# The Stability of Virtual Equilibrium

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## Abstract

The impact of information technology (IT) on the stability of market equilibrium is explained from a simple microeconomic standpoint. Attributes of a dynamically stable "virtual" market equilibrium are described assuming consumer rationality, an elastic supply curve, and minimum static market demand. Three conditions are necessary for long-run price stability of such a "virtual" equilibrium: (1) firm-specific strategic effects have to be completely offset by aggregate demand growth effects, (2) market equilibrium must arise under the constraint of demand sustainability, and (3) consumer indirect utility gains from information availability must exceed their respective disutility from locational search costs. Those conditions stem from more elastic supply together with less elastic demand compared to when IT is not utilized.

## Keywords

**information technology, virtual market, equilibrium stability**

## JEL Classification Codes

**D0-M2-L2**

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## Introduction

This short note attempts to present a simple assessment of the impact of information technology (IT) on equilibrium market stability. Different necessary conditions are discussed, rather than derived, for a stable "virtual" equilibrium if markets are characterized by consumer rationality, elastic firm supply, and minimum static demand. The analysis is descriptive rather than theoretical, hence no formal research findings are claimed with the exception of, perhaps, those thoughts related to the dissemination of ideas pertaining to the topic at hand. To start with, the Internet Revolution and the advent of the strategic use of information technology in most successful lines of business, along with its popular use among consumer purchase and search agents, is currently shaping a new business model that has, and will have, profound effects on the conduct, volume, and speed of business transactions in the world economy. The Internet Revolution, just like its Industrial predecessor, is expected to fuel consumer demand yet for different reasons: lower search costs, more aggressive market competition, customization, and the universal availability of price comparisons free of charge. Other reasons in favor of increased consumer demand include automated orders, virtual supply of goods and services, interactive marketing, and electronic commerce. The impact of increasing consumer demand through the use of IT may change the level of market equilibrium towards a relative change of *degree*, rather than a change in equilibrium *structure* (Canning, 1999a). This relative change in equilibrium degree, caused by fueling consumer demand, may cause prices to rise in the short-run. However, the strategic use of information technology to lower-down costs of production and distribution, in addition to its efficient use in product innovations and product development, may exert an opposite effect on prices, ultimately reducing prices to the marginal rates of substitution in demand.

The impact of information technology holds a dual effect from an economic point of view: a microeconomic business effect, and a more global developmental effect. The microeconomic business effect concerns itself with a new business model of a more flexible organizational structure, a shrinkage of the production supply-chain, a drastic shortening of distribution lead-times, and a dramatic decline in consumer search costs. It also holds, however, larger financial risks and a more vulnerable and volatile business environment, which may not necessarily transfer its technological efficiency into short-run profits. In addition, customization of goods and services, based on the efficient specialization of resources and on product differentiation, may fuel consumer demand to a point where aggregate business supply may not meet demand equilibrium at reasonable prices. Also as challenging are the legal and ownership issues related

to property rights (Nash, 2000), the delicacy of customization of products while holding on to some degree of product differentiation (Schipchandler & Moore, 2000), in addition to labor productivity (Raths, 2000), and demand forecasting concerns (Grimes, 2000). All of these barriers seem rather minute and ultimately solvable, given the enormous benefits which information technology can bring to a business venture: low barriers to entry, availability of common IT technologies, multiple revenue sources, universal consumer access, low distribution and search costs, inexpensive business-to-business transactions, virtual low overhead, electronic transactions, and endless new market opportunities.

## "Virtual" Equilibrium

Central to the success of any new business or product venture is the effective *strategic* use of information technology as a corporate competitive advantage in the marketplace. That strategy calls for using information to create new value for the customer, and for encompassing an information technology visionary leadership and systems development management for the firm's future. In retrospect, the stability of market equilibrium and the change in consumer preferences through perceived behavior are now more deeply related than before. This may induce a more elastic supply curve with more inelastic demand, thus causing equilibrium prices to be heavily influenced by consumer preferences, and for gross social surplus to be more caught by consumer surplus than producer profits. This would also act to stabilize prices in the long-run, assuming that rising demand would be readily met by business growth and expansion, thus giving rise to a "virtual" equilibrium which could be dynamically stable (Figure 1). In addition, information technology makes information more readily available for both consumers and producers, thus bridging the apparent gap in asymmetric information within the marketplace. Imperfect or incomplete information, however, remain strictly viable.

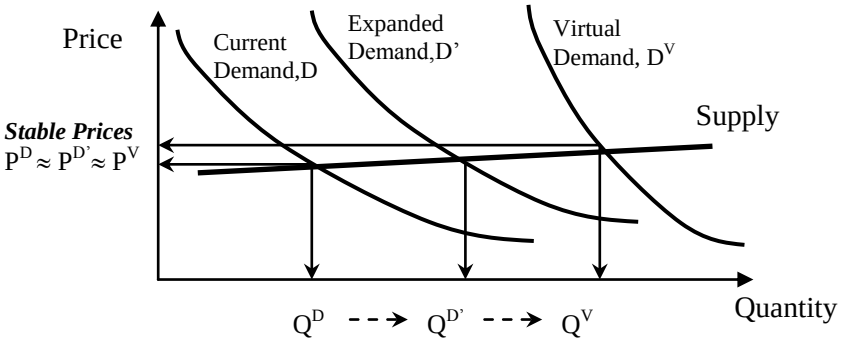


**Figure 1: Stable "Virtual" Equilibrium**

## The Stability of "Virtual" Equilibrium

Information technology, as argued in the previous discussions, bring to economic markets a new evolutionary conduct of supply & demand analysis as seen from the eyes of micro-economic theory. The instantaneous access to information, and the apparent reduction in asymmetric

information between consumers and producers utilizing virtual markets, in addition to the dramatic decline of search costs associated with consumer purchase, all argue for a new "virtual" equilibrium approach characterized by demand expansion and stable, if not declining, prices. The purpose of this section is to provide a quantitative assessment (albeit, elementary) of such a virtual market equilibrium.

Consider a competitive firm in a market with *n-1* other competing firms of the same product, facing the following demand curve:

$$\begin{aligned} & p(q) = \alpha - \beta Q^D \\ & \sum_{i=1}^{n} q_i = Q^D \end{aligned} \qquad \text{(A)}$$

with $Q^D$ denoting aggregate market demand, $\alpha$ the maximum consumer willingness-to-pay for a firm's product, $q$ denoting firm-specific supply, and with a downward-sloping consumer demand function ($\alpha, \beta > 0$). Aggregate demand, $Q^D$, is assumed to grow linearly (or, equivalently, exponentially with log-linear transformation) according to a minimum static market demand ($m$) and to a dynamic growing virtual demand ($s$), where the former is a demand requirement for market sustainability, whereas the latter is a growth requirement for expanded demand via the use of information technology, as follows:

$$\begin{aligned} & Q^D = m + st \\ & \dot{Q} = s \\ & \dot{q} > 0 \end{aligned} \qquad \text{(B)}$$

Differentiating the price function in (A) with respect to time, and equating the result to (B), we get:

$$-\frac{1}{\beta}\left[\dot{p}(q) + p'(q)\dot{q}\right] = s \qquad \text{(C)}$$

This translates to:

$$\dot{p}(q) = -s\beta - p'(q)\dot{q} \qquad \text{(D)}$$

In the short-run, quantity adjustments to aggregate demand fluctuations are negligible, with price adjustments taking the lead. However, in the long-run, price and quantity adjustments to changes in aggregate demand are both feasible, especially in markets characterized by low barriers to entry, an advantage bought through via the use of information technology and market information-sharing. In such a scenario with expanded virtual demand, (D) above states that the dynamics of market price are governed by two forces working in opposite directions: the first force is a firm-specific *strategic* effect to lower prices (the first term in (D) above, which is negative), while the second force is a market-led *growth* effect working to bring prices upwards,

in response to expanded virtual demand (captured by the second term in (D) above, which is positive, assuming $p'(q) < 0$ in individual product demand).

The first effect (the strategic effect) calls for lowering of own-prices for effective market penetration and for strategic product positioning. It is therefore firm-specific, negative on aggregate, yet with varying degrees of dispersion depending on the size of the firm in question, and depending on the nature of products it delivers to the market. If it dominates, then, prices are expected to decline, even though market demand is rising, thus causing $\dot{p}(q) < 0$. On the other hand, the second effect (the growth effect) calls for an increase in market prices due to explosive demand through impatient consumption, due to drastic lowering of consumer search costs and to increases in marginal utilities from information-driven goods consumption. Such a growth effect, if dominant, will cause prices to rise in the long-run, resulting in $\dot{p}(q) > 0$.

Price *stability* within a long-run virtual market equilibrium, driven by information technology, requires that these two opposing forces (the strategic and growth effects) offset each other. The reduction in firm-specific prices caused by lower overheads and greater technical efficiency induced by the use of information technology and Internet provision, and also by the shrinkage of the production supply-chain with drastic shortening of delivery lead-times, must be offset by the long-run increase in prices induced by the growth in aggregate demand, through the faster channels of information technology and the Internet. Such a tradeoff, as a requirement for a dynamically stable virtual equilibrium, can therefore be summarized by the following three constraints:

$$\begin{aligned} &\dot{q} = \frac{-s\beta}{p'(q)} = \frac{s}{\varepsilon_D p'(q)} \\ &Q(\dot{x}_c) > m \\ &v[p(q)] > \lambda \end{aligned} \qquad \text{(E)}$$

where $\varepsilon_D$ is the price elasticity of aggregate demand, $m$ is the minimum static market demand required for market sustainability, $\dot{x}_c$ denotes the critical input supply flow-rate required for sustainable demand, $v[\cdot]$ is the consumer's indirect utility gain from information availability, and $\lambda$ is the consumer's disutility from locational search costs.

The first constraint plainly states that the strategic effect has to exactly offset the growth effect in order to arrive at stable long-run prices. Virtual market stability, therefore, requires that firm-specific cost reductions associated with the use of IT and transmitted to consumers in the form of lower prices, have to be completely offset by increases in aggregate virtual demand. This would be achieved by a *growth* in market supply just equal to that of market demand, yet inversely augmented by the price elasticity of aggregate demand and by the slope of the individual product demand curve.

The second constraint imposes demand sustainability on market equilibrium. The supply of virtual goods and services have to exceed the minimum static market demand required for sustainability. In other words, there has to be a critical flow-rate for required production inputs

($\dot{x}_c$) capable of inducing a level of aggregate supply ($Q$) which exceeds minimum static demand ($m$). This also acts as a constraint for environmental stability, whereby the depletion of aggregate economic resources due to supply effects are at least met by minimum static consumption. The reduction in asymmetric information between consumers and producers in the marketplace, through the use of the Internet and information technology, would also indirectly stabilize resource depletion towards such a sustainability constraint.

The third constraint, which is a rationality constraint, states that consumers will not demand goods and services through virtual IT technology or the Internet unless their indirect utility gain from information availability, $v[p(q)]$, exceeds their respective disutilities from locational search costs, $\lambda$. This is a standard argument based on consumption rationality induced by maximization of utility subject to a loss function based on consumer search costs. Since the advent of information technology drastically reduces consumer search costs, such a constraint is arguably always binding, in the sense that rational consumers will not choose to purchase a virtual product (via the use of IT) unless their gain in expected utility out of that purchase exceeds their absolute disutility from physical locational search.

## CONCLUSION

A simple quantitative microeconomic model has been developed to arrive at different constraints required for price stability of a 'virtual' market equilibrium. Three major constraints are arrived at for long-run price stability: (1) firm-specific strategic effects have to be offset by aggregate demand growth effects, (2) market equilibrium must arise under the constraint of demand sustainability, and (3) a rationality constraint for consumer choice must be binding, whereby consumers' indirect utility gains from information availability exceed their respective disutilities from locational search costs.

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