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Unlocking the Power of Prices: Why Demand Elasticities Matter and How to Properly Estimate Them

A Guide for Firms, Lawyers, Regulators, and Policymakers

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Why Demand Elasticities Matter

"Why Are C.E.O.s Suddenly Obsessed With 'Elasticity'?" asked a recent New York Times article,[1] highlighting the renewed interest of decisionmakers in the price elasticity of demand. But it is not just CEOs that should be interested in elasticities: regulators, litigators, and judges also rely on demand elasticities to inform high stakes decisions with far-reaching impacts.

The demand elasticity is crucial to firms' pricing decisions, litigation, and the efficacy of key policy tools such as taxes and subsidies. As inflationary pressures mount, businesses are compelled to reassess their pricing approaches to safeguard their margins. Legal experts require an understanding of firm market power to assess the extent of anticompetitive behaviour and potential damages to claimants. Meanwhile, policymakers grapple with the challenge of shielding households from the cost of living crisis while steering our economies towards decarbonisation through measures like carbon pricing and subsidies for electric vehicles (EVs).[2]

In economics, the price elasticity of demand is (even) more important to decision making than you might think. If you get the elasticity right, you will be fine, but if your estimate of the elasticity is off, the consequences could be severely detrimental to firm profitability, litigation outcomes, and taxpayer returns. In this article, we will help you understand what is at stake, the challenges of estimating elasticities in practice, and how to do things properly.

Taking a Textbook Concept into the Real World

The price elasticity of demand is an age-old economic concept that measures how sensitive buyers are to price changes. There are two important concepts:

- Own price elasticity of demand: Measures the effect of a 1% change in price on the percentage change in quantity demanded (e.g., an elasticity of -1 could indicate that a 1% increase in price of a Tesla is associated with a 1% reduction in quantity of Teslas bought).
- Cross-price elasticity of demand: Measures the effect of a 1% change in price of another related product on the percentage change in quantity demanded (e.g., an elasticity of 0.2 could indicate that a 1% increase in price of a Nissan Leaf is associated with a 0.2% increase in quantity of Teslas bought).

While it is easy to draw a theoretical demand curve and associated elasticities in a classroom, the problem is that, in practice, the elasticity of demand is often unknown, even to the most successful business leaders, litigators, experienced policymakers, and renowned academics. Take Elon Musk as an example. During Tesla's 2023 Investor Day, Elon Musk openly admitted that "one of the things we weren't sure about is the price elasticity of demand for Tesla, so as we lower the price how much does demand increase."[3]

Without this crucial information, making informed pricing decisions for businesses and policymakers is like crossing the ocean with a compass but no map: you know the likely direction, but you have no idea exactly where you will end up. In other words, executives, lawyers, and policymakers simply do not know the actual impact of some of our major pricing decisions.

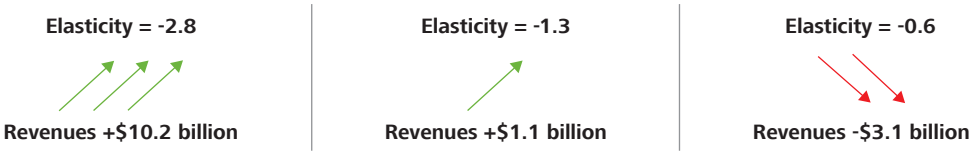
Pricing, Litigation, and Policy Issues: The Elasticity of Demand Is Everywhere

Pricing decisions have major implications for sales volumes, profit margins, and behavioural responses. Changing prices without having prior knowledge of the likely impact of that price change could lead to billions of dollars in lost margins, major problems in court, or billions of dollars in wasted tax revenues. Below, we discuss a few cases in which the price elasticity of demand plays a crucial role to inform high stakes firm, legal, and policy decisions.

Firm Product Pricing

Continuing our brief focus on Tesla, take, for example, its recent price reductions.[4] A rough analysis indicates that the revenue effect of reducing prices on all Tesla models by 10% is highly dependent on the price elasticity of demand and that small changes in the elasticity can make a big difference (see Figure 1). Suppose Elon Musk was under the impression the elasticity Tesla faces equals -1.3. This might have induced him to go ahead and lower Tesla's prices. After all, with this or an even more elastic demand, a price reduction would lead to revenue gains. With an elasticity of -2.8, these revenue gains could be as high as $10 billion. However, if the true elasticity actually equals -0.6, then the price reduction would lead to decreasing instead of increasing revenues.

Figure 1. **Impact of Tesla's Price Reduction Depends Heavily on the Price Elasticity**



Notes: Based on total automotive revenues in 2022 of $67.0 billion and a total number of Teslas sold of 1.37 million, the average price of a Tesla is around $49,000. A 10% price reduction on all Tesla vehicles sold in 2022 would therefore reduce average prices to $44,000. In the case of an elasticity of -1.3, this results in a quantity increase of 13% (elasticity times price change in percentages), which leads to a new vehicle output of 1.55 million and a new revenue of $68.1 billion. This calculation is analogous for the other two cases.

Source: NERA analysis of Statista (2023), Number of Tesla vehicles produced worldwide in 2022.[5]

This points to a more general principle, namely that the more elastic demand is, the more likely a price reduction is to achieve its purpose of increasing sales. When demand is inelastic (between 0 and -1), price discounts are ineffective at boosting sales. However, a low elasticity is more favourable for companies when prices rise (e.g., due to inflationary pressures) because margins can be increased without losing too many customers.

Several other factors are also important but are left aside here, for instance the extent to which Tesla's competitors change prices at the same time and how far the prices of Tesla's competitors affect Tesla's own demand, as well as the ultimate effect on a firm's profit margin. We return to these issues later in the paper.

Legal Disputes

Elasticities are also essential to resolve legal disputes related to anticompetitive behaviour. For example, in antitrust cases, the elasticity of demand is a crucial input for "pass-on" calculations. While in the past the economics of a cartel case would have been mostly concerned with the extent to which a claimant was subject to a price increase due to anticompetitive behaviour (an overcharge), recent years have seen increased relevance of the pass-on argument.

Pass-on refers to the claimant passing on an alleged overcharge (due to anticompetitive behaviour) to the downstream market by raising its own prices. Whether pass-on did in fact help the claimant recoup some of its losses from the overcharge depends on its ability to pass on prices, which is heavily influenced by the price elasticity of demand.

Suppose that, after reviewing the evidence before it, a tribunal concludes that the claimant faces a high elasticity in its downstream market. The tribunal might deduce that passing-on an overcharge would not have been very beneficial for the claimant, as the claimant would see a big drop in sales after increasing its own prices. However, if the elasticity is relatively low, then the claimant would have benefitted from passing on the overcharge because it can easily increase prices without losing lots of sales. By wrongly assuming the elasticity is high, the tribunal would have underestimated the claimants' benefits from passing on the overcharge.

In merger cases, the price elasticity of demand also plays a crucial role in defining the relevant market (through the so called SSNIP test) and in merger pricing models which are important in assessing whether the merger will result in a substantial lessening of competition. The cross-price elasticity is also used in these cases to determine how closely substitutable products are and hence how much of an impact on competition a merger is likely to have.

Policy Decisions

The effectiveness of taxes and subsidies also depends on the price elasticity of demand. As a rule of thumb, the more elastic the demand, the more effective a price signal will be to increase or decrease demand.

Take subsidies on electric vehicles (EVs) as an example. Many industrialised countries including the UK, the US, and Germany have subsidised the sale and production of EVs with a view to stimulating demand and reducing carbon emissions of the vehicle fleet. It is uncontroversial that subsidies boost demand for EVs by lowering their relative price compared to other conventional vehicles. However, if demand is inelastic, the subsidy will only induce a small additional increase in EV purchases. Therefore, in order to determine the efficacy of the subsidy, policymakers need to know by how much the demand for EVs goes up when prices fall and compare this to the overall cost of the subsidy.

Take for example, a study for the UK Department for Transport, which found that the Plug in Car Grant (PICG) was roughly estimated to have increased EV demand by 10%–30%, depending on the assumed price elasticity of demand (ranging between -1.0 and -3.7).[6] This subsequently reduced emissions by £0.04–£0.12 billion in monetary terms. Comparing these emissions benefits to the cost of the programme (£1.36 billion between 2011 and 2021) indicates that for the PICG to have a net gain to society in monetary terms, either:

- The elasticity of demand would have had to be significantly larger;
- The societal cost of carbon would have had to be significantly larger; or
- The wider benefits of the subsidy (such as to the growth uptake of EVs in the future or network effects from the subsidy) would have to be large.

In such a case, other policy tools may have been better suited to reduce emissions, such as subsidising EV infrastructure, imposing higher taxes on gasoline, or investing in other means of reducing emission such as wind farms and cycling infrastructure. However, without knowledge of the own price and cross-price elasticity of demand in the car market, there is no way to know which approach works best.

The Literature-Based Approach: A Useful (but Imprecise) Starting Point

The quickest and easiest way to obtain a value for the demand elasticity for a product or market of interest is to obtain elasticities based on a literature review. This is also the first place you would turn, as it is a useful starting point to figure it out what others have found and what methods have been used. However, there are several challenges for implementing a literature-based approach to identify the specific elasticity for your case as studies may:

- Only be available for historical time periods or for different countries, products, or firms;
- Apply unreliable methods (e.g., they may not estimate the specific type of elasticity you require or account for 'simultaneity' between demand and supply (see below)); or
- Not exist for a specific topic.

In these instances, there may be ways to attempt to adjust existing elasticities to be more representative, however this is often arbitrary and imprecise. For example, consider two recent estimates of elasticities for EVs from the literature:

- A 2021 article published in the *European Transport Research Review* found an own price elasticity of demand for battery EVs in Norway in 2016 to be -1.0,[7] whereas
- A 2021 study published in the *Journal of Environmental Economics and Management* estimated the same elasticity in the US in 2014 to be -2.8.[8]

So why are these two elasticities for the same product so different? The most obvious difference is that they are from different countries. However, a less obvious but crucial difference is that the studies apply different data and methods, and therefore one is closer to a market elasticity that considers the impact on demand in the market as a whole in response to a change in price charged by firms across the market (the Norwegian study) whereas the other is closer to a firm elasticity that considers the impact on a firm's demand in response to a change in that firm's price (the US study).

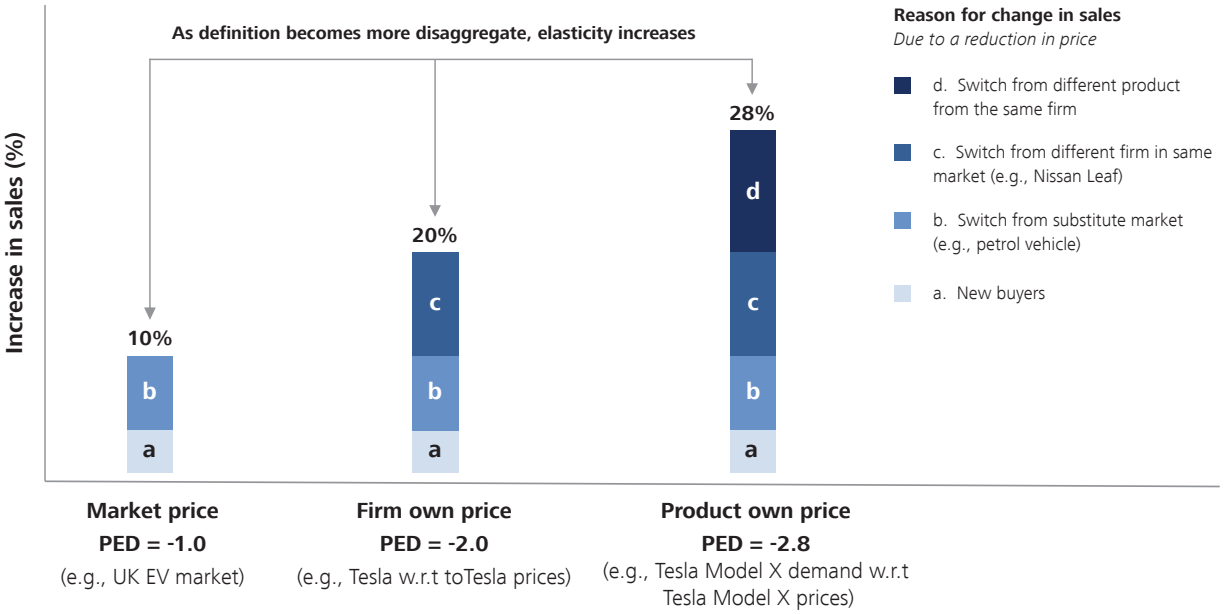
This makes a huge difference. In Figure 2, we show that as the elasticity definition becomes more disaggregated, consumers have more options to switch to other firms and products, and therefore the price elasticity of demand becomes a lot larger. This matters because:

- The magnitude of the demand response to a change in price is significantly different at the market, firm, and product level; and
- The relevant elasticity that should be used to infer demand responsiveness depends on the type of analysis that is being carried out.

For example, to estimate the effect of a change in price of a Tesla Model X on demand for the Model X requires the product own price elasticity, whereas to estimate the effect of a market-wide EV subsidy requires the market price elasticity.

So how can the differences between the two studies above be reconciled? One option would be to choose the elasticity that is most relevant in the specific circumstance. However, when the stakes are high, it is worth thinking through how to estimate elasticities more precisely.

Figure 2. **Market Price Elasticity Is Lower than Firm and Product Price Elasticity Due to Degree of Substitutability**



Notes: Increase in sales based on reduction in price of 10%. PED represents own price elasticity of demand. Elasticities are illustrative. W.r.t. is short for "with respect to".

Source: NERA analysis.

The Direct-Estimation Approach: More Precise but Requires Diligent Analysis

Another approach to quantifying elasticities more precisely is via direct estimation using market, firm, or product level data. Estimating elasticities directly is generally preferred because it ensures that elasticities are directly relevant to the case at hand in terms of geography, time period, and type of method and therefore more accurate.

However, there are several challenges that need to be overcome in order to robustly estimate the relevant elasticity. This includes gathering suitable data, processing the data, and most importantly, performing the analysis correctly. These days, we have access to reams of data, so in this article, we focus on the challenge of estimating demand elasticities correctly.

There are three main challenges to correctly estimating demand elasticities:

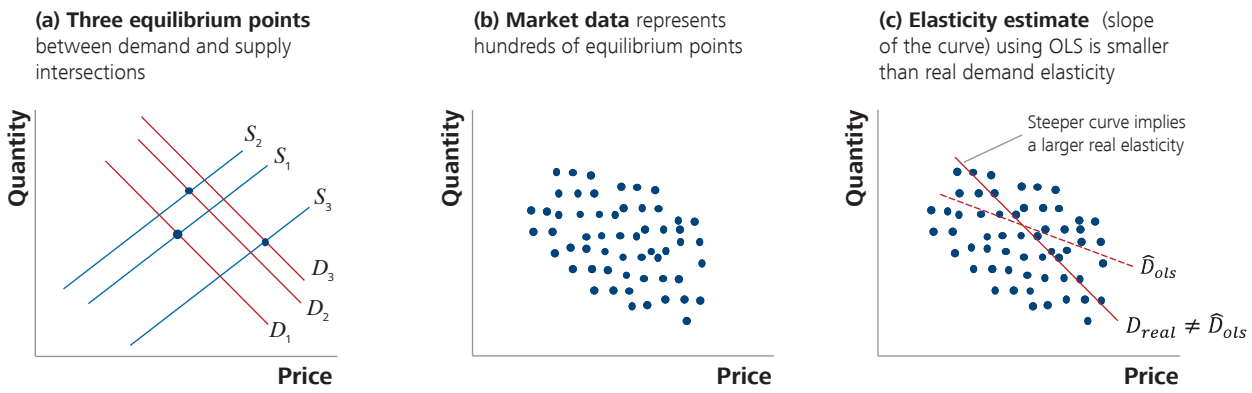
1. The first challenge is how to estimate the right elasticity (market, firm, or product level). This ultimately boils down to using the right type of price change. In order to estimate the market elasticity, one needs to use price changes that affect all competitors similarly; meanwhile, to identify the firm or product elasticity, one needs to use price changes that are specific to that firm or product.

2. The second challenge is whether and how to account for competitor prices. This can be important when estimating a firm's own price elasticity. Normally we do this by analysing how demand responds to a change in price while assuming that other firms hold their prices constant. However, when a firm raises (or lowers) prices, competitors often follow suit, which can depress the effects of the price adjustment and thereby the magnitude of the estimated demand elasticity. In the real world, it can be difficult

to anticipate exactly how competitors will respond, therefore it may be useful to allow changes in competitor prices to be captured in the demand elasticity, in which case the firm's own price elasticity will capture how competitors have best responded to price changes in the past. This is particularly useful when doing a historical assessment of the elasticity (e.g., for damages assessment in litigation) or if it is reasonable to assume that competitors will behave in a similar manner as in the past. Meanwhile, when estimating a market price elasticity, the assumption is that all prices increase by the same amount, so accounting for competitor prices is not necessary.

3. The third challenge is how to account for 'simultaneity' between demand and supply. Simultaneity bias sounds like an obscure technical point, but it is an important and often overlooked feature of all markets because price and quantity are determined by the interaction of demand and supply. Figure 3 illustrates this issue. As shown in panel (a), each observation of quantity and price actually represents a unique intersection of a demand curve and a supply curve. The data therefore rarely provide a clear downward sloping demand curve as most textbooks would suggest but rather a cloud of these intersections of demand and supply, as indicated in panel (b). Conventional approaches to analysing the demand curve (like simple OLS regressions) often miss this and estimate an elasticity that will be less negative (indicating less elastic demand) than the actual elasticity (see panel (c) below). This is because the demand curve is estimated based on changes in supply *as well as* demand.

Figure 3. **Simultaneity Between Demand and Supply Means that Demand Elasticities Will Be Underestimated Using Conventional Approaches Such As OLS**



Notes: OLS stands for Ordinary Least Squares and is the conventional regression approach for estimating the linear relationship between two variables (quantity and price in this setting).

Source: NERA analysis.

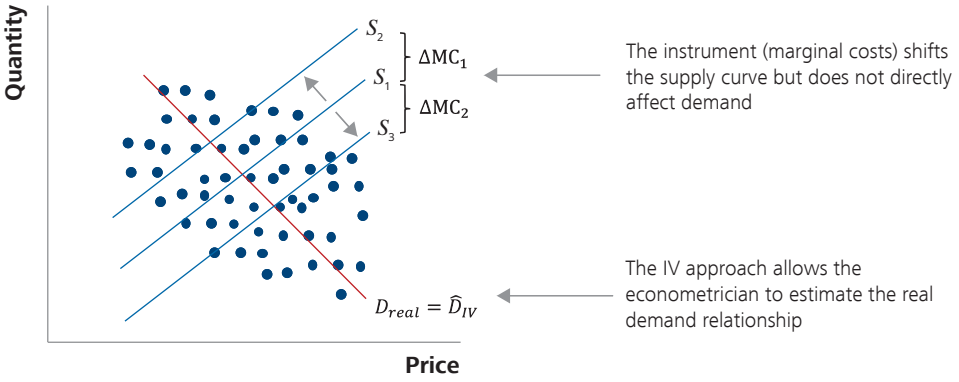
Applying the Right Approach Yields the Correct Estimate

Fortunately, economists have devised several methods to properly estimate demand elasticities, which involve a family of statistical analysis designed to tackle economic questions called econometrics. The leading approach for doing so is instrumental variables (IV). This approach uses changes in prices, most commonly input (marginal) costs in production, that shift the supply curve but are not directly related to the demand curve.

This allows the economist to solve the challenges previously described. By isolating price changes due to shifts in supply, this enables one to remove simultaneity bias and trace out

the real demand curve, as shown in Figure 4. These supply shifters can also be used to estimate different price elasticities, depending on whether they are relevant to all market participants or only to the firm or product in question. Finally, by including or excluding competitor prices in the analysis, one can either estimate an own price elasticity, holding competitor prices fixed, or estimate an elasticity that incorporates historical changes in competitor prices.

Figure 4. **An IV Approach Uses Shifts in the Supply Curve to Identify the Real (Correct) Demand Elasticity**



Source: NERA analysis.

The Bottom Line: Why It Is Important to Estimate Demand Elasticities Properly

Analysing demand elasticities properly is challenging, so why bother?

The answer is because it can make the difference between success and failure in pricing decisions, swing the outcome of court cases and regulatory proceedings, and underpin sound government policy. As we show in the case of EVs, product and firm elasticities can be more than two or three times larger than market elasticities. The decision on whether to assume that competitors hold their prices constant when a firm changes its own price can make a similarly vast difference to the analysis, particularly in today's world in which people and businesses are under commercial pressure and seem to be increasingly focused on price. And accounting for simultaneity bias has been shown to increase demand elasticities by about 50% (although in our experience, this can often be a lot larger).[9] This shows that when the stakes are high, it is worth thinking through how to estimate elasticities properly. The prize of getting it right can be huge, as can the costs of getting it wrong!

Our experts at NERA Economic Consulting are highly skilled economists with substantial experience in demand analysis. We have worked closely with firms and governments across the globe to estimate demand elasticities accurately across a variety of settings. For more information on how to quantify demand elasticities that are relevant for your situation, please get in touch.

Notes

[1] Jason Karaian and Veronica Majerol, "Why Are C.E.O.s Suddenly Obsessed With 'Elasticity'?," *New York Times*, 19 August 2022, available at https://www.nytimes.com/2022/08/19/business/elasticity-prices-inflation.html.

[2] "Cost of living," *BBC News*, 20 September 2023, available at https://www.bbc.co.uk/news/topics/cljev4jz3pjt.

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[4] Mrinmay Dey, Shubham Kalia, and Kevin Krolicki, "Tesla cuts U.S. Model S and Model X prices between 4% and 9%," *Reuters*, 6 March 2023, available at https://www.reuters.com/business/autos-transportation/tesla-cuts-prices-model-y-model-x-variants-us-website-2023-03-06/.

[5] "Number of Tesla vehicles produced worldwide from 1st quarter 2016 to 2nd quarter 2023," Statista, 28 August 2023, available at https://www.statista.com/statistics/715421/tesla-quarterly-vehicle-production/.

[6] "OZEV – Portfolio-Level Retrospective Evaluation," Frontier Economics, 6 May 2023, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1082401/ozev-portfolio-level-retrospective-evaluation.pdf.

[7] L. Fridstrøm and V. Østli, "Direct and cross price elasticities of demand for gasoline, diesel, hybrid and battery electric cars: the case of Norway," *European Transport Research Review*, 13(3), 2021.

[8] J. Xing, B. Leard, and S. Li, "What does an electric vehicle replace?," *Journal of Environmental Economics and Management*, 2021, p. 107.

[9] T. H. A. Bijmolt, H. J. Van Heerde, and R. G. M. Pieters, "New Empirical Generalizations on the Determinants of Price Elasticity," *Journal of Marketing Research*, 42(2), 2005, pp. 141–156.

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