

# The Law of Demand and Lost Profits Analysis

Chapter Seven

*A Primer on Economic Damages in Intellectual Property Matters*

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## **ABSTRACT**

In many lost profit cases, the Panduit factors are invoked. A proper analysis requires the practitioner to adhere to the well known economic principles embodied in the law of demand. While “the law of demand” is easy enough to understand, some of the exceptions and dynamics, as well as the conceptual disputes, are not as generally well understood. It is important to have a strong grounding in basic concepts of demand and supply in order to fully appreciate how they impinge on proper analysis of lost profit measurements. In patent infringement litigation, some of the fundamental economic principles are often seemingly assumed away or ignored altogether. Part and parcel of understanding the demand for a product is the need to understand the market in which the product is sold and what transpires after an alleged infringement. Generally the two concepts go together; practitioners that tend to neglect the law of demand are usually not analyzing the market dynamics in which the products are sold, either. We first discuss this basic principle of economic theory, present a primer on supply and demand and then present several examples of why the law of demand *and* its market dynamics are important and the danger that arises when they are ignored.

### I. Introduction

In a patent infringement case it is well known that if the court finds for a plaintiff, one potential remedy is to award the plaintiff compensation for profits lost by the plaintiff, “but for” the infringement of the patent. It is also generally accepted that the appropriate way to calculate lost profits is to uncover the revenues of the alleged infringer and to then determine the percentage of those potential sales that would have been made by the patent holder “but for” the infringement, and to then apply the incremental costs of the plaintiff to those sales to determine lost profits. As always, the devil is in the details. When determining what sales would have been made “but for” the infringement, it is crucial to understand fundamental economic principles of supply and demand and especially to understand the empirical ramifications of the “law of demand.” This so-called “law” simply states that as price declines in a market, all else equal, people will purchase more of the commodity. The law generally holds, but not always. Just how much more people will buy when price declines (or how much less for a price increase) depends on all the dynamics of the market at issue in any particular matter. This chapter carefully discusses these market dynamics at a very elementary level and presents case studies to illustrate how economic principles should be taken into account when conducting lost profit analyses. The papers by Gerardi and Thomas, Sullivan and David and Stewart in this book discuss the concept of lost profits in more detail. In order to calculate these “but for profits,” a seminal case came down in 1978; the infamous *Panduit Corp. v. Stablin Bros.* (“*Panduit*”).<sup>1</sup> Just as certain cases have had important ramifications for the application of economics to antitrust law, the *Panduit* case was an important legal decision in applying economic principles to the determination of lost profits. In that decision, the court laid out the following four-pronged test for the patent owner’s entitlement to lost profits damages:

To obtain as damages the profits on sales she would have made absent the infringement, i.e., the sales made by the infringer, a patent owner must prove: (1) demand for the patented product, (2) absence of acceptable noninfringing substitutes, (3) her manufacturing and marketing capability to exploit the demand, and (4) the amount of the profit she would have made.

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<sup>1</sup> *Panduit Corp. v. Stablin Bros. Fibre Works, Inc.*, 575 F.2d 1152, 1164, 197 USPQ 726, 736, (6th Cir.:1978).

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The present chapter will focus on the first and second *Panduit* factors with specific reference to price. That is, some expert witnesses have calculated lost profits using the general methodology outlined above, but some have essentially ignored price differentials between potential acceptable noninfringing products and applied patent holder marginal profit rates to all sales by the infringer. As noted above, such a calculation ignores fundamental economic principles and assumptions underlying the so-called “law of demand.” This chapter will discuss that concept fully and give examples of how the concept has been used and can be misused. Fortunately, the courts are aware of the problems that arise in ignoring some aspects of these economic principles and market dynamics and one case in particular, *BIC Leisure Products, Inc. v. Windsurfing International, Inc.*, (850 F. Supp. 224; *BIC Leisure Products, Inc. v. Windsurfing International Inc.*, 1 F.3d) has made it clear that ignoring some of these economic principles and market dynamics is not acceptable. The court said in the *BIC* matter that an alternative product (here a sail board used for windsurfing) is not acceptable (as a noninfringing alternative) if the two products in question have different price ranges or are sold to different classes of consumers. Thus, a product has to be not only noninfringing from a technical perspective, but also acceptable from an economic and consumer perspective. The discussion to follow in this chapter will clarify these concepts further.

## II. The Law of Demand and its Evolution <sup>2</sup>

Price in a market for a product is determined by dynamic interactions between demand and supply. Attempts to examine how supply and demand interact began with Adam Smith’s *The Wealth of Nations*, first published in 1776. In this book, Smith generally assumed that the supply price was fixed, but demand would increase or decrease as the price decreased or increased. David Ricardo published the book *Principles of Political Economy and Taxation*, in 1817 in which the first idea of an economic model was proposed. He laid down the idea of the assumptions that were used to build his supply and demand concepts.

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<sup>2</sup> Much of this chapter is derived from Wikipedia, the free encyclopedia. While much of the form of Wikipedia is followed, most of these concepts are so well known among economists that no specific attribution is required. Indeed, in the Wikipedia discussion, none is given for most of these elementary economic principles.

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During the late 19th century the marginalist school of thought emerged, led mainly by Jevons, Menger, and Leon Walras. The key idea was that the price was set at the highest point, i.e. the price at the margin. This was a substantial change from Adam Smith's thoughts on determining the supply price.

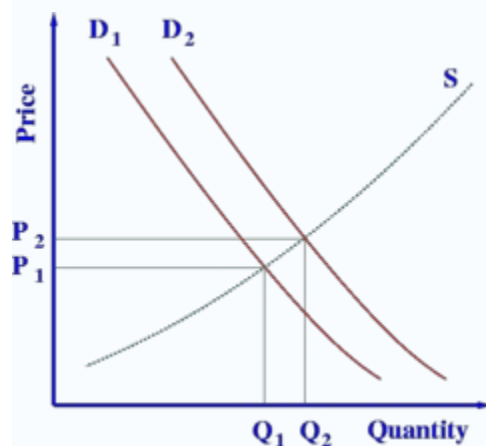
Most of the basics of the modern school theory of supply and demand were formalized by Alfred Marshall and Leon Walras when they combined the ideas about supply and the ideas about demand and began looking at the equilibrium point where the two curves crossed. They also began looking at the effect of markets on each other. The theory of supply and demand has been largely unchanged since the late 19th century. Most of the additional work has been in examining the exceptions to the model (like oligarchy, transaction costs, non-rationality).

Marshall's theory of supply and demand runs counter to the ideas of economists from Adam Smith and David Ricardo through the marginalist school of thought. Although Marshall's theories are dominant in elite universities today, not everyone has taken the fork in the road that he and the marginalists proposed. One theory counter to Marshall is that price is already known for a commodity before it reaches the market, negating his idea that some abstract market is conveying price information. The only thing the market communicates is whether or not an object is exchangeable or not (in which case it would change from an object to a commodity). This would mean that the producer creates the goods without already having customers - blindly producing, hoping that someone will buy them (*buy* meaning exchange money for the commodities).

Keynesian economics also runs somewhat counter to the theory of supply and demand. In Keynesian theory, prices can become "sticky" or resistant to change, especially in the case of price decreases (for labor for instance). This leads to a market failure. Modern supporters of Keynes, such as Paul Krugman, have noted this in recent history, such as when the Boston housing market dried up in the early 1990's, with neither buyers nor sellers willing to exchange at the price equilibrium.

## IIA.SUPPLY AND DEMAND MODELS

The **supply and demand** model describes how prices vary as a result of a balance between product availability at each price (supply) and the desires of those with purchasing power at each price (demand). The graph below depicts an increase in demand from  $D_1$  to  $D_2$  along with the consequent increase in price and quantity required to reach a new market-clearing equilibrium point on the supply curve (S). The introduction of a new (perhaps allegedly infringing) technology, a new advertising campaign, the lowering of switching costs (again, perhaps due to infringement) or the reverse engineering of products already on the market could all cause such a movement. Any of these events could trigger a change in demand for the product depicted in the graph.



Similarly, shifts in supply, as may occur coincidentally or after an infringing product is introduced, can move prices and quantities that need to be evaluated.

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The *partial equilibrium supply and demand* model originally developed by Marshall attempts to describe, explain, and predict changes in the price and quantity of products in competitive markets. The model is only a first approximation for describing an *imperfectly competitive market*, as often characterizes markets with few players and innovators. But Marshall's work formalizes the theories of some economists before him, and is one of the most fundamental models of modern economic schools, widely used as a basic building block in more detailed models and theories. The theory of demand and supply is important for understanding of a market economy since it provides an explanation of the mechanism by which many resource allocation decisions are made. However, unlike general equilibrium models, supply schedules in this partial equilibrium model are fixed by unexplained forces. One of those "unexplained forces" could be the infringement of someone else's intellectual property.

### Assumptions and definitions

When employing these basic economic models for forensic purposes, it is critical to appreciate the import of these assumptions since these underlying concepts may lead to very different outcomes from case to case. For instance, the theory of supply and demand usually assumes that markets are perfectly competitive. This implies that there are many buyers and sellers in the market and none of them have the capacity to influence the price of the good. In many real life transactions, the assumption fails because some individual buyers or sellers or groups of buyers or sellers do have enough ability to influence prices. The first mover in a market (the owner of the intellectual property), may significantly impact price in that market. Quite often more sophisticated analysis is required than is common in order to understand the demand-supply equation of a product, especially one that is undergoing rapid technical development. However, the theory works well in simple situations.

Economic theory cannot assume a priori that markets are preferable to other forms of social organization. In fact, much analysis has been and is devoted to cases where “market failures” lead to allocation that is suboptimal by some standard. In such cases, economists may attempt to find policies that will avoid waste; directly by government control, indirectly by regulation that induces market participants to act in a manner consistent with optimal welfare, or by creating 'missing' markets to enable efficient trading where none had previously existed. This is studied in the field of collective action.

### Demand

A demand schedule is constructed to show the quantity demanded at any given price. It can be represented on a graph as a line or curve by plotting the quantity demanded at each price. It can also be described mathematically by a demand equation. The main determinants of the quantity someone is willing to purchase will be the price of the product, the person’s level of income, personal tastes

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and characteristics, the price of “substitute” products, and the price and availability of complementary products.

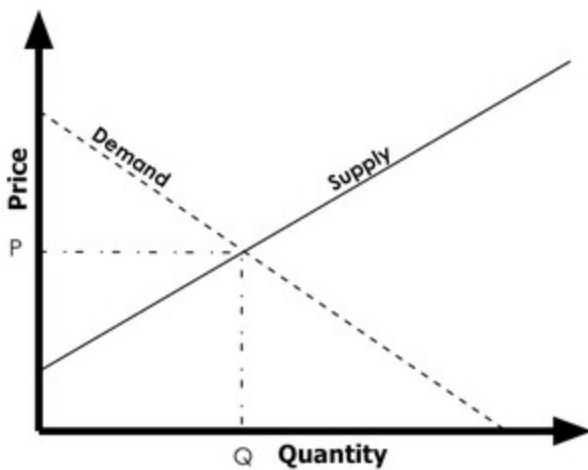
### Supply

**Supply** is the quantity that producers are willing to sell at a given price. The main determinants of supply will be the market price of the product and the *cost of producing it*. In fact, supply curves are constructed from the firm's long-run cost schedule. New product introductions, technological advances, more efficient production processes, and other economic factors may all be patented and can of course impact the location and shape of a supply curve.

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## Simple supply and demand curves

Economic theory conceives a series of supply and demand relationships, and then adjusts for factors which produce "stickiness" between supply and demand. Analysis is then done to see what "trade offs" are made in the "market" as interactions between sellers and buyers. Analysis takes note of the point at which the ability of sellers to sell becomes less beneficial than other opportunities. This is related to "marginal" costs - or the price to produce the last unit that can be sold profitably, versus the chance of using the same effort to engage in some other activity.



Graph of simple supply and demand curves

The slope of the demand curve (downward-to-the-right) indicates that a greater quantity will be demanded when the price is lower. On the other hand, the slope of the supply curve (upward-to-

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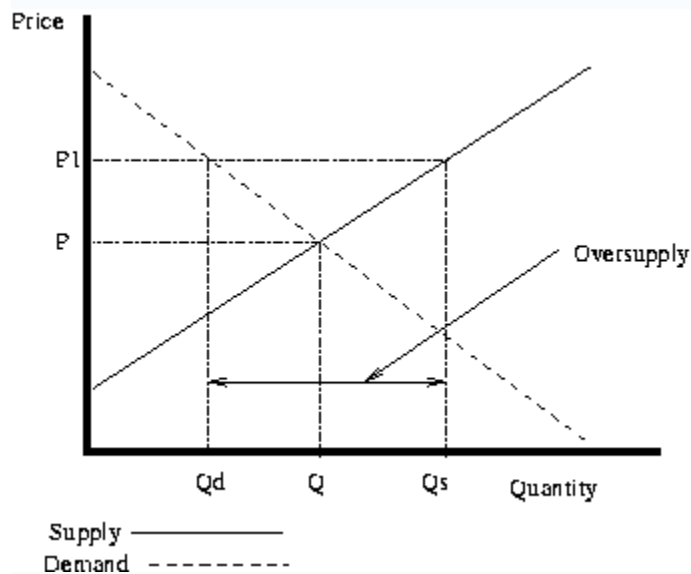
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the-right) tells us that as the price goes up, producers are willing to produce more goods. The point where these curves intersect is the equilibrium point. The idea of a hypothetical negotiation where a willing seller and willing buyer arrive at a royalty rate (which is just a price, after all) is one example of this. At a price of  $P$  producers will be willing to supply  $Q$  units per period of time and buyers will demand the same quantity.  $P$  in this example, is the equilibrating price that equates supply with demand.

In the figures, straight lines are drawn instead of the more general curves. This is typical in analysis looking at the simplified relationships between supply and demand because the shape of the curve does not change the general relationships and lessons of the supply and demand theory. The shape of the curves far away from the equilibrium point are less likely to be important because they do not affect the market clearing price and will not affect it unless large shifts in the supply or demand occur. So straight lines for supply and demand with the proper slope will convey most of the information the model can offer. Determining the exact shape of the curve is the domain of econometrics/statistics. The general shape of the curve, especially its slope near the equilibrium point, has an impact on how a market will adjust to changes in demand or supply. This issue is analysed with the concept of elasticity. The precise shape over a range and a period of alleged infringement is of central interest in intellectual property litigation.

It should be noted that both supply and demand curves are drawn as a function of price. The two functions interact in a manner that is representative of market outcomes. In practice any currency or commodity used to measure price is also the subject of supply and demand.

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**Effects of being away from the equilibrium point**


Consider how prices and quantities not at the equilibrium point tend to move towards the equilibrium. Assume that some organization (say government or industry cartel) has the ability to set prices. If the price is set too high, such as at  $P_1$  in the diagram to the right, then the quantity produced will be  $Q_s$ . The quantity demanded will be  $Q_d$ . Since the quantity demanded is less than the quantity supplied there will be an oversupply (also called surplus or excess supply). On the other hand, if the price is set too low, then too little will be produced to meet demand at that price. This will cause an undersupply problem (also called a shortage).

Now assume that individual firms have the ability to alter the quantities supplied and the price they are willing to accept, and consumers have the ability to alter the quantities that they demand and the amount they are willing to pay. Businesses and consumers will respond by adjusting their price (and quantity) levels and this will eventually restore the quantity and the price to the equilibrium. When a damages expert is attempting to quantify how (say) a “but for” world would look, (that is without an infringer in a given market), these price and quantity adjustments can be very important.

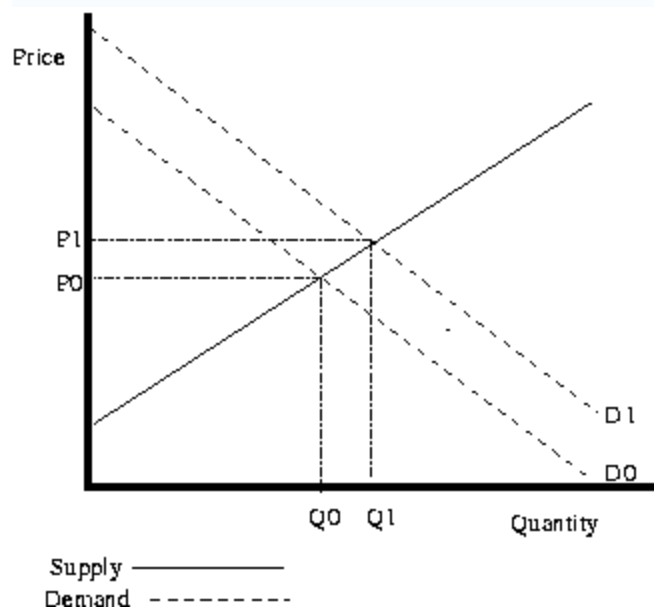
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In the case of too high a price and oversupply, (seen in the diagram at the left) the profit maximizing businesses will soon have too much excess inventory, so they will lower prices (from  $P_1$  to  $P$ ) to reduce this. Again, contemplate a situation where an infringing product is legally bound to exit a market, this would affect the market equilibrium as currently being discussed. Quantity supplied will be reduced from  $Q_s$  to  $Q$  and the oversupply will be eliminated. In the case of too low a price and undersupply, consumers will likely compete to obtain the good at the low price, but since more consumers would like to buy the good at the price that is too low, the profit maximizing firm would raise the price to the highest they can, which is the equilibrium point. In each case, the actions of independent market participants cause the quantity and price to move towards the equilibrium point.

Demand curve shifts



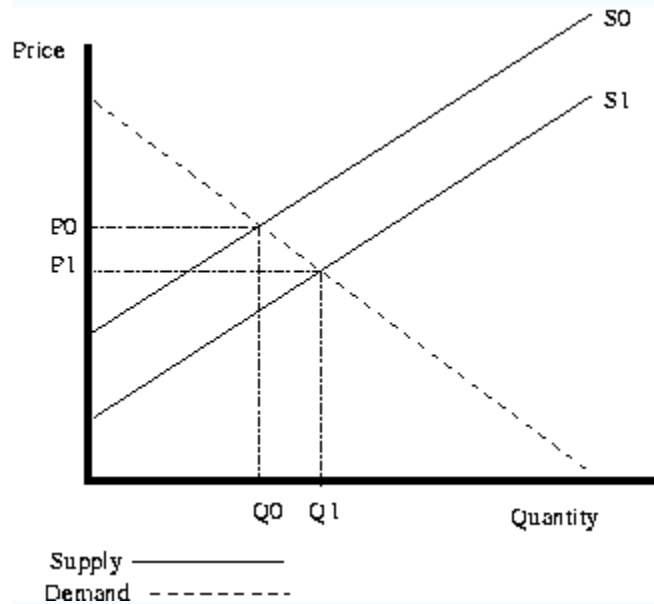
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When more people want something, the quantity demanded at all prices will tend to increase. This can be referred to as an *increase in demand*. The increase in demand could also come from changing tastes due to advertising or new product introductions, where the same consumers desire more of the same good than they previously did. Increased demand can be represented on the graph as the curve being shifted right, because at each price point, a greater quantity is demanded. An example of this would be more people suddenly wanting more coffee. This will cause the demand curve to shift from the initial curve D0 to the new curve D1. This raises the equilibrium price from P0 to the higher P1. This raises the equilibrium quantity from Q0 to the higher Q1. In this situation, we say that there has been an *increase* in demand which has caused an *extension* in supply.

Conversely, if the demand decreases, the opposite happens. If the demand starts at D1, and then *decreases* to D0, the price will decrease and the quantity supplied will decrease - a *contraction* in supply. Notice that this is purely an effect of demand changing. The quantity supplied at each price is the same as before the demand shift (at both Q0 and Q1). The reason that the equilibrium quantity and price are different is the demand is different.

## Supply curve shifts



When the suppliers' costs change the supply curve will shift. For example, assume that someone invents and patents a better process of growing wheat so that the amount of wheat that can be grown for a given cost will increase. Producers will be willing to supply more wheat at every price and this shifts the supply curve  $S_0$  to the right, to  $S_1$  - an *increase in supply*. This causes the equilibrium price to decrease from  $P_0$  to  $P_1$ . The equilibrium quantity increases from  $Q_0$  to  $Q_1$  as the quantity demanded increases at the new lower prices. Notice that in the case of a supply curve shift, the price and the quantity move in opposite directions.

Conversely, if the quantity supplied *decreases*, the opposite happens. If the supply curve starts at  $S_1$ , and then shifts to  $S_0$ , the equilibrium price will increase and the quantity will decrease. Notice that this is purely an effect of supply changing. The quantity demanded at each price is the same as

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before the supply shift (at both  $Q_0$  and  $Q_1$ ). The reason that the equilibrium quantity and price are different is the *supply* is different.

Another way to view this is that the supply curve moves up and down as opposed to left and right (respectively). If the ability to produce increases as compared to a steady price, the supply shifts up (as opposed to left). If the ability to produce decreases, the supply curve shifts down (as opposed to right). The validation or invalidation of a patent (from either a court or the patent office) could cause such a shift. This is a more intuitive approach for beginners, but it is unfortunately not commonly taught.

### Market 'clearance'

The market 'clears' at the point where all the supply and demand at a given price balance. That is, the amount of a commodity available at a given price equals the amount that buyers are willing to purchase at that price. It is assumed that there is a process that will result in the market reaching this point, but exactly what the process is in a real situation is an ongoing subject of research. Markets which do not clear will react in some way, either by a change in price, or in the amount produced, or in the amount demanded. Graphically the situation can be represented by two curves: one showing the price-quantity combinations buyers will pay for, or the demand curve; and one showing the combinations sellers will sell for, or the supply curve. The market clears where the two are in equilibrium, that is where the curves intersect. In general equilibrium models, all markets in all products and services clear simultaneously and the 'price' can be described entirely in terms of tradeoffs with other products. "Say's Law" states that markets, as a whole, would always clear and thus be in balance. This has been a cornerstone of economic thinking for a very long time.

Similarly in a patent infringement case, the damages expert must contemplate how this market clears if an infringing product is lifted from a market or if it is prevented by (say) a court from entering a market. To understand how such an act would impact the equilibrium price in the market a necessary condition is that one understands the market per se. This would seem obvious, but as the case studies below illustrate, this is not always so.

### Elasticity

An important concept in understanding supply and demand theory and in calculating lost profits is the concept of an **elasticity**. In this context, it refers to how supply and demand change in response to various stimuli. One way of defining elasticity is the percentage change in one variable divided by the percentage change in another variable (known as *arc elasticity* because it calculates the elasticity over a range of values - This can be contrasted with *point elasticity* that uses differential calculus to determine the elasticity at a specific point). Thus it is a measure of *relative* changes.

Often, it is useful to know how the quantity supplied or demanded will change when the price changes. This is known as the price elasticity of demand or supply. If producers choose to increase the price of their product, how will this affect their sales revenue? It is possible that the increased price offsets the likely decrease in sales volume? If a government imposes a tax on a product, the quantity demanded will likely decrease because the effective price has been increased. If a damages expert has to quantify how many widgets would have been sold for 3 times the price that they were actually sold for, elasticities become very important. The case studies below show this requirement of quantifying such sales and their impact on price happens with considerable frequency.

If one does not wish to calculate elasticity, it would be simpler to look at the slope of the curve. But, this has units of measurement of quantity over monetary unit (For example, liters per Euro), which is not a convenient measure to use for most purposes. For example if one wished to compare the effect of a price change of gasoline in France versus the USA, there is a conversion between gallons per dollar and liters per euro. For this reason economists often use relative changes in percentages, or elasticity. Another reason is that elasticity is more than just the slope of the function: It is the slope of a function in a coordinate space, that is, a line with a constant slope will have different elasticities at various points. As an example, if the price moves from \$1.00 to \$1.05, and the quantity supplied goes from 100 pens to 102 pens, the slope is  $2/0.05$  or 40 pens per dollar. Since the elasticity depends on the percentages, the quantity of pens increased by 2%, and the price increased

by 5%, so the elasticity is  $2/5$  or 0.4. Changing the unit of measurement or the currency will not affect the elasticity. If the quantity demanded or supplied changes a great deal when the price changes a little, it is said that demand is “elastic”. If the quantity changes little when the prices change a lot, it is said to be “inelastic”. An example of perfectly inelastic supply, or zero elasticity, is represented by a vertical supply curve.

Elasticity in relation to variables other than price can also be considered. One of the most important is income. This is known as the income elasticity of demand. For example how much would the demand for a printer increase if average income increased by 10%? If it is positive, this increase in demand would be represented on a graph by a positive shift in the demand curve, because at all price levels, a greater number of printers would be demanded.

Another elasticity that is sometimes considered is the “*cross elasticity of demand*” which measures the responsiveness of the quantity demanded of a good to a change in the price of another good. This is often considered when looking at the relative changes in demand when studying **complement** and **substitute** products. Complement goods are goods that are typically utilized together, where if one is consumed, usually the other is also. Substitute goods are those where one can be substituted for the other and if the price of one good rises, one may purchase less of it and instead purchase its substitute. These concepts are very important when determining Panduit factors 1 and 2 in a patent infringement case, for obvious reasons. We say more on this below.

Cross elasticity of demand is measured as the percentage change in demand for the first good that occurs in response to a percentage change in price of the second good. For an example with a complement good, if, in response to a 10% increase in the price of fuel, the quantity of new cars demanded decreased by 20%, the cross elasticity of demand would be  $-20\%/10\%$  or, -2.

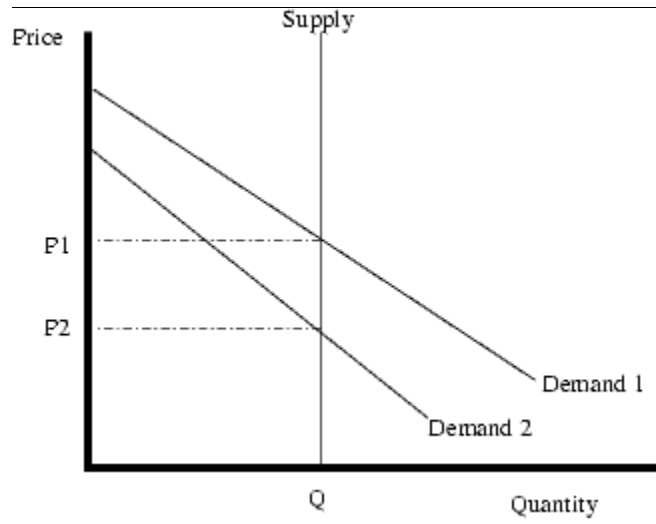
### Vertical supply curve

It is sometimes the case that the supply curve is vertical: that is the quantity supplied is fixed, no matter what the market price. For example, the amount of land in the world can be considered fixed. In this case, no matter how much someone would be willing to pay for a piece of land, the extra cannot be created. Also, even if no one wanted all the land, it still would exist. These conditions create a vertical supply curve, giving it zero elasticity (ie. - no matter how large the change in price, the quantity supplied will not change).

Over short spans of time vertical supply curves are more common. If a game is sold out, increasing the number of seats in the stadium is nearly impossible. The supply of tickets for this game is vertical. If the organizers of this event underestimated demand, then it may very well be the case that the price that they set is below the equilibrium price. In this case there will likely be people who paid the lower price who only value the ticket at that price, and people who could not get tickets, even though they would be willing to pay more. If some of the people who value the tickets less sell them to people who are willing to pay more (i.e. scalp the tickets), then the effective price will rise to the equilibrium price.

The graph below illustrates a vertical supply curve. When the demand 1 is in effect, the price will be  $p_1$ . When demand 2 is occurring, the price will be  $p_2$ . Notice that at both values the quantity is  $Q$ . Since the supply is fixed, any shifts in demand will only affect price.

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### Other market forms

When there are many buyers but a single “**monopoly**” supplier, it can adjust the supply or price of a good at will. The granting of a patent is of course one example of how monopoly arises. The monopolist will adjust the price so that his profit is maximized given the amount that is demanded at that price. This price will be higher than in a competitive market. A similar analysis using supply and demand can be applied when a good has a single buyer, a “**monopsony**”, but many sellers.

Where there are both few buyers or few sellers, the theory of supply and demand cannot be applied because both decisions of the buyers and sellers are interdependent - changes in supply can affect demand and vice versa. Game theory can be used to analyse this kind of situation. Oligopoly is a similar situation.

The supply curve does not have to be linear. However, if the supply is from a profit maximizing firm, it can be proven that supply curves are not downward sloping (i.e. if the price increases, the quantity supplied will not decrease). Supply curves from profit maximizing firms can be vertical, horizontal or upward sloping. While it is possible for industry supply curves to be downward sloping, supply curves for individual firms are never downward sloping).

Standard microeconomic assumptions cannot be used to prove that the demand curve is downward sloping. However, despite years of searching, no generally agreed upon example of a good that has an upward sloping demand curve has been found (known as a giffen good). Non-economists sometimes think that certain goods would have such a curve. People may buy a luxury car because it is expensive. In this case the good demanded is actually prestige, and not just a car. When the price of the luxury car decreases, it is actually changing the amount of prestige so the demand is not decreasing since it is a different good (see Veblen good). Even with downward sloping demand curves, it is possible that an increase in income may lead to a decrease in demand for a particular

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good, probably due to the existence of more attractive alternatives which become affordable: a good with this property is known as an inferior good.

### An example: Supply and demand in a 6-person economy

Supply and demand can be thought of in terms of individual people interacting at a market. Suppose the following six people participate in this simplified economy<sup>3</sup>:

- Alice is willing to pay \$10 for a sack of potatoes.
- Bob is willing to pay \$20 for a sack of potatoes.
- Cathy is willing to pay \$30 for a sack of potatoes.
- Dan is willing to sell a sack of potatoes for \$5.
- Emily is willing to sell a sack of potatoes for \$15.
- Fred is willing to sell a sack of potatoes for \$25.

There are many possible trades that would be mutually agreeable to both people, but not all of them will happen. For example, Cathy and Fred would be interested in trading with each other for any price between \$25 and \$30. If the price is above \$30, Cathy is not interested, since the price is too high. If the price is below \$25, Fred is not interested since the price is too low. However at the market, Cathy will discover that there are other sellers willing to sell at well below \$25, so she will not trade with Fred at all. In an efficient market, each seller will get as high a price as possible, and each buyer will get as low a price as possible.

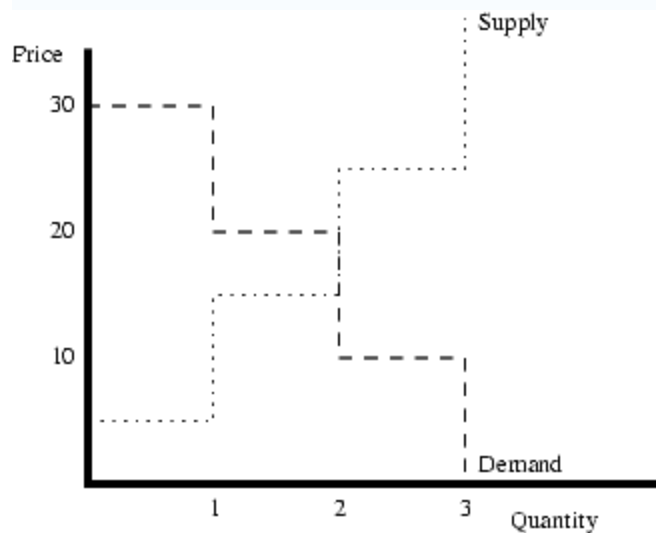
Imagine that Cathy and Fred are bartering over the price. Fred offers \$25 for a sack of potatoes. Before Cathy can agree, Emily offers a sack of potatoes for \$24. Fred is not willing to sell at \$24, so he drops out. At this point, Dan offers to sell for \$12. Emily won't sell for that amount so it looks like the deal might go through. At this point Bob steps in and offers \$14. Now we have two people willing to pay \$14 for a sack of potatoes (Cathy and Bob), but only one person (Dan) willing to sell for \$14. Cathy notices this, and doesn't want to lose a good deal, so she offers Dan \$16 for his potatoes. Now Emily also offers to sell for \$16, so there are two buyers and two sellers at that price

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<sup>3</sup> See Wikipedia discussion of Supply and Demand, for this example.

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(note that they could have settled on any price between \$15 and \$20), and the bartering can stop. But what about Fred and Alice? Well, Fred and Alice are not willing to trade with each other since Alice is only willing to pay \$10 and Fred will not sell for any amount under \$25. Alice can't outbid Cathy or Bob to purchase from Dan so Alice will not be able to get a trade with them. Fred can't underbid Dan or Emily so he will not be able to get a trade with Cathy. In other words, a stable equilibrium has been reached.



A supply and demand graph could also be drawn from this. The demand would be:

- 1 person is willing to pay \$30 (Cathy).
- 2 people are willing to pay \$20 (Cathy and Bob).
- 3 people are willing to pay \$10 (Cathy, Bob, and Alice).

The supply would be:

- 1 person is willing to sell for \$5 (Dan).
- 2 people are willing to sell for \$15 (Dan and Emily).

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- 3 people are willing to sell for \$25 (Dan, Emily, and Fred).

Supply and demand match when the quantity traded is two sacks and the price is between \$15 and \$20. Whether Dan sells to Cathy, and Emily to Bob, or the other way round, and what precisely is the price agreed cannot be determined. This is the only limitation of this simple model. When considering the full assumptions of perfect competition the price would be fully determined since there would be enough participants to determine the price. For example, if the "last trade" was between someone willing to sell at \$15.50 and someone willing to pay \$15.51, then the price could be determined to the penny. As more participants enter, the more likely there will be a close bracketing of the equilibrium price.

It is important to note that this example violates the assumption of perfect competition in that there are a limited number of market participants. However this simplification shows how the equilibrium price and quantity can be determined in an easily understood situation. The results are similar when unlimited market participants and the other assumptions of perfect competition are considered.

### Decision-making

Economics generally assumes that individuals seek to maximize their happiness or utility, but whether they **rationally** attempt to optimize their well-being given available information is a source of much debate. In this view, which underpins much of economic writing, individuals make choices between alternatives based on their estimation of which will yield the best results. Many important economic ideas, such as the "efficient market hypothesis" rest on this view of decision making.

However, this framework, once called "homo economicus" - has for decades been the focus of unease even by those who apply it. Milton Friedman once defended the idea by saying that inaccurate assumptions could produce accurate results. Marshall was careful to differentiate the tendency to maximize happiness, with maximizing economic well being. The limits of rationality have been the subject of intense study, for example Herbert Simon's model for "bounded rationality", was awarded a Nobel Prize in 1978. Irrational behavior and imperfect information have increasingly been the subject of formal modelling, in an area referred to as **behavioral economics**. Daniel Kahneman won a Nobel Prize in 2002 for his experiments and work in this area which subsumes the growing field of **behavioral finance** which combines previous theory with cognitive psychology.

The new model of information and decision making focuses on asymmetrical information, when some participants have key facts that others do not, and on decision making based, not on the economic pressures, but on the decisions of other economic actors. Asymmetrical information and behavioral dynamics lead to different conclusions: in a world of asymmetrical information, markets are generally not efficient, and inefficiencies grow up as means of hedging against information. While not yet universally accepted, it is increasingly influential in policy, for example the writing of Joseph Stiglitz and financial modelling

### III. CASE STUDIES

In this section we now present some case studies to illustrate some of the problems that arise when experts seemingly ignore standard economic principles that determine the dynamics of a particular market under scrutiny.

#### Case Study 1.

The first case study we present involves patents relating to a fitness machine. The patents at issue claimed to have the advantages of (1) low price, simple to make and easy to use, (2) enables an individual to perform many exercises; and (3) is light and easy to move. The company that makes the product, Muscle Up (a fictitious name) promotes itself as a leading maker of fitness products. Muscle Up sells the product covered by the patents in suit, the Work Hard Always Machine (WHAM), for \$2500. Get Fit (a fictitious name) is also one of the largest manufacturers and marketers of home fitness equipment worldwide. One of their products, the Brutalizer, was accused of infringing the patents at issue. The Brutalizer sells for \$350. Get Fit started selling the Brutalizer in late 2000. Get Fit sold a total of 100,000 of these machines at roughly \$350 per unit.

Any damages which accrue to the Plaintiffs in this case arise from sales of WHAM which were lost directly to sales of the Brutalizer. In order to determine the magnitude of any such sales, an analysis of the market in which these two products are sold should have been undertaken. As a threshold matter, if the relevant market for consideration is improperly defined, the analysis of damages will be speculative and unreasonable. The opposing expert (“Expert A”) calculated lost profits by assuming that most of the sales of the allegedly infringing product (85,000 units out of 100,000) would have been made by Muscle Up, but for the infringement. That is, Expert A assumed that thousands of sales of a product that sold in actuality for \$350 would have sold for \$2500, but for the infringement. This assumption is of course a textbook case of violating the law of demand. As long as there exists a downward sloping demand curve, a price increase of seven times over the infringer’s

price would result in a decline (likely to be precipitous) in the quantity of units demanded, *ceteris paribus* (everything else equal). The only way this outcome would not result would be if the demand for the machines was completely price inelastic (meaning consumers do not respond at all to a price change) and the demand curve was vertical (as was discussed above) and not negatively sloped. Expert A in this matter should have at least contemplated the construction of a statistical model to calculate the elasticity of demand (see the paper by Millimet et al. in this book) and determined the price elasticity of demand to see by how much a change in price would impact the quantity demanded of the fitness machines. The discussion in this chapter should make clear that determinants of demand and supply need to be accounted for before merely asserting that two products with potentially different price and income elasticities, that might be purchased by different classes of buyers, would have a cross elasticity of demand between them of zero. Market research would have suggested that some of the important considerations for any consumer in the market for home fitness equipment are price, quality of construction, variety of possible exercises, and ability to deliver promised results. However, the weight afforded to each of these considerations depends crucially on the type of consumer making the purchase with respect to the factors just discussed. It would have also been apparent from a careful assessment of the market dynamics for home fitness services that there are several distinct market segments within the market for home fitness equipment, each with distinct distribution methods and ranges of price elasticities. This is precisely the type of case the BIC decision was meant to address. Merely assuming away the law of demand will only result in unreasonable and speculative damages numbers.

### **Case Study 2.**

In our second case study, the patents relate to the design and functionality of the Boris Company's (fictitious name) computer printer component. In general, a utility patent is issued for the invention of a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof. It generally permits its owner to exclude others from making, using, or selling the invention for a period of up to twenty years from the date of patent application filing. Design patents protect the ornamental and cosmetic aspects of products – but not their function. The disclosure and description of the invention in a design application is entirely in the drawing and not

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in the words. The single claim in a design patent is for "the appearance of a – whatever the product is usually called – as shown in the drawing."

Once again in this matter, the expert on damages ("Expert B") for Boris assumed that all of the sales of the alleged infringer, Tank (a fictitious name) would have been made by Boris but for the infringement. Here the printer component sold by Boris (for its own printer) was \$39. A replacement component sold by Tank was \$9. Here Expert B assumed that 20,000 printer components that were sold by Tank for \$9 would have been sold by Boris for \$39, but for the infringement. The market for the printers is presumed in our hypothetical example to be fiercely competitive. In the worldwide consumer market, four manufacturers are assumed to account for the majority of printer sales: Print it Now, Best Print, Hot-Cold (H-C), and Boris. Further assume that a common business model for printer components sold by the OEM (original equipment manufacturer) involves selling the actual printer at or even below cost, while dramatically marking up the price of the (proprietary and/or patented) printer components. The most important considerations for any consumer in the market for a printer are price and print quality. However, the weight afforded to each of these considerations depends crucially on the type of user making the purchase. Different types of users can be reasonably classified based on their priorities with regard to printing needs:

- What types of output will the consumer primarily print (e.g., charts, letters, presentations, photos, kids' homework, greeting cards)?
- How much does the consumer wish to spend, both in terms of up-front costs as well as ongoing costs for replacement ink and paper?

This again suggests users will have different price and income elasticities. Let us assume that it becomes apparent from a careful assessment of the imaginary market laid out in this case study for printer components and consumables in general, and the Boris products in particular, that there are at least two distinct market segments within the market for printer components, each with different ranges of price and income elasticities. The first segment we can call the "branded or premium-choice" segment, those customers whose concern about the quality and longevity of their prints

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(particularly color photographs) dictate the choice of printer component replacements, despite the fact that these components sell at up to four times the cost of the non-branded versions. The second segment we refer to as “Thrifty” users, those who are very cost-conscious and will spare no effort in finding the cheapest method of printing. The existence of these two market segments should bear crucially on the issue of what damages might accrue to the Plaintiffs in this matter. As in the last example, Expert B did not analyze the market and even attempt to estimate what the price elasticity of demand was for the products in question. It is once again merely speculating and unreasonable to assume that the law of demand does not hold and that the demand for printer components is completely inelastic, meaning they exhibit a completely vertical demand curve. Expert B should have analyzed the market dynamic’s for the printer components carefully and formally estimated the price and income elasticity of demand for the components to see how responsive consumers truly are to changes in price.

### **Case Study 3.**

As one final example, we look at the ceiling fan market. Suppose the imaginary subject litigation involved a patent covering a ceiling fan’s ability to move air. The patent was owned by Easy Fan (a fictitious name) that makes fans and sells them in Big Tool Home Improvement stores. Big Tools main competitor, Wrenches R’ Us, sells Cool Fans, which are alleged to infringe the patent. Neither chain sells the fans that are sold by its competitor. Once, again the opposing expert (“Expert C”) for Easy Fan assumed that but for the infringement, all of the sales of Cool Fans in Wrenches R’ Us stores would have been made by Easy Fan in Big Tool stores. Once again, a demand elasticity of zero was assumed, here by Expert C. Easy fans sell for \$99 while Cool fans sell for \$29. Here again, Expert C simply ignored the law of demand. The opposing expert did not analyze the market dynamic’s here and did not discuss the fact that there are many other brands of ceiling fans on the market, as well. A well-known case, *State Industries, Inc. v. Mor-Flo Industries, Inc.*, 883 F.2d 1573, 12 USPQ 2D 1026 (CAFC 1989), discusses how to partition sales in a lost profit analysis when there are more than two players in the relevant market. In this example it is assumed that some are sold by Big Tool and some brands are sold by Wrenches R’ Us. Ceiling fans are also sold in specialty stores, in major retailers and the list goes on. The only reasonable conclusion to be drawn in evaluating Expert C’s lost profit analysis would be that it is speculative and it is devoid of any meaningful economic analysis and is not reasonable. Ignoring the law of demand dooms any calculation of economic damages in a patent infringement matter where you are attempting to quantify lost profits.

### **IV. Conclusions**

The purpose of this chapter has been to illustrate the importance of understanding elementary economic principles, in performing a “Panduit Analysis” in calculating lost profits, in a patent infringement case. This chapter discussed the concepts of supply and demand in a very simple but detailed way in order to help lawyers, accountants and decision makers grasp why these elementary concepts must be taken into account when analyzing a lost profits. Some expert witnesses ignore the “law of demand” and other economic fundamentals in performing lost profit analyses. Market dynamics will likely vary from case to case and the economic damages expert should always be cognizant of how they impact the particular market he or she is analyzing.

## V. REFERENCES

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