Quantitative Applications in Determination of Relevant Market for Competition Assessment with Special Emphasis on Econometric Techniques

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Pranav Mohindra

Place: New Delhi
Date: ............
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Abbreviations

ACF  Auto Correlation Function
ADF  Augmented Dickey Fuller
AIC  Akaike Information Criterion
BEUC Bureau of European Consumer Organizations
CCI  Competition Commission of India
CLRM Classical Linear Regression Model
DF  Dickey Fuller
DSP  Difference Stationary Process
ECM  Error Correction Model
ECU  European Currency Unit
EEA European Economic Area
EFTA European Free Trade Association
FTC  Federal Trade Commission
GLS Generalized Least Square
IFS Institute for Fiscal Studies
LIFO Little in from outside
LOFI Little out from inside
MAFF Ministry of Agriculture, Fisheries and Food
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<th>Abbreviation</th>
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<td>MMC</td>
<td>Monopolies and Mergers Commission</td>
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<td>MRTP</td>
<td>Monopolistic and Restrictive Trade Practice</td>
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<td>OFT</td>
<td>Office of Fair Trading</td>
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<td>OLS</td>
<td>Ordinary Least Square</td>
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<td>RSS</td>
<td>Residual Sum of Square</td>
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<td>RWM</td>
<td>Random Walk Model</td>
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<td>SAS</td>
<td>Statistical Analysis Software</td>
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<td>SIC</td>
<td>Schwarz Information Criterion</td>
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<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<td>SSNIP</td>
<td>Small but Significant Non – Transitory Increase in Price</td>
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<td>STATA</td>
<td>Statistical package</td>
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<td>TS</td>
<td>Trend Stationary Process</td>
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<td>VAR</td>
<td>Vector Auto Regressive</td>
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Executive Summary

The study is an attempt to uncover various techniques which are used by the competition authorities all over the world to assess competition in industries or markets. The study is divided into five sections. The first section highlights the notion of the study through the introductory part. In the second section the importance of competition along with need for the assessment of the same is depicted. The concept and relevance of the relevant market is dealt independently, as the delineation of market with respect to the product or region is the starting point for assessing the competitive behaviour of the underlying market and moreover the objective of the study is to get an insight of various techniques with which the relevant market is determined. Relevant market is the smallest set of products in a market which is to be investigated for Anti-Competitive behaviour. The delineation of the relevant market is done either on the basis of product/products in a specified region or on the basis of different regions for an underlying product; the former is used for the definition of Relevant Product Market and the latter for delineating Relevant Geographic Market.

The third section lays emphasis on the quantitative techniques available for the determination of relevant market. The SSNIP test is one of the tests with which the relevant market is delineated which is widely accepted and hence is dealt in depth. As per the SSNIP test criterion, the hypothetical monopolist of product/products must be profitable by incorporating a 5-10% non transitory increase in price of the underlying product, should the market be stated as a Relevant Product Market or Relevant Geographic Market. The quantitative techniques which directly take into account the SSNIP test criterion incorporates the application of own price elasticity and brings SSNIP test into functionality through the Critical Loss & Critical Elasticity Analysis, which are detailed in this section. The Elzinga-Hogarty test which is used for the determination of Relevant Geographic Market is also dealt in this section.
The fourth section of the study covers the Econometric techniques which are available for the delineation of the relevant market. Econometrics is a discipline which is specifically used to model the economic theories with the usage of statistics. Econometric Techniques do not satisfy the SSNIP test criterion directly but since the SSNIP test criterion is met indirectly, econometric techniques are widely used indirect techniques to determine relevant market. The study elaborates in detail four extensively used econometric techniques viz. Price Correlation analysis, Granger Causality test, Co-Integration analysis and Hedonic Price analysis, all of them analyzes the prices of the products within or across the region and the relevant market is defined on the basis of the conclusion drawn from the analysis of the prices. The concept, relevance, data requirements, interpretation and the application in actual competition cases, for each of the econometric model is illustrated separately in this section. It is evident that econometric techniques alone must not be taken by the competition authorities as the basis for settling competition claims but enough theoretical bases must be there to support the verdict. The last section summarizes and concludes the study.
1. Introduction

The concept of relevant market plays a central and often critical role in the application of competition law in various countries. It is quite evident that competition leads to the overall welfare of the society and hence it is all the more important to assess the underlying market for competition investigations. The significance of competition assessment in the market has been acknowledged by competition authorities which has prompted them to develop a framework within which thorough analysis and investigation for the underlying market could be comprehensively done. The purpose of the competition authorities is to monitor and discourage anti-competitive acts. India have also recognized the importance of competition and hence like the OFT of UK, FTC of US etc. have enacted a competition law in 2002 replacing the MRTP Act 1969. The issues that come under the scrutiny of Competition Commission of India (CCI) are Anti-competitive agreements\(^1\), Combination\(^2\) and Abuse of Dominance\(^3\); the objective of the

\(^1\) According to Competition Act 2007; Agreements which cause or are likely to cause appreciable adverse effect on competition are anti-competitive agreements. Horizontal agreements are those that are between enterprises at the same stage of the production chain. For example, agreement between two rivals is a horizontal agreement. In cases of agreements between rivals for fixing prices or for limiting production or for sharing markets, there is a presumption in the Act that such agreements cause appreciable adverse effects on competition. Cartel is a horizontal agreement between producers of goods or providers of services for price-fixing or sharing of market, and is generally regarded as the most pernicious form of anti-competitive agreement. Vertical agreements are those that are between enterprises at different stages of the production chain. For example, an agreement between the manufacturer and a distributor is a vertical agreement. The presumptive rule does not apply to vertical agreements. The question whether the vertical agreement is causing appreciable adverse effect on competition is to be determined by rule of reason, which essentially means that the positive as well as the negative impact of such agreement on competition will have to be taken into account before coming to any conclusion. The law recognizes intellectual property rights and in order to facilitate their protection, it permits reasonable restrictions imposed by their owners. Since exports do not impact markets in India, agreement between exporters, in spite of being horizontal, are exempted.

\(^2\) According to Competition Act 2007; Combinations include mergers, amalgamations and acquisition of control, shares, voting rights or assets. Combinations are classified into horizontal, vertical and conglomerate combinations. If a proposed combination causes or is likely to cause appreciable adverse effect on competition, it cannot be permitted to take effect. Horizontal combinations are those that are between rivals and are most likely to cause appreciable adverse effect on competition. Vertical combinations are those that are between enterprises that are at different stages of the production chain and are less likely to cause appreciable adverse effect on competition. Conglomerate combinations are those that are between enterprises not in the same line of
CCI is to ensure that none of these acts have appreciable adverse effect on competition or more specifically that they are not anti-competitive. The primary activity of all these investigations is the delineation of the underlying market and therefore relevant market definition is the stepping stone in the assessment of competition. Relevant market is a market where *effective competition* prevails. There are various quantitative techniques available for determination of relevant market and are generally divided into *direct and indirect* techniques; direct techniques takes into account the SSNIP test criterion directly and indirect techniques do not take into account SSNIP test criterion directly. The most widely used direct techniques for relevant market determination are; own price elasticity, cross price elasticity, critical elasticity and critical loss, residual demand analysis, whereas the indirectly used techniques include; elzinga-hogarthy test, price correlation test, hedonic price analysis, granger causality and co integration test. Econometrics techniques even though do not take into account the SSNIP criterion *directly* but do take into the SSNIP criterion *indirectly* with the help of thorough economic and statistical expertise.

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3 According to Competition Act 2007;
(1) No enterprise or group shall abuse its dominant position.
(2) There shall be an abuse of dominant position [under sub-section (1), if an enterprise or a group].—-
   (a) directly or indirectly, imposes unfair or discriminatory—
   (i) condition in purchase or sale of goods or service; or
   (ii) price in purchase or sale (including predatory price) of goods or service.
   (b) limits or restricts—
   (i) production of goods or provision of services or market therefore; or
   (ii) technical or scientific development relating to goods or services to the prejudice of consumers; or
   (c) indulges in practice or practices resulting in denial of market access [in any manner]; or
   (d) makes conclusion of contracts subject to acceptance by other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts; or
   (e) uses its dominant position in one relevant market to enter into, or protect, other relevant market.

4 Discussed later in the study.
The use of Econometrics is preferred at times, as it has provided new dimension in quantitative analysis and does overcome the applicability constraints and complexities associated with the direct measures. Price is the major variable which is considered for the analysis of relevant market and the intuition behind the econometric techniques is that there should be a relationship between the prices of products under investigation and the type of relationship should reveal the extent and depth of the relevant market.
2. Competition, its Assessment and Relevant Market

2.1 Need for Competition

Competition is when two or more firms compete in a market, either through prices or quantities. The significance of competition assessment can be realized with the number of advantages competition offers. From the analysis of various competition models of economics viz. monopoly\(^5\), oligopoly\(^6\) and perfect competition\(^7\), it is evident that perfect competition in a market has the best to offer to both consumers and competitors, and hence the objective of competition authorities is to make sure that the market is competitive. Since perfect competition ensures both the allocative efficiency\(^8\) and productive efficiency\(^9\), it serves the best for the overall welfare of the society. Generally Allocative efficiency is looked upon to identify the type of competition, since it is the core differentiating criterion for market specification. (Monopoly is allocatively

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\(^5\) Monopoly is a situation in the market where a monopolist (single seller or firm) is in a position to exercise its market power.

\(^6\) Oligopoly is a market form in which a market or industry has two or more sellers (generally not more than 10). Because there are few participants in this type of market, each oligopolist is aware of the actions of the others. The analysis of the behavior of the firms is very important since these types of markets are most likely to have cartels.

\(^7\) A perfectly competitive market is characterized by the fact that no single firm has influence on the price of the product it sells. The market has large numbers of buyers and sellers for homogenous products at competitive price levels, with free entry and exit. The welfare of the society is maximized since perfectly competitive markets are usually productively and allocatively efficient.

\(^8\) Allocative efficiency refers to a situation in which the limited resources in the market are allocated in accordance with the wishes of consumers. An allocatively efficient market produces an "optimal mix" of commodities. A firm is allocatively efficient when its price is equal to its marginal costs (that is, \(P = MC\)) in a perfect market.

\(^9\) Productive efficiency occurs when the market is operating at its production possibility frontier (PPF). This takes place when production of one good is achieved at the lowest cost possible, given the production of the other good(s). Equivalently, it is when the highest possible output of one good is produced, given the production level of the other good(s). In long-run equilibrium for perfectly competitive markets, this is where average cost is at the lowest point on the Average Cost curve. (\(MC = AC\)).
inefficient whereas perfectly competitive market is allocatively efficient and generally both can be productively efficient).

Further, the importance of the assessment of competition can be realized with the evils attached with the imperfect markets (monopoly and oligopoly). An Imperfect or uncompetitive market ought to be harmful for the overall social welfare and justice. The absence of competition in a market may result in dominance (comparatively higher market share), price discrimination (charging different prices from different consumers), foreclosure (barriers to entry and driving existing competitors out of the market), allocative inefficiency, restriction of output, denial of market access, compulsory conditional agreements, double marginalization\(^\text{10}\) etc.

For these and many more reasons the competition in a market is highly encouraged.

### 2.2 Importance of Competition Assessment

The competition has to be assessed beforehand in order to comment on the degree of competition in an underlying market. Competition assessment is the most vital activity of competition authorities without which settlement of competition claims is impractical. Without measuring the competition in a market and their effects, it is improbable to conclude whether perfect competition or monopoly is good/bad for the overall welfare of the society. Even if there is available theoretical base and knowledge as to what type of competition is best suited for the welfare of the society, the actual estimation and measurement of the competition has to be made for real analysis for its comparison with the economic theories. It may be possible that even a theoretically perfect competitive market is not serving the best to the welfare of the society and hence the measurement of the actual competition is the basis before any conclusions could be drawn upon.

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\(^{10}\) Double marginalization is defined as the “exercise of market power at successive vertical layers in a supply chain.” It is an impetus to mark up the product’s price above marginal cost, and prices above marginal cost results in deadweight loss due to allocative inefficiency. Under double marginalization the phenomena is repeated twice at two different vertical layers and hence is a vital concern for competitive authorities, especially in the case of Vertical Mergers and Integrations.
2.3 Relevance of Relevant Market

Even though enough theoretical evidence is provided by *economic models of competition* but the real world assessment is a daunting task. It is neither feasible nor appropriate to assess competition without any methodological approach. Hence, to analyze the degree of competition in a market, the competition authorities have used the concept of relevant market as the basic step for the competition assessment.

*Relevant market is the smallest set of products in a market which is to be investigated for anti-competitive behaviour.* It is the relevant market with which the degree of competition and its depth, in the specified region/regions for the underlying product/products can be assessed. Therefore, the determination and the extent of relevant market is the premier step in assessing competition in a market or Industry.

The definition of relevant market is the first step in analyzing anti-competitive activities and agreements which starts with the identification of those products and services which are considered as an effective competitive constraint\(^{11}\) on the behaviour of the products or services being offered by the parties under investigation. In effect, the relevant market seeks to restrict the attention only to those products or services that have significant impact on the competition.

Assessing the competition in a given market or industry is a daunting task since there is no specific unique reliable technique with which the analysis could be made. The basic characteristics which are to be taken into consideration for market definition (both product and geographic markets) includes; number of competing suppliers of the

\(^{11}\) Competitive constraints are required in a market to remain at competitive levels. These constraints are pre-requisites for the definition of Relevant Market. There are three types of competitive constants viz. Demand Side Substitutability, Supply Side Substitutability and Potential competition.
underlying product/products (basis for supply side substitution\textsuperscript{12}) and their market shares and concentration, availability of substitutes (basis for demand side substitution\textsuperscript{13}), the existence of barriers to entry and potential competition\textsuperscript{14}, the nature of oligopolistic interaction\textsuperscript{15} between firms, of which the three most important competitive constraints which are significant for delineation of the relevant market are demand side substitutability, supply side substitutability and potential competition and negligence of any of these factors would deter the precise relevant market definition which would result in biased judgments and unfair verdicts in settling competition claims by competition authorities.

The delineation of the relevant market is done either on the basis of product/products in a specified region or on the basis of different regions for an underlying product; the former is used for the definition of Relevant Product Market and the latter for delineating Relevant Geographic Market.

\textsuperscript{12} Demand-side substitution takes place when consumers switch from one product to another in response to a change in the relative prices of the products. If consumers are in a position to switch to available substitute products or to begin sourcing their requirements from suppliers located in other areas, then it is unlikely that price increases will be profitable. Therefore, it is necessary to progressively include in the Relevant market the products to which consumers would most likely switch in response to a relative price rise, repeating the exercise at each stage until a collection of products is reached that is worth monopolizing. Determining both the likely extent of demand-side substitution, and the level of substitution which would imply that monopolization was not worthwhile, requires an assessment of the price-elasticity of demand. This is generally done using the SSNIP-test.

\textsuperscript{13} Sometimes consumers may be unable to react to a price increase, nevertheless, producers may be able to do so by for example, increasing their supply to satisfy the demand of these consumers. If other producers respond to an increase in the relative price of the products supplied by the single supplier by switching production facilities to producing the monopolized collection of products, the increased level of supply may render any attempted price increase unprofitable. In this case, those producers with the ability for supply-side substitution should be included in the Relevant market.

\textsuperscript{14} Potential competition constraint is likely to be there when it is expected that competitiveness would prevail should a new entrant enter a market.

\textsuperscript{15} Firms in a market generally interact or compete either by setting the quantity (Cournot Oligopolistic behavior) or by setting the price (Bertrand Oligopolistic behaviour). The interaction may result in a collusion or cartel (Cooperative) in an infinite game horizon or may result in defection (Non-Cooperative) in a finite game horizon, subject to the information and knowledge criteria. For more details see Gibbons, R: Game Theory for Applied Economists.
Relevant Product Market: A market comprising all those products and services which are regarded as interchangeable or substitutable by the consumer, by the reason of characteristics of the products or services, their prices and intended use\(^{16}\).

Relevant Geographic Market: A market comprising the area in which the conditions of competition for supply of goods or provision of services or demand of goods or services are distinctly homogenous and can be distinguished from the conditions prevailing in the neighboring areas\(^{17}\).

The major objective of competition authorities is to ensure that there is effective competition\(^{18}\) in the market and more importantly it is maintained in the market in such a way so that no business activity or agreement deters the same. Effective competition is where no firm/group of firms can exercise its/their market power\(^{19}\), which brings to us that even if a firm or group of firms are in a dominant position or have market power, it may not deter competition, but the exercise of that power is what which is to be looked by the competition authorities. The dominant position\(^{20}\) in a market can be empirically assessed but it is very difficult to measure the strength of the dominance i.e. whether or not the firm/group of firms can exercise the market power.

Therefore the basis for the determination of the relevant market is the presence of effective competition in the market. Consequently a “relevant market is a set of products or services in a market where effective competition prevails”\(^{21}\).

\(^{16}\) As per Competition Act 2007.

\(^{17}\) As per Competition Act 2007

\(^{18}\) As per competition law of EU.

\(^{19}\) A Firm (group of firms) is (are) in a position to exercise its (their) market power, if it has (they have) the ability to raise the market price over and above the competitive price level, profitably.

\(^{20}\) As per Competition Act 2007, Dominant position means a position of strength, enjoyed by an enterprise, in the relevant market, in India, which enables it to—

(i) operate independently of competitive forces prevailing in the relevant market; or

(ii) affect its competitors or consumers or the relevant market in its favour.

Market Power\textsuperscript{22} is largely dependent on the competitive constraints present in the market, the most vital being the availability of products’ close substitutes (demand side substitutability), the other being supply side substitutability and potential competition. The more the competitive constraints present in a relevant market, the less is the ability of the firm/ group of firms to exercise their market power, if they have it. Therefore, in a relevant market if product/set of products (close substitutes) is controlled by a hypothetical monopolist\textsuperscript{23}, then the monopolist must have the ability to exercise its market power, i.e. the price rise above the competitive level must be profitable. Therefore the definition of the relevant market is concerned with the identification of these substitute products and services and adding (one by one) all those close substitutes in the market unless and until it results in the hypothetical monopolist controlling all the products has the ability to raise the price above the competitive level \textit{profitably} i.e. is in a position to exercise its market power. Hence,” a relevant market is something worth monopolizing by a hypothetical monopolist.”\textsuperscript{24}

\textit{Relevant Product Market Example}

Let a market (or an industry) consist of 3 products viz. A, B and C, further product A and B are considered as close substitutes. Each of the products is produced by several distinct firms i.e. product A by 5 firms, B by 6 firms and C by 4 firms. In order to assess competition in the underlying market or Industry, the smallest set of homogenous products (or close substitutes) must be segregated on the basis of their substitutability and the separated lot would be the relevant market for set of product or products, if it

\textsuperscript{22} Market Power is the ability of a firm/group of firms to raise the price over and above the competitive level, profitably.
\textsuperscript{23} If product or set of products is controlled by one single hypothetical firm, instead of several distinct firms, then the single hypothetical firm is what is called as a hypothetical monopolist.
qualifies the *SSNIP test criterion*\(^{25}\). In our example, we have to start from the scratch i.e. we have to verify whether one single product A is enough to be a separate relevant market or not, and if not, then the closest substitute of the underlying product i.e. product B is to be added with the underlying product (i.e. product A) for the delineation of relevant market. The process of addition of close substitutes of the underlying product is done until the SSNIP test criterion is met, the final outcome would be the smallest set of products and the so called market would be the relevant market for those products. Since product B lays competitive constraint (is a close substitute) on product A, both products must belong to the same relevant market, whereas product C which does not bear competitive constraint on the underlying product (product A) and hence should belong to a separate relevant market.

**Relevant Geographic Market Example**

For a specific product A, two distinct regions X and Y would be delineated as a relevant geographic market for a specific product, if both the regions bear enough competitive constraint on each other for the underlying product. The competitive constraint between the regions would be there if the demand and supply conditions\(^{26}\) are similar or homogenous in both the regions for the underlying product. If both X and Y regions have homogenous conditions for product A, then they belong to the same relevant geographic market for product A, whereas if the conditions for product A are different in both the regions then, X and Y are two distinct relevant geographic markets.

\(^{25}\)SSNIP test is one of the measures for the determination of relevant market used by various jurisdictions. The techniques which satisfy the test directly are called direct techniques and indirectly satisfying techniques are indirect techniques, for the determination of relevant market. SSNIP test and various techniques are elaborated later.

\(^{26}\)Transportation cost is generally not considered.
3. **Quantitative Techniques available for Relevant Market Analysis**

The framework provided by the relevant market sets the basis for assessment of competition and settling competition claims. With the definition of relevant market, the acts ‘*which have appreciable adverse effect on competition*’ can be looked at. It is certainly not acceptable to define a market in an informal manner without any theoretical and empirical foundation. The competition can be measured by analyzing those *factors* or *variables* (like price, quantity, market share, firms, producers and consumer welfare, substitutes etc) which reflects the behaviour of the type of competition a firm, group of firms or an industry as a whole is facing. The factors which are taken into account as per Competition Act 2002 for delineation of relevant product market are interchangeability or substitutability by the consumer, by the reason of *characteristics* of the products or services, their *prices* and *intended use*. The quantification of such variables is the most challenging task, since all variables cannot be quantified and hence the proxies of such variables are taken, which does require expertise in economic applications and in-depth knowledge of all pros and cons associated with it. The other issue in the assessment of relevant market is the availability of actual data for the variables. There are times when the appropriate variables are identified but no data is available for the analysis and assessment of competition.

Even with the problems of quantification of variables and data unavailability, there are available Quantitative techniques which successfully identify the variables needed for relevant market delineation but the data availability depends on the kind of market definition (i.e. product or region or both). The use of quantitative techniques has made the judgment for acts which have appreciable adverse effect on competition much more accurate and reliable purely because the empirical results are easily comparable, understandable and communicable. But the biasness of the results is an issue, which

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27 As per Competition Act 2007.
could be due to technique malfunctioning, misinterpretation of results, inappropriate variables usage or the type of data. Hence the appropriate quantitative techniques are those which are truly based on the economic theories.

The basic criterion which is expected to be covered by all the quantitative techniques is the SSNIP test criterion. Some of the quantitative techniques directly takes into account the SSNIP test criterion, some indirectly and some do not.

There are many quantitative techniques used for the direct definition of the relevant market and takes into account the SSNIP test criterion like the elasticity and concentration tests, whereas some indirectly determines the relevant market like price correlation and causality tests and does not consider the SSNIP test criterion.²⁸

²⁸ Are dealt later in the study.
3.1 **SSNIP (Small but Non-Transitory Increase in Price) Test**

In 1982 the U.S. Department of Justice Merger Guidelines introduced the SSNIP test as a new method for defining markets and for measuring market power directly. In the EU it was used for the first time in the Nestlé/Perrier case in 1992, in Australia in 1993 and has been officially recognized by the European Commission in its "Commission's Notice for the definition of the relevant market " in 1997.

Currently the most renowned and largely accepted approach used by competition authorities all over the world for the determination of relevant market which the quantitative techniques are expected to take into account, is the hypothetical monopolist test or cartel test or 5-10 % test or the SSNIP (Small but Significant Non Transitory Increase in Price) test.

This test seeks to identify the smallest set of products and producers (containing the product under investigation), where a hypothetical monopolist, controlling the supply of all the products in that set, could increase profits by instituting a small, but appreciable, non transitory increase in price over the competitive level. The underlying approach can be applied to geographic market identification as well as to product market identification. Hence the hypothetical monopolist has to profitably increase the price of the product by 5-10 % in a market and therefore the market in which it is successfully done is defined as the relevant market. But if that’s not the case, then the close substitutes of the underlying product are to be considered and are added in the market; the addition of the closest substitutes of the underlying product in the market is recursively done until the SSNIP test is successful and with its success the relevant market is determined too, with the set of products in an area (Relevant Product Market) or with a product, in distinct geographic regions of homogenous characteristics (Relevant Geographic Market).

Whether or not a 5-10 % non transitory price increase for a product can be profitable or not depends on the lost sales due to that increase in the price. With the increase in the price of a product, some sales are likely to be forgone either due to demand side
substitutability (rationality and preferences of the consumers and availability of substitutes) or supply side substitutability (capability of other suppliers to diversify).  

The point is whether the loss of sales would be sufficient to offset the increased profits that would be made from the retained sales following the price rise which in turn depends on the price elasticity of demand. The fact that an increase in price by a hypothetical monopolist would result in shift of consumers to the closest available substitutes due to their preferences and rationality but for the SSNIP test to be valid for relevant market delineation, not more than 10% of the shift of marginal consumers must be there. If more than 10% of the consumers substitute the product, other substituted products have to belong to the same relevant market and another test is required to determine more appropriate relevant market and its depth.

The fact that SSNIP test takes into consideration both the competitive constraints (demand side substitutability and supply side substitutability) for delineation of relevant market, it makes it a reliable and an effective technique, but there are three major problems associated with SSNIP test applicability which gives other econometric methods an edge and hence are more appropriate at times. First of all, the data required for the SSNIP test is very difficult to obtain. The second difficulty relates to the treatment of the supply-side. No competition authority knows quite what to do about the supply-side. The problem is that if we define the market only on the demand-side, we may find that due to supply-side substitutability even a monopolist of a relevant market could not raise prices. But if we take account of the supply-side at the market definition stage, then where do we draw the line between supply-side substitutes and potential entrants? The Commission has steered a sensible middle course in the draft Notice. Supply-side substitutes whose “effects are equivalent to those of demand substitutes in terms of effectiveness and immediacy” will be included in the market definition. Where supply-side substitutability is not immediate and would require some additional investment and

29 SSNIP test takes the two vital competitive constraints into account i.e. the demand side substitutability and supply side substitutability but does not consider the other competitive constraint i.e. Potential Competitors.

30 Dealt later in the study.
time, then supply-side substitutes will be treated like potential entrants and will not be included in the market definition. Finally, it is subject to *Cellophane Fallacy*.

It arises from the question of what is the *base price level* from which we should apply the 5% to 10% price increase. The *Du Pont case*\(^\text{31}\) suffered from cellophane fallacy, where the SSNIP test concluded that there was no market power though estimated high own price elasticity suggested that the small but significant non transitory price would be unprofitable. There was a fallacy for the product named cellophane, since the market power was already being exercised at the given price level which was not identified by the SSNIP test. Therefore, *if the prices are already over and above the competitive level for a product*, then SSNIP test fails as in the case of Cellophane of Du Pont.

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3.2 Quantitative Techniques and Tests

3.2.1 Elasticities

The Demand Elasticity estimates are widely used and accepted due to the very basic reason that it directly takes into account the SSNIP test criterion for relevant market definition. Since elasticity” measures the percentage change in the quantity due to the percentage change in the price”, the Own Price Elasticity gives the results whether or not, a small but significant non transitory increase in price would be profitable for a Hypothetical monopolist, i.e. it reveals the percentage change in the quantity of the underlying product due to the percentage change in the price of that very product.

On the other hand the Cross Price Elasticity measures the percentage change in the quantity of the underlying product due to the percentage change in the price of the other product.

Both own price elasticity and cross price elasticity can be used separately or jointly to assess the relevant market. Individually, the own price elasticity takes into account own capability to loose/gain in sales, which can further be used to identify whether the underlying product is a Ordinary good/product or Giffen good/product\(^{32}\) and cross price elasticity takes into account the ability of substitutes to gain/loose the sales due to the

\(^{32}\) Both Ordinary and Giffen goods/products are related to the effect of the change of price on the demand of the quantity. Ordinary goods/products are those for which the demand of quantity increases with the decrease in the price and vice versa, i.e. the law of demand holds suggesting negative price elasticity of demand, whereas the opposite of Ordinary goods/products are Giffen goods/products, which are an exception to the Law of Demand suggesting an increase in price results in increase in quantity demanded i.e. a positive price elasticity of demand.

Normal goods/products and Inferior goods/products are as well of great importance and directly take into account income elasticity. A normal good’s demand increases when income increases, i.e. with a positive income elasticity of demand, on the other hand, the demand of a good decreases with the increase in the income for inferior goods i.e. with a negative income elasticity of demand.

A normal good/product is always an ordinary good/product, while an ordinary one can be either normal or inferior.

price rise, through which it can be concluded that whether a product with reference to the other is a Complementary good/product or Substitute good/product\textsuperscript{33}.

A high own price elasticity (\textit{in absolute terms}) of a normal good/product\textsuperscript{34} indicates that a small change in price would result in a proportionally much larger change in the quantity demanded. A high own elasticity of a product states that there is enough competitive constraints present in the market to make any SSNIP unprofitable and hence the underlying product is not a separate relevant market, therefore the demand side substitutes must be added in the market suggesting there is healthy competition in the market.

Whereas a high (positive) cross price elasticity of demand suggests that the two products are substitutes of each other, i.e. with the increase in the price of a product the demand of other product is increased, the two products can be assumed to be in the same relevant market, since they bear competitive constraints on each other. On the other hand, very low or negative cross price elasticity of demand indicates that the products belong to different relevant markets. One important consideration to be taken into account is, even if say a product X is a competitive constraint on another product Y (which can be measured by cross price elasticity of Y), what if it is not the other way around i.e. what if the own price elasticity of the product X is inelastic (i.e. the price increase would be profitable to product X and no sales would be taken by product Y), if this is the case then both must be part of separate relevant markets, since one way substitutability cannot reveal the relevant market but \textit{two way Substitutability} certainly can.

\textsuperscript{33}A complementary good in economics is a good which is consumed with another good. This means that, if goods A and B were complements, more of good A being bought would result in more of good B also being bought. An increase in the price of one of the goods will result in a leftward shift of both demand curves; less of each good would be demanded. A decrease in the price of one of the goods will result in a rightward shift of both demand curves; more of each good would be demanded. Hence cross price elasticity is negative for complimentary goods. Whereas a good is said to be a substitute good for another insofar as the two kinds of goods can be consumed or used in place of one another in at least some of their possible uses. An increase in price for one kind of good (ceteris paribus) will result in an increase in demand for its substitute goods, and a decrease in price (ceteris paribus, again) will result in a decrease in demand for its substitutes. Hence the cross price elasticity of substitutes is positive.

\textsuperscript{34}It is with reference to a Normal good/product unless it is mentioned otherwise.
Therefore, the Cross Price Elasticity can be used to identify substitutes of the underlying product by two way substitutability criterion and further the Own Price Elasticity can be used to verify whether or not the delineated market with the underlying product and its substitutes is enough to be stated as a Relevant Market as per the SSNIP Hypothetical Monopolist test. The process is to be recursively done until the test is successful.
Applications of Elasticities

(i) Critical Loss Analysis

The critical Loss analysis makes the SSNIP test operational for the determination of the relevant market. The SSNIP test states that, a small but significant non-transitory increase in price of a product must be profitable for a hypothetical monopolist so as to qualify as a relevant market. The monopolist’s demand curve is downward sloping from left to right and any price increase results in the loss of sales at higher prices. The amount of quantity lost due to the increase in the price is dependent on the demand elasticity. The critical loss for any given price increase is “the percentage loss in sales necessary to make the specified price increase, unprofitable”. Critical loss analysis estimates how much the hypothetical monopolist’s sales must be lost in order to make the hypothetical price rise unprofitable. If the reduction in sales is greater than the critical loss, then it would result in the reduction of profits. Whereas, if the reduction in unit sales is less than the critical loss, the price increase will raise profits for the hypothetical monopolist.

The definition of the relevant market is on the basis of the relationship between critical loss, lost sales and profitability. If the lost sales are more than the critical loss, then it would not be profitable and hence the relevant market is to be expanded further, whereas if the lost sales are less than critical loss, then it would be profitable and hence the relevant market must not be expanded since the underlying market is the relevant market. The intuition is that the remaining sales (actual sales minus hypothetical lost sales) would be profitable at higher price only up to a certain extent, after that high price would be left with small enough sales to make the profits less as compared to the profits without that hypothetical increase in the price.

First of all, an increase in price would decrease the total sales and hence would further decrease the total variable cost, as less selling units would require less of variables cost\(^\text{35}\). Secondly, decreased sales due to increase in price would increase the profit per unit. Therefore, the lesser the sales, the lesser would be the average variable cost and more

\(^{35}\) Variable cost is charged on the variable factors and output is one of the most important one.
would be the profit per unit due to the increase in the price. There would be lost sales (forgone sales) due to an increased price which would be necessary to make the residual sales unprofitable, which is what is called as critical loss, above which the effect of the decrease in average variable cost and increase in profit per unit would not be enough to make the remaining sales profitable whereas remaining sales below the critical loss would make it profitable.

Critical Loss = \[ \frac{Y}{(Y + PCM)} \] \times 100^{36}

Where, \( Y \) = hypothetical price increase

\[
PCM = \text{price-cost margin} = \left[ \frac{(P - AVC)}{P} \right]
\]

Where, \( P = \text{Initial Price}, AVC = \text{Average Variable Cost} \)

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\[^{36} \text{OFT 266, “Quantitative techniques in competition analysis”, page 77-78.} \]
(ii) Critical Elasticity Analysis

The Critical Elasticity is the price elasticity calculated to assess whether or not the actual elasticity facing a firm would make the hypothetical monopolist profitable with a small but significant non-transitory increase in price and hence defines the relevant market. If the estimated own price elasticity of the hypothetical monopolist is greater than the critical elasticity, then the price increase would be unprofitable as the significant lost sales would suggest the presence of close substitutes in the market and hence the market has to be widened with the inclusion of those substitutes which lay competitive constraints. Whereas if the own price elasticity is less than the critical elasticity, then the price increase would be profitable and hence no need to further widen the market since the underlying market is the relevant market.

Critical Elasticity = \( \frac{(1 + t)}{(m + t)} \)

where; \( t \) = Hypothetical price rise
\( m \) = Price-Cost margin = \( \left[ \frac{(P - VC)}{P} \right] \)

and, \( P \) = Initial Price, \( AC \) = Variable Cost

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37 Estimated values are the numerical values of the parameters calculated from the sample data by estimating the model. Elasticities can be estimated from Econometric regression equation in Logarithms form and Residual Demand analysis.
Methodology for Relevant Market Definition through Own Price and Critical Elasticity

Step 1: **Estimation of Own Price Elasticity**

Estimate the Own Price Elasticity from the Regression Equation logarithms form (*the regression equation in log form measure the elasticity of the underlying variables*), by regressing the sales of the underlying product on its own price, prices of substitutes, income of the consumers, market share or concentration and all the variables which are assumed to lay competitive constraint on the sales of the underlying product. All these variables must be included in the regression equation to have the best possible influence of the price of the underlying product on its own sales (own elasticity).

\[
\log Q_{1t} = a + b_1 \log P_{1t} + b_2 \log P_{2t} + \sum_{S} \text{Others}_t + U_t
\]

Where

- \( Q_{1t} \) = Sales of the underlying product
- \( P_{1t} \) = Price of the Underlying products
- \( P_{2t} \) = Price of the Substitute of the underlying products.
- \( \sum_{S} \text{Others}_t \) = All other relevant variables
- \( U_t \) = Error term with mean equals zero and constant variance.
The coefficient of $\log P_1$, i.e. $b_1$, is the Own Price Elasticity of Product 1 and the coefficient of $\log P_2$, i.e. $b_2$, is the Cross Price Elasticity of Product 1 with respect to Product 2.

**Step 2: Calculation of the Critical Elasticity**

Critical Elasticity = \( \frac{(1 + t)}{(m + t)} \)

Where;  
- \( t \) = Hypothetical Price rise  
- \( m \) = Price-Cost Margin = \( \frac{(P - VC)}{P} \)  

Where, \( P \) = Initial Price, \( AVC \) = Variable Cost

**Step 3: Comparisons between Estimated Own Price Elasticity and Critical Elasticity for Determination of Relevant Market**

- Own Price Elasticity > Critical Elasticity = Relevant Market not defined, need to add substitutes in the market and the depth is increased.
- Own Price Elasticity < Critical Elasticity = Relevant Market is defined and no need to add substitutes in the market, the underlying market is the Relevant Market.
One critical aspect of the critical elasticity analysis is that it does not take into account the cross price elasticity, which in itself is an influential supply side competitive constraint. The technique which takes into account both Own Price Elasticity and Cross Price Elasticity, specifically for Merger Analysis, is called Diversion Ratios39.

39 The Diversion Ratio can be used to estimate the likely effect on prices of mergers. The diversion ratio from product A to product B (DAB) is the cross price elasticity of demand for A with respect to the price of B (\( \varepsilon_{AB} \)) divided by the own price elasticity of demand for A (\( \varepsilon_{AA} \)). For applications of diversion ratios see Bishop, S and Walker, M, “Economics of E.C. Competition Law: Concepts, Application and Measurement”.
3.2.2 **Elzinga - Hogarty Test**

E-H test\(^{40}\) is an indirect method used for the determination of *Relevant Geographic Market* when the data on the prices are difficult to avail. The quantity variable is used which is relatively easy to get as compared to the prices. The E-H test uses quantitative data to assess whether significant product flows are present between two regions to verify whether they belong to same relevant geographic market or not. It takes into account the four variables viz. production, consumption, imports and exports. The test is used to assess the extent to which firms in one region lay a competitive constraint on firms in another region based on the notion that product flows between regions indicate the existence of competitive constraints between regions. The consumers can switch for a product from local suppliers to non-local suppliers which are what is analyzed through E-H test.

In order to access the competition between two different regions the two criteria which the E-H test provides which specifically analyzes the flows between regions.

1. The *LIFO* (*little in from outside)* test is related to the demand side of the market, and asks whether total consumption in a particular region is provided by the local suppliers of that region or not. LIFO threshold criterion states that “*the percentage of consumption not produced locally should not exceed 10%.*” It asks whether imports into the region are small relative to total sales. If that’s the case then the other region does not put enough competitive constraints to be qualified for being in the same relevant geographic market. Whereas, if more than 10% of the imports are in a region then both the regions are assumed to be in the same relevant geographic market for the underlying product.

\[
LIFO = \frac{\text{Production minus Exports}}{\text{Consumption}} = 1 - \frac{\text{Imports}}{\text{Consumption}}
\]

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2. The LOFI (little out from inside) test is related to the supply side of the market and asks whether total production in a particular region is consumed by local consumers of that region or not. LOFI threshold criterion states that “the percentage of production not consumed locally should not exceed 10%.” It asks whether exports from the region are small relative to total production. If that’s the case then the other region does not put enough competitive constraints to be qualified for being in the same relevant geographic market. Whereas, if more than 10% of the exports are to a region from other region then both the regions are assumed to be in the same relevant geographic market for the underlying product.

\[
LOFI = \frac{\text{Production minus Exports}}{\text{Production}} = 1 - \frac{\text{Exports}}{\text{Production}}
\]

If any one of the two criteria is not met, it can be concluded that the region under investigation is subject to the effective constraints from suppliers from other region and the width of the relevant geographic market expands with the inclusion of other region and the underlying region in the same relevant geographic market.

The econometric techniques used in the determination of relevant market are dealt in depth separately in the subsequent section.
4. Econometric techniques and their applications in Relevant Market Analysis

Econometrics is concerned with the tasks of developing and applying quantitative or statistical methods to the study and elucidation of economic principles. Econometrics combines economic theory with statistics to analyze and test economic relationships. Econometrics generally incorporates mathematical and statistical modeling keeping economics theories as a base. The regression equation is generally used to define a functional form of a proposed theory where the dependent variable is determined endogenously (from the model) and the Independent variable is determined exogenously (outside the model). The data for the variables can be time series data, cross sectional data or panel data (the combination of the time series and cross sectional data). In the econometric regression model, the endogenous (dependent) variable is dependent on the exogenous (independent) variable /variables and the error term. The most widely method which is used for the estimation of the regression equation is the OLS (Ordinary Least Square) under certain assumptions and the model is called as the Classical Linear Regression Model (CLRM). The unexplained power of the independent variable /variables in explaining the dependent variable is captured by the residuals (RSS if OLS is used), that is the error term, and the explanatory power of the overall right hand equation in explaining the left hand variable is captured by the coefficients of the independent variable (R² when OLS is used). The estimated regression equation reveals the degree of association of each independent (exogenous) variable with the dependent (endogenous) variable measured by the coefficients of the independent variables. The statistical significance of each coefficient can be measured by the $t$ or $z$ test and that of the overall regression equation by the $F$ test.

The econometric techniques specifically come under the indirect measures. The price correlation analysis, granger causality, co integration tests and hedonic price analysis are some of the frequently used econometrics techniques. Price is the most important factor
with which the actual competition effects can be examined specifically the welfare aspects of producers and consumers and hence the econometric analyses are generally done with investigation of the prices of the underlying product/products for the delineation of the relevant market. These techniques do provide a good enough support for relevant market definition but have some issues (like the stationarity of time series data and the common factors’ influence in the data) which are to be considered and hence analyses of each technique is done for its relevance and applicability in determination of relevant market.
4.1 Price Correlation Analysis

Price is one of the most important factors for competition assessment and hence price correlation analysis is frequently used to determine whether two products or geographic regions belong to the same relevant market or not. It is one of the quantitative techniques used for the definition of relevant market. The price correlation analysis has also been used by various judiciaries even in the cases of Mergers Viz. Nestle/Perrier\textsuperscript{41}, Mannesmann/Vallouree/Illa\textsuperscript{42}, P&G/VP Schickendanz\textsuperscript{43}, Lonrho/Gencor\textsuperscript{44}, Guiness/Grand Metropolitan\textsuperscript{45}.

Correlation analysis is a statistical technique used to measure the degree of association between two variables. Two variables are said to be correlated if a change in one variable is associated with a change in the other. This need not imply a causal relationship between the two since the movement in both variables can be influenced by other variables not included in the analysis. Correlation is positive when the changes in the two variables have the same sign (that is, they both become larger or smaller, indicating the products being substitutes of each other), and negative otherwise (that is, one becomes larger while the other becomes smaller, indicating the products being complementary to each other). Variables that are independent do not depend upon each other and will only be correlated by chance (‘spurious correlation’).

Price Correlation analysis measures the degree of association between two price series; however the magnitude, direction and causation between these variables are not

\textsuperscript{41} Case IV/M190 [1997] O.J. L356/1.
\textsuperscript{42} Case IV/M315 [1994] O.J. L102.
\textsuperscript{43} Case IV/M430 [1994] O.J. L354/2.
\textsuperscript{44} Case IV/M619 [1997] O.J. L11/30.
explained by it. The covariance between two time series of prices along with the standard deviation of both the price series is measured in price correlation analysis.

The correlation coefficient between two variables, \( x \) and \( y \) is a standardized measure of association between two variables:

\[
r = \frac{\text{Cov}(x, y)}{\text{SD}(x) \cdot \text{SD}(y)}
\]

Where \( \text{Cov}(x, y) \) is the covariance between \( x \) and \( y \), and \( \text{SD}(x) \) and \( \text{SD}(y) \) are the standard deviations of \( x \) and \( y \) respectively.

The correlation coefficient is a number ranging between -1 and 1. A coefficient of -1 implies perfect negative correlation, a coefficient of 1 implies perfect positive correlation, and a coefficient of zero implies no correlation (although it does not necessarily imply that they are independent).

**Data Requirements and Interpretation**

The data required for the prices of two products or areas is Time Series data with at least 30 Observations\(^{46}\). The time series data if used in an ad hoc manner would result in absurd analysis without meaningful and accurate results. Hence it is customary to compute the correlation coefficient using natural logarithms for both the price series for the efficiency motive and for the very basic reason that the first difference\(^{47}\) of the series in log form is an approximation to growth rate (a meaningful estimate), moreover equal changes in log represents equal percentage changes in price and hence the magnitude of the data when compressed in Logarithmic form is unbiased as compared to the original results. It is also customary to compute the correlation both between levels and differences in log prices.

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\(^{46}\) In order to capture the effect of large population, 30 or more observations are required as per the applicability of Z test. For more details refer to, Mathematical Statistics by Freund and Walpole.

\(^{47}\) For a variable \( Y_t \), the first difference is basically the change in \( Y_t \) i.e. \( Y_t - Y_{t-1} \).

Numerically \( \Delta Y_t = Y_t - Y_{t-1} \). For more details refer to ‘Basic Econometrics’ by Gujarati .D.
Another concern is that the data of the two price series may show movement in a particular direction simply because of the presence of *common factors* influence or due to the *seasonal factor*. Therefore the influence of the common factors ought to be purged before calculating the correlation coefficient. Thorough knowledge of economics and expertise are required for the identification of those common factors. Moreover the seasonal factors influence has to be taken into account, which is generally dealt in econometrics with the inclusion of dummy variables\textsuperscript{48}.

The computation of the correlation coefficient can easily be done as all statistical softwares packages such as SPSS, SAS, STATA, E–VIEWS etc have the capability for its calculation.

**Relevance in Relevant Market Determination**

Loosely speaking, it is argued that a given time series price data for two products or areas, the correlation coefficients between their levels and first differences can be used to determine whether these products or areas are in the same relevant market. If two products belong to the same relevant market, they ought to be substitutes and price correlation analysis would reveal it with positive correlation coefficient between the prices of both the products. On the other hand, if the correlation coefficient turns out to be negative, then it can be assumed that the products are *complementary* and do not exert competitive pressure on each other rather there prices move in opposite directions and hence must be separate relevant markets. Even a low positive correlation coefficient suggests that the products are not close substitutes and hence must belong to separate relevant markets.

Prices can differ because of transport and transaction costs or because of temporary demand or supply shocks, so that the correlation coefficients will be less than 1 even in a perfect market. It is however impossible to determine how big the correlation coefficient

\textsuperscript{48} To capture the effect of qualitative variables and structural break in time series data Dummy Variables are used For a dummy variable the values of 1 and 0 are assigned for a given situation, 1 for the true condition and 0 for it being false. For more details refer to ‘Basic Econometrics’ by Gujarati .D.
needs to be in order for the analysis to conclude that two areas or products are in the same market.

Even if the estimated correlation coefficient is statistically different from zero, the economic interpretation of the test is not straightforward. This is due to the lack of an obvious cutoff point where it can be decided whether the estimated degree of interdependence between the prices can be taken as an indication of price uniformity.

The other important consideration is to remove the influence of common factors which can lead to erroneous conclusions especially in the times of high inflation, simply because if common inputs price rises, it would result in high correlation and suggest that both products lay competitive constraint on each other and belong to the same relevant market, even though in reality that may not be the case.

The influence of common factors can be purged either by De-Trending\textsuperscript{49} all the variables beforehand or by using regression analysis: the price is regressed on the influencing factors, both common factors and seasonal factors (input price, or a time trend, or seasonal dummies, etc), and the residuals from that regression are taken to represent the purged series.

Two most significant economic aspects while using correlation analysis must be taken into consideration before concluding are:
First of all, the price responses for some product or in some areas may take some time to reach the equilibrium i.e. the gestation period may be too long to capture instantaneous relationship and hence the effect may not be observed in the short term time series data of prices and would show low correlation coefficient even though the long term equilibrium relationship may exist. Hence it is all the more important to have as many observations as possible. Never the less graphical plotting of the data may help in revealing the long term relation even with the limited time series data, which too require enough experience and knowledge for the analysis of the same.

\textsuperscript{49} If the transformation of non-stationary time series data to stationary time series data is achieved through trend stationary (TS) process i.e. if their linear combination exhibits a trend, then it’s de-trending.
Secondly, a low correlation of two price series may also be due to the fact that both the products are *close substitutes and their supply is elastic*.

Even though Price correlation analysis is a good measure for relevant market definition and merger cases but it does not provide any evidence and neither have any relevance with the 5 % test (SSNIP test) i.e. whether a 5 % non transitory increase in the price of a product would be profitable for the hypothetical monopolist or not, is not answered by the correlation analysis which is the basis for relevant market definition. Hence it is better to use Price correlation analysis as a support rather than as a sole base for judgment of competition claims.

**Competition Cases**

1. **Nestle/Perrier Merger**\(^{50}\)

To assess the merger of Nestle and Perrier (1992) the analysis of relevant markets of *still mineral water*, *sparkling mineral water* and *other soft drinks* was done. Since, the merger would result in 2 from 3 firms in the market and further the merged firms would have 50 % of combined sales of sparkling and still mineral water, post merger. The evidence was enough for the dominance in the market, post merger and hence the assessment of the relevant market was all the more important for all the three products. The major concern was that whether soft drinks were an effective competitive constraint for mineral water products or not. In other words, the issue was to check the relevant market extent of mineral waters and soft drinks; whether both belonged to the same relevant market or they constitute separate and distinct relevant markets.

It could be argued that there was no separate market for mineral water and that the relevant market in which to assess the proposed merger should have been that for non-alcoholic refreshment beverages, including both mineral water and soft drinks (i.e. all the

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three products viz. sparking mineral water, still mineral water and soft drinks). The commission opposed the argument that there was a distinction between sparkling mineral water and still mineral water from the perspective of competition analysis.

In order to get insight of the case and settling the dispute and testing the extent of the relevant market, price correlation analysis was used. The results of price correlation revealed, high correlation coefficients between prices of various brands of sparkling mineral water, high correlation coefficients prices of between various brands of still mineral water and more importantly there was high correlation coefficients between the prices of sparking mineral water brands and still mineral water brands suggesting that there existed significant competitive constraints between both the products and hence they were in the same and unique relevant product market of mineral water.

Conversely, the correlation coefficient between brands of mineral water and soft drinks were found to be uniformly low, indicating the absence of competitive constraint on mineral water from soft drinks and suggesting a separate relevant market for both of them.

The price correlation analysis concluded that there were separate relevant product markets for soft drinks and mineral water and a single relevant market for both still mineral water and sparking mineral water, which was what argued by the commission.

2. **Procter and Gamble / VP Schickedanz Acquisition**

The investigation was concerned with the impact of the proposed acquisition of VP Schickedanz by P&G in the feminine hygiene industry of Germany. The high market share in feminine hygiene product in Germany and Spain, post acquisition, raised the need for the assessment of the extent of relevant geographic market for sanitary towels.

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definitely because of the dominant position in the market, post acquisition, which could result in the exercise of the market power and hence would be anti-competitive.

The prices of sanitary towels for various northern European countries were used. The commission argued with the correlation test results that the prices in Germany, France, UK and Netherlands did not move together between the beginning of 1991 and the beginning of 1993. Over this period, prices in Germany rose by 10%, whereas in other countries moved much faster; 43% in UK, 24% in France and 45% in Netherlands, suggesting that they must be separate relevant geographic markets and hence the acquisition would not be anti-competitive from the evidence of lack of competitive constraints between the regions, as per price correlation analysis.

3. **Wholesale Petrol Market in US**

Stigler and Sherwin have used correlation analysis to test whether or not the cities of Chicago, Detroit and New Orleans were in the same relevant geographic market for wholesale petrol.

Monthly fuel prices were correlated in the three cities during the period 1980-82 (inclusive). The effect of serial correlation was eliminated by taking the first difference of every third element of the price series. The effect of common factors were eradicated too, which is a very important step in the analysis of petrol prices, as fluctuations in the price of crude oil tend to influence the price of refined petrol quite heavily. The results indicated that the correlation coefficients were very high: the coefficient between New Orleans and Chicago was 0.792; that between New Orleans and Detroit was 0.967; and that between Chicago and Detroit was 0.77. These results indicated that the three cities were in the same relevant market. However, correlation analysis, as the sole means of reducing market breadth is an insufficient measure to delineate relevant market.

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52 OFT 266, “Quantitative techniques in competition analysis”, para 5.8.
4.2 Granger Causality Test

As in correlation analysis where the degree of association between two variables is measured or in regression analysis where both the degree and magnitude between two variables are measured, the causality test determines the causality from one variable to another (unidirectional) or mutual determination (bidirectional), which neither the correlation analysis nor regression analysis determine.

Standard regression techniques assume that there is a cause and effect relationship between dependent and independent variables. In determining the economic model to be estimated, prior knowledge of economic theory is typically drawn upon, taking into account the particular characteristics of the industry under investigation. It is unavoidable however, that some assumptions about the direction and degree of causality between variables need to be made. The need to examine these assumptions has lead to the development of the concept of Granger Causality.

According to Granger Causality test, a variable X is said to Granger cause another variable Y, if taking into account past values of variable X leads to better prediction of variable Y\(^{53}\). There are three dimensions of Granger Causality:

- X causes Y (Unidirectional Causality)
- Y causes X (Unidirectional Causality)
- X causes Y and Y causes X (Bidirectional Causality)

The intuition behind Granger Causality is to check whether or not with the analysis of causality relation, two or more products lie in the same relevant market and exerts enough competitive constraint on each other.

Strictly speaking, if two products X and Y lie in the same relevant market, then one would expect that the price of product X to affect the price of product Y and vice versa.

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\(^{53}\) When the present value of a variable is significant in determining the present value of other variable then it’s the case of instantaneous causality which is generally found in financial data due to near perfection in the flow of information.
This suggests the prediction of the prices of Y obtained using available information on the prices of X and Y will be better than those obtained using only the information on price of Y. The same would be true for the predictions of the price of X.

If product X is in the same product market as product Y, then it would be expected that there would be some link between the price series of the two products simply because the relevant market consists of closest substitutes and it is evident that the demand for all those products would be fairly elastic and any movement in one variable would result in some changes in the other.

For instance, if two regions form part of same relevant geographic market, a disturbance in one region will spill over into the other region and the data should indicate that the price in one region Granger-Causes the price in the other region. In contrast, if the two regions are sufficiently distinct, there should be no spillover and the data should not indicate Granger Causality between the regions.

Therefore, even though quite unrealistic, “in a perfect relevant market the causality is ought to be bidirectional, indicating the products are homogenous and perfect substitutes.”

**Auto Regressive Equations and the Causality Detection Test**

1. \( Y_t = \sum a_i X_{t-i} + \sum b_i Y_{t-i} + U_{1t} \)
2. \( X_t = \sum c_i X_{t-i} + \sum d_i Y_{t-i} + U_{2t} \)

**Testing Causalities**

The coefficients of the lagged values of X in equation 1 reveal the explanatory power of X variable in determining the Y variable and hence all these coefficients (\( a_i \)’s) are
estimated and then statistically tested for the hypothesis of X causing Y and similarly all the coefficients of Y (d_i’s) in equation 2 reveals causality from Y to X.

- From the 1st equation, if all the coefficients of Variable X, jointly are not equal to zero and statistically significant, then one can conclude that X Granger-Causes Y.
- From the 2nd equation, if all the coefficients of Variable Y, jointly are not equal to zero and statistically significant, then one can conclude that Y Granger-Causes X.
- If both the above statements are true then, X Granger-Causes Y and Y Granger-Causes X i.e. both X and Y is determined mutually.
- If none of the above 3 statements are true, then there is not enough statistical significance of any causality flowing from X to Y, Y to X or both and hence the two products belong to separate relevant markets.

**Data Requirements and Interpretation**

Time series data is generally required for each of the variables. The no of lags are of most importance since for each additional lag, two extra explanatory variables are introduced in the equation and one additional observation is lost. For example if there are 5 lags in the regression model, 5 observations are lost and there are 10 regressors in the equation. It is advised to take *minimum of 50 observations*.

The t-test is used for the statistical significance of each individual coefficient of independent variables and F- test for the overall significance of combined explanatory power of the independent variables in determining the dependent variable.

The regression model is run by OLS method for the estimation of all the coefficients in the absence of autocorrelation and heteroscedasticity but in their presence GLS method is used.

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54 Serial Correlation between the error terms is what is referred to as Autocorrelation which invalidities the OLS method but GLS method is used instead. For more details see ‘Basic Econometrics’ by Gujarati D.

55 In regression analysis, heteroscedasticity means a situation in which the variance of the dependent variable varies across the data i.e. is not constant. Heteroscedasticity complicates analysis because many methods in regression analysis are based on an assumption of equal variance or homoscedasticity.
**Important factors to be considered in Granger Causality Test**

1. Both the time series have to be stationary before regressing the equations. Stationarity of series implies that both the mean and variance are *time invariant*. To test the stationarity of series ACF (Auto Correlation Function)\(^{56}\) or/and Unit Root Test could be used. Generally stationarity can be achieved either by taking the First differences or by regressing the time (trend) on the underlying variable and the residuals from this regression are stationary.

2. The influence of common factors and seasonal variations are to be removed or filtered before regressing the equation using time series data, since this may lead to *spurious regression*. It can be done in two ways either by De-Trending all the variables beforehand or by using regression analysis: the price is regressed on the influencing factors both common factors and seasonal factors (input price, or a time trend, or seasonal dummies, etc), and the residuals from that regression are taken to represent the purged series.

3. The error terms have to be uncorrelated as it would lead to autocorrelation. Since, the presence of autocorrelation is often encountered in time series data, which eventually invalidates the F-test even though it does not affect the unbiasness property, special consideration must be given for the same.

   The detection could be made by Durbin-Watson (d statistic) and Durbin Watson (h statistic) if it is an autoregressive model and the model used for Granger Causality is Auto Regressive since the dependent variable is regressed on its own lagged values. Further if the presence of autocorrelation is detected, it is customary to transform the time series to eliminate autocorrelation by either GLS or Newey-West method.

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\(^{56}\) Statistical packages like STATA have inbuilt functions to test the stationarity of series.
4. Since the price of today \((t)\) is related to the previous lagged prices \((t-k)\), the problem of multicollinearity\(^57\) is quite possible and must be dealt very carefully as the presence of multicollinearity results in high standard errors and hence low t-value\(^58\) for each of the variables. This would make the estimated parameters statistically insignificant even though they might be significant.

5. The number of Lags to be taken must be according to Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC).

6. If more than two variables are used for testing causality relation, then VAR (Vector Auto Regressive)\(^59\) is used.

7. Even if all the coefficients are not jointly equal to zero (rejecting Null Hypothesis) but some individual coefficients are not equal to zero and some are, then also there is an evidence of causality flow but it’s up the analyst’s expertise and knowledge to interpret those results. One option is to drop the insignificant variable and then again test the hypothesis since it may increase the explanatory power as well as the \(t\) and \(F\) values, but that may be controversial.

8. The price of one product even if appears to Granger-Cause the price of another product, and vice versa, does not show that they exert enough competitive pressure on each other on the same market. The competitive constraints imposed by that product may nonetheless be insufficient to make unprofitable a price rise of 5-10\% above the competitive level by a hypothetical monopolist. The prices of two products could Granger-Cause each other without being in the same relevant market and, equally, the prices of two products might not Granger-Cause each other even though they belong to the same relevant market.

\(^{57}\) Multicollinearity is present in a model when the Independent/Exogenous variables are correlated, which invalidates OLS method and hence GLS is used instead.

\(^{58}\) The low calculated t-value increases the probability of the underlying parameter to be statistically insignificant. Since the table value at the given significance level could be more than the calculated value, the Null Hypothesis is more often than not accepted.

\(^{59}\) Statistical software like STATA does incorporate the VAR model for detecting causality for more than 2 variables.
Hypothetical Example

\[ P_1 = -2.22 + .85 P_{1t-1} + .3 P_{1t-2} + .01 P_{1t-3} + .6 P_{2t-1} + .5 P_{2t-2} + .3 P_{2t-3} \]

\[ \begin{array}{cccccc}
(-6.1) & (165.8) & (56.4) & (15.6) & (122.5) & (28.1) \\
\end{array} \]

\[ R^2 = .97 \]

\[ RSS = 20.93 \]

No of observations = 100

F test = 34 at 5% significance

The estimated regression equation, where P1 and P2 are the prices of the products at 3 lagged periods, captured the explanatory power of 2\textsuperscript{nd} product in determination of the 1\textsuperscript{st} product price i.e. Product 2 Granger Causes Product 1 is what the equation investigated.

The figures in the brackets are the t-values i.e. the statistical significance of each individual estimated parameter at 5% significance level.

The interpretation of the equation reveals that product 2 Granger Causes product 1.

Since, all the three coefficients of P2 are statistically different from zero, the Alternate Hypothesis is accepted and the Null Hypothesis of all the coefficients of product 2 are simultaneously equal to zero is rejected. This can be observed by the F value (34) which certifies P2 Granger Causes P1 i.e. Product 2 does exert competitive constraint on Product 1 and hence keeping other things constant this proposes that both must belong to same relevant market.

The value of \( R^2 \) suggests that explanatory power is very high, the unexplained power is very low and the equation has fitted significantly pretty well, suggesting P2 Granger causes P1.

Similarly the causality from product 1 to product 2 can be tested and if the result is in affirmative, this would be a case of bidirectional causality; even making stronger statements of both the products belonging to one common relevant market.
Competition Cases

1. US Wholesale Petrol Markets

The Granger Causality test was used to determine relevant geographic market of petrol in US regions. The objective of the Commission was to verify whether or not, the North-East, South-East and Western Region belonged to the same relevant market for Wholesale Petrol. The weekly data on wholesale prices from March 1981 to February 1982 (that is, 52 observations) was taken, two cities for each region were chosen, namely Greensboro and Spartanburg for the South-East; Baltimore and Boston for the North-East; and Los Angeles and San Francisco for the West Coast. Granger Causality test was performed between each pair of cities, both within and across regions by testing the prices data. To counter the effect of common influences between regions a vector of common factors to each regression was added in order to eliminate the effect of those common factors. Such vector contained quadratic functions of time. The length of the lags to be added to each equation was set at five, as the addition of five lags eliminated all traces of autocorrelation.

The tests for exogeneity between each pair of cities lead to the following conclusions. The South-East region was one separate relevant geographic market as the prices of the petrol in South-East region neither Granger Caused the prices of petrol in North-East and Western region nor was Granger Caused by any of these two regions, i.e. there was no evidence of competitive constraints from North-East and Western regions on the South-East regions for petrol. However, there was some evidence of interrelation between city pairs in the North-East and South-East, but weak enough to be conclusive. The West Coast and the South-East form quite distinct markets which were expected.

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60 OFT 266, “Quantitative techniques in competition analysis”, para 7.7
2. **Mannesmann/Vallourec/Ilyva Merger**

The Mannesmann group of companies had a total world-wide turnover of ECU 18,163 million in 1996 and Vallourec group of companies had a total world-wide turnover of ECU 1,186 million. The combined aggregate world-wide turnover of all the undertakings concerned would have exceeded ECU 5,000 million. Each of the undertakings had a Community-wide turnover in excess of ECU 250 million, but they did not achieve more than two-thirds of their aggregate Community-wide turnover within one and the same Member State. The notified operation therefore had a Community dimension according to Article 1(2) of the Merger Regulation. It did not qualify for co-operation with the EFTA surveillance Authority pursuant to Article 57 of the EEA Agreement.

The activities of Mannesmann group and Vallourec overlapped in the field of production of carbon and alloy steel tubes, precision tubes, bearing tubes, gas cylinders, tubular automotive components, production of steel and semi-finished steel products and in the retail distribution of steel tubes.

Hence, the assessment for the definition of relevant product markets and relevant geographic markets was done for the verdict of the proposed merger.

The Granger Causality test was used for the definition of relevant geographic market. The objective was to examine whether the United States, the European Union and Eastern Europe were part of the same relevant geographic market for Seamless Stainless Steel Tubes.

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The Regression equation used for “Region X Granger Causing Region Y”

\[ Y_t = B_0 + \sum S B_s X_{t-s} + u_t \]

Where \( Y_t \) denotes the price at time t in region Y and is regressed on the past values of variable \( X_{t-s} \), which denotes the price in region X at time t-s. The determination of the relevant geographic market was revealed by testing the significance of the coefficients of \( X_{t-s} (B_s) \), by regressing the time series data of Prices of the underlying product in region Y on region X i.e. to test whether the region X at time (t-s) Granger Caused the Region Y at time (t). The hypothesis was all the coefficients of region X (Bs) being simultaneous equal to zero. If all the coefficients were zero, then this would imply that there is no causality from Region X to Region Y on the basics of the prices in the specified regions for the underlying product at the respective time periods which would state that there is no competitive constraints between the specified regions and hence both would belong to separate relevant geographic markets for the underlying product.

The result of the Granger- Causality tests indicated strongly that all the 3 regions for Seamless Stainless steel tubes were linked. U.S. and E.U prices for Seamless Stainless steel tubes showed U.S Granger Causing E.U. and E.U. Granger Causing U.S i.e. there was bidirectional causality between both the regions and that to at high degree of statistical significance, indication both were in the same relevant geographic market for the underlying product. Similarly, Eastern Europe prices were shown to Granger-Cause U.S and E.U but the effect of U.S. and E.U. Granger Causing Eastern Europe was not statistically that significant. However, it was argued that all the three regions belonged to the same relevant geographic market for seamless stainless steel tubes.
4.3 Co Integration Analysis

Dynamic Price Regression analysis is too assessed with the Co-Integration technique. Co-integration test is an indirect measure for the relevant market delineation as it does not take into account the SSNIP test criterion. Co-integration analysis is used to determine the extent of the market and analyze the mechanism by which price changes are transmitted across products and geographic areas. Price adjustments across markets may take place over a period of time instead of instantaneous adjustments; therefore the integration of the markets critically depends on the length or duration of the price adjustments. The reactive adjustment process to changes in one price through a set of products or geographic areas can be represented by a class of econometric models called Error Correction Models (ECM). ECM can be used to test whether or not two or more series of price data exhibit Stable Long Term Relationships or Equilibrium and further can be used to estimate the time required for such relationships to be re-established, when a shock causes them to depart from equilibrium.

Strictly speaking, two non stationary time series are said to be Co-Integrated if they have a “linear combination” that is stationary. Further, if enough evidence of Cointegration of two time series has been witnessed by estimation, then it can be concluded that the two time series have a long term relationship and equilibrium. That is there are competitive constraints between the two products or regions and the long term relationship between the products exists and hence they must be considered in the same Relevant Product or Geographic market.
Stationarity Concept and Integration of Time Series

A time series is said to be stationary if the mean and the variance are constant over time i.e. they are “time invariant” and the value of covariance between the two time periods depends only on the time lag between the two time periods and not on the actual time at which the covariance is computed. Whereas a non stationary time series’ mean and variance changes with time i.e. both are “time variant”.

The stationarity of the time series can be tested through the DF test (Unit Root Test) and if the error terms are correlated then by ADF test at the formal level, whereas at the informal level it can be tested by the Correlogram approach or ACF(Auto Correlation Function).

Depending on the type of the series, the non stationary series can be converted into a stationary series either by taking the difference (first, second, third and so forth...) or by De-Trending. If the series is brought to the stationary status by taking the difference then it is called Difference Stationary\(^{62}\) and if by De-Trending, then Trend Stationary\(^{63}\).

“It is a pre-requisite for any time series to be stationary before its usage but Cointegration is a total exception.” Since, for Cointegration analysis it is necessary for both the time series to be non stationary beforehand.

If two non stationary series after their integration i.e. their linear combination becomes stationary, then both the series are called Cointegrated. The intuition behind this

\(^{62}\) A series brought to the stationarity by taking the appropriate difference is called as difference stationary process (DSP). For example the first difference of the Random Walk Model (RWM) without drift is a stationary time series.
Non Stationary RWM: \(Y_t = Y_{t-1} + U_t\)
Stationary RWM (Taking 1\(^{st}\) Difference): \(Y_t - Y_{t-1} = U_t\) (both mean and variance are time invariant)

\(^{63}\) The regression equation where the dependent variable(Y) is dependent on the independent variable (t) is \(Y_t = b_1 + b_2t\). And when the mean of \(Y_t\) is subtracted from \(Y_t\), the resulting series is a stationary time series and hence the name trend stationary (TS) and the process is called as detrending.
phenomenon is; due to the long term relationship of the variables, the error terms cancels out and hence the resultant series is a cointegrated stationary series obtained from the combination of two non stationary Series. But, when the combination of the two non stationary series results in a non stationary series, it reveals the absence of any long term relationship and hence results in spurious regression. Therefore thorough economics knowledge and expertise is a pre-requisite for the application, analysis and interpretation of cointegration analysis in competition assessment.

*Auto Regressive Equation*

The equation is estimated in logarithms forms represented by capital letters due to efficiency reason and the *first difference of the logarithms is the growth rate*, which is from the point of view of economics a significant measure.

\[
P_1 t = a_0 + b_0 P_2 t + b_1 P_2 t-1 + cP_1 t-1 + U_t \quad \ldots \ldots \quad 1
\]

Subtracting \( P_1 t-1 \) from both sides of the equation, and adding and subtracting \( b_1 P_2 t-1 \) from the right-hand side, after simple manipulations we obtain:

*Error Correction Representation of the above equation (ECM)*

\[
\Delta P_1 t = a_0 + b_0 \Delta P_2 t - (1 - c) \left\{ P_1 t-1 - \left[ (b_0 + b_1 ) / (1 - c) \right] P_2 t-1 \right\} + U_t \quad \ldots \ldots \quad 2
\]

55
Measurement of Types of Causality Relationships

- $b_0$ measures the long term difference between two prices.

- $(1-c) \{ P1_{t-1} - \left[ (b_0 + b_1) / (1-c) \right] P2_{t-1} \}$ is the error-correction term because since it reflects the current ‘error’ in attaining long-run equilibrium: it measures the extent to which the two prices have diverged.

- The parameter $c$ has to be less than one for the system to be stable, that is, to ensure convergence towards the equilibrium. Then $-(1-c)$ is negative, which implies that the deviation from the long-run equilibrium is corrected during the next periods. If $c$ is equal to zero, the adjustment would be instantaneous.

The advantage of using ECM is that by regressing $\Delta P1_t$ on $\Delta P2_t$ results in less multicollinearity, and therefore more precise estimates, further as stated before, the first difference of the log of a variable is approximation of growth rate.

Data Requirements and Interpretation

Time series data for both the price series is needed. The OLS method is used if there is no heteroscedasticity and autocorrelation, and if any of them is present then GLS is used. The Unit Root Test (DF test) is used to check the non stationarity of the series (it is pre requisite for both the series to be non stationary). In the presence of autocorrelation ADF test is used to detect the non-stationarity of both the series.
The Cointegration tests which can be used are Engel-Granger test, Augmented Engel-Granger test and Co-Integration Regression Durbin Watson Test, which reveals whether or not the linear combination of two non stationary time series results in a cointegrated series having long term relationship or spurious regression. If both the Time Series are of same order then both are totally dependent on the random errors, hence no relation can exist between the two and therefore results in spurious regression.

If the prices in one region are found to affect the prices in another region, suggesting that it is due to their long term relationship, is still not a good enough indicator to suggest that both the regions belong to the same relevant market.

**Competition Cases**

1. **Nestle (Nescafe) Supply of Soluble Coffee**

In 1990 OFT found that Nestle was in a dominant position in soluble coffee market; its share was around 48 % in volume, 56 % in value and had relatively high profits than other related firms in UK. It was evident that Nescafe (Nestlé’s brand) was in a dominant position but whether the abuse of the dominance was exercised or not, was the major concern.

The Co Integration test was used to check the fluctuation of slow adjustments of prices of soluble coffee with respect to the coffee beans.

It was found that the Nescafe was particularly slow to adjust to these price changes, which was defended by them by explaining that the frequent changes in the prices of coffee beans could not be passed to the customers that often, by changing the retail prices of the soluble coffee.

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64 OFT 266, “Quantitative techniques in competition analysis”, page 66-67.
The study by the Ministry of Agriculture, Fisheries and Food (MAFF) comparing the prices of instant and ground coffee with changes in green coffee bean prices between 1979 and 1989 was based on quarterly data from the National Food Survey. MAFF analyzed the correlation of retail prices of ground and instant coffee with the level of the raw bean equivalent price based on the sub-group indices of the Producer Price Index. The results from this analysis showed that a closer relationship between ground coffee prices and raw bean prices than between soluble coffee prices and raw bean prices. The correlation became stronger if the price of ground coffee was lagged two quarters, while the instant coffee price was best correlated after one quarter. Furthermore the study found that, on average, both instant and ground coffee prices respond more to raw bean price rises than price falls.

GFL, the second largest supplier of soluble coffee in the UK market, submitted a study undertaken by economic consultants who analyzed the relationship between input and output prices of soluble coffee. The analysis focused particularly on how the price changes in the green coffee bean market fed through to retail prices and the extent to which this transmission explained changes in retail coffee prices. The econometric estimation showed that an increase in the cost of beans for delivery led to an almost exact increase in retail selling prices. Furthermore, estimations of the relationship between green coffee bean prices and wholesale realizations (1981-90) found that these prices also moved closely together. Over 50% of the change in the purchase cost of beans fed through to wholesale realizations within three months, and 75% of any change in wholesale realizations were transmitted to retail prices in the same quarter.

When testing for asymmetry in the relationship between green bean and output prices for periods of green bean price rises against price falls, the consultants found no asymmetry – both increases and decreases were reflected in output prices to a similar extent and within similar time periods. The price of Maxwell House (GFL’s leading brand) was found largely to follow movements in the price of Nescafe.
2. **Colorado Petrol Markets**[^65]

The Co Integration test was used to analyze whether the petrol prices of Denver and other neighboring towns of Tulsa, Kansas city, Cheyenne and Billings were linked or not, that is whether they belonged to the same relevant geographic market of petrol or not. The weekly price series for the period from Jan 1992 to July 1997 was taken to check the causality relationships. Since petrol prices are highly influenced by crude oil prices, these effects (common factors) were purged.

The result revealed that there was a long term equilibrium relationship between Denver prices of petrol and Tulsa, Kansas city, Cheyenne and Billings, with Billing’s relationship comparatively weaker but never the less concluded that all belonged to the same relevant market of wholesale petrol.

3. **Lonrho/Gencor Merger**[^66]

The proposed Merger between Lonrho and Gencor needed an analysis of the market definition of products; platinum, rhodium, palladium, gold and silver. The Co integration test was applied on the prices of all the products and found that their were no long run relationships, and the prices of all the products varied independently of each other and hence there were no competitive constraints between the prices of products. Concluding that both were separate and distinct relevant markets and must be studied separately for anti-competitive or anti-trust issues.

[^65]: OFT 266, “Quantitative techniques in competition analysis”, para 8.12

4.4 Hedonic Price Analysis

Hedonic price analysis is used to compare the price of products whose quality changes over time or over product space, due to either technological or subjective factors, or other services and optional equipment. Typical examples of products whose quality differs at one point in time, or whose quality varies dramatically over time, are cars and computers. In such circumstances, price analysis has to be adjusted to account properly for quality differences or quality changes. Hedonic price analysis is a particular kind of regression analysis that has been developed to purge prices of the effect of quality differences, so that the pure price difference between ‘standardized’ products can be isolated. Purged prices can then be used to carry out other price tests.

Hypothetical Example of Car Industry

A product C (Car) with three distinct qualitative characteristics (X (Horse Power), Y (Weight), Z (Mileage)), which are the factors responsible for differences in brands.

Assume there are different brands of cars in India, for simplicity assuming there are 3 major car brands; Hyundai, Maruti and Ford. Further assume that all brands have different versions; Santro and i10 of Hyundai, Zen and Swift of Maruti, and Fiesta and Icon of Ford. The time period for which the prices are to be compared is also taken, for simplicity let it be 3 years.

The problem is to compare the prices of different versions of cars, since the quality attributes determines the car prices, the comparisons cannot be made without purging the influence of quality variables from the actual (incomparable) prices. Hence the prices can only be compared by bringing all the car prices at a base level, after purging quality’s
influence, and thus further comparisons and analysis of the dominance or anti-competitive behavior by any brand or company can be made by the competitive authorities for competition assessment.

**Regression Equation**

\[
\log P(C_i) = a_1 + a_2D_2 + a_3D_3 + b_1X_i + b_2Y_i + b_3Z_i + u_i
\]

The Price of the \(i^{th}\) car of any of the brand and version is dependent on the time period, captured by the coefficients of dummy variable \(D_2\) and \(D_3\); \(a_2, a_3\) and the intercept \(a_1\), on the coefficients of characteristics or quality attributes variables \(X_i, Y_i, Z_i\); \(b_1, b_2\) and \(b_3\) and on the normally distributed error term \((u_i)\) with mean equal to zero and constant variance.

According to the example where there are 3 brands with 2 versions of each brand, in total there would be 6 car prices that would be captured by the dependent variable \(\log P(C_i)\) and hence \((i=6)\).

The Dummy variables (Time Dummies) \(D_2\) and \(D_3\) reveal the time effect on the price of the \(i^{th}\) car:
- \(D_3 = 0\), for period 1 and period 2 and \(D_3 = 1\) for period 3
- \(D_2 = 0\), for period 1 and period 3 and \(D_2 = 1\) for period 2
- \(D_2 = 0\) and \(D_3 = 0\), for period 1

OLS method is used for the estimation of the regression equation. And after the estimation of the regression equation, the anti-log of the coefficients of dummy variables \(D2\) and \(D3\) and intercept is taken.
The antilog of $a_1$, $a_2$ and $a_3$ generates the *Quality Adjusted Price Indices*. The new coefficients are then normalized with the base year value (Antilog ($a_1$)) set to Unity (1), for simplicity, in period one. The Hedonic Price Index is 1 in period one, exp(Antilog ($a_2$)) in period two, exp(Antilog ($a_3$)) in period three and hence exp(Antilog ($a_n$)) in $n$th period.

For example if the Hedonic Price for period one is 1 and period 2 is .87, then what can be concluded is that Quality Adjusted Price of Car C has gone down by 13%.

*Strongly Speaking, if the Non-adjusted quality price of car C had actually gone up substantially, prompting allegations of price fixing or monopolistic abuse, hedonic price analysis would show that all the price increase was due to changes in the quality mix of the product, not necessarily to anti competitive behavior by the Brand maker or Producer.*

**Data Requirements and Interpretation**

The hedonic price analysis needs a combination of time series and cross-sectional data on the product’s price and its characteristics. Data will be needed on a range of prices over a number of years. It is advisable to have a large enough number of observations for the results to be meaningful; the analysis should be carried out with at least 20 to 30 observations plus as many observations as the number of regressors in the estimated equation. The estimation of hedonic price regression can be carried out using all econometric packages that have a built-in routine to run multivariate regressions.

The price of the product is solely dependent on the Time dummies and the characteristics variables and hence all the relevant variables must be included in the model as the omission of any significant quality variable\(^\text{67}\) would deter the unbiasness property of the

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\(^{67}\) For proof refer to “Basic Econometrics” by Gujarati. D.
parameters of the regression variables. The data is heterogeneous due to cross sectional
data and hence the problem of heteroscedasticity is very likely to be encountered.
Therefore GLS method would be customary to be applied over OLS.
The fact that the quality is the major factor for the product differentiation and hence it can
be stated that Hedonic Price method are more often than used for the differentiated
products when quality variables are the Independent variables.

Competition Cases

1. **European Car Price Differentials**\(^{68}\)

The concern of whether the prices charged in national markets for similar products differ
significantly and, if so, whether they are converging, is what was tested in European car market. In the case of cars, models differ widely across countries and their characteristics
change substantially over time. Hence this particular nature of the market makes the
hedonic price analysis the best methodology to carry out comparisons of prices between
national markets.

For the UK, the first available study is a 1982 IFS report analyzing car prices in the UK
and Belgium. The report showed that the average price differential, at 39%,
underestimated the quality-adjusted differential, which was 44%. Ten years later the
MMC compared car prices in the UK, Germany, France, the Netherlands and Belgium.
The study sought to control for differences in characteristics, but not all specification
differences were eliminated. Also, comparisons referred to the year 1990, when the UK
and the other countries were at very different phases of the economic cycle. Surprisingly,
the MMC report found no significant differentials in general, and only significant
differences in the prices of smaller models. The conclusions reached by the MMC report
were not substantiated by further studies: a report by LAL found quality-adjusted

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\(^{68}\) OFT 266, “Quantitative techniques in competition analysis”, page 50-51.
differentials between the UK and other countries ranging from 13.8 to 35% for four models. All of the UK studies have used the hedonic price analysis. The variation in their results may be due to the incorrect filtering of the effect of the varying characteristics, which led to the results being somewhat biased.

At the European level, a report by the BEUC on behalf of the European Commission’s DGXI estimated differentials of between 12% to 50% for UK cars compared to Belgium, Germany, Greece, Spain, France, Ireland and Luxembourg and the Netherlands. The results of the study were unreliable, as they were not quality-adjusted. Flam and Nordstrom found price differences as high as 50%, averaging at around 12%. Model comparisons carried out in 1995 by the European Commission showed differentials in excess of 20%. Although cars were compared by model, the specifications of each model tend to vary across countries and it is expected the estimated differentials to be biased.

**Quantitative techniques not Covered**

There are some more useful quantitative techniques which are used for merger cases and hence have influence on the relevant market definition indirectly. They too require high precision for their application and interpretation and hence must be dealt in detail. They are specifically *Diversion Ratios, Price Concentration Analysis and Residual Demand analysis*. 
5. Summary/Conclusion

It is evident that competition should prevail in the market so as to give the best to the society in terms of the overall welfare. India have setup CCI in 2002 with the motive to ensure that the acts by the enterprises do not have appreciable adverse effect on competition. The delineation of the relevant market is the first step in assessment of competition with respect to the product or region which sets the foundation for analyzing the extent and degree of competition the underlying market entrails within itself. Further on the basis of the analyses, the competition claims are settled either by punishing the enterprise (firm) that has behaved or is behaving anti-competitively or adjudging in favour of the enterprise in question i.e. denying the claim against it for the anticompetitive behaviour. Hence no judgment can be made without the assessment of competition at first. The most important task is to first delineate the market or identify the market for the analysis of competition; more precisely the delineated market is then investigated for anti competitive behaviour. The concept of relevant market has come up with the solution of the same since a relevant market is the smallest set of products which are delineated on the basis of the product or region, the former is the relevant product market and the latter the relevant geographic market, and the resultant delineated market is the relevant market which is then assessed for anti-competitive behaviour.

There are various measures with which the delineation of the relevant market could be done but the most renowned is the SSNIP test. As per the SSNIP test, the hypothetical monopolist must be profitable by successfully increasing the price (non- transitory) by 5 to10 % and with its success the relevant market is defined. There are several quantitative methods which do take into account the SSNIP test criterion and some do not. The direct methods consider SSNIP test criterion directly and indirect methods do not. Own price elasticity is one such technique which considers SSNIP test criterion, further the critical elasticity and critical loss makes the SSNIP test operational.
The techniques which do not take into account the SSNIP test criterion are sometimes more useful than those which do take it because data problems, variable quantification and other complexities make direct methods unfeasible and impracticable.

Econometric techniques are hence widely used for the determination of relevant market. Since price is one of the most relevant factors, econometric techniques take into account the price of the product/products within or across the regions. The data used in econometric techniques are specifically time series data, cross sectional data and panel data. The notion behind econometric techniques is that the price of the underlying product with respect to products in the same region or across regions should have a relationship. The nature of the relationship is then studied to comment on the extent and size of the relevant market and the intuition behind each relationship differ across techniques. The four widely used econometric techniques are price correlation analysis, granger causality test, co-integration analysis and hedonic price analysis.

The price correlation analysis takes into account the prices of the products which are considered as closest substitute. The intuition behind the analysis is that a relevant market consists of substitutes or homogenous products and the prices of homogenous products moves in the same direction. Therefore the delineation of relevant market is with the set of products within or across the regions, the prices of which move in the same direction. Granger causality test states that if both products belong to the same relevant market then the past prices of a product must effect the price of the underlying product and if these past prices are taken into account along with the prices of the underlying product, then it must result in better prediction of the prices of the underlying product as compared to the prediction of the prices of the underlying product when taking into account its own prices only. The co-integration even though simple requires lot of economics and econometric sense, since it is a pre-requisite for the two time series of prices to be of different integrating orders and must be non stationary. As per co integration analysis if the prices of the two products bear a long term relationship then they must belong to the same relevant market. When differentiated product market is taken into account where quality is the basis for the differentiation, the delineation of relevant market is quite difficult as the prices are charged differently due to the difference in the quality of the brands.
Hedonic price analysis is used to bring down the prices at a comparable level by eliminating the quality price differentials and hence relevant market delineation and inferences about anti-competitive behaviour are easily done. Hedonic price analysis is widely used in the car and computer markets.

The relevant market would be precisely defined and delineated if not only the direct measures are used but the indirect measure which do take into account the SSNIP test criterion indirectly seconds the results of direct measures. Enough consideration should be given to the fact that an imprecisely delineated relevant market would not only deter the objective of competition authorities but would also put off the faith that competition in the market provides best to the overall welfare of the society. Therefore economics literature and theories must be integrated with the all the quantitative techniques which are used for the delineation of the relevant market since competition itself lays its foundation in economics.
6. **Bibliography**


