

# Price and Income Elasticity of Demand for Broadband Subscriptions: A Cross-Sectional Model of OECD Countries

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In this brief paper we explore the relationship between price, wealth and broadband adoption to determine the importance of price as a driver of demand.

## 1 Introduction

Internet access via broadband access networks is now widely adopted throughout the 30 member countries of the Organisation for Economic Co-operation and Development (OECD). On average, there are 18.8 broadband subscribers per 100 inhabitants. However, this average varies from a high of 34.3 % in Denmark to just 4.6 % in Mexico, as shown in Figure 1.



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We also find that there are substantial variations in the price of broadband access. According to the OECD's Broadband Portal (<http://www.oecd.org/sti/ict/broadband>), in October 2007 the highest average subscription price per month is found in the Czech Republic (\$ 88.91) and the lowest in Finland (\$ 31.18). There is also a substantial variation in the level of income measured as GDP<sup>1)</sup> per capita: \$ 77,841 in Luxembourg down to \$ 8,571 in Turkey.

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## 2 The Data

All the data used in our model of price and income elasticity are sourced from the OECD and are briefly described overleaf. The capitalised text in parentheses refers to the label given to the variable in our model.

## 3 Model Specification

We were only able to obtain data for a single point in time. We have therefore created a cross section model as at October 2007.

We have found that the best models are based on logged values of *PEN*, *PRICE* and *GDPPC*. *YSL* and *YSL*<sup>2</sup> have not been converted to log values as they need to be kept in level values. The model therefore takes the functional form:

$$\log(PEN) = \alpha + \beta \log(PRICE) + \chi \log(GDPPC) + \delta YSL + \phi YSL^2 + \epsilon$$

A useful characteristic of log models is that the value of the coefficient on  $\log(PRICE)$  and  $\log(GDPPC)$  can be interpreted as the elasticity.

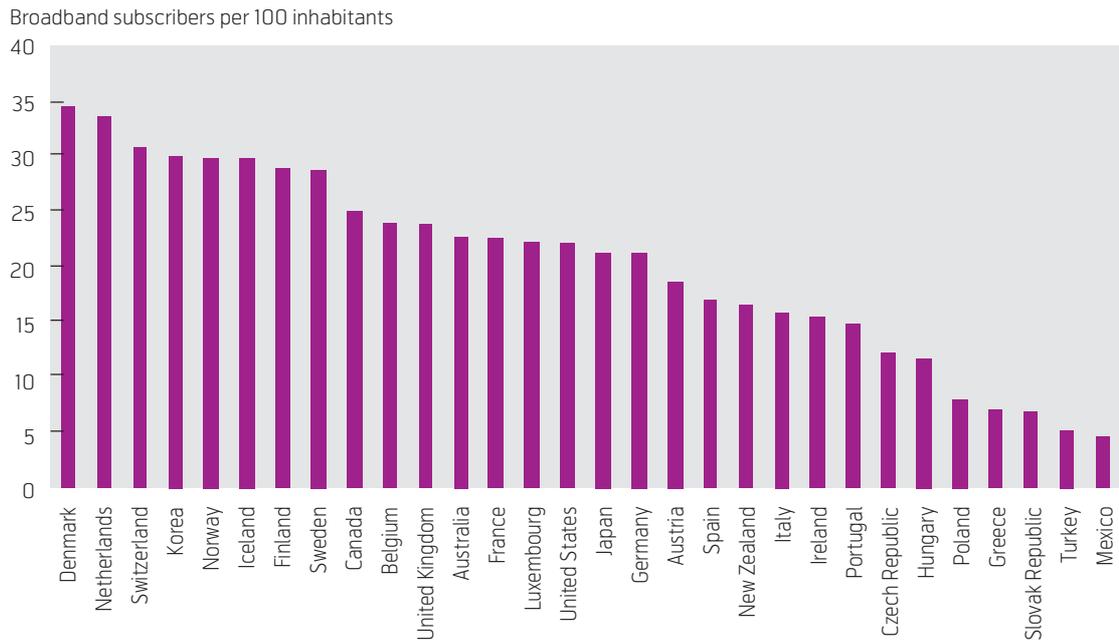


Figure 1 Broadband Subscriber per 100 inhabitants (Source: OECD Broadband Portal)

1) Gross Domestic Product.

Subscribers: (PEN)	Broadband subscribers per 100 inhabitants, which is the generally accepted measure of adoption for electronic communications services.	October 2007
Price: (PRICE)	Average price, in Purchasing Power Parity dollars (PPP\$) for monthly subscriptions. We would expect to find a negative relationship between price and adoption: ie. where prices are lower we expect a higher penetration rate.	October 2007
GDP per Capita (GDPPC)	This is a measure of personal income to account for the variation in wealth across the OECD. We expect to find a positive relationship between GDP per Capita and adoption: richer per capita countries will have a larger proportion of their populations subscribing to broadband.	2006
Years since Launch (YSL, YSL <sup>2</sup> )	This measures the number of years since the launch of commercial DSL. We accept that this is an imperfect measure of the period since the launch of broadband, as in some countries cable was launched first. However, it is the best measure available of how long broadband has been available. It is likely that where broadband has been available longer, there will be more subscribers. Our model also includes the variable Years since Launch Squared (YSL <sup>2</sup> ). By including the square of the number of years since launch, the model captures the non-linear growth of broadband. We expect to see a diminishing rate of growth, the longer broadband has been available.	October 2007

## 4 Results

The results of the model, based on 28 observations, are presented in the table below. The Slovak Republic was excluded due to lack of YSL data as was Spain due to lack of comparable PRICE data: only a simple average price was available whereas for all other countries a weighted average price has been used.

Algebraically the results are presented below:

$$\log(PEN) = -7.05 - 0.43 \log(PRICE) + 0.78 \log(GDPPC) + 0.80YSL - 0.04YSL^2$$

The column labelled t-Statistic measures the statistical significance of results for each variable. In all cases the results are significant at 1 %, except PRICE which is significant at 3 %. Given that the normal measure used is significance at 5 % our model gives very strong results.

The cell 'Adjusted R<sup>2</sup>' is a measure of how well the model 'fits' the data, in other words, how good are the predictive qualities of the model. This measure is on a scale of 0 to 1. So an Adjusted R<sup>2</sup> of 0.82 suggests a very good fit: 82 % of the variation in demand across the OECD at October 2007 can be explained by the model.

## 5 Interpretation of Results

Cross section elasticity models provide estimates of long run elasticities and these tend to be higher than short run elasticities. In a cross section model consumers are assumed to have already responded to changes in prices and to be at their long term equilibrium.

The elasticity estimated in a cross sectional model is the steady state or equilibrium elasticity. But circumstances may change during the period of adjustment to a new equilibrium after a price change. In a model constructed using time series data we would expect demand to change in relation to a price change, *other things being equal* (ceteris paribus). In a cross sectional model, this ceteris paribus assumption may be violated. In the context of cross sectional models for residential access demand in the US and Canada, Prof. Lester Taylor<sup>2)</sup>, says he would not expect the "drop off" from the network to be as large as the model elasticities imply if customers were faced with a large price increase because of the long adjustment period required (which can't be estimated in a cross sectional model) and changing circumstances.

The above comments notwithstanding, our model suggests that:

Dependent Variable: log(PEN) Method: Least Squares				
	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha$	-7.058982	1.784562	-3.955583	0.0006
log(PRICE)	-0.433873	0.186351	-2.328255	0.0291
log(GDPPC)	0.779007	0.108699	7.166654	0.0000
YSL	0.795029	0.194857	4.080053	0.0005
YSLSQ	-0.041176	0.012167	-3.384264	0.0026
R-squared	0.849429	Mean dependent var		2.911734
Adjusted R-squared	0.823242	S.D. dependent var		0.550601
S.E. of regression	0.231487			
F-statistic	32.43787	Prob(F-statistic)		0.000000

- a) The long-run price elasticity of demand is in the inelastic range. The coefficient of -0.43 indicates that a 1 % decrease in price would lead to a 0.43 % increase in demand over the long run. Demand does not appear to be strongly influenced by price. However, this elasticity is towards the top end of the typical price elasticity of demand for telephone line rental and local and long distance calling found in developed countries<sup>3)</sup>.
- b) The long run income elasticity of demand, measured by GDPPC is somewhat stronger. A 1 % increase in wealth would lead to 0.78 % increase in demand, again over the long run. This is also in line with other studies on income elasticity of demand which suggest that higher income countries would have a coefficient of less than one.<sup>4)</sup>
- c) The coefficients on YSL and YSL<sup>2</sup> indicate that growth in demand for broadband is non-linear and in the strong growth phase. As expected, the coefficient on YSL<sup>2</sup> is negative.

## 6 Further Work

The model presented here is a first and early examination of the price and income elasticity of demand for broadband. To develop more robust models we need to develop a longer time series of prices in each country together with other data, such as the price of substitutes, which might explain changes in demand for broadband. Given that there are likely to be network effects affecting demand for broadband, the number of subscribers in the previous period and number of websites may also be factors affecting demand.

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<sup>2)</sup> Taylor, Lester D, *Telecommunications Demand in Theory and Practice*, 1993, page 126.

<sup>3)</sup> See, for example Wheatley, J, *Price Elasticities for Telecommunications Services with Reference to Developing Countries*, <http://www.lse.ac.uk/collections/media@lse/pdf/Wheatley%20paper%2003.02.2006.PDF>.

<sup>4)</sup> Milne, Claire, *Improving affordability of telecommunications: cross-fertilisation between the developed and the developing world. Telecommunications Policy Research Conference 2006, George Mason University, Virginia.*

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