic freedom, that many countries have experienced since the 1980s have had many positive effects on individual welfare. Economic freedom is related to growth (Berggren 2003; de Haan and Sturm 2000;

Dawson 1998, 2003; Gwartney and 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) reveals 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 et al. (2010) also use the Economic Freedom of the World index to explore a potential economic freedom and child mortality relationship. They find no 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. In contrast, the results in this study suggest that economic freedom is also related to some unhealthy behavior, and 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.

## APPENDIX

**Table A1. List of countries included in the analysis.**

Australia	Hong Kong (1993, 1998, 2003)	Norway
Austria	Iceland	Portugal (1998, 2003)
Bahrain (1988, 2003)	Ireland (1993, 1998, 2003)	Singapore (1993, 1998, 2003)
Belgium	Israel (1993, 1998, 2003)	Slovenia (1998, 2003)
Canada	Italy	Spain (1993, 1998, 2003)
Cyprus (1998, 2003)	Japan	Sweden
Denmark	Korea (1998, 2003)	Switzerland
Finland	Kuwait (1998, 2003)	United Kingdom
France	Luxembourg	United States
Germany	Netherlands	
Greece (1988, 2003)	New Zealand	

**Notes:** If no years are listed together with the country, it is in the sample all five years 1983, 1988, 1993, 1998, and 2003. Being in the sample in for example 2003 means that economic freedom and other control variables are observed this year, and BMI in 2008.



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