

The Behavior of Technology Suppliers in the Presence of Network Externalities

Soheil Yousef-Sibdari

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Master of Art
in
Economics

Robert Gilles, Chairman
Nancy Lutz
Mark Stegeman

May 9, 2001
Blacksburg, Virginia

Keywords: Microeconomics Theory, Industrial Organization, Network Externalities, Information Goods, and Technology Suppliers.

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Soheil Yousef-Sibdari

Abstract

This study surveys the theoretical literature dealing with the behavior of technology suppliers in the presence of network externalities with a focus on economies of compatibility setting and promotional pricing. Positive network externalities arise when a good is more valuable to a user because more users adopt the same good or compatible ones. There are two issues with network externalities: demand side and supply side. This paper focuses on the supply side, and it relates the way that technologies are chosen and promoted. On the supply side, product compatibility choice, technology sponsorship, penetration pricing, and product pre-announcement are the competing strategies of firms operating in a market with network externalities. Among these strategies, compatibility choice decisions and promotional pricing are presented in the two different subsections, which follows.

1. Introduction

Network externality has been defined as a change in the benefit, or surplus, that a consumer or an agent derives from a good when the number of other agents consuming the same kind of good changes. Many products have a small value in isolation, but generate greater value when combined with others. As many people use fax machines, your fax machine becomes increasingly valuable since you will have greater use for it. Another example can be the videocassette recorder (VCR). There are two competing technologies, Beta and VHS that are incompatible with each other. Because of the increasing returns to scale in the provision of the complementary good, the owner of a VCR will find a greater number of programming opportunities available for his machine, if more consumers buy the same technology of VCR. He also benefits from the ability to exchange cassettes with other users of compatible machines and also from more customer service that may be available for the VCR technology with the larger network size. Farrell and Saloner (1985) point to the benefits that arise when the value of a good for one user is increasing if other users have compatible goods, and when the availability and prices of complementary goods improved if others adopt compatible good.

Katz and Shapiro (1985) establish three possible sources of benefits of positive network externalities. 1) *Direct-physical-effect*, the utility that a consumer derives from purchasing a good depends on the number of other households or businesses that have joined the same network, for example, telephone, fax, telex, and data networks. 2) *Indirect effects* also give rise to consumption externalities. For example, a consumer purchasing a piece of hardware, say a computer, will be concerned with the number of

other agents purchasing similar hardware units. Because the amount of software that will be supplied for use with a given computer will be an increasing function of hardware units that have been sold. They called it the “hardware-software paradigm.” Other examples can be video games, video players and recorders. 3) *Experience and size of service networks*. Network externalities may arise for a durable good like automobiles when the quality and availability of post purchase service of the good depend on the experience and size of the service network, which vary with the number of units of the good that have been sold. In all of these cases, the utility that a given user derives from the good depends upon the number of other users who are in the same “network” as is he or she.

The papers in this area explore the economics of such systems in demand and supply sides. Market competition between individual products, which highlights some issues like expectations, coordination, and compatibility is an example of the studies in the supply side. The role of user preferences and the strategies for adopting technologies are discussed in the demand side. The most recent research has focused on the behavior and performance of private and public institutions that arise in markets to influence expectation, facilitate coordination, and achieve compatibility.

This paper is organized as follows: In Section 2 we will explain more about different issues related to network externalities. Section 3 focuses on the supply side of network externality that is the main issue of this paper. In two subsections, we describe two important issues in the supply side: compatibility choice by firm and equilibrium pricing. Section 4 consists of conclusions, remarks, and criticism of the papers.

2. Network Externalities and recent work

The first issue with network externalities lies on the demand side. Economists realized that consumers of some products benefit from the products' installed base¹ as well as inherent quality of products. Users must anticipate which technology will be widely used by other users. This will introduce coordination problem, since users may have conflicting preferences about which technology to coordinate on. On the other hand, consumers' expectations about the ultimate network size are crucial to network formation. In Farrell and Saloner (1985) and Tirole (1988), these problems might lead to two potential inefficiencies: 1) users will wait to adopt a new technology or they will choose several technologies (excess inertia). 2) Consumers are afraid of moving alone. So, they will rush to an inferior technology for fear of getting standard with the old one (excess momentum). The issues in the demand side can be studied independent of the way the technologies are supplied.

The second issue relates to the supply side. In the presence of network externalities, standards are often agreed upon by the government or by private bodies such as industry committees. One advantage of standardization is that it avoids excess inertia, and it also reduces the users' search and coordination costs. In Tirole (1988), when technology choices are left to the marketplace, firms sponsoring incompatible technologies have an incentive to develop an "installed base" in order to obtain a competitive advantage over their rivals. To this purpose, different authors suggest a wide variety of ways of competing strategies of firms operating in a market with network benefit such as product compatibility choice, technology sponsorship, penetration

¹ An installed base is a technology that emerges as the standard setting. (Farrell and Saloner, 1985).

pricing, and product pre-announcement. Product compatibility choice and penetration pricing are discussed in the next section of this paper.

In Tirole (1988), on the demand side, the externalities give rise to a multiplicity of equilibria, to inefficiencies, and to a need for coordination. On the supply side, the choice of technology by firms, in order for compatibility, relates to the problem of product diversity. And on both sides, decisions by firms and consumers to choose a technology introduce a timing game. In this survey paper, we will focus only on the supply side.

3. The supply side: sponsorship and strategic behavior

Technologies can have private sponsorship when firms have preferences among those technologies. In Besen and Johnson (1986), sponsorship can arise in one of three ways. First, when each technology owned by a firm through a patent. In this case each firm will prefer its technology to be the “installed base.” Second, when firms have different production costs for different nonproprietary technologies, the firms might prefer standardization on those technologies with cost advantage. Third, when firms have adopted incompatible nonproprietary technologies, private sponsorship of a particular technology can emerge. In this case firms may benefit from a movement to complete compatibility. This happens because the firms that must switch to achieve compatibility may incur costs in doing so. Most of the papers presented in this paper use unsponsored technologies to analyze compatibility decisions². A compatibility decision by firms is one of the most important issues related to the supply side of network externalities. A strategy by the firms can make their product incompatible and reduce the size of their network. Or the firm can achieve compatibility, either individually (by the choice of the technology or

² Katz and Shapiro (1986a) is an exception.

by building adapters) or by reaching agreements with their competitors through committees.

Another important issue in the supply side is penetration pricing. Most of the early models of network externalities included the assumptions that technologies offered by firms were given and firms are limited to choose a particular technology and also the price at which it was offered. In those models, firms had no opportunity to behave strategically, as for example offering lower prices to encourage early adopters. But in recent models, by assuming that different consumers make adoption decisions at different times, the firms have the opportunity of behave strategically by using lower pricing in early periods to influence the choice of later adopters. On the other hand, each firm can be expected to consider the effects of its pricing strategies on both present and future choices by other firms and users. In the next two subsections we will discuss some theoretical literature about penetration pricing and compatibility.

3.1. Compatibility Decision and Standard Setting Process

3.1.1. Katz and Shapiro (1985a) develop a static model of oligopoly to analyze a market in the presence of network externalities. To do so, first, they study the effect of network externalities on the form of the market equilibrium. Second, they explore the compatibility decisions by the firms in a static model³. Because of importance of their model we will briefly explain their model. They assume that a duopoly offers two incompatible and perfect substitute products with the same inherent qualities. On the other hand consumers have unit demands and they are assumed to be heterogeneous in

³ They analyze their model by an unsponsored technology where initially none of the firms has a preference over technologies.

their basic willingness to pay for the product, which uniformly distributed between minus infinity and a positive number, say A , with density one. But, the consumers are homogeneous in their valuations of the network externalities. They impose that in equilibrium consumers' expectation about the ultimate network size are fulfilled. A consumer of type r has a willingness to pay $v(q_i)$ plus a consumer-specific constant, r , where q_i is the size of firm i 's network. On the other hand, a generalized price p_i for a consumer is defined by $p_i - v(q_i^e)$, where p_i is the price charged by firm i and q_i^e is the consumers' expectation of the size of the firm i 's network. Because the two products are perfect substitutes with the same qualities, the consumers choose the product with lowest price: $\tilde{p} = \min(\tilde{p}_1, \tilde{p}_2)$. The number of consumers buying at \tilde{p} is $q = 1 - \tilde{p}$. Assuming the market structure is a Cournot competition, firms choose their output, q_1 and q_2 simultaneously. Then market clearing gives equilibrium price. $\tilde{p} = 1 - (q_1 + q_2)$. The firm thus charges $p_i = v(q_i^e) + 1 - q_1 - q_2$. So, firm i 's profit is $\Pi^i(q_i, q_j) = q_i(1 + v(q_i^e) - c - q_1 - q_2)$. The intuition behind the last equation is that the valuation for the network, $v(q_i^e)$, is equivalent to a reduction in marginal cost or an increase in the demand function. They find Nash equilibrium in outputs under certain assumption on the $v(\cdot)$ function. Then they analyze the same game, assuming that the products are compatible, where the consumer's valuation for the network is $v(q_1^e + q_2^e)$. Finally, they discover that total output is higher in the compatible case⁴.

In Katz and Shapiro (1985), after firms have adopted incompatible technologies and after calculating the cost and benefit of achieving compatibility, a firm with adopted

⁴ See Tirole (1988). (pp 409).

technology may prefer that other firms adopt the same technology. Since, the technologies are nonproprietary no firm can prevent another from adopting a technology and other firms may prefer to remain with an incompatible technology because their profits are larger if they remain with the older technology.

Their model shows the firm's incentive to make its product compatible can be achieved either in a cooperative way through agreement between two firms or unilaterally through the construction of an adapter. Also they find that a smaller firm has more incentive to become compatible than a larger one. In the duopoly case, they examine the incentives of one of the firms to spend a fixed cost in contrast to an adapter that makes its product compatible with those of others. They show that if the combined gains to all firms from compatibility exceed the costs of switching, side payments⁵ among all firms can bring compatibility. They also show that the side payments are necessary to achieve compatibility when some firms are better off without compatibility. Side payments are sufficient to achieve compatibility when the gains of those who benefit from compatibility are greater the losses of those who benefit from incompatibility. Using these definitions, they show that when the gains of side payments to block compatibility are not feasible, then the adapter will be contrasted as long as at least one firm can make positive profit. Katz and Shapiro (1985) based on homogeneous products and elastic demand make their conclusions such as an increase in compatibility leads to a lower price in equilibrium. This can be a disadvantage of this paper, because in the absence of those assumptions their conclusions may not hold.

⁵ Licensing fees and compensation for the expenses of making the products compatible are examples of such payments.

3.1.2. Katz and Shapiro (1992) study the introduction of a new product in a market with network externalities. In many industries on the supply side, there is ongoing technological progress and firms introduce new durable product technology. On the demand side, buyers choose which product to purchase, and each buyer receives greater benefits from the larger network. And the larger one is the installed base of the selected technology. The goal of Katz and Shapiro (1992) is to understand product introduction and pricing in industries where installed bases are important. The key question of this paper is whether there is a bias toward existing products or systems over newer technologies. This bias is described as “*excess inertia*.” They provide some conditions under which *excess inertia* cannot arise. In Katz and Shapiro (1992), entry may be profitable even if it reduces the performance of the industry by losing customers who own the older technology. They show that markets with network externalities in which new technologies are provided exhibit a bias toward new technologies. They call this bias, which is the opposite of excess inertia, “*insufficient friction*.” They determine the pattern of pricing and consumer adoption decisions when an older technology, that is the installed base, compete against a newer technology under two regimes: intergenerational compatibility and incompatibility. Intergenerational compatibility issues focus on the question of whether the sponsor of the new technology designs its product to be compatible with old-generation products. For example the developer of a new audio system may design its system to play music recorded in an older format. With incompatible product, they show that bandwagon effects⁶ and multiple fulfilled expectation equilibria might be occurred. They also find that firms introducing new and

⁶ The tendency for a technology that seems to be winning to gather additional supports simply because of being ahead.

incompatible technologies will bring out their products earlier than would be socially desirable. In contrast to Katz and Shapiro (1985), they find that when licensing fees are infeasible, the sponsor of the new technology is biased against compatibility. The difference between this paper and other papers is as follows: First, in Katz and Shapiro (1992), the technologies are not supplied by perfect competitors, so the pricing is endogenous. Second, the timing of new-technology introduction is also endogenous⁷. These are advantages of this paper.

3.1.3. Converters, emulators, or adapters can make a technology compatible, say partially compatible, with another. Farrell and Saloner (1992) show that for horizontal products, converters might achieve compatibility in competing technologies. They analyze the equilibrium market adoption of incompatible technologies when such converters are available and the incentive to provide these converters is present. They consider a model in which there are two technologies, and the buyer has heterogeneous preferences. They suppose that buyers are “located” on a unit interval where the technologies are located at the extreme points and each buyer has a locational preference for one of the technologies over others. So, the buyer’s utility increases in the number of other users with whom the buyer’s product is compatible. Their model introduces the trade-off between compatibility and variety. They show compatibility may or may not involve loss in the variety of products that are available. For example, standardizing videocassettes on the VHS format would imply the elimination of the beta format, which has advantages in order to compactness, which is an important determinant of the size of

⁷ Other papers like Farrell and Saloner (1986) and Aurtor (1986) restrict their attention to technologies supplied at cost by competitive firms.

videocameras. But, standardizing telephone jacks does not limit the variety of handsets. On the other hand, the authors show that when converters are costless and perfect, they might be profitable, but that situation is rare. In general, the welfare impact of the availability of such converters can be negative or positive. “The converter, by lowering the private cost to a user who disrupts the standards, can reduce welfare by making such disruption more likely, even though they also make it less disruptive.” On the other hand, when compatibility is the only important issue, in the absence of a converter, incompatibility would be the result. In this case, converters tend to increase compatibility and social welfare. They use heterogeneous products and inelastic demand in their model. Also they analyze the trade-off between variety and standardization in their paper. These are the strength of this paper.

3.1.4. Economides (1989) shows that even in the absence of network externalities, prices and profits will be higher in the case of compatibility. He discusses competition under full compatibility and under incompatibility. He shows that for any given number of firms, equilibrium prices and profits are higher under compatibility. He derives the same results in the absence of positive consumption externalities. To explain the intuition behind the pricing results, he supposes that a firm faces the same demand function in the both cases, and the firm cuts the price of its first component under compatibility by p and similarly cuts the price of its system with the same amount under incompatibility⁸. In the case of compatibility, the demand response is in units of the first component, while in the case of incompatibility, the demand response is in units on the first component and the second component. So, the equal price cut will lead to a higher value response under

⁸ Economides (1989) called the products that correspond to the smaller arrays of characteristics, a *component*. And the product that corresponds to the full array of characteristics, a *system*.

incompatibility, which says that residual demand under incompatibility is more elastic. Thus, competition is more intense under incompatibility, and a lower price will occur in this case. On the other hand, a higher profit under incompatibility implies that the number of firms will be higher, and, in that case, a larger number of competitors will increase competition.

This model compares two extreme situations of full compatibility and full incompatibility, and the author does not analyze situations where some firms produce compatible components and some do not. So, we cannot claim that, in general, firms non-cooperatively will choose compatibility. This is a weakness of this paper.

3.1.5. Baake and Boom (2001), analyze the subgame perfect equilibrium of a four-stage game in a model of vertical product differentiation where the consumers' utility depends on products' quality and the network's size. This paper focuses on compatibility decisions of oligopolistic firms where network externalities are a new quality dimension, which the firms can control. They analyze the effect of existing adapters on the compatibility decisions, product prices and social welfare. In contrast to the other existing literature, where the network size is the only vertical dimension, they assume that consumers' willingness to pay increases in both the product's quality and the size of its network. In a two player's game; first, two firms choose their products' qualities q_1 and q_2 from the interval $[0, q]$ non co-operatively. Second, they may mutually agree on providing an adapter before competing in prices, if they do, they need the consent of their rival. Third, the firms set their price p_1 and p_2 non co-operatively. Finally the consumers decide on buying one, or none, of the two products. They derive the subgame perfect equilibrium from the subgame perfect equilibria where the reduced

game is analyzed for both compatible and incompatible cases. In the absence of adapter the high quality firm has a larger competitive advantage and also its higher quality attracts more consumers, and increases its network size and the quality received by consumers is higher. Hence, the high quality firm would prefer no adapter to be provided, and low quality firm prefers an adapter. They show that how the low quality firm can successfully prevent the incompatibility equilibrium through its quality and price choice. Finally, they show that both firms might be agreeing on the contract an adapter although the high quality firm prefers equilibrium without an adapter. Their results show that social welfare is higher with an adapter and also the network externalities consumers enjoy are greater than the case without an adapter.

3.2. Promotional Pricing and the Coase Theorem

A question that economists have to address is to what extent the dynamic monopoly pricing theory applies to goods which exhibit positive network externalities. Coase (1972) has developed the implication of such theories. Coasian Dynamic theory consists of two theories: “1) higher valuation adapters make their purchase no later than lower valuation adapters (the skimming property). 2) Equilibrium price is non-increasing over time (the price monotonicity property).” In the recent papers, authors show that the second property need not always hold when network externalities are present. By employing promotional pricing in early periods, firms are able to increase the installed base of their products and also the size of the networks. This may affect their sales in later periods. Since the externalities to consumers depend on the number of other users on the same network, a firm can increase the demand for its product by reducing the price to those consumers who adopt its product early. So, under some assumptions, this can be

a profitable strategy. Presented in this subsection are examples of models in which strategic behavior of this type is analyzed.

3.2.1. Katz and Shapiro (1986a) develop a simple model of technology adoption in industries in the presence of network externalities and relation between the adoption pattern and technology sponsorship. They also examine the implications of strategic pricing when there is competition between two technologies. First, they explain how technology adoption in industries depends on whether technologies are sponsored, where the sponsor is an entity that has property rights to the technology. Second, in the simplest case, they show that, if a single firm controls the property rights to a given technology, then a supplier will be willing to make investments in the form of promotional pricing to establish the technology and extend the size of the network. These investments have later benefits when prices are greater than the marginal cost. In the demand side, the authors establish a model to show how consumers respond to a given time path of prices. To do so, they consider a two-period model and a two-time period generation of consumers. A period t consumer has a completely inelastic demand for one unit of the good in that period where there are two technologies with different prices in each period. They suppose that the first product is cheaper to produce in the first period and that the second is cheaper in the second period. For example, if a second product is a newer technology, it can be expected that the market be biased toward the first technology. So, a firm would build an installed base in the first period and use this installed base to corner the second-period market. However, market adoption is biased toward the technology that is cheaper in the second period. A firm can penetrate the market in the first period by pricing low and using a cheap technology in the second period. Its low second-period cost commits it

to a low second-period price and increases the network size in the second period. Thus, technologies cannot guarantee an extension of its installed base if its owner cannot commit to a low second-period price. So, sponsorship can internalize some of the externalities through below-cost pricing at the beginning of a technology's period. On the other hand, in Katz and Shapiro (1986a), sponsorship can create some problems for the sponsor. For example, when one technology is sponsored and the others are not, the sponsored technology tends to be adopted too much.

3.2.2. Cabral, Salant and Woroch (1999) address the questions: "How should a monopolist price a durable good or a new technology that is subject to network externalities? And should the monopolist set a low 'introductory price' to attract a 'critical mass' of adapter?" Where "critical mass" here is the minimum network size that can be sustained in equilibrium, given the cost and market structure of the industry.

In their paper, they provide intuition as to when and why introductory pricing might occur in the presence of network externalities. They characterize the equilibrium price path when a monopolist sells a durable good that gives a network externality to a set of rational buyers. They establish whether equilibrium prices can increase over time under some assumption related to the size of consumers, demand, and cost. Cabral, Salant and Woroch (1999) describe situations in which introductory pricing is an equilibrium pricing strategy when network externalities prevail and monopoly power is present. Furthermore, in each model they present, introductory pricing fails to occur unless network externalities are present.

They also develop a model in the case of unknown cost to buyers. They find perfect Bayesian equilibria in which discounted prices rise over time. They show that firms use introductory prices as a signal of low cost. So, this may raise early buyers'

expectations about the likelihood of future sales. “The lower the seller’s cost is, the greater future sales will be, and thus the higher the expected utility of purchase today is.”

The second question of Cabral, Salant and Woroch (1999) is related to verification the “Coase conjecture” regarding a monopolist selling a durable good. Using different cases of perfect and incomplete information, they find equilibria in which prices increase over time. The intuition for the latter results is different between the two cases of small buyers and large buyers. When buyers are small, the firm will charge a low first-period price to compensate for the uncertainty of early adoptions. When buyers are large, delaying a purchase can actually increase the probability that other buyers will eventually adopt. In this case, the firm sets a lower first-period price to encourage consumers to delay adoption.

3.2.3. Bensaïd and Lense (1996) study the optimal dynamic monopoly pricing for a good, which exhibits positive network externalities. They show that positive network externalities lead to the monopoly price of a durable good increasing over time and so invalidate the Coase results. They provide an explicit analysis of this possibility in a discrete time model. They demonstrate a certain type of network externalities in which the monopolist prices above marginal cost at all times. They show if the externalities are sufficiently large, prices may rise over time and the monopolist’s profits may not be affected if it does not have the ability to commit to a production plan.

In Bensaïd and Lense (1996), the consumers’ intertemporal substitution effect is satisfied by a vertical differentiation effect. When the monopolist lowers its first period price, this increases the number of initial consumers and also increases the quality of its future production through the network externalities. This could allow a credible increase

of its future prices. In any case, future prices could fall under consumers' valuation of the network effect. As this valuation is greater than the marginal cost, this ensures that the monopolist will make non-negligible profits.

3.2.4. Mason (2000) examines the production of a durable good in the presence of network externalities. The main question in his paper is: "What is the effect of market structure on the development of a network in a dynamic model with rational expectation?" First, he shows that the Coase conjecture fails when network benefits are increasing in the current network size. The last buyer has a total valuation equal to the marginal cost of production. Consumers anticipate that price will equal cost in the long run. This leads the price of the good to drop in the continuous time model. Secondly, when network externalities are sufficiently large, a committed monopolist might be socially preferable to a time consistent producer. Mason also demonstrates that both the competitive market and the monopolist produce less than a planner who would fully internalize the externality does.

Mason (2000)'s model has the limitation that network externalities are not allowed to vary over time with the size of the evolving network. When network benefits are increasing in the network size over some interval, industries extend the network too slowly compared to the social optimum.

3.2.5. Economides (2000) analyzes the model of multi-period monopoly in durable goods. He shows that nominal and real prices decrease over time but above cost, which is a violation of the "Coase conjecture." He also considers the case in which the monopolist introduces "new" durable goods, which are partially compatible with "old" durable goods. In this case, he finds that introduction of new goods which have variable

degrees of network externalities compared to older ones could lead the monopolist to increase price over time. In Economides (2000), a monopolist who faces a possibility of entry in the future, which may drive prices to marginal cost in future periods, will charge significantly less than a monopolist who does not face such threat. The extent of the threat depends on the degree of compatibility of the entrants' products with the products of the incumbent monopolist. He finds that partial compatibility occurs when the intensity of network externalities in the case of weak partial forward compatibility is low compared to the intensity of network externalities in the case of partial backward compatibility⁹. He shows that a new product introduced by an entrant is successful when it has strong externalities arising from forward compatibility. In this case, the entrant and the incumbent have opposite incentives with respect to the degree of forward compatibility of the new product.

4. Conclusions and Remarks

Network Externalities are real and important phenomena. The popular example is the telephone network. The value of phone service depends on the number of people who have phone service. On the supply side of network externality issues, firms that compete in markets where network externalities are present face tradeoffs between technical standards. On the other hand, learning compatibility standards allow the firm's product to capture the benefit of a large network. These features bring some competing strategies for firms operating in a market with network externalities, such as product compatibility decisions, technology sponsorship, promotional pricing and product pre-announcements

⁹ Partial forward compatibility influences the demand of the old good from sales of the new one and partial backward compatibility influences the demand of the new good from sales of the old one.

described above. In the models of the supply side, there are some omissions related to the analyze of network externalities. Since the models are limited to non-cooperative settings, they are useless in analyzing the cases in which standards are developed cooperatively. Some models suggest situations in which cooperative behavior is desirable, however, they do not explore in detail whether cooperative behavior will occur, what form of cooperation it will take, which firms will deviate from cooperation and whether the standard that is chosen will be the correct one¹⁰. The models described in the previous sections generally deal with the behavior of a single firm and a single set of users. But many different types of firms are often influenced on the standard setting process and setting the promotional prices. These models do not examine a complicated model in which compatibility is achieved via coordination among a more diverse collection of agents.

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¹⁰ Katz and Shapiro (1992), Besen and Saloner (1987) and Besen and Johnson (1986) express this same critique in papers.

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Soheil Yousefsibdari

Grado Department of Industrial and System Engineering
Virginia Polytechnic Institute and State University (0118)
Blacksburg, VA 24061-0316
USA

Home: (540) 200-0082
Office: (540) 231-6656
Fax: (540) 231-3322
email: ssibdari@vt.edu

EDUCATION:

Ph.D. candidate Industrial and Systems Engineering (Operations Research),
expected 2004, Virginia Polytechnic Institute and State University, Blacksburg, VA.

M.A., Economics, May 2001, Virginia Polytechnic Institute and State University,
Blacksburg, VA. Thesis title: “The Behavior of Technology Suppliers in the Presence
of network Externalities: Offering a Cheap Low-Quality Product.”

M.A., Socio-Economic Systems Engineering, Jan. 1999, Institute for Research in Planning and
Development (IRPD), Tehran, Iran, (Incomplete).

B.S., Computer Science, University of Shahid Beheshti (USB), Tehran, Iran, 1997, Thesis Title: “
Design a Software Interface for a Persian Digital Counter.”

PROFESSIONAL EXPERIENCE:

Research assistant to Prof. Djavad Salehi-Isfahani at Virginia Polytechnic Institute and State University, Economics Department in the project “Fertility Transition or Intertemporal Substitution in Post-Revolution Iran?” August 2000 to date.

Computer staff, Department of Economics, Virginia Tech, USA, Aug. 1999 - Oct. 2000. Performing System Administration, System Support and Web design.

Research assistant, IRPD, Tehran, Iran

- “ The Plan of Amending Structure of Commercial and Policies and International Trade”, Prof. Zooalnor, June 1998- August 1999.
- “Study of politics, Locality and Economic Restructuring of strawberry Industry in the Kordestan Area.”, Prof. Asali, August 1998- Jan 1999.
- "Economic aspects in service of addiction (a Section of National Plan to Confront Drug abuse in Iran)", Prof. A. H. Mehryar and Prof. Salehi, December 1996-June 1997.

Research expert to Strategic Planning Department at Chabahar and Qeshm Free Zone in the project “Strategic planning in Qeshm Free Zone.” August 1997- August 1998.

- Assist in the project “Official automation system and Strategic Planning in Qeshm Free Zone using the Balanced Scored Card method and Linkwork package.”
- Development and justified control for existing projects including identification of profit improvement, design of advanced control strategies, and project justification.

Teaching assistant to Prof. Mortezaei at USB-Computer Science department- in the Network Architecture Programming, Aug 1994-Jan 1995 and summer 1995.

TEACHING:

Introduction of Programming in Pascal, summer 1994, Office of Razmandegan, University of Shahid Beheshti (Tehran-Iran).

One year of experience as a **tutor** in the Economics and Athletic department at Virginia Tech (2000-2001) and also four years of tutoring in different high school (1992-1996).

SKILLS:

Economic Analysis

- Time series and Cross-sectional analysis
- Maintaining databases
- Forecasted Economics Trends

COMPUTER SKILLS:

- Language: C++, JAVA, HTML, Visual Basic, and Fortran.
- Software: - Extensive work in Matlab, Stata, Eviews, TSP, Vensim, Microsoft Project and Microsoft Office (Access, Excel, Word and Power Point).
- Working knowledge of Statistical Analysis System (SAS)

LANGUAGE:

- Persian: Maternal language • English: Fluent • Arabic: Reading and Writing

ENGLISH TRAINING:

- GTA (Graduate Teaching Assistant) Training Workshop, Virginia Tech fall 1999
- Advanced technical writing, Virginia Tech spring 2000
- Teaching and Presentation Skills: English as a Second Language, Virginia Tech fall 2000

HONORS:

- Number 19 in national-wide university entrance competition among almost 120,000 competitors at 1992

REFERENCES:

Professor Djavad Salehi-Isfahani.
Department of Economics (0316)
Virginia Tech
Blacksburg, VA 24061
(540) 231-4069
salehi@vt.edu

Professor Nancy Lutz
Department of Economics (0316)
Virginia Tech
Blacksburg, VA 24061
(540) 231-7353
nlutz@vt.edu

Professor Amir H. Mehryar
Institute for Research in Planning and Development
Tehran, Iran
mehr@dena.irpd.ac.ir

Professor Shahla Tabatabai
Department of Computer and Electronic
Shahid Beheshti University
Tehran, Iran
S-Tabatabai@cc.sbu.ac.ir