Multi-tier tax competition on Gasoline

Marie-Laure Breuillé, CAESAR, INRAE
Emmanuelle Taugourdeau, CNRS, CREST

9th of December 2021
International Conference on Mobility Challenges
Motivation

Gasoline price and taxation features

- disparities of prices between countries, regions and "départements" + transparency (development of web sites)
Gasoline price in the US

See what gas prices are around the country at a glance. Areas are color coded according to their price for the average price for regular unleaded gasoline.
Gasoline price in France

Prix moyen du litre du SP95-E10

Prix moyen du litre (en €)

1.6 1.62 1.55 1.77

Prix au 14 octobre 2021
Rechercher des points de vente de carburants

Choix des carburants

- Gazole
- SP98
- SP95-E10
- SP95
- GPLc
- E85

Localisation

Par département
- 33 - Girondes

Par commune ou un code postal
- Par exemple "Toulouse" ou "33200"

Choisissez un type d'enseigne
- Toutes les enseignes

Choisissez un ou plusieurs services

Voir la liste des stations
Motivation

Gasoline price and taxation features

- disparities of prices between countries, regions and "départements" + transparency (development of web sites)
- no consensus in the literature about the measure of price elasticity of gasoline demand
Gasoline purchase decision

Characteristics most important in purchase decisions

<table>
<thead>
<tr>
<th>Gas Consumers</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>71%</td>
<td>64%</td>
<td>61%</td>
<td>58%</td>
<td>59%</td>
</tr>
<tr>
<td>Location of store/station</td>
<td>18%</td>
<td>20%</td>
<td>25%</td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td>Ease of entrance or exit</td>
<td>8%</td>
<td>9%</td>
<td>8%</td>
<td>11%</td>
<td>8%</td>
</tr>
<tr>
<td>Quality of in-store items</td>
<td>3%</td>
<td>6%</td>
<td>4%</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>

* Not asked in previous studies (2015-2017)

Behavior at the Pump, NACS Report 2019
Gasoline price and taxation features

- disparities of prices between countries, regions and "départements" + transparency (development of web sites)
- no consensus in the literature about the measure of price elasticity of gasoline demand
- gasoline/fuel taxation: easiest and cheapest form of automative taxation at local level...
Motivation

Gasoline price and taxation features

- disparities of prices between countries, regions and “départements” + transparency (development of web sites)
- no consensus in the literature about the measure of price elasticity of gasoline demand
- gasoline/fuel taxation: easiest and cheapest form of automative taxation at local level...
- ....but indeed, complex: horizontal + vertical
Gasoline price and taxation features

- disparities of prices between countries, regions and "départements" + transparency (development of web sites)
- no consensus in the literature about the measure of price elasticity of gasoline demand
- gazoline/fuel taxation: easiest and cheapest form of automotive taxation at local level...
- ....but indeed, complex: horizontal + vertical
- ...and regressive (but less than carbon tax (Teixido and Verde 2017))
Price of gasoline at the pump (France)

<table>
<thead>
<tr>
<th></th>
<th>Unleaded 95</th>
<th>Gazole 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>0.23</td>
<td>0.2</td>
</tr>
<tr>
<td>Brent</td>
<td>0.66</td>
<td>0.54</td>
</tr>
<tr>
<td>Refining</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Distribution</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>Excise tax</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>VAT</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>% of taxes:</td>
<td>65%</td>
<td>61%</td>
</tr>
<tr>
<td>Price:</td>
<td>1.39 €/l</td>
<td>1.21 €/l</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Unleaded 95</th>
<th>Gazole 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>0.26</td>
<td>0.24</td>
</tr>
<tr>
<td>Brent</td>
<td>0.69</td>
<td>0.61</td>
</tr>
<tr>
<td>Refining</td>
<td>0.15</td>
<td>0.16</td>
</tr>
<tr>
<td>Distribution</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>Excise tax</td>
<td>0.47</td>
<td>0.43</td>
</tr>
<tr>
<td>VAT</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td>% of taxes:</td>
<td>61,4%</td>
<td>61%</td>
</tr>
<tr>
<td>Price:</td>
<td>1.59 €/l</td>
<td>1.44 €/l</td>
</tr>
</tbody>
</table>
Some insights:

- Taxes: 60% of the gasoline price
- Almost 35 billions of euros
- More than 20 billions for the central Gvt
- 6 billions euros for Regions (20% of their revenue)
- 6 billions euros for départements (6% of their revenue)
- From 2011 to 2016: Regions had possibility to determine their own TICPE share according to two brackets (< 0.025 euros/l)
- From 2016: Central gvt redistributes a portion of TICPE revenue according to the revenues generated in the region.
Our approach

- Is gasoline tax a good instrument for local governments?
- Should local government intervene more in gasoline tax setting?

Better understanding of the gasoline tax system through a general theoretical model with:

- horizontal fiscal competition
- vertical interactions
- a specific price elasticity of demand
“cross border shopping” : Keen and Kanbur (AER 1993)
tax reaction functions Vrijburg and de Mooij (ITAX 2012), Graziosi (ITAX 2015, WP 2016)
Devereux and al (JPubE 2007) (no VAT + transport costs)
2 regions

$N$ agents in each region ($N = 1$)

agents uniformly distributed on $[-1, 1]$
The Model (2)

- gasoline price at the pump: \( P_i = q_i(1 + \theta) \)
  with \( q_i = p_i + t_i + T \) price without VAT

- Agents consume 2 goods: \( c_i \) and \( x_i \)

- quasi linear utility function: \( c_i + u(x_i) \)

- budget constraint:
  \[ c^i_k(1 + \theta) : \text{numeraire good expenditures} \]
  \[ \bar{y} \rightarrow x^j_k P_j : \text{gasoline purchases} \]
  \[ (\delta + \alpha P_j) |s^i_k - S_j| : \text{transport costs} \]
Gasoline Demand / Choice of the gasoline station

Consumer choice leads:

\[
\begin{align*}
q_j & \quad \Rightarrow \quad x^j \quad \downarrow \\
t_j & \quad \Rightarrow \quad x^j \quad \downarrow \\
T & \quad \Rightarrow \quad x^j \quad \downarrow \\
\end{align*}
\]

\begin{align*}
\theta & \quad \Rightarrow \quad x^j \quad \text{unchanged}
\end{align*}

\theta \text{ applies either on gasoline and numeraire good} \Rightarrow \text{no arbitrage based on VAT.}
Choice of the station to refuel

Agent $k$ chooses $S_1$ iff $V^1_k > V^2_k$

$$V^j_k = c_i + u(x^j).$$

$s$: consumer who is indifferent between bying in 1 or 2

$$\tilde{s} = \frac{u(x^1) - (x^1 + \alpha) q_1 - (u(x^2) - (x^2 + \alpha) q_2)}{\rho}.$$  

$\rho$ is the transportation cost:  
increases with $T$ and $t_i$ (through prices included taxes);  
decreases with $\theta$: reduces the psychological cost relative to the monetary one.
$q_1 > q_2$

\[ S_1 - \Delta p_1 - \Delta q_1 - \Delta t_1 - \Delta \theta - \Delta p_2 - \Delta q_2 - \Delta t_2 - \Delta T = S_2 \]

Region 1

Region 2
$q_1 < q_2$

\[ \Delta^+ p_1 \]
\[ \Delta^+ q_1 \]
\[ \Delta^+ t_1 \]
\[ \Delta^+ \theta \]

\[ \Delta^+ p_2 \]
\[ \Delta^+ q_2 \]
\[ \Delta^+ t_2 \]
Governments are Leviathan

Local governments
- choose $t_i$
- to maximize tax revenue: $r_i = t_i \times \text{local tax base}$

Federal government
- chooses $T$ and $\theta$
- to maximize tax revenue: $R = \theta C + \sum_{i=1}^{2} (\theta q_i + T) X_i$
Local tax base = $x_i s_i(q_i, q_j, \theta)$

$s_i$ : number of shoppers in $i$.
Can be evaluated from the ”threshold” shopper :

$s_1 = 1 + \tilde{s}$ and $s_2 = 1 - \tilde{s}$
Local taxes reaction functions (1)

The optimal local excise tax depends on:
- gasoline demand elasticity to the tax per shopper.
- mobility elasticity to the tax ($\bar{s}$): number of shoppers.

Both elasticities are negative.

From the local government choice

\[ t_j \uparrow \iff t^i \uparrow \]

\[ \theta \uparrow \iff t_i \downarrow \]

\[ T \uparrow \iff t_i \text{ unclear} \]

Specific cases:

i) inelastic demand \( \frac{\partial t_i}{\partial T} > 0 \)

ii) iso-elastic demand \( \frac{\partial t_i}{\partial T} > 0 \)
Local taxes reaction functions (2)

Figure – Effect of a rise in $\theta$ (from $\theta = 0.2$ to $\theta = 0.35$) with $p_1 = 0.55$ and $p_2 = 0.5$. 
Figure – Effect of a rise in $T$ (from $T = 0.63$ to $T = 0.8$) with $p_1 = 0.55$ and $p_2 = 0.5$
Federal gvt/ non cooperative choice (Nash)

Federal government maximizes his tax revenue:

- VAT on numeraire good
- VAT on gasoline expenditures (net of tax)
- Excise tax per unit of gasoline consumption
- VAT on excise taxes (fed and local)

Warning: numeraire goods are the residual consumptions after deducing gasoline expenses from income $\Rightarrow$ they depend on local taxes.
Federal taxes reaction functions - symmetric regions

From the central government choice, **symmetric regions**:

\[
T \uparrow \implies \theta \downarrow
\]

\[
\theta \uparrow \implies T \downarrow
\]

\[
t_i \uparrow \implies T \downarrow
\]

\[
t_i \uparrow \implies \theta \downarrow
\]

but introducing **asymmetry** \((p_1 \neq p_2)\), we can observe:

\[
T \uparrow \implies \theta \uparrow \text{ and } \theta \uparrow \implies T \uparrow
\]
Nash versus Social Planner

- Social planner maximizes the sum of the objective:
  \[ SP = R(t_1, t_2, T, \theta) + r_1(t_1, t_2, T, \theta) + r_2(t_1, t_2, T, \theta) \]
  with the set of instruments \((t_1, t_2, T, \theta)\)

- SP=Benchmark

- First best that internalizes externalities
Externalities

i) local taxes imply positive externalities at the horizontal level and negative externalities at the vertical level: \( t_i \uparrow \Rightarrow r_j \uparrow \) and \( t_i \Rightarrow R \downarrow \)

ii) The federal tax \( T \) (excise tax) implies negative externalities at the local level: \( T \Rightarrow r_1 + r_2 \downarrow \)

iii) VAT has no effect on local governments’ revenues: \( \theta \Rightarrow r_1 + r_2 \) unchanged
Let us fix $t_1$ and $t_2$

$$T^{SP} < T^N$$

$$\theta^{SP} \leq \theta^N$$

Let us fix $\theta$ and $T$

$t_i^{SP} < t_i^N$ if vertical externalities dominate horizontal externalities, and

$$r_i^{SP} < r_i^N$$

$\implies$ Surprising in a tax competition framework
Sequential game: Centralized leadership

Sequential game: federal gvt has a leadership position

Centralized leadership vs Nash

For $\varepsilon_x > -1$ and $\frac{\partial t_i}{\partial T} > 0$

- $\theta^{CL} > \theta^N$
- $T^{CL} < T^N$
- $t_i^{CL} < t_i^N$
- $r_i^{CL} < r_i^N$

$\implies$ centralized leadership equilibrium is detrimental for the local government revenues.

But local tax lower than at the Nash equi (as SP solution)
Conclusion

- Fiscal tools from the different tiers of governments are interdependent:
  - the federal reaction functions to local taxes changes are of opposite signs
  - excise taxes are strategic complements
- Price elasticity of demand plays a crucial role
- Sequence of decision of the taxes matters.
- Local excise tax: a good instrument for local governments?
  not sure: the optimal solution suggests low local rates; instrument with a low room for manoeuvre.
Thank you for your attention!
Federal taxes choice / non cooperative choice (Nash)

Federal government maximizes his tax revenue:

\[
R(t_1, t_2, T, \theta) = \theta C + \sum_{i=1}^{2} (\theta q_i + T) X_i
\]

and \( C \) depends on the local tax choices since

\[
C(t_1, t_2, T, \theta) = \int_{-1}^{\tilde{s}} c_1 ds + \int_{\tilde{s}}^{1} c_2 ds
\]

with \( c_1 \) and \( c_2 \) are the residual consumptions after deducting gasoline expenses from income (which depend on local taxes).