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Petrol taxes on Rail Ridership.

Introduction

The average consumer in European major cities often has multiple ways to travel throughout their day. One of the major decisions that individuals have to make for longer distances is whether to drive or to take public transportation as these are considered substitutes. As consumers make choices at the margin this means that the choice will often come down to the marginal cost of one days travel, that is one day's worth of petrol consumption for their automobile or the price of public transit that day.

Why this of interest in relation to government policy, is because in Europe there are significant taxes on petrol, often increasing the price of petrol to double the original price[1], such as in figure 3, reasons for which are discussed in the background section. Of course as these choices are made by separate sovereign nations so different decisions will be made in regards to taxation and there may be unintended consequences of raising the tax. Below is figure 1, cross sectional data from 12/11/12 with countries and the average price in euros per liter for Euro Super-95. Prices in from other nations who use other currencies are converted into euros at the current exchange rate. Already we can see that prices and income of the average individual doesn't always line up and that it's not priced the same across Europe. Luxemburg for example

[1] From the Oil Commision

is charging a price of €1.32 which is the same as Bulgaria but there is a night and day difference between their GPD per capita numbers given by Figure 2, that difference being over 100,000 USD. This implies that there are differences in economic thought, at least so far as how high to make the taxes, the reasoning and collection are all similar, and this is reflected in figure 3 where petrol taxes aren't all the same throughout Europe. The tax percentage in Sweden is actually lower than in the UK despite Sweden having a higher GDP per capita. This paper asks then how do petrol taxes affect rail ridership in Europe?

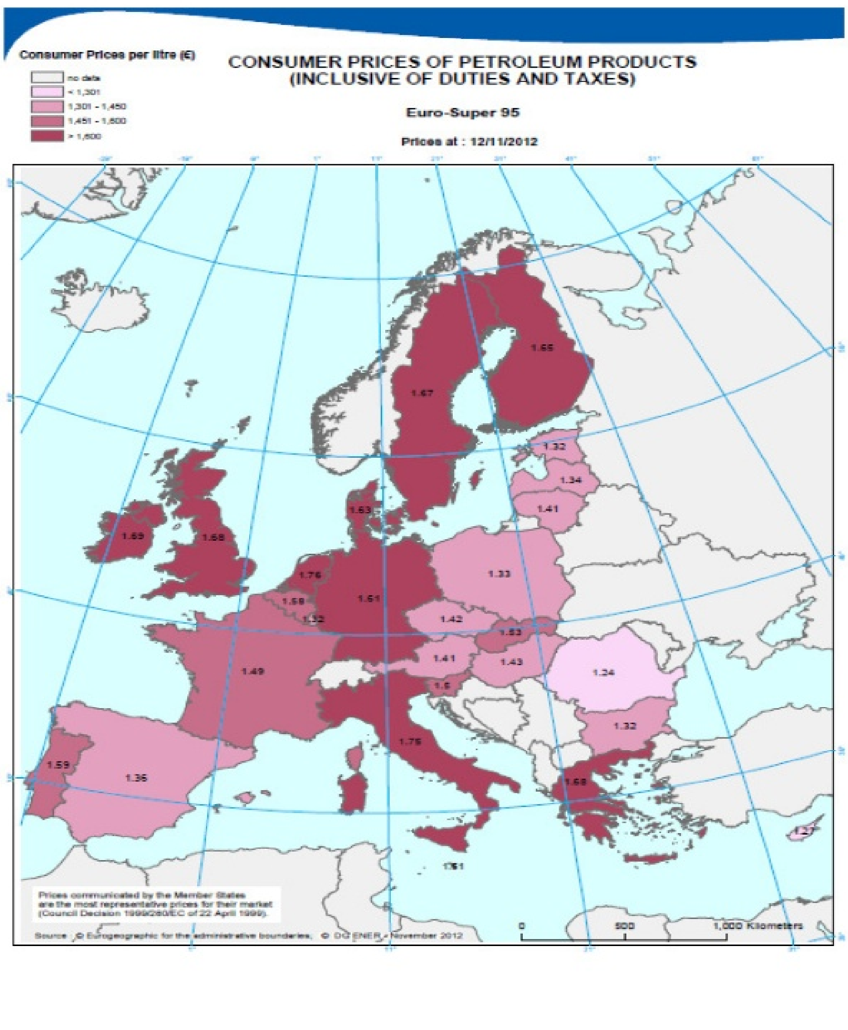
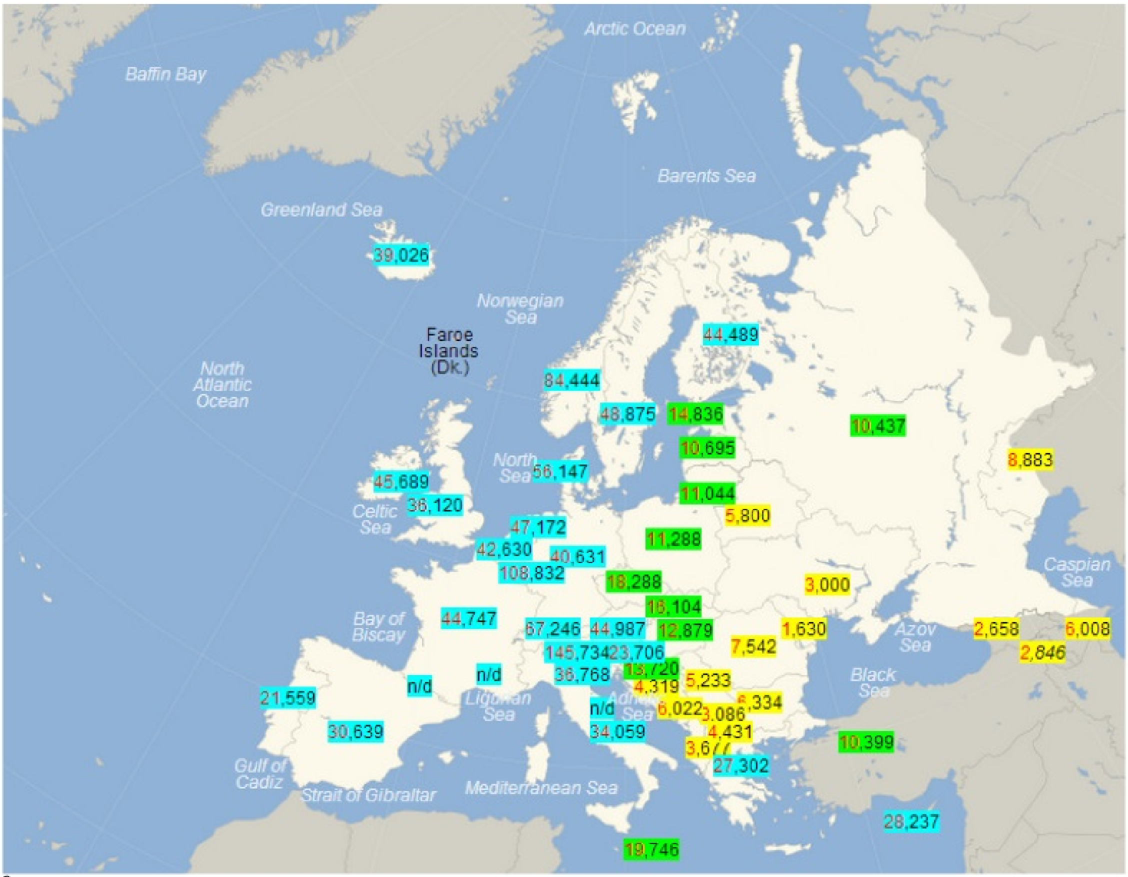


Figure 1

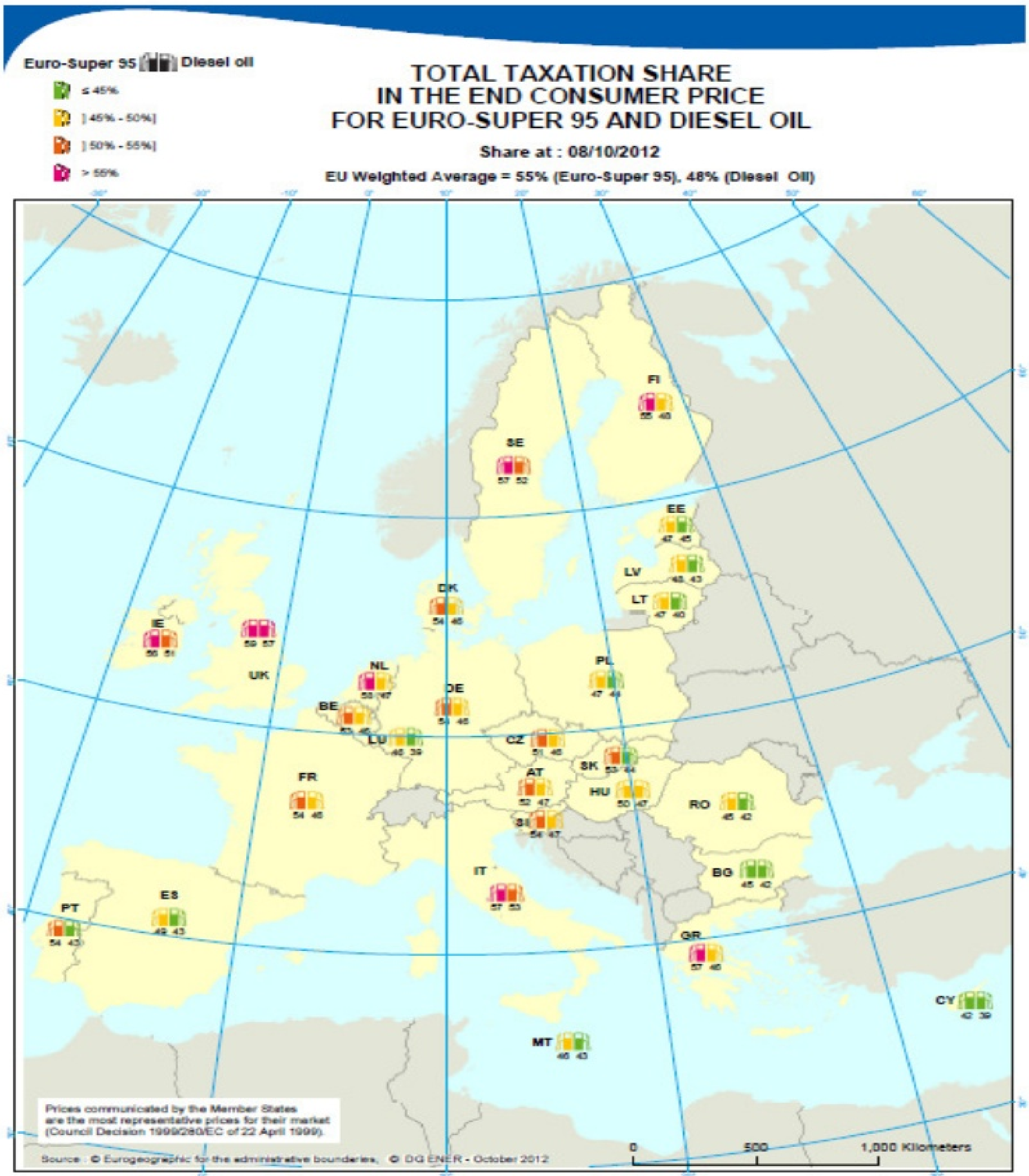
Figure 2



[2]

[2] Figures given by IMF, unit is international dollars.

Figure 3


Euro-Super 95 Diesel oil
≤ 45%
]45% - 50%]
]50% - 55%]
> 55%
TOTAL TAXATION SHARE
IN THE END CONSUMER PRICE
FOR EURO-SUPER 95 AND DIESEL OIL
Share at : 08/10/2012
EU Weighted Average = 55% (Euro-Super 95), 48% (Diesel Oil)
FI
SE
EE
LV
LT
DK
IE
UK
NL
PL
BE
DE
LU
CZ
SK
AT
FR
HU
RO
SI
IT
BG
ES
PT
GR
CY
MT
Prices communicated by the Member States
are the most representative prices for their market
(Council Decision 1999/280/EC of 22 April 1999).
Source : © Eurogeographic for the administrative boundaries, © DG ENER - October 2012
0
500
1,000 Kilometers

Background

Petrol taxes are taxed through an excise tax as well as what is referred to as a Value Added Tax, both of these prices is paid at the pump. Clearly there is a varied history of implementation throughout different countries but there are three major reasons for instituting it in the first place.

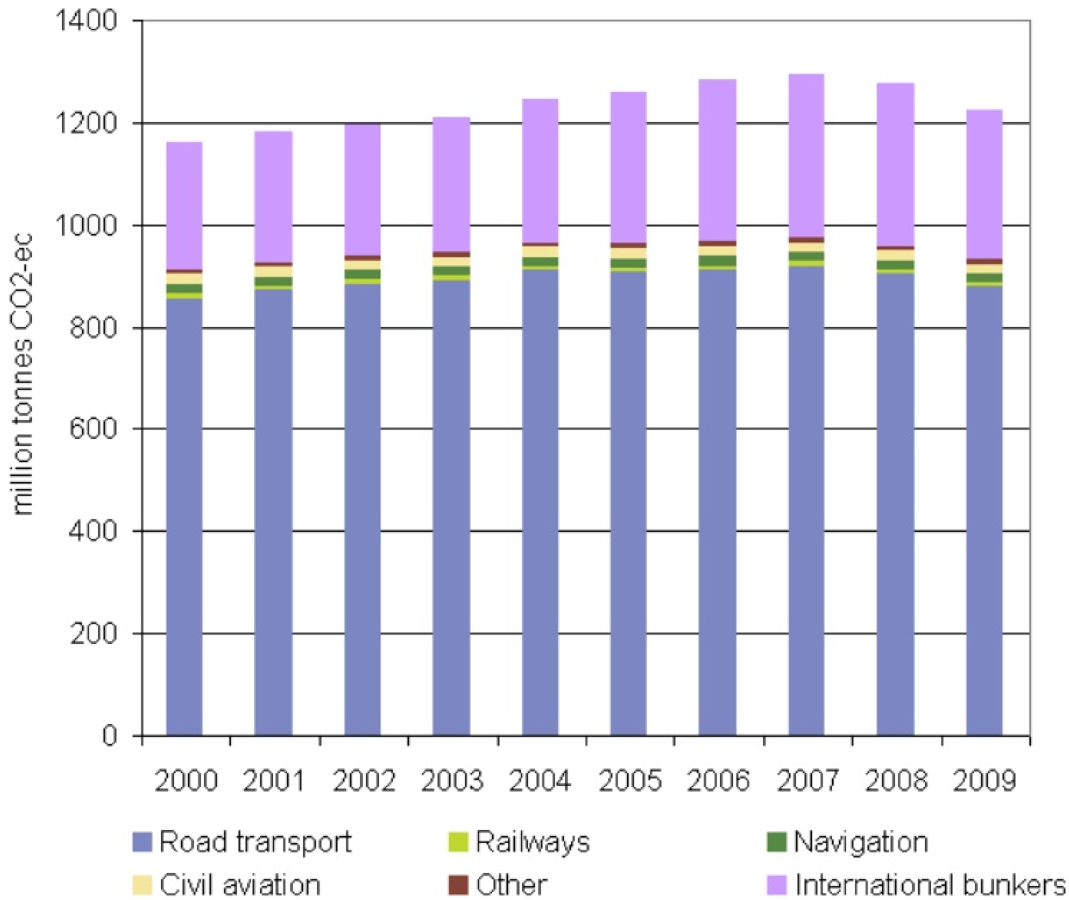
1. User Fees. [3]

Nations use part of the taxes as a means to fund their infrastructure such as highways, or even other infrastructure, including the USA. Economically this makes sense, for an individual citizen to use a car on roads and bridges they must have the ability to use them in this matter, and that is contingent upon them having an automobile as well as petrol. If they use more petrol then they'll drive more on the publicly provided roads that would otherwise be paid for by other taxes. So why not tax petrol usage and use that proceeds towards something that will help the motorist? An alternative method would be collect toll fees on the roads but this would induce a transaction cost from slowing down to pay the toll and part of the toll fees would have to be used to pay toll booth workers which would result in a loss of welfare for the individual wanting to use the road as well as the government collecting the toll and so taxing at the pump is preferable all other things equal.

[3] Information taken from http://www.fhwa.dot.gov/infrastructure/gastax.cfm

2. Externality[4]

Figure 4



Source: EEA Greenhouse Gas Data Viewer

With recent Environmental research it's been shown that increased carbon emissions are resulting in global warming. Since burning petrol through driving is a source of that as seen above in figure 4, accounting for nearly three fifths of total EU emissions in 2008 it's a negative externality to other individuals and thus we have market failure. Out of the normal three methods

[4] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Climate_change_-_driving_forces

of taxation, subsidy or regulation, European nations have chosen Pigovian taxes and are trying to reach a goal of 20% reduction by 2020 from their base year of 1990[5]. The United States on the other hand prefers to regulate through fuel economy standards. [6] Governments need to be careful though with this type of taxation, they can't give the money back to actors in the economy such as by paying for roads or subsidizing refining otherwise it will defeat the purpose of instituting a Pigovian tax in the first place. Because of this if a tax is to be raised for both to combat externalities and as user fees care has to be taken to tax adequately as they are mutually exclusive goals and for this reason taxes will likely be large in nations that do so.

3. Inelastic demand

Elasticity of demand for petrol is extremely low[7] in the short run, but not so in the long run. This leads it to being a source of stable income in the short term for governments that might have trouble running into financing needs through other channels. Although as national politics differ from country to country as well as income levels it's easier to do in some countries than others.

There are also arguments against raising taxes on petrol or even lowering it.

1. Regressive nature

[5] Sustainable development
in the European Union 2009 monitoring report
of the EU sustainable development strategy, page 74
http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-78-09-865/EN/KS-78-09-865-EN.PDF

[6] http://www.nytimes.com/2012/08/29/business/energy-environment/obama-unveils-tighter-fuel-efficiency-standards.html?_r=0

[7] http://www.econ.ucdavis.edu/faculty/knittel/papers/gas_demand_083006.pdf

Petrol taxes have been shown to be regressive [8]in nature and thus raising them impacts the least well off in society the most. Poterba shows that it is not as bad as is commonly thought but regressive taxes, or even fair head taxes are politically unpopular.

2. Recession worries.

After coming out of a recent recession, and some would say that we are currently in a depression[9], there are still large amounts of uncertainty in the economy as to the direction each nation and even the whole world is going in. In response political will to raise taxes is low because losses to incur through taxation could push more small industries out of business and raise costs for those looking for work. Likewise linked with the regressive nature of the taxes it may be seen as a measure of stimulus to the economy to stop raising if not lower taxes on petrol.

Literature Review

Bonnel and Pochet (2002)[10] wrote a paper entitled "Analysis of principal trends of mobility related to location policy, car ownership, supply policy and ageing of the population[11]". The section of relevance to this paper was section three, Consequences for sustainable transport, where they concluded the trends appearing in the data about increased car ownership and increased usage, as well as other factors like urban sprawl show that public transit is not favorable for the future and ask for methods to restrict car use in favor of public transportation. Should the regressions find a practical impact it's feasible that raising petrol taxes could be one such method, in particular for the short run.

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[8]Poterba http://www.nber.org/papers/w3578.pdf?new_window=1
It says working paper but it was published in Tax Policy and the Economy, Volume 5 (1991), The MIT Press

[9] http://www.nytimes.com/2010/06/28/opinion/28krugman.html Paul Krugman's blog.

[10] http://www.econ.ucdavis.edu/faculty/knittel/papers/gas_demand_083006.pdf

[11] http://halshs.archives-ouvertes.fr/docs/00/08/82/17/PDF/stella_2.pdf

Goeverden et al (2006)[12] wrote an article entitled "Subsidies in public transport", which while not useful in the context of this paper, due to lack of variables in the area, is none the less valuable to those that have information regarding pricing of rails. They explored the extremes of public transport, full subsidization and no subsidization and talked about how most types of public transport are somewhere in between in Europe. This would also be useful in running a cost benefit analysis of the results of this paper to see if there will be gains made by increasing petrol taxes.

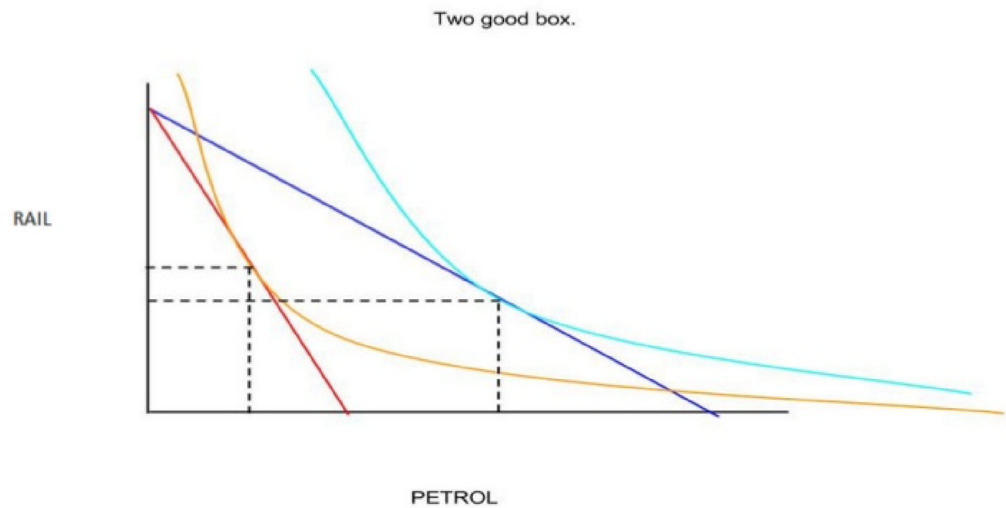
Economic Theory

Public transit is one of the classic examples of an inferior good, which is to say that the income elasticity of demand for it is negative. That is to say that should the budget constraint move inwards on an individual then they would prefer the inferior good to that of a substitute. While in this paper the income is held constant through state and year dummies, the petrol tax is changing, which will impact the overall price of petrol. So in a two good world of petrol and metro transit the budget constraint will stay fixed at the point of no petrol and all ridership and swing inwards to reflect that purchasing petrol has become more expensive. So we should still see a substitution effect as prices for petrol increase public transit should become more appealing. Figure 5 below demonstrates this by starting at the blue line budget constraint and moving towards the red budget constraint.

It's also worth noting that the price elasticity for petrol is quite low in the short run but higher in the long run. For this reason this paper will be using finite distributed lagged regressions.

[12] http://www.openstarts.units.it/dspace/bitstream/10077/5892/1/vanGoeverden_et_al_ET32.pdf

Figure 5



Data

summuary table

Variable	Obs	Mean	Std. Dev.	Min	Max
country	0				
year	120	2007.5	1.714986	2005	2010
petrolwtax	120	1.152042	.1682845	.568	1.446
petrolntax	120	.4907833	.0916464	.362	1.132
inflation	120	1.024317	.0255527	.983	1.153
rpasskm	120	14121.81	20515.85	231	82837
ppp	120	92.305	23.64888	54.9	143.8
inflcomp	120	1.083984	.0819717	1	1.397894

unemp	120	8.4125	3.559897	3.4	20.1
population	120	1.93e+07	2.34e+07	1340127	8.25e+07
raillength	120	8400.335	8829.556	925	38206
APT	120	1.204263	.242458	.5387214	1.743975
mrpkmn	120	618.5057	322.4335	68.95786	1223.053
rpkmr	120	1.257934	.8657776	.1306857	3.514921
mAPL	120	.129405	.0922829	.0226475	.3492266
APT_1	100	1.200566	.2511414	.5387214	1.743975
APT_2	80	1.232179	.2574886	.5387214	1.743975
APT_3	60	1.245631	.2575822	.8493927	1.743975
APT_4	40	1.252572	.2660047	.8493927	1.743975
APT_5	20	1.240085	.2750975	.8493927	1.736462

Data Description

The data given here was taken primarily from the Oil Bulletin and Euro stat. The data ranges from 2005 to 2010 and covers 20 countries in Europe being Austria, Belgium, the Czech Republic, Germany, Denmark, Estonia, Spain, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland, Sweden, Slovenia, Slovakia and the United Kingdom. From the Oil Bulletin were gathered petrol prices with taxes and without taxes. The values were taken weekly and averaged in excel to create annual values as petrolwtax and petrolntax respectively. Inflation was taken from Eurostat, the figures were percentage increases from year to year and these were taken to be recalculated as percent changes from 2005 as inflcomp so when dividing nominal prices by inflcomp it will give real prices for the rest of the time. Population was taken on an annual basis by Eurostat as was rail length (raillength) and unemployment (unemp). Ppp is a measure of purchasing power parity given by Eurostat; it's a way to analyze relative price levels across countries. APT is the price of petrol with tax divided by inflcomp and ppp to make the prices both real and comparative across countries. APT_1, APT_2, APT_3, APT_4 and APT_5 are lagged variables of APT, meaning that APT_1 in 2010 is the APT of 2009. Rpasskm is in million rail passenger kilometers which is the number of passengers in a given country in a given year multiplied by the average length of a trip. Mrpkmn, mAPL, rpkmr are all derivatives of this, mrpkmn is rpasskm divided by the population level of the country in that year, rpkmr is rpasskm divided by the length of the rails in the country in kilometers, mAPL is both of these, rail passenger kilometers divided by both population and rail length. When rpasskm is divided by something to get any of these figures multiplication by 1,000,000 is used to get back to normalized levels.

Empirical Strategy

The dependent variable in these regressions is a measure of how far population travels in a year, in the main regression mrpkmn is used, and rpkmr, mAPL and rpasskm are also used. APT and its lagged versions are used as dependent variables in these regressions, the lagged variables being used for a finite distributed lag model. Since petrol is known to be a price inelastic good in the short run it is worthwhile to see how consumers react to not only in current year prices but how they respond to trends as well. APT, is adjusted for inflation as well as purchasing power parity between countries so that prices between countries are accounted for. The unemployment rate is also included in these regressions to account for various economic wellbeing of each nation’s economy. Country and year dummies are of course included as well because this is a panel data set.

It is expected that the sign for APT is positive given the argument presented in the economic reasoning section of the paper, but without a guess as to the magnitude, because it is unknown prior towards doing these regressions how close these two are as substitutes. The sign for APT's lagged versions are expected to be positive if any of them end up being statistically significant. The sign for unemployment is expected to be negative, the reason being that unemployed individuals are thought to travel less often as they don't have the obligation to travel as much. One only needs to look at figure 6 below to see that there is variation between countries and between years to see that this variable should not be counted for entirely through country and year dummies in the regressions. Lastly unemployment and petrol prices are interlinked between petrol prices are tied to domestic shipping which large segments of the economy rely on, so should this variable be left out it would be a cause for omitted variable bias, which needs to be avoided.

Regressions are conducted just using APT and a form of an output variable and then recalculated using various lag structures. All regressions are done as level regressions.

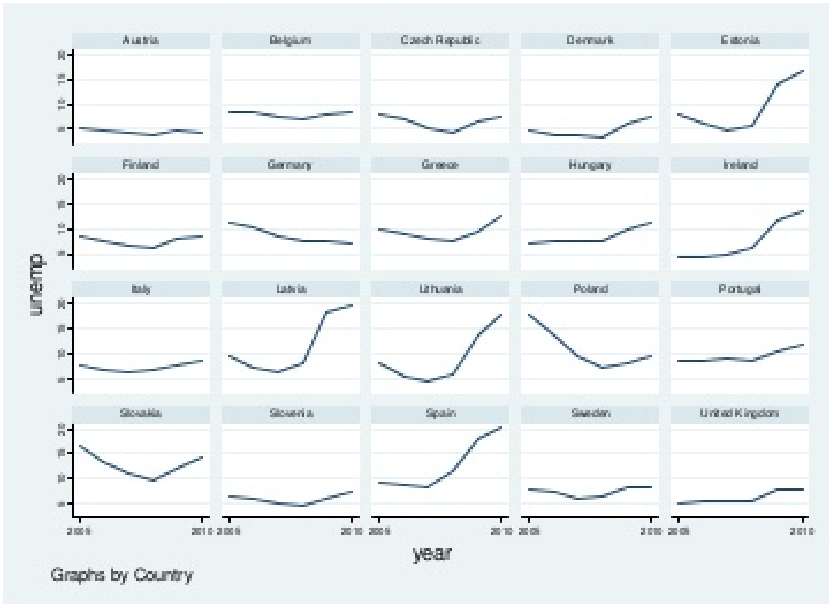


Figure 6

Regressions

Country and year dummies dropped from regression results.

Regression 1

```
. reg  mrpkmn  APT unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =     120
-------------+------------------------------           F( 26,    93) =  294.87
       Model |  12223366.2    26  470129.469           Prob > F      =  0.0000
    Residual |  148276.017    93  1594.36578           R-squared     =  0.9880
-------------+------------------------------           Adj R-squared =  0.9847
       Total |  12371642.2   119   103963.38           Root MSE      =   39.93

------------------------------------------------------------------------------
      mrpkmn |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   138.1142   48.13063     2.87   0.005     42.53628    233.6921
       unemp |  -5.353921   1.710258    -3.13   0.002    -8.750155   -1.957687
```

```
       _cons |   274.1241   83.33722     3.29   0.001     108.6329    439.6153
```

Regression 2

```
. reg  mrpkmn  APT APT_1 unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =     100
-------------+------------------------------           F( 27,    72) =  226.59
       Model |  9562827.63    27  354178.801           Prob > F      =  0.0000
    Residual |  112542.056    72  1563.08411           R-squared     =  0.9884
-------------+------------------------------           Adj R-squared =  0.9840
       Total |  9675369.69    99  97731.0069           Root MSE      =  39.536


------------------------------------------------------------------------------
      mrpkmn |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   208.9886   66.50416     3.14   0.002     76.41498    341.5622
       APT_1 |   19.27941   22.25833     0.87   0.389    -25.09175    63.65058
       unemp |  -5.642374   1.854853    -3.04   0.003    -9.339956   -1.944792
       _cons |    344.875    83.3466     4.14   0.000     178.7266    511.0234
------------------------------------------------------------------------------
```

Regression 3

```
. reg  mrpkmn  APT APT_1 APT_2 unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =      80
-------------+------------------------------           F( 28,    51) =  183.23
       Model |  8243321.19    28  294404.328           Prob > F      =  0.0000
    Residual |  81944.4345    51  1606.75362           R-squared     =  0.9902
-------------+------------------------------           Adj R-squared =  0.9848
       Total |  8325265.62    79  105383.109           Root MSE      =  40.084


------------------------------------------------------------------------------
      mrpkmn |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |    245.849   82.04888     3.00   0.004     81.12901     410.569
```

```
       APT_1 |   19.13558   49.74009     0.38   0.702    -80.72182     118.993
       APT_2 |  -6.467045   46.58281    -0.14   0.890    -99.98594    87.05185
       unemp |  -6.581167   2.063573    -3.19   0.002    -10.72396   -2.438371

       _cons |   922.7025   87.36597    10.56   0.000      747.308    1098.097
```

Regression 4

```
. reg  mrpkmn  APT APT_1 APT_2 APT_3 unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =      60
-------------+------------------------------           F( 29,    30) =  115.85
       Model |  5532040.64    29  190760.022           Prob > F      =  0.0000
    Residual |  49397.3777    30  1646.57926           R-squared     =  0.9911
-------------+------------------------------           Adj R-squared =  0.9826
       Total |  5581438.02    59  94600.6444           Root MSE      =  40.578


------------------------------------------------------------------------------
      mrpkmn |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   398.1022   106.4697     3.74   0.001     180.6621    615.5423
       APT_1 |  -32.55317   59.64709    -0.55   0.589    -154.3688    89.26244
       APT_2 |   3.737246   77.86233     0.05   0.962    -155.2788    162.7533
       APT_3 |   31.23579   69.83381     0.45   0.658    -111.3839    173.8555
       unemp |  -6.784877   2.762938    -2.46   0.020    -12.42755   -1.142204
       _cons |   768.2571   122.3567     6.28   0.000     518.3713    1018.143
------------------------------------------------------------------------------
```

Regression 5

```
. reg  rpasskm  APT  unemp ctrdum* yrdum*


      Source |       SS       df       MS              Number of obs =     120
-------------+------------------------------           F( 26,    93) = 1345.55
       Model |  4.9954e+10    26  1.9213e+09           Prob > F      =  0.0000
    Residual |   132794969    93   1427902.9           R-squared     =  0.9973
-------------+------------------------------           Adj R-squared =  0.9966
```

```
       Total |  5.0087e+10   119   420900162           Root MSE      =  1194.9

------------------------------------------------------------------------------
     rpasskm |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   2380.383   1440.379     1.65   0.102    -479.9247    5240.691
       unemp |  -50.64273   51.18198    -0.99   0.325      -152.28    50.99454

       _cons |  -529.3079   2493.988    -0.21   0.832    -5481.874    4423.258
------------------------------------------------------------------------------
```

Regression 6

```
. reg  rpasskm  APT  APT_1 unemp ctrdum* yrdum*
      Source |       SS       df       MS              Number of obs =     100
-------------+------------------------------           F( 27,    72) = 1090.59
       Model |  4.8030e+10    27  1.7789e+09           Prob > F      =  0.0000
    Residual |   117440933    72  1631124.07           R-squared     =  0.9976
-------------+------------------------------           Adj R-squared =  0.9966
       Total |  4.8148e+10    99   486338584           Root MSE      =  1277.2

------------------------------------------------------------------------------
     rpasskm |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   4884.805   2148.331     2.27   0.026     602.1861    9167.425
       APT_1 |    711.791   719.0264     0.99   0.326     -721.562    2145.144
       unemp |  -65.89886   59.91862    -1.10   0.275    -185.3445    53.54673
       _cons |   17524.56   2692.404     6.51   0.000     12157.35    22891.77
------------------------------------------------------------------------------
```

Regression 7

```
. reg  rpasskm  APT  APT_1 APT_2 APT_3 APT_4 unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =      40
-------------+------------------------------           F( 28,    11) =  828.56
       Model |  1.7113e+10    28   611191854           Prob > F      =  0.0000
    Residual |  8114252.32    11  737659.302           R-squared     =  0.9995
```

```
-------------+------------------------------           Adj R-squared =  0.9983
       Total |  1.7121e+10    39   439012465           Root MSE      =  858.87

------------------------------------------------------------------------------
     rpasskm |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   8289.367   3229.065     2.57   0.026     1182.243    15396.49
       APT_1 |  -121.3112   2155.085    -0.06   0.956    -4864.621    4621.999
       APT_2 |   3176.044   2143.135     1.48   0.166    -1540.964    7893.052
       APT_3 |   914.1605   4447.048     0.21   0.841    -8873.727    10702.05
       APT_4 |  -1301.854   3343.413    -0.39   0.704    -8660.656    6056.948
       unemp |  -76.12521   111.5013    -0.68   0.509    -321.5379    169.2874
       _cons |  -4062.716   4358.613    -0.93   0.371    -13655.96    5530.525
```

Regression 8

```
. reg  mAPL  APT  unemp ctrdum* yrdum*
      Source |       SS       df       MS              Number of obs =     120
-------------+------------------------------           F( 26,    93) =  462.27
       Model |  1.00563894    26  .038678421           Prob > F      =  0.0000
    Residual |  .007781403    93  .000083671           R-squared     =  0.9923
-------------+------------------------------           Adj R-squared =  0.9902
       Total |  1.01342035   119  .008516137           Root MSE      =  .00915

------------------------------------------------------------------------------
        mAPL |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   .0053717   .0110259     0.49   0.627    -.0165236     .027267
       unemp |  -.0013716   .0003918    -3.50   0.001    -.0021496   -.0005935
       _cons |   .1254294   .0190912     6.57   0.000     .0875181    .1633407
```

Regression 9

```
. reg  mAPL  APT APT_1 APT_2  APT_3 unemp ctrdum* yrdum*
      Source |       SS       df       MS              Number of obs =      60
-------------+------------------------------           F( 29,    30) =  221.58
       Model |  .486994341    29  .016792908           Prob > F      =  0.0000
    Residual |  .002273635    30  .000075788           R-squared     =  0.9954
```

```
-------------+------------------------------           Adj R-squared =  0.9909
       Total |  .489267976    59  .008292678           Root MSE      =  .00871
------------------------------------------------------------------------------
        mAPL |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   .0449786    .022842     1.97   0.058     -.001671    .0916282
       APT_1 |  -.0181701   .0127967    -1.42   0.166    -.0443044    .0079643
       APT_2 |  -.0002572   .0167046    -0.02   0.988    -.0343726    .0338581
       APT_3 |   .0100576   .0149822     0.67   0.507      -.02054    .0406553
       unemp |  -.0016247   .0005928    -2.74   0.010    -.0028353   -.0004141
       _cons |   .3206536   .0262504    12.22   0.000     .2670431    .3742641
```

Regression 10

```
. reg  rpkmr  APT  unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =     120
-------------+------------------------------           F( 26,    93) =  371.70
       Model |  88.3487431    26  3.39802858           Prob > F      =  0.0000
    Residual |  .850183419    93  .009141757           R-squared     =  0.9905
-------------+------------------------------           Adj R-squared =  0.9878
       Total |  89.1989265   119  .749570811           Root MSE      =  .09561

------------------------------------------------------------------------------
       rpkmr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   .1289363   .1152504     1.12   0.266    -.0999281    .3578007
       unemp |  -.0068321   .0040953    -1.67   0.099    -.0149645    .0013003

       _cons |   .5313918   .1995537     2.66   0.009     .1351176    .9276659
------------------------------------------------------------------------------
```

Regression 11

```
. reg  rpkmr  APT APT_1 APT_2 unemp ctrdum* yrdum*

      Source |       SS       df       MS              Number of obs =      80
-------------+------------------------------           F( 28,    51) =  262.71
       Model |  59.9953482    28  2.14269101           Prob > F      =  0.0000
```

```
    Residual |  .415966629    51  .008156208           R-squared     =  0.9931
-------------+------------------------------           Adj R-squared =  0.9893
       Total |  60.4113148    79  .764700188           Root MSE      =  .09031

------------------------------------------------------------------------------
       rpkmr |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         APT |   .3715035   .1848597     2.01   0.050     .0003822    .7426248
       APT_1 |  -.0460953   .1120666    -0.41   0.683    -.2710783    .1788878
       APT_2 |   .0955585   .1049531     0.91   0.367    -.1151436    .3062606
       unemp |  -.0101767   .0046493    -2.19   0.033    -.0195106   -.0008428

       _cons |   1.617731   .1968393     8.22   0.000      1.22256    2.012903
------------------------------------------------------------------------------
```

Discussion

From the regressions it seems pretty clear that unemployment is negatively correlated with railway usage and petrol prices are positively correlated. The lagged petrol prices weren't statistically significant but they often increased the t statistic of the APT variable enough to be significant at the 5% level once enough lagged terms were included in the regressions, with the exception of regression 9, but even in that regression it had been fairly close at about the 6% level. This leads to the conclusion that while the previous year's petrol prices might not be important the change between the previous year and this year would be as at first there wasn't a control for that but there was in the secondary regressions and thus seem to be suffering from omitted variable bias in the regressions without lagged terms. In regression 7 we also see that we lose statistical certainty when adding in a 4th lagged term. Given the potential confusion caused by unemployment being reported as a percentage to begin with, when it is said that unemployment increased by 1 percent, it is implied that the level would increase, that is to say for example the US unemployment rate is 7.7 for November 2012[13] a one percent increase in this sense would be an increase to 8.7 percent unemployment, not 7.777 percent. The difference is crucial to understanding the results of the regression.

Looking at finite distributed lagged models we see that in regression 4 that the beta value for APT is 398.1022 and the beta value for unemployment is -6.784877. Since the output for this regression is mrpkmn which is passenger kilometers per capita it means that all things equal a 10 cent increase in adjusted petrol prices results in a 39.81 passenger kilometer per capita increase in ridership and if unemployment were to go up a percent then there would be 6.78 passenger kilometer per capita decrease in ridership in the respective countries. Both variables are statistically significant. This is practically significant given that the average for this variable is 618.5037 or an increase of about 6.4% or decrease of 1.1% respectively.

In regression 7 the beta value for APT is 8289.367 and for unemployment is -76.12521 although unemployment is statistically insignificant. This means that for an increase of 10 cents in this year's adjusted gas prices will result in an increase of 828.367 million in rail passenger kilometers, which is practically significant given that the mean is 14121.81million, the increase being about 5.8% of the mean. Regressions 8 and 9 returned insignificant results for APT but in regression 9 we see that the beta for unemployment is -.0016247. Given mAPL's average is .129405 and is a measure of average kilometers traveled per capita we see that on average if unemployment increases by 1 percent by level then ridership will go down by about 1.255 percent as well. Which falls in line with similar results from up above and makes sense with our prediction people who are unemployed, as well as any dependents they might have, would have less reason to use the rail system than before holding all else equal.

[13] US bureau of labor statistics http://data.bls.gov/timeseries/LNS14000000

Lastly in regression 11 we see that the beta values for APT and unemployment are .3715035 and -.0101767 respectively and are both statistically significant at the 5 percent level. Given that rpkmr is a measure of passengers times the ratio of average rail length divided by the total system and has a mean of 1.257934 then these represent a 2.95% increase in rail use if the APT increases by 10 cents and a .81% decrease in rail use if unemployment increases by 1 percent. These similarly fall in line with results from above.

The results seem to indicate that that an increase of 10 cents in real petrol prices with tax, all things else held equal, will have about a 5% increase in ridership and an increase in unemployment will respond will likely a near kind decrease in ridership, all things else held equal.

Conclusion

Petrol taxes are enacted in Europe mainly to pay for infrastructure, fix externalities from pollution and/or raise revenue. The rate of these taxes varies from country to country and has changed over time depending on government decisions. Economic theory leads to us to believe that should rates go up that individuals will seek substitutes, one of them being public transportation through rail and that they will travel more on rail as their budget constraint moves in. Regressions in this paper and economic analysis show that raised prices on petrol, all else held constant, will have a modest increase in ridership levels across the countries analyzed and that increases in unemployment, all else held constant will have a slight decrease in ridership. This points to the conclusion that if a government's goal is to increase rail ridership that raising taxes on petrol would be an effective method in the short run.

Further research ideas

With an increased data set in terms of years it seems likely that the true impact of trends could be measured through a longer finite distributed lag model. A true passenger count would also be beneficial to use to determine whether the impact on ridership is stronger on trip length or on the number of individual riders. While Eurostat didn't report numbers in a shorter time period than annual if one could obtain ridership levels on a quarterly basis, or even weekly and used finite distributed lags it would yield a great estimate on decisions regarding transport given restricted information used by individuals. Lastly a measure of average cost of the tickets would have also been useful.

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