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Harvey Leibenstein, and an anomaly called X-Efficiency

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Abstract
Harvey Leibenstein was one of the pre-Kahneman and Tversky behavioral economists who questioned the assumptions of complete rationality, maximizing behavior, and independent decision making. He is most known for X-Efficiency (XE) theory. In the then conventional wisdom the only form of inefficiency was allocative (in)efficiency, in which markets could be inefficient due to market power but firms were always efficient, that is producing on their production and cost frontiers. Leibenstein questioned whether firms were always efficient, and since inefficient firms would constitute an anomaly, Leibenstein called it X – for unknown – efficiency. In this paper the nature and causes of XE are discussed. This is followed by a review of only a few of the over 200 empirical studies on XE. The average level of XE for firms in many industries and in every region of the world is .8. This means that on average firms are producing 20% off their frontiers. This is followed by some implications of the existence of XE.

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Keywords
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Allocative and X-efficiency

In the current issue of JBEP we have articles about economists, and one French sociologist, most of whom are part of "old" behavioral economics era, i.e., the pre-Kahneman and Tversky "new" behavioral economics era which has had a profound effect on the profession of economics. The "old" group, which includes George Katona, Herbert Simon and all the people written about in this issue, with the exception of Gary Becker and Richard Thaler, questioned the rationality and maximization assumptions, and the assumption that individuals make decisions independent of all others. This questioning opened the "door" to behavioral economics. This article focuses on one member of the "old" group, Harvey Leibenstein.

In the June 1966 issue of the American Economic Review Harvey Leibenstein published his seminal article on X-Efficiency theory: "Allocative Efficiency vs. 'X-Efficiency'". The title speaks for itself. In 1966 the economic paradigm included a belief that people are homo economicus –fully rational– and that the only form of efficiency is allocative-market-efficiency. Leibenstein proposed that there is another form of efficiency, a non-allocative form. This non-allocative form was a violation of the then conventional wisdom.

Allocative efficiency is an efficiency of the market when it is pressured by competition and led to produce where $P = MC$. Allocative inefficiency is an inefficiency of the market, caused by market power and resulting in $P \neq MC$. The effect of allocative-market-inefficiency is shown by the welfare triangle, the deadweight welfare loss, estimated to be between .001 to .0001 of GDP (Mundell, 1962). However, even when the market is inefficient the firm is assumed to be efficient, i.e., they purchase and utilize all inputs efficiently and hence they operate on their output and cost frontiers.

A non-allocative inefficiency is an inefficiency of the firm, i.e., the failure to minimize costs of production due to the use of more inputs than is technologically necessary. Leibenstein understood that an inefficiency of a firm is an anomaly of the then conventional wisdom. This is one reason why he called it X-inefficiency. The X stands for an inefficiency whose nature is unknown. Unknown or otherwise, X-inefficiency has been estimated to be perhaps .04 of GDP (Bergsman, 1974), or 40 to 400 times larger than allocative inefficiency. Thus, for public policy purposes, if we want to increase efficiency we should focus our efforts on increasing X-efficiency.

In his 1966 seminal article on XE theory Leibenstein said that "At the core of economics is the concept of efficiency. Microeconomic theory is concerned with allocative efficiency. Empirical evidence has been accumulating that suggests that the problem of allocative efficiency is trivial. Yet it is hard to escape the notion that efficiency in some broad sense is significant" (Leibenstein, 1966, p. 392). In 1966 and the time surrounding 1966 micro theory was very restricted, little more than applied logic. It was a "world" inhabited by ECONS, only ECONS. In the short run, the quantity of labor indicates

the maximum attainable output which is also the actual output. This means that the production function is complete. And the output rate gives the minimum attainable costs which is also the actual costs. The best is always the achieved. In the long run the isoquants and isocosts show us the same things. This means that the cost function is complete. Motivations don't determine output or costs because output and costs are completely determined by physical circumstances, i.e., technology. There is a 1:1 correspondence between inputs and output, and between output and costs. That is, every quantity of inputs lead to a single level of output, and every level of output leads to a single level of costs. The firm is nothing but a set of engineering blueprints where everything has its place and everything fits perfectly and effortlessly with everything else. All prices are known and all inputs are marketed. Entrepreneurship is a trivial activity, hardly worth mentioning. The output rate and the costs of production are whatever the engineers blueprints reveal them to be. In this world there aren't any HUMANS. There is no indeterminacy of output or costs. It is a world of pure perfection. It is what was so attractive about micro theory. And it turned out it what was so wrong about it.

Leibenstein was able to recognize the significance of non-allocative inefficiency because he opened the "black box" of conventional micro theory which had tightly restricted itself to only considering allocative inefficiency. As Katona and Simon did in the 1950's, in the mid 1960's Leibenstein peeked inside the "black box" of conventional micro theory and saw an anomaly of the theory called XE theory, what is a subset or sub-discipline of behavioral economics. In XE theory there is not a 1:1 correspondence between inputs and outputs. Any amount of inputs can result in a range of output, depending on several factors including the pressure for performance. There is also not a 1:1 correspondence between output and cost. For any given output costs can and do range depending on HUMAN behavior within the firm. The incomplete production function means that individuals have effort discretion. The incomplete cost function means that costs can exceed the technological minimum: enter HUMAN behavior. There are some inputs which are not marketed, including management knowledge, and management's ability to find inputs that are not marketed even in well-organized markets. Enter the need for entrepreneurs. The "air tight" "closed" completely determined world of conventional economic theory was being pried open. In summary

> Behavioral economics was essential because it uses concepts from psychology, sociology, neuroscience, and biology to explain HUMAN behavior. In Leibenstein's case he cited the dual personality consisting of the superego, and the id. The former seeks the maximum, the latter seeks the minimum satisficing solution. The push and pull of the two creates a balance between the two. Thaler and Shefrin (1981) referred to the two parts of the personality the "myopic doer" and the "farsighted planner". For Leibenstein the dual personality meant that homo economicus rationality is replaced by selective rationality whereby an individual is at times homo economicus and at other times less than fully rational. This is aimilar to Akerloff and Yellen's concept of "near" rationality (Akerlof and Yellen, 1985), and Thaler's concept of "quasi" rationality (Russell and Thaler, 1985). He discussed what became known as gift exchange to explain intra-firm productivity levels. If the firm gives more to the employees then the employees are willing to work with more effort so that productivity and XE are higher. He wrote about the procedures which lead to better decisions and higher levels of XE. One is the absence of "time deferral", the absence of procrastination (Akerlof, 1991) or the absence of a "present-bias" (O'Donoghue, T., & Rabin, M., 1999). Another procedure was making independent decisions, or avoiding "herding" behavior" (Burke, Tobler, Schultz, and Baddeley, 2010; Baddeley, M., Burke, C., Schultz, W., and Tobler, P. 2012; Baddeley, 2010; Baddeley, 2015).

However, the most direct causes of XE was when individuals and firms are under competitive pressure because the firm's environment changes. The firm may find itself in a new deregulated environment. There may be new entrants into the market. The nation may choose to join an international organization such as the WTO, or a regional organization such as the EU. The communist party may be replaced by the market. The theory predicts that in these cases the firm will produce closer to their frontier.

Anomaly

Richard Thaler, in his article, "Winner's Curse", says that an anomaly can take the form of "an empirical result… difficult to 'rationalize' or if implausible assumptions are necessary to explain it within the paradigm" (Thaler, 1988, p. 191). More than 20 years before Richard Thaler started down the anomalies' "road" to a very well deserved Nobel Prize, Harvey Leibenstein revealed an anomaly in the existence of non-allocative (in) efficiency.

Thaler's example of the winner's curse is the outcome of oil firms bidding for the drilling rights to a piece of land. The winner of the bidding process is "cursed" because the winning bid exceeds the value of the rights to drill. The "winner" loses money. Thaler explains that "The winner's curse cannot occur if all the bidders are rational… so evidence of a winner's curse in market settings would constitute an anomaly" (Thaler, 1988, p. 192). Likewise, says I, X-inefficiency cannot occur if the employees are (fully) rational… so evidence of X-inefficiency would constitute an anomaly. Evidence? That the firm is not producing on either their production or cost frontier.

Empirical estimates of XE

The first empirical study of XE was done one year after Leibenstein's seminal article in 1966. Since 1967 there have been approximately 300 empirical studies of XE. Almost all of them are consistent with XE theory. In this paper I will discuss only a few published papers from different regions of the world and different industries. These studies will show that XE is an anomaly only with regard to the conventional wisdom of economic theory before the advent of behavioral economics. The authors rarely tested the psychological causes of XE. Rather they describe an environment which for a variety of reasons changed in a way which placed the individuals under extra pressure to produce efficiently. They then fit either a production or a cost function both before and after the change and observe how close the firm was to the frontier. If the environment became more competitive or stringent and the firm got closer to the frontier then this is taken as proof of XE theory.

U.S.

Berger and Humphrey (1997) reviewed XE research among financial institutions covering 130 empirical studies in 21 countries from all regions of the world[1]. Firms on the frontier have an XE ranking of 1.0. All other firms have a ranking from .99 to 0.0. An XE score of .8 means that X-inefficiency is .2[2]. This implies two things. First, for the same amount of inputs the firm could have produced 20% more, And, second, for the same output the firm could have used 20% fewer inputs.

Among U.S. banks the average level of X-efficiency using nonparametric and parametric approaches was .72 and .84, respectively. Among all U.S. financial institutions, the average level of XE for banks was .79, .79 for insurance firms, .83 for S&Ls, and .88 for credit unions. For all financial institutions in all countries the average level of XE is 0.77. Financial institutions are on average operating about 20% off their frontier.

Berger and Humphrey (1992) tested the effect of "megamergers" –banks with at least $1 billion in assets– on XE with a sample of U.S. banks for the period 1981-89. The authors found that a merger has a very small increase in XE vis-à-vis non-merging banks. The most successful mergers led to large increases in relative XE, but the least successful led to large decreases in relative XE. Shaffer (1993) used the "thick frontier" method, and a sample of commercial banks with assets of greater than $1 billion during the period 1984-89. Mergers among the most X-efficient banks reduced costs by about 21 percent. Mergers among the least X-efficient banks increased costs by about 21 percent.

[1] The studies listed here in my current paper and among the more than 200 studies mentioned are written in terms of XE theory. There are hundreds if not thousands of other studies which are almost identical in terms of methodology and results but which never mention XE.

[2] X-inefficiency has been calculated in two ways. First (1- xe level). Second, (1-xe level/xe level). If XE is .8 then X-inefficiency is either 1-.8 = .2, or (1-.8)/.8 = .25. We will use the first: X-inefficiency = 1=XE, or XE = 1-X-inefficiency.

Rai (1996) examines insurance firms in 11 countries for the years 1988-92. The average XE for all firms is .77. Choi and Elyasiani (2011). investigate XE among property liability firms in the U.S. for the period 1992-2000. Average XE for foreign-owned, and domestic-owned firms is .81 and .80, respectively. Bauer and Hancock (1993) investigated the FED's efficiency in check processing services between 1979-90. Average XE for the 47 centers averaged .71. The average level of XE among U.S. firms in the financial sector for some studies are listed below . Berger and DeYoung (1997), .92. DeYoung (1998), .71, Peristiani (1998), .7. Berger and Hannan (1997), .68. McAllister and McManus (1993), .65. Mester (1993), .89.

China

Fu and Hefferman (2007) studied state-owned and joint-stock (private) banks between 1985-2002. They utilize the parametric stochastic frontier approach (SFA) technique. For state-owned commercial banks XE ranges from .35 to .41. For privately-owned commercial banks the range is .44 to .47. The main causes of X-inefficiency are a lack of incentives for managers, a high rate of non-performing loans, the underreporting of bad loans, and poor management quality, all of which are characteristic of state-owned banks. The results also show that listing shares of a bank on an exchange improves XE because managers become answerable to owners.

Chen, Skully, and Brown (2005) examined allocative and X-efficiency among 43 Chinese banks during the period 1993-2000. Prior to China's financial deregulation via the Commercial Bank Law of 1995 average XE was .78. After 1995 average XE score was .81. Yao, Jiang, Feng, and Willenbockel (2007) used data from 22 banks over the period 1995 to 2001. In 2001 China joined the WTO. Average bank XE was approximately .65. The estimated average XE of state-owned banks is .6 and that of privately-owned banks is .78. Jiang, Yao, and Zhang (2009) estimated efficiency using the parametric Stochastic Frontier Approach and an Output Distance Function for all major commercial banks in China. The average level of XE was about .7. Private commercial banks are overall the most x-efficient with an average level of .81. Kwan (2006) investigated causes of x-(in)efficiency among Hong Kong (HK) banks from 1992-1999. For the period under study x-efficiency among HK banks averaged between .7 to .85. The average level of XE among Chinese firms in the financial sector for some studies are listed below. Rezvanian, Ariss, and Mehdian (2011), .97. Yao, Han, Feng (2008), .85. Fung & Cheng (2010), .64. García-Herrero, et al (2009), .5. Fu and Hefferman (2009), .87.

Taiwan

Z-John Liu, and Justine Chang (2013) use a sample of nine state-owned banks in Taiwan that began privatization in 1998 along with a sample of foreign banks with similar size for 1995-2007 Data Envelopment Analysis (DEA) is used. The results show that before privatization, the state-owned banks

had a level of XE significantly lower than foreign banks. After privatization there was no statistical difference in XE between the two groups, meaning that privatization enhanced government-owned banks more than private banks. In the case of the Chiao Tung Bank, XE before and after privatization was .63 and .97, respectively. Their analysis also showed that when government is the largest bank shareholder, XE is lower by a statistically significant amount.

Liu, Chen, and Pai (2007) use DEA and four categories of performance to investigate the effects of mergers on XE among 60 telecommunication firms in Taiwan for the period 1993-2003. Average XE ratings for firms with, and without any merger activity was .9, and .96, respectively. Average XE before and after merger activity was .98, and .94, respectively. Management capability (output per employee, and net profits per employee) is shown to be lower after merger activity and is statistically significant at the 1% level.

Chang-Sheng Liao (2009) uses DEA to investigate the effect of managerial ability on relative X-efficiency and productivity of domestic and foreign banks in Taiwan for the years 2002-04. For the entire period average XE among the Taiwanese banks was .87, .82 for foreign banks. The average level of XE among Taiwanese and Singapore firms in the financial sector for some studies listed below. Peiyu, Yu and Van Luu (2003), .78. Hao and Cho (2005), .64. Hsiao et. Al (2010), .85. Hu and Fang (2010), .96.

Japan and the Phillipines

Hosono, Sakai, and Tsuru (2006) examine the causes and effects of the consolidation of Shinkin banks for the period 1984-2002. Average X-efficiency for all banks was 0.44. Rezvanian and Mehdian (2002) use the DEA and a translog cost function to investigate XE among 10 Singapore commercial banks duing the period 1991-97. For all firms average XE was approximately .75. Chelo and Manlagnit (2011) use a stochastic frontier approach to estimate cost efficiency among commercial banks in the Phillipines over the period 1990 to 2006. The average level of XE was .75.

India

Lall and Rodrigo (2001) use the Stochastic Frontier Analysis on plant level data on four Indian industries. The industries are leather products, motor vehicles, machine tools, and electronics and computers. Average XE for the four industries is in the .5 to .6 range. The low technology-intensive industry, leather products has an average XE of .44. Patibandla (1998) estimates XE among cutting tool industry in 1983-84. The data show that average XE ranged from .37 to .59. He also reports that XE is highest for medium sized firms and lower for small and large firms. Small firms suffer from outdated technology and low labor skills. Small firms suffer from outdated technology and low labor skills while large firms suffer from being too large.

Europe

Girardone, Molyneux, and Gardner (2004) investigate the main determinants of Italian banks' X-efficiency over the Single Market Programme –deregulation period 1993-1996. Bank size was measured by total assets. Average XE levels from the smallest size group to the largest size group were .88, .86, .86, and .83, respectively. XE increased over the entire period for all bank sizes suggesting that deregulation and the 1992 Single Market Programme had positive effects on XE over time.

Tourtosa-Ausina (2002) examines the effects of deregulation among Spanish banks which were among the most regulated banks in Europe. The period of investigation was 1985-1995. Among commercial banks average XE in 1985 and 1995 was .6 and .77, respectively. Among savings banks the averages are .44 and .80, respectively. Among all banks the averages were .53 and .79, respectively. The effect of deregulation was clearly to enhance XE.

Huang, Shen, Chen, and Tseng (2011) sample are banks in 14 transitional countries from Eastern Europe and the former Soviet Union over the period 1993-2004. The average XE score was .66. The average score for foreign owned banks, state-owned banks, and domestic private banks were .73, .67, and .59, respectively. Thus, "... the first thing that needs to be done in the banking sector of the transition countries is to promote banks' managerial ability. Whether to optimize the input mix is relatively less of an issue".

Delis, Koutsomanoli-Fillipaki, Staikouras, and Katerina (2009) estimate XE among a sample of Greek banks during the period 1993-2005. Banks were under pressure from Greece joining the EMU and the Single European Market during the late 1980's and 1990's. The average level of XE among all banks was .81. Over time, under the pressure of deregulation in all its forms, XE increased from .62 (1993) to .9 (2005). Chortareas, Girardone, and Ventouri (2009). Covering the period when Greece entered the EMU, XE averaged about .87, and increased by 4.3% over 1998-2003. DeGuevara and Maudos (2007) use a panel of Spanish commercial and savings banks for the period 1986-2002. XE among all banks in the sample is .93. Mertens and Urga (2001)17 use a sample is 79 Ukranian banks for the year 1998. For all banks, the average XE was .68. XE among large and medium banks, small, and very small banks averaged 0.63, 0.69, and 0.73, respectively.

Middle East

Al Shamsia, F., Alyb, H., El-Bassiounic, M. (2009) used DEA approach to measuring efficiency for a cross section of UAE banks in 2004. The average level of x-efficiency among UAE banks is .55. Aftab, M., Ahamad, S., Ullah, W., and Sheikh, R. (2011) study the relationship between efficiency on stock performance among a sample of seven Pakistani banks for the period 2003-07. Stock performance is measured by the cumulative annual share returns (CASR), and X-efficiency by the DEA. Average XE was .7. CASR ranged from 6% to 13%. The regression with CASR as the dependent variable

shows that XE has a positive and statistically significant effect on CASR. In other words, more efficient banks are more successful banks, providing support for the efficient markets hypothesis.

Latin America

Chortaseas, Garza-Garcia, and Girardone (2011) includes a sample of commercial banks from nine Latin American countries for the period 1997-2005. Data comes from BankScope. DEA analysis led to the average x-efficiency scores for each of the nine countries. The mean score ranges from .45 for Brazil to .84 for Chile. For all nine countries the average x-efficiency score is .67.

Figueira, Nellis, and Parker (2009) investigate how ownership form affects bank performance for 2001. Liberalization and privatization of Latin American banks has meant increased foreign capital injections and the privatization of state-owned banks. The average x-efficiency scores for all banks ranged from .58 to .8. Among countries, the highest was Chile which had an average XE score of .91; the lowest average was Uruguay at .19. Among private banks, Chile had the highest average, .92, while Uruguay had the lowest, .19. Banks with 50% or more government ownership the highest and lowest scores were .73 (Brazil) and .41 (Peru). With 50% or more foreign ownership the averages were .84 (Chile), and .19 (Uruguay). DEA analysis showed that foreign ownership, an informal economy, and government intervention reduce XE.

Africa

Okeahalm (2006) uses a parametric Bayesian stochastic frontier analysis to investigate the production efficiency of banks in South Africa. Four large South African banks control more than 85 percent of deposits and bank assets. Economic regulation of banks is weak. Consumers complain about poor quality and high bank chargers. Banks complain about burdensome regulations. The data for this study comes from the Banking Costs in South Africa (BCSA) data set. BCSA includes data on 61 branches of one bank. The data is for 1999. The 61 branches operated with an average level of x-efficiency of .83. Paul Marschall and Steffen Flessa (2011) investigated relative efficiency of primary care facilities in Nouna, a rural health district in Burkina Faso. They report that average XE was .86.

Policy implications

The other 200 + empirical studies on XE theory from all parts of the world and in many industries are consistent with the studies reported here. If my ability to calculate an average from all the studies to date is solid then the average from all regions of the world and in many industries is approximately .8. The average firm is about 20% below their (output and/or cost) frontier. Not 2% below, found in one study published in the infamous Journal of Nonreproducible Results. But 20% in over 200 studies published in some of the world's leading economic journals. The average level of allocative efficiency in the studies reporting this figure is closer to .85 or .9. If we want to increase efficiency among firms the largest payoff is to increase X-efficiency because $XE < AE$. Firms are closer to their optimal size than they are to their frontier. They are also better at using the optimal input ratio than they are at producing on their frontier. In his 1966 article Leibenstein was prescient when he said that "it is one thing to purchase or hire inputs in a given combination; it is something else to get a predetermined output out of them" (Leibenstein, 1966, p. 408).

Although not shown here, the empirical results show several things. First, big is not necessarily better, or more efficient. Larger firms are not necessarily more X-efficient than smaller firms, and most mergers either do not increase XE or the increase is small. Regulators need to consider XE when deciding on mergers and not merely the effect of mergers on prices and output rates. Second, firms can be monitored carefully which enhances XE. Third, government ownership and control tends to reduce XE. This is true whether the issue is the communist government of China or the regulated banking industry in Western Europe or the U.S vis-à-vis the performance of financial institutions when regulations were reduced. Hence, deregulation and the freeing of markets enhances XE. Fourth, firms tend to be more X-efficient when power and control are more equally distributed within the firm. For example, the CEO is neither the Chair of the Board or President of the firm. In general when power and control are distributed such that idividuals (firms) feel the pressure to be X-efficient, then XE will be enhanced.

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