Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.

This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

http://www.elsevier.com/authorsrights

Author's personal copy

Journal of Comparative Economics 41 (2013) 621–633

Contents lists available at SciVerse ScienceDirect

Journal of Comparative Economics

journal homepage: www.elsevier.com/locate/jce

Does legal heritage affect obesity? The channel of motor vehicle dependence

Paul S. Carlin [a,*], Michael P. Kidd [b], Mehmet A. Ulubaşoğlu [c]

[a] IUPUI, Indianapolis, IN, USA
[b] School of Economics and Finance, Queensland University of Technology, Brisbane, QLD, Australia
[c] School of Accounting, Economics and Finance, Deakin University, Melbourne, VIC, Australia

ARTICLE INFO

Article history:
Received 20 November 2011
Revised 30 August 2012
Available online 25 September 2012

JEL classification:
I1
P48
P51

Keywords:
Common law
Civil law
Obesity
Motor vehicles
OECD

ABSTRACT

Carlin, Paul S., Kidd, Michael P., and Ulubaşoğlu, Mehmet A.—Does legal heritage affect obesity? The channel of motor vehicle dependence

We find a robust relationship between motor vehicle ownership, its interaction with legal heritage and obesity in OECD countries. Our estimates indicate that an increase of 100 motor vehicles per thousand residents is associated with about a 6% point increase in obesity in common law countries, whereas it has a much smaller or insignificant impact in civil law countries. These relations hold whether we examine trend data and simple correlations, or conduct cross-section or panel data regression analysis. Our results suggest that obesity rises with motor vehicle ownership in countries following a common law tradition where individual liberty is encouraged, whereas the link is small or statistically non-existent in countries with a civil law background where the rights of the individual tend to be circumscribed by the power of the state. *Journal of Comparative Economics* **41** (2) (2013) 621–633. IUPUI, Indianapolis, IN, USA; School of Economics and Finance, Queensland University of Technology, Brisbane, QLD, Australia; School of Accounting, Economics and Finance, Deakin University, Melbourne, VIC, Australia.
© 2012 Association for Comparative Economic Studies Published by Elsevier Inc. All rights reserved.

1. Introduction

We contribute to the literature on the impact of governmental behavior on human welfare by establishing a surprising link between legal heritage and rising obesity in the developed world. Obesity represents an international epidemic affecting millions around the globe, with a myriad of government interventions consuming significant state and national budgets. Given current growth rates, obesity is projected to afflict 103 million Americans prior to the end of the decade. The US is projected to spend $344 billion on obesity related health care problems corresponding to 21% of healthcare spending, with a per-capita expense of $1425 (Thorpe, 2009). Obesity is often quoted as the fastest growing public concern in many countries, leading to thousands of deaths annually and closely linked to many adverse medical conditions.

We examine OECD data on per capita motor vehicle ownership and obesity in the context of legal heritage. Utilizing a range of empirical techniques including the analysis of trend data, simple correlations, cross-sectional and panel data, we find significant evidence of a direct relationship between motor vehicle ownership and obesity.[1] Interestingly, the link is very

* Corresponding author. Address: IUPUI, 425 University Blvd., Indianapolis, IN 46202-5140, USA. Fax: +1 317 274 0097.
E-mail addresses: pcarlin@iupui.edu (P.S. Carlin), michael.kidd@qut.edu.au (M.P. Kidd), maulubas@deakin.edu.au (M.A. Ulubaşoğlu).

[1] We use the standard definition of obesity. Given weight in kilograms (kg) and height in meters (m), an individual is considered obese if their body mass index (=kg/m^2) exceeds 30.

0147-5967/$ - see front matter © 2012 Association for Comparative Economic Studies Published by Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.jce.2012.09.001

Author's personal copy

strong in countries with a common law heritage and either non-existent or very much weaker in countries with a civil law heritage. The finding is not entirely unexpected as common law tends to restrict while civil law extends the power of the state, affecting in turn choices regarding motor vehicle ownership. Our results suggest that countries with a common law heritage may be at a disadvantage in combating the obesity promoting effects of motor vehicle ownership. This indicates how a constitutional arrangement such as a legal system may interact with daily choices of individuals to produce severe public health problems with social and economic consequences. Our results contrast with the burgeoning literature echoing Hayek (1973) which points to the superiority of common law for economic welfare, see La Porta et al. (1998) and Acemoglu and Johnson (2005).

Two core competing explanations for the rising tide of obesity both in the US and elsewhere[2] are (i) the role of reduced exercise, especially on the job, see Lakdawalla and Philipson (2005), Philipson (2001) and Philipson and Posner (1999) and (ii) increased calorie intake, see Cutler et al. (2003). Thus ceteris paribus increases in calorie intake or reductions in physical activity lead to an increase in weight.

Philipson emphasizes the role of technological change in reducing the physical expenditure of calories per hour worked in the market and at home. This raises the cost of expending calories as time is diverted from passive to active leisure activities rather than exercise being a by-product of work hours. Following the lead of La Porta et al. (1999), Cutler et al. stress the role of legal heritage and regulatory authority on access to food preparation technology. Restricted access to such technology raises the price of fast, calorie-heavy meals, thus limiting the caloric intake and hence the development of obesity.[3]

La Porta et al. (1999) argue that common law tradition (as in England) is a proxy for intent to limit the state while civil law tradition as in France, Germany and other European countries is a proxy for intent to extend the power of the state. Common law countries tend to emphasize the private rights of individuals in any regulation; civil law countries focus regulation on obtaining an appropriate resolution from the state's viewpoint. Quoting Damaska (1986), La Porta et al. (2008) express the difference as: while common law is "dispute resolving", civil law is "policy implementing". Further, alluding to Pistor (2006), they argue that common law supports "unconditioned private contracting" in contrast to French Civil Law, which embraces "socially conditioned private contracting". Given that legal system refers to over-arching ideas, rules and regulations in a country, La Porta et al. (2008) "adopt a broad conception of legal origin as a style of social control of economic life (and maybe of other aspects of life as well)" (p. 3). Strong support is provided by diverse literatures demonstrating the impact of legal origin on several spheres of economic life, including financial development, unemployment, investment and business formation, the size of the unofficial economy, and international trade together with economic growth (e.g., La Porta et al., 2002; Djankov et al., 2002; Botero et al., 2004, and Mulligan and Shleifer, 2005. See La Porta et al., 2008 and the references therein).

There are at least two channels for legal systems to affect obesity through motor vehicle ownership. The first channel is direct motor vehicle regulation and the second is indirect via restrictions on urban sprawl. Following La Porta et al.'s (2008) notion that the influence of legal origin extends to social control of life, one may argue that, in civil law countries, the state tends to place greater restraint on the private use of motor vehicles, particularly in regard to commuting. These restraints often take the form of high taxes, parking fees and restrictions, limited spaces, or outright bans on motor vehicle usage. The Transportation Research Board (2001) notes that, "Gasoline prices are indeed much higher in Western Europe than in the United States, mainly because of higher taxes. Moreover, motor vehicle sales and excise taxes, registration charges, license fees, and other government levies are higher." On parking, the Transportation Research Board reports that fewer than 10% of American commuters pay any parking fee. In contrast, "Although many Western European businesses also provide free parking for their customers and employees, a higher proportion of businesses are located in commercial districts where parking is limited by available space and government regulations." This latter quote makes it clear that governments in Western Europe (with predominantly civil law heritage) tend to restrict parking. This suggests that increased motor vehicle ownership in common law countries will have fewer restraints placed on individual discretion; in civil law countries, regulation will channel the reliance of motor vehicles in ways the state perceives appropriate. Under civil law mass transit alternatives benefit from these restrictions leading to an associated societal increase in physical activity.

In terms of urban sprawl, the positive relationship between spatial development of cities and physical inactivity, obesity and other health problems is widely documented (e.g., Ewing et al., 2003; Zhao and Kaestner, 2010). On the other hand, common (civil) law countries are likely to be associated with lower (greater) regulatory barriers to the spread of home ownership to the far suburbs, with a concomitant decrease (increase) in population density and increased (decreased) reliance on motor vehicles.[4] Automobile dependence in common law countries is evident from Houghton's (2003) estimates of per capita greenhouse gas emissions: of the top twenty countries ranked by per capita gas emissions in 2000, sixteen were common law

[2] See OECD Health Division data at www.oecd.org/dataoecd/20/51/37622205.xls for data showing rising obesity rates in all OECD countries, albeit from very different levels. The US doubled its rate from around 15% in 1978 to over 30 by 2000; in the UK the rate tripled from around 7 in 1980 to 21% by 2000; most countries on the continent of Europe rose from 5% to 7% in the 1970s and 1980s to the 9–13% range by the early 2000s. The contrast in levels may not be quite as stark because the European levels are based on self-reports while those for the USA and the UK are based on actual measurements taken. Nevertheless substantial differences in levels would likely remain were the Europeans to use the same measurement techniques.

[3] Of course, technological improvements have also contributed to many scientific advances, especially in common law countries, so these restrictions may have unintended side effects. Furthermore, civil law governments may not always implement what is best for social welfare.

[4] Consider OECD cities of 1.5 million population or larger; 27 rank in the top 100 cities ranked by population density with twenty-two civil law countries and five common law countries. In the next 100 densest cities, the situation is reversed; thirty represent common law countries and five civil law countries. Large cities in common law countries tend to have lower density, consistent with the notion that these countries have fewer restrictions on urban sprawl (City Mayors, 2011).

Author's personal copy

countries. Furthermore, the International Association of Public Transport (2005) points to the difference between civil and common law countries as follows: "the gaps separating 'energy efficient' towns from 'high energy consumption' towns are considerable: from 12,000 to 16,000 mega joules per year per inhabitant in the majority of European towns to over 30,000 in North American and Australian towns. In concrete terms, this gap represents 400–500 kg of crude oil per inhabitant per year."[5] Hence the cross-country impact of increased motor vehicle usage on the level of obesity may differ by legal heritage. We present evidence in Section 5 below that neither region per se nor population density drives our main results.

In our work we focus on OECD countries; the main advantage is that all member countries are relatively advanced in their economic development, have relatively comparable data, yet vary in their cultural and legal heritage. Following La Porta et al. (1999), we distinguish between civil and common law countries, and also briefly consider the sub-categories of civil law, i.e. French, German, Scandinavian and Old Socialist legal systems. The central goal is to investigate the relationship between obesity and the interaction between motor vehicle ownership and legal heritage.

Results across panel and instrumental variable approaches with fixed and random effects are robust. Overall, having 100 extra motor vehicles per 1000 residents raises obesity rates by between 4% and 5% points in common law countries. However, this effect is significantly reduced in civil law countries and, in fact, we cannot reject the null hypothesis of zero impact. Reductions in motor vehicle ownership in common law countries would have a substantial impact on obesity rates but the same reductions in civil law countries would essentially have no effect. This reinforces the view that it is not ownership of motor vehicles per se, but the interaction with access and regulation that affects the degree of obesity. This result is in stark contrast to the recent literature pointing to the superior performance of common law vis-à-vis civil law heritage with respect to economic welfare (La Porta et al. (1999) and Acemoglu and Johnson (2005) for example).

2. Data

Our data come primarily from the *OECD National Accounts Statistics* (http://www.oecdilibrary.org). The available information allows us to form an unbalanced panel, which includes 147 observations spanning 29 countries between 1990 and 2005.[6] The dependent variable in our analysis is *Obesity*, the percentage of residents who are obese. Key explanatory variables include: *Motor Vehicles* (number of motor vehicles per 1000 residents); *Civil* (1 if the country has a civil law tradition, 0 if the legal system type is common law); and the interaction between *Motor Vehicles* and *Civil*. We use the La Porta et al. (1999) assignment of legal heritage. Specifically, the common law countries in our sample consist of Great Britain, Ireland, Australia, Canada, New Zealand and the US. All other countries in our data set belong to the civil law tradition. La Porta et al. (1999), utilizes the disaggregation[7] of civil law countries in an analysis of the impact of legal heritage on such diverse topics as political freedom, government intervention and public sector size and provision. We explore an equivalent disaggregated classification in the context of obesity.[8,9]

In the empirical analysis, we control for PPP-adjusted *Gross Domestic Product per capita* (in US dollars), available from the *OECD National Accounts Statistics*. This avoids confounding motor vehicle effects with overall development effects on obesity. Cutler et al. (2003) argue that this variable proxies mass food preparation technology that facilitates the consumption of foods with high calorie content, and thus greater obesity.[10] In line with economic reasoning, we also consider lagged health expenditures, food prices, and log population density as potential regressors in the obesity specification.[11]

2.1. Trends and relations

Fig. 1 shows a scatter diagram for 29 OECD countries with motor vehicles per 1000 residents and obesity in a cross-sectional context.[12] It is evident that the unconditional relationship is positive. A panel data set enables us to look at a broader set

[5] Further to the point, Catford (2003) reports that transport is the second highest household expenditure item in Australia (15.5%), with 93.6% of this being for private motoring and 6.4% of it being for public transport.

[6] The OECD data listed no motor vehicle ownership data for Mexico. Furthermore, Mexico had only one observation available for obesity, pertaining to the year 2000. So Mexico was not included in our sample.

[7] The sub-division revolves around cross-county differences in corporation law.

[8] OECD countries are fairly equally distributed across more disaggregated civil law categories. The French law countries include Belgium, France, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain, and Turkey. The German law countries are Austria, Germany, Japan, South Korea and Switzerland. The countries having a Scandinavian legal system are Denmark, Finland, Norway, and Sweden, and the old socialist countries are Czech Republic, Hungary, Slovak Republic, and Poland.

[9] La Porta et al. (2008) update this classification, mainly re-assigning former communist bloc countries to their pre-communism legal systems. Because our focus is on motor vehicle dependence and the related habits which would be relevant in the long term, we stick to the old socialist classification for such countries.

[10] Cutler et al. also use female participation in the labor force as a control but we do not elect to use it due to its high correlation with GDP per capita (the correlation coefficient is 0.52 in our sample).

[11] The food price index is obtained from *International Labour Organization* consumer prices (food indices) data http://laborsta.ilo.org; public expenditure on health as percentage of total health expenditure is from *OECD Health Statistics* (http://www.sourceoecde.org), and population density from the *World Development Indicators* (2008).

[12] We form a cross-country data set from the panel data set by averaging the observations belonging to the 1998–2003 period. This period maximizes the number of countries that can be included in the analysis. Two exceptions are Australia, which provides data from 1995, and Poland, whose 1996 and 2004 observations are averaged.

Author's personal copy

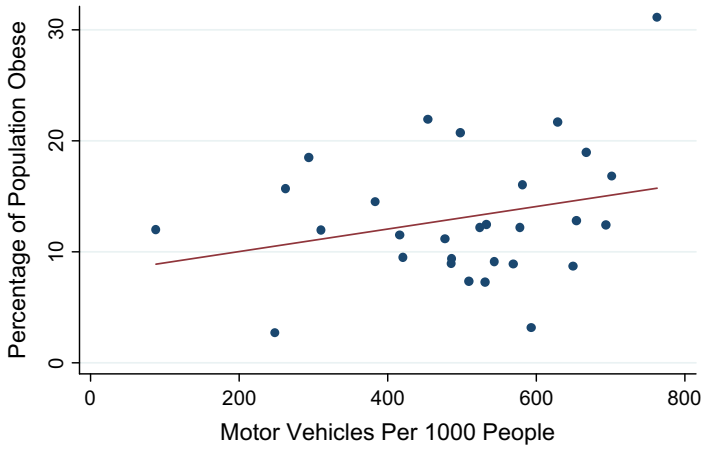

Fig. 1. Obesity vs. motor vehicle reliance cross-sectional relationship (1998–2003).

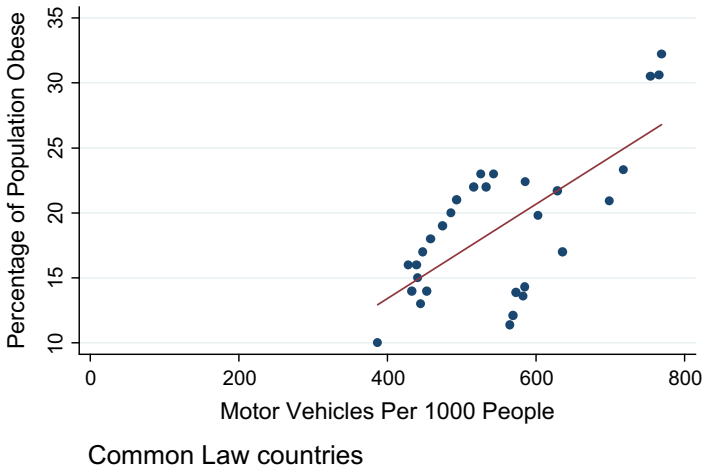

Fig. 2. Obesity and motor vehicle reliance panel data set (1990–2004).

of observations from 1990 to 2005. There are 30 observations for the six common law countries and 117 for the 23 civil law countries.

As seen through Figs. 2 and 3, there appears to be a strong, positive association for the common law countries, although the impression is undoubtedly accentuated by the three US data points in the far northeast corner of the scatter diagram.[13] The relationship for the civil law countries also appears positive but is difficult to discern due to the scattering of observations in the northwest quadrant with fairly high obesity levels and low motor vehicles per capita. These data points are associated with the former Soviet bloc countries of Hungary, Poland, and the Slovak Republic. Nevertheless, the slope of the fitted regression line is noticeably flatter than in the common law case. The correlation coefficient for *Motor Vehicles* and obesity is only +0.06 in civil law countries compared to +0.70 for the common law countries, with the former being insignificant and the latter highly significant. Although both correlations are positive, the coefficient for the common law countries is noticeably higher.

Table 1 shows the summary statistics for all variables employed in the empirical analysis.

3. Econometric methodology

Our approach is to estimate the following reduced form regression:

$$Y = XB + V\Gamma + \varepsilon, \tag{1}$$

where, for the 29 OECD countries, Y is the percentage of residents who are obese, X is a vector of variables including legal heritage, PPP-adjusted *GDP per capita* (in natural logarithms) and its square, time dummies and other controls. Besides capturing non-model variation in obesity over time, time dummies also help eliminate the disadvantage related to drawing

[13] Median motor vehicle ownership in common law countries is 538 per 1000 residents while it is 500 in civil law countries. We fail to reject the equality of medians at the 5% level.

Author's personal copy

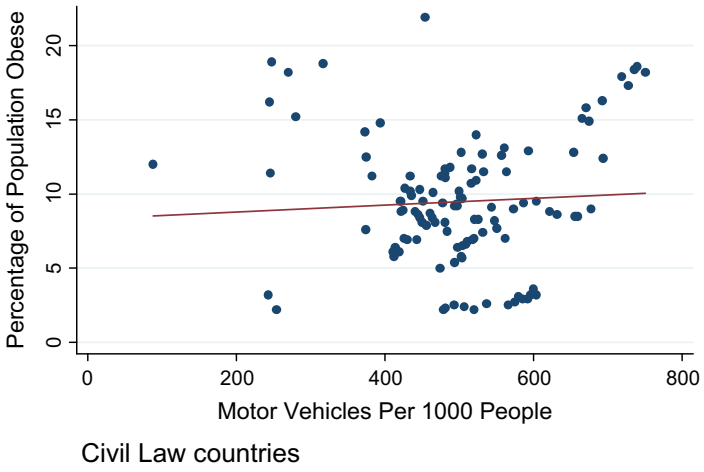

Fig. 3. Obesity and motor vehicle reliance panel data set (1990–2004).

observations from an unbalanced data set. ***V*** is a vector including *Motor Vehicles* and an interaction term between *Motor Vehicles* and legal heritage. A priori we expect *Motor Vehicles* to be positively related to obesity, with this effect weaker in countries with civil law origins where the use of motor vehicles is more highly regulated. We estimate several variants of this model to check the sensitivity of our results; robustness is discussed further in Section 5.

We include additional control variables in our benchmark specification capturing other possible determinants of obesity outside the specified channels. While a full-blown economic model of obesity is beyond the scope of this paper, economic reasoning suggests that food prices, log population density, and public health expenditure on obesity may be relevant regressors.[14] Of these, log population density controls for space differences between common law countries such as the US, Australia and New Zealand, which are large in space relative to population, and European countries which are generally tight in space and follow civil law. Also, given increased government funding of obesity prevention initiatives we proxy obesity-related expenditure via public health expenditure as a share of total health expenditure.[15,16] We use lagged values of the public health expenditure share.[17]

We start with cross-section ordinary least squares (OLS) to establish a benchmark. We then turn to fixed and random effects panel OLS estimation on our unbalanced panel. To address potential endogeneity concerns we identify potential instruments for a two-stage least squares estimation and, in our preferred specification, utilize fixed effects limited information maximum likelihood estimation. Finally we explore the robustness of our results to a variety of specifications. The extensive sensitivity and robustness checks confirm our main results are robust across both estimation method and specification.

4. Results

4.1. OLS results: cross-sectional data

Despite a modest sample size, the cross-sectional dataset is useful to get a feel for the basic relationships. Model 1 of Table 2 shows that the unconditional relationship between *Motor Vehicles* and obesity is positive, but significant at only the 17% level. Model 2 presents the unconditional association between *Civil* and obesity. The results suggest that the level of obesity is on average 8.7% higher in countries with common law heritage relative to civil law countries. The distinction is highly significant. Model 3 reports the conditional associations involving *Motor Vehicles*, *Civil* and their interaction. *Motor Vehicles* is a positive and statistically significant determinant of obesity. The intercept *Civil* is also positive and significant at 10%. Moreover, the sign and magnitude of the interaction term implies that the slope effect is substantively and significantly different

[14] Car prices may also be relevant in a reduced form. Comparable car price data for recent times are available only for the EU countries (see Degryse and Verboven 2000). Thus, it is difficult to capture most of the common law countries. Nevertheless, inability to control for car prices in the regression should not affect our results. Degryse and Verboven argue that car price differentials across countries can be explained by exchange rate fluctiations in the short-term and taxes in the long-term. One can add transportation costs to this list, considering the non-EU countries in our sample. But note that transportation costs would be captured by country-fixed effects in our models, and tax regimes can reasonably be explained by legal systems. Exchange rate fluctuations are unlikely to affect obesity in the short-term.

[15] Even these data are not comprehensively available for an analysis that is consistent with our investigation (available only for less than half of the dataset). Hence we extrapolate these data to obtain a comparable sample. The means and the standard deviations of original and extrapolated data are highly similar. As an additional robustness check we also used public social expenditure as a percentage of GDP instead of health data. Results were similar.

[16] Obesity-related expenditures are only a part of the total health expenditures (note that the share projected for the US for 2018 is 21%).

[17] While one may argue for reverse causation from the level of obesity to the amount of money allocated from the budget to alleviate the epidemic,there is no indication that funds spent have worked to cure or alleviate the obesity problem so far. Rather, governments still seem to be reactive. On the other hand, funds spent are unlikely to affect the BMIs in the same year, so the use of lagged health expenditures is again appropriate in that respect.

Author's personal copy

Table 1
Summary statistics (panel data).

Variable		Mean	Median	Max	Min	Std. dev.
Civil law		0.80	1	1	0	0.40
French legal system		0.37	0	1	0	0.48
German legal system		0.15	0	1	0	0.36
Scandinavian legal system		0.20	0	1	0	0.40
Old socialist country		0.08	0	1	0	0.26
Common law		0.20	0	1	0	0.40
Percentage of population obese (%)	Overall	11.39	10.1	32.2	2.2	5.98
	Civil	9.47	9.10	21.9	2.2	4.32
	Common	18.89	18.50	32.2	10	5.66
		(0.00)	(0.00)			
Motor vehicles (per 1000 people)	Overall	510	503	769	88	114.65
	Civil	500	500	751	88	109
	Common	551	538	769	387	114
		(0.03)	(0.07)			
M2/GDP (%)	Overall	99.54	72.39	393.94	28.53	72.34
	Civil	102.41	68.05	393.94	28.53	80.00
	Common	88.45	79.64	150.08	52.78	24.99
		(0.35)	(0.05)			
Petrol purchasing power (scaled by 10,000)	Overall	3.0148	2.7532	8.8367	0.5493	1.3113
	Civil	2.8396	2.7532	6.5253	0.5493	1.0651
	Common	3.6952	2.8508	8.8367	2.1018	1.8766
		(0.00)	(0.86)			
PPP-adjusted GDP per capita (US$)	Overall	24,414	23,841	57,392	6682	8314
	Civil	24,301	23,904	57,392	6682	8,796
	Common	24,855	23,403	39,590	16,546	6,185
		(0.75)	(0.87)			

In parentheses are the probability values for the test of equality of means/medians for civil and common law countries.

Table 2
Legal systems, motor vehicles reliance and obesity – OLS regressions.

	Dependent variable: percentage of population obese						
	Cross-sectional dataset				Panel dataset		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Motor vehicles	0.0101		0.0440**	0.0420**	−0.00226	0.0444***	0.0378***
	(1.40)		(2.72)	(2.48)	(−0.259)	(4.842)	(4.978)
Civil law		−8.723***	18.54*	14.84			
		(−3.88)	(1.81)	(1.29)			
Motor vehicles∗Civil Law			−0.0465**	−0.0402**		−0.0487***	−0.0446***
			(−2.69)	(−2.05)		(−8.370)	(−11.54)
Log per capita income				−69.43			−94.28***
				(−0.88)			(−2.988)
Log per capita income sq.				3.475			4.838***
				(0.87)			(3.129)
Constant			−6.047	341.7	22.11***	−7.211	456.2***
			(−0.62)	(0.87)	(4.171)	(−1.287)	(2.832)
Observations	29	29	29	29	147	147	147
Adj. R-squared	0.07	0.36	0.45	0.42			
Time effects	0.03	0.33			YES	YES	YES
Panel effects					FE	FE	FE

Robust *t* statistics in parentheses. Cross-sectional dataset is the 1998–2003 average of observations. In panel analysis, all standard errors are clustered at the country level. FE: Fixed Effects.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$,

depending on whether the country in question has a civil or a common law tradition. Specifically, it suggests that motor vehicle ownership is positively related to obesity in common law countries, while the effect is almost zero in the civil law countries. Adding a quadratic in log GDP per capita to the regression in Model 4 makes little difference to the above results, except the intercept *Civil* becomes insignificant. Moreover, as in Cutler et al. (2003), we find log GDP per capita (and its square) to be insignificant in the cross-sectional context.

Author's personal copy

The limited degrees of freedom available with the cross-sectional data do not allow us to explore additional factors. We would like to stress that, in this cross-sectional analysis, motor vehicle ownership may be viewed as a proxy for physical activity/exercise, and that it may be strongly correlated with other country level variables that are not captured in the equation, such as type of food, crime and police protection, parking availability, and so on. Nevertheless, this finding offers significant preliminary support for our suggested relationships between legal system, motor vehicle ownership and obesity.

4.2. OLS results: panel data

We explore the panel dimension extensively using OLS first but later consider 2SLS and LIML. For each estimator except LIML, we adopt both Fixed Effects (FE) and Random Effects (RE) treatments to address the country-specific effects in the data; RE is not applicable to LIML. The RE model has the advantage of keeping time-invariant legal system variables in the regression while addressing the panel effects.[18] But RE also requires that country-effects be uncorrelated with the independent variables.

Table 2 also presents the OLS panel data results. Only Fixed Effects (FE) results are presented because the Hausman tests do not support the RE treatment for panel effects within the context of OLS. Nevertheless, the FE results strongly reaffirm the cross-section results in terms of the suggested relationships, providing several important implications.[19] Model 5 reports the insignificant unconditional relationship between *Motor Vehicles* and *Obesity*. Model 6 introduces legal heritage and its interaction with *Motor Vehicles*. The results suggest that *Motor Vehicles* is positively and significantly related to *Obesity* in common law countries, with a marginal effect of 4.4% while this effect is almost zero in civil law countries, given the magnitude of the interaction term. Adding a quadratic in log GDP per capita to the specification in Model 7 has little impact on the results. However, contrary to the Cutler et al. finding, a significant curvilinear (U-shaped) relationship is suggested between GDP per capita and obesity with our panel data. At this stage of our analysis, Model 7 is the preferred specification, with motor vehicles per capita increasing obesity by 3.8% points in common law countries with little effect in civil law countries.

4.3. 2SLS and LIML results: panel data

4.3.1. Endogeneity of motor vehicles

It may be argued that higher levels of obesity are associated with greater reliance on motor vehicles for transportation as captured by motor vehicles per capita. This suggests a possible reverse causation between the dependent variable and *Motor Vehicles* and its interactions in Eq. (1).[20] Thus, we adopt an instrumentation strategy whereby M2/GDP and petrol purchasing power (*Petrol*) are employed as instruments for *Motor Vehicles*. M2/GDP is widely utilized in the literature as a variable proxying the level of financial depth in a country. Higher levels of M2/GDP point to a broader based financial system where citizens have easier access to funds for borrowing. Thus, ease of borrowing, leasing, and other financial arrangements is expected to be associated with more motor vehicles in a country. The other instrument, *Petrol*, is PPP-adjusted GDP per capita divided by the price of 1 L of petrol as charged in petrol stations.[21] The ability to purchase greater amounts of petrol for a typical level of income provides a stronger incentive to own a car.[22] Together these represent two key elements in the budgeting process, i.e. access to the necessary funds for financing a car, and if financed, ability to run the car, given petrol costs. Hence a set of three instruments, M2/GDP, *Petrol*, and their interaction, is employed in our two stage least squares estimation.

Figs. 4 and 5 in Appendix display strong initial support for our choice of instrumental variables to tackle the endogeneity problem. Motor vehicle ownership is positively associated with both M2/GDP and petrol purchasing power. In addition to the levels of M2/GDP and *Petrol*, we also consider their product given that these two key elements may interact in the motor vehicle purchase decision. For instance, higher petrol expenses imply lower ability to make repayments for car financing, and higher car repayments imply a more restricted ability to buy petrol. Thus, people may differ in their assessment of petrol (borrowing) costs at different levels of borrowing (petrol) expenses.

Let us now consider the properties required of our chosen instrumental variables. First, the instruments must be exogenous to obesity. This appears plausible; it is unlikely that obesity causes M2/GDP[23] and/or *Petrol*. Second, instruments should

[18] Our main results are robust to the choice of FE vs. RE.

[19] The fixed effects treatment removes the cross-country variation in the data and the remaining variation in the data is only due to within-country variation over time.

[20] One may also argue that legal heritage is not completely exogenous in that it may be shaped by people's unobserved tastes and preferences, and is largely cultural. We follow the La Porta et al. (2008) argument that these rules are norms which are largely exogenous to a country, at least in an obesity regression. Further, the arguments against the exogeneity of legal heritage seem to rest on country-level time-invariant factors, which are addressed through our panel treatment.

[21] The data source for M2/GDP is World Development Indicators (online) for non-EU countries and International Financial Statistics (online) for the EU countries. The data for petrol prices are obtained from International Energy Agency (2003). Premium Unleaded (95 RON) prices have been used (except Denmark, Japan and South Korea, for which only regular unleaded (91-92 RON) prices were available). Premium and regular unleaded prices are highly correlated.

[22] For instance, summary statistics in Table 1 show that while a typical US citizen is able to purchase around 88,000 L of petrol (i.e., about 24,000 gallons) with average annual income (the maximum amount in the data set), a typical Turkish citizen can buy only about 5500 L of petrol.

[23] M2/GDP could be correlated with the obesity error term through correlation with other factors affecting obesity. In a reduced form regression of M2/GDP, none of the coefficients for factors suggested by Cutler et al (2003), such as length of time to open a business, Big Mac Price Index, frequency of price control implementation, producer protection, and number of food statutes were statistically significant (results available from authors).

Author's personal copy

Table 3
First stage and reduced form results.

	(1)	(2)	(3)	(4)
	First-stage Dependent variable: motor vehicle per capita			Reduced form DV: Obesity
Petrol	−5.212	−5.416	19.38**	4.227***
	(−0.364)	(−0.354)	(2.191)	(8.670)
Petrol∗Civil Law			−44.83***	−4.321***
			(−3.547)	(−6.557)
M2/GDP	−0.00150	−0.116	0.801**	0.183***
	(−0.00683)	(−0.451)	(2.100)	(12.33)
M2/GDP∗Civil Law			−0.791**	−0.184***
			(−2.249)	(−10.03)
M2/GDP∗Petrol	0.0199	0.0364	−0.314***	−0.0397***
	(0.166)	(0.298)	(−2.858)	(−9.047)
M2/GDP∗Petrol∗Civil law			0.510***	0.0369***
			(4.777)	(6.740)
Log per capita income		−1540**	−1383**	−86.77***
		(−2.240)	(−2.354)	(−3.796)
Log per capita income Sq.		79.03**	73.41**	4.360***
		(2.225)	(2.417)	(3.578)
Food price index	0.776*	0.958***	0.835***	−0.0113*
	(1.794)	(5.279)	(5.697)	(−2.037)
Log population density	−54.16	−325.5	−131.4	14.64
	(−0.140)	(−0.863)	(−0.438)	(1.421)
Lag public health expenditure	0.846	1.021	0.952	0.0971
	(0.506)	(0.746)	(0.806)	(1.461)
Constant	633.3**	8332**	7070**	419.3***
	(2.097)	(2.343)	(2.322)	(3.771)
Observations	121	121	121	121
Time effects	YES	YES	YES	YES
Panel effects	FE	FE	FE	FE
F-statistics on excluded instruments	0.06	0.07	8.72***	

Robust *t*-statistics in parentheses. All standard errors are clustered at the country level. FE: Fixed Effects.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

be excludable from the main obesity equation; it seems reasonable to assume that M2/GDP, *Petrol* and their interaction would affect obesity only via the motor vehicles linkage.[24] The IV assumptions relating to exogeneity and excludability may be checked via Hansen over-identification [*J*-] tests. In all specifications, the Hansen *J*-test suggests that our instrumentation strategy is legitimate in both 2SLS and LIML.[25,26] Third, the coefficients of the IVs should be significant in the regressions of *Motor Vehicles* on the IVs and all other exogenous variables. This requirement relates to the recent literature on strong instruments to which we now turn.

In order to judge the instrument strength based on the Stock and Yogo (2005) rule, we need to consider the interaction terms between the legal system variable, *Civil* and the three IVs, which are also considered as instruments in the first stage. Thus we have two endogenous variables (*Motor Vehicles* and *Motor Vehicles∗Civil*) and six instruments. Stock and Yogo suggest two criteria for diagnosing weak instruments. The first is that the size distortion on the estimator be less than 10%. The critical F-value to attain this standard in our case is 12.33. A second standard is that the IV estimator has a maximal bias of 0.10 relative to the OLS estimator; the critical *F*-value for this standard is 9.48. As our *F*-value is 8.72, our instruments are not strong; hence we adopt a Limited Information Maximum Likelihood estimator, which is robust to weak instruments and unbalanced panels.[27] The instruments, although not quite strong, appear to satisfy all other statistical requirements.

[24] If, conditional on car ownership, car use would decline due to higher petrol prices, then *Petrol* is not excludable from the main regression. A counter-argument is that petrol prices tend to vary uniformly across countries with the world price. Our concern is lessened by the finding that when *Petrol* is included in the Obesity regression its coefficient is statistically insignificant (results available from authors).

[25] There might be a correlation between legal systems and M2/GDP and *Petrol*. During our instrumentation procedure, both the aggregate civil law variable and the disaggregated *French*, *German*, *Scandinavian* and *Oldsoc* variables are included in the first stage regressions. This leaves us with non-legal system effects of M2/GDP and *Petrol* to be associated with motor vehicles usage for the second stage estimations. This is what is needed as an exogenous source of variation for the instrumentation.

[26] We also considered public transportation availability as an instrument. However, it is difficult to measure this availability at the *country* level. One can get information on a few major cities through, perhaps, metro lines or stations per person. But wide availability of public transport in New York does not necessarily imply that the US overall, or even the state of New York has good public transportation. In addition, this measure would hardly change over time, limiting its inclusion in the panel exploration.

[27] The only disadvantage mentioned by Greene (2002) is that it is not robust to non-normality of the error term.

Author's personal copy

Before proceeding to the IV and LIML findings, we discuss the first-stage and reduced form relationships between our instruments, M2/GDP, *Petrol*, and M2/GDP∗*Petrol* and motor vehicle ownership and obesity. Table 3 displays the relationships using FE treatment of panel effects. Models 1 and 2 demonstrate that excluding legal heritage may lead one to incorrectly conclude that the instruments, Petrol and M2/GDP, are uncorrelated with motor vehicles per capita. Once legal heritage is introduced in Models 3 and 4, the coefficients no longer directly reflect the marginal effects of M2/GDP and *Petrol* on *Motor Vehicles* and the derivatives must be evaluated at a particular point. From Model 3 results for the first stage regression, we find the common law marginal effect of *Petrol* evaluated at the mean of *M2/GDP* is −8.4; similarly the marginal effect of M2/GDP is −0.359. In the reduced form, column 4, the equivalent marginal effects are 0.716 and 0.036. The equivalent effects for civil law countries are −5.38 and 0.541 from column 3 and −0.381 and 0.009 for the reduced form.

The results are disappointing in that the first stage marginal effects appear to be rather counter-intuitive. A priori we would expect a ceteris paribus increase in petrol affordability to increase the number of motor vehicles per capita which would in turn increase the level of obesity in the reduced form. However, in common law countries petrol affordability decreases the number of motor vehicles and yet increases obesity. Similarly, as M2/GDP rises, we would anticipate greater access to funds, consequently an increase in the first stage motor vehicles, which in turn would lead to a rise in obesity. Unfortunately, once again for common law countries, there is a conflict between the marginal effects in the first stage and the reduced form. Thus the results do not match the intuition. The reduced form results for common law countries make perfect sense but conflict with the first stage. For civil law countries the reduced form marginal effects for petrol and M2/GDP are both close to zero as expected- but once again there are conflicts with the first stage. Thus despite some statistical support for our instruments and nice intuition underlying the reduced form results, their weakness in the sense of failure to satisfy the Stock and Yogo (2005) rule combined with first stage regression results which are at odds with intuition suggests caution.

In Table 4, we report a variety of specifications estimated via 2SLS and LIML with FE and RE treatments. From the outset, note that the essential findings are qualitatively similar across most specifications, estimation techniques, and panel data treatments; once the interaction term between *Motor Vehicles* and *Civil Law* is introduced, the results (in columns 7–9) are highly robust to the choice of LIML vs. 2SLS, and FE vs. RE. In Table 4, *Motor Vehicles* are positively related to the obesity percentage but not for civil law countries. First consider the Models 1–6. Models 1–3 all find a positive unconditional relationship between *Motor Vehicles* and *Obesity*, with significance depending on the panel treatment. Models 4 through 6 add a quadratic in Log GDP per capita as well as controls for food prices, population density, and lagged public health spending. Models 7–9 estimate the effects of *Motor Vehicles*, *Civil* and their interaction on *Obesity*, in the presence of the controls listed

Table 4
Civil vs. common law, motor vehicle reliance, and obesity – IV estimations.

	Dependent variable: percentage of population obese								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Motor vehicles PC	0.0929	0.683	0.0258***	−0.228	−0.590	0.0379**	0.0517***	0.0553***	0.0508***
	(0.704)	(0.122)	(2.734)	(−0.443)	(−0.191)	(2.217)	(5.181)	(3.441)	(5.118)
MVPC∗Civil law							−0.0547***	−0.0564***	−0.0552***
							(−14.52)	(−16.09)	(−8.690)
Civil law									22.56***
									(4.968)
Log per capita income				−473.2	−1027	−107.9***	−108.2***	−104.6***	−103.3***
				(−0.581)	(−0.215)	(−2.973)	(−4.625)	(−3.864)	(−5.884)
Log per capita Income Sq.				24.37	52.61	4.995***	5.578***	5.391***	5.288***
				(0.587)	(0.216)	(2.611)	(4.597)	(3.821)	(5.726)
Food price index				0.215	0.562	−0.00715	−0.00571	−0.00768	−0.00581
				(0.433)	(0.189)	(−0.879)	(−0.561)	(−0.504)	(−0.893)
Log population density				−74.60	−190.2	−0.874	−5.708	−5.205	0.203
				(−0.356)	(−0.174)	(−1.439)	(−0.583)	(−0.473)	(0.242)
Lag public health expenditure				0.297	0.651	−0.0841	0.0478	0.0450	0.0438
				(0.496)	(0.202)	(−1.581)	(0.833)	(0.718)	(1.081)
Observations	126	126	126	121	121	121	121	121	121
Estimation method	2SLS	LIML	2SLS	2SLS	LIML	2SLS	2SLS	LIML	2SLS
Instruments	Petrol, M2/GDP and Petrol∗M2/GDP			Petrol, M2/GDP and Petrol∗M2/GDP and their interactions with civil law			Petrol, M2/GDP and Petrol∗M2/GDP and their interactions with civil law		
Hansen's *J* (*p*-value)	0.31	0.90		0.77	0.94		0.11	0.11	
Time effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel effects	FE	FE	RE	FE	FE	RE	FE	FE	RE
Hausman test (*p*-value)			0.50			0.98			1.00

Constant term included in all specifications. Robust *z*-statistics in parentheses. All standard errors are clustered at the country level (except when RE is used). Hansen's *J* test for overidentifying restrictions, with the null hypothesis that excluded restrictions are valid. Hausman test – FE vs. RE: The associated *p*-value for systematic difference between Fixed Effects and Random Effects coefficients, with "no difference" being the null.

** $p < 0.05$.

*** $p < 0.01$.

Author's personal copy

above for Models 4–6. Estimated coefficients on the main variables of interest are strongly significant. The food price, population density and public health expenditure control variables are insignificant in all specifications; hence these factors are of second-order importance in explaining cross-country obesity differences over time. *Motor Vehicles* and the *Civil* intercept term have positive signs, while their interactions have negative signs. Depending on the panel treatment and the estimation method, a 100 unit increase in motor vehicles per 1000 residents is associated with a 5.1–5.5% point increase in obesity in common law countries, while this effect is numerically and statistically zero in civil law countries. The models also confirm the U-shaped relationship between obesity and GDP per capita. Ignoring the caveat concerning the first stage IV results, model 8 is the preferred specification within Table 4 as LIML is preferred given an unbalanced panel and instruments that are not quite strong.

5. Robustness analysis

In this section we consider the robustness of our OLS panel results, Table 2, to a series of robustness checks reported in Table 5. Although the IV estimation is statistically valid, our earlier caution about the lack of empirical support in the first stage regressions for the intuition of the instruments, leads us to focus our robustness analysis on the panel OLS estimations. Findings with the IV estimation of the relevant models are consistent with the reported results but are not discussed or reported.

It may be that the lower population density of common law vis-a-vis civil law countries is driving these results. Model 1 adds the logarithm of the population density to the Model 7 specification, from Table 2. With some additional data points gained, the results remain qualitatively similar. Model 2 interacts log population density with *Motor Vehicles* and our results related to the effects of legal heritage also survive this check. Treating this interaction term as endogenous does not make a difference to the results (unreported). The results on legal heritage are not driven by differences in population density.

Next we consider the disaggregated legal system types. While there is no explicit theoretical justification for a finer classification of legal heritage within the civil law tradition in terms of motor vehicles–obesity relationship, the previous literature shows that the propensity towards control-seeking regulations tends to be greater in French than German and Scandinavian law systems (e.g., La Porta et al., 1999). Our objective here is simply to investigate whether these tendencies are also present in the case of the motor vehicle–obesity relationship. The coefficients in Models 3 imply that an increase of 100 motor vehicles per 1000 residents is, on average, associated with a 4% point increase in obesity in common law coun-

Table 5
Sensitivity Analysis.

	Dependent variable: percentage of population obese							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Motor vehicles PC	0.0332***	0.0655***	0.0403***	0.0815***	−0.0150*	−0.0101	0.0226***	0.0572***
	(6.123)	(3.518)	(4.764)	(3.697)	(−1.714)	(−0.336)	(3.769)	(3.443)
MVPC∗Civil law	−0.0435***	−0.0462***					−0.0449***	−0.0479***
	(−17.22)	(−11.76)					(−17.72)	(−16.08)
MVPC∗French law			−0.0441***	−0.0415***				
			(−11.58)	(−9.438)				
MVPC∗German law			−0.0680***	−0.0604***				
			(−8.495)	(−6.380)				
MVPC∗Scandinavian law			−0.0385***	−0.0589***				
			(−6.417)	(−4.685)				
MVPC∗Old socialist law			−0.0487***	−0.0471***				
			(−3.701)	(−3.679)				
MVPC∗Europe					0.00983	0.00994	0.0152***	0.0163***
					(0.987)	(1.031)	(2.706)	(3.016)
Log per capita Income	−96.46***	−101.9***	−90.94***	−118.3***	−108.0**	−109.0**	−93.86***	−99.58***
	(−2.762)	(−3.071)	(−2.619)	(−3.565)	(−2.425)	(−2.542)	(−2.805)	(−3.190)
Log per capita income Sq.	4.990***	5.173***	4.454**	5.909***	5.688**	5.726**	4.719***	4.901***
	(2.836)	(3.078)	(2.491)	(3.427)	(2.419)	(2.504)	(2.801)	(3.115)
Log population density	6.987	**6.966**	5.341	**−1.980**	12.25	**12.30**	9.094	**9.224**
	(0.864)	**(0.883)**	(0.599)	**(−0.233)**	(0.787)	**(0.775)**	(1.218)	**(1.312)**
MVPC∗log pop density		**−0.00574****		**−0.00887***		**−0.000957**		**−0.00628****
		(−2.143)		**(−1.942)**		**(−0.190)**		**(−2.492)**
Observations	136	136	136	136	136	136	136	136
Time effects	YES	YES	YES	YES	YES	YES	YES	YES
Panel effects	FE	FE	FE	FE	FE	FE	FE	FE
F-test (*p*-value)		**0.10**		**0.14**		**0.71**		**0.04**

Robust *z*-statistics in parentheses. OLS estimations. All standard errors are clustered at the country level. Food price index and lag public health expenditure are included in the regressions. *F*-test is for the joint significance of the regressors in bold in the respective equation.

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Author's personal copy

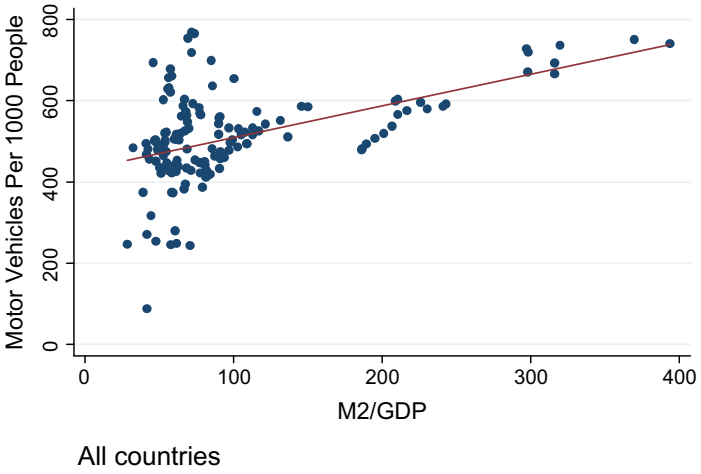

Fig. 4. M2/GDP and motor vehicle reliance panel data set (1990–2004).

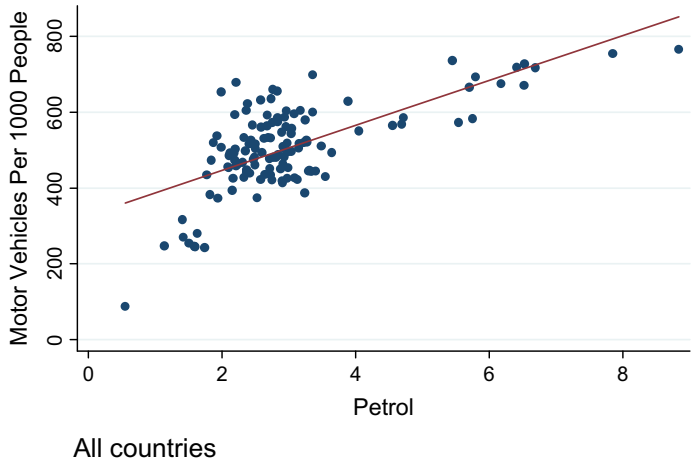

Fig. 5. Petrol and motor vehicle reliance panel data set (1990–2004).

tries. However, the marginal effects (i.e. incorporating the interaction term) are noticeably lower for French, German, Scandinavian and old socialist legal heritage. In fact, the *p*-values of the Wald test in Model 3 for the hypothesis that the coefficient of *Motor Vehicles* and the relevant legal regime/motor vehicle interaction term suggest that in French and Scandinavian legal heritage countries the effect is effectively zero. Using IV estimation as a statistical device to address endogeneity of *Motor Vehicles*, all disaggregated legal system types including German legal heritage are found to have a zero effect (unreported).[28] Model 4 reports that interacting Motor Vehicles with log population density in this setting does not make a difference to the general nature of the results with disaggregated legal heritage. These findings suggest that the finer classifications of legal systems within the civil law family do not seem to differ from each other in the motor vehicle–obesity relationship.

To investigate further whether legal origin, rather than other characteristics of a group of countries, is driving the results, we test a competing classification. The obvious alternative is geography: What if we classified the countries first between Europe and non-Europe instead of common and civil law, instead of by legal heritage? Models 5 and 6 show that these alternative classifications are insignificant in explaining the motor vehicles–obesity relationship and thus are not driving our main findings.[29] Models 7 and 8 run a 'horse race' between *MVPC*∗*Civil* and *MVPC*∗*Europe* by including them in the same regression. Interestingly both are found to be significant, with *MVPC*∗*Europe* having a positive coefficient and *MVPC*∗*Civil* still having negative coefficient. We conclude that the civil law/common law distinction is important for both Europe and the rest of the

[28] All the Hansen tests justify our IV strategy in this case as well. First-stage and reduced form results in the case of disaggregate legal systems offer similar conclusions as in the case of binary categorization above (results available upon request). It must be mentioned, however, that the critical value tables provided in Stock and Yogo become inapplicable when the disaggregated legal system variables are used. It is also unclear how the unbalanced panel nature of the dataset and the error covariance structure affect all the inference related to *F*-statistics. See, for instance, Bun and de Haan (2010). The 2SLS and the LIML results, nevertheless, offer qualitatively and quantitatively close implications in our context.

[29] We would like to thank a referee for this point. We make a similar classification by Western Europe and North America, Eastern Europe, and the rest of the OECD countries, but our results remain similar.

Author's personal copy

world, and once one controls for legal heritage and other factors there remains a small but statistically significant positive effect on obesity in Europe vis-a-vis non-European OECD countries on the order of 1.6%.

Is there any potential non-linearity regarding the impact of motor vehicles on obesity? Expanding the model with motor vehicles squared and its interaction with *Civil* does not deliver significant results.[30] Hence, we prefer the linear models.

All in all, our results are remarkably consistent across estimation method and specification. The impact of an increase in motor vehicle ownership consistently leads to a rise in obesity of around 4–5% in common law countries, but virtually no impact in common law countries. At this stage, a hypothetical question might help put things into perspective. What if a typical common law country would regulate motor vehicle use just as a civil law country does? Using the standard calculation for the marginal effect of a discrete variable we find that a common law country with current median motor vehicle ownership at 551 would see a ceteris paribus reduction of 7.86% in its obesity level.

6. Conclusion

In examining the role of legal heritage in the pattern of international obesity, we find highly robust results. Obesity growth rates appear to be higher in common law countries of the OECD where there is a strong positive correlation between obesity and motor vehicles per capita. Econometric analysis of cross-country and panel data for the period 1990–2005 suggests that motor vehicle ownership is strongly and directly associated with the prevalence of obesity across country and over time for common law countries; little or no such evidence emerges for countries following a civil law tradition. These results hold with fixed effects, random effects, instrumental variables, and limited information maximum likelihood estimation.

Despite some inherent limitations of the data, our findings indicate the significant role that legal heritage plays in translating motor vehicle ownership into a contributory factor to obesity. Increased motor vehicle ownership is implicated in rising obesity in common law countries such as the US. Common law countries, as opposed to countries following civil law, appear to be at particular risk; reduced physical activity is implicated in the obesity rise where government does not substantially restrict the use of motor vehicles or control urban sprawl. This finding provides a counterweight to the growing economics literature echoing Hayek (1973) which points to the superiority of common law for economic welfare, see La Porta et al. (1999) and Acemoglu and Johnson (2005).

Our work also sheds light on governmental behavior that is induced by daily choices of individuals. Becker and Murphy's (1988) rational addiction model suggests individuals with high discount rates may make individual choices that lead (rationally) to addiction. But substantial health care financing externalities mean that individual and social welfare may not line up. Hence there is a role for government to potentially improve social welfare by altering individual decision-making calculations. Governments following a common law heritage may face difficulties related to passing and enforcing laws that circumscribe individual choice on transport mode, and residential location. Countries with civil law heritage can do so more easily with a concomitant reduction in the growth of obesity.

Countries with a common law heritage tend to place a high weight on individual choice. The challenge for such countries is to find mechanisms for increasing overall physical activity so that individual choice may be respected without adverse health consequences and without increasing overall costs to society. Interestingly in a different public health challenge, cigarette smoking, the US, despite its common law heritage, has been able to achieve severe restrictions on individuals' right to smoke. Although there are differences, examining that public health campaign might provide valuable lessons for common law heritage countries aiming to withstand the rise in obesity.

Acknowledgments

We acknowledge excellent research assistance from Amir Hayat, Sasi Iamsiraroj, Samet Kayacik, Ramakanta Patra and Yang Xu.

Appendix A

See Figs. 4 and 5.

References

Acemoglu, Daron, Johnson, Simon, 2005. Unbundling institutions. Journal of Political Economy 113, 949–995.
Becker, Gary S., Murphy, Kevin M., 1988. A theory of rational addiction. Journal of Political Economy 96, 675–700.
Botero, Juan C., Djankov, Simeon, La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, 2004. The regulation of labor. Quarterly Journal of Economics 119, 1339–1382.
Bun, Maurice, de Haan, Monique, 2010. Weak instruments ad the first stage *F*-statistics in IV models with a nonscalar error covariance structure. UvA-Econometrics Discussion Paper 2010/2.
Catford, Robert, 2003. Transport as a determinant of health: what role for the health sector? Camwest Report, New South Wales.
City Mayors (2011), London NW11 7HW, England, 28 October 2011. <http://www.citymayors.com/statistics/largest-cities-density-125.html> and <http://citymayors.com/statistics/largest-cities-density-250.html>.

[30] These two nonlinearity results are available upon request.

Author's personal copy

Cutler, David, Glaeser, Edward, Shapiro, Jesse, 2003. Why have Americans become more obese? Journal of Economic Perspectives 17, 93–118.
Damaska, Mirjan, 1986. The Faces of Justice and State Authority. Yale University Press, New Haven, CT.
Degryse, Hans, Verboven, Frank, 2000. Car price differentials in the European union: an economic analysis. An investigation for the Competition Directorate-General of the European Commission. Centre for Economic Policy Research, London.
Djankov, Simeon, La Porta, Rafael, Lopez de-Silanes, Florencio, Shleifer, Andrei, 2002. The regulation of entry. Quarterly Journal of Economics 117, 1–37.
Ewing, Reid, Schmid, Tom, Killingsworth, Richard, Zlot, Amy, Raudenbush, Stephen R., 2003. Relationship between urban sprawl and physical activity, obesity, and morbidity. American Journal of Health Promotion, September/October 18 (1), 47–57.
Greene, William H., 2002. Econometric Analysis. Prentice Hall.
Hayek, Friedrich A. von, 1973. Rules and order. In: Law, Legislation and Liberty. vol. V1. Routledge and Kegan Paul, London.
Houghton, Richard A., 2003. Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850–2000. Tellus B 55, 378–390.
International Association of Public Transport, 2005. Mobility in Cities Database. Brussels, Belgium.
International Energy Agency 2003. Part II: Energy End-Use Prices in OECD Countries. Energy Prices and Taxes, 3rd Quarter.
Lakdawalla, Darius, Philipson, Tomas, 2005. Welfare enhancing technological change and the growth of obesity. American Economic Review Papers and Proceedings 95, 253–257.
La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, 2008. The economic consequences of legal origins. Journal of Economic Literature 46, 285–332.
La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, Vishny, Robert W., 1998. Law and finance. Journal of Political Economy 106, 1113–1155.
La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, Vishny, Robert W., 1999. The quality of government. Journal of Law, Economics and Organization 15, 222–279.
La Porta, Rafael, Lopez-de-Silanes, Florencio, Shleifer, Andrei, Vishny, Robert W., 2002. Investor protection and corporate valuation. Journal of Finance 57, 1147–1170.
Mulligan, Casey B., Shleifer, Andrei, 2005. Conscription as regulation. American Law and Economics Review 7, 85–111.
Philipson, Tomas, 2001. The world-wide growth in obesity: an economic research agenda. Health Economics 10, 1–7.
Philipson, Tomas, Posner, Richard A., 1999. The long-run growth in obesity as a function of technical change. Perspectives in biology and medicine, vol. 46, pp. 87–108 (NBER Working Paper No. 7423. National Bureau of Economic Research, Cambridge, Ma).
Pistor, Katharina, 2006. Legal ground rules in coordinated and liberal market economies. In: Hopt, Klaus J. et al. (Eds.), Corporate Governance in Context: Corporations, States, and Markets in Europe, Japan and the US. Oxford University Press, Oxford, UK.
Stock, James H., Yogo, Motohiro, 2005. Testing for weak instruments in linear IV regression. In: Donald, W.K., Andrews, Stock, James H. (Eds.), Identification and Inference in Econometric Models: Essays in Honor of Thomas J. Rothenberg. Cambridge University Press, Cambridge, England, United Kingdom.
Thorpe, Kenneth E., 2009. The future costs of obesity: national and state estimates of the impact of obesity on direct health care expenses. A Collaborative Report from United Health Foundation, the American Public Health Association and Partnership for Prevention.
Transportation Research Board, 2001. National Research Council, National Academy Press, Special Report 257. Making Transit Work: Insight from Western Europe, Canada, and the United States.
World Development Indicators, 2008. Online version. World Bank.
Zhao, Zhenxiang, Kaestner, Robert, 2010. Effects of urban sprawl on obesity. Journal of Health Economics 29, 779–787.