

Price Elasticity of the Enterprise Computing Resource Market

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Abstract—Pricing is an important property of a product in that it significantly affects the customer's purchasing behavior. In the enterprise computing resource market, suppliers often compete for market share with price reductions. In many cases, price reductions are the outcome of business intuition rather than rigorous reasoning, and often at the cost of losing revenue and profit. In this paper, we study the supply and demand relationship of the global enterprise computing resource market, using market research data between 2006 and 2013. We find out that consumers in different market segments are not equally sensitive to price changes, and we quantitatively measure such sensitivity with the concept of price elasticity of demand. Furthermore, we analyze the success and failure of the major players in the market using the theory of price elasticity of demand.

Index Terms—enterprise computing resource market, cloud computing, microeconomics, price elasticity of demand

1 INTRODUCTION

Pricing strategies are crucial business decisions in the life cycle of a product, especially when there are multiple competitors in the market. In a perfect competition market, there are multiple suppliers offering similar products, while no participant is powerful enough to control the price of the product. To compete for market share, suppliers often use price reduction in promotional campaigns. However, many of such price reductions are the outcome of business intuition rather than rigorous reasoning, and often at the cost of losing revenue and profit.

The enterprise computing resource market seems to be a perfect competition market with multiple players. Traditionally, enterprise can buy servers from hardware vendors, or rent servers from hosting service providers. In recent years, Infrastructure-as-a-Service (IaaS) is gradually making its way into the enterprise computing resource market. Amazon Web Services (AWS) are widely recognized as examples of public cloud services. Over the past years, the market witnessed a trend in developing new applications on AWS, or migrating existing applications to AWS. Inspired by the dramatic growth of AWS, there quickly emerged many followers in the market, including Microsoft Windows Azure and Google Compute Engine. New service providers often employ price reduction as a strategy to win customers from competitors. Existing service providers are forced to carry out further price reductions to maintain competitiveness in the market. In this study, we are particularly interested in the following three questions:

- In the enterprise computing resource market, how sensitive the consumers are to price changes?
- Is price reduction an effective way to win in the market?

- Does cloud computing exhibit the same supply and demand relationship?

To answer these questions, we study the supply and demand relationship of the global enterprise computing resource market between 2006 and 2013. We quantitatively measure the consumer's sensitivity to price changes using the concept of price elasticity of demand. We analyze the impact of different pricing strategies on the performance of the business, using the server sales business of IBM, HP and DELL as case studies. This research provides new insights into the microeconomics characteristics of the enterprise computing resource market, and can help participants in various market segments design better pricing strategies.

For the server sales business, we collect data from Gartner's quarterly reports on worldwide server shipments between 2006 and 2013. For the server rental business, we use Rackspace as an example of this market segment, and collect data regarding revenue and the number of servers from Rackspace's annual report (Form 10-K) to the United States Securities and Exchange Commission (SEC). For public clouds, we use the estimated number of servers for AWS EC2 derived by a number of cloud computing professionals in the industry as the foundation to carry out our analysis.

2 THE ENTERPRISE COMPUTING RESOURCE MARKET

The major suppliers in the server sales business are hardware vendors, including IBM, HP, and DELL. Consumers can order servers directly from the vendors, or through a third-party distributor. The cost to acquire new servers is denoted as capital expense (CapEx) in accounting, and is usually paid to the

supplier in a single payment before or after hardware delivery. Depending on the brand name and the configuration of the product, the acquisition cost can vary from thousands to tens of thousands of US Dollars per server. The acquisition time usually falls within weeks for low-end servers when local stockage is available, but can be months for high-end servers requiring pre-orders. When the servers are delivered to the consumer, their ownership is also transferred to the consumer. The life cycle of server hardware usually falls between three to five years, depending on the accounting and fixed-asset depreciation policies of the consumer. It is the consumer's responsibility to maintain the health of the server hardware, unless the consumer chooses to purchase additional service contracts from the vendor.

The major suppliers in the server rental business are hosting service providers, including Rackspace, OVH, and SoftLayer. Consumers usually establish a server rental contract directly with the service provider. The length of the contract varies from months to years, depending on the consumer's need for computing resource. According to the contract, the consumer pays a recurring monthly fee to maintain access to designated computing resource through network. Such cost is denoted as operations expense (OpEx) in accounting. Depending on the configuration of the computing resource, the recurring cost can vary from hundreds to thousands of US Dollars per server per month. The time needed to acquire access to computing resource after signing the contract usually falls within days, but can be weeks if new computing resource needs to be ordered by the service provider. The server rental contract does not change the ownership of the computing resource, but some service providers choose to give the ownership to the consumer after the successful execution of a long contract (e.g., 3 years). The server rental contract usually comes with a service level agreement (SLA). It is the service provider's responsibility to maintain the health of the computing resource to meet SLA requirements.

The major suppliers in public clouds are AWS, Google Compute Engine, Microsoft Windows Azure, and Rackspace. Consumers can directly request for, and gain instant access to, computing resource through web portals or application programming interfaces (API). In a manner similar to public utilities such as gas and electricity, consumers only pay for the amount of computing resource they use for the duration of their usage. The cost associated with such usage is denoted as OpEx in accounting. The time needed to acquire access to computing resource after request usually falls within minutes. The ownership of the physical computing resource always belongs to the service providers. Consumers do not bear any responsibility for the underlying infrastructure beyond the pay-as-you-go expense. It is the supplier's responsibility to maintain the health of the computing

resource to meet SLA requirements.

3 ANALYSIS ON PRICE ELASTICITY OF DEMAND

3.1 Price Elasticity of Demand

Price elasticity of demand is defined by the percentage change in demand over the percentage change in price. More formally,

$$E = \frac{\left(\frac{dQ}{Q}\right)}{\left(\frac{dP}{P}\right)}, \quad (1)$$

where E represents the price elasticity of demand, P represents price and Q represents demand, while dP and dQ represent the percentage changes (in absolute values) in price and demand. When E is greater than 1, the percentage change in demand is greater than the percentage change in price, which is classified as elastic demand. When E is smaller than 1, the percentage change in demand is smaller than the percentage change in price, which is classified as inelastic demand. When E equals to 1, the percentage change in demand equals to the percentage change in price, which is classified as unitary demand. When demand is inelastic, a rise in price leads to a rise in revenue. When demand is elastic, a fall in price leads to a rise in revenue.

In general, there are two factors contributing to the price elasticity of demand of a product. The first factor is the availability of close substitutes. If a buyer has greater choice among close substitutes in consumption, the price elasticity of demand is greater. The second factor is the proportion of a buyer's budget that is devoted to a product. The larger the proportion of budget, the more responsive is the quantity demanded to price changes, and the price elasticity of demand is greater.

To identify the price elasticity of demand in this study, we carry out linear regression with history price and demand data. We can express the relationship between price and demand as

$$Q = b_0 + b_1 P. \quad (2)$$

The slope of a linear curve b_1 can also be expressed as

$$b_1 = \frac{dQ}{dP}. \quad (3)$$

Therefore

$$E = -b_1 \frac{P}{Q}. \quad (4)$$

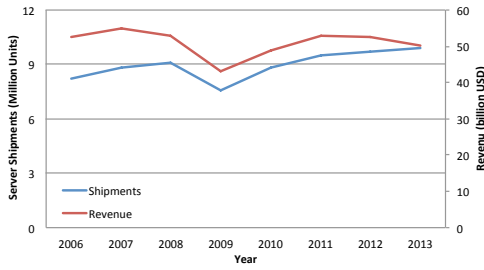


Fig. 1. Worldwide server shipments and revenue

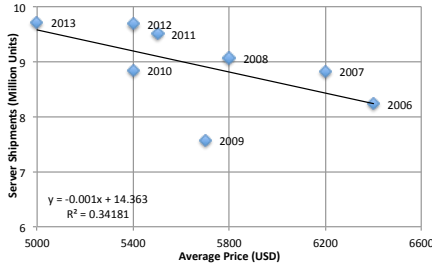


Fig. 2. Demand curve for server sales business

3.2 Price Elasticity of Server Sales Business

Figure 1 shows the number of worldwide server shipments and the revenue between 2006 and 2013. The significant drop in both server shipments and revenue in 2009 was the result of the global economic recession between 2008 and 2009. Figure 2 is a supply and demand plot for the server sales business with a linear regression trend line, where supply is represented by the price and demand is represented by the number of server shipments. Using Equation 4, the price elasticity of demand for the worldwide server market is calculated as 0.51 in 2013, which is extremely inelastic.

For enterprise consumers, when they need computing resource the first option that comes to mind is purchasing some server hardware. Other forms of computing resource are not close substitutes for various reasons. From a budget perspective, server hardware purchases, as fixed-asset investments, are usually decided at the organization level, and are only a small proportion of an organization's annual budget. The lack of close substitutes, and the small proportion of budget, combined contribute to the inelastic demand in server hardware. In other words, organizations invest on server hardware based on their business plans, regardless of price changes in the market.

A fundamental characteristic of inelastic demand is that the percentage change in demand is less than the percentage change in price. In other words, price reduction might produce more demand, but will also result in revenue lost. As shown in Figure 1, Regardless of the steady growth in worldwide server shipments, the overall revenue from server sales seems to be decreasing.

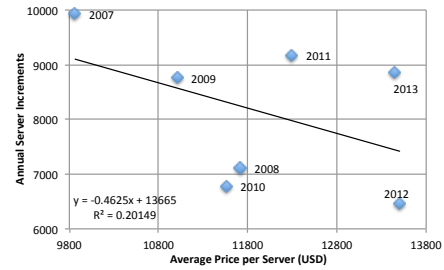


Fig. 3. Demand curve for server rental business

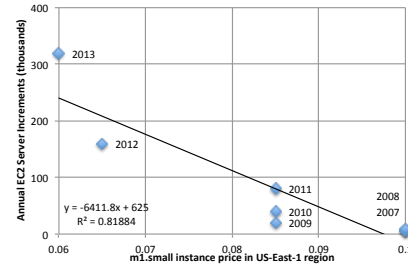


Fig. 4. Demand curve for Amazon EC2 Service

3.3 Price Elasticity of Server Rental Business

In Section 3.2, the number of worldwide server shipments represents the newly added computing resource every year. To facilitate a fair comparison, we calculate the annual server increments for Rackspace's dedicated hosting business, and use that number to calculate the price elasticity of demand. Figure 3 is a supply and demand plot with the average price on the horizontal axis and the annual server increments on the vertical axis, with a linear regression trend line. The calculated price elasticity of demand for Rackspace's dedicated hosting business is 0.70 in 2013, which is modestly inelastic.

Enterprise consumers choose server rental over buying server hardware for various reasons. For small and medium businesses, the cost and effort to build and maintain a small data center with the appropriate networking capacity is overwhelming. There are many server hosting service providers available, including international and local ones. An enterprise usually go through a comparison and selection process before deciding which vendor to work with. Once a decision has been made, a long-term contract with the selected vendor will be setup. The length of such contract is usually measured by months or even years, depending on the consumer's business plan. Such a long-term contract effectively eliminates the possibility of migrating to alternative options when there is a price change in the market. Thus, enterprise consumers invest on server rental based on business plans, which are usually not sensitive to price changes.

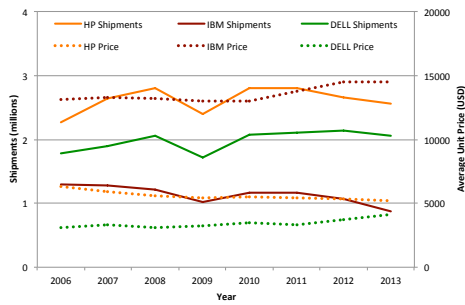


Fig. 5. Server shipments and average prices for HP, IBM, and DELL

3.4 Price Elasticity of Public Clouds

For the public cloud business, we use the estimated number of servers for AWS EC2 derived by a number of cloud computing professionals in the industry as the foundation to carry out our analysis. Figure 4 is a supply and demand plot showing the estimated amount of annual EC2 server increments and the price of m1.small instance in US-East-1 region between 2008 and 2013, with a linear regression trend line. The calculated price elasticity of demand is 1.20 in 2013, which is modestly elastic.

Many consumers consider EC2 as an alternative to traditional server rental services and virtual private server (VPS) services. Spending on EC2, as an operations expense, is usually decided at the project level, and is usually a big portion of a project's budget. The availability of close substitutes, and the big proportion of budget, combined contribute to the elastic demand for EC2. In other words, enterprise consumers spend on EC2 based on actual business needs rather than business plan, and are sensitive to price changes because of budget limitations.

In general, inelastic demand is closely related to planned buying, while elastic demand is closely related to unplanned buying. With the fixed-asset model, when enterprise consumers need computing resource, the budget for the needed computing resource must first be secured before making an order. Then it takes weeks for the needed computing resource to be delivered and deployed. With the utility model, consumers have instant access to computing resource with no capital expense at affordable prices. In other words, the utility model makes it possible for customers to react to price changes in a timely manner.

4 CASE STUDIES

Figure 5 shows the annual server shipments and the average prices for IBM, HP and DELL. The significant gaps in the average prices indicate that these vendors are not competing in the same fine-grained market segment. IBM dominates the high-end server market, HP occupies the mid-range server market, while DELL dominates the low-end server market.

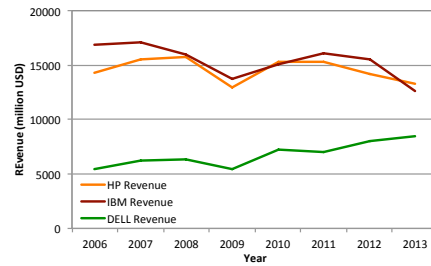


Fig. 6. Revenue for HP, IBM, and DELL

For IBM, the average price did not change much between 2006 and 2010. The slight decrease in its annual server shipments during this period was an indicator that the market preference was gradually shifting from high-end servers to mid-range and low-end servers. Between 2010 and 2012, there was an 11% increase in the average price, with a corresponding 8% decrease in shipments. The price elasticity of demand for IBM servers was 0.73, which was modestly inelastic. For HP, there was an 18% percent decrease in average price between 2006 and 2013, with a corresponding 13% increase in shipments. The price elasticity of demand for HP servers was 0.72, which was very similar to IBM. For DELL, there was a 28% increase in average price, with a corresponding 15% increase in server shipments. The simultaneous increase in price and shipments indicates that the price elasticity of demand for DELL servers was extremely inelastic.

The inelasticity in demand, plus the significant gaps in the average prices, suggest that enterprise consumers do not perceive IBM, HP and DELL servers as close substitutes for each other. These vendors are de-facto monopolies in their own fine-grained market segment, and have the market power over pricing. IBM responded to the inelastic demand with up-pricing. However, the market preference was shifting from high-end servers to mid-range and low-end servers, resulting in the decrease in revenue. HP responded to the inelastic demand with down-pricing, resulting in increase in shipments but decrease in revenue. DELL responded to the inelastic demand with up-pricing. Coupled with the shift in market preference from high-end servers to mid-range and low-end servers, DELL achieved simultaneous increases in shipments and revenue.

5 CONCLUSIONS

In the paper, we study the supply and demand relationship of the global enterprise computing resource market, using market research data between 2006 and 2013. We reveal and conclude that:

1. The enterprise computing resource market is not a perfect competition market. In the server sales business, the hardware vendors are not competing in the same fine-grained market segment. IBM dominates

the high-end server market, HP occupies the mid-range server market, while DELL dominates the low-end server market. They are de-facto monopolies in their own fine-grained market segment, and have the market power over pricing.

2. The price elasticity of demand is inelastic for the server sales business and the server rental business. Enterprise customers purchase or rent server hardware based on their business plan, and are less sensitive to price changes in the market. The price elasticity of demand is modestly elastic for public clouds. Enterprise consumers using public cloud are sensitive to price changes, and tend to respond to price deductions with increasing consumption.

3. Price reduction is an effective pricing strategy for inelastic demands. In our case studies, HP made an unfavorable response to the inelastic demand by down-pricing, resulting in increases in shipments but decreases in revenue. DELL made a favorable response to the inelastic demand by up-pricing, resulting in increases in both shipments and revenue.

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