

Analysis of tendencies and structural breaks on the French automobile market. Econometric estimation of the diesel penetration



Elodie Sentenac-Chemin - Frédéric Lantz
elodie.sentenac@ifp.fr – frederic.lantz@ifp.fr

- **Introduction**
- 1. Economic analysis and data
- 2. Methodology
- 3. Empirical results
- Conclusion



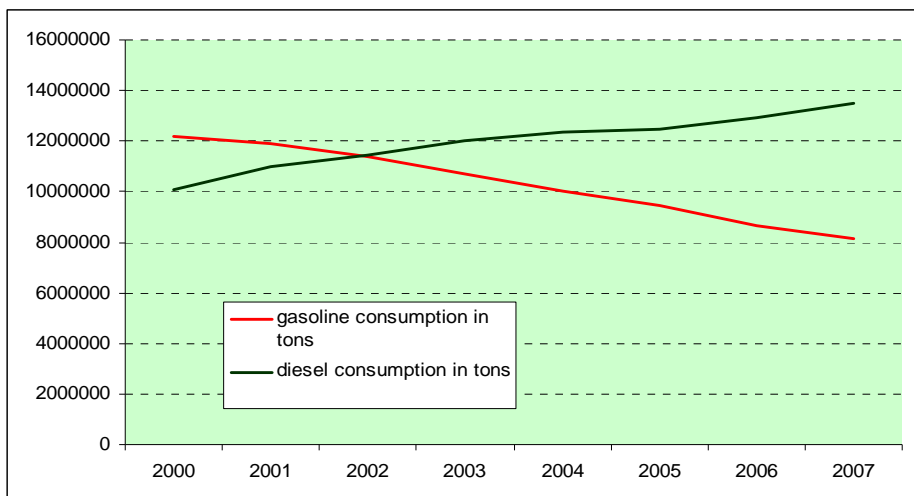
- French automobile market
 - New registrations:

	2000	2007
gasoline	51%	27%
diesel	49%	73%

- This substitution has some consequences on fuel consumption

- Conclusions in term of energy consumption
 - Gasoline consumption: a decrease of 4 million tons between 2000 and 2007
 - Diesel: an increase of 3,8 million tons between 2000 and 2007
 - So the French fuel consumption is reduced by about 580000 tons between 2000 and 2007

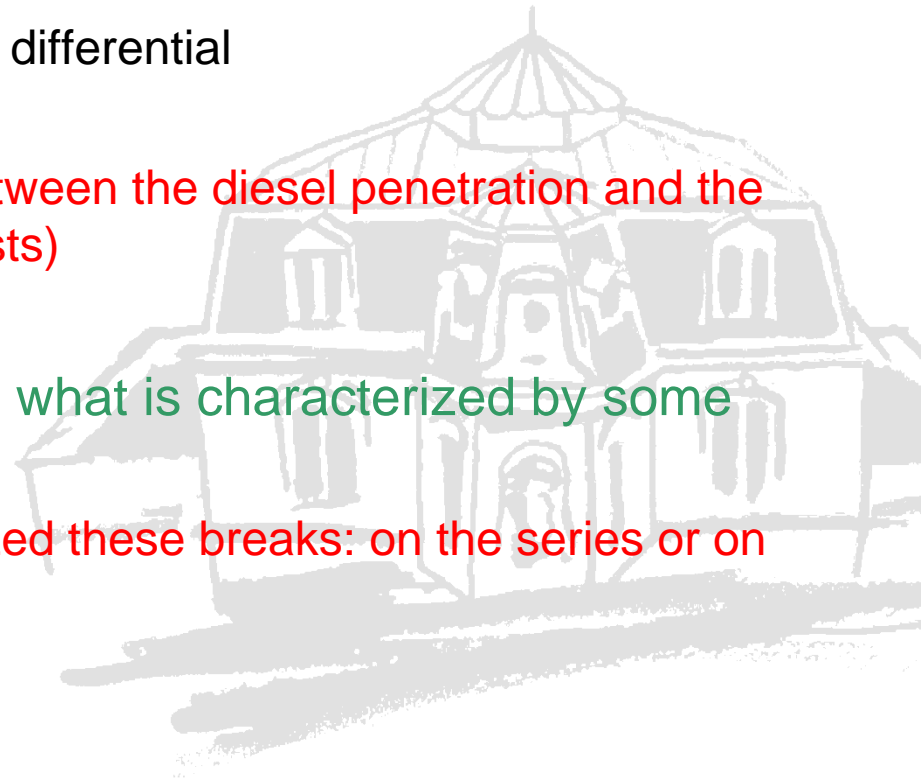
Figure 1: Gasoline and diesel consumption in France



→ This substitution between gasoline vehicles and diesel vehicles leads to reduce the consumption
How can we explain the consumers behaviors?

Analysis of the diesel penetration in the vehicles fleet in France: tendencies and structural changes

- Different factors can explain this penetration:
 - Fuel prices differential
 - Average consumption per vehicle differential
 - GDP
- ➔ Analysis of a long-run relationship between the diesel penetration and the explanatory factors (co-integration tests)
- We work on a 1985-2008 sample, what is characterized by some important structural breaks
- ➔ Different tests are used to characterized these breaks: on the series or on the long-run relationship



- Introduction
- **1. Economic analysis and data**
- 2. Methodology
- 3. Empirical results
- Conclusion

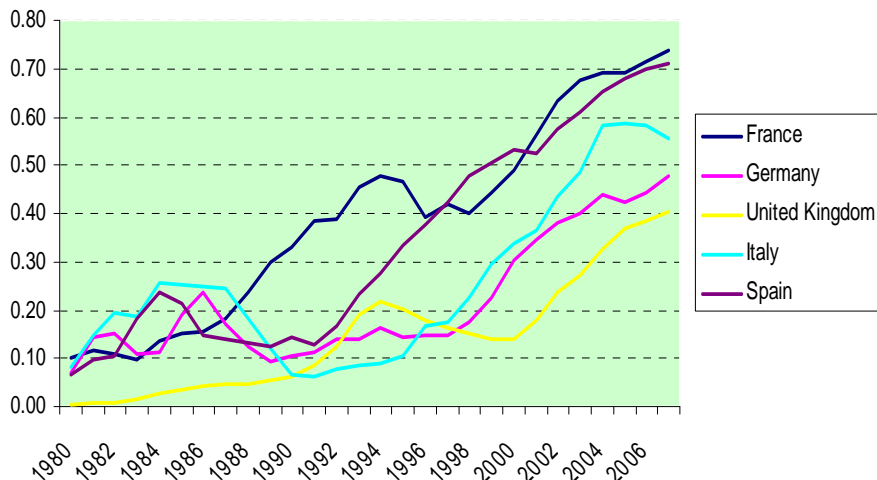


1.1 Diesel penetration on the new cars registrations in Europe and France

Europe

France

Figure 2 – dieselization rates in different European markets



- Diesel cars represent 78% of the new cars registrations and 50% of the cars fleet
- There are three steps in the diesel diffusion in France :
 - Increase up to the mid-1990's where the penetration rate is around 50%
 - 10% fall in the mid-90's because of an increase in taxes on diesel price and an announcement effect on the light environmental performances of diesel vehicles
 - Increase since 2000 with the diffusion of the direct injection in the middle range diesel vehicles

1.2 The effects of the fuel prices differential and the unitary consumption differential

- The fuel price differential:
 - Increase of taxes on the diesel price in the mid-1990's : 75% of the price in 1998
 - The effect on the diesel penetration seems to be in the beginning of the sample

- The unitary consumption differential
 - Stimulation of the sales with the direct injection motorization on the middle range cars
 - The effect on the diesel penetration seems to be in the end of the sample

Figure 3: fuel prices differential between gasoline and diesel (constant euros/liter)

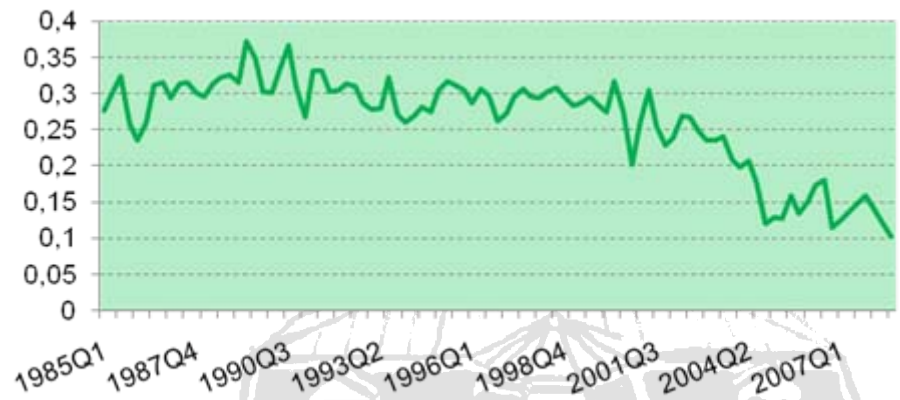
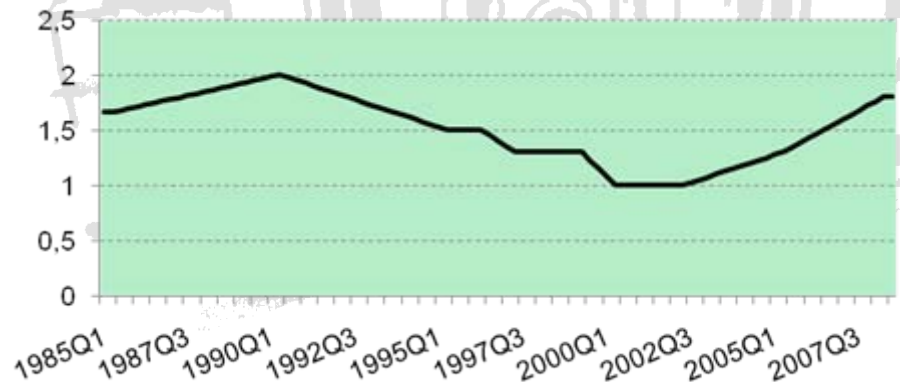
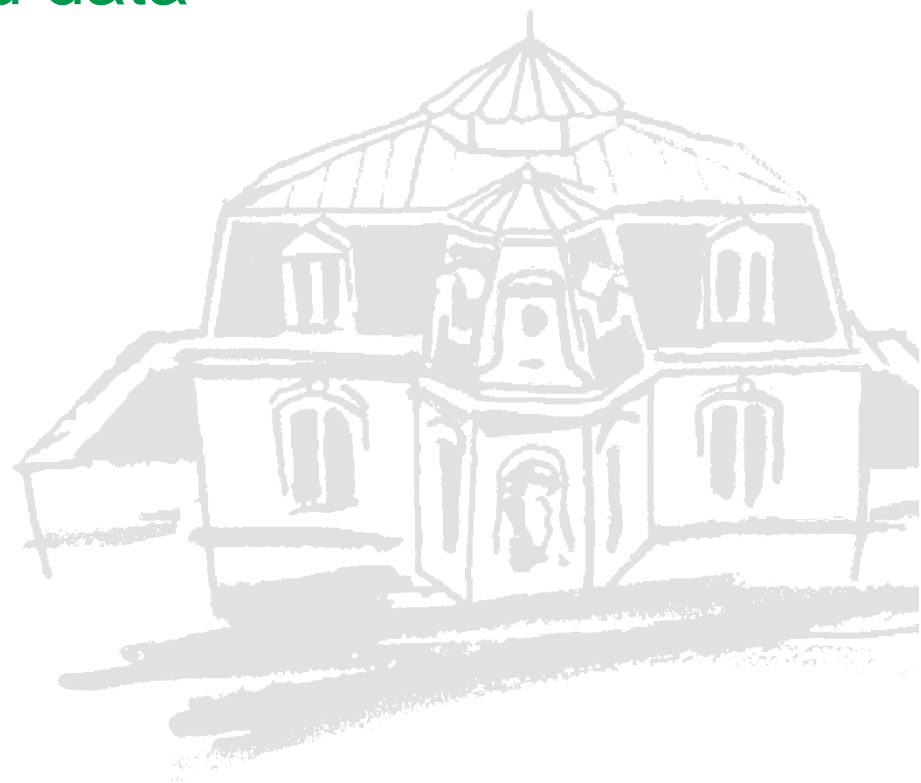


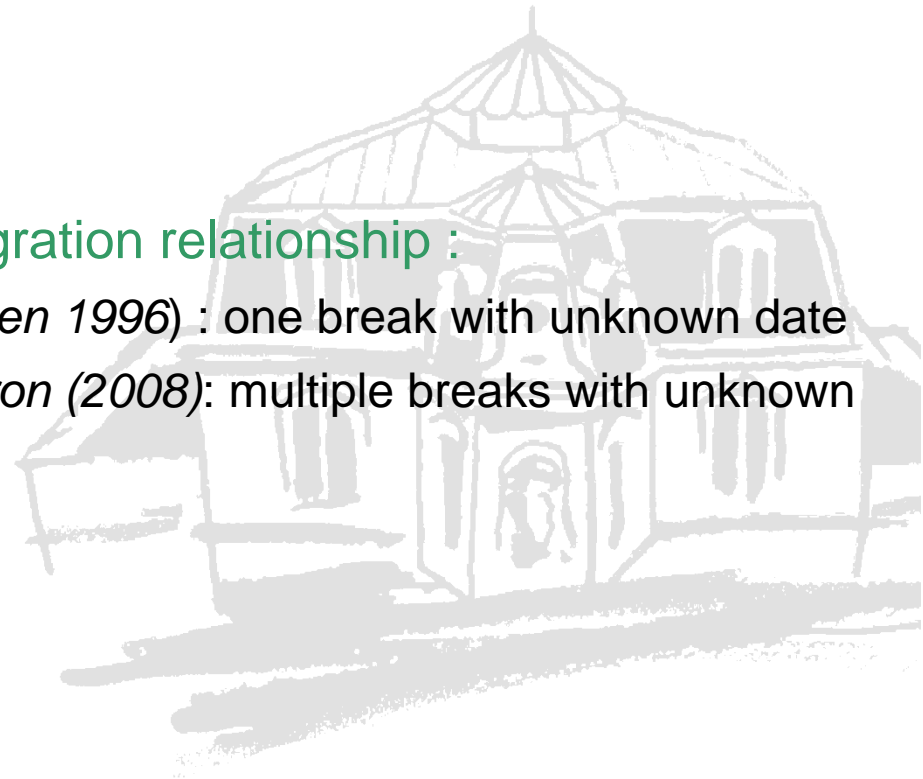
Figure 4: unitary consumption differential between gasoline and diesel cars (l/100km)



- Introduction
- 1. Economic analysis and data
- **2. Methodology**
- 3. Empirical results
- Conclusion

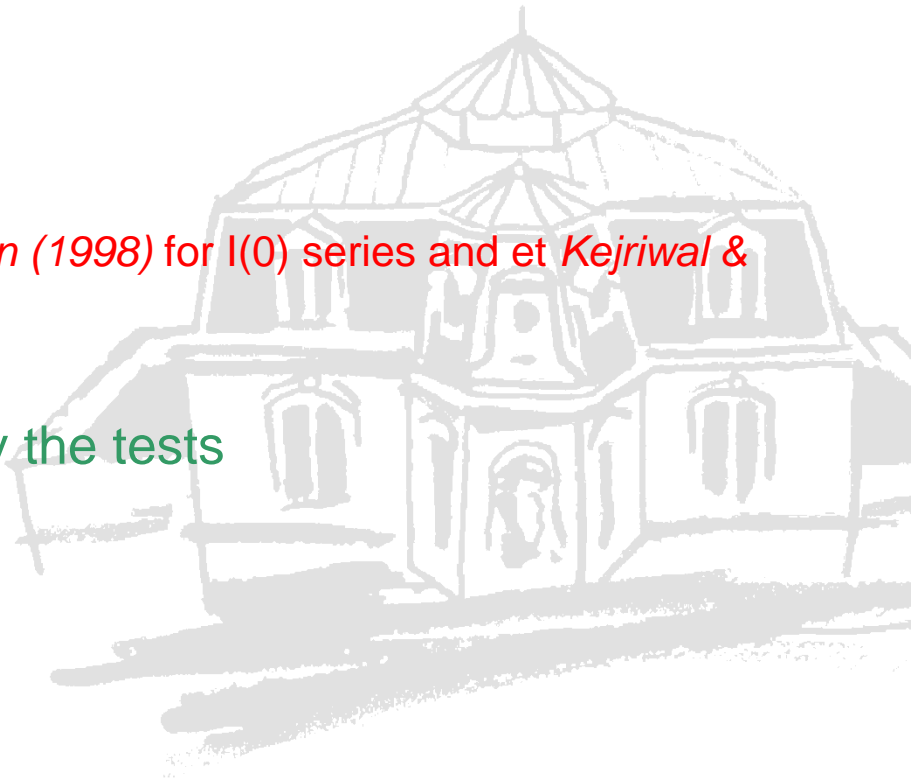


- Unit root tests :
 - usual tests *ADF* and *Phillips-Perron*
 - unit root tests with breaks (*Perron 1989, 1994, 1997; Perron & Vogelsang 1992, 1998; Zivot & Andrews 1992*)
- Co-integration test: *Johansen 1988*
- Structural breaks tests in the co-integration relationship :
 - *Gregory et Hansen (Gregory & Hansen 1996)* : one break with unknown date
 - *Bai & Perron (2003), Kejriwal & Perron (2008)*: multiple breaks with unknown dates



2.2 Sup-F tests: *Bai et Perron (1998, 2003)*

- Two important tests
 - SupF test (Fisher statistics)
 - H_0 : no break
 - H_1 : an unknown number of break
 - Sequential SupF (SEQ)
 - H_0 : l breaks
 - H_1 : $l+1$ breaks
- ⇒ Critical values are tabulated by *Bai & Perron (1998)* for $I(0)$ series and et *Kejriwal & Perron (2008)* for $I(1)$ series
- The break dates are determined by the tests



- Introduction
- 1. Economic analysis and data
- 2. Methodology
- **3. Empirical results**
- Conclusion



3.1 Unit root tests and unit root tests with breaks

- Quarterly data
 - Sample: 1985Q1 - 2008Q3
 - Series: dieselization rate (*TXD*), growth domestic product (*GDP*), fuel price differential (*DIP*), unitary consumption differential (*DIC*)
- Unit root tests (*ADF*, *PP*) indicate that variables are integrated for order 1.
 - Unit root tests with breaks (*Zivot & Andrews 1992*, *Perron 1997*) indicate the existence of a break in two series: *TXD* and *DIC*

dieselization rate	Break in 1994Q4	Increase of taxes in diesel price
unitary consumption differential	Break in 1999Q1	Diffusion of the direct injection in the cars' middle range

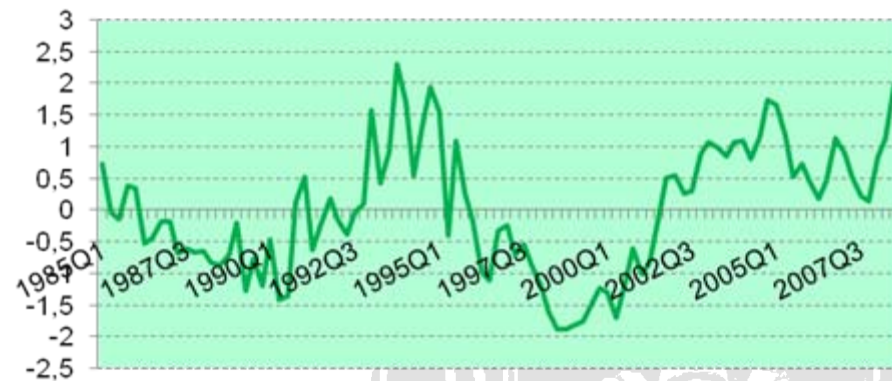
3.2 Co-integration test, *Johansen (1988)*

- Tests

Range r	λ trace	λ max
$r = 0$	57,39**	31,26**
$r \leq 1$	26,13	17,32
$r \leq 2$	8,81	6,31
$r \leq 3$	2,49	2,49

*** 1% sign, ** 5% sign, * 10% sign

Figure 4: Residuals graph for the co-integration relationship



- We cannot reject the existence of a co-integration relationship between dieselization rate, price differential, unitary consumption differential and GDP. But it seems that this equilibrium is not stable.

➔ We used *Gregory Hansen* and *Bai Perron's* tests for structural changes in the co-integration relationship

- Test for one break, *Gregory Hansen (1996)*
 - There is one break in the co-integration relationship, in **1996Q1**. But the analysed sample is subject to multiple changes (technologic, politic etc) so we test for multiple structural changes.
- Multiple breaks tests, *Bai et Perron (1998, 2003), Kejriwal et Perron (2008)*

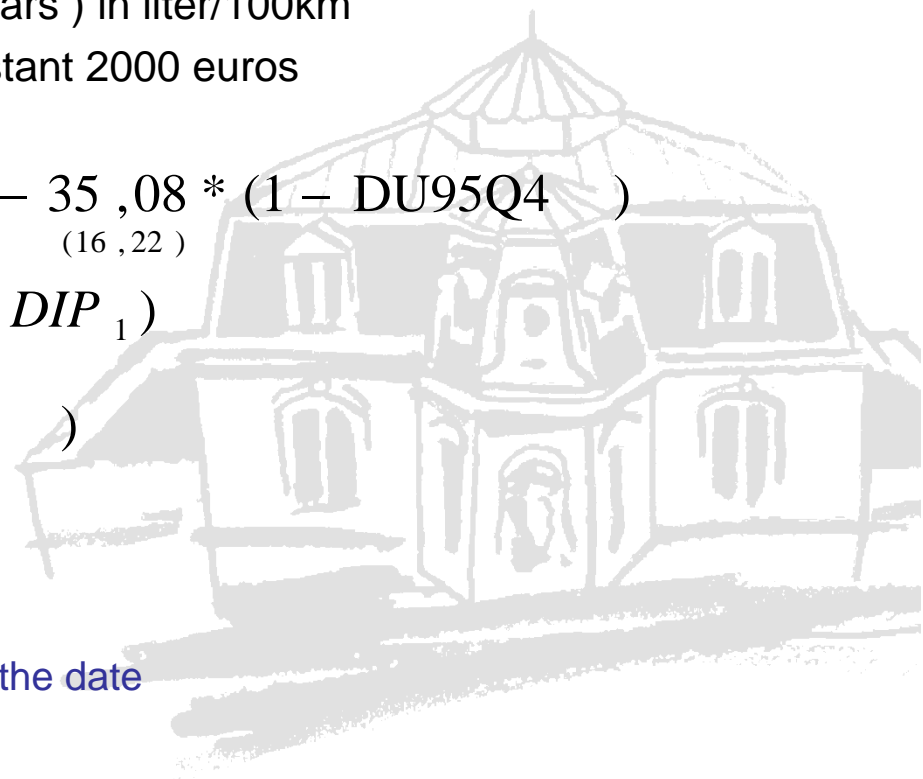
Specifications Qf=2	Qb=1	$\varepsilon = 0,15$
SupF test SupF(1) 22,05***	SupF(2) 28,76***	SupF(3) 292,12***
sequential SupF SEQ(1/0) 22,05***	Test SEQ(2/1) 16,9***	SEQ(3/2) 5,86
Breaks dates: 1995Q4	2001Q1	

3.4 Econometric modeling with structural changes

- 1985Q1 to 2008Q3
- *TXD*: dieselization rate
- *DIP*: fuel price differential (gasoline price – diesel price) in constant 2000 euros/liter
- *DIC*: unitary consumption differential (unitary consumption for new gasoline cars – unitary consumption for new diesel cars) in liter/100km
- *GDP*: growth domestic product in constant 2000 euros

$$\begin{aligned}
 TXD = & - 35,16 * DU95Q4 - 35,08 * (1 - DU95Q4) \\
 & \quad (16,18) \quad \quad \quad (16,22) \\
 & + 1,34 * \ln(PIB) + 0,05 * \ln(DIP_{-1}) \\
 & \quad (16,4) \quad \quad \quad (4,11) \\
 & + 0,08 * \ln(DIC) * (DU01Q1) \\
 & \quad (2,2) \\
 & + dummies + \varepsilon
 \end{aligned}$$

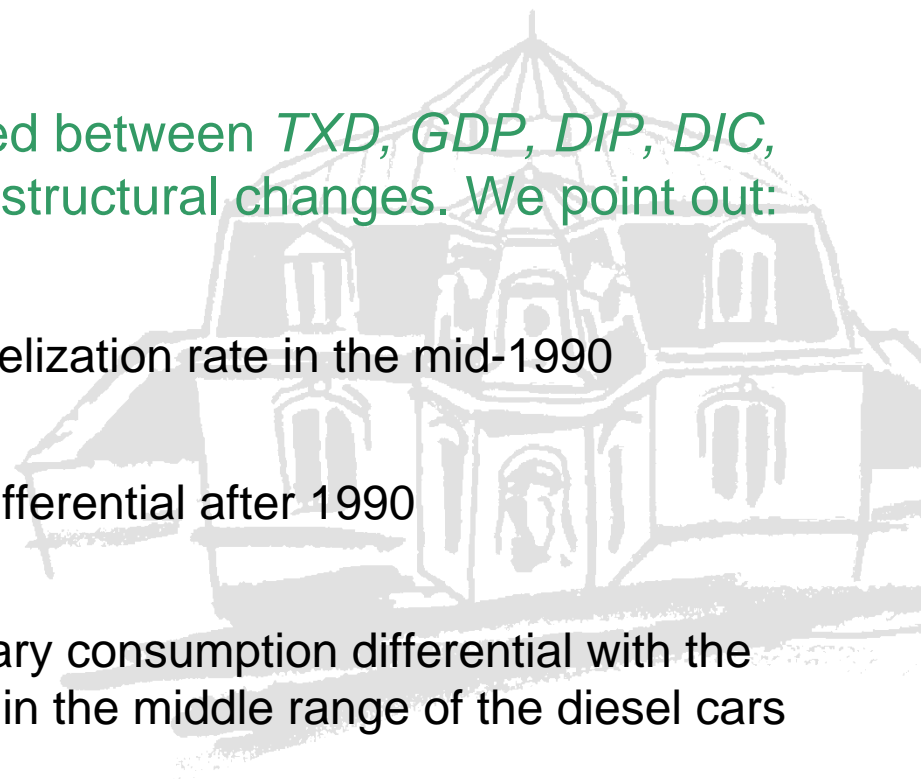
- DUdate = 0 up to the date; =1 after the date
- R² = 0,97; n=95
- () : t-student



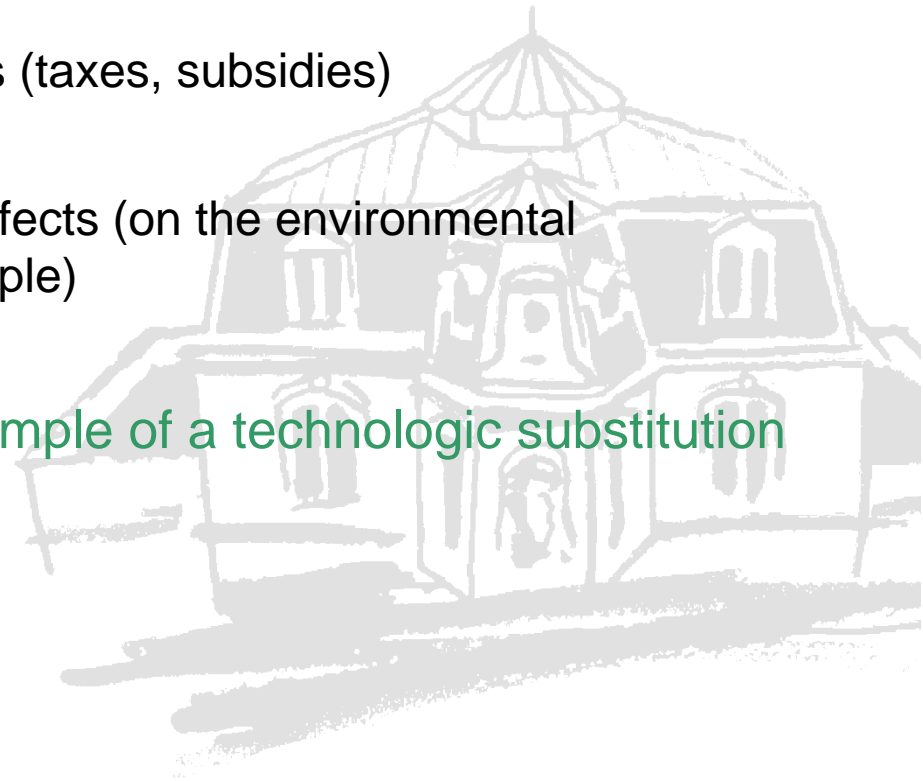
- Introduction
- 1. Economic analysis and data
- 2. Methodology
- 3. Empirical results
- Conclusion



- Usual econometric tests are suspicious when there are some events that can lead to breaks in the equilibrium relationship
- Break tests (series, co-integration relationship) are used to characterized this breaks
- A long-term relationship is estimated between *TXD*, *GDP*, *DIP*, *DIC*, assuming the presence of multiple structural changes. We point out:
 - A break in the evolution of the dieselization rate in the mid-1990
 - A diminishing impact of the price differential after 1990
 - A break in the evolution of the unitary consumption differential with the development of the direct injection in the middle range of the diesel cars



- These different breaks illustrate consumer behaviors changes. This kind of changes can occurred when:
 - there are some technologic improvements
 - there are some economic policies (taxes, subsidies)
 - there are some announcement effects (on the environmental performance of the cars for example)
- To generalize, this work is an example of a technologic substitution in a car fleet



Thanks for your attention!

