Game Theory Under the Purview of Digital Payments

Dr. Kiran Kumar Tarikere
Associate Professor and Research Supervisor, Karnatak Arts College, Dharwad, Karnataka, India
kirantkc@gmail.com
Akhil Dattatraya Joshi
Research Scholar, Kousali Institute of Management Studies, Karnatak University, Dharwad, Karnataka, India
akhiljoshi5859@gmail.com

Abstract:
Problem: Game Theory is a theory which deals with such a situation that is competitive in nature. Competitive nature arises due to conflicting opinions or interests. These different interests give rise to different preferences. With the difference in preferences, provides with different strategies. There are mainly pure strategies and mixed strategies when it comes to Strategy. Under different strategies, Pay-Off Matrix is formed. Each game gives a point where maximum of a minimum row coincides with minimum of maximum column. Such point is called as Saddle Point. Even with respect to Digital payments this technique can be used. Application of Game Theory in Digital Finance will open up a new branch for Operations Research. Such Game Theory can also be called as Digital Game Theory. Combining Game Theory and Digital Finance can help to resolve many technical problems which rise at the course of execution of Digital payments in the Digital World. In this paper the problem is about application of game theory in the world of Digital Finance. If Game Theory principles are applicable in Digital Finance then to what extent it is applicable? How the applicability can be visualized? What conclusion can be drawn? **Approach:** To apply Game Theory in Digital Finance first all the Digital Payments platforms have to be listed. In order to make users well versed with Digital Payments, there have been many schemes which have been implemented such as Digitalization, Digital India, Jan Dhan Yojana etc. These schemes help in initiating digital payments easily. There are many digital payment platforms where Digital transactions can be done very easily. Namely UPI, BHIM, NEFT, AePS, IMPS, APBS and NETC. The data with respect to all the listed payments gateways are recorded. Later the principles of game theory are applied in order to understand the saddle point amongst the Digital avenues. In order to find the saddle point, basically three year data with respect to all digital avenues are taken and recorded. All data is recorded with respect to Value of Transactions and volume of transactions. **Findings:** This paper discusses about how to apply the knowledge of game theory in the world of digital payments. The key findings with respect to application of Game Theory in Digital Payments states that with respect to value of transactions, the saddle point is calculated to be at NEFT payment gateway whereas for the volume of transactions, the saddle point is calculated to be at UPI payment gateway. **Conclusions:** It can be concluded that the most preferred payment gateway from Value of transactions point of view is NEFT Payment platform whereas with respect to Volume of Transactions, UPI is the most preferred payment gateway.
Keywords: Game Theory, Digital Payments, Saddle point.

Introduction: Digitalization and its impact can be seen with initiation of different payment platforms across the world. Under these platforms there are different product ranges which have given new ray of hope for further upliftment of Digital Finance. Virtual Financial Organizations, growing fintech applications and urge to become financially independent has made Digital Finance to be a part of everybody's life. Digital Finance has been a game changer in the field of Finance. Even the start of Crypto currency has emerged in a much

better way compared to other investment platforms. This has attracted the minds of many investors. Under digitalization, there are many payment platforms which are mainly UPI, BHIM, NEFT, AePS, IMPS, APBS and NETC. These Digital paying cells help in making Digital payments to within the specified range of payments. For the application of game theory in Digital payments, both the value of transactions as well as volume of transactions is taken into consideration.

Literature Review:

1. Fintech Application: Financial Stability is the need of each and every person which is turning towards financial independence. Under this, application of technology in finance gives more strength and security as compared to the traditional method of saving and securing the money. With the increased utility of technology, it is not only able to serve the purpose of financial transaction but also it helps in generating employment to new startups. [**Li, B., Xu, Z.(2021)**].

2. Digitalization: As Digitalization is being introduced in the Indian scenario, many digital startups have come up. In this the traditional way of carrying out the transactions has been minimized and on board recording of transactions has been done automatically. Availability of up to date transactions, email notifications, App oriented short message services, timely notified texts and many more help the users to make the financial transactions comfortably relevant in their procurement.[**Rachinger, M., Rauter, R., Müller, C., Vorraber, W. and Schirgi, E. (2019)**].

3. Digital Payments: In order to initiate digitalization, digital payments were implemented. This kind of payments deal with such system where hard physical cash are not involved. Under this system a payment gateway which is digital in nature. Accessible to most and cash availability at ease. Under this setup, there are two types of digital payments. One is the value of digital payments. Another one is volume of digital payments. Both the types help in evaluating the payments to a much greater extent as compared transactions [**Alaa Mahdi Sahi, Haliyana Khalid, Alhamzah F. Abbas, Saleh F.A. Khatib (2021)**].

4. Value of Transactions: Under Digital payments, this is the first type. In this type of Digital Payments how much amount of money has been paid from one account to another account is recorded**.** The amount that is paid at the time of digital payments is called as Value of Transactions. It gives the amount of money transferred is non physical as compared to Physical Cash. [**Shree, S., Pratap, B., Saroy, R. *et al* (2021)**].

5. Volume of Transactions: Under Digital Payments, this is the second type. In this type of Digital Payments, the frequency at which the payments are done is recorded. The number of times Digital Payments are done is recorded**.** The number of times a digital payment is done in order to transfer money from one account to another account digitally is called as Volume of Digital Payments. [**K. Kajol, Ranjit Singh, Justin Paul (2022)**].

6. UPI: Unified Payment Interface: This payment gateway was started in the year 2015. To facilitate the digital payments, UPI was introduced. This led to more involvement of customers in terms of digital payments at retail level. Even for small things like stationary gifts, eatables and other items, UPI is being used and preferred as compared to all other payment gateways. Vegetable vendors, fruit sellers and retail shop owners are using OR code operated payment systems. These payment systems are connected with UPI payment gateway. [**Fahad, Mohammad Shahid (2022)**].

7. BHIM: Bharat Interface for Money: It is a payment gateway used in order to transfer money digitally. BHIM was launched in 30 December 2016. This payment platform was launched by NPCI. NPCI is known as National Payments Corporation of India. NPCI draws its guidelines from RBI. [**Borde, Ajit & Borgave, Sachin. (2020)**].

8. NEFT: It is referred as National Electronic Fund Transfer. It is an electronic system where funds are transferred in a secured way. It comes under the direct maintenance of Reserve bank of India. In order to use NEFT, the bank accounts should be made NEFT enabled bank accounts. The NEFT system was started in the

year 2005. It was initiated by Institute for Development and research in Banking Technology. [**Timilsina, Satyendra & Rao, Prof. (2019)**]

9. AePS: It is known as Aadhaar Enabled Payment System. In this payment system, Aadhaar cards are used in order to transfer the amount from one account to another account. Under this, the 12 digit Aadhaar number is used confirm the transfer of amount. As the Aadhaar card number is unique to the individual's identification, it is found to be the most secured payment gateway. [**Sharmin i, Kamila. (2020)**].

10. IMPS: It is also known as Immediate Payment System. It was started in the year 2010. The processing in this payment system is carried out with the help of an inter bank electronic funds transfer. The technique used by the IMPS is Interbank Electronic Funds transfer system. **[Vindhya KT (2015)**].

11. APBS: It is known as Aadhaar Payment Bridge System. There are many government subsidies which need to be channelized. This payment gateway deals with subsidy management of government departments. In this system aadhaar is the key component for transferring amount from one account to another account. Along with APBS, another element is present which is DBT where DBT means Direct Benefit Transfer. [**Cristian Alonso, Tanuj Bhojwani, Emine Hanedar, Dinar Prihardin, Gerardo Uña, and Kateryna Zhabska (2023)**]

12. NETC: Toll is very important for any country from revenue point of view. Toll on road transportation and other means of transportation have significantly contributed to the development. Digitalization of toll is one such area which has been associated with the economic development as well as social development. Integration of Digital Finance in Toll collection has brought big change at National Scenario. Usage of different digital platforms for Digital Payments with respect to toll makes the payment automatic and at ease.[**Joshi, Bharavi & Bhagat, Kajal & Desai, Hetakshi & Patel, Malvik & Parmar, Jekishan. (2017)**.]

13. Operations Research: Systematic application of scientific theories in order to achieve the targeted generally refers to Operations Research. On a broad scale it can be said that the research of operations is said to be Operations Research. The scientific theories that have been developed by the human mind are applied on a given set of problems. These problems can be real or human made. The application oriented scientific approach makes the steps to be taken in a simpler way making the things happen. [**Datta, Subhash. (2000)**]

14. Game Theory: Game Theory is a part of Operations Research where every outcome of the game is an interaction between players. These players can be in any number. Generally for analysis, two players are taken. Interaction between two players leads to different outcomes. This kind of matrices is called as Pay-off. Pay-off deals with the possibility of outcomes available between two players. Pay-off is generally represented with matrix structure.

[**Norozpour, Sajedeh & Safaei, Mehdi. (2020)**]

15. Game Theory Strategy: Strategies are common with respect to management. When it comes to Operations Research, Strategy with respect to outcomes is very important. If the Strategy deals with the outcome of a game, then players use different strategies to deal under different situation. Taking proper decisions with respect to Game can be done with the help of strategies. Application of Game Theory with respect to Decision making is one of the most important application of Operations Research. [**Heiets, Iryna & Oleshko, Tamara & Leshchinsky, Oleg. (2023)**]

16. **Strategy**: There certain set of rules and regulations which need to be followed at the time of playing the game. These rules shape the game and provide ample opportunity for the player to set their own strategies. In Game Theory, strategy plays an important role for the benefit of both the players. Interestingly to decide on a particular strategy knowing of other player's strategy is not necessary. [**Jong-Tsong Chiang(1995)**].

17. Pure Strategy: There are different course of action which has to be taken by the players playing the game. These courses of actions depend upon the game. A decision is taken after the execution of the game in order to play efficiency without compromising the rules of game. The point of execution of the game plays an important role for Pure Strategy. [**J. M. Binner, F. Ciardiello, L. R. Fletcher and V. N. Kolokoltsov (2019)**].

18. Mixed Strategy: Another kind of strategy which is involved in the Game Theory is Mixed Strategy. Under Mixed Strategy, the course of action is decided before the Execution of the game. As it is decided before, it can be said as the predetermined action which is taken for the implementation. [**Evan M. Calford (2021)**]

19. Value of Game: Each and every game in the game theory has a valid meaning and point with respect to its intention of play and execution of strategies. Under such condition, the value pertaining to the game is very important. What monetary value does a game hold can be understood with the help of Value of Game. It also provides a scalar dimension of the game. Scalar dimension of the Game shows the worth of the game. The value of game can be calculated with the help of saddle point.[**MYERSON, R. B. (1992)**]

20. Saddle Point: a common point is calculated which suffices the all the rows and columns held in the pay-off of the matrix. It is also called as Equilibrium point where the entire game is stable and forms a stable game. This point can be calculated with the help of different principles. Mainly Principle of Dominance and Maximin – Minimax Theory is used. [**Radzik, T (1991)**].

21. Maximin- Minimax Theory: This principle of Maximun- Minimax consists of two parts. One part is the Maximin Theory. It is also called as Criteria of Pessimism. In this theory, the Minimum value is calculated out of Maximum values generated in the column. Another part under this theory is Minimax. This is also called as Criteria of Savage. In this theory, the Maximum out of the Minimum value is chosen. After choosing, both are compared with each other to justify whether both the values are same or not. [**Atsuhiro Satoh and Yasuhito Tanaka (2018)**].

22. Application of Maximin- Minimax Theory: There are many applications where Maximin- Minimax Theory has been applied. One of such applications is Strategic Management. There are many strategies which have been framed by the organizations. Amongst them, the strategy which works the most can be evaluated with the help of Maximin- Minimax Method. Another application of Maximin- Minimax Theory is its utility in decision theory. Many decisions are taken up by an individual under certain course of action. In order to pickup an accurate decision, Maximin- Minimax Theory is used.

Objectives:

1. To study the different digital payments gateway.
2. To study graphically different digital payments.
3. To find saddle point using Maximin- Minimax Principle with respect to different Digital Payments.

Theoretical Framework:

1. Two players are taken into consideration: Digital Payment Channels, Years.
2. All payment channels are listed
3. These Payment channels are named accordingly with the names

SL.No	Payment Channel	Names
1	UPI	A1
2	BHIM	A2
3	NEFT	A3
4	AePS	A4
5	IMPS	A5
6	APBS	A6
7	NETC	A7

4. Three years are taken into consideration: 2019-20, 2020-21, 2021-22.
5. The years are named according with names:

Sl.No	Year	Names
1	2019-20	B1
2	2020-21	B2
3	2021-22	B3

Data Collection:

a. Value of Transactions

Payment Channels	lakh crore		
Year	**2019-20 (B1)**	**2020-21 (B2)**	**2021-22 (B3)**
UPI (A1)	21.32	41.04	84.16
BHIM (A2)	0.01	0.03	0.06
NEFT (A3)	229.46	251.31	287.25
AePS (A4)	0.005	0.01	0.01
IMPS (A5)	23.38	29.41	41.71
APBS (A6)	0.99	1.11	1.33
NETC (A7)	0.002	0.01	0.02

b. Volume of Transactions:

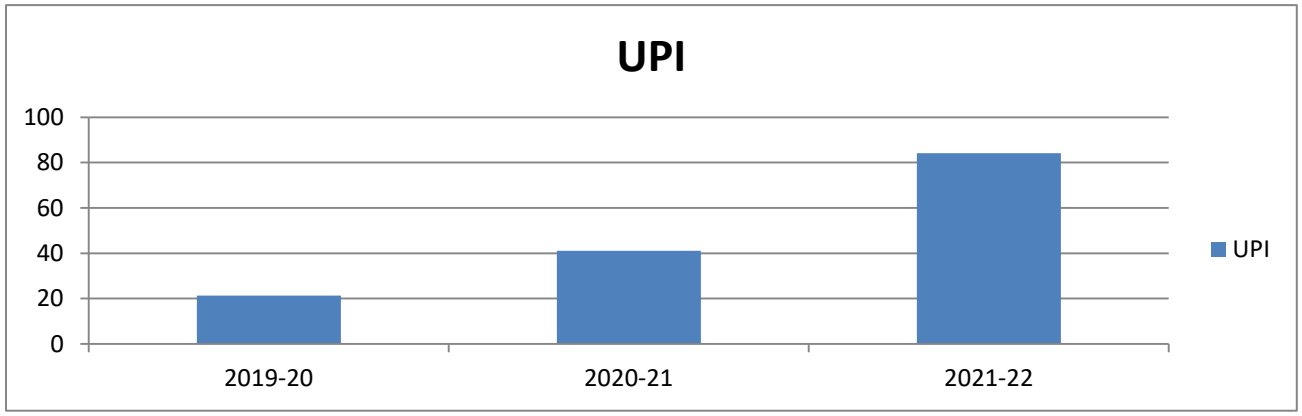
Payment Channels	lakh		
Year	**2019-20 (B1)**	**2020-21 (B2)**	**2021-22 (B3)**
UPI (A1)	125186	223307	459561
BHIM (A2)	91	161	228
NEFT (A3)	27445	30928	40407
AePS (A4)	10	11	10
IMPS (A5)	25792	32783	46625
APBS (A6)	16747	14373	12298
NETC (A7)	93	650	1207

Source:
https://rbidocs.rbi.org.in/rdocs/AnnualReport/PDFs/9PAYMENTANDSETTLEMENT033C9414C22C4370AD16C837C55EDDC9.PDF

Data Analysis:

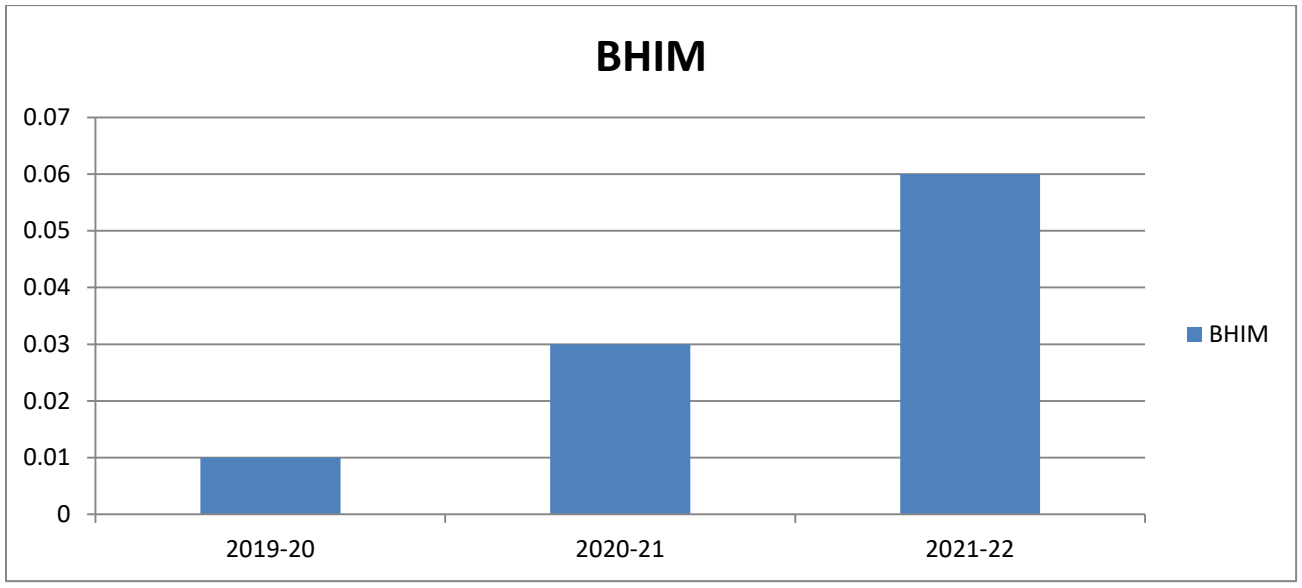
I. Graphical Representation:

a.UPI:



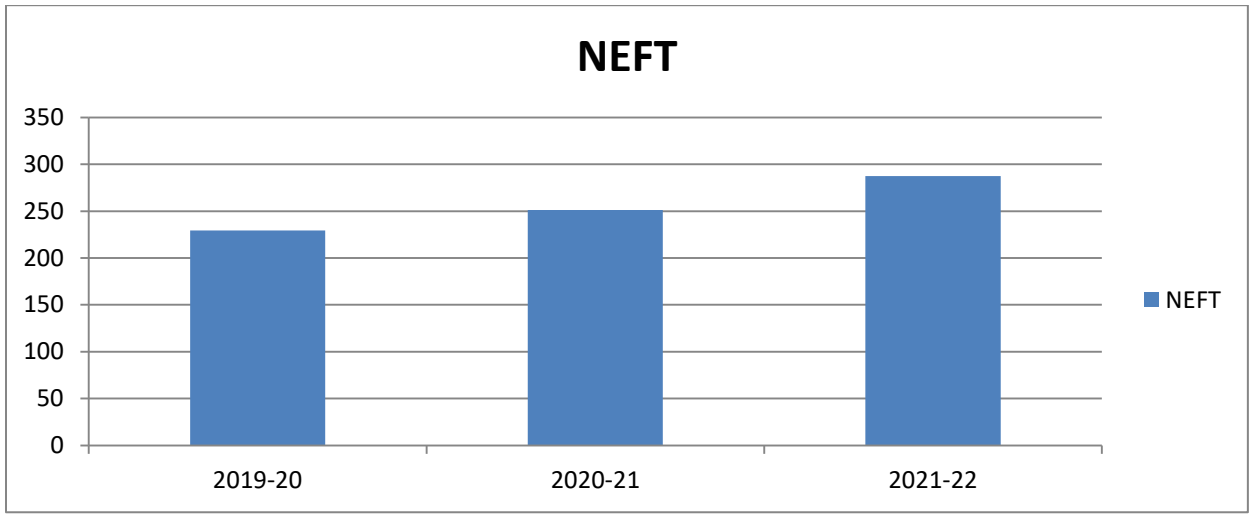
Interpretation: The value of transactions is showing an increasing trend with respect to the UPI each year. Almost 2 times the growth can be seen from 2019-20 where it recorded the transactions of 21.32 to 41.04 lakh crores in 2020-21. Interestingly, number of transactions recorded in

b. BHIM:



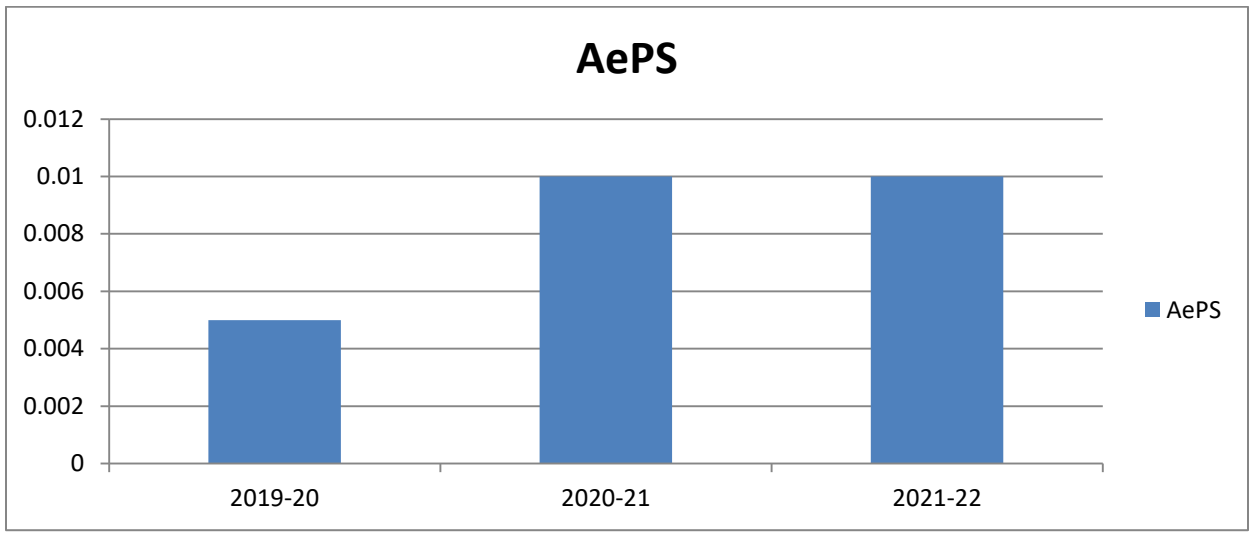
Interpretation: The value of transactions are increasing from 2019-20 to 2021-22. An increasing trend of transactions can be seen with respect to three years. Compared to first year, three times the BHIM transactions have increased. Compared to 2020-21, two times the transactions of BHIM have increased in 2021-22.

c. NEFT:



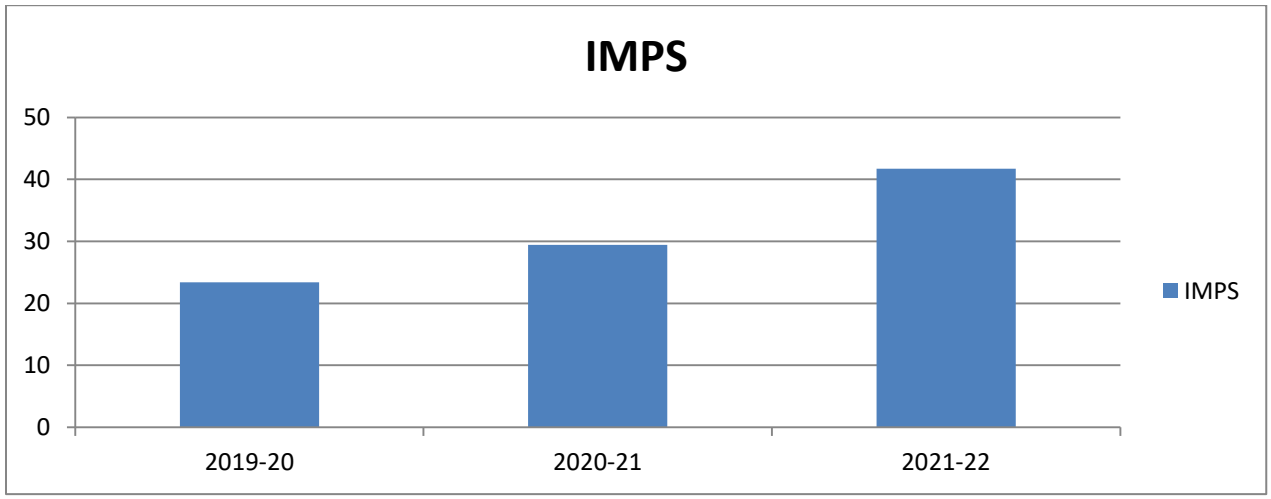
Interpretation: In 2019-20, the NEFT transactions were 229.46 lakh crores. In the succeeding year, the value of transactions with respect 2019-20 have increased by 1.095. making total transactions about 229.46 lakh crores. In 2021-22, the transactions where increased by 1.1430 times making the total transactions of 287.25 lakh crores. So the Value transactions of NEFT are steady in nature.

d. AePS:



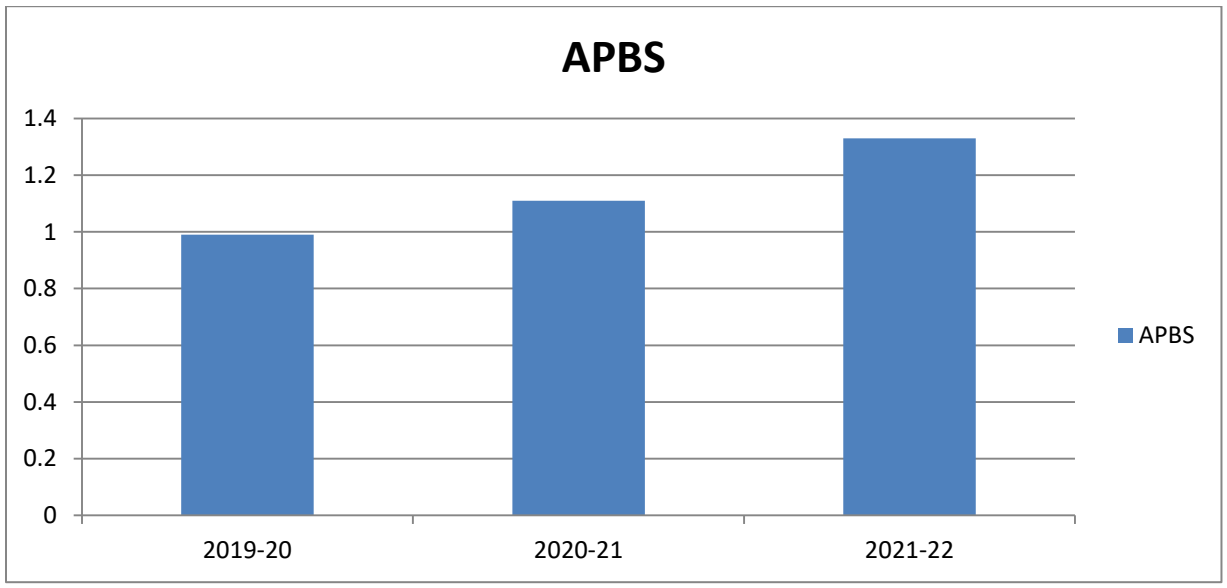
Interpretation: The Value of transactions has increased from 0.005 lakh crore to 0.01lakh crore by 2 times. This change has happened from 2019-20 to 2020-21. In 2021-22, the value of transactions are same. In 2021-22, the value of transactions has been steady by keeping the record of 0.01 lakh crore of transactions.

e. IMPS:



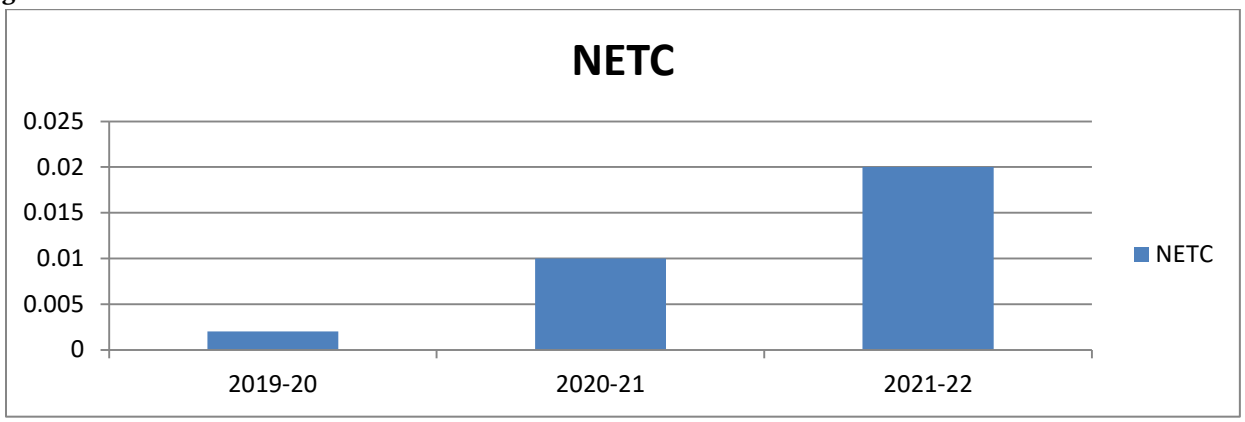
Interpretation: Under IMPS, the value of transactions has recorded upto 23.38 lakh crores in the year 2019-20. The Transactions have increased from 23.38 lakh crores to 29.41 Lakh crores, making the transactions increase by 1.2579 times. In 2021-22, the value of transactions have increased up to 41.71 lakh crores making a drastic increase by 1.4 times.

f. APBS:



Interpretation: In the year 2019-20, the value of transactions has been 0.99 lakh crores. The value of transactions have increased from 0.99 lakh crores to 1.11 lakh crores in the year 2020-21. This has been almost 1.12 times more than the 2019-20's value of transactions. In the year 2021-22, the value of transactions have increased from 1.11 lakh Cores to 1.33 Lakh crores making the total transactions of 2021-22 increase by 1.198 times.

g. NETC



Interpretation: In 2019-20, the value of transactions has been 0.002 lakh crores. In the 2020-21, the value of transactions has increased from 0.002 lakh crores to 0.01 lakh crores. This has led to a drastic change in number of transactions by 5 times. In 2021-22, the value of transactions has increased from 0.01 lakh crores to 0.02 lakh crores. This increase has led to change by 2 times.

II. Using Game Theory of Maximin- Minimax principle

a) Row Minimum:

Payment Channels	**lakh crore**			**Minimum**
Year	**2019-20**	**2020-21**	**2021-22**	
UPI	21.32	41.04	84.16	21.32
BHIM	0.01	0.03	0.06	0.01
NEFT	229.46	251.31	287.25	229.46
AePS	0.005	0.01	0.01	0.005
IMPS	23.38	29.41	41.71	23.38
APBS	0.99	1.11	1.33	0.99
NETC	0.002	0.01	0.02	0.002

b) Column Maximum

Payment Channels	**lakh crore**			**Minimum**
Year	**2019-20**	**2020-21**	**2021-22**	
UPI	21.32	41.04	84.16	21.32
BHIM	0.01	0.03	0.06	0.01
NEFT	229.46	251.31	287.25	229.46
AePS	0.005	0.01	0.01	0.005
IMPS	23.38	29.41	41.71	23.38
APBS	0.99	1.11	1.33	0.99

NETC	0.002	0.01	0.02	0.002
Maximum	229.46	251.31	287.25	

c) Row Minimax

Payment Channels	**lakh crore**			**Minimum**	**Minimax**
Year	**2019-20**	**2020-21**	**2021-22**		
UPI	21.32	41.04	84.16	21.32	
BHIM	0.01	0.03	0.06	0.01	
NEFT	229.46	251.31	287.25	229.46	229.46
AePS	0.005	0.01	0.01	0.005	
IMPS	23.38	29.41	41.71	23.38	
APBS	0.99	1.11	1.33	0.99	
NETC	0.002	0.01	0.02	0.002	
Maximum	229.46	251.31	287.25		

d) Column Maximin

Payment Channels	**lakh crore**			**Minimum**	**Minimax**
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BHIM	0.01	0.03	0.06	0.01	
NEFT	229.46	251.31	287.25	229.46	229.46
AePS	0.005	0.01	0.01	0.005	
IMPS	23.38	29.41	41.71	23.38	
APBS	0.99	1.11	1.33	0.99	
NETC	0.002	0.01	0.02	0.002	
Maximum	229.46	251.31	287.25		
Maximin	229.46				

II. Using Game Theory of Maximin- Minimax principle

a) Row Minimum:

Payment Channels	**lakh**			**Minimum**
Year	**2019-20**	**2020-21**	**2021-22**	
UPI	125186	223307	459561	125186
BHIM	91	161	228	91
NEFT	27445	30928	40407	27445
AePS	10	11	10	10
IMPS	25792	32783	46625	25792
APBS	16747	14373	12298	12298
NETC	93	650	1207	93

b) Column Maximum

Payment Channels	lakh			Minimum
Year	2019-20	2020-21	2021-22	
UPI	125186	223307	459561	125186
BHIM	91	161	228	91
NEFT	27445	30928	40407	27445
AePS	10	11	10	10
IMPS	25792	32783	46625	25792
APBS	16747	14373	12298	12298
NETC	93	650	1207	93
Maximum	125186	223307	459561	

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BHIM	91	161	228	91	
NEFT	27445	30928	40407	27445	125186
AePS	10	11	10	10	
IMPS	25792	32783	46625	25792	
APBS	16747	14373	12298	12298	
NETC	93	650	1207	93	
Maximum	125186	223307	459561		

d) Column Maximin

Payment Channels	lakh			Minimum	Minimax
Year	2019-20	2020-21	2021-22		
UPI	125186	223307	459561	125186	
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AePS	10	11	10	10	
IMPS	25792	32783	46625	25792	
APBS	16747	14373	12298	12298	
NETC	93	650	1207	93	
Maximum	125186	223307	459561		
Maximin	125186				

Findings and Suggestions:

1. The value of game with respect to Value of Transactions is 229.46 Lakh Crore.
2. The value of game with respect to Volume of Transactions is 125186 lakh.
3. The saddle point with respect to Value of Transactions is A3, B1.
4. The saddle point with respect to Volume of Transactions is A1, B1.
5. The Saddle point for Value of Transactions deals with NEFT Payment Gateway.
6. The Saddle Point for Volume of Transactions deals with UPI Payment Gateway.
7. With the help of above analysis it can be concluded that from Value of transactions point of view, NEFT is the Game Player.
8. From volume of transactions point of view, UPI is the Game Player.

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