EFFICIENCY AND COMPETITIVENESS OF BANKNOTE PRINTING INDUSTRY IN INDIA

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ABSTRACT

Indian banknote printing industry has undergone major structural changes in the past decade. This has been explored in this study with special focus to its performance. This study took up task of identifying the variables involved in its production cost and using them the efficiency and its competitiveness are studied. This uses data envelopment analysis to understand efficiency and productivity changes through Malmquist Index and preparation of competitiveness index and ranking.

Key Words: *Efficiency, competitiveness, Malmquist Index, Data Envelopment Analysis, printing, printing industry, banknote*

INTRODUCTION

India is producing more banknotes than each previous year. Its production and supply of banknotes has increased from 8657 million banknote pieces in 2001 to 16416 million pieces in 2010, which is a growth of 189.63percent (Reserve Bank of India, 1999-2000 to 2011-2012). Cost of production of banknotes in India is one of the lowest in the world. Availability of banknotes per person is Rs. 7196.653 by value, which is one of the lowest in the world (Reserve bank of India, 2010). The cost of banknote production has a major bearing on the monetary economy due to the fact that the volume of production is very high. The study seeks to 1) ascertain the efficiency and productivity changes in banknote printing in India: Banknotes are in India are produced by two methods - by government owned corporation and by central bank owned subsidiary and 2) To evaluate the competitiveness of the banknote printing industry covering the period of ten years from 2000 to 2010.In fact the two producers are competing with each other to supply an identical product to a single buyer.

BANKNOTE PRINTING INDUSTRY

Demand for Banknote

The demand for cash is made up of several components. The Table 1 below shows the growing demand for banknotes in India.

Table I: Banknotes Produced and Supplied (in billions of pieces)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Country										
India	8.66	9.63	11.37	13.17	12.59	7.00	11.52	12.75	15.23	16.42

Source: Author's calculations on the basis of the Reserve Bank of India Annual Reports from 1999 to 2011.

Industry Structure

Banknote printing has traditionally been carried out by governments or central banks. Banknote printers can be classified into the following categories on the basis of their structural constitution.

1. Owned by the government of the country of issue of banknote,
2. Owned by the central bank, which issues the country's banknote,
3. Owned by private enterprises and
4. Jointly owned by central bank, government and private entrepreneurs.

BANKNOTE PRINTING IN INDIA

Until 1996-97 it was the case of a single buyer and single government owned producer as seller. On recommendations of Expenditure Reforms Commission (ERC) appointed by the Government of India all the nine Security Units functioning under the administrative control of the Department of Economic Affairs, Ministry of Finance were taken over by the newly set up Corporation named as Security Printing and Minting Corporation of India – SPMCIL (Ministry of Finance, Government of India, 2006). The Bhartiya Reserve Bank Note Mudran Private Limited- BRBNMPL came into being with two printing presses in the year 1996. This is a wholly owned subsidiary of Reserve Bank of India -RBI.

The annual licensed and installed capacity Currency Note Press, Nashik is 4400 million pieces (SPMCIL, 2008). The production of Bank Note Press was started in the year 1974 with annual licensed and installed capacity is 2495 million pieces of banknotes. This press also manufactures different types of security ink for various security organizations (BNP, Dewas).The present capacity of both the presses of Bharatiya Reserve Bank Note Mudran Private Limited – BRBNMPL is 30 billion note pieces per year on a three shift basis (BRBNMPL, 2011).The Government of India manages seignior age of the country and in this it is assisted by the RBI.Since July 2010 the currency and coinage issues are dealt by the Currency Directorate in the Department of Economic Affairs of Ministry of Finance. It has the administrative control of the Security Printing Minting Corporation of India Limited (Ministry of Finance, Government of India, August 29, 2011.).

Demand, Production and Supply of Banknotes in India

The quantity of banknotes in circulation in India since independence is given below.

Table 2Banknote Circulation in India Compared with its GDP

Year	Banknotes in circulation	Growth in circulation	GDP	Banknotes in circulation/ GDP
	Rupees in million	Percentage	Rupees in million	Percentage
1953-54	13300		110190	12.07
1955-56	16140	17.60	105180	15.35
1960-61	21540	25.07	165120	13.05

1965-66	28410	24.18	260470	10.91
1970-71	45570	37.66	429810	10.60
1975-76	70530	35.39	770710	9.15
1980-81	143070	50.70	1325200	10.80
1985-86	265240	46.06	2544270	10.42
1990-91	552820	52.02	5150320	10.73
1995-96	1225690	54.90	10832890	11.31
2000-01	2182050	43.83	19250170	11.34
2005-06	4295780	49.20	34023160	12.63
2009-10	7995490	46.27	58683320	13.62
Average for the 55 years		40.24		11.66

Source: Handbook of Statistics on the Indian Economy, Reserve Bank of India 2009-10 and author's calculations.

The Production Scenario

India with its annual production of 16,416 million pieces banknotes in 2009-10 and is the second largest producer of banknotes in the world and the RBI has incurred an expenditure of Rs. 27,540 million on printing banknotes. The quantity of banknotes printed and supplied by SPMCIL and BRBNMPL to the central bank during the period of study and their details of production and supply are given below.

Table 3Banknote Production and Cost in India

Year	Banknotes produced and supplied by SPMCIL and BRBNMPL	Change	Cost of banknotes produced	Change in
	Pieces in million	In Percentage	Rupees in million	Percentage
2000-01	8657		11210	
2001-02	9629	10.09	13340	15.97
2002-03	11370	15.31	14330	6.91
2003-04	13166	13.64	17100	16.20
2004-05	12593	-4.55	14440	-18.42
2005-06	7001	-79.87	10350	-39.52
2006-07	11522	39.24	20210	48.79
2007-08	12745	9.60	20320	0.54
2008-09	15225	16.29	20630	1.50
2009-10	16416	7.26	27540	25.09
Change between 2000-01 to 2009-10		89.63		145.67

Source: Annual Reports of Reserve Bank of India; Report of High level Committee to Reserve Bank of India, August 2009; Annual Reports of Security Printing and Minting Corporation of India; Annual Reports of Ministry of Finance, Government of India and author's calculations.

The annual demand of banknotes by Reserve Bank of India is given in the table below.

Table 4Indent and Supply of Banknotes

Year	Demand by Reserve Bank of India	Change	Banknotes produced and supplied by SPMCIL and BRBNMPL	Demand of RBI met	Banknotes in Circulation	Change
	Pieces in million	In percentage	Pieces in million	In percentage	Pieces in million	In percentage
2000-01	*		8657		35704	
2001-02	10500		9629	91.70	38338	7.38
2002-03	13588	29.41	11370	83.68	37309	-2.68
2003-04	15800	16.28	13166	83.33	38336	2.75
2004-05	14855	-5.98	12593	84.77	36984	-3.53
2005-06	15000	0.98	7001	46.67	37851	2.34
2006-07	11500	-23.33	11522	100.19	39831	5.23
2007-08	12700	10.43	12745	100.35	44225	11.03
2008-09	15250	20.08	15225	99.84	48963	10.71
2009-10	16800	10.16	16416	97.71	56549	15.49
Average change between 2000-01 to 2009-10	7.25		87.58		5.41	

*Source: Annual Reports of Reserve Bank of India; Report of High level Committee to Reserve Bank of India, August 2009; Annual Reports of Security Printing and Minting Corporation of India; Annual Reports of Ministry of Finance, Government of India and author's calculations. (*Data not found available)*

The Economics of Production and Supply of Banknotes

The banknote printing industry is controlled by a single source - the RBI, who is the single buyer. If there is only one customer for a certain good, that customer has a monopsony in the market for that good. A common theoretical implication is that the price of the good is pushed down near the cost of production. Market power is a continuum from perfectly competitive to monopsony. RBI exerts this power in abundance. The exercise of monopsony power results in prices being depressed below competitive levels (Organisation for Economic Co-operation and Development, December 17, 2009).

BRIEF REVIEW OF LITERATURE

Money, Banknote and Banknote Production Methods

The history of banknote production has been dealt in detail in the Reserve Bank of India Volume I, Volume II and Volume 3 by S. L. N. Simha, G. Balachandran and RBI's History Cell (Simha, 1970), (Balachandran, 1998), (Rangarajan, 2005). The central banks and banknote printing presses rely on a variety of strategies to enhance efficiency in the production and supply of banknotes to the economy (Baxter, 2005). Some include, creating subsidiary companies, turning production over to the private sector and combining currency printing and distribution under one roof, in a single complex (Banco de la República, 2005). At the Central Bank of Japan, Nishihara found that changes in the banknote printing methods in central banks of the Executives Meeting of East Asia and Pacific (EMEAP)[1] have developed on the central bank's relationship with the government, the financial sector and private companies, as well as the modernization strategy adopted by each central bank (Nishihara, May 2006).

Industry Economics, Structure and Denomination Structure

Jorge Eduardo Galán Camacho and Miguel Sarmiento Paipillauses, studied banknote printing costs and through comparative analysis showed that the major differences among central banks are primarily due to the size of the country's population and the amount of currency in circulation. The estimation of the cost function used, showed that the number of denominations and the size of banknotes are relevant factors in determining printing costs. They also showed that consequently, reductions in these characteristics lead to major cost savings (Paipilla, 2007).They also identify, the method a central bank uses to produce banknotes also was found to be a determinant of printing costs. In fact, it was found that government printing is the costliest method, while involving the private sector in the production process (e.g. joint ventures, subsidiaries, specialized companies) substantially reduces costs by the study (Paipilla, 2007).

Efficiency and Productivity Changes

The cost function let us determines the banknote printing costs, as well as the different strategies that central banks may use to reduce their printing costs. This analysis, enables measuring the technical efficiency on banknote printing and changes in productivity during the period are identified. These measures are obtained by estimating an efficient production frontier and by constructing the Malmquist index. The latter measure allows decomposing changes in productivity into changes in efficiency and technology through the years under study. The efficient frontier model used by Jorge Eduardo Galán Camacho and Miguel Sarmiento Paipilla found that most central banks have increased its technical efficiency during the period, especially in where the private-sector has involved. (Paipilla, 2007).

An efficiency frontier can be estimated through, the non-parametric approach Data Envelopment Analysis (DEA) or the parametric methodology Stochastic Frontier Approach (SFA). The SFA presented by Aigner et.al. (Aigner, 1977)is based on the estimation of a cost or a

[1]The EMEAP is composed of the central banks of Australia, China, Hong Kong S.A.R., Indonesia, Japan, South Korea, Malaysia, New Zealand, Philippines, Singapore and Thailand.

production function (e.g., Cobb Douglas or Trans-log), where the parameters make it possible to characterize the efficiency frontier. Among the most recent applications to central banking is the study by Wheelock and Wilson (Wheelook, 1999), which used a DEA model to gauge checks processing efficiency at the offices of United States Federal Reserve Bank and study by Bohn et.al (Bohn, 2001), (Mester, 2003).As to productivity change, it can be estimated through either production function or cost function or the construction of index numbers using non-parametric methods. Under the latter approach, the Malmquist index was initially presented by Caves et.al. (Caves, 1982) and widely developed by Fare et.al. (Fare, 1989), for analyzing productivity changes after financial liberalization processes (Humphrey, 1993).

Competitiveness

The actual expression of competitiveness has an implicit meaning of progress and advance,although it is difficult to find a unanimous agreement on the definition of the term. In this paper competitiveness is defined as firms, industries or nations' ability to achieve success against the competitors. Many authors have discussed this issue. In his work, 'Competitive Advantage', 1985, Porter highlights the significance of acquiring a competitive advantage as basis to successfully overcome the shifting conditions of the environment. The author discusses how to acquire and keep competitive advantages (Porter, Competitive Advantage, 1985). But with the publication of 'The Competitive Advantage of Nations', he offers a global view. The author spells out the role played by the environment, the institutions and the economic policies of a country in the competitive success of some industries. He introduces a model of study, employed widely by the scientific community: 'the diamond' (Porter, The Competitive Advantage of Nations, 1991).

It is affirmed that the strategy of the business should be based on its resources and internal capacities, having these factors preponderance the market (Grant, 1996). Although these two approaches, the external one (Five forces of Porter, among others) and the internal one (Resources and Capabilities) have been presented as different alternatives for the study of an industry's competitiveness, some authors consider them complementary (Henderson R., 2000).A composite indicator is the mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis (Saisana, 2002). Composite index represents aggregate measures of a combination of complex phenomena (Booysen, An Overview and Evaluation of Composite Indices of Development, 2002). Composite indicators can be used to summarise complex or multidimensional issues, in view of supporting decision-makers (Tarantola, 2002). In the context of policy analysis, indicators are useful in identifying trends and drawing attention to particular issues. They can also be helpful in benchmarking or monitoring performance.

Printing Costs, Currency in Circulation, Population, GDP and Per capita GNP

All these data and information have been obtained from the Annual Reports of the Reserve Bank of India its occasional papers, high level committee reports; Annual Reports of the Department of Economic Affairs, Ministry of Finance in Government of India; Annual reports of the Security Printing and Minting Corporation of India since its formation and Handbook of Statistics on the Indian Economy by Reserve Bank of India.

RESEARCH METHODOLOGY

The industry taken up for this study and its product is clearly unique and all the manufacturers available in this field of industry make an identical product and sell them to a same buyer. Also studying a manufacturing activity towards production function to ascertain cost is historic as has numerous examples from the past and this study also relies upon those earlier studies in identifying data for collection. The data available is basically from the sole and only buyer – the central bank, the government and the recently corporatized government corporation. According to the presenter of the study, the period from 2000 to 2010 is eventful if not path breaking.

Secondary Data

A wide range of journals on banknote printing industry, printing industry, newspapers, trade directories and studies, journals on economics of repute from both India and abroad, government publications, central bank publications from India and abroad, business magazines and secured web sites served as sources of secondary information.

Analytical Tools and Techniques and Employed

The DEA input oriented model is used to evaluate technical efficiency on banknote printing for banknote printing industry in India for the years between2000-01 to 2009-10. This approach is used to calculate the Malmquist index and estimate changes in productivity and its components during the period under study. Using the non-parametric approach to estimate efficiency and productivity measures does not impose a specific functional form for the production or technology structure (unknown in this case), contrary to the parametric approach. In addition, the Malmquist index does not require information about quantity and prices of inputs and outputs, as well as assumptions about profit maximization or cost minimization. These two features make the Malmquist index a great instrument to identify productivity changes in public sector and central banking, where usually prices are not available.

1 Technical, Global and Scale Efficiency

Under the DEA approach, a production possibility set (PPS) enveloped, convex and with strong availability of inputs and outputs is assumed. The PPS or technology, which is referred as *Z*, is composed by vector *M* of inputs $x = (x_1, \ldots, x_M)' \in R^M_+$, which is used to produce a vector *S* of outputs $y = ((y_1, \ldots, y_s)' \in R^s_+$.

After the production technology is defined, we have *N* central banks which consume *M* inputs to produce *S* outputs. Fare (1998) define the inside the PPS of outputs $P(x)$ and one of the inputs $L(y)$, it si true that $(x,y) \in Z$ $y \in P(x)$. Given this relation, Z has strong inputs and outputs availability if for productive process $(x,y) \in Z$, $x' \geq x$ $(x',y) \in Z$ and $y' \geq y$ $(x,y') \in Z$, alternatively if $x \in L(y)$, $x' \in L(y)$, $x' \geq x$ and $y \in P(x)$, $y' \in P(x)$, $0 \leq y' \geq y$.

The central bank *j* consumes X_{ji} of input *i* and produces $Y_{jr}$of output *r*, assuming that $X_{ji} \geq 0$ and $Y_{jr} \geq 0$. In fact, *X* and *Y* are both Matrixes *M x N* and *S x N* which contain all inputs and outputs corresponding to the *N* evaluated central banks. So the model which allows measuring inputs technical efficiency for each central bank during the period *t* is (A. Charnes, 1978):

$\text{Min}\theta$

θ,λ

$r.t.\ \lambda X^t - \theta x^t_0 \leq 0$

$\lambda Y^t \geq y^t_0$

$\lambda \leq 0$

The model stated in equation (6) pretends to minimize the inputs quantity used by the assessed by the central bank, where θ is a scalar accompanying each input and λ an intensity vector ($Nx1$) weighing the input and output level of every central bank evaluated. The process is the same for each central bank j, by introducing in the model $(x_0,y_0) = (X_j,y_j)$. Therefore, a central bank is technically efficient if $\theta^* = 1$ and $\lambda^* = 0$; on the other hand, it is inefficient if $\theta^*<1$ and $\lambda^*>0$. Nevertheless, a central bank may present $\theta^*=1$ and $\lambda^*>0$. This is a frontier point located in the weak zone of the efficiency frontier. In order to distinguish between a frontier point and an efficient frontier point, (Thrall, 1990) state that the radial projection $(x_0, y_0) \rightarrow (\theta^* x_0, y_0)$ always takes to a frontier point, but the efficiency only is reached if $\theta^* x_0 = X\lambda^*$ and $y_0 = Y\lambda^*$, for every λ^*. Therefore, to reach technical efficiency, restrictions must be filled with equalities.

The model assumes constant returns to scale (CRS), which implies that every central bank operates under optimal production scale. Nevertheless, market failures and variables not controlled by central banks (e.g. demand for currency), to may cause banks not producing at optimal scales. In fact, Banker et.al.(Banker, 1984)study variable returns to scale (VRS) by incorporating to equation (6) the restriction $e_T\lambda = 1$ (where e is a one's vector of $Nx1$). This generates an additional convexity requirement where the production possibilities efficient frontier must have segments joining the extreme points. Then, with a CRS model measurement of global technical efficiency (GTE), without scale efficiencies, is obtained; while using a VRS model a technical efficiency is found and if a central bank is producing on increasing or decreasing returns to scale zone is identified. The ratio of both models allows finding out a scale efficiency (SE) measurement for every central bank as follows: $SE = \theta^{CRS}/\theta^{VRS}$

2 Productivity Change – Malmquist Index Approach

To estimate changes in productivity, the Malmquist index approach presented by Fare et.al. (1989) is used, where changes in productivity are determined by efficiency and technology changes through time. The Malmquist index is expressed as follows:

$$M_j(X^{t+1},Y^{t+1},X^t,Y^t) = \frac{D_j^{t+1}(X^{t+1},Y^{t+1})}{D_j^t(X^t,Y^t)}\left[\left(\frac{D_j^t(X^{t+1},Y^{t+1})}{D_j^{t+1}(X^{t+1},Y^{t+1})}\right)\left(\frac{D_j^t(X^t,Y^t)}{D_j^{t+1}(X^t,Y^t)}\right)\right]^{1/2}$$

The first component in (7) calculates changes in technical efficiency (catch up) by comparing the distance from central bank to the efficiency frontier each year. If this ratio has a value higher than 1, the central bank is more efficient in period $t+1$ than in period t (it is closer to frontier in the period$t+1$). The opposite is interpreted if the ratio value is lower than 1. The second component in (7) calculates technical change or boundary shift of industry (in this case allbanknote presses as a set) by comparing the distance between the efficiency frontiers in t and the

one in *t+1*. Therefore, if the result of this component is higher than 1, the industry presented a positive technological shift, improving the banknote press relative efficiency.

The result of multiplying both the components is the Malmquist index. If it is higher than 1, the central bank increased its productivity during the period evaluated. This increase may be consequence of an increase in technical efficiency and / or a positive technological shift. When there are variables returns to scale (VRS), the change in efficiency may be divided into two other components: pure technical efficiency and scale efficiency (R. Fare, 1989).

$$CE = \frac{D_I^{t+1}(X^{t+1},Y^{t+1})}{D_I^t(X^t,Y^t)} = \frac{D_{VRS}^{t+1}(X^{t+1},Y^{t+1})}{D_{VRS}^t(X^t,Y^t)} \times \frac{\frac{D_{CRS}^{t+1}(X^{t+1},Y^{t+1})}{D_{VRS}^{t+1}(X^{t+1},Y^{t+1})}}{\frac{D_{CRS}^t(X^t,Y^t)}{D_{VRS}^t(X^t,Y^t)}}$$

For the Malmquist index calculation, the non-parametric method (DEA) is used, assuming distance functions reciprocal to the input oriented technical efficiency measure defined above in equation (6) (Seiford, 1990).

3 Competitiveness

3.1 Profiling Competition

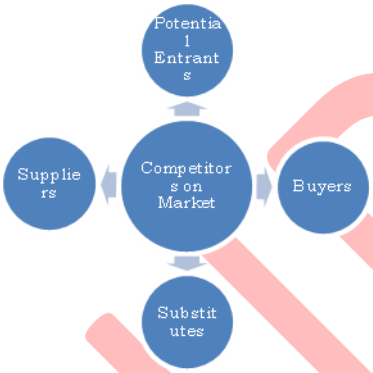

Figure 1Forces of competition in an industry

Source: Wheelen T.L., Hunger J.D. Strategic Management and BusinessPolicy – Entering 21st Century Global Society. 7th. New Jersey: Prentice-Hall:, 2000.

The competition is profiled on the aspects including number of players, total market size, relative share of the players, nature of competition - monopsony to oligopsony, differentiation by various players and barriers in the industry, entry barriers, mobility and exit barriers. Since both the producers are engaged in the sovereign function of printing currency for the country they are not engaged in pricing strategies. The price of the government owned corporation is expenses on production plus, central bank subsidiary is engaged in cost reduction and minimisation to offer lower price. The single buyer virtuallycontrols the market offering to buy what it needs each year. The quantity offered to each printing organisation mostly depends on the basis of its capacity. The figure 1 diagrams these competitive forces.

3.2 Firms' Competitive Position in the Industry

The average growth in demand for banknotes has increased by 5.14 percent during the period of study. This indicates the scope for further augmentation of capacity in raw material production in the short term and augmentation of banknote production capacities in the mid-term. The ongoing government policies of liberalisation and integration of India globally, will result in up-gradation and or augmentation of production capacities, newer entrants in hitherto unseen structures for

production of banknote paper and ink are visualised. In the last five years of the study a lot of churning in the organisational structure – formation of SPMCIL, augmentation of production and operational capacities by both SPMCIL and BRBNMPL(Expenditure Reforms Commission, December 22, 2000), initiatives in augmenting raw material production capacities(Expenditure Reforms Commission, December 22, 2000) and setting up of banknote paper mill as a joint venture between SPMCIL and BRBNMPL(Security Printing and Minting Corporation of India, 2009) are taking place. Though this may not result in altering the monopsonic nature of this industry, it will result in changes in the ways the industry has functioned with regard to quality and efficiency. The growth of non-cash transactions and other modes of e-payments are, though currently at primitive stages are going to increase with the phenomenal growth of telecommunications and information technology. This will certainly have an impact on the growth of the banknote printing industry both in India and worldwide.

As has been elaborated with the single buyer – RBI and current two suppliers, with a host of global printing presses and overcapacity in supply, the buyer will have absolute monopsony powers in demanding the price, quality and quantity. This is unlikely to change in the near future unless a number of banks are authorised to issue banknotes as is the case in Hong Kong(HKMA)or banknotes being printed by different banknote printers working as a cartel as in the case of Euro banknotes. There are three important supplies on which Indian banknote industry rely on. They are banknote printing and processing machineries, banknote paper and banknote inks. The suppliers of them are spread across globe and they exert monopoly pressure on technology and supply of machineries and equipment throughout the world. They also determine the raw materials and consumables needed depending on what printing process they have developed and try dominating the supply of raw materials through cartels.

3.3 Measuring Competition

The variables that compose the competitiveness composite index for Indian banknote printing industry have been identified on the basis of factors related to competitiveness at the firm level, considering the specific issues peculiar to the Indian banknote printing industry as discussed in the preceding section. Total number of sub-indicators used for the competitiveness index are11.The sub-indicators, which are used to construct the competitiveness index of the firm, are listed in Table 3. All of these sub-indicators are grouped into six main indicators that clearly describe its components.

Table 1Description of the Sub-indicators in the Competitiveness Index for Indian Banknote Printing Industry

	Indicators		Sub - Indicators
1	Productive performance	a	Capacity utilisation
		b	Labour productivity
2	Sales and marketing strategy	a	Market share
3	Consumer satisfaction		
4	Technology and environmental factors	a	R&D expenditure

		b	Number of production plants
		c	Environmental indicators (SLUDGE)
5	Foreign trade measure	a	Net foreign exchange earned/ spent
6	Growth variables and potential	a	Growth variables

Source: Annual Reports of from 2000-01 to 2010-11, Ministry of Finance, Government of India, Reserve Bank of India and SPMCIL; Tender notifications by SPMCIL and BRBNMPL and author's calculations.

3.4 Normalizing Technique, Weighing and Aggregation of Indicators

Normalisation is required prior to any data aggregation to render them comparable as the indicators in a raw data often have different characteristics. Therefore this has to be transformed in pure, dimensionless numbers. For this, number of normalisation methods can be used(Freudenberg, 2003).The normalisation method used should take into account the data properties, as well as the objectives of the study (E. Giovannini, 2005). Considering this Range Equalisation Method is used where variables are re-scaled between 0 to 100 with the help of equation 1. This requires points of reference relative to which indicators can be scaled. A minimum and a maximum value are identified for each of the variables. Subtracting the minimum value of the particular variable from its actual value and dividing it by the difference between the selected maximum and minimum values determine the values of the indicators. Then we multiplied this value of the indicators by 100, so that it ranges between 0 (worst performer) and 100 (best performer). This method of re-scaling the data widens the range of indicators, which makes the differences more distinct.

$$\text{Normalisation} = \frac{\text{Actual Value} - \text{Minimum Value}}{\text{Maximum Value} - \text{Minimum Value}} \times 100 \qquad (1)$$

Different factors of competitiveness have different impact on the competitiveness index, both negative and positive. For this reverse of the value i.e. '100- value' of the index is taken, which solves the issue of directionality. For benchmarking, weights can have a significant effect on the overall composite index and the rankings. Different weights may be assigned to indicatorsto reflect their economic significance, statistical adequacy, cyclical conformity, speed of available of data, etc. A number of weighing techniques are available, which could not be used for the purpose as most of them are based on the correlations between the indicators. Correlations do not necessarily represent the real influence of the sub-indicators on the phenomenon being measured (Nardo, 2005).

In the present study, the six broad categories of indicators were listed in the questionnaires itself so that experts in the field could assign weights to them out of 100 as per their relative importance in the competitiveness of the firm. This reduced the subjectivity in the index asofficials already working in the industry, which had worked and have clear insight into the problem of competitiveness. The weights then were averaged across the sample firms. However, for sub-indicators, equal weights have been used as asking relative importance of 8 sub-indicators to the officials of the firm was not possible due to their unwillingness and sensitivity.

Table 2Weights of the Indicators of Competitiveness for Indian Banknote Printing Industry

	Indicators	Average weight		Sub - Indicators	Average weight
1	Productive performance	42	a	Capacity utilisation	21
			b	Labour productivity	21
2	Sales and marketing strategy	8		Market share	8
3	Consumer satisfaction	7			7
4	Technology and environmental factors	23	a	R&D expenditure	7.66
			b	Number of production plants	7.66
			c	Environmental indicators (SLUDGE)	7.66
5	Growth variables and potential	20	a	Growth variables	10
			b	Future sales	10
	Total	100			100

Source: Author's survey among industry experts.

After weight allocation to each component index, these scores are aggregated into a composite score. The aggregation of indices tends to be of either an additive or a functional nature (Booysen, An Overview and Evaluation of Composite Indices of Development, 2002). The most widespread method of linear aggregation is used in the index construction where the mere summation of weighted and normalised indicators is done.

The aggregate index for each of the ten indicators is derived first using relevant variables (sub-indicators). The formula used for this is given below:

$$V_i = \frac{1}{n}\sum_{i=1}^{n} x_i \qquad (2)$$

where, V_i is i^{th} indicator, x_i is the i^{th} sub-indicator , n is the number of sub-indicators within the indicators.

The next step is of aggregating these ten indicator indices into one competitiveness index for a firm in the automobile industry. This is done in the same manner as in equation 2.

$$C_j = \frac{\sum_{i=1}^{n} Wi\,Vi}{\sum_{i=1}^{n} Wi} \qquad (3)$$

where, $C_j$is the competitiveness index of j^{th} firm, Wi is weight of the i^{th} indicator, Vi is i^{th} indicator (i=1 to 10) and n is the number of indicators. Then the six indicators are grouped and constructed the indices for the purpose of analysis. The scores of the sample firms to benchmark the average competitiveness in the industry are also averaged.

RESULTS

The data were interpolated to the framework as required and the results were obtained. Each of the hypotheses has been considered using these methodologies in arriving at the results.

Results of Efficiency and Productivity Change Analysis

To measure technical efficiency and changes in productivity, printing costs of banknotes produced year-wise were introduced as inputs in the model, for considering them as variables under the control of the banknote printing industry. On the other side, the number of banknotes produced in a year was introduced as output variables in the model. These variables showed high statistical significance as determinants of printing costs. Estimations were calculated for the Indian banknote printing industry, SPMCIL and BRBNMPL used in the econometric model as given below inTable 7 to Table 9.

Table 3Variables used in the Panel Data Model

Variable	Average	Maximum	Minimum	Standard Deviation
*C**	17710.61	27541.2	11227.8	6063.993467
N	1096.6	1019	1170	47.6092428
Circ	39554100000	48963000000	2263748289	3810104734.78
Y	314826	501600	176930	102432.4293
Sec.	11	12	10	1
Size	105.66426	108.66	103.6671	2.446011467
*Production**	11760	17034	7004	2683

(Sample: Indian Banknote Industry; Years: 2000-01 to 2009-10; Observations 10)
**Variables used in the estimations of the efficient frontier model the Malmquist index*
C: Printing costs in millions of Rupees.
N: Population in millions of inhabitants
Circ: Currency in circulation in millions.
Y: GNP per capita in Rupee.
Den: Number of denominations in circulation.
Sec: Number of average security features of circulating banknotes.
Size: Average size of circulating banknotes in cm^2.
Source: 2000-01 to 2009-10 Annual Reports of Reserve Bank of India, Ministry of Finance in Government of India, Security printing and Minting Corporation of India, Statistical Handbook on Indian Economy of Reserve Bank of India and Author's calculations.

Table 4Variables used in the Panel Data Model

Variable	Average	Maximum	Minimum	Standard Deviation
*C**	851.043	1594	405.9	304.3609
N	451	597	211	97.674026
Circ	18920840842	3633055794	65544292	887910572
Y	314826	501600	176930	102432.4

Sec.	11	12	10	1
Size	105.6643	108.66	103.6671	2.446011
Production*	4741.825	7083.094	2594.167	1190.788

(Sample: SPMCIL; Years: 2000-01 to 2009-10; Observations 10)
**Variables used in the estimations of the efficient frontier model the Malmquist index*
C: Printing costs of SPMCIL in millions of Rupees.
N: Population in millions of inhabitants catered by SPMCIL.
Circ: Currency in circulation in millions supplied by SPMCIL.
Y: GNP per capita in Rupee.
Den: Number of denominations in circulation.
Sec: Number of average security features of circulating banknotes.
Size: Average size of circulating banknotes in cm^2.
Source: 2000-01 to 2009-10 Annual Reports of Reserve Bank of India, Ministry of Finance in Government of India, Security printing and Minting Corporation of India, Statistical Handbook on Indian Economy of Reserve Bank of India and Author's calculations.

Table 5Variables used in the Panel Data Model

Variable	Average	Maximum	Minimum	Standard Deviation
C*	841.902	1160	571.87	226.0181
N	637	689	525	55.41239
Circ	2679766217	4881453216	1269027428	1141105717
Y	314826	501600	176930	102432.4
Sec.	11	12	10	1
Size	105.6643	108.661	103.667	2.446011
Production*	6876.4	9517	4307	1678.1075

(Sample: BRBNMPL; Years: 2000-01 to 2009-10; Observations 10)
**Variables used in the estimations of the efficient frontier model the Malmquist index*
C: Printing costs of BRBNMPL in millions of Rupees.
N: Population in millions of inhabitants catered by BRBNMPL.
Circ: Currency in circulation in millions supplied by BRBNMPL.
Y: GNP per capita in Rupee.
Den: Number of denominations in circulation.
Sec: Number of average security features of circulating banknotes.
Size: Average size of circulating banknotes in cm^2.
Source: 2000-01 to 2009-10 Annual Reports of Reserve Bank of India, Ministry of Finance in Government of India, Security printing and Minting Corporation of India, Statistical Handbook on Indian Economy of Reserve Bank of India and Author's calculations.

The output oriented Malmquist Index is calculated for Indian banknote printing Industry and BRBNMPL in one table and another BRBNMPL to SPMCIL for constant returns to scale. Table 10 and Table 11 show results of three efficiency measures namely efficiency change, pure efficiency change, scale efficiency change, technological efficiency change; calculated using model in equation (6) (7) and (8) to arrive at the Malmquist Index. The year-wise changes in

productivity calculated for the ten year period from 2000-01 to 2009-10 has been calculated and produced below.

Table 6Technical, Global and Scale Efficiency of BRBNMPL to SPMCIL

Year	EC	PEC	SEC	TC	MI
2000-01	1.059	0.866	1.223	0.771	0.816
2001-02	1.195	1.468	0.814	0.771	0.921
2002-03	0.995	1.288	0.773	0.771	0.767
2003-04	0.379	0.46	0.823	0.771	0.292
2004-05	0.578	0.78	0.741	0.771	0.446
2005-06	1.763	1.594	1.106	0.771	1.359
2006-07	0.833	0.997	0.835	0.771	0.642
2007-08	1.139	1.133	1.006	0.771	0.878
2008-09	1.161	1.118	1.038	0.771	0.894
2009-10	0.703	1	0.703	0.771	0.542
Average	0.985	1.0704	0.9062	0.771	0.7557

(Sample: Years: 2000-01 to 2009-10; Observations 10)
*MI = EC * TC; MI = PEC * SEC * TC*

MI: Malmquist Index, TC: Technical Change (VRS model), EC: Efficiency Change (CRS model), TC: Technological Change, SEC: Scale Efficiency Change, PEC: Pure Efficiency Change. Source: Author's calculations

In general, productivity increases are primarily a consequence of increases in efficiencyand in a lower proportion of technical change. In most of the cases, a positive change ionefficiency is mainly the result of higher scale efficiency, while in a minor proportion of the closer locations of the printing press to the reference frontier efficiency (pure efficiency). This could obeyto high demand for banknotes. It has generated an important increase of the production in banknotefor both the printing presses.

After examining the efficiency change (EC), pure efficiency change (PEC), scale efficiency change and technical change (TC) the Malmquist index (MI) is calculated. Results of the constant returns to scale (CRS) show that a fluctuation of scale efficiency is observed, going down to an average of 0.9062. This is a consequence of the CRS approach, where both the banknote presses is compared assuming that they operate at an optimal production scale. However, this is not a real situation for banknote presses due to market failures, particularly, differences in the currency demand behaviour. This result is proved empirically through the scale efficiency index (SEC), where it is observed that in the first four years it had been increasing and touched 1.106 in 2005-06and from 2006-07 increased from 0.835and went down to 0.703 in the year 2009-10. Only on the years 2005-06, 2007-08 and 2008-09 the SEC is in the range near to constant returns to scale (crs) at an optimal zone with an index equal to 1.006 to 1.106 and has reported 1.223 in 2000-01 which is higher and beyond the optimal zone showing increasing returns to scale (irs).Results of the Malmquist index show an increasing trend from 2000-01 to 2004-05 for both the printing units by peeking to 1.359 in 2005-06 and started going down gradually to 0.542. It is very useful to know the kind of scale returns because it allows identifying key aspects of the performance of

BRBNMPL and SPMCIL. In fact, the years in which increasing returns to scales are located, an increase in the inputs level will result in more than proportional increases in the output level. For example, in the case of year 2009-10, this means that a larger producing scale would generate a more than proportional increase in the production level.

Table 7Technical, Global and Scale Efficiency of Indian Banknote Printing Industry to BRBNMPL

Year	EC	PEC	SEC	TC	MI
2000-01	0.794	1	0.794	1.384	1.099
2001-02	0.753	0.76	0.99	1.384	1.042
2002-03	0.823	0.841	0.978	1.384	1.139
2003-04	0.932	0.999	0.933	1.384	1.29
2004-05	1	1	1	1.384	1.384
2005-06	0.731	0.627	1.166	1.384	1.012
2006-07	0.885	0.996	0.888	1.384	1.225
2007-08	0.788	0.965	0.817	1.384	1.091
2008-09	0.719	0.894	0.804	1.384	0.996
2009-10	0.994	1	0.994	1.384	1.376
Average	0.842	0.908	0.936	1.384	1.165

(Sample: Years: 2000-01 to 2009-10; Observations 10)
*MI = EC * TC; MI = PEC * SEC * TC*

MI: Malmquist Index, TC: Technical Change (VRS model), EC: Efficiency Change (CRS model), TC: Technological Change, SEC: Scale Efficiency Change, PEC: Pure Efficiency Change. Source: Author's calculations

In case of the results of the constant returns to scale (CRS) show that a fluctuation of scale efficiency is observed, going down to 0.994average. This is a consequence of the CRS approach, where both the banknote printing industry as whole and BRBNMPL is compared assuming that they operate at an optimal production scale. However, this is not a real situation for the press and industry in which it operates. The variation may occur due to market failures, particularly, differences in the currency demand behaviour as stated above. In this case too this result is proved empirically through the scale efficiency index (SEC), where it is observed that in the first fouryears it had been increasing in a fluctuating manner and touched 1.166 in 2005-06 and from 2006- 07 increased from 0.888 and reached 0.994 in the year 2009-10. Only on the year 2004-05, theSEC is in the range near to constant returns to scale (crs) at an optimal zone with an index equal to 1and has reported 1.166 in 2000-01 which is higher and beyond the optimal zone showingincreasing returns to scale (irs).Results of the Malmquist index show an increasing trend from
1.099 in 2000-01 peaking to 1.384 in 2004-05 for both the industry and BRBNMPL and started growing again gradually from 1.012 in 2005-06 to 1.376 in 2009-10.

Results of Competitiveness Analysis

Using the weighted average of the sub-indicator indices, financial and non-financial indices are constructed.

Table 8Results of Competitiveness Analysis

	Indicators		Sub - Indicators	
1	Productive Performance	a	Capacity utilisation	8
		b	Labour productivity	12
2	Sales and marketing strategy		Market share	8
3	Consumer satisfaction			10
4	Technology and environmental factors	a	R&D expenditure	6
		b	Number of production plants	4
		c	Environmental indicators (SLUDGE)	10
5	Growth variables and potential	a	Growth variables	3
		b	Future sales	2

1 Analysis

Table 9Scores and Ranks for Indian Banknote Printing Industry

	SPMCIL		BRBNMPL		Industry	
Indicators	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Productive performance						
Capacity utilisation	6.30	1	8.40	2	7.35	2
Labour productivity	6.30	1	9.45	1	7.88	1
Sales and marketing strategy						
Market share	1.64	7	2.32	5	1.98	6
Consumer satisfaction	2.21	4	0.74	8	1.47	8
Technology and environmental factors						
R&D expenditure	1.10	8	1.47	7	1.28	9
Number of production plants	2.75	3	3.67	3	3.21	4
Environmental indicators	1.83	6	1.83	6	1.83	7
Growth variables and potential						
Growth variables	3.5	2	3.00	4	3.25	3
Future sales	2.00	5	3.00	4	2.50	5

Source: Author's survey among industry experts and calculations.

Table 10Overall Rankings and Scores for Indian Banknote Printing Industry

	Score	Rank
SPMCIL	27.63	3
BRBNMPL	33.87	1
Industry	30.75	2

Source: Author's survey among industry experts.

Industry average score of competitiveness index has been calculated at 30.75, which is used to analyse the competitive performance of firms above and below it. It is hence used as benchmark the firms' competitive standings in the industry. BRBNMPL's performance is above industry average with a score of 33.87 and that of SPMCIL is found to be below it with a score of 27.63. BRBNMPL has outscored the industry in case of consumer satisfaction with a score of 0.74 and growth variables with score of 3.00. Since the SPMCIL had taken initiatives to ascertain the consumer satisfaction in a planned systematic way with an established in order to enhance its performance in this aspect it stands out. In growth variables BRBNMPL has a score lesser than the industry score due to it being a single product firm which is also a wholly owned subsidiary of the central bank which has a negative influence on its product development and diversification efforts. SPMCIL has outscored the industry and BRBNMPL in the indicator – growth variables due to the fact that it is multi-product company and it has a diversified portfolio of security product production units and has almost elastic resources. BRBNMPL also equaled the industry average at
1.83 in the environmental indicators, while that of SPMCIL is also same. Basically banknote printing industry generates enormous quantities of ink sludge disproportionate to the nature of industry (printing) it is in and it therefore has the problem of disposing them as per statutory normswhich is major challenge in the years to come due to strict environmental regulations. Both the firms depend heavily on the imported raw materials, capital items and major consumables which isa favourable proposition. The good competitive position BRBNMPL enjoys in productive performance is because of its highest capacity utilization and labour productivity in the banknote printing industry. In market share and future sales the SPMCIL lags behind due to its lesser capacity and use of older machines and in some instances technology where BRBNMPL stands ahead of it. Also from the point of productive performance BRBNMPL is far ahead of its older competitor.

It is also observed that out of these two firms, one exclusively prints banknotes and the other has a range of products including coins, security paper, security documents, stamps and medals. This shows that SPMCIL can diversify and compete with higher prices. It will also be useful to policy makers to judge the competitive performance of this industry and firms in the industry from the product quality point of view. It can hence be said that the BRBNMPL can dominate the industry completely if it keeps and improve its performance.

CONCLUSIONS

India has one of the finely managed currencies in the world. But it faces the challenge and threat of fast outdating of technologies of printing of banknotes and threat of counterfeiting due to the latest 'off the shelf' printing technologies. This is coupled with the growing overcapacity of banknote printing in the world and the single monopsony buyer demanding cheaper banknotes at world class qualities is a concern for the Indian banknote printing presses. Still the dependence on machinery and equipment from foreign suppliers is to be overcome which may take a considerable time. Therefore the presenter feels the need for increasing the effort on research and developments in all aspects of banknote printing to focus on development of new cost efficient and better performing security features, long lasting substrates, optimising banknote sizes, development of state of the art quality assurance and quality control systems and production of raw materials which are cost effective and secured in the short and medium terms. In doing so it has to consider the developments which are taking place in other areas of the central banking, finance and general monetary developments in India and abroad.

LIMITATIONS OF THE STUDY

The present study has not covered all the aspects of the banknote printing industry in India which is other than production cost function. Therefore this is not an all-encompassing study. Also this has not dealt into the industrial aspects of technology, manpower, skill factors, knowhow, machineries and other capital equipment and their performance.

SCOPE FOR FURTHER STUDY

The areas of technology used, developed and their performance in relation to the availability of the technology in India needs to be looked into for a deeper study. The industry's supply chain and storage and distribution is an important area of its functioning need an elaborate study. The effect of counterfeits on the banknote producer and response by the banknote producer and the central bank is an interesting area of study. The optimal structure for the banknote printing industry andthe optimal product mix for the industry and for its firms requires a study in depth.

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