RISING DIESEL PRICES, WHICH IMPACTS ON THE ROAD FREIGHT TRANSPORT DEMAND?

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Abstract

In many developed countries, measures related to price signals have long been the most important instruments to generate tax revenue for transport. The determination of fuel price elasticities of road freight demand can be used to assess the relevance of these measures. Using the cointegration approach, we estimate the diesel oil price elasticity of road freight traffic in Tunisia using annual data spanning 1997 - 2018. The results indicate that the tonne-kilometre elasticity to diesel fuel price is positive and close to 0 contrary to other studies in another country.

Key words: diesel oil price, road freight transport, elasticity, cointegration

JEL classification: C22, H23, Q43, R41

1. INTRODUCTION

A wide literature highlights the positive contribution of road transport to economic activity as a factor of production, spatial structuring and location. Recently, the negative effects of this mode have been widely denounced, especially with the emergence of the concept of «sustainable transport», which is currently and more than ever a major concern that is the subject of several political debates and scientific writings. This concept led the researchers to advocate the modal shift of the road towards alternative modes more respectful of environmental constraints.

The signal given by the price of transport or the price of fuel is considered one of the fundamental tools to ensure the modal shift. Hence the need to estimate the elasticity of demand for freight transport at price in order to assess the impact of this measure on the behaviour of users.

2. LITERATURE REVIEW

Several researchers propose to use the transfer of freight from the road to substitutable modes as an effective measure improving the impact of transport on the environment. Modal shift is defined as the transition from one mode of transport to another mode or to several alternative modes. It is the change from one mode of transport to another. Marcault (2010) points out that this concept refers to "the possibility of changing the mode of transport in an intermodal or multimodal manner; it is the possibility given to the user to use this or that mode of transport in a combined or alternating manner".

It is known that road transport has a large capacity to transport goods at low cost. Thus, the fall in road prices, and the improvement in the quality offered, results in an increase in demand; hence the use of price signals in order to encourage users to shift the road modal to other modes more respectful of environmental constraints. The signal given by the price of transport or the price of fuel is one of the main measures to change behaviour and internalise the external costs of road transport. Road transport pricing is based on two principles:

- First, demand is elastic in relation to price so when prices are increased, the use of the road mode decreases and therefore traffic decreases more sharply. So, we can say that price is a tool to influence demand. Knowledge of the elasticities of transport demand at the transport price on the one hand and at the fuel price on the other is a major tool for transport policy and in particular for combating greenhouse gas emissions.
- The second is the polluter pays principle, which is to make users pay for the damage they cause to others. It is an economic principle that seeks to impute the costs related to the fight against pollution, it was developed by the Organisation for Economic Cooperation and Development (OECD) in 1975.

This principle means that the polluter should be charged with the costs associated with the measures taken by the public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should be reflected in the cost of the goods and services that cause pollution as a result of their production or consumption. (OECD, 1975)

The General Commission for Sustainable Development (2009) underlines that economically, various pricing logics can be imposed: the pricing at the "first tier optimum" and the "second rank optimum " pricing. The "first-tier optimum" pricing resulting in short-run marginal cost pricing is an important principle for internalisation. In fact, the price of transport corresponds to the additional short-term cost generated by an additional travel. According to this approach, the marginal cost includes the marginal production cost for the infrastructure manager, the external costs from other users (congestion cost) and other particularly environmental external costs (air pollution, noise, accidents, etc.). The short-run marginal cost is based on the capacity level of the existing infrastructure while the long-run marginal cost would follow the level of infrastructure suitability that would be optimal for the traffic level under consideration.

This pricing bears no relation to the fixed costs seen as cruel for transport infrastructure. So, it is the state that takes care of the heavy investments considered as fixed costs. However, this approach causes a budget deficit as the marginal cost is lower than the average cost. Only the State can fill this deficit by resorting to taxes, however this solution is costly and generates significant distribution effects. (Briand, 2004)

The pricing at "the second rank optimum" corresponds mainly to:

- pricing at average cost
- binomial non-linear pricing
- Ramsey-Boiteux pricing

According to average cost pricing, the company sets a price equal to its average cost, thus seeking to maximize the collective surplus but without worrying about social returns or efficiency. This approach is considered a second-best optimum, also called “lesser evil” as opposed to marginal cost pricing which is considered a first-rank optimum and causes damage. As for non-linear or binomial pricing, it includes a fixed part and a variable part called “mark-ups” which is added to the marginal cost.

Finally, Ramsey-Boiteux pricing known as "mark-ups" is inversely proportional to the price elasticity of demand. It is based on the principle that the price paid by the user must be higher than the marginal cost inversely proportional to the elasticity of demand to the price of the good in question, it is the captive users who bear the fixed costs. (Percebois, 2009).

The introduction of environmental taxation, defined by all the "taxes, fees and charges whose base is made up of a pollutant, or more generally by a product or a service which deteriorates the environment or which results in a levy on renewable or non-renewable natural resources” (OECD, 2001), can provide many advantages in terms of internalising the external costs associated with the use of road transport. Among the existing ecofiscal measures (Ivanova, 2020), we can cite: the carbon tax, the kilometre tax and the bonus-malus.

- the carbon tax is an environmental tax which seeks to reduce the Carbon dioxide emissions (CO_2) which is responsible for global warming. (Gupta et al, 2019). It applies to the selling price of fuels (gasoline, diesel).

- the kilometre tax also called the ecotax on heavy goods vehicles is a kilometre charge which varies in particular according to the distance travelled on a road included in the tax zone. The idea is to internalize the external costs of road transport by paying it the cost of environmental degradation.

- the bonus-malus (or feebates) is a tax measure which consists of encouraging the acquisition of new, more virtuous vehicles emitting less CO_2, via a bonus, and of penalizing the purchase of energy-consuming models that emit more CO_2, via a penalty, by increasing their costs.

In order to know whether the policies linked to the price signal are able to influence the generation of road transport, the determination of the elasticity of the demand for road freight to the price is necessary.

Determining the impact of changes in transport prices on freight demand may encounter the difficulty of reconstructing a series of long-term average prices. In this context, Sauvant (2002) reconstructed a road and rail price for France over the period 1845 - 1940, weighted by modal shares and deflated according to a consumer price index. The estimation of transport demand as a function of economic growth and weighted relative price shows that the impact of price is statistically very significant: the evolution of the price of transport is therefore an important determinant of the evolution of freight transport demand.

For Bleijenberg (2003), the fall in the price of road transport leads companies to resort to it more in order to save on other costs. In the Netherlands, during the period from 1850 to 2000, the road mode saw the most remarkable drop in costs. Transport (road, rail, inland waterways) has become faster, leading to an even more pronounced reduction in generalized costs. The fall in the price of transport has encouraged major logistical changes. These logistical changes have reduced total production costs even with the increase in the volume of goods transported.

Hivert et al (2005) report that in goods, a 10% increase in the price of road transport reduces by 8% heavy goods traffic expressed in vehicles.km but the demand for road transport, measured in tonnes.km, contracts much less (only 5%). This differentiation is in fact due to the modal shift of part of road traffic to rail and the improvement in the efficiency of road vehicles (fewer empty returns, grouping of shipments, etc.).

Seeking to quantify the effect of a change in the price of diesel on the demand for freight transport, Bouguerra and Rizet (2013) propose to estimate the link between road freight and the price of fuel in France, based on an error correction model. This study shows the sensitivity of freight demand to the price of diesel with an elasticity of around -0.3.

It should be noted that in Denmark, Bjørner (1999) points out that a 10% increase in cost causes an 8% decrease in heavy goods traffic and only 5% in tonnage per kilometer. Based on data provided by the TRM (Transport Routier de Marchandises) surveys, Quinet (1994) postulates that the elasticity of French road traffic to the price of transport varies between -0.7 and -0.9. For Meyer (1996), the sensitivity of vehicle kilometres for all modes of transport to the price of road transport is -0.24, while that of road traffic is -0.55. The elasticity of traffic to road price calculated by Bergel and Nespoux (1996) is -0.36. Eight years later, research carried out by CEMT (2003) shows that the elasticity of road traffic to the price of transport is -0.8. (Bouguerra and Rizet, 2013)

Several studies provide orders of magnitude on the elasticities of transport demand to the price of transport on the one hand and to the price of fuel on the other hand. Nevertheless, elasticity values are highly variable, but all are negative signs.

This confirms the primordial role of the price of transport and the price of fuel, considered as effective measures to change the behaviour of transporters, shippers and logisticians. Any increase in the price prompts these players to reduce their transport costs (reduction of empty kilometres, increase in filling, etc.) and to resort to rail transport. The questions which then arise are as follows:

- What is the effect of a variation in the price of fuel on road freight transport in Tunisia?
- Is the impact of changing fuel prices on road freight different from other developed countries?

3. RESEARCH METHODOLOGY

In the context of work carried out on the initiative of CEMT (2000), BAUM postulates that in the past economic activity and transport demand have evolved in parallel. This finding prompts the researcher to deduce "a general law that is practically immutable, according to which the increase in economic growth is coupled with an increase in transport". In other words, it is a close link between developments in economic growth and those in transport. This is the coupling relationship that is defined by Joignaux and Verny (2003) as a relationship of induction of transport demand through economic growth.

3.1. MODEL ESTIMATION

In order to estimate the relationship between the generation of road freight transport and the price of fuel in Tunisia, and based on the model advanced by Sauvant (2002) and Bouguerra and Rizet (2013), we base ourselves on the following model which expresses the demand for road freight transport as a function of economic growth (retained as a control variable in this model) and the price of fuel.

$$LTKM = \alpha + \beta_1 LGDP + \beta_2 LPX + \varepsilon_t$$

with: - LTKM denotes the demand for road freight transport taken in logarithm.

- LGDP is the Gross Domestic Product (constant 2005 US $) taken as a logarithm

- LPX indicates the pump price of diesel fuel (US $ per litre) taken in logarithm.

We use annual data covering the period from 1997 to 2018. The data are then expressed in logarithm in order to have coefficients that can be easily interpreted as elasticities. The procedure to be followed to estimate the demand for road freight transport takes place in three phases: checking the stationarity of different variables, carrying out a cointegration test if these variables are non-stationary and integrated of order 1, identification of the relation long term between variables.

3.2. EMPIRICAL RESULTS OF COINTEGRATION ANALYSIS

The Augmented Dicky-Fuller unit root test (ADF) is considered the most widely adopted test to validate or not the stationarity of a time series and to determine the order of integration of the variables. This test is carried out under the following 3 assumptions: presence of a constant and a trend (model 3), presence of a constant (model 2), absence of a constant (model 1)

Table 1. *Results of the unit root test (ADF test)*

Variables	Constant	Trend	At level		At first difference		Order of integration
			Statistic	Critical value	Statistic	Critical value	
LTKM	No	No	2.75	-1.94	-1.98	-1.94	I(1)
LGDP	No	No	4.64	-1.94	-2.60	-1.94	I(1)
LPX	No	No	-1.20	-1.94	-2.97	-1.94	I(1)

The results of this test for each series are displayed in the table below (Table 1) and reveal the non-stationarity of the series (LTKM), (LGDP) and (LPX) in level and their integration of order 1.

JOHANSEN's multivariate cointegration test (1988) is performed to verify the presence of the long-term relationship. Johansen's statistic is of the form:

$$\lambda_{trace} = n\sum_{i=r+1}^{k} 1 - \lambda_i$$

with n: number of observations, i_{th}: eigenvalue of the matrix Γ, k: number of variables and r the rank of the matrix Γ.

When the value of is greater than the critical value read in the table of Johansen and Juselius (1990), the hypothesis H0 (r = 0, r = 1, ...) is rejected. If H_0 (r = k-1) is refused, then the rank of the matrix is r = k and there is no cointegration relation because the variables are stationary.

Before proceeding with the Johansen cointegration test, it is useful to identify the optimal number of lags of the autoregressive vector model VAR. The selection of the optimal delay number is based on the information criteria of Akaike (AIC), Schwarz (SC), Hannan-Quinn (HQ), Final Prediction Error (FPE) and Sequential Modified LR test statistic . It is a question of choosing the optimal VAR which jointly minimizes these criteria. The results are summarized in the following table.

Table 2. *Choice of the optimal number of delays according to the information criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	25.994	NA	1.56e-05	-2.554	-2.406	-2.534
1	93.862	105.573*	2.30e-08	-9.095	-8.502	-9.014
2	102.672	10.767	2.62e-08	-9.074	-8.036	-8.931
3	121.391	16.639	1.19e-08*	-10.154	-8.670*	-9.950*

4	130.625	5.129	2.38e-08	-10.180*	-8.251	-9.914

* indicates the number of delays selected according to the criterion

It emerges from this table that the three information criteria calculated (FPE, SC and HQ) lead to retain a VAR with three (3) delays while the LR criterion indicates a single optimal delay (1) and that of AIC indicates four delays. Given the convergence of the majority of criteria, an optimal number of lags of three is adopted. At this level, the Johansen cointegration test is carried out, this test consists in identifying the number of cointegration relations retained for each type of model (from the statistics of the trace and the maximum eigenvalue (Max-Eigen Statistic)) and identify the optimal model. It should be noted that the different sub-models of the general model tested are as follows: (Bourbonnais, 2000)

- model 1: absence of a linear trend in the VAR and of a constant in the cointegration relations
- model 2: absence of a linear trend in the VAR, while the cointegration relations include a constant
- model 3: presence of a linear trend in the VAR and of a constant in the cointegrating relations.
- model 4: presence of a linear trend in the VAR and in the cointegration relations
- model 5: presence of a quadratic trend in the VAR and a linear trend in the cointegrating relations.

Table 3. *Test of the number of cointegrating relations*

Model / Test	Model1	Model2	Model3	Model4	Model5
Trace	1	1	1	1	1
Max-Eig	0	1	1	1	1

From the results reported in this table, the trace test and the maximum eigenvalue test indicate a single cointegration relationship for the last four sub-models. For the first sub-model, there is no relation according to the maximum eigenvalue test and only one relation according to the trace test. Following these observations, it would be appropriate to discern the type of the optimal model and to specify the number of cointegrating relations to be integrated into the model by relying on the information criteria of Akaike (AIC) and Schwarz. (SC). (Table 4.)

Table 4. *Determination of the type of the optimal model*

Number of cointegrating	Model2	Model3	Model4
Akaike Information Criteria by Rank (rows) and Model (columns)			
0	-7.464	-7.707	-7.707
1	-8.082	-8.708*	-8. 071
2	-7.846	-8.170	-8.658

3	-7.564	-7.564	-8.376
Schwarz Criteria by Rank (rows) and Model (columns)			
0	-6.569	-6.663	-6.663
1	-6.840	-6.966	-7.309*
2	-6.255	-6.529	-6.918
3	-5.626	-5.626	-6.288

Upon analysis of Table 4, we notice that the Akaike criterion (AIC) suggests the choice of model 3 while that of Schwarz (SC) leads to the retention of model 4. By virtue of the principle of parsimony, we choose the model which indicates that there are constants in the VAR and in the cointegration relation and no linear trends (model 3). We have shown above (Table 3.) that this model admits a single cointegration relation according to the trace test. This finding is confirmed by the table below.

Table 5. Results of the trace test

Number of cointegrating relations	Eigenvalue	Trace statistics	5% Critical value	Prob**
None *	0.660	31.478	29.797	0.031
At most 1	0.383	12.045	15.494	0.154
At most 2	0.168	3.330	3.841	0.068

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* indicates rejection of the null hypothesis at the 5% threshold
** MacKinnon-Haug-Michelis (1999) p-values

The results of the trace test shows that the null hypothesis of no cointegration was rejected (31.478> 29.797). On the other hand, the null hypothesis according to which there is at most a cointegration relation between the demand for road transport of goods, the Gross Domestic Product and the price of diesel fuel is accepted (the trace statistic is lower than the critical value at threshold of 5% (12,045 <15,494). The long-term relationship is given by the following equation:

$$LTKM = 3.68 + 0.51\ LGDP + 0.04\ LPX$$

$$(0.033) \qquad (0.019)$$

$$[15.44] \qquad [2.443]$$

$R^2 = 0{,}89$ R^2 adjusted = 0.88 F-statistic= 71,253 (p-value<0,0001)

As we can notice, the effect of the price of diesel on the generation of transport is statistically significant but unlike most developed countries, a 1% increase in the price of diesel leads to a 0.04% change in demand. road transport. The calculated elasticity is radically opposed to that calculated in previous work.

3.3. VARIABLE ELASTICITY TO THE PRICE OF DIESEL

Also interested in variable elasticities, we are based on the same model but this time without logarithms $TKM = \alpha + \theta_1 GDP + \theta_2 PX + \varepsilon_t$, with level variables to determine the effect of a change in the price of diesel on road freight. (Bouguerra and Rizet, 2013).

The estimation of this model gives us the following results:

$$TKM=0.38+0.14GDP+0.06PX$$

(0.016) (0.0065)

[8.98] [9.51]

$R^2 = 0, 89$ R^2 adjusted = 0.88 F-statistic= 80,83 (p-value<0,0001)

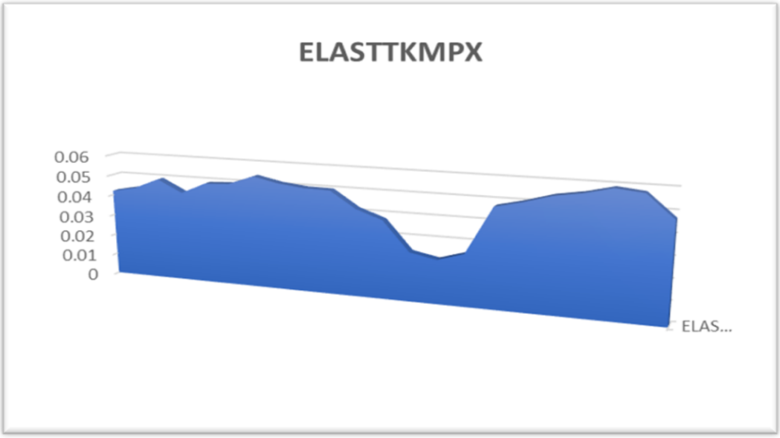

Figure 1. *Evolution of the elasticity of Kilometric traffic in Tunisia from 1997 to 2018*

The preceding graph traces the evolution of the elasticity to the price of diesel from 1997 to 2018. It confirms that the demand for road freight transport seems weakly and positively impacted by the price of diesel (the price elasticity is close to 0), which is astonishing.

3.4. RESULTS AND POLICY IMPLICATIONS

The price change is accompanied by a small change in the quantity of transport, which is considered an exception to the classic rule of supply and demand. It is quite possible that the positive sign of the diesel price elasticity and its low value is due to passive behaviour of freight transport operators in Tunisia when the price of diesel increases. The price increase is absorbable, it does not encourage firms to reduce tonnes. Kilometer by resorting to modal shift in favour of alternative transport and therefore any instrument attached to the price signal could be incapable of changing behaviour.

An essential question then arises: is the surprising reaction of the Tunisian road freight user to the rise in the price of diesel due to its heavy dependence on the road mode?

In fact, changing the behaviour of operators by introducing taxes and any other measure based on the signal given by the price of transport or the price of fuel is not profitable in Tunisia. Such an increase in price is hampered by its social acceptability by businesses, shippers and the economy as a whole. The experience of the finance law for 2014 confirms this observation. In fact, this law imposed in January 2014 new taxes on the various means of transport in order to make up the budget deficit. Protest movements were launched in several regions by road transport users following this decision. Protesters blocked roads and paralyzed traffic to express their refusal and annoyance at the exaggerated tax hike. They argue that the finance ministry failed to consider the continuing increases in fuel prices, insurance amounts and deteriorating infrastructure causing damage to their vehicles. Most drivers and business executives believe their situation will worsen as a result of an additional tax. A few days later, the government overturned its decisions and protesters' demands were met.

The financial incentive (taxes and levies) is therefore not able to change behaviour but it risks penalizing the economic sector. This finding prompts us to think about other measures to effectively achieve a modal shift without resorting to price signal policies. It is a question of thinking primarily of the revitalization of Tunisian rail transport and presenting it as an adequate alternative to the road mode. Specific attention should be paid to revitalizing rail transport by strengthening rail infrastructure. It is in fact about building new infrastructure by adding the missing links in order to eliminate bottlenecks and give different economic actors the possibility of reaching various regional and local markets under the best conditions.

As part of a North African logic and to strengthen trade with the Maghreb countries, the extension of existing lines to the Libyan border is necessary. There is also a need to look at existing tracks and platforms by upgrading and maintaining them regularly to allow easy access to stations. Investments must also be made in the acquisition of wagons suitable for intermodal loading units, handling equipment to avoid load breaks and the consolidation of safety and security according to global standards.

It should be noted that Tunisia has a rail network made up of lines with metric gauge, others with standard gauge and a few kilometres with "hybrid" gauge (metric and standard). The width of the metric track (narrow gauge) is then a handicap especially the north-south lines in connection with Libya. Thus, by focusing on the interoperability problems encountered, the public authorities must try to homogenize and standardize the gauge of the rails, especially the north-south axis.

The production carried out in the interior areas of the country must pass through the freight stations located in Tunis to reach the major ports of the country. We must therefore think of improving the integration of rail transport into logistics chains, and the establishment of platforms and warehouses connected to the various lines of the railway so as to ensure the efficiency of the services offered.

The railway must increase its competitiveness by improving its brand image and the quality of service offered (respect for delivery times, regularity, etc.) The National Company of Tunisian Railways must attract new shippers and retain the old ones. by investing more in combined transport techniques (efficient means of transhipment) and by developing an effective commercial policy. The National Company of Tunisian Railways must think of greater complementarity with other modes and of strengthening its own fleet of heavy goods vehicles. It is important to encourage the use of computer techniques and advanced telecommunications means allowing the tracking of shipments and obtaining real-time information on the goods moved.

4. CONCLUSION

Our macroeconomic analysis of the factors influencing road freight is necessary from a double point of view: to estimate the elasticity of road freight traffic to the price of diesel and to check whether the tax incentive can achieve a modal shift. However, a microeconomic survey analysis aimed at identifying the factors that favour the use of road to the detriment of rail is mandatory. It is about understanding the lack of interest in rail transport in order to propose, if possible, avenues for improvement to ensure a modal shift from road to alternative modes.

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