

Automobile Sales and Macroeconomic Variables: A Pooled Mean Group Analysis for Asean Countries

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Abstract : The objective of this paper is to analyse the impact of economic variables on automobile sales in five ASEAN countries. The long term and short term correlation between these variables are implemented using the panel error-correction model. Annual data from 1996 to 2010 involving five variables from five ASEAN countries namely Malaysia, Singapore, Thailand, Philippines and Thailand were accumulated as sample for this research. Result from the test shows that gross domestic product (GDP), inflation (CPI), unemployment rate (UNEMP) and loan rate (LR) have significant long term correlation with automobile sales in these ASEAN countries. The value of error correction in the short term to achieve long term stability based on ECT parameter is found to be significant in Malaysia, Singapore and Thailand. On the other hand, each country is influenced by different variables in the short term period.

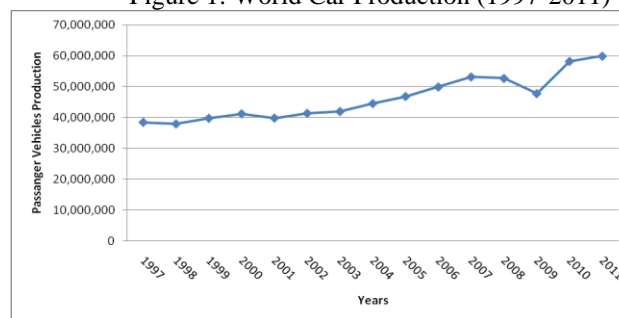
Keywords - Automobile sales, macroeconomic variables, ASEAN, dynamic relationship, panel error correction

I. Introduction

Transportation is one of the most essential economic goods in the modern world. An efficient mode of transportation ensures the mobility of individuals and product delivery could be conducted in a safe and timely manner. To meet this requirement, various types and models of vehicles were produced by automotive companies to fulfil the needs of consumers especially in the context of passenger vehicles.

Based on OICA statistics, the world production of passenger vehicles had increased tremendously at the rate of 56% for the last 15 years (1997-2011). In 2011 alone, a total of 60 million cars were produced compared to just 38 million in 1998. This is as illustrated in Figure 1 below.

Figure 1: World Car Production (1997-2011)



Based on Figure 1, it is found out that the world car production has been consistently on the increase from year to year except for the brief period between 2008 and 2009. This temporary downward trend was partly caused by the economic crisis in the United States (U.S) particularly the bankruptcy of its major car manufacturer, General Motors (GM) (Sturgeon and Van Biesebroeck, 2010). Following the successful recovery plan launched by the U.S Government to tackle this crisis, the number of car production again took off with positive growth from 2010 to 2011 despite the huge natural disasters (earthquake and tsunami) which struck Japan in March 2010 (McAlinden *et al.*, 2010)

This rapid growth in car production was influenced by many factors. In addition to production cost, Abu-Eisheh and Mannering (2002) emphasised that travelling trends, tourism activities, road design and residential location also contribute towards the emergence of wide variety of choices and consumer preferences in the car market. In this relation, affordability and consumer satisfaction to own cars and benefit from this economic good is an important indicator to measure the level of development of any particular country (Litman, 2011).

The importance of owning a car in today's daily life is undeniable. According to Sean *et al* (2003), the need to purchase personal vehicles is considered the second priority after house ownership in the U.S society.

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Besides its role in facilitating everyday life, the usage of cars also contributes towards the rate of national energy consumption as well as the value of Gross Domestic Product (GDP) (McAlinden, Dziczek dan Menk, 2008). The total number of employment provided by this sector stands at 8.4 million as shown on Table 1.

Table 1: Number of Employment in World Automotive Industry

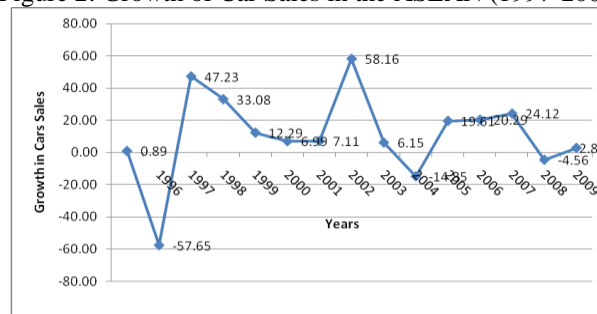
Country	Number of Workers	Country	Number of Workers
Argentina	12,166	Korea	246,900
Australia	43,000	Malaysia	47,000
Austria	32,000	Mexico	137,000
Belgium	45,600	Netherlands	24,500
Brazil	289,082	Poland	94,000
Canada	159,000	Portugal	22,800
China	1,605,000	Romania	59,000
Croatia	4,861	Russia	755,000
Czech Rep.	101,500	Serbia	14,454
Denmark	6,300	Slovakia	57,376
Egypt	73,200	Slovenia	7,900
Finland	6,530	South Africa	112,300
France	304,000	Spain	330,000
Germany	773,217	Sweden	140,000
Greece	2,219	Switzerland	15,500
Hungary	40,800	Thailand	182,300
India	270,000	Turkey	230,736
Indonesia	64,000	UK	213,000
Italy	196,000	USA	954,210
Japan	725,000	Total	8,397,451

Source: OICA

Analysis of Figure 2 reveals that China recorded the highest number of employees in the automotive industry, followed by the U.S, Russia and Germany. In the ASEAN region, the three main car manufacturing countries, Thailand, Indonesia and Malaysia have a combined number of 0.3 million employees.

Considering that the three ASEAN countries are significant part of the world automotive industry, this research will focus its attention on macro analysis of variables that influence the number of car sales in the short term and long term. This specific trend analysis is chosen to mark the dramatic increase of car sales during the period between 1996 and 2011 with market expansion of nearly 170%. The positive growth of car sales in the ASEAN region is as per demonstrated in Figure 2.

Figure 2: Growth of Car Sales in the ASEAN (1997-2009)



Based on Figure 2, it can be observed that as a whole, the annual growth of car sales in the ASEAN region is two digits most of the time. However, significant plunge in car sales was recorded for several intermittent periods such as in 1997, 1999-2001, 2003-2004 and 2007-2008. This was attributed to several factors including the 1997/1998 economic crisis and the U.S sub-prime crisis in 2008. The 2004 car sales reduction was spurred by the political crisis in the Philippines (Yap, Reyes and Cuenca, 2009) and the hike in import tariffs for vehicles that had led to 20-25% increase in car prices in Vietnam (Vu Long, 2004).

From this point onwards, this research will be structured in the following manner. The second part will present findings from past researches followed by analysis of data and research methodology in part-3 and part-4 respectively. Part-5 will elaborate the research findings and part-6 will put forth the final conclusions.

II. Literature Review

Past researches on the correlation between the number of car sales and macroeconomic variables are scarce, especially those specifically covering ASEAN countries. Based on the review of these researches, several factors have been identified capable of influencing car sales. These include fluctuation in fuel prices as well as loan interest, unemployment and income rates.

The research by Hamilton (1988), Pindyck dan Rotemberg (1984), Barber *et al.* (1999) reveals that significant increase in fuel price could impact car sales. This factor is found to induce uncertainty in operation cost that could affect the total car production cost. This in turn impacts value of investment and demand from consumers. The same finding is shown by Lee and Ni (2002) in their research on 14 industrial countries. The hike in fuel prices is found to disrupt supply by the industrial sector while at the same time influenced consumer demand for industrial products, especially vehicles. Duncan (1980) proved that increase in fuel price had swayed consumer preferences towards choosing small sized vehicles.

Other factors that have been analysed were income level, interest rate, financial aggregate and unemployment rate. These include the research by Shahabudin (2009) on domestic and foreign car sales. In this research, it was discovered that all variables could significantly influence car sales. However, this regression model suffered from heterocedasticity that affected the efficiency to gauge domestic and foreign car sales. In this research, it is proven that all variables could significantly influence car sales. However, the problem of heterocedasticity had impaired the efficiency of the model as a whole.

On the other hand, Ludvigson (1998) tested the impact of financial policy on car sales *pula* which was attributed to the offering of bank loans for car purchase. The increase of basic interest rate was found to pose a significant negative impact on car sales. This is due to the lack of ability among commercial banks to provide loans for car buyers

As described by Dargay dan Gately (1999) following their research on car ownership in 26 countries from 1960 to 1992, it was discovered that the projected rate of car ownership for two decades until 2015 is high for low income nations. The same statistics is expected to be recorded in other economies including Portugal, Greece and Ireland. This is based on these countries' own expectation that they will achieve high income growth in the future. On the other hand, for China, India and Pakistan, car ownership increased twofold in line with their per capita income growth.

Dargay (2001) using Family Expenditure Survey from 1970 to 1995, it was found out that the statistics of vehicle ownership recorded a positive upward trend with income increase. However, there is a negative correlation when there is an income reduction. This is associated with the personal habit of individual consumers as vehicle is seen as an important necessity in the present context of everyday life

Specific researches involving ASEAN countries on this subject is however limited. The few available works are focused on developmental and policy oriented analysis. Among these are Wad, P. and Govindaraju (2011) dan Mohd Rosli (2006).

Considering that there is no specific research conducted to analyse the relationship between these economic variables in the context of ASEAN countries thus far, the objective of this paper is to study the long term correlation and causal relationship between the rate of car sales and specific macroeconomic variables in five ASEAN countries namely Indonesia, Malaysia, Thailand, Philippines and Singapore.

III. Research Methodology

This study is focused on the correlation between the statistics of car sales (including other passenger vehicles, PV) in five ASEAN countries particularly Indonesia, Malaysia, Singapore, Philippines and Thailand with four macroeconomic variables namely Gross Domestic Product (GDP), inflations rate (INF), unemployment rate (UNEMPT) and Base Lending Rate (BLR) for the period between 1996 to 2010. The selection of these ASEAN countries is due to the availability of data for the time period in addition to fulfilling the criteria of balanced data required for regression panel analysis to be implemented in this research.

To analyze long term and short term causal relationship between variables in this research, dynamic panel analysis is utilized. Two methods are implemented specifically the Mean Group (MG) and Pooled Mean Group (PMG). These two methods were introduced by Pesaran dan Smith (1995) and Pesaran *et al.* (1999). The relationship between growth in GDP, INF, UNEMP and BLR on the rate of car sales (PV) which is being studied in this paper is shown in the following panel error-correction model equation.

$$\Delta X_{i,t} = \alpha_i + \theta_i(X_{i,t-1} - \beta_i \Delta Z_{i,t}^s) + \sum_{j=i}^{p-1} \gamma_{i,j} \Delta Z_{i,t}^s + \sum_{j=1}^{q-1} \varphi_{i,j} \Delta X_{i,t} + \mu_i + \varepsilon_{i,t} \quad (1)$$

With β_i as long term parameter, θ_i as equilibrium parameter (correction), $X_{i,t}$ as rate of car sales and Z as the studied macroeconomic variables. Whereas i represents countries, t refers to research duration.

In analyzing long term relationship between the variables in equation (1) above, the same general procedures in VAR method for time series data are applied. The first procedure is to conduct unit source test followed by co-integration and error correction. Considering that this research utilizes panel data, panel source unit test is applied. There are many types of available unit source test which could be applied in this case. For this research, Levin, Lin and Chu, LLC (Levin *et al.*, 2002), Ipshin (Im *et al.*, 1997) and Hadri (2000) are applied. LLC and Ipshin's test has a null hypothesis which means that the research variable has unit root problem, while the test by Hadri yield a stationary result at benchmark level. Unit source test is crucial to ensure that research variables possess the same integration degree. This degree of integration is an early indicator that may reveal the existence of long term relationship. In this study, Hadri (2000) test will be conducted. According to Das (2011), this test is the most accurate compared to other types of test with null hypothesis.

To distinguish whether this long term relationship exists or not, two forms of co-integration panel tests are applied. The first is the Persyn dan Westerlund (2008) co-integration test with four co-integration test applied, namely G_{α} , G_t , P_{α} and P_t bivariately for each variable. Two tests (G_{α} , G_t) refer to alternative hypothesis that at least one unit will co-integrate, while another two tests (P_{α} , P_t) refers to alternative hypothesis of full panel co-integration. If the null hypothesis of this co-integration test is rejected, it will prove that there exists a long term relationship between these variables. In this regard, panel error correction test can be conducted to find out both long term and short term parameters. Considering that the regression model for this research is in vector form, Engle and Granger (1987) test will also be applied as secondary method. Through this co-integration method, the existence of relationship will be determined in two phases. Firstly, the research model will be put under regression to attain residual value. This figure will next be tested for static value with a static null hypothesis. If this result is achieved, this proves that the research variable has long term correlation. Next, error correction model with ECT(-1) term could be tested for significant value in this research.

Considering that panel error correction test is applied in a dynamic form, Pooled Mean Group, PMG (Pesaran *et al.*, 1999) and Mean Group, MG (Pesaran and Smith, 1995) are implemented. Based on PMG method, short term heterogeneous correlation between units is recorded. However, long term co-efficiency is the same for all units while intercept, speed of adjustment and short term co-efficiency are different between units. Asteriou (2009) showed in detail the formula for PMG method in his research. On the other hand, the MG method yielded a contrastive result compared to PMG in which the long term, short term and intercept are different for every unit. Due to the availability of these two methods, Hausman (1978) test is implemented to determine the best model. The hypothesis in this study is tested to decide the suitability of this long term coefficient with all units in the model. If this hypothesis is rejected, the MG is more suitable compared to PMG (Eng dan Muzaffar, 2006).

IV. Empirical Results

Static test result for research variables is shown in Table 2 below. Based on Hadri (2000) unit source test, it is discovered that all research variables have the same degree of integration. This shows that there is a possibility of long term correlation between the studied variables and rate of car sales in ASEAN countries.

Table 2: Static Test

Variable	Level	Difference
lnPV	4.3319*	2.2688**
lnGDP	6.5750*	1.6040***
lnINF	6.4852*	2.3636*
UNEMP	2.6589*	2.4111*
BLR	4.4762*	2.7372*

*, **, *** significant at 1, 5 and 10%

Based on the same integration level shown on Table 1, the Persyn and Westerlund (2008) co-integration test is implemented. Result of the analysis is shown in the following Table 3.

Table 3: Bivariate Cointegration Test

Tests	lnGDP	lnINF	UNEMP	LR
G_{α}	-14.915*	-14.515*	-9.568*	-14.266*
G_t	-3.213	-3.526	-12.064	-15.058
P_{α}	-7.915*	-2.516	-3.918	-2.429
P_t	-3.137	-2.174	-6.867	-12.189

*Significant at 1%

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Based on Table 3, it is discovered that the four variables cointegrate with rate of car sales. This result proves that the four macroeconomic variables do influence car sales in the long term. The findings of this co-integration test are also supported by co-integration analysis test conducted by Engle and Granger (1987). Static test results show that it is static (Z value = 1.1768; P value = 0.1196). This clearly proves that analyzed variables do influence car sales in the long run.

In this regard, the error correction term (ECT) must be incorporated in the regression model to study this correlation. To determine the suitable type of model to describe this long term relationship between these research variables and rate of car sales in ASEAN countries, the Hausman (1978) test is utilised. The result is shown in the following Table 4.

Table 4: Hausman Test

Chi Square (χ^2)	P-value	Selection
0.94	0.9190	PMG

Based on Table 4, it is discovered that the impact of GDP, INF, UNEMP and LR on rate of car sales could be appropriately analyzed using the PMG model. Failure to reject this null hypothesis shows that the long term correlation between units or countries is the same.

Thefore, the relationship between the studied variables in ASEAN countries could be demonstrated in Table 5.

Table 5: PMG Estimates of Passenger Vehicles Sales Equation for 5 countries

	Long Run Coefficients
GDP	0.7151* (0.2363)
INF	-1.6614* (0.6896)
UNEMP	-0.9887* (0.0894)
LR	-1.4413* (0.1811)
	Short run Coefficients
ECT	-0.6291** (0.2529)
Δ GDP	-2.6485 (3.0868)
Δ INF	0.2189 (2.1325)
Δ UNEMP	0.2034 (0.2139)
Δ LR	-0.0599 (0.5922)
Constant	13.7549* (5.3327)

*,**,*** significant at 1%,5% and 10%
() standard error

According to Table 5, all analyzed variables have significant long term correlation with car sales in ASEAN countries. The increase in GDP is found to give positive impact towards car sales while changes in INF, UNEMP and LR cause the opposite. Significant ECT value recorded also supports this finding. It is proven that car sales has to bear the burden of short term equilibrium correction to achieve long term stability of 63%. However, for the short term period, it is discovered that this variable does not show a significant causal correlation.

Despite this, a more specific analysis according to country reveals that the level of short term causal correlation is different between countries. This result is presented in Table 6 below.

Table 6: Individual Results of Panel ECM of Passenger Vehicles Sales

Equation for 5 countries

Variable	Malaysia	Indonesia	Singapore	Philippine	Thailand
Short run Coefficients					
ECM	-1.2129* (0.2768)	-0.1350 (0.1034)	-0.0703 (0.1123)	-0.4946** (0.2407)	-1.2326* (0.2582)
ΔGDP	-0.5965 (0.5729)	2.2945 (2.6097)	0.3704 (1.7095)	-14.8207** (7.1069)	-0.4906 (1.6287)
ΔINF	1.0165 (2.2000)	-5.1078*** (2.6354)	-2.9422 (3.9673)	7.4095 (10.5141)	0.7186 (2.4597)
ΔUNEMP	-0.8787 (0.5219)	-0.3719 (1.2098)	0.1500 (0.5253)	0.8555 (1.2537)	0.4713** (0.2385)
ΔLR	0.1912 (0.5152)	-1.9904 (1.0079)	-0.4943 (0.7349)	1.6306 (1.1963)	0.3628 (0.4009)

*, **, *** significant at 1%, 5% and 10%

() standard error

Based on Table 6, it is discovered that error correction term (ECT) is significant for three countries namely Malaysia, Philippines and Thailand. On contrast, from the perspective of short term causal correlation, it is found out that the inflation variable is significant towards car sales in Indonesia, while GDP and UNEMP variables are significant for Philippines and Thailand. The negative correlation between GDP and car sales in the Philippines could be traced back to an earlier study by Sivak and Thimhoni (2008). According to this research, the increase in population will lessen the level of per capita income for individuals. This indirectly causes the reduction of average purchasing power among consumer. On the other hand, according to Wu *et al.* (2012) and Pelletiere and Reinert (2006), increase in the sales of used vehicles may also influence this relationship. For Thailand, the reduction in unemployment rate is found to give positive impact on car sales. This is partly caused by government's taxation policy which imposes lower road tax for the purchase of first car besides its obvious support towards the domestic automotive sector (see: www.ieat.go.th)

V. Conclusion

This paper analysed the causal correlation between for macroeconomic variables and car sales in five ASEAN countries for the period between 1996 and 2010. The findings from this research show that all of the variables have long term correlation with car sales. The GDP variable is found to have positive relationship with car sales. This proves that national income level is an important determinant for the automotive industry. On contrast, spikes of inflation, unemployment rate and interest rate are found to inflict negative impact on car sales. In this regard, financial and fiscal policies must be implemented carefully to prevent this from occurring. This is due to the fact that the sales rate in the automotive sector is considered an important reference to economic growth and performance in any particular country.

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