



São Paulo University

System Dynamics Society 27th International Conference

*Renewable Energy: A Framework to
Model a Brazilian Case of Success
(Part I)*



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Agenda

- Tell the story
- Graph the Variables
- Making the System Visible
 - Subsystem Diagram
 - Causal Loops Diagrams
- Identify the lessons



Tell the Story

What is this?





Tell the Story

What is this?



A flex-fuel engine with its flex-fuel electronic injection system



Tell the Story

What is this?



WHY IS IT IMPORTANT?

A flex-fuel engine with its flex-fuel electronic injection system



Tell the Story

What is this?

Sugar Cane
Industry

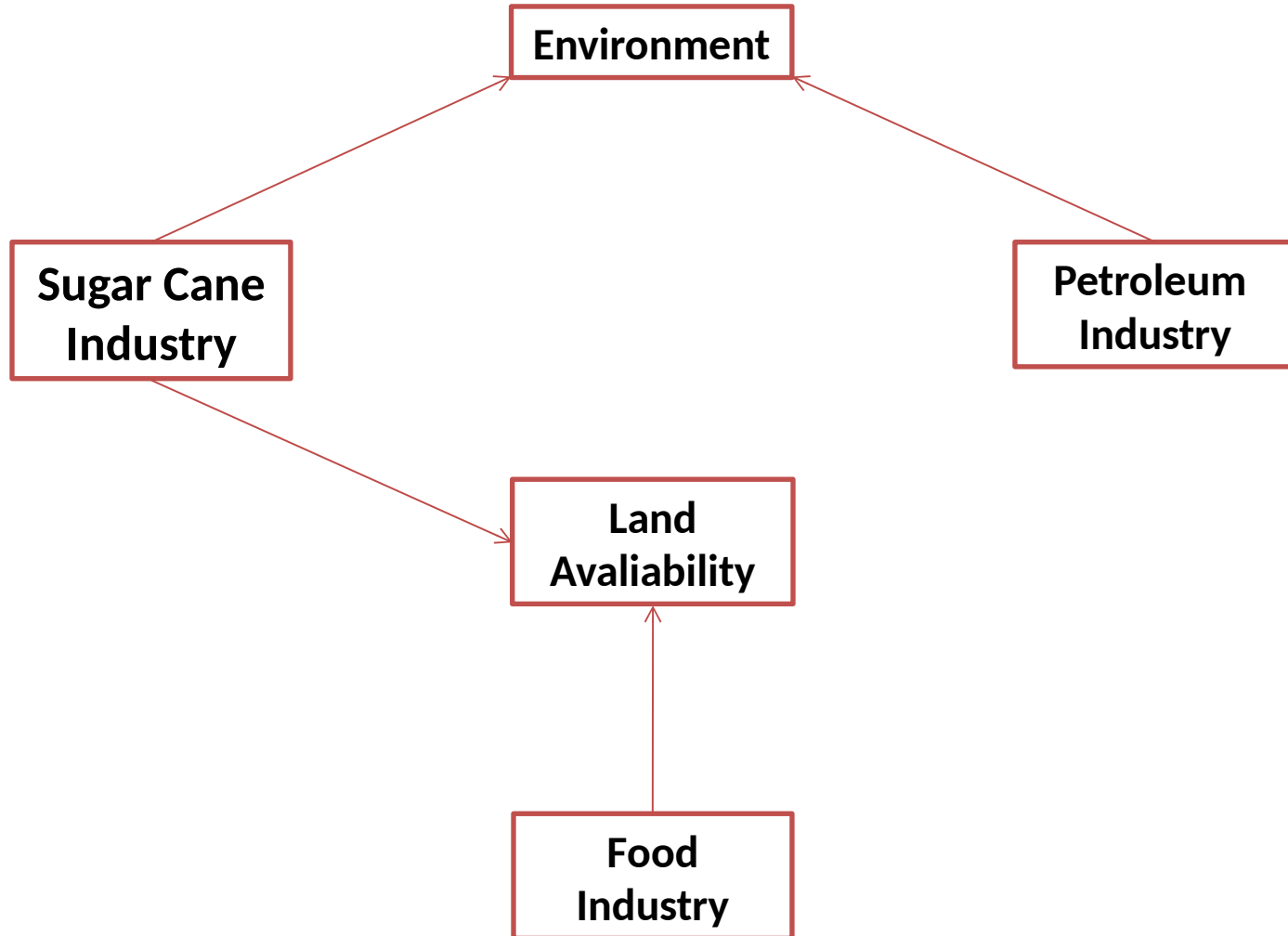


Petroleum
Industry

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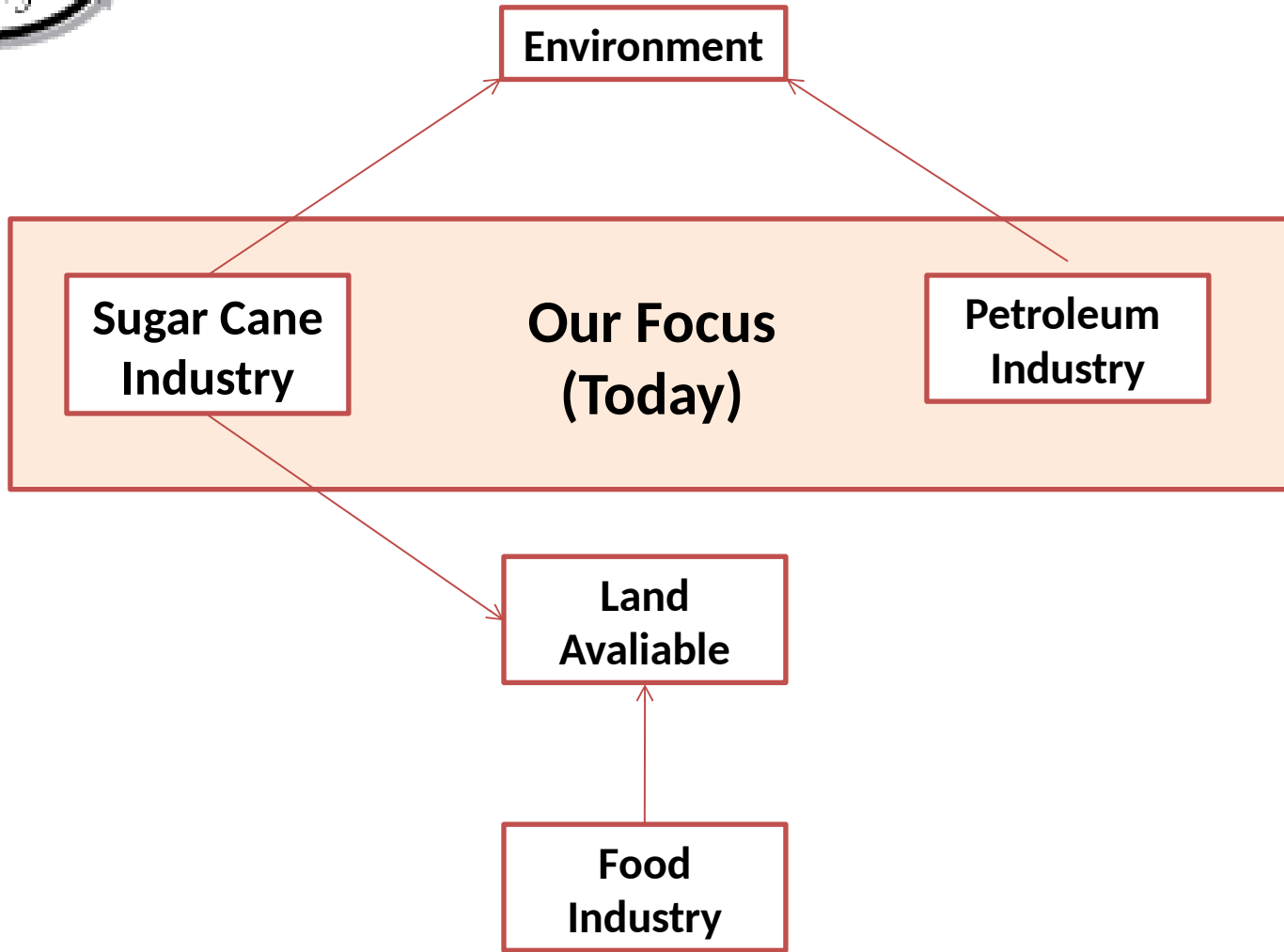


Tell the Story



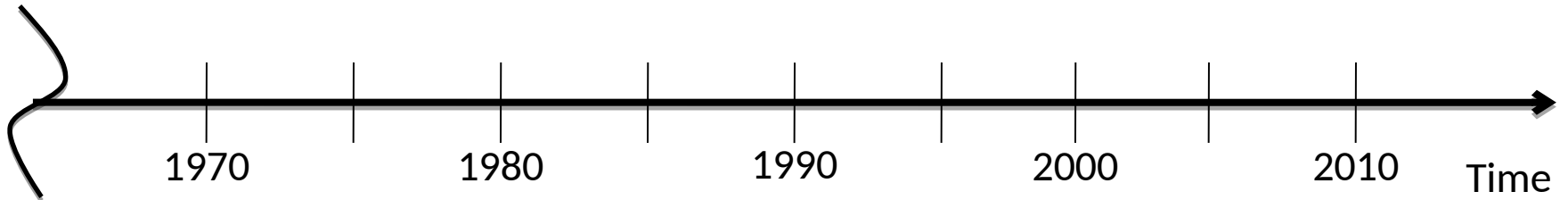


Tell the Story





Tell the story

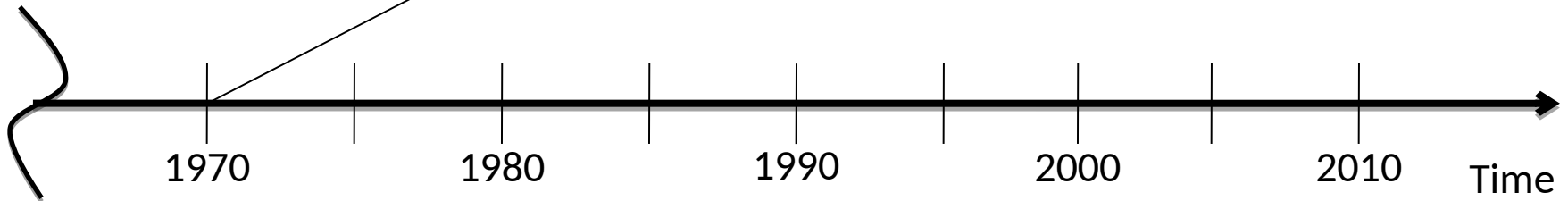




Tell the story

From 1950 to 1973

- World oil demand increased steadily at a rate of 9.5%/year
- Petroleum Costs stable around 2.5 US dollars per barrel

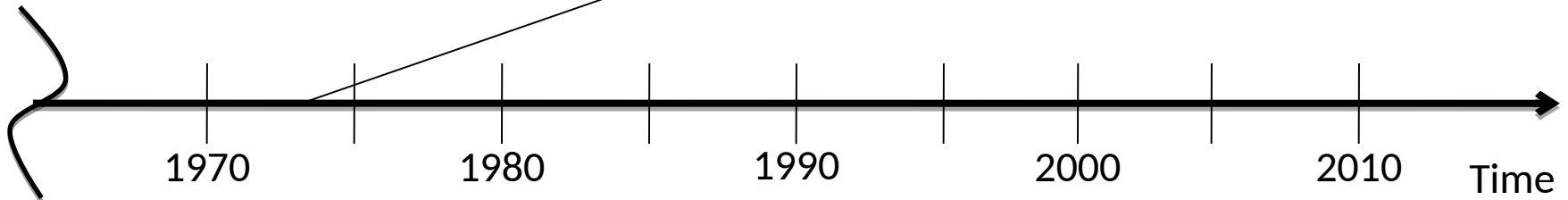




Tell the story

First Oil Crisis (1973)

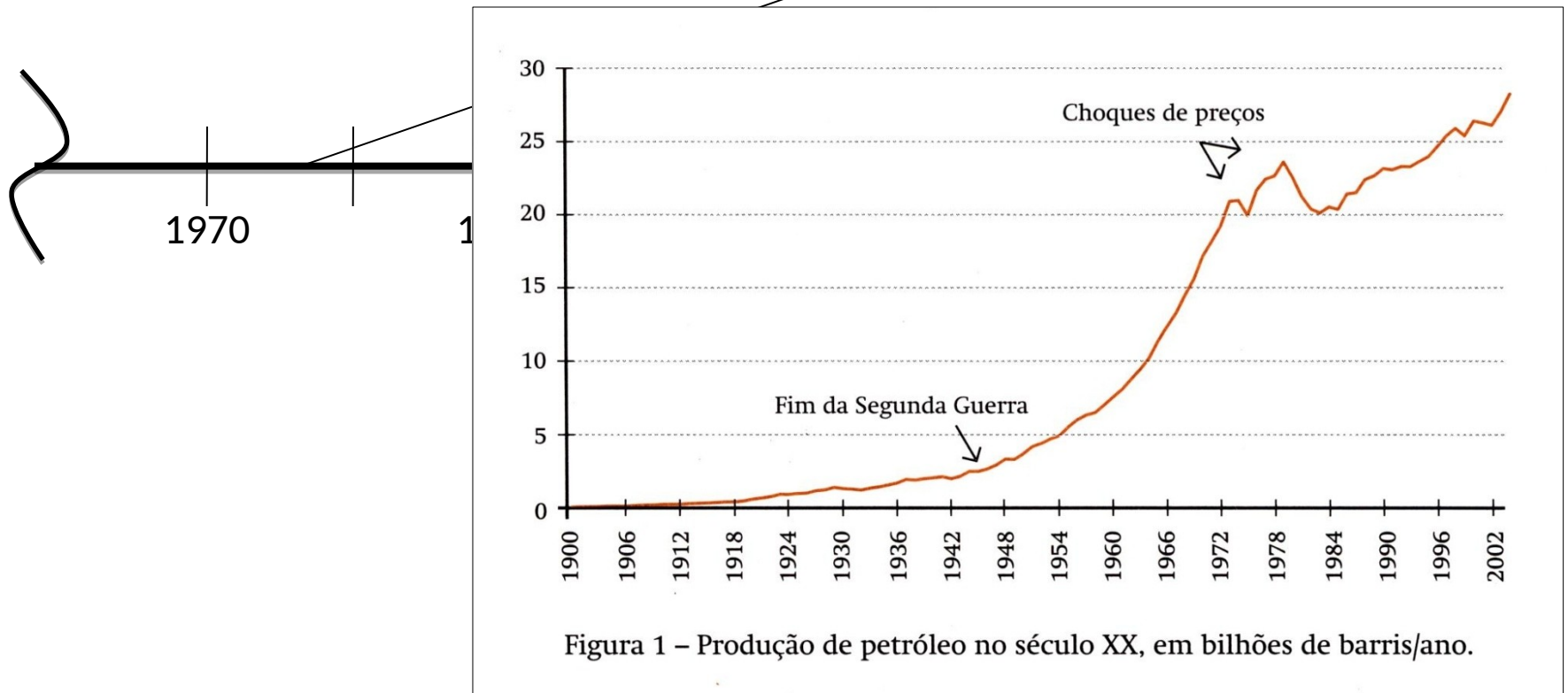
- The Organization of the Petroleum Exporting Countries (OPEC), established a new production level and costs policy
- Barrel price increased to 11.65 US dollars.



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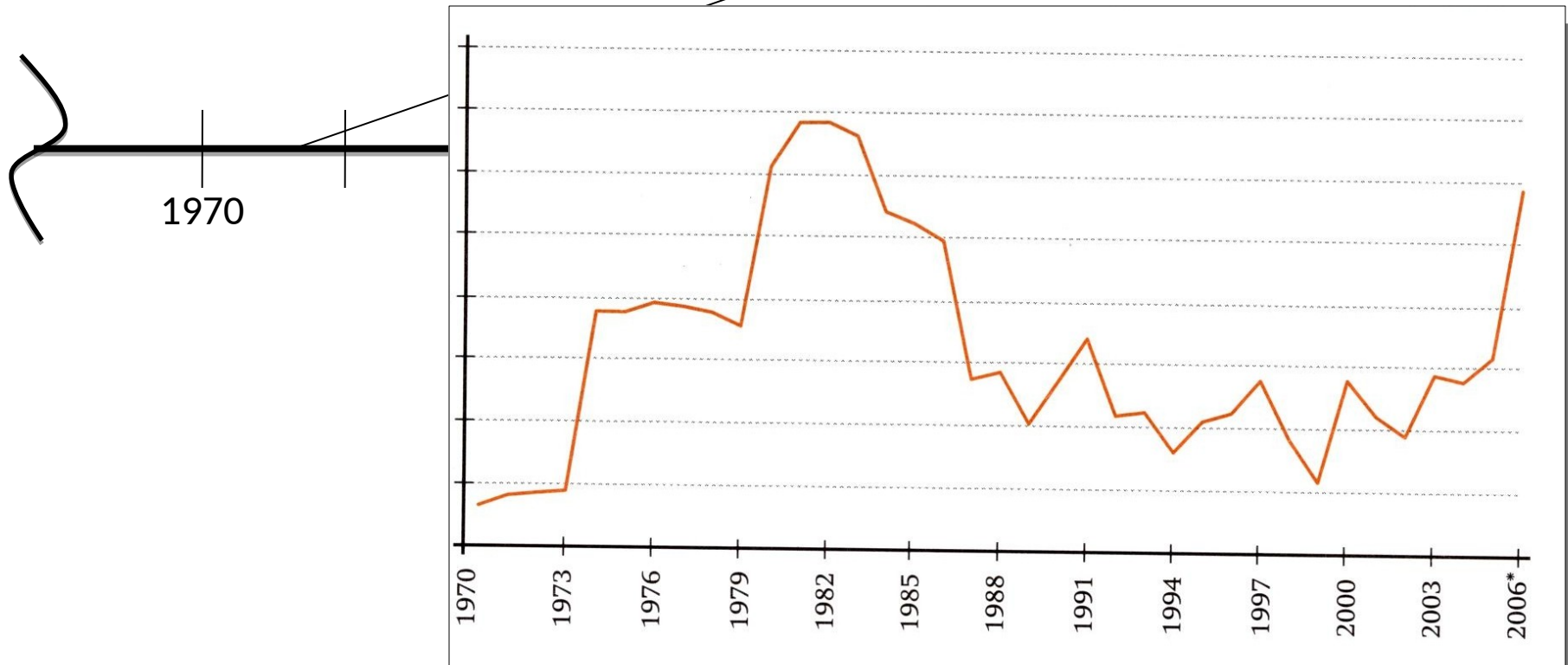




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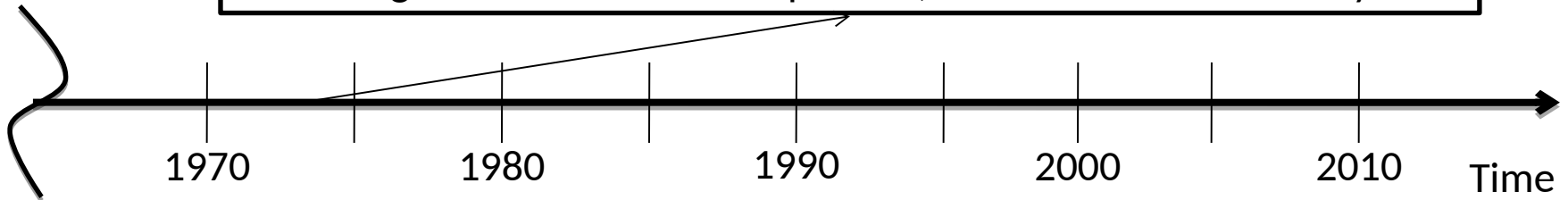




Tell the story

Effects of First Oil Crisis (1973)

- Relative short term demand inelasticity
- Many countries faced a serious economic situation
- Decreased discretionary oil consumption, reducing its relative importance in their energy matrix
- Changes in macroeconomic policies, both fiscal and monetary

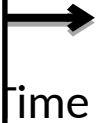
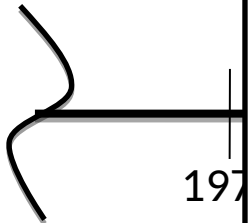




Tell the story

Effects of First Oil Crisis (1973) – Brazil

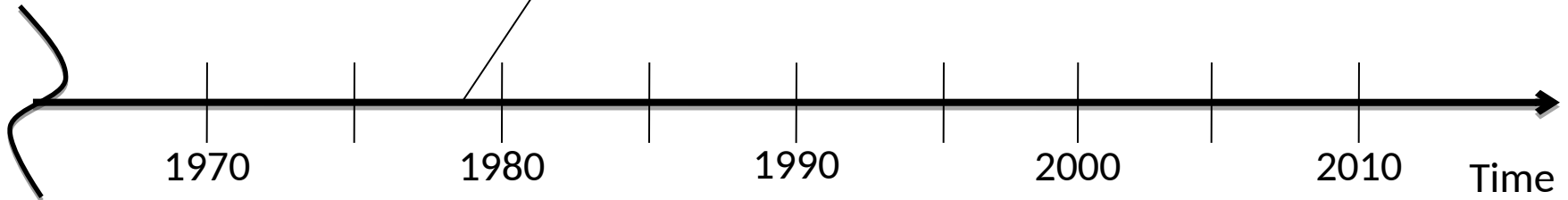
- Systematic use of sugarcane ethanol as an alternative fuel started in 1934.
- From 1934 to 1975 anhydrous ethanol was added to petrol.
- In 1975, Brazil started its Alcohol Program, so called Proalcool.
- At the beginning, the aim of the program was a modest replacement of petrol with anhydrous ethanol.
- In 1980 the goal became more ambitious. This new policy achieved a relevant percentage of petrol replacement: from 1% in 1971 to 41% in 1985. (Leite, 2007).
- Investment in Petrobras (Brazilian Petroleum Company)





Tell the story

Late 1970's - Proalcool Program

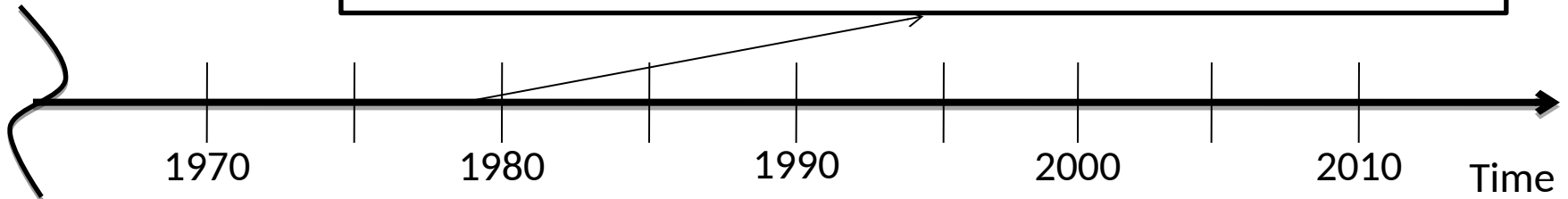




Tell the story

Late 1970's – Proalcool Program

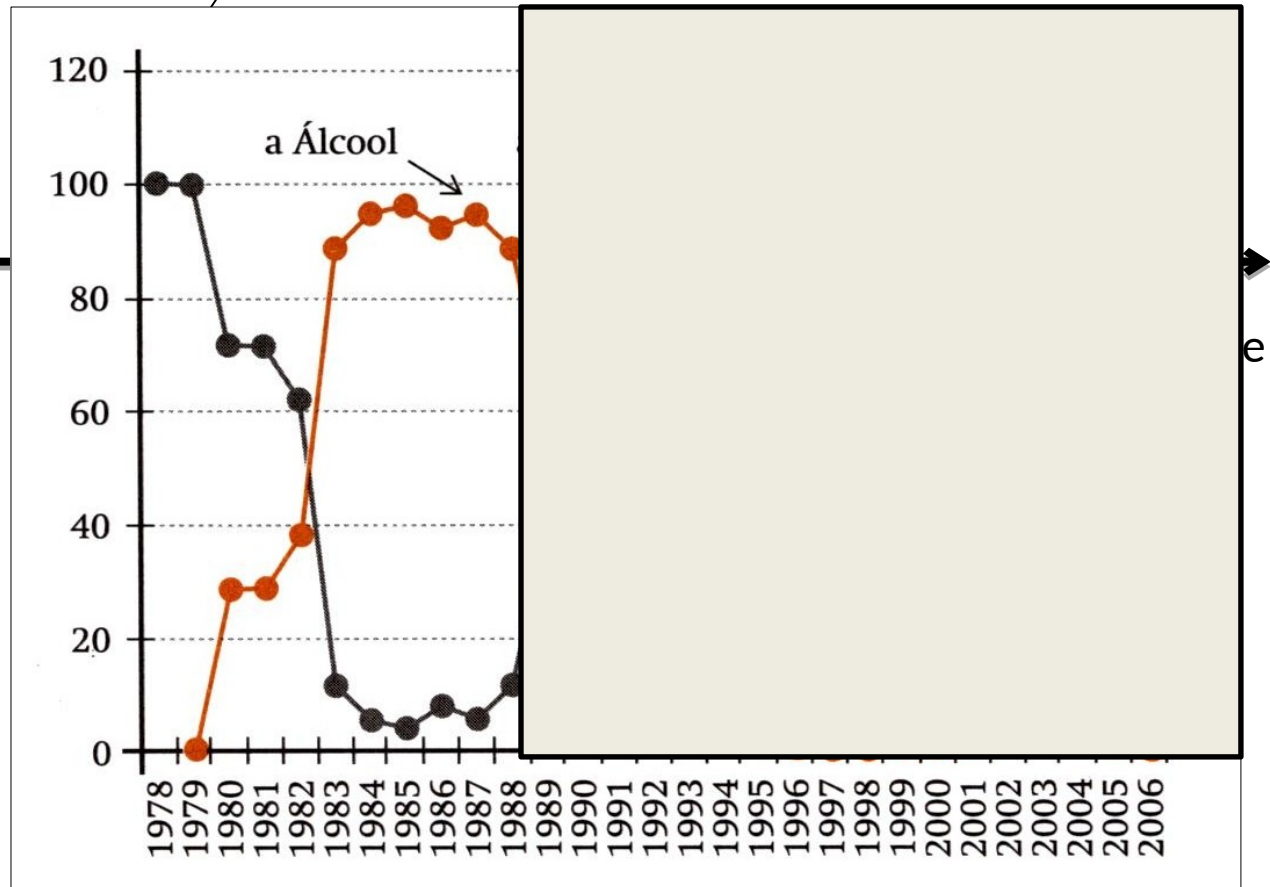
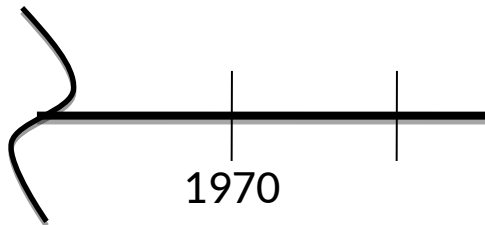
- In country development of E-100 cars.
- In 1978, an agreement between the Brazilian Government and the National Association of Motor Vehicle Manufactures (Anfavea) established the beginning of E-100 development.
- In 1979 the E-100 was in the streets.





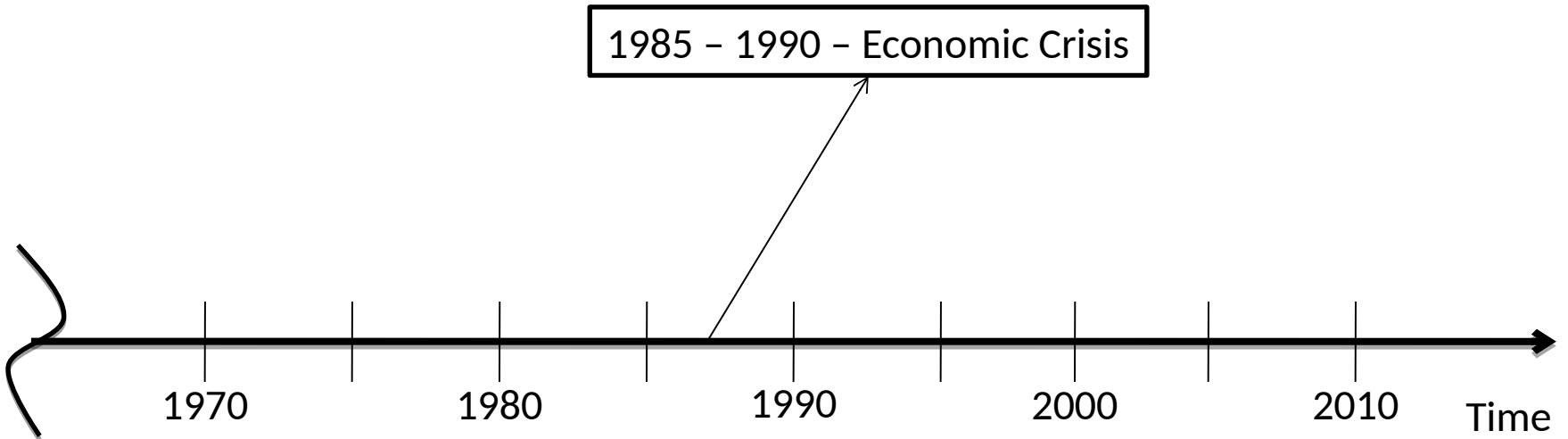
Tell the story

Late 1970's - Proalcool Program





Tell the story

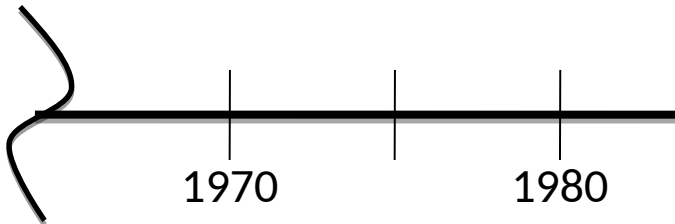




Tell the story

1985 - 1990 - Economic Crisis

- Political changes
- Economic pressures:
 - High inflation
 - Low GDP for more than fifteen years.
- Cut of subsidies
- The total ethanol fractional usage reduced from 50% (1988) to 40% (1994).
- During the 1980's 70% of vehicles sold in Brazil were E-100. The ethanol fleet was relevant and it would take a decade to be deactivated.





Tell the story

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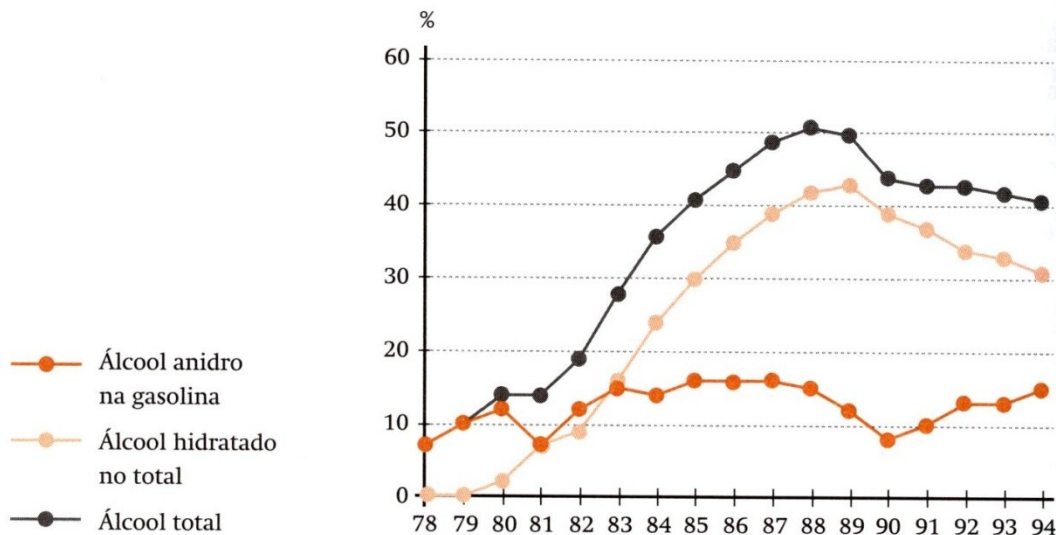


Figura 17 - Proporção de álcool no consumo do combustível automotivo.

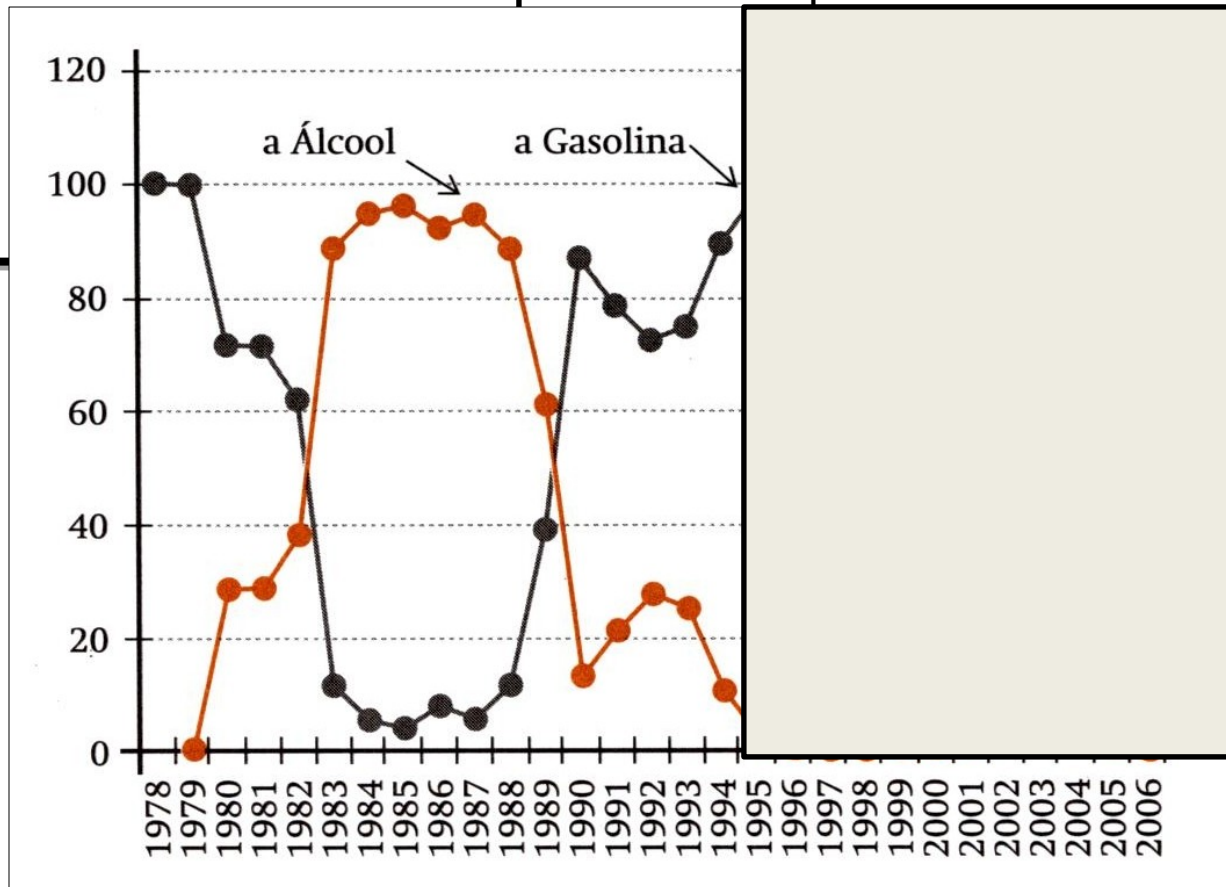
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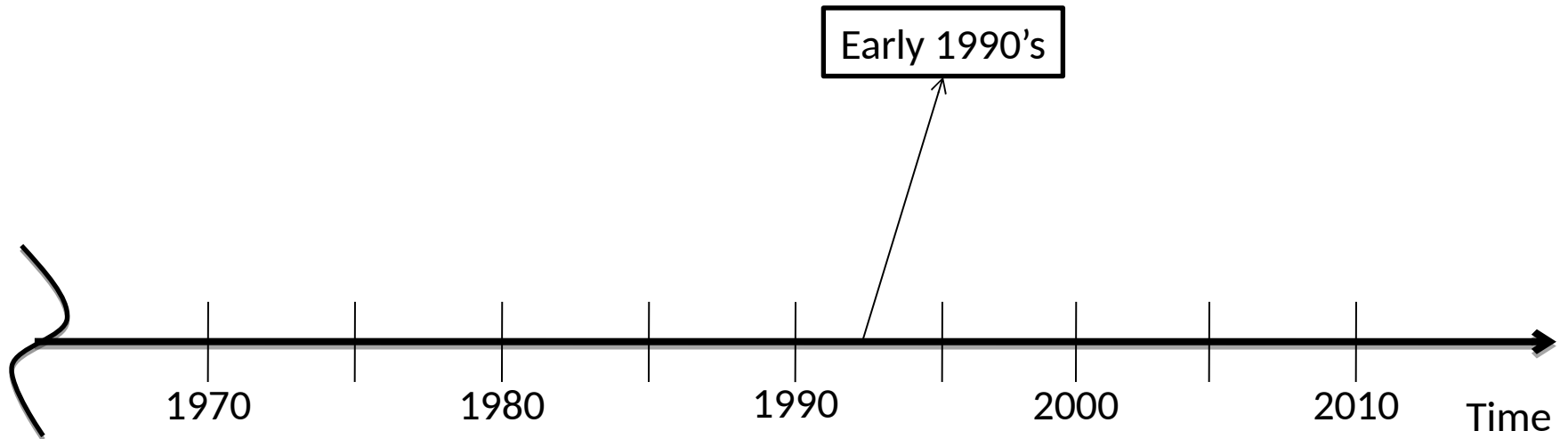
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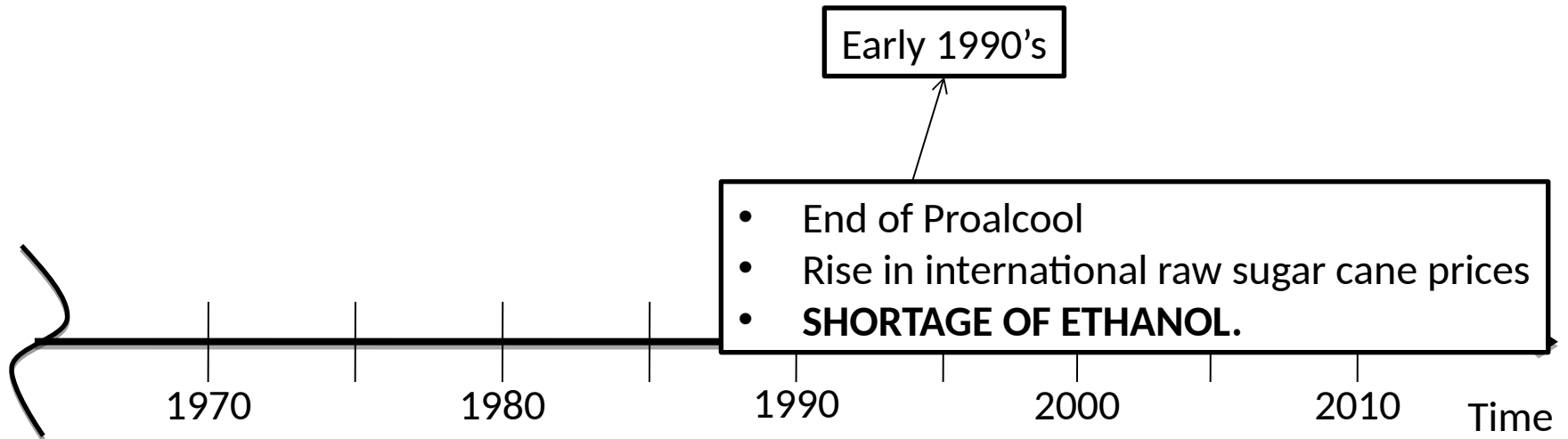


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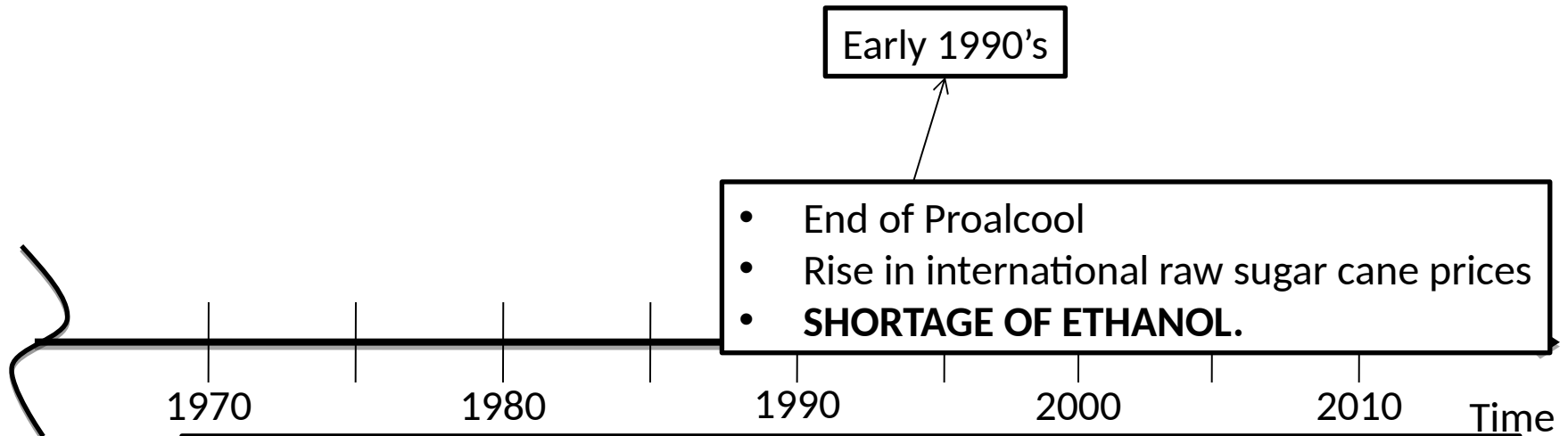


Tell the story





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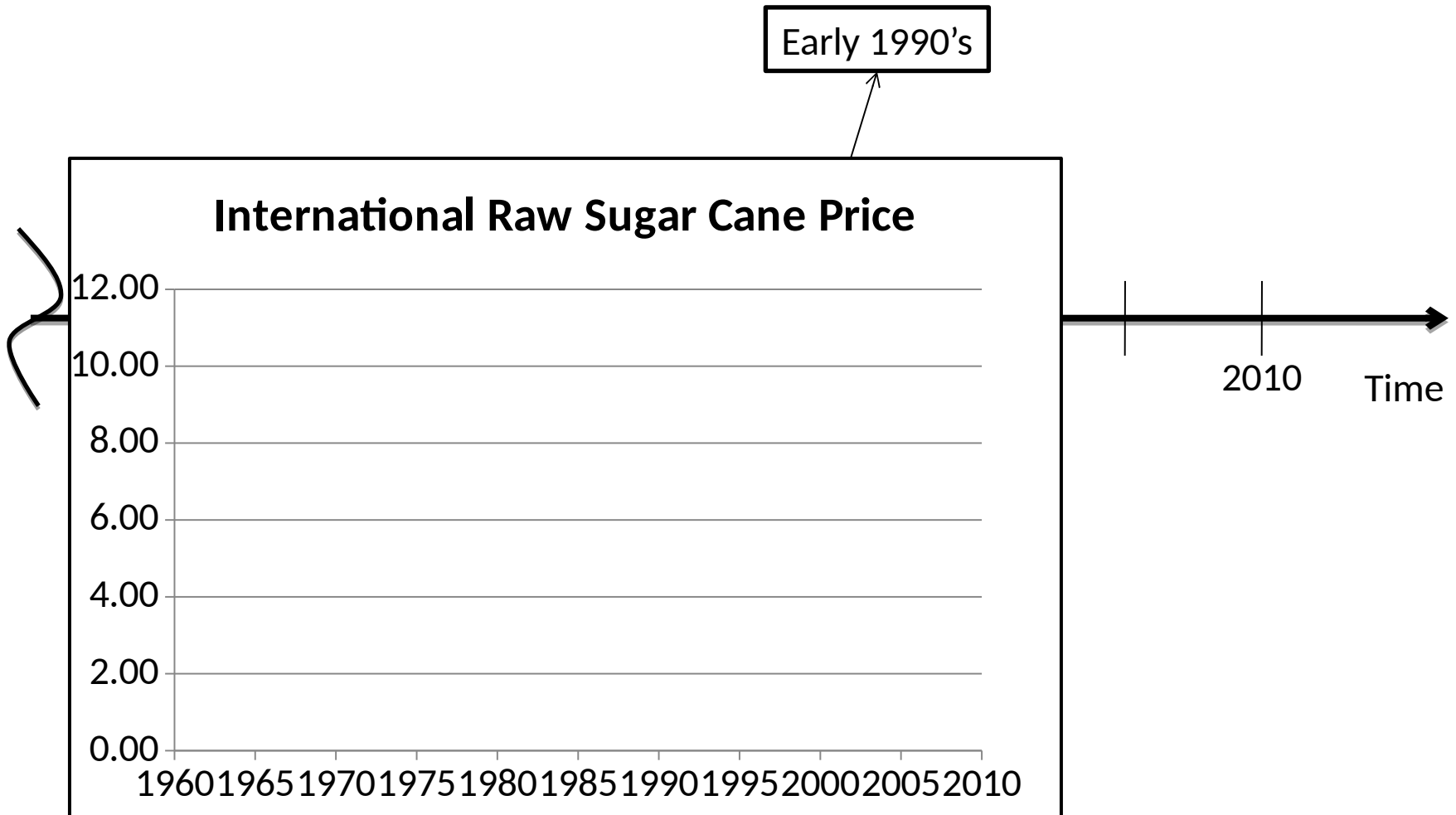


Lost of consumer confidence

- This would charge its price later.
- From 1986 to 2003, consumers no longer bought ethanol E-100 cars.
- The remainder ethanol cars still sold were results of the sugarcane sector pressure for government incentives and the so called "*green fleet*", part of the Government cars fleets should be E-100.

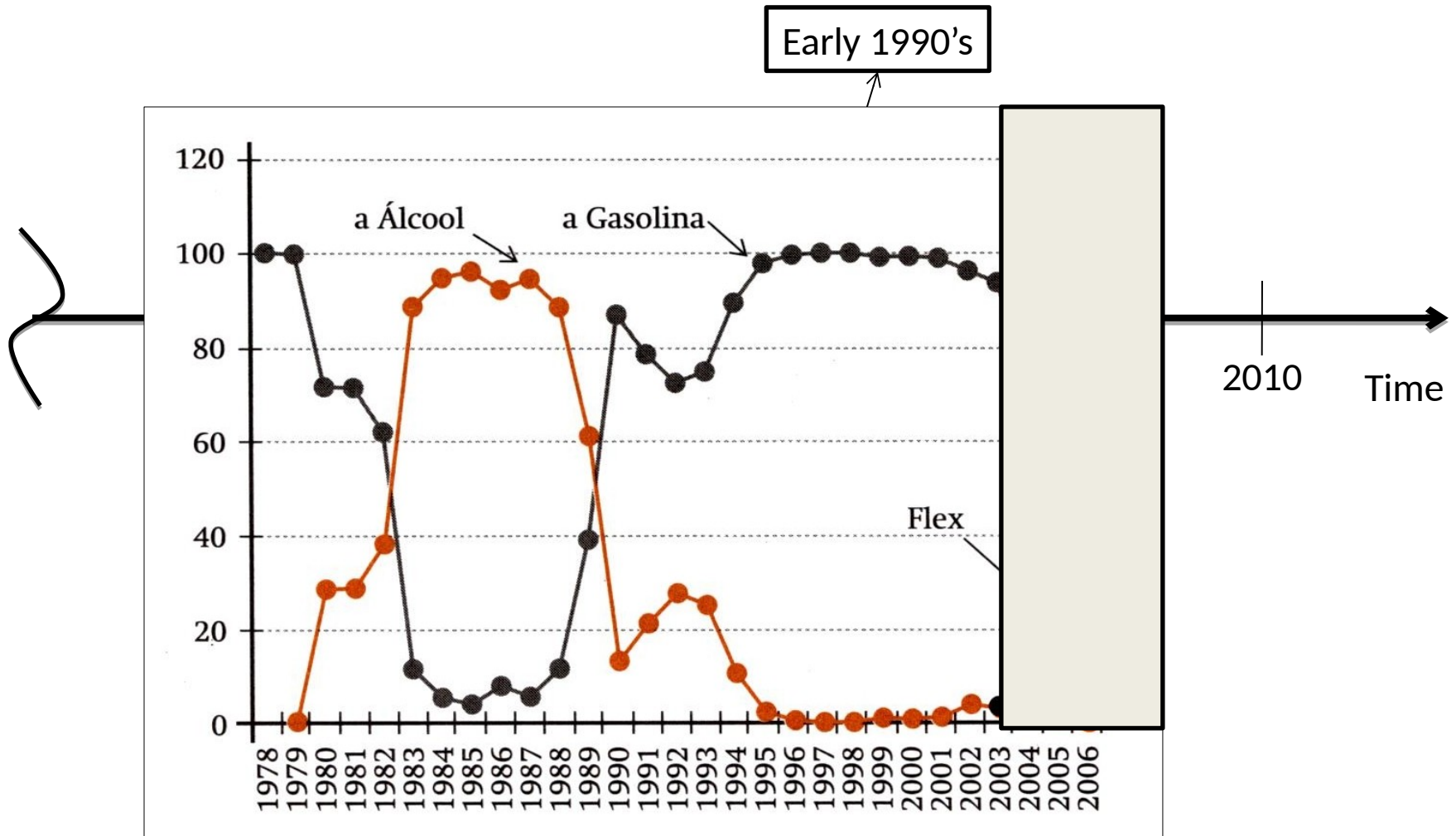


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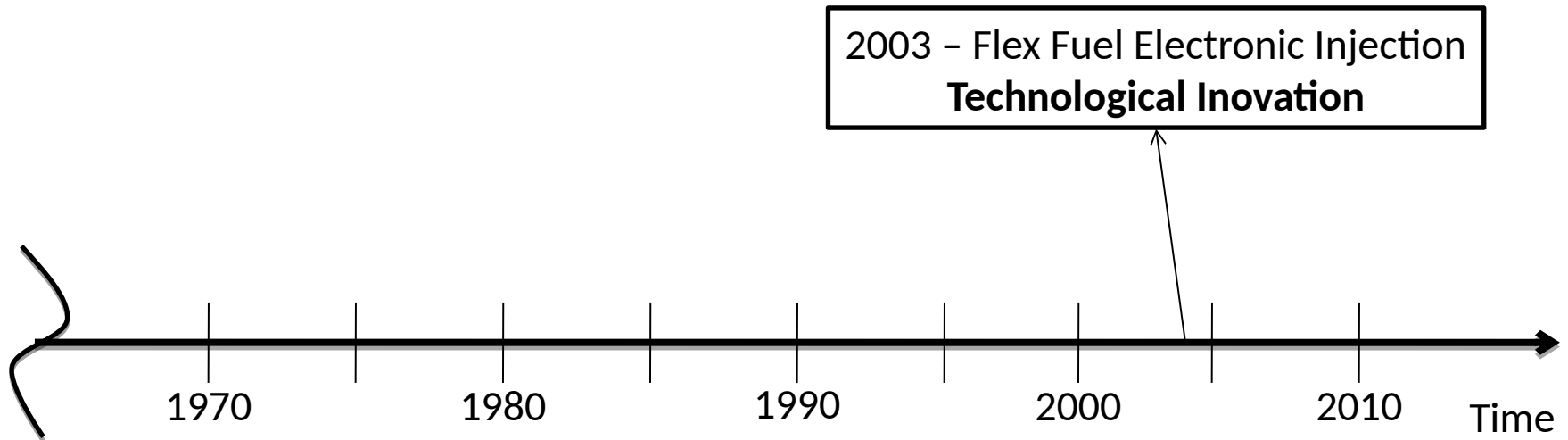


Tell the story





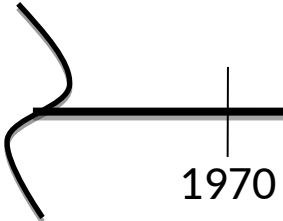
Tell the story





Tell the story

2003 - Flex Fuel Electronic Injection



- A **technological innovation**, the flex fuel electronic injection, was already available in the US. Bosch started to study this solution in 1988, in California, USA.
- Due to the technology adopted, Bosch solution was expensive for Brazilian patterns costs and Brazilian motor vehicle manufactures refused to use it.
- Moreover, dual sensor technology was not suitable for Brazil due to the presence of hydrated ethanol.

time



Tell the story

2003 - Flex Fuel Electronic Injection

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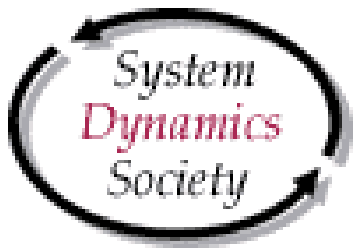
1970

• Magnetti Marelli launched the flex fuel electronic injection system with only one sensor.

• Volkswagen do Brasil launches its first flex car in 2003

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due



Graph the Variables

Cars sold in Brazil

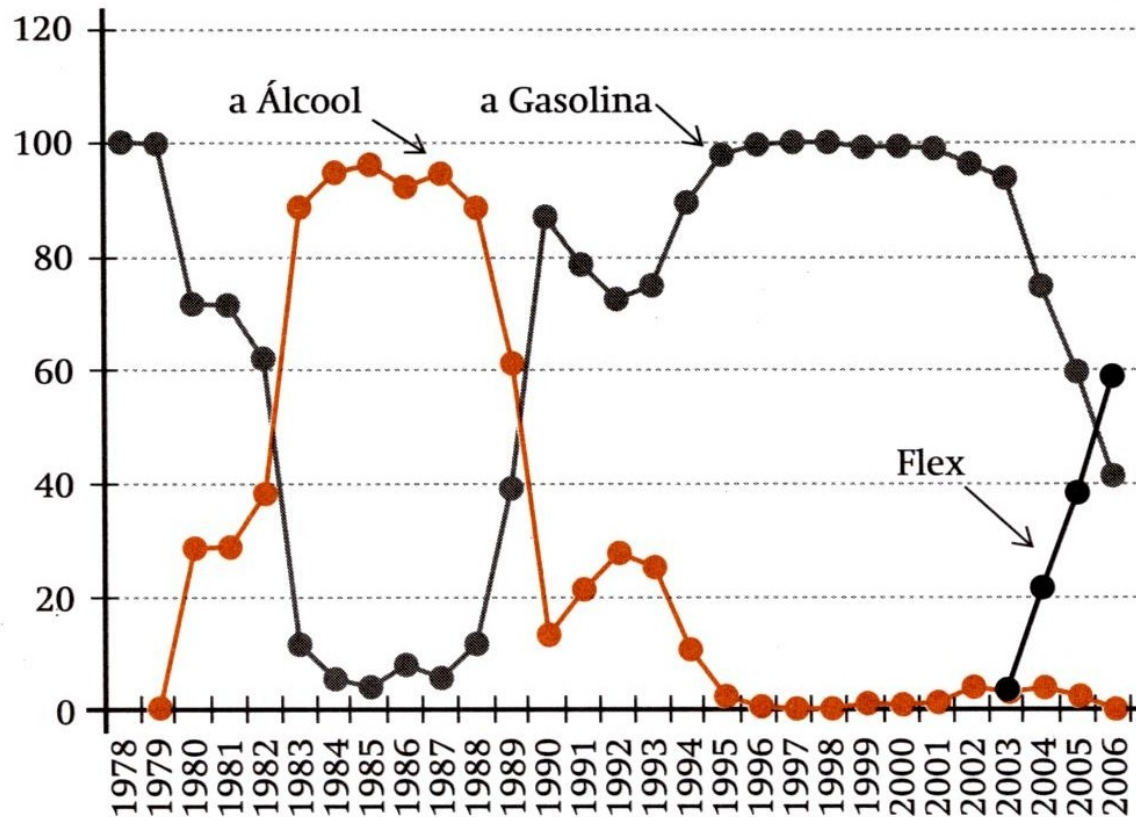
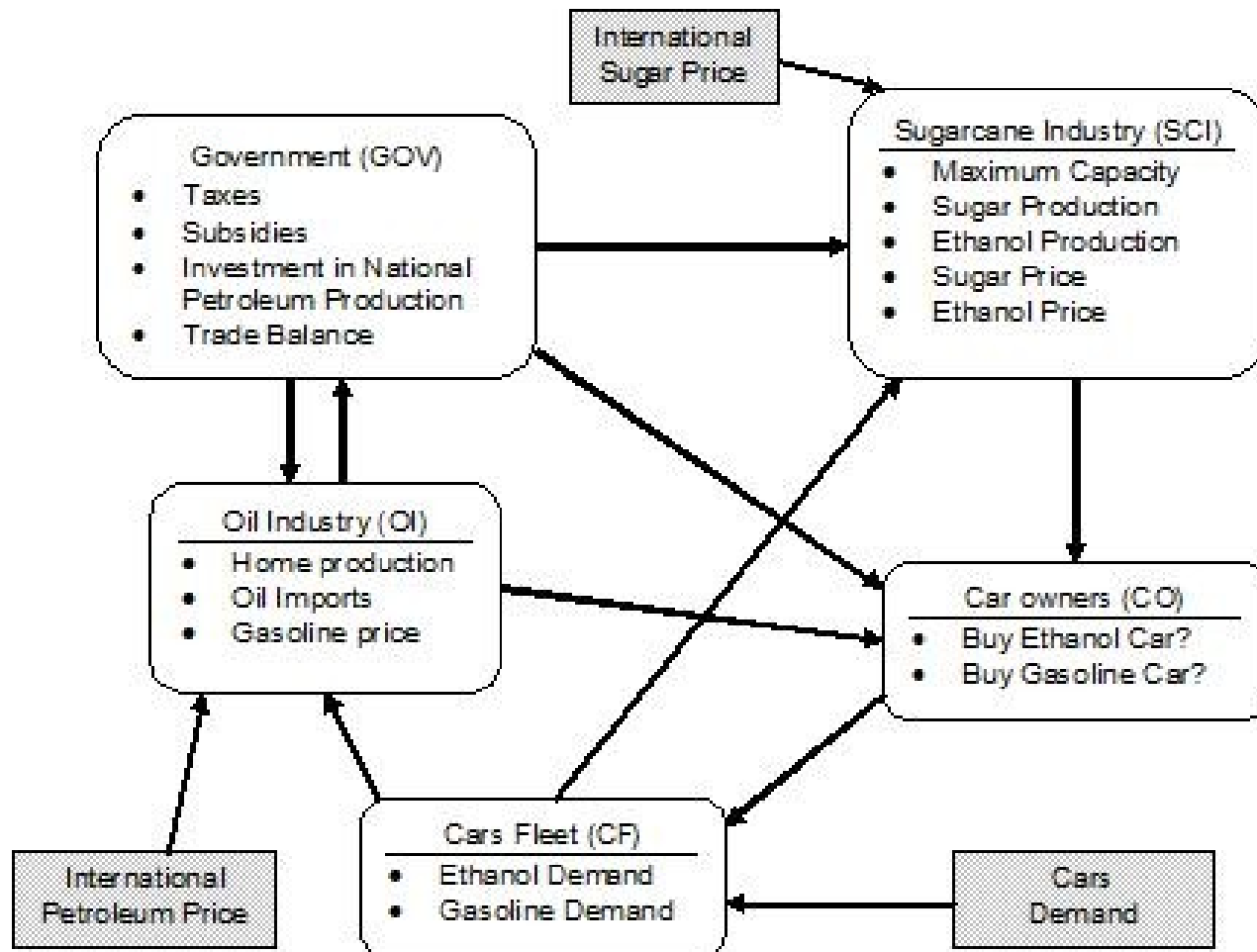


Figura 31 – Venda de automóveis no mercado interno, por tipo de combustível, em %.



Making the System Visible

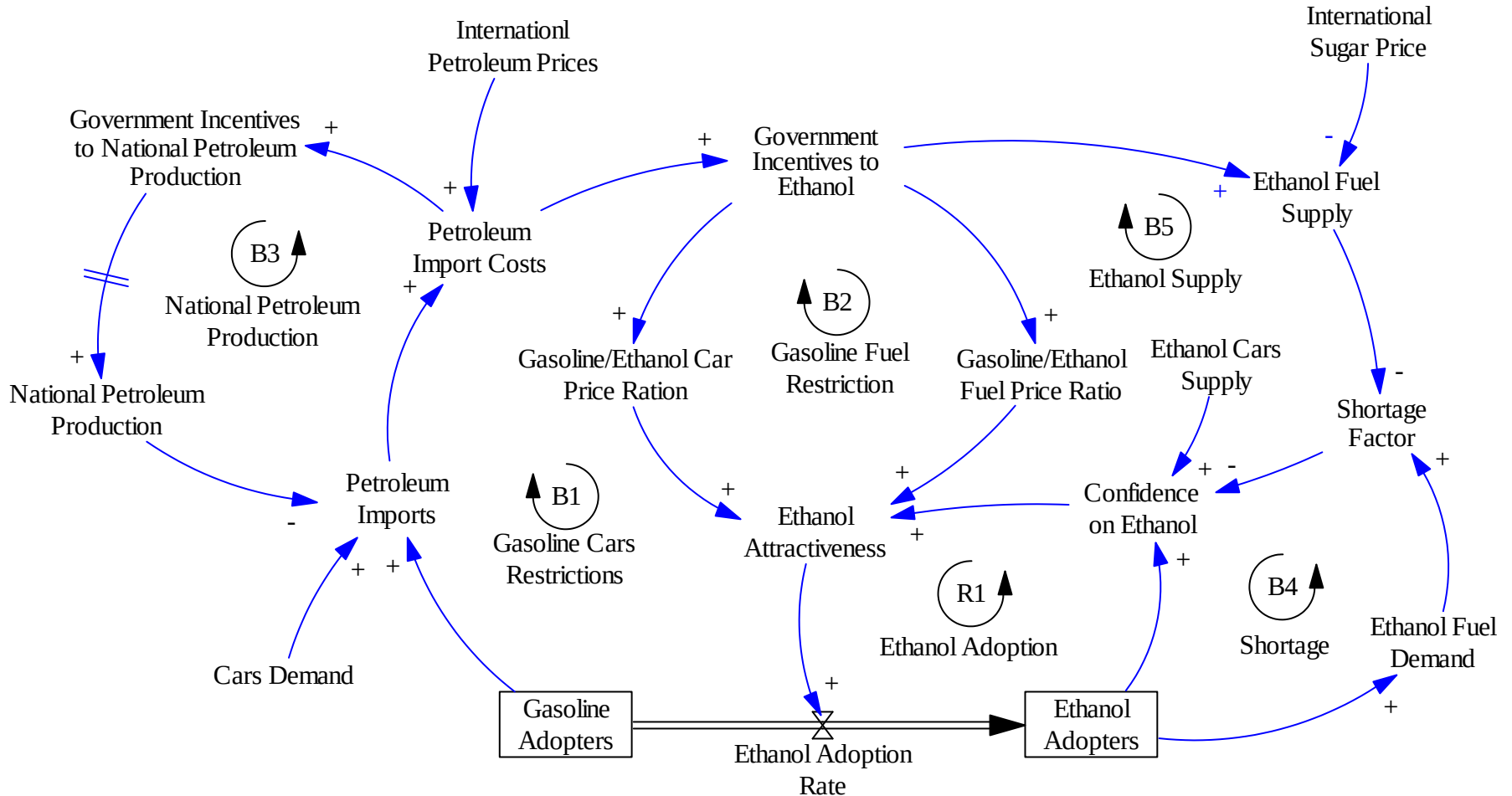
Subsystem Diagram





Making the System Visible

Causal loop Diagram





Identify the Lessons

- This paper is 35 years late!!!
- With this preliminary analysis, it is possible to understand the shift in loops dominance and why they happened
- Flex fuel technology became a dominant design and changed the consumer behavior
- Pro-alcohol program is now self sufficient and its long term effects must be studied in advance.



Next Step

- Build a simulation model to explore some scenarios
- Expand the model so as to include other relevant issues (land, food and environmental aspects)



Thank you very much!

Questions ...?