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Modeling the Dynamic Response of Automobile Sales in Troubled Times: A Real-Time Vector Autoregressive Analysis with Causality Testing for Greece

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Abstract: In this paper, we investigate the factors that affect multi-segments automobile sales in, Greece. Various relevant quantitative techniques have been employed, such as stationarity, causality and cointegration. A Vector Autoregressive (VAR) model was also developed and long-term impacts of the different variables of interest on car sales have been estimated through generalized impulse response functions (GIRF). The impact of the current financial crisis on the Greek automobile market was also taken into account. The results show that fuel prices Granger cause total car sales. The results also indicate the absence of long run cointegrating relationships among the variables. The full blown model shows that demand for new automobiles depends on the existing social, financial and political conditions of the local economy and that the various shocks observed have a temporary medium-run character on car sales, whereas the system is found to be stable.

Keywords: car sales; VAR model; GIRF, Granger causality; Greece; recession; crisis.

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1. Introduction

Car sales analysis can serve a dual purpose. First, to help the car sales industry to adjust to demand forecasts since underestimation of new car sales demand might lead to lost sales and thus to reduced profit; meanwhile, overestimation could result in the production of unwanted cars that remain overstock (Wang et al., 2011). Second, at the economy-wide level of analysis, accurate demand modeling of car sales can assist policy decisions, related to the total economy and the transport sector. The car industry offers a large range of products and the particular position of each type of car in the market varies over time as economic conditions change and, therefore, it depends on a large number of factors such as GDP, unemployment, fuel, car prices and tax policies (Danielsen and Hilliard, 1983).

Although private cars have played an important role as an urban transport mode over the past decades, the car sales sector in Greece has been significantly affected by the ongoing crisis showing a reduction of total sales that exceeded 20% (Roul et al. 2012). This is a much higher trend than the respective one (13%) observed in the OECD area (OECD, 2013). Meanwhile, government policies on car sales has to face the conflicting objectives of raising tax revenues, improving the balance of foreign trade and reducing environmental effects. New car sales have a twofold impact on the economy: on the one hand they bring revenues through taxation and tend to have a positive effect on the environment; on the other hand, they have a negative impact on the foreign balance of payment. In times of recession and economic instability the above conflicting objectives lead to frequent changes in taxation policies that create positive or negative shocks in car sales. Moreover, car

sales and car use affect the share of the other transport modes. Thus, car sales policy measures affect both the economy and the transport sector.

The aim of the paper is to analyze the main factors that affect new car sales and explore the impact of financial recession on the car sales market in Greece, using monthly time series data. More precisely, the present study attempts to identify the determinants of car sales in Greece and, more broadly, their bi-directional dependence with the economy, using aggregate data and a Vector Autoregressive (VAR) model.

In this context, we employ a number of econometric tests to identify the properties of the data and specifically their order of integration, the causality from a number of potential determinants towards car sales and their mutual equilibrium relations using the Generalized Impulse Response Functions (GIRFs) introduced by Pesaran and Shin (1998) that are capable of producing robust results that are invariant of the ordering of the equations. The study spans the period 2000M9-2012M9. The period under investigation includes both a period of growth as well as the downturn, following the global financial crisis and the Greek crisis. Therefore, our study benefits from the examination of a through-the-cycle sample enhancing the reliability of our results.

The paper is organized as follows: a brief literature review on car sales is followed by a brief description of the methodology used and the dataset employed. Then, empirical results are presented and discussed followed by relevant policy insights. Finally, closing remarks are made in the last section.

2. Related Studies

A number of factors that affect new car sales have been analyzed, in the literature, using a variety of methodologies.

First, regarding the factors affecting car sales, statistically significant relations have been identified among new car sales and income, interest rates, oil and car prices, tax increases and employment level variations. According to Danielsen and Hilliard (1983), demand for new car sales is affected by variations in income and oil price variables. Sivak (2013) examined the relationship between car sales and GDP in both developed and developing countries and concluded that GDP is a strong predictor of automobile sales. The link between gasoline prices and vehicle sales was analyzed by McManus et al. (2007). Moreover, automobile demand is affected by advertising and sales promotion as well as by technological development (Donatos and Kioulafas, 1999; Landwehr et al. 2011). Relatively recently, Mabit (2014) analyzed vehicle purchasing behavior through vehicle type choice using a mixed logit model. Technological development, fuel prices and tax reform were used as the explanatory variables.

Variations in car sales market due to changes in the social and economic environment is considered to be a crucial issue in demand analysis. According to Vasconcellos (1997), automobile demand is highly influenced by economic and transportation policies. Taxation can definitely determine consumers' purchase decision, especially in times of economic recession (Ryan et al., 2009, Hennessy and Tol, 2011). Ryan et al. (2009) found that car related taxes (fuel, vehicle registration, circulation) show a strong impact on new passenger car sales. There is no doubt that in times of crises- that imply economic and social instability- demand for new cars is

shrinking. Moreover, increasing inequalities in income distribution result in an increase in the top and the low-cost car segment market shares (Tommaso, 2015; Chung, 2015). Thus, during economic recession periods, car segments are not affected in the same way, with consumers revealing a clear preference towards small and used cars on one hand (OECD, 2009) and expensive, luxury vehicles on the other (Kohler and Jimenez, 2012).

Second, regarding the methodological framework, different methodologies for analyzing car sales demand, using both aggregate and disaggregate data, have been adopted in the literature (Karlaftis and Golias, 2002). Depending on the nature of the data, two main methodological procedures are followed: time series and discrete choice analysis. Generally, the former analysis examines the process of car sales over time (macro level), while the later explores consumers' preferences on car types and attributes (micro level), using revealed and stated choice experiments (Lee and Cho, 2009).

Discrete choice models have been used in the literature to investigate the impact of socio-demographic attributes and psychological variables on car purchases. These factors mainly explain consumers' preferences regarding the type and the characteristics of the vehicle. Location of residence and intension to buy an environmentally friendly car influence the type of car purchased, including the level of emissions (Nayum et al., 2013). Preferences on alternative fuel vehicles (electric car, fuel cell car) depend on commuting behavior, gender and annual mileage (Hoen and Koetse, 2014). Based on behavior demand models, Dagsvik and Liu (2009) estimated demand price elasticities and willingness to pay for alternative fuel vehicles. According to their results high income households value alternative fuel vehicles higher than conventional cars.

There is also a substantial body of research on time series analysis and demand forecasting for vehicles. However, there is limited research exploring automobile demand taking into account the (non-) stationary characteristics of the economic indicators. The (non-) stationary properties of the automobile sales indicators present additional challenges to new car sales prediction (Sangasoongsong et al., 2012; Karlaftis and Vlahogianni, 2009). Barber et al. (1999) used a structural VAR model to investigate the impact of shocks to oil prices and exchange rates on new car sales of American and Japanese automakers in U.S. market. They applied unit root and cointegration tests and finally concluded that estimation of a VAR is an appropriate methodology. Franses (1994) estimated an econometric model for new car sales using cointegration techniques. Sangasoongsong et al. (2012) used Granger-causality and cointegration techniques in order to identify the dynamic relationships among automobile sales and macroeconomic variables.

Based on the methodological framework of time series analysis, the purpose of this study is to investigate the impact of specific variables related to financial recession on automobile market using unit root, cointegration and causality for Greece.

3. Methods

We briefly present step-by-step econometric properties of the original series and their derived components, their causality with respect to other variables of interest, the existence of mutual long-run relationships and, finally, the incorporation of this information into a full-blown model. In this context, standard practice of modern econometric techniques dictate that all the time series employed in the model should

be stationary over time, i.e. their statistical properties should be time invariant, whereas in case of I(1) variables possible existence of long-run relatioships among them should be accessed based on relevant cointegration tests. Lastly, specification of endogenous variables in VAR models is assessed *a priori* using Granger causality testing.

- *Stationarity*

Following, among others, Pesaran et al. (2004), we begin our analysis by testing for stationarity, based on the popular Augmented Dickey-Fuller (ADF) methodology (Dickey and Fuller, 1979).

- *Optimum Lag Length*

In this paper, we make use of the so-called Schwartz-Bayes Information criterion (SBIC) introduced by Schwartz (1978), because it is an optimal selection criterion when used in finite samples (Breiman and Freedman, 1983 and Speed and Yu, 1992).

- *Granger Causality*

After examining the stationarity properties of the data series, we use Granger causality to test the predictive ability of the variables that enter the model. As Engle and Granger (1987) showed, if two variables are cointegrated, the general model is not appropriate for testing causality. Instead, a test based on cointegration and error-correction models should be employed. Through building an error-correction model

(ECM), the dynamic co-movement among variables and the adjustment process toward long-term equilibrium may be examined without facing cointegration issues.

After having estimated the ECM term, we modify the Granger test in order to incorporate the adjustment towards long-run equilibrium.

- *Cointegration*

Consequently, as a preliminary step before estimating the model, we investigate the existence of cointegration among the variables of the system, in order to inform the model's specification. We employ Johansen's (1988) methodology that allows for more than one cointegrating relationship, in contrast to other tests.

The investigation of causality, as described above, is very useful in uncovering the co-movement of the variables, with respect to our main variable of interest, here the car sales. However, the full-blown model will be presented below. The VAR model enables identifying how the variables of the system co-move and how car sales respond to shocks in other variables.

- *VAR model*

The Vector Autoregressive (VAR) model will be employed in order to characterize the joint dynamic behavior of the variables of interest. The model is compactly expressed in the following form:

$$X_t = \begin{pmatrix} x_{1,t} \\ \vdots \\ x_{n,t} \end{pmatrix}, c = \begin{pmatrix} c_1 \\ \vdots \\ c_n \end{pmatrix}, A_i = \begin{pmatrix} a_{11,i} & \dots & a_{1n,i} \\ \vdots & \ddots & \vdots \\ a_{n1,i} & \dots & a_{nn,i} \end{pmatrix}, \varepsilon_t = \begin{pmatrix} \varepsilon_{1,t} \\ \vdots \\ \varepsilon_{n,t} \end{pmatrix}$$

Alternatively:

$$X_t = c + A_1 X_{t-1} + \cdots + A_p X_{t-p} + \varepsilon_t$$

where: $c_i$are intercepts, $x_{i,t}$ are the endogenous variables $i, a_{ij,k}$is the impact of variable $j$on variable $i$lagged by$k$, and $\varepsilon_{i,t}$ is the residual of i. Parameter$p$ shows how long we goback in time. As usual, we assume that the residual's vector ε_t is white noise. Also, there is no correlation across time, and no autocorrelation.

Also, the VAR (p) model can be expressed as follows:

$$Y = A^* Z + U$$

where: $Y = [X_{p+1}, X_{p+2}, \ldots, X_N]$, $A^* = [\boldsymbol{C}, A_1, A_2, \ldots, A_p]$, or:

$$Z = \begin{pmatrix} 1 & 1 & \ldots & 1 \\ X_p & X_{p+1} & \ldots & X_{N-1} \\ \vdots & \vdots & \vdots & \\ & X_1 X_2 \ldots X_{N-p} & & \end{pmatrix}, U = \left(\varepsilon_{p+1}, \varepsilon_{p+2}, \ldots, \varepsilon_N\right)$$

To model exogenous effects we incorporate q exogenous variables, $z_1(t)$, ..., $z_q(t)$, as follows:

$$X_t = A_1 X_{t-1} + \cdots + A_p X_{t-p} + \boldsymbol{c}_1 z_{1,t} + \cdots + \boldsymbol{c}_q z_{q,t} + \varepsilon_t$$

where: $\boldsymbol{c}_j$is the vector of size $n \times 1$ $(j = 1, \ldots, q)$. Also, we augment A^* by including $\boldsymbol{c}_1$, ...,$\boldsymbol{c}_q$ to obtain the Ordinary Least Squares (OLS) estimates of Ai and $\boldsymbol{c}_j$. Of course, when the variables are cointegrated, we use a Vector Error-Correction (VEC) model,by incorporating the error correction terms in the VAR.

Following the relevant literature, we assess the results using the Generalized Impulse Response Functions (GIRFs), which measure how an unanticipated/unexpected shock in one of the variables affects the dynamic behaviour of the rest of the variables in the model.

4. Data and Variables

The on-going economic crisis that hit Greece, has had a severe impact on the economy: unemployment rose to approximately 26%, Gross Domestic Product (GDP)

declined by more than 20%, whereas fuel price increased by approximately 50%. The data used in the analysis that were readily available to us, spanning the period 2000M9-2012M9, are collected from the Association of Motor Vehicle Importers' Representatives Database. Data on gasoline prices are collected, at monthly intervals, from the Greek Ministry of Development. GDP, unemployment rate (which includes the non-registered workers) and population are obtained from the Greek Statistical Authority, whereas data on economic sentiment come from the OECD main economic indicators database. Gasoline prices and gross domestic product are in 2011 and 2005 prices, respectively.

Table 1 presents some descriptive statistics regarding selected variables used in the analysis, while Table 2 describes the data used and the techniques implemented.

Table 1: Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Car sales	145	3,333.000	31,880.000	17,285.807	6,743.727
Population	145	10,090,543	11,403,199	11,143,877	139,086.07
Unemployment	145	7.268	26.000	11.358	4.124
Gasoline prices	145	0.913	1.830	1.214	0.262
GDP	145	38761.971	55318.000	47,222.642	4456.061
Economic sentiment	145	-89.000	17.000	-33.627	24.018

Table 2: Data source and techniques implemented

Variables	Period	Data source	Econometric Technique
Car Sales	2000 (M9)-2012 (M9)	Association of motor vehicle Importers Representatives	VAR, Unit root test, Granger causality test, cointegration test
Population	2000 (M9)-2012 (M9)	Hellenic Statistical Authority	Unit root test, Granger causality test, cointegration test
Economic Sentiment	2000 (M9)-2012 (M9	OECD, Main Economic Indicators Database	Unit root test, Granger causality test, cointegration test
Unemployment	2000 (M9)-2012 (M9)	Hellenic Statistical Authority	VAR, Unit root test, cointegration test
Gasoline prices	2000 (M9)-2012 (M9)	Greek Ministry of Development	VAR, Unit root test, Granger causality test, cointegration test
GDP	2000 (M9)-2012 (M9)	Hellenic Statistical Authority	VAR, Unit root test, t, cointegration test

Also, some dummy variables were included in the model. More precisely, in order to analyze the impact of the recent economic recession on automobile demand, a dummy variable was included in the model. More specifically, the dummy variable "economic recession" takes the value one (1) from May 2010 to December 2012, and zero (0) elsewhere. The dummy variable "loans" takes the value one (1) from January 2003 to December 2008, and zero (0) elsewhere. It refers to the period when favorable conditions for consumer loans were adopted by Greek banks. The variable "taxes" takes the value one (1) from May 2009 to August 2009 and the value zero (0) elsewhere. During that time, reduced registration taxes were put forward by the government.

5. Empirical Results

5.1 Unit Root test

The methodology adopted includes stationarity, Granger causality and cointegration testing. We begin the analysis applying a unit root test on the variables included in the dataset. As can be seen in Table 3, the null hypothesis that each of the variables contains a unit root was not rejected at the 10% critical level, except for total car sales. Analytically, the ADF t-statistics for the first difference of the variables are statistically significant leading to the rejection of the null hypothesis that the first differences are non-stationary. That is, total car sales are stationary while all the other variables of interest (population, fuel price, GDP and unemployment) are characterized by integration of degree one I(1).

In order to cross validate our findings on the order of integration of the various time series we also employed the Phillips-Perron (PP) (1989) unit root test and the

Kwiatkowski–Phillips–Schmidt–Shin or KPSS) test. The results of the tests, which are available upon request by the authors, implied non-rejection of the PP statistic and rejection of the KPSS statistic, which is evidence of a unit root process I(1) for the variables of (population, fuel price, GDP and unemployment). Meanwhile, for the time series variable of Total Car Sales there was a rejection of the Phillips Perron (PP) statistic but failure to reject the KPSS statistic is viewed as strong evidence of covariance stationarity I(0). In addition, based on the Auto Correlation Function (ACF), we witness an almost exponential decay rate, a fact which is a strong indication of short-term memory models (intergated of degree 0), in contrast to the possible existence of long memory (Karlaftis and Vlahogianni, 2009).

Table 3: Unit Root test

	ADF (levels)			**ADF (first differences)**		
Variable	**t-stat**	**Critical Values**	**Stationarity**	**t-stat**	**Critical Values**	**Stationarity**
Total car sales	-3.327	-3.145 (10%)	Yes	-	-	-
Greek population	-2.387	-3.145 (10%)	No	-12.321	-3.497 (1%)	Yes
G.D.P (base year 2005)	-2.437	-3.145 (10%)	No	-10.234	-3.497 (1%)	Yes
Unemployment	2.952	-3.145 (10%)	No	-8.996	-3.497 (1%)	Yes
Fuel price	-2.025	-3.145 (10%)	No	-6.789	-3.497 (1%)	Yes
Economic sentiment	-2.720	-3.145 (10%)	No	-14.234	-3.497 (1%)	Yes

5.2 Cointegration test

Since the variables were I(1), we tested for the existence of cointegration of rank up to one vector, using the methodology presented in the previous section. Table 4 summarizes the results. The results of Johansen's test suggest the absence of cointegration among the variables; both the trace and the maximum eigenvalue statistics confirm this finding (the null hypothesis of zero cointegrating relationships is not rejected).

Table 4: Johansen cointegration Test

Maximum Rank	Log Likelihood	Eigenvalue	Trace Statistic	5% Critical value	Cointegration
0	-2498.27		204.1944	62.99	No
1	-2461.21	0.40661	130.0844	42.44	No
2	-2430.54	0.35079	68.741	25.32	No
3	-2404.88	0.30328	17.4263	12.25	No
4	-2396.17	0.11549			

5.3 Granger Causality tests

When estimating VARs or conducting Granger causality analysis, the test is sensitive to the lag length selected. Table 5 reports the optimal lag lengths chosen by SBIC. According to the results reported in Table 5, different lag lengths were selected for the causality tests, namely 6 lags for the causality test between total car sales and fuel price, and 3 lags for the test between total car sales and population.

Table 5: Lag selection for Granger causality test

Variables	Lags	SBIC
Total car sales and Gasoline Price	0	17.109
	1	16.565
	2	16.441
	3	16.466
	4	16.583
	5	16.616
	6	16.419*
	7	16.467
	8	16.566
Total car sales and GDP	0	38.253
	1	37.762
	2	37.674
	3	37.736
	4	37.719
	5	37.702
	6	36.055*
	7	36.139
	8	36.271
Total car sales and Unemployment Rate	0	21.150

	1	20.580
	2	20.506*
	3	20.553
	4	20.694
	5	20.799
	6	20.561
	7	20.642
	8	20.754

Table 6: Granger causality test

Null Hypothesis	Lags	Number of observations	F statistic	(Prob>F)	Result
Fuel price *does not Granger cause* total sales	6	138	2.0436	0.0651	Reject H_0
GDP *does not Granger cause* total sales	6	138	3.4213	0.0031	Reject H_0
Unemployment *does not Granger cause* total sales	2	142	4.9872	0.0000	Reject H_0

The possible existence of Granger causality between total car sales, fuel price, Greek GDP and Greek unemployment was explored by applying a Granger causality test. In Table 6, the F-test as well as the respective p-values are reported. The test results, at the 95% level of significance, indicate that fuel price, Greek GDP and Greek Unemployment *do* Granger cause total car sales.

5.4. The VAR model

VAR models with exogenous variables have been widely used in the transportation literature (see, for instance, Tsirigotis, Vlahogianni and Karlaftis, 2012). Recent developments indicate that a VAR model specified in differences is valid only if the variables under study are not cointegrated (Lee and Oha, 2004). Since no

cointegration relationships were found among the variables we proceed to estimate the VAR model (Barder et al., 1999). In order to assess the selection of the optimal lag length in the VAR model, the SBIC information criterion was applied and one lag for the VAR model was selected. See Table 7.

Table 7: Lag length selection for the VAR Model

Lag	SBIC
0	34.9858
1	34.3355*
2	35.5757
3	35.9887
4	36.2744
5	35.0855
6	35.4744
7	35.7958
8	34.9858

A number of socioeconomic factors, as well as changes in car taxation that occurred during those years were included as *exogenous* variables. More specifically, the endogenous variables included in the VAR model are: total car sales, fuel price, Greek GDP and Greek unemployment, all in first differences when needed, so as to ensure stationarity. The exogenous variables included in the VAR (financial recession, loans, registration taxes, presumptions, economic sentiment, population) simply act as extra explanatory (exogenous) variables for all the equations in the VAR model, as discussed earlier.

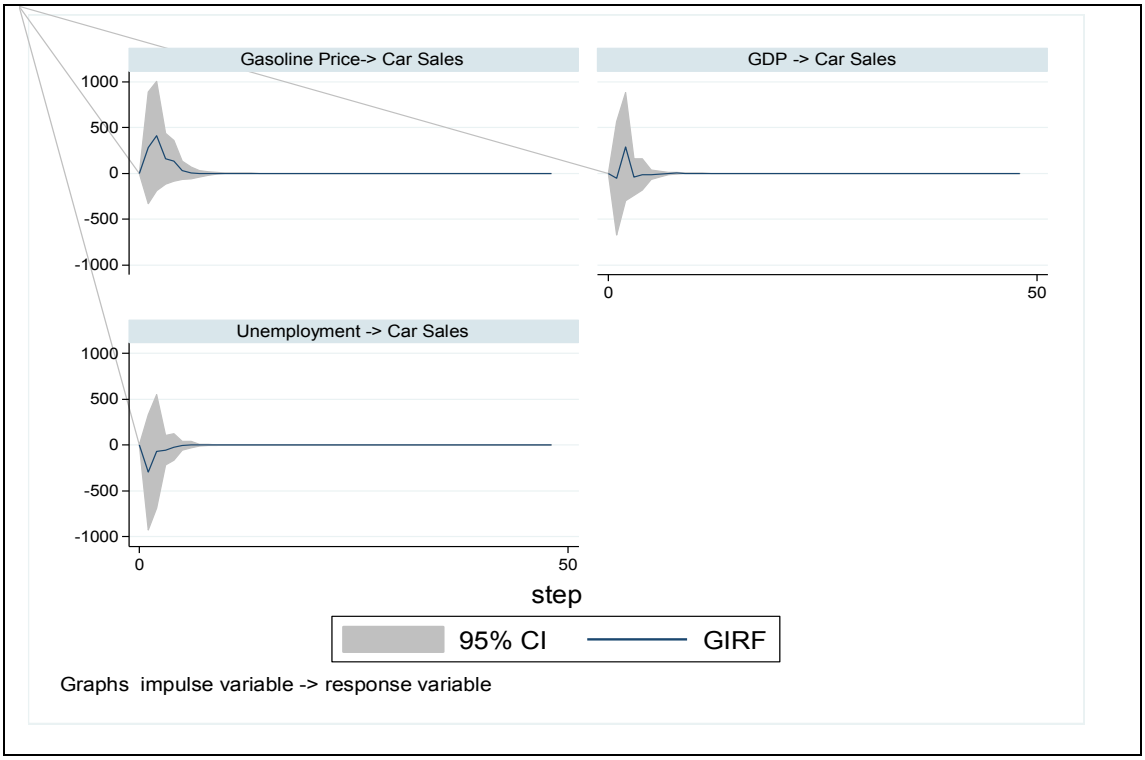
5.5. GIRFs

The IRFs analyze the dynamic effects of the system when the model reacts to a shock (Zhang et al., 2015). They trace out the effect on the dependent variables in the VAR to shocks in all the variables in the model. As we have seen, the shock occurs through the error term and affects the dependent variable over time.

The results in Figure 1, regarding total car sales, suggest that a shock in the Greek GDP, which captures aggregate income fluctuations, affects positively total car sales in the first months, while in the fifth month, a reduction in total car sales is observed. This effect has a short run character since it seems to die out in less than eight months and total car sales reach their equilibrium position. Finally, based on Figure 1, a shock in unemployment has a negative effect that lasts for less than five months, when total car sales return back to their initial equilibrium position.

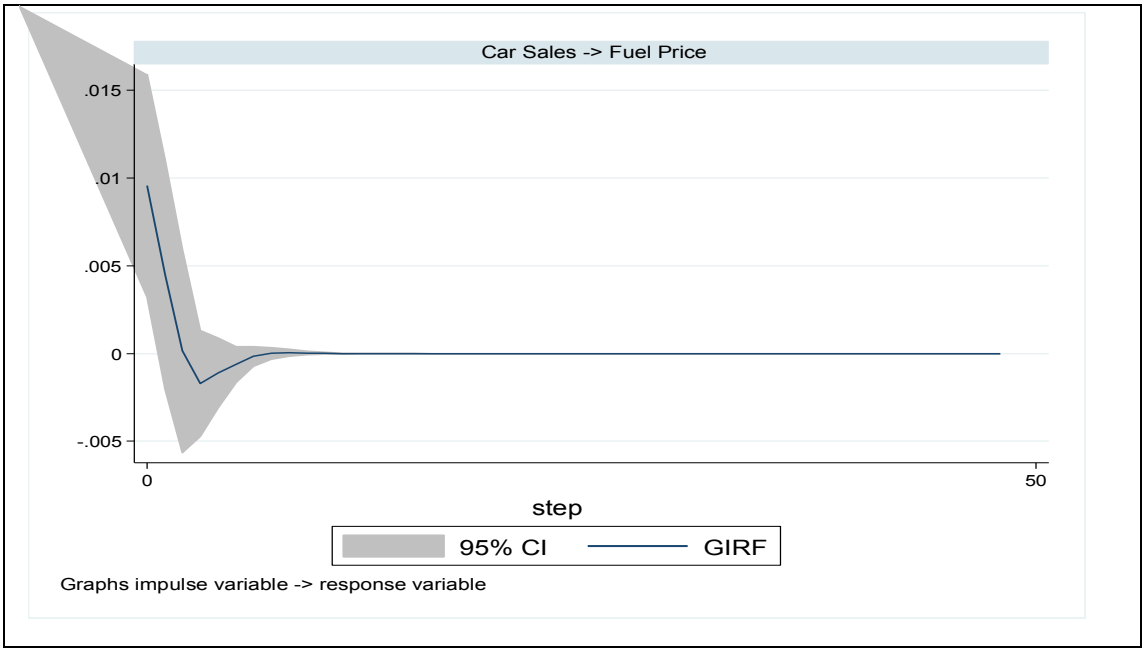
It is also worth noting that the impulse response functions can also produce confidence intervals to determine whether they are significant. According to the 95% confidence interval no significant effect is present. Moreover, according to Figure 1, a shock in fuel price appears to have a positive short run effect on total car sales, which dies out in less than five months with total car sales reaching their equilibrium position.

Figure 1: GIRFs response of Total Car Sales



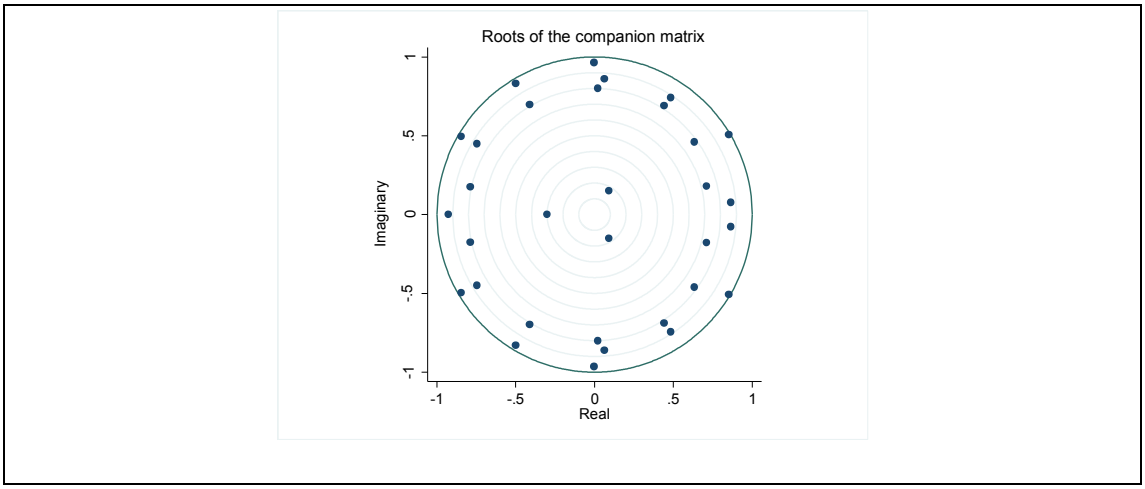
According to Figure 2, a shock in total car sales seems to have a small positive short run effect on fuel price, which lasts for less than five months when the fuel price reaches its equilibrium position. Nevertheless, no statistical significance is evident.

Figure 2: GIRFs Gasoline Price



If the time path of the impulse response function becomes negligible over time, the system of equations is stable. All the effects presented in Figures 1-2 settle down relatively quickly, usually in less than eight months, when all the variables reach their equilibrium position. This is also supported by the increased stability of the VAR model, presented in Figure 4. More specifically, the VAR model estimated is stable since the moduli of all eigenvalues in the system lie inside the unit circle.

Figure 4: VAR stability



6. Policy Implications

Nowadays, Greece is still in recession and the correct sectoral policy mix should be re-examined. In this context, the automobile car sales sector is an important asset for the Greek economy since it accounts for a significant part of government revenues, especially through the registration taxes that are directly implemented whenever a car sale takes place as well as through the presumptions implemented once a year. Of course, as we have seen, the car sales sector in Greece was significantly affected by the ongoing crisis with a reduction of total sales that exceeded 20% (Roul et al.2012), which -in turn- affected government revenues. Thus, the Greek Government was forced to counter-balance the revenue losses through alternative austerity measures. Hence, it is of outmost importance to investigate the policy implications in the Greek automobile sales industry which deserve careful screening.

Policy implications in the car sales sector concern both the transport sector and the economy as a whole. During economic recessions, policy measures attempt to create a favorable compromise among tax revenues and balance of foreign trade on the one hand, and to exercise the right influence towards sustainable mobility, on the other hand. In the case of Greece, policy issues have to face two main characteristics; first, that recession is very deep and long-lasting and second, that Greece itself is not a car producing country. The following findings of this study make clear the available options related to policy issues both on the market and on the transport sector.

As far as transport policy issues are concerned, model results indicate that demand for new car sales is significantly affected by the economic recession in Greece. As a result of the economic crisis, unemployment has increased and income has declined dramatically, resulting in a decrease in car sales. Economic uncertainty,

difficulty to obtain bank loans, and fear of job loss have also contributed to this direction. Private car mode is a competitive transport mode to Public Transport (PT) in urban areas, especially in areas not efficiently covered by PT network. Since car use is more expensive than PT, the drop in car sales during recession probably indicates a shift to PT mode. The latter is also observed in other studies which report that economic conditions result to a shift to PT mode share, since commuters have to face the always-increasing cost of private car use (Efthymiou and Antoniou, 2017). However, the full extent of this shift, partly shown by the drop of new car sales, is not easily measured since a total drop in urban transport demand has also been observed simultaneously, because of the economic recession.

Regarding the economy as a whole, policy measures attempt to achieve a compromise between balance of foreign trade, environmental aspects and tax revenues. Although government intervention has always been a controversial topic (OECD, 2009), the study showed that using favorable taxation policies, automobile demand could be positively affected. Adjusting fuel taxes, registration taxes, and providing incentives to consumers are possible measures that could be taken by governments and public authorities, in general, to mitigate the negative impacts on automobile industry.

The Granger causality relationship between gasoline price and car sales indicated that policies regarding fuel taxes could have an impact on automobile demand, not only by controlling car sales but also by creating a shift to more fuel-efficient and environmentally-friendly vehicles. Second, tax schemes including reduced registration taxes and exemptions could be an efficient way to boost auto sales in the short term. A cut in the registration tax on new cars applicable between May and August 2009 resulted in an increase in car sales in the corresponding period

despite the short implementation of this policy. Finally, favorable conditions for loans proved also to be an effective measure to increase consumption in automobile markets in the pre-recession period. However, the bank crisis that occurred during the recent recession, made this type of stimulus difficult to be pursued.

Thus, taxation measures and related incentives appear to be the only available tools for influencing car sales. It has been observed that the policies discussed have temporary impacts on car demand; demand returns to the previous levels, after the schemes end (OECD, 2009). For instance, in Spain, tax schemes maintained demand for new cars stable during the first crisis years but new car sales declined significantly when those schemes were abandoned (Kohler and Jiménez, 2012).

To conclude, the direction of the policy measures should support the general economic plans adopted to face recession and lead back to development. If improving the balance of foreign trade is considered to be of primary importance, car sales should not be encouraged by favorable taxation measures at the cost of losing some jobs in the car sales market and some market revenues from new car sales and use. In this case, public transport should be reinforced to undertake extra passenger demand resulting from restricted car use. Alternatively, car sales could be encouraged by reducing some of the taxes that are related to car use and also by providing incentives for obtaining environmentally friendly cars through scrappage benefits. In the context of a social policy, during recession periods, car reduction could be more generous for low-cost cars.

7. Conclusions

In this paper, we investigated the factors that influence car sales in, Greece. The methodology adopted includes unit root, stationarity, cointegration and causality testing. A VAR model of multi segments automobile sales was developed, and the impacts on automobile sales were estimated based on GIRFs. The impact of the current financial crisis on the Greek automobile market was also taken into account.

According to the results, Gasoline price, GDP and Unemployment have a causal result on total car sales. In this context, all the factors that exhibit a causal relationship with total car sales were included as endogenous variables in the VAR model employed. The results also indicate the absence of cointegrating relationships among the variables. The VAR model developed showed that demand for new automobiles depends on the existing social, financial and political conditions of the country; unemployment rate and the dummy variable capturing the impact of financial recession affect negatively automobile sales, while variables related to favorable conditions for loans and reduced registration taxes positively affect automobile sales in Greece. In this context, policies regarding taxes and incentives on automobile market that could match the general economic policies for facing financial recession have been discussed.

Despite the fact that economic recession has had a severe effect on car sales, the GIRFs showed that all the effects settle down quickly and the model is stable, indicating that automobile market will recover relatively quickly. This finding is in line with Chung (2015) who found that the financial recession has had a strong but only short term impact on the automobile market.

Of course, although it is believed that the automobile market is likely to recover to the pre-crisis levels, when the economy recovers, consumers may shift to other market segments. Recession experience made them more cautious about spending and thus, a transition towards small, less expensive cars might be expected.

Moreover, in times of crisis individual attitudes and perceptions towards cars and mobility change (Bungsche, 2015) and, hence, a shift towards more sustainable mobility might be expected. A good example for further research on the topic would involve disaggregating Total Car Sales to distinct groups that should account for different kinds of vehicles i.e. SUV, hatchback, sedan, etc which could also be further disaggregated based on fuel type and/or engine displacement. In this way, a thorough investigation on the model choice and model parameterization could take place, and the findings would clearly be of great interest.

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