The Future of World Car Fleet: The Road Ahead
(A BBVA Research model for long-term automobile projections)

November, 2012

Cross-Country Emerging Markets Unit
Key Messages

Motivation: Analysis of long run determinants of car industry

- Developing Models for tracking long term changes (“pionering model”)
- Analysis of long term trends which are shaping the new economic order.
- Wealth not population is driving the economic transformation
- Population+Wealth (“Middle Classes”) will be key for business opportunities

Results: Car industry will experience an important transformation

- Population, Wealth, Middle Classes and Urbanization will bias the future of Car Fleet to Emerging Markets
- East Asia will experience the highest increase followed by Latam
- Development Economies will experience moderate increases except in the US economy
- BBVA Markets will improve depending on where we focus

Annex: The BBVA Research Car Model

- Motivation and alternative models
- The BBVA CAR Model: Specification, estimation and comparative results
- Comparative analysis
Contents

Analysis of long run determinants of Car Industry

Global results

Annex: The BBVA Research CAR Model
# Car Fleet Determinants

**BBVA Model:** Car Fleet Determinants  
*Source: BBVA Research*

## World Car Fleet Determinants

<table>
<thead>
<tr>
<th>Population</th>
<th>Car Ownership</th>
<th>Cyclical Determinants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long Run Saturation levels</td>
<td>GDP Growth Acceleration</td>
</tr>
<tr>
<td></td>
<td>Real GDP per Capita</td>
<td>Economic Recessions (dummy)</td>
</tr>
<tr>
<td></td>
<td>Population Density</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urbanization Rates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infrastructure (Roads Quality)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Financial Depth (Private Credit/ GDP)</td>
<td></td>
</tr>
</tbody>
</table>
Different Population Dynamics

Population pyramids for selected economies (2010)
Source: BBVA Research and UN

G7 Countries

Eagles Ageing Advanced

Eagles Populating Premium
Labor force will gradually decline in EM but still maintains an important premium with Developed
..But Household size will also decline limiting the population decline impact in some goods
The Wealth Effects: GDP per capita growth differences will remain important...

GDP per capita Growth Rate (1980-2020)
(% yoy. in nominal PPP-adjusted USD)
Source: BBVA Research
A BBVA Research model for long-term automobile projections

...With a Fast track in Middle Classes creation

Estimation of income distribution by GDP per capita in emerging economies (1980-2020)

(millions of people and % of total population; original data in real PPP-adjusted USD)

Source: BBVA Research

Slow Motion Distribution changes

Fast Track

Affluent (>40000 USD)  High Middle Income (25000 to 40000 USD)  Medium Middle Income (15000 to 25000 USD)  Low Middle Income (5000 USD to 15000 USD)  Low Income (1000 USD to 5000 USD)  Poor (<1000 USD)
Estimation of income distribution by GDP per capita in emerging economies regions (1980-2020)
(millions of people and % of total population; original data in real PPP-adjusted USD)
Source: BBVA Research
... and in some segments related to different consumption patterns.
Middle classes will trigger demand for semi necessities and discretionary spending...

Consumption Patterns in China (2000-2020)
(% of total urban household spending)
Source: McKinsey

1In real 2010 dollars in 2010, $1 = 6.73 renminbi. Figures may not sum to 100%, because of rounding.
2Compounded annual growth rate.
3Forecast.
Urbanization will increase very fast in some of the regions...
Regional Aggregates mask some rapid changes in some countries (Andeans & South East Asia)

**World Urbanization Rates (2011)**
(Urban population as a % of total)

**World Urbanization Rates (2030)**
(Urban population as a % of total)
...and we will observe an intensive Urban agglomeration process specially in Asia

Percentage of urban population and agglomerations by size class
Source: UN Urbanization Prospects, 2011 revision
... But Emerging Markets still lags in transport infrastructure ...
.. and this leads to important opportunities of investment in this segment...

**Public Private Initiatives Infrastructure Transport Projects**

(US Billions)

Source: World Bank
Contents

Analysis of long run determinants of Car Industry

Global results

Annex: The BBVA Research CAR Model
A brief reminder on the composition of aggregates

<table>
<thead>
<tr>
<th>Region</th>
<th>EAGLEs</th>
<th>Nest</th>
<th>G7</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>Russia, Turkey</td>
<td>Poland, Ukraine</td>
<td>France, Germany, Italy, UK</td>
<td>Spain</td>
</tr>
<tr>
<td>America</td>
<td>Brazil, Mexico</td>
<td>Argentina, Chile, Colombia, Peru</td>
<td>Canada, USA</td>
<td></td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>China, India, Indonesia, Korea, Taiwan</td>
<td>Bangladesh, Malaysia, Pakistan, Philippines, Thailand, Vietnam</td>
<td>Japan, Australia</td>
<td></td>
</tr>
<tr>
<td>Middle E. &amp; Africa</td>
<td>Egypt, Nigeria, S.Africa</td>
<td></td>
<td>Iran, S.Arabia</td>
<td></td>
</tr>
</tbody>
</table>
Increase and distribution of world car fleet by decades: Eagles (China) will lead the next decade

**Distribution of world car fleet (1980-2020)**

(% of total world car fleet)

Source: BBVA Research

**Increase of world car fleet by decades (mn)**

(Million cars)

Source: BBVA Research
Expected increase in 2010-2020 and levels of car fleet by 2020

Increase of world car fleet ex China (2020 vs 2010)
(Million cars)
Source: BBVA Research

Car fleet of largest markets in 2020 (mn)
(Million cars)
Source: BBVA Research
Determinants of the expected increase in the car fleet. Wealth not population as the main driver

Determinants of Car Fleet Expansion (1980-2020)

Source: BBVA Research
Change and levels of car ownership

Car ownership Evolution (1980-2020)
(Cars Units per 1000 people)
Source: BBVA Research

Car ownership Groups Evolution (1980-2020)
(Cars Units per 1000 people. Bubble size proportional to car fleet)
Source: BBVA Research

Change and levels of car ownership
Expected annual increase in car fleet for the next decade concentrated in Asia and Latam

**Expected annual increase in World Car Fleet (2010-2020)**

(% yearly growth)

Source: BBVA Research
Different “Growth Areas” across the world

Car Ownership “Gomperzt” Curve
(Car Ownership and Sensitivity to GDP per Capita Growth as a function of GDP per capita levels)
Source: BBVA Research

Car Fleet Growth Areas
(Car Ownership and Sensitivity to GDP per Capita Growth as a function of GDP per capita levels)
Source: BBVA Research

<table>
<thead>
<tr>
<th>Growth Area</th>
<th>Long-term income per capita (in real PPP-adjusted USD)</th>
<th>Sensitivity of car ownership to income per capita*</th>
</tr>
</thead>
<tbody>
<tr>
<td>From... To</td>
<td>From... To</td>
<td></td>
</tr>
<tr>
<td>Accelerating Growth</td>
<td>1,100 To 4,600</td>
<td>1 To 2.5</td>
</tr>
<tr>
<td>Explosive Growth</td>
<td>4,600 To 12,500</td>
<td>2.5 To 3.1(max)</td>
</tr>
<tr>
<td>Strong Growth</td>
<td>12,500 To 15,800</td>
<td>175 To 2.5</td>
</tr>
<tr>
<td>Growth</td>
<td>15,800 To 19,900</td>
<td>1 To 1.75</td>
</tr>
<tr>
<td>Moderate Growth</td>
<td>19,900 To 24,400</td>
<td>0.5 To 1</td>
</tr>
<tr>
<td>Saturation</td>
<td>24,400 + min &gt; 0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Change of car ownership (units per 1000 people) to a change of 100 USD in income per capita
Explosive and strong growth will be concentrated in Asia, Latam and Turkey

### Car Fleet Growth Areas
*(Car Ownership and Sensitivity to GDP per Capita Growth as a function of GDP per capita levels)*

Source: BBVA Research

<table>
<thead>
<tr>
<th>Growth Area</th>
<th>Long-term income per capita (in real PPP-adjusted USD)</th>
<th>Sensitivity of car ownership to income per capita*</th>
<th>Countries and Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From... to From...</td>
<td>From... to From...</td>
<td></td>
</tr>
<tr>
<td>Accelerating Growth</td>
<td>1,100 to 4,600</td>
<td>1 to 2.5</td>
<td>Bangladesh, Pakistan, Nigeria, Vietnam, Philippines, India, Cameroon, Kenya</td>
</tr>
<tr>
<td>Explosive Growth</td>
<td>4,600 to 12,500</td>
<td>2.5 to 3.1 (max)</td>
<td>Indonesia, Egypt, Ukraine, Thailand, Colombia, China, S.Africa, Peru, Brazil, Paraguay, Bolivia, Ecuador</td>
</tr>
<tr>
<td>Strong Growth</td>
<td>12,500 to 15,800</td>
<td>1.75 to 2.5</td>
<td>Turkey, Mexico, Panama, Uruguay, Bulgaria, Romania</td>
</tr>
<tr>
<td>Growth</td>
<td>15,800 to 19,900</td>
<td>1 to 1.75</td>
<td>Malaysia, Chile, Russia, Argentina, Hungary, Croatia, Lithuania, Latvia</td>
</tr>
<tr>
<td>Moderate Growth</td>
<td>19,900 to 24,400</td>
<td>0.5 to 1</td>
<td>Poland, Portugal, Slovakia, Saudi Arabia, Greece, Estonia, Oman</td>
</tr>
<tr>
<td>Saturation</td>
<td>24,400 +</td>
<td>min&gt;0 to 0.5</td>
<td>Korea, G7, Australia, Spain, Switzerland, Netherlands, Czech Republic, Slovenia, New Zealand</td>
</tr>
</tbody>
</table>

*Change of car ownership (units per 1,000 people) to a change of 100 USD in income per capita*
Growth markets will lie in the Emerging Markets area.
Contents

Analysis of long run determinants of Car Industry

Global results

Annex: The BBVA Research CAR Model
Literature on car ownership

- **Dargay, Gately and Sommer (2007):** They use a similar saturation model. Panel of 45 countries. They assume a different sensitivity of every country to GDP per capita.

- **Chamon, Mauro, and Okawa (2008):** They assume there is no saturation rate. They concentrate on estimating a “take off” income threshold at which car demand starts to grow exponentially.

- **Medlock, K. B., and Soligo, R. (2002):** Panel of 28 countries. The model includes the user cost of capital and assume and find different saturation levels for each country.
Enhancements of BBVA Car Model

• We include the level of financial development and an infrastructure quality indicator as determinants of each country saturation level.

• We associate the saturation level to a long-term or «structural» level of income instead of the observed GDP per capita.

• We allow short term deviations of income per capita from its «structural» level to account for short-term variations in car ownership, instead of relying on the lagged value of the dependent variable to model short-term dynamics.
Model specification

The model is estimated by maximum likelihood using a non-linear estimator with robust standard errors. The equation that we finally estimate is the following:

\[
\ln(CAROW_{it}) = \ln\left\{ \left( \alpha + \beta_1 \left( \frac{GDPPC_{it}^{5yMA}}{GDPPC_{it}^{15yMA}} - \frac{GDPPC_{it}^{15yMA}}{GDPPC_{it}^{15yMA}} \right) \right) \\
+ \beta_2 (DENS)_{it}^{>US} + \beta_3 (DENS)_{it}^{<US} + \beta_4 (URB)_{it}^{>US} \\
+ \beta_4 (URB)_{it}^{<US} + \beta_6 (ROADSQ)_{it} + \beta_7 PCRED_{it}^{5yMA} \right\} \\
* \exp\left[ \gamma * \exp\left( \beta_8 \left( \frac{GDPPC_{it}^{15yMA}}{GDPPC_{it}^{15yMA}} \right) \right) \right] + \beta_9 \left( GDPPC_{it} - \frac{GDPPC_{it}^{15yMA}}{GDPPC_{it}^{15yMA}} \right) \\
+ \beta_{10} \left( GDPPC_{it} - \frac{GDPPC_{it}^{15yMA}}{GDPPC_{it}^{15yMA}} \right)_{GDP<0} \right\}
\]

CAROW = Car Ownership, GDPPC = Real GDP per capita in PPP-adj. USD, DENS = Population Density, URB = Urbanization Ratio, ROADSQ = Quality of Road Infrastructure, PCRED = Private Credit Ratio
### Estimated regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ (max. constant Saturation Level)</td>
<td>499.9***</td>
</tr>
<tr>
<td>$\gamma$ (Gompertz curve shape)</td>
<td>-3.95***</td>
</tr>
<tr>
<td>$\beta$ (real GDPpc PPP-adj. 15y MA)</td>
<td>-0.00017***</td>
</tr>
<tr>
<td>Real GDPpc PPP-adj. deviation 5yMA-15yMA</td>
<td>0.007***</td>
</tr>
<tr>
<td>Population density (above US)</td>
<td>-0.18***</td>
</tr>
<tr>
<td>Population density (below US)</td>
<td>-0.19</td>
</tr>
<tr>
<td>Urbanization rate (above US)</td>
<td>2.259***</td>
</tr>
<tr>
<td>Urbanization rate (below US)</td>
<td>-1.06*</td>
</tr>
<tr>
<td>Roads quality Indicator</td>
<td>90.86***</td>
</tr>
<tr>
<td>Credit to private sector</td>
<td>1.152***</td>
</tr>
<tr>
<td>Real GDPpc PPP-adj. dev. Obs.-5yMA</td>
<td>0.009***</td>
</tr>
<tr>
<td>Real GDPpc PPP-adj. dev. obs.-5yMA (in recessions)</td>
<td>-0.011***</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.991</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>2,001</td>
</tr>
<tr>
<td>Number of Countries</td>
<td>92</td>
</tr>
</tbody>
</table>

*** indicates significance at a 1% confidence level, ** at a 5% level and * at a 10% level.
BBVA Research forecasts (2012) compared with previous IMF work (2008)

**Growth of Car fleet (2010-2020)**
(average % yoy)
Source: BBVA Research

**Car fleet of largest markets in 2020**
(Million cars)
Source: BBVA Research

*BBVA Research uses only passenger cars and not light trucks*
## Variables definition and source

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car ownership</td>
<td>Passenger cars per 1,000 people</td>
<td>World Bank and UN</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>Real GDP per capita in PPP-adjusted USD 2005 constant terms)</td>
<td>IMF and BBVA Research</td>
</tr>
<tr>
<td>Population density</td>
<td>Population per km$^2$ of area</td>
<td>United Nations</td>
</tr>
<tr>
<td>Urbanization</td>
<td>Percentage of urban population</td>
<td>United Nations</td>
</tr>
<tr>
<td>Road density 1</td>
<td>Road kilometers per km$^2$ of area</td>
<td>World Bank</td>
</tr>
<tr>
<td>Road density 2</td>
<td>Road kilometers per capita</td>
<td>World Bank</td>
</tr>
<tr>
<td>Private credit</td>
<td>Private credit to non-financial institutions to GDP ratio</td>
<td>World Bank, Haver and BBVA Research</td>
</tr>
</tbody>
</table>
Cross-country emerging markets analysis unit

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