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Role of Technological Factors in the Price: A Cross Country Comparison across Server Vendors

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The presence of alternative technology platform and alternative technology architecture provided by rival brands has added a new dimension in the quality adjustment for the construction of price indexes for computer server. The earlier attempts to construct hedonic price index have mainly focused on mainframe segment of the computer market and hence did not take into account alternative technology architecture. Moreover, the contribution of "Moore's Law" has implication on these studies as the presence of next level technology can provide better performance at a cheaper cost. This research article analyses the technological determinants of server prices with the help of hedonic regression for three major brands namely, IBM, HP and SUN. The analysis shows that alternative technology architectures play an important role in the variation in computer server price while interestingly, the types of operating system (OS), as an essential software component, do not play any significant role. This analysis also shows that irrespective of the vendors, the price variation tendency based on the components of the system remain almost same across countries under study (in India, China and Singapore).

JEL classification: D40, L1, L63, O3

1. Introduction

Competition and rapid innovation outdates a product in the technology market much before than its lifetime expires. This difference in the product life and market life plays an important role in setting the price of a product by a firm to maximise return from the investment it made before a new and more advanced technology drives the existing product out of the market. In unison, to reduce the risk of investment associated with its own innovation process, especially in the technology market, a vendor normally offers a wide range of products. Products with varieties of specifications gives rise to a vast range of model of the same system and are made available in the market at different price range. According to the researchers, albeit absence of general consciousness, this normally leads a firm/ vendor to adopt a quality adjustment pricing strategy.

In real life, construction of price index[1] is complicated by the changes in the quality of the goods included in the index. A failure to adjust for changes in price resulting from an improvement in quality will lead to biased estimates of the actual rate of inflation. Therefore, the problems of quality adjustment cannot be ignored in any market. A computer market with various components and technology factors - which are responsible for the system's performance, can be considered as a model market for analysing the problems of constructing price indexes. This problem becomes severe in case of server[2] because of the presence of alternate platform technology[3] and alternative technology architecture[4] of its various components. Since server is considered as a general purpose technology[5] and has a network effect (which also involves switching cost), a lack of proper pricing strategy and therefore resulting in a lack of competition in this market may cost an economy. Moreover, customers claim

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that even in the presence of competition among the firms, prices are on the higher end for high end server in comparison with the entry level server (Kathuria & Bera, 2010). Therefore an examination of quality adjusted price index in this market is justified. In an early study of the computer industry, Ratchford and Ford (1976) found that machines produced by the dominant firm (IBM), carry a quality adjusted price premium of 40-50 per cent over those made by its competitors. However, constant innovation and claimed superiority of its products forces vendors to go for price negotiation. Price negotiation takes place because consumers are also well aware about the availability of the latest technology, technical specificity and functionality of the system.[6] Therefore it is important to know how the quality components determine the price of a system.

Previous attempts to construct a quality adjusted price indexes for computer was done with the main focus only on mainframe segment of this market (Nelson, Tanguay, Patterson, 1994). Most of these studies focussed on the price falls due to the introduction of a new advanced technology. The earliest study by Chow (1967) found that quality adjusted prices fell by an annual average rate of 21 per cent over the period 1960-65. Gordon (1990) also has done a similar study for personal computer based on pilot survey. There is no doubt that contribution of "Moore's law" has implication on these as the presence of next level technology can provide better performance at a cheaper cost. However, in a market, where alternate technology platforms coexist with a significant share of total market, pricing strategy becomes more complicated to achieve market efficiency and to increase profit. Although there are a number of studies (e.g., Rochet and Tirole, 2003; Caillaud and Jullien, 2003; Armstrong, 2005; Katsamakas and Economides, 2006) that focused on the market where an intermediary provides a products/ services to two or more sides of the market, unfortunately none of these studies have taken alternative technology architecture that has added a new dimension in the (one sided market of) ICT segment. Existence of alternative technology architecture with varying performance level may leave an impact on the price of the system. This calls for examining the quality components of the price of a system before constructing hedonic price index. In this paper our main objective is to bridge that gap by analysing the technological determinant of the price of the server system rather than focusing on the changes in the quality adjusted price of a particular vendor over a long period of time. Again since in technology market(especially in server market), transactions are made on the basis of dealing price, depending on the demand a vendor may adopt different pricing strategies across countries. There is no such meaningful study on server market in this regard. We are also interested to know whether vendors have different pricing strategy for different market situation, particularly in the different countries.

The paper contributes by identifying the components of a system first by considering those as probable factors of the system price. After identifying the variables paper focus on the methodology adopted to carry the analysis both for RACK server as well as for Standalone server. Keeping the nature and types of the server, a separate analysis for both the types of server for each country has been conducted. Thereafter a cross country comparison is made in the same section followed by a conclusion.

2. Technological Determinants of Price

In a technology market, especially ICT products show a very rapid change in quality, and accordingly they throw the quality adjustment problem in hedonic price indices.[7]In

case of computer server, introduction of the new products pushes the old products to the lower segments of the market by offering those at a lower price and hence lingers its exit from the market. Since there is no strict mechanism for segmenting the market, lower end server hypothetically can compete with the high end server.[8]This indicates that environment of server market is such that an old model can coexist with the new and more advanced model and market life of the products lasts a little longer. Moreover, in the server market, products offered by a vendor are usually based on specific technology architecture; rival products based on alternative technology architecture therefore make it difficult to compare the quality adjusted price of these products.

Perspicuously, an analysis of price of the server needs to take into account the technology architectures that are responsible for the quality of a system. In this paper we have carried out a simple econometric analysis to understand how the technology factors are affecting the price of a system.

3. Variables Considered

Vendors usually do not mention their list price in their website because installation of a system requires modification and customization according to the need of the customer. This customization involves cost and it forces the customer to consider a dealing price rather than the list price. Since a system consists of number of hardware and software components, hence the presence of various technology factors come into play. Therefore, it is fair to assume that a deal is made only after considering these factors. This dealing price may include discount given to the customer and therefore it is difficult to calculate average price of a machine in order to compare it with the similar machine provided by other vendors. Although dealing price depends on a number of attributes (i.e. size of the user, brand reputation, etc), it is safe to assume that for a particular vendor, price will vary depending on the technology factors such as the type of processor and number of CPU installed in a system. In our model, the dependent variable is the average price of the system, which equals to revenue earned/ number of shipment. This average price of the system includes the price of operating system (OS).

After discussing with various industry experts both from supply and demand side, independent technology variables that we have considered in our model are as follows.

CPU (central processing unit)(types of processor) - A particular type of processor is made to do a particular type of work. Hence the efficiency varies depending on the type of work that a client wants to do. There are various processor architecture available in the market among them x86, RISC are considered as most popular. In our analysis we have grouped all other processor as ‘others’ which include IBM’s power processor. Depending on the licensing pattern, these processors again can be divided into two groups; X86 architecture is considered as open technology whereas others are identified as proprietary technology. In our model, following industry perception we are assuming that that proprietary technology will be costlier than open technology.

Number of CPU - Although a particular type of processor is made to do a particular type of work, but the speed of a system depends on the number CPU in it. Greater number of CPU in a system increases its speed and hence reduces the computing time. Since a faster system is expected to come at higher price, we are assuming that

greater the number of CPU, higher will be the price of the system. In our model number of CPU is a pure number.

Types of OS (operating system)– Operating System (OS) is a software platform on which a user can run a number of applications. Therefore an OS integrates the varieties of applications running on the same machine. Since a solid, secure and scalable platform helps to run varieties of application smoothly, types of OS can be considered as an important factor in determining the price of a system. There are two types of OS available in the market- *proprietary software* developed by hardware vendor and by individual software company like Microsoft and *open source software* which is available at free of cost or at a very low price. Since functionality of a system largely depends on the efficiency of the OS to run a particular type of application, it is expected that proprietary software will have more influence on pricing. It is also true that open source software (especially OS) is yet to get popularity among the industry users because of the lack of service providers.[9]In our model we have considered Windows OS, which has a large market share, as a standard OS to compare the role of OS on the pricing.

Rack Density– The rack contains multiple mounting slots called bays, each designed to hold a hardware unit. Bigger the space it takes higher will be the footprint cost and cooling cost. Clearly a server with a smaller number of racks will be more condensed and is expected to lower the running cost. A server with a greater number of racks will have the capability to handle more dataflow. This indicates that a server with higher density may have a higher price. In our model, we are assuming that a server with higher rack density will be costlier than the server with a low rack density.

Core-central processing units of a computer are known as core. Core is the unit that read and execute program instructions. Core indicates the number of processor in a computer chip. Each processor have their own data path, logic units, etc. and therefore the throughput (the number calculations done at a time). This indicates increased number of core in a computer chip improves the performance of the system. In our model we have assumed that greater the number of core higher will be the price of the system.

4. Data and Methodology

After selecting the variable, we have collected data from Gartner[10]for the time period 2000-2009. In order to compare the impact of technology factor on price, we have used a simple hedonic regression method with an ordinary linear approach given by

$$P = \alpha_1 + \sum_{k=1}^{K} \beta_k x_k$$

With hedonic prices $\frac{\partial P}{\partial x_k} = \beta_k$, where x_k is the k-th character of a component and β_k indicates the *marginal change* of the price with respect to a change of the k-th characteristic x_k of the system. A modification over simple hedonic model has been made by introducing two multi-class dummy variables for the processor and operating system separately in our regression model. In our model we have selected x86 processor technology and Windows Operating System as a standard platform technology because of their greater market share. To capture the impact of the

technology factor on the pricing we have used simple OLS separately for IBM, HP and SUNas these are the three leading vendors of the high-end server occupy majority of the market.

We must mention that although there are a number of ways to classify the server, but on the basis of technology criteria we can have two broad categories of servers known as Rack and Standalone server.[11] Since Standalone server and Rack servers are different in nature and in their capabilities, to do a meaningful analysis we have done separate analysis for Rack server and for Standalone server.

Our model for the rack server is

$$\text{AP(Average Price)} = \alpha_1 + \beta_1.\text{Processor} + \beta_2.\text{CPU} + \beta_3.\text{Rack} + \beta_4\ \text{OS} + \beta_5.\text{number of core}$$

As we have mentioned that standalone server provide services to the client without any assistance from the network therefore, it is believed to be technically more stable and reliable than the rack server. In general, standalone server has a technologically advanced processor and it is not required to add rack server along with it. In our analysis for standalone server we have modified our model by excluding the variable *number of rack* from the equation. The modified model for standalone server is

$$\text{AP(Average Price)} = \alpha_1 + \beta_1\text{Processor} + \beta_2\ \text{CPU} + \beta_3\ \text{OS} + \beta_4\ \text{number of core}$$

After constructing the model in order to understand whether a vendor adopts a different price strategy for different countries, the same analysis has been repeated for Singapore because of its highest ICT penetration rate in Asia and for India and China because of their rapidly growing demand for ICT to support their economic growth.[12]

5. Econometric Results for RACK Server

From the result as shown in the **Table1** it is clear that RISC processor makes the system costlier than the system with x86 processor. Processor pertains to *others* category makes HP machine costlier and IBM system cheaper, whereas Sun does not use any other processor. Here we must point out that the group *others* for IBM includes IA64 processor which is specially made for low level x series machine and therefore the system with this processor will have a lower price. This specifies that processor with alternative technology architecture have significant impact on the price of the system irrespective of the vendors.

We have mentioned that another important component of the system is CPU. Technological development now allows a user to have multiple CPU in a system. Theoretically, an increase in the number of CPU in a system should increase the speed of the system subject to the application that user is running on the system. Although there is a limit to this factor but still an increase in the number of CPU enhances the efficiency of a system and hence a rise in the price. **Table1** shows that our result is in the line with the common theoretical belief and true for all countries.

Table1: Regression Result for Rack Server

IBM	INDIA	CHINA	SINGAPORE
RISC	35174.03 (6.79)*	38951.61 (8.33)*	11413.78 (1.51)
OTHER Processor	-168007.9 (-6.17)*	-29179.61 (-1.52)	-242093.6 (-9.49)*
Max CPU	15177.64 (21.47)*	11359.51 (20.03)*	24132.58 (34.25)*
RACK	2852.72 (5.95)*	2387.211 (5.30)*	-498.8988 (-0.90)
Linux OS	-723.6357 (-0.15)	-2689.629 (-0.58)	3866.626 (0.63)
UNIX OS	-5013.015 (-1.06)	5944.373 (1.25)	5332.715 (0.70)
Other OS	75477.41 (9.81)*	3775.988 (0.13)	186636.8 (14.14)*
CORES	2970.76 (1.29)	2160.129 (1.20)	5796.635 (2.26)
Const	-46243.13 (-9.40)*	-35923.56 (-7.97)*	-59742.76 (-10.21)*
HP	**INDIA**	**CHINA**	**SINGAPORE**
RISC	38506.48 (15.69)*	27667.62 (10.74)*	7337.868 (2.10)*
OTHER Processor	28371.87 (13.20)*	35002.75 (20.25)*	26606.03 (9.03)*
Max CPU	16140.94 (36.78)*	6604.065 (21.51)*	17707.35 (33.13)*
RACK	1444.848 (4.76)*	2867.93 (6.70)*	2859.595 (6.85)*
Linux OS	267.0031 (0.14)	679.1277 (0.48)	5357.724 (2.34)*
UNIX OS	700.5405 (0.39)	-1034.558 (-0.49)	13406.19 (5.34)*
Other OS	-1998.634 (-0.41)	7635.853 (0.88)	16135.57 (2.93)*
CORES	2266.02 (1.96)*	-2925.013 (-3.07)*	471.7268 (0.30)
Const	-44018.38 (-19.86)*	-31382.82 (-11.02)*	-54802.95 (-19.46)*
SUN	**INDIA**	**CHINA**	**SINGAPORE**
RISC	9367.1 (4.66)*	5207.633 (4.65)*	10842.34 (3.97)*
OTHER Processor	Dropped	Dropped	Dropped
Max CPU	7673.205 (21.03)*	5784.223 (31.93)*	7114.287 (15.79)*
RACK	383.7156 (1.66)	293.5079 (2.17)*	677.8871 (2.07)
Linux OS	-719.4924 (-0.12)	1263.694 (0.55)	-790.7392 (-0.26)
UNIX OS	-403.6589 (-0.07)	3707.14 (1.68)*	-3839.912 (-1.12)
Other OS	(dropped)	(dropped)	(dropped)
CORES	1100.683 (1.95)*	2026.624 (7.98)*	1732.578 (2.73)*
Const	-15186.44 (-2.50)*	-15341.54 (-6.99)*	-15045.56 (-5.31)*

t values are in the parentheses
*Are significant at $p < 0.005$

All the hardware components and the installed applications are monitored and controlled by a platform called OS (Operating System). Therefore OS is considered as one of the most important components of a system for its efficiency and reliability. It is expected that the choice of OS will have a huge impact on the pricing of a system. Here we must mention that rejecting the general perception regarding OSS(open source software) as cheap, proprietary software vendors(including hardware vendor who offer proprietary software) argue that proprietary software is more reliable, stable and secure and open source software is not at par with the proprietary OS especially in running mission critical application. Interestingly, our result shows that choice of OS does not have any significant impact on the pricing of IBM, HP machine.[13]One possible reason for this could be that there are no significant differences in the prices of different types of OS or, since choice of OS is dependent on the choice of application software that user wants to run. Notwithstanding, it is difficult to come to a strong conclusion, yet it is safe to say that OS does not have significant role to play in the pricing of a system.

Again, as expected in most of the cases, our result shows that an increase in the number of core increases the price of a system. Technically speaking, increase in the number of cores reduces the queuing time hence increases the speed of the system. However, we must mention that the relation between *number of cores* and *average price* of the system is not significant in case of IBM, whereas the same is significant for HP in case of India and China and for SUN it is significant for all the three countries.

In general, increase in the number of rack saves space and therefore users are expected to pay a price for that. Although there is such a scope but considering the vibration rate of the rack, weight on the floor and height of the room usually limits the number of rack preferred by the user. Our results, relaxing all these restriction into account, show that an increase in the number of racks inevitably leads to an increase in the price of the system.[14]

From the above it is evident that while types of processor, number of CPU, number of racks have significant impact on the price of the system, OS does not have significant impact on the price of the system. At the same time it is difficult to come to a general conclusion about the impact of *numbers of cores* on the price of the system. It is also evident that the technology components have almost similar impact on the price of a system in all three countries for all the vendors. Therefore, for Rack server we can say that vendors are not adopting different pricing strategies in different countries.

6. Econometric Results for the Standalone Server

Standalone servers are mostly high end server and are built with a specific purpose in mind. Therefore the components that suited best for those purpose are selected mainly on the basis of the technical reasons, as for example, IBM mainly use their own z processor, HP mainly use a variant of x86 processor and RISC processor, whereas Sun use only RISC processor. Results in the **Table2** shows that as in the case of rack server, RISC processor increases the price of the HP system[15]. A cross country comparison shows that this is true for all countries but in case of IBM it is true for Singapore only. While ‘other’processor does not show any significant relations between the *choice of processor*[16]and *price of the system product* for HP and SUN, in case of IBM, ‘other’ processor (includes only its own z processor which are claimed to be high performance processor) increases the price of a system.[17]

Table 2 also shows that increase in the number of CPU as in the case of rack server increases the price of the standalone server. Our model shows the same result except for IBM in Singapore. In Singapore, depending on the client's need, IBM has shipped its servers with different makes of CPU. Due to this variety of CPU incorporated in IBM system shipped to Singapore, the effect of number of CPU on pricing the product is not reflected in our result.

Although, we have mentioned that choice of OS is an important aspect but most of the high end servers are bundled with specific types of OS (mostly provided by the hardware vendor) hence this limits the option for user. Our result shows that choice of OS does not have any significant role in determining price of standalone server as well. Nonetheless, choice of OS may have a role in determining the price of the system if users are allowed to choose an OS at their own will.

Again, we have also mentioned that increase in the number of cores in a system reduces the queuing time of a task which in turn increases the speed of the system especially when it is performing multiple tasks. Therefore, depending on the numbers of cores, performance level of a server may vary. However, standalone server also comes with varieties of performance level. As per the requirement of the user, such as rate of dataflow, number of instructions per second and downtime, a particular model of a vendor is selected. In general, in order to avoid the problem of high queuing time, instead of increasing the number of core usually an user prefers to buy a next level machine thinking of his future requirement (very often machines are installed thinking of the future expansions). Therefore user usually prefers to have a machine with the capacity which is well above the present requirement. This indicates that user prefers to have a single core with greater speed rather than having multiple cores in a system.[18]In our analysis unlike in the case of rack server *number of core* does not have a significant impact on the *price of the system* except in the case of Sun server where it shows a weakly significant relation in all three countries.

Table2: Regression Results for Standalone Server

IBM	India	China	Singapore
RISC	-3448.407 (-0.04)	118315.9 (1.44)	553994.5 (2.81)*
OTHER Processor	430729.2 (4.20)*	1828310 (17.95)*	1876203 (8.81)*
CPU	14271.23 (5.37)*	21710.36 (6.58)*	5585.439 (1.25)
LINUX OS	6337.445 (0.13)	-1161.827 (-0.01)	118875.3 (0.84)
UNIX OS	-2230.492 (-0.05)	-6270.966 (-0.09)	-131015.7 (-0.90)
Other OS	211944.3 (2.34)	(dropped)	-294472.8 (-1.47)
Cores	7622.146 (0.40)	29641.99 (1.04)	23847 (0.42)
Const	-38336.56 (-0.75)	-102526.1 (-1.21)	-58853.02 (-0.39)
HP	**India**	**China**	**Singapore**
RISC	279780.9 (1.80)	131276 (2.14)*	340538 (4.63)*
OTHER Processor	-98997.34 (-0.49)	116527.2 (1.77)	611792 (5.74)*
CPU	14252.09 (4.71)*	5639.401 (6.79)*	6645.147 (5.14)*
LINUX OS	-32746.59 (-0.30)	39519.7 (0.95)	16736.51 (0.28)
UNIX OS	-59895.34 (-0.46)	28437.72 (0.68)	22577.46 (0.33)
Other OS	124289.1 (0.87)	170759.1 (2.86)*	52540.68 (0.67)
Cores	36080.24 (0.66)	-14758.94 (-0.98)	4019.642 (0.18)
Const	-58640.06 (-0.56)	10675.01 (0.25)	-30409.83 (-0.54)
SUN	**India**	**China**	**Singapore**
RISC	(dropped)	(dropped)	(dropped)
OTHER Processor	(dropped)	(dropped)	(dropped)
CPU	7966.825 (11.58)*	7678.153 (11.34)*	8212.52 (10.55)*
LINUX OS	(dropped)	(dropped)	(dropped)
UNIX OS	(dropped)	(dropped)	(dropped)
Other OS	(dropped)	(dropped)	(dropped)
Cores	84588.69 (1.62)	25941.86 (0.58)	114283.8 (2.16)*
Const	-34396.51 (-0.51)	-3009.299 (-0.05)	-32529.38 (-0.49)

t values are in the parentheses
*Are significant at $p < 0.005$

Clearly from the above we can sum up that *types of processor* and *number of CPU* have a positive impact on the pricing of a system irrespective of the vendors. However, *types of OS* do not have any significant impact on the pricing of an IBM, HP or Sun system. Although there is a possibility that a particular type of OS may be chosen

along with hardware provided by a particular vendor, but price variation of a system provided by IBM, HP or SUN is not significant because of the types of OS installed in the system.

7. Conclusion

High end servers are made to do multiple works at a particular point of time and are capable of handling huge dataflow as compared to small entry level server. According to the industry experts, user can have multiple small servers to do multiple works and can coordinate to solve the compatibility issues among those. This indicates that depending on the preference of the user, small server can also pose competition, at least to some extent, to the high end server. Presence of competition in the server market leads to a quality as well as price competition in both hardware and software technology component markets. Most interestingly, our analysis reveals that hardware technology plays a major role in determining the price, whereas, the operating system i.e., software technology doesnot have any significant role in the variance in pricing of rack and standalone server. Which contradicts the popular belief that software component also plays a major role in determining the price of a server system. Moreover, hardware components have a different level of influence on the pricing of a system. Oureconometric models also specify that while processor technology architecture and number of CPU play important role in determining the price of server irrespective of its type (rack or standalone), but the same strong conclusion cannot be made regarding the impact of *number of core* on the price for both the types of server.

Our analysis we have assumed that the bargaining power of seller and buyer in setting the dealing price are same as they are aware of the latest technology available in the market. However, variation in the level of knowledge regarding the latest technology available in the market may vary the bargaining power of the sellers and buyers therefore alter the dealing price. Scope for analysing the role of bargaining power in determining the price of the system is beyond the scope of this paper.

Clearly from the above we can conclude that various technology component play important role in determining the price of the system irrespective of its make (vendor). It is also observed that for a particular vendor the impact of a particular type of technology platform/architecture is almost the same for all three countries indicating that they do not adopt different pricing strategy in different countries. The variance in the result may be because of the difference in the nature and types of user and their demand for server in different countries.The scope for test of significance of these factors on the price is beyond the scope of this paper.

Endnotes

[1] Such as CPI or producer price index which intends to measure the effects of price changes while keeping other economic factors constant

[2]A server is a computer or device on a network that manages network resources. A server is considered as the backbone of the modern communication system that controls huge dataflow and as information storage.

[3]Platform technology is a term for technology that enables the creation of products and processes that support present or future development. A literature survey by Nasiriyar& Jolly (2007) concludes that technology platform consists of a set of distinctive technological competencies which are related and are

common in different product families and applications. In order to maintain the relative permanence of technological knowledge, firm assimilates new knowledge and discards that are obsolete.

[4]Technology Architecture refers to the hardware/software setup used to produce the end application. Each component executes a sequence of instruction. The instructions supported by a component such as a particular processor and their byte-level encodings are known as its instruction-set architecture (ISA). Different "families" of processors have different ISAs. A program compiled for one type of machine will not run on another. On the other hand, there are many different models of processors within a single family. Each manufacturer produces processors of ever-growing performance and complexity, but the different models remain compatible at the ISA level (Randal E. Bryant and David R. O'Hallaron (2010).

[5] Server is a component of Information and Communication technology which is considered as general purpose technology.

[6] It is also true that in ICT users usually do not prefer to be the first user of a new technology unless they have sufficient information. (O, Hanseth, M. Aanestad, 2003 Available at http://folk.uio.no/margunn/2003/MimBootstrapping.pdf)

[7]There are four major quality adjustment methodologies for ICT products each of which rely on the different kind of information from the hedonic function. The first two (the time dummy variable method and the characteristics price index method) have sometimes been referred to as "direct" methods, because all their price information comes from the hedonic function; no prices come from an alternative source. Direct methods require that a hedonic function be estimated for each period for which a price index is needed. The second two hedonic price index methods (the hedonic price imputation method and the hedonic quality adjustment method) have been described as "indirect" or "composite" methods. They are often called "imputation" methods, because the hedonic function is used only to impute prices or to adjust for quality changes in the sample of computers in cases where matched comparisons break down(Jack Triplett, 2006)

[8] In fact according to the industry experts number of small x86 server can be clubbed to have performance at par with the high end server.

[9]Our interaction with the Indian industry experts reveals that lack of service provider is one of the hindering factors for adoption of open source operating system.

[10]Gartner is a technology consulting company known for its reliable market information.

[11] A Standalone server is not part of a larger network infrastructure such as an Active Directory domain. In a general sense, a standalone server provides services to clients without relying on any external resources, including authentication. A rack server, also called a rack-mounted server, is a computer dedicated to use as a server and designed to be installed in a framework called a rack. The rack contains multiple mounting slots called bays, each designed to hold a hardware unit secured in place with screws. A rack server has a low-profile enclosure, in contrast to a tower server, which is built into an upright, standalone cabinet.(Wikipedia)

[12] Among the Asian countries Singapore is at the top of ICT diffusion whereas China's huge population and demand for high end server for the corporate sectors, especially banks to serve the people is considered as a big market for server vendor. Uniqueness of India is that in one hand India is contributing significantly to the world market while a large pocket of population is still in the process to come under the umbrella of ICT.

[13] In Singapore, in case of HP, any OS other than Windows increases the price of the system. From the data we have observed that in Singapore OSs are mostly provided by the hardware vendors. This could be one way of reducing the burden of user for coordinating different vendors providing different components of the system. Only in China, although depicts a weak relation, UNIX OS increases the price of the SUN system. This UNIX OS is SUN's own variant of UNIX system and considered as proprietary software hence supports the popular belief that OSS is cheaper.

[14] We have not taken into account any restriction, assuming that rational user, who is well aware about the running cost, can increase the number of rack at his will. In the Appendix of the paper we have discussed about the running cost.

[15] In case of India and China coefficient is weakly significant at 0.05 level of significance.

[16]Gartner data shows that SUN do not use other processor for their standalone server and in case of HP, server with other processor (mainly IA64) are very less (only 12 out of 120 shipments) compared to the total number of shipment to India.

[17] Here we must mention that while 'other processor' for IBM includes its own highest level processor, in case of HP and SUN the same includes lower level processor hence shows contrasting results.

[18] There is no denying about the fact that if the focus is on multiple tasking, users may prefer to have greater numbers of core in his system.

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