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PREDICTING VEHICLE SALES FROM GDP IN 48 COUNTRIES: 2005-2011

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16. Abstract

This study examined the relationship between GDP and vehicle sales in 48 developed and developing countries during the years 2005 through 2011. The countries examined were Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Luxembourg, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Pakistan, the Philippines, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom, the United States, Uruguay, and Venezuela. The annual vehicle sales in the individual countries ranged from about 16 thousand to about 18.5 million. The annual GDP values for the individual countries ranged from about 23 billion to about 11.7 trillion constant 2000 US$.

The main result is that the logarithm of GDP is a strong linear predictor of the logarithm of vehicle sales. This relationship held both for the seven years combined and for each individual year during these seven years—a period that included both general economic prosperity and economic downturn.

Using the obtained regression equations, average vehicle sales per GDP value were calculated for the 48 countries for each of the eight time periods of interest. For the combined years 2005 through 2011, this turned out to be 1,869 vehicles per 1 billion constant 2000 US$.

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Contents

Introduction

In a recent study (Sivak and Tsimhoni, 2008), we examined economic influences on car sales in 25 developing countries for a given year. The main finding was that gross domestic product (GDP) and population size accounted for 93% of the variance in car sales.

The question of interest in the present, follow-up study is whether the relationship between GDP and vehicle sales holds not only for developing but also for developed countries, and whether the relationship holds over time. Thus, the data for 48 developed and developing countries over seven years were analyzed.

Method

A backward linear regression of vehicle sales on GDP was performed using data for seven individual years (2005-2011). Data for *all vehicles* were analyzed, in order to avoid differences between countries in the classification of cars and trucks.

All countries that had data listed in *World Motor Vehicle Data 2012* (WardsAuto Group, 2012) for 2005 through 2011 were included in the analysis. This set consisted of the following 48 countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Luxembourg, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Pakistan, the Philippines, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom, the United States, Uruguay, and Venezuela. Out of the examined 48 countries, 25 are in Europe, 10 in Asia, 6 in South America, 3 in North America, 2 in Africa, and 2 in Oceania. The annual vehicle sales in the individual countries ranged from about 16 thousand to about 18.5 million.

The data for the predictor variable (GDP in constant 2000 US$) were obtained from the World Bank (World Bank, 2012). The annual GDP values for the individual countries ranged from about 23 billion US$ to about 11.7 trillion US$.

Results

Graphical representation of the data

Figures 1 presents a scatter plot of the natural logarithm of vehicle sales versus the natural logarithm of GDP for all seven years combined (with seven data points for each country). Figure 2 contains seven analogous yearly plots, with each point representing the data for one country for one year. The graphical information in Figures 1 and 2 indicates strong linear relationships between the two variables plotted.

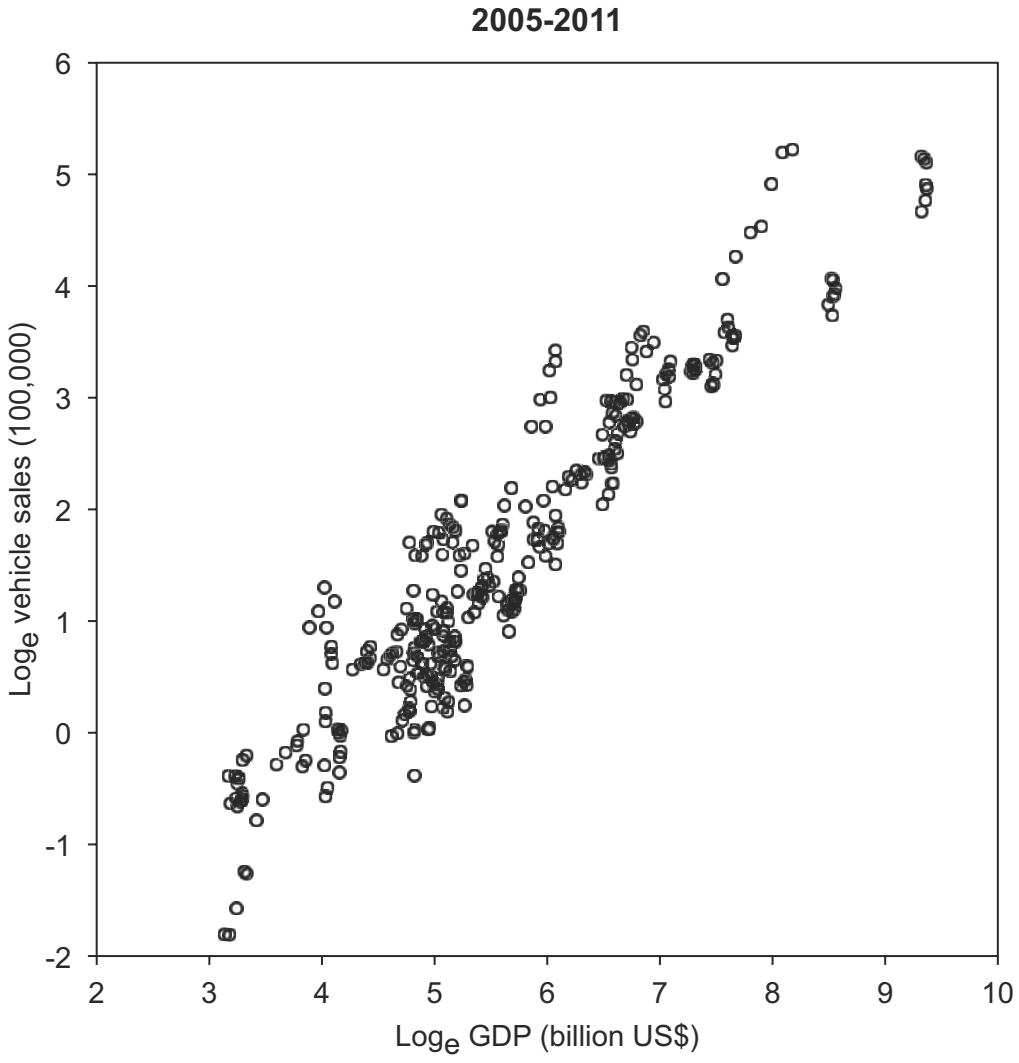

Figure 1. Scatter plot of the natural logarithm of vehicle sales versus the natural logarithm of GDP for the seven years combined.

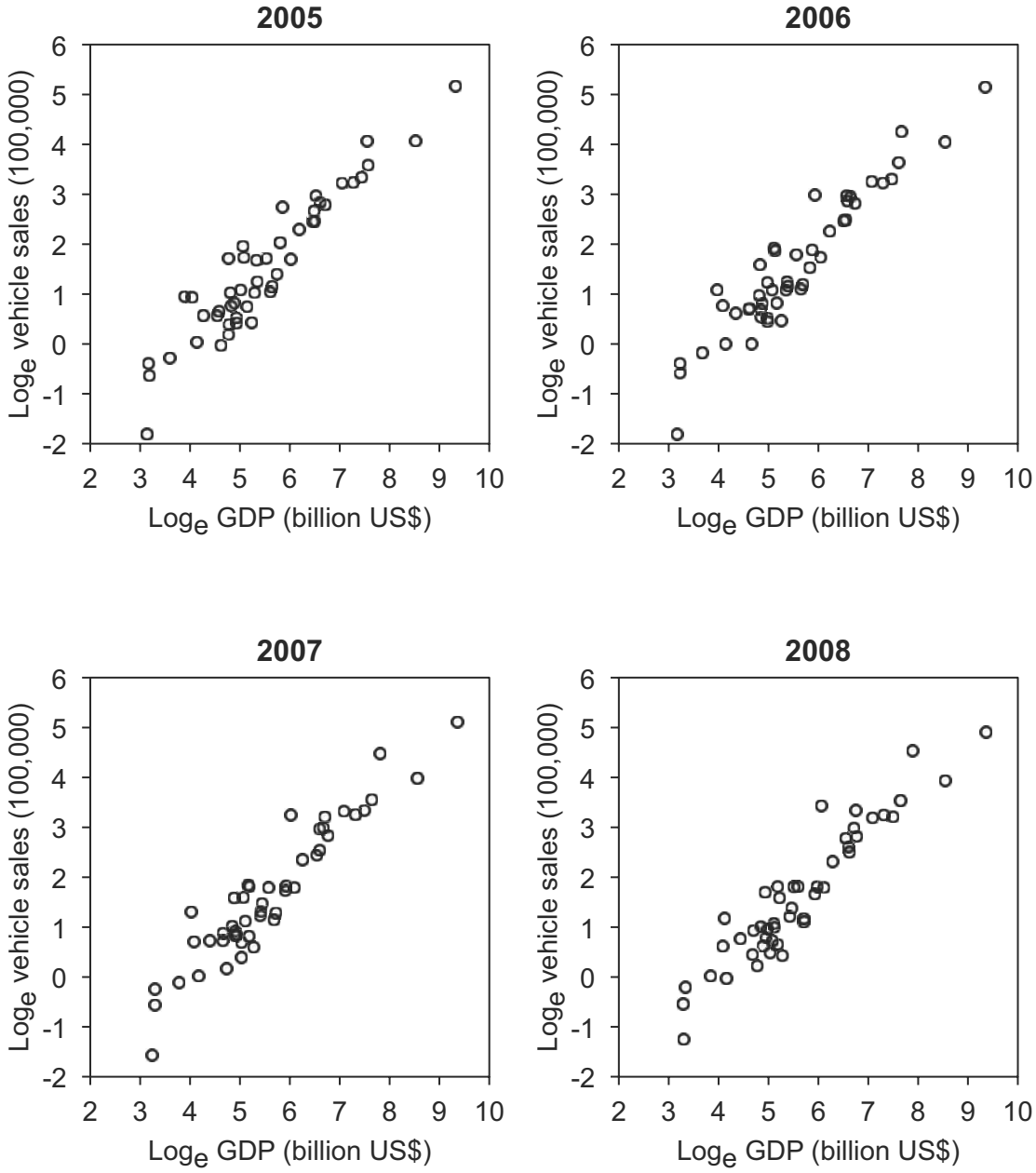

Figure 2. Scatter plots of the natural logarithm of vehicle sales versus the natural logarithm of GDP for the individual years.

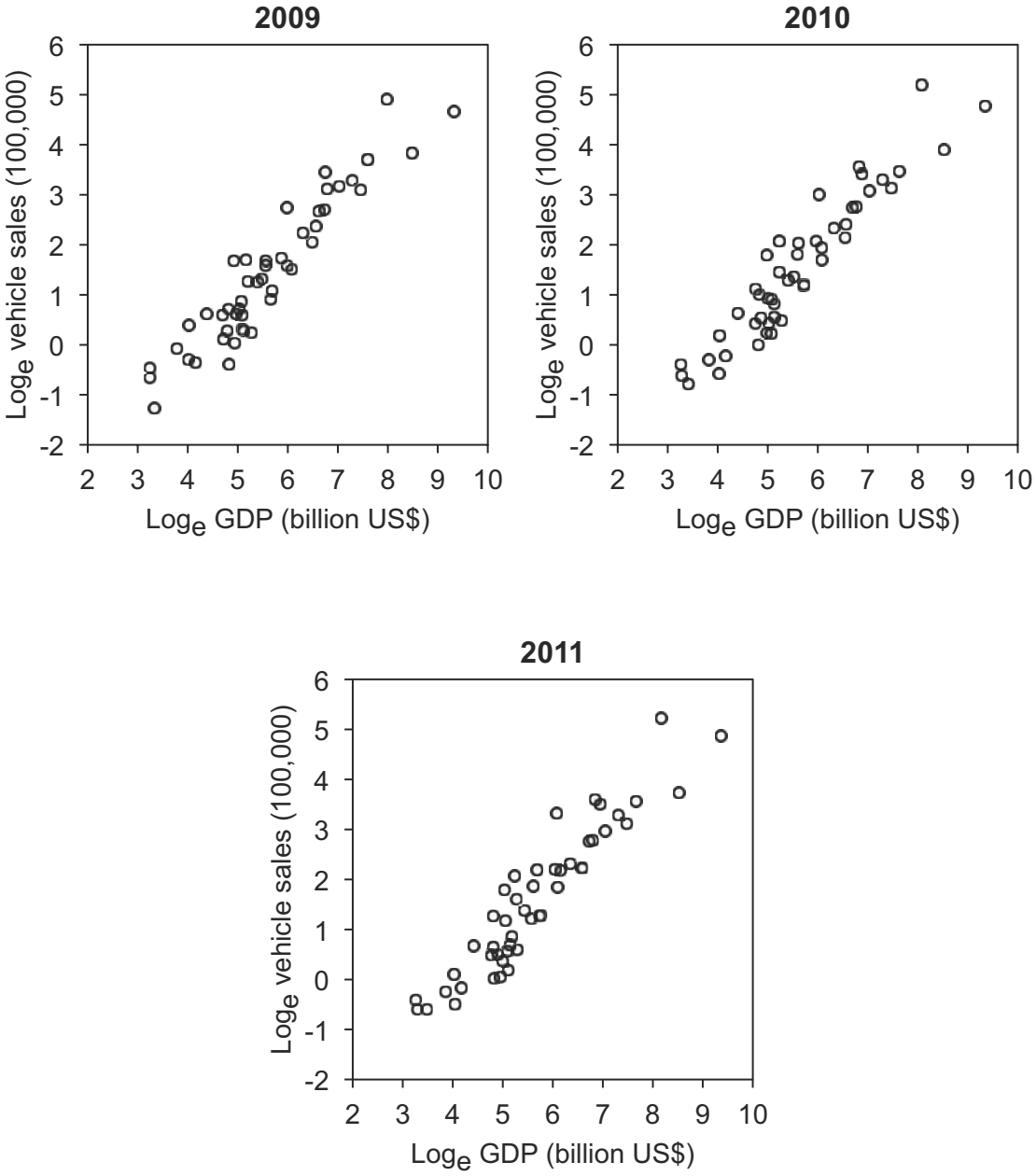

Figure 2 (continued).

Regression analyses

All eight regressions (one for all seven years combined and one for each individual year) confirmed the strong linear relationships between the log transformed variables evident in Figures 1 and 2—suggesting a power-law relationship between vehicle sales and GDP. A summary of these regressions is presented in Table 1.

The main findings of the regression analyses are as follows:

- All regressions were statistically significant.
- The slopes of all regressions were similar (between .98 and 1.02), and the standard errors indicate that all confidence intervals include the value of 1.
- The intercepts ranged from -3.85 to -4.33.
- The variances accounted for by the regressions were all high and similar (88 or 89%).

Table 1
Summary of the regression analyses.

Year(s)	*p*	Slope (standard error)	Intercept (standard error)	Variance accounted for (%)
2005-2011	<.001	.99 (.020)	-3.98 (.112)	89
2005	<.001	.98 (.051)	-3.85 (.288)	89
2006	<.001	.98 (.050)	-3.86 (.287)	89
2007	<.001	.96 (.050)	-3.74 (.288)	89
2008	<.001	.96 (.050)	-3.74 (.290)	88
2009	<.001	1.03 (.054)	-4.33 (.308)	89
2010	<.001	1.02 (.053)	-4.19 (.305)	89
2011	<.001	1.02 (.055)	-4.18 (.321)	88

Discussion

The results indicate that the slopes of all regressions are statistically not significantly different from 1. Thus, assuming that the slopes of all regressions are equal to 1, the linear functions in the log space can be transformed into linear functions (i.e., power-law functions with the exponent of 1) in the linear space. Below is an example of such a transformation for the regression of the data for the seven years combined.

$$\log_e(\text{vehicle sales in 100,000}) = -3.98 + (1 \times \log_e(\text{GDP in billions})) \quad (1)$$

$$\downarrow$$

$$\text{vehicle sales in 100,000} = e^{-3.98} \times \text{GDP in billions} \quad (2)$$

$$\downarrow$$

$$\text{vehicle sales in 100,000} = 0.01869 \times \text{GDP in billions} \quad (3)$$

Using Equation (3), one can calculate average vehicle sales per GDP value for the 48 countries for each of the eight time periods. In the case of the seven years combined, this turns out to be 1,869 vehicles per 1 billion constant 2000 US$. Table 2 presents the calculated average vehicle sales per unit of GDP for each of the eight time periods.

Table 2
Average vehicle sales per 1 billion constant 2000 US$ of GDP calculated from the regressions for the seven years combined and for each individual year.

Year(s)	Vehicles
2005-2011	1,869
2005	2,128
2006	2,107
2007	2,375
2008	2,375
2009	1,317
2010	1,515
2011	1,530

The data for the individual years in Table 2 indicate that the average number of vehicles sold in the 48 countries per 1 billion US$ of GDP peaked in 2007 and 2008 at 2,375. The average number dropped to 1,317 in 2009—in the midst of the recent economic downturn.

Summary

This study examined the relationship between GDP and vehicle sales in 48 developed and developing countries during the years 2005 through 2011. Out of the examined 48 countries, 25 are in Europe, 10 in Asia, 6 in South America, 3 in North America, 2 in Africa, and 2 in Oceania. The annual vehicle sales in the individual countries ranged from about 16 thousand to about 18.5 million. The annual GDP values for the individual countries ranged from about 23 billion to about 11.7 trillion constant 2000 US$.

The main result is that the logarithm of GDP is a strong linear predictor of the logarithm of vehicle sales. This relationship held both for the seven years combined and for each individual year during these seven years—a period that included both general economic prosperity and economic downturn.

Using the obtained regression equations, average vehicle sales per GDP value were calculated for the 48 countries for each of the eight time periods of interest. For the combined years 2005 through 2011, this turned out to be 1,869 vehicles per 1 billion constant 2000 US$.

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