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Implications of Banking Regulations on Online Payment Failures*

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Abstract

This paper explores the 'latent economy' of online transaction failure that prevails in the digital payment system. A two-variant model of profit, with a different cost function in each variant, has been proposed to examine the profit of commercial banks. The model considers that when an online transaction fails, banks use the money held in the Unified Payment System to earn revenue in the form of interest income by investing the same. The theoretical exposition of the model has been corroborated by simulation by assuming feasible parametric restrictions and exogenous values. The paper finds that commercial banks make profit by using the held amount at the existing cost. As the proportion of the held money used by the banks increases, their profits increase and the commercial banks incur losses when an 'alternative cost' with stricter penalties is imposed.

JEL Classification: E58, G18, G28, L51

Keywords: Digital Payments, Transaction Failure, UPI Payment Failure.

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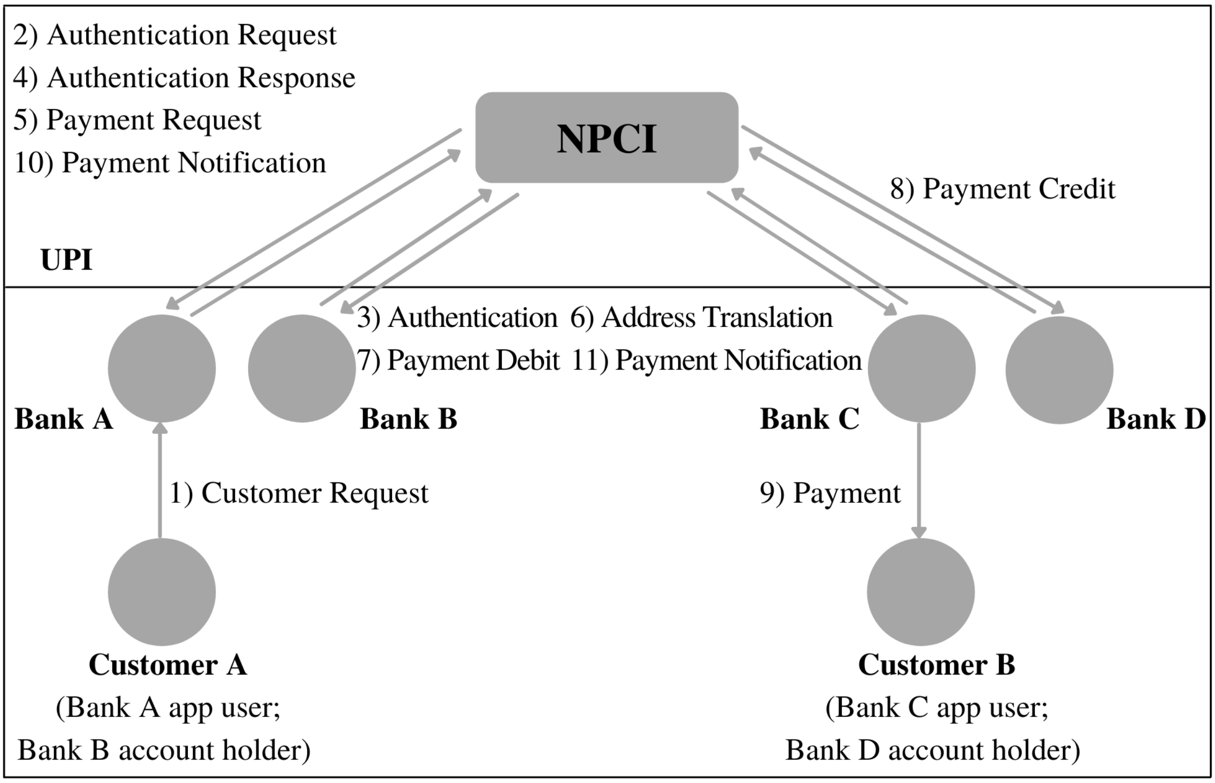
1 Introduction

Monetary transaction system is an integral part of any economy, being the channel through which the finances from one segment of the economy flow to the other. Unlike traditional cash-based payment network, there has been a significant paradigm shift in how this payment system works in the twenty-first century. The transactions are taking place without face-to-face human interaction. A wide variety of online payment systems are constantly being developed in the modern economy which includes, but not limited to, debit card, credit card, virtual credit cards, smart cards, e-wallets, e-cash, wireless payments, stored-value card payments, loyalty cards, person-to-person payment methods and the payments made electronically at kiosks (Koponen, 2006). Specifically, in mobile payment system, the transfer of money happens through a mobile device that initiates, authorizes, and confirms the transaction (Au and Kauffman, 2008).

Many studies argue that such a cashless system is reliable as it offers immunity against theft of paper. In addition, e-payment system saves time, reduces paperwork and provides better customer service, greater reach, easy and twenty-four hours access to information (Balasubramanian and Amanullah, 2019; Rouibah, 2009). Despite these advantages, existing literature also suggests that the e-payment system does face some challenges like, but not limited to– lack of infrastructure, security issues, social-cultural challenges, and regulatory challenges. Studies in the context of African countries find that, the lack of infrastructure which includes internet connectivity issues, affordability of internet services, low bandwidth, and frequent power cuts, result in lack of adoption of such e-payment technologies and ultimately these initiatives fail (Bassey, 2008; Haruna, 2012). Sathye (1999) studies the major factors that affect the adoption of internet banking services in Australia and finds that lack of awareness and security are the two major concerns that affect the adoption of these services. Another quasi-experiment conducted by Rouibah (2009) to study the failure of Mnet, a mobile payment technology in Kuwait, finds that a live demonstration of how to use mobile payment technology positively affects the adoption of technology. His study further reveals that the gender of the consumer, males being more inclined to adopt mobile payment services, also moderately affects the adoption of mobile payment services.

In the context of India, the evolution of the payment system led to the development of a low-cost retail mobile digital payments system known as Unified Payment Interface (UPI). Launched by the National Payment Corporation of India (NPCI) in August 2016, UPI is an advanced mobile-based payment system that enables real-time bank payments (Gochhwal, 2017). Cook and Raman (2019) demonstrate in detail how the UPI model functions. Figure 1 demonstrates the functioning of the UPI model concerning person-to-person (P2P) transactions. It presents the UPI model where there are two customers - A and B, who use the UPI facility. When Customer A requests the UPI application (app) for a payment transfer, the request is transferred by the app to the NPCI. Once the authentication is complete and the NPCI recognises where the funds need to go, it facilitates the actual transaction by sending the notifications to all the involved parties - customers, apps, and banks. Then the actual transfer, i.e. debit and credit of respective accounts, occurs through Real Time Gross Settlement (RTGS) without the involvement of the NPCI.

Figure 1: Person-to-Person online transaction using UPI



Source: Cook and Raman (2019)

The UPI is also regarded as India's game-changer as it has completely revolutionized the way the payment system works (Mathur, 2019). Gochhwal (2017) states that the UPI is an improved financial technology (FinTech[1]) over the existing payment systems because it is a secure system of payments as the transactions are authenticated and authorised on the personal mobile phone of the user. His findings further suggest that the UPI has very efficiently handled the aspects

[1] *FinTech: "...fintech encompasses innovative financial solutions enabled by IT and,.... also includes the incumbent financial services providers like banks and insurers"* (Puschmann, 2017)

of identity, account validation, application security, transaction level security, and other security issues despite being at a very infant stage.

Over the years, despite momentous growth in UPI transactions, reports of faults in the transaction system have started pouring in. A significant number of transactions fail each day where the funds transferred to someone, who might be in urgent need of them, does not receive them, even though the money got debited from the payer's account. Furthermore, the data also shows that there has been a surge in the number of failed transactions since the onset of pandemic in India because of the increased volume of digital payments. The UPI network for ten banks recorded failure rates of over 3% for the month of September, 2020. However, before July, the technical failure rates for these banks stood at less than 1% as per the NPCI reports (Manikandan, 2020; Nandi and Abhaskar, 2020).

The situation of increasing frequency of failed online transactions is further aggravated as the payer cannot file an immediate complaint with the payment application as it states- *"If it's been three days or less since your transaction, customer support can't help yet."*[2] Now the question that arises is- where did the money vanish? Above all, the NPCI, the parent organization for all UPI payments in India, has no concrete mechanism to address such issues (Alam, 2018).

In order to hold the commercial banks accountable for the failing transactions, the Reserve Bank of India (RBI) has put in place some compensatory policies for the beneficiary (RBI, 2019). The compensation that is paid to the customer is formula-based and depends upon, but not limited to- the number of days for which the amount was held, the amount held and the repo rate. However, observe that this compensation policy for failed transactions is not uniform across the different modes of transferring payments, such as, UPI and RTGS failed transactions (RBI, 2019, 2013).

The existing literature discusses the significance of online payment systems, services they provide, and how the advanced technology has successfully created a very secure system that takes negligible time to settle the transfers. However, none of them focuses on what happens when an online transaction fails. Often, studies focus on why the adoption rate of net banking services is low from the demand-side of the customer. On the supply-side, there are studies such as Chen et al. (2017) and Accenture (2014) focus on technical infrastructure issues with traditional banks. However, aspects related to fraudulent banking activities, non-compliance of government policies by banks, and human resource problems at banks, lead to non-adoption of e-payment services by customers,

[2] *Source*:- 'Help and Support' section on Google Pay. Available at `https://support.google.com/pay/india/answer/9494510?hl=en-GB`

have not been sufficiently explored. As far as the Indian economy is concerned, there has been a paradigm shift towards successful implementation of the online payment technology through numerous initiatives like- 'Digi Dhan Abhiyan' campaign (Mallick, 2016), Bharat Interface for Money (BHIM) application (Rakesh et al., 2018), and 'UPI Chalega' campaign (Surabhi, 2020), as the country's major quest to migrate from a cash to a cashless economy. In this context, the studies on cashless economy do not capture the frequency of a UPI transaction failure as one of the significant flaws that this system has. Moreover, to the best of our knowledge, it does not interrogate the fact that when a UPI transaction fails, why the redressal mechanism of this system does not address the issue before three days from the day the amount got debited.

Most of the existing literature focuses on examining the aspects like – the evolution of the payment model, different modes of online payments, how reliable the online payment system is, how it protects us against theft, and how secure the system is. However, the contradictory reports by some news agencies with respect to failed UPI transactions (Manikandan, 2020; Nandi and Abhaskar, 2020; Alam, 2018), motivated us to study about the fate of the money that gets held by the various financial institutions when an online transaction fails. In order to further understand how grave the situation of online payment failure is, we conducted a pilot survey through snowball sampling in August, 2019 by floating an online questionnaire. We received 304 responses in total, out of which nearly 65% of the respondents belonged to 15-19 age group[3]. The survey revealed that nearly 26% of the participants (80 participants) had got their money held while transacting money digitally. Table 1 shows the summary of the descriptive statistics of the amount held in those 80 transactions. On an average the amount of money held for those 80 participants was approximately 4100. The most frequently held amount was 500. The maximum and the minimum amount held was 98000 and 1 respectively. The standard deviation of the amount from mean is approximately 11900 which shows that the spread of the amount held of different participants is very large. This survey made it intensely pertinent to study the online payment failure system.

Table 1: Descriptive statistics of the amount held (in Rupees)

Mean	Mode	Maximum	Minimum	Standard Deviation
4168.76	500	98000	1	11991.092

Based on the pilot survey and the literature review, this paper tries to assess how financial institutions, say commercial banks, can make profit by using the money held in a UPI failed transaction

[3] *15-19 age group*- inclusive of both ages 15 years and 19 years.

under the existing compensatory policy prescribed by the RBI. This compensation is a cost to the commercial banks such that if an online transaction fails and the reversal of the transaction does not take place on the same day, then the commercial banks are liable to pay hundred rupees per day to the beneficiary on each subsequent day. This paper also aims to find how the profits of commercial banks get affected when we vary the parameters through an analytical model as well as a simulation exercise. Furthermore, this paper aims to theoretically analyse the effect of non-uniform compensatory policy of the RBI for different modes of online payment on the profits of the commercial banks. To study the effect of this cost differential on the profits of the commercial banks, analysis with respect to an alternative cost function has been done. This cost function is based on the RBI's compensation policy for RTGS failed transactions. The reason for considering the policies for RTGS over any other mode of digital payment transfer is two-fold- (1) The UPI system works through RTGS system only (Cook and Raman, 2019). (2) The policy for this particular compensatory measure is associated with a cost that rises progressively with the amount of money held when an online transaction fails, unlike the UPI compensation policy.

The key findings of the paper are-

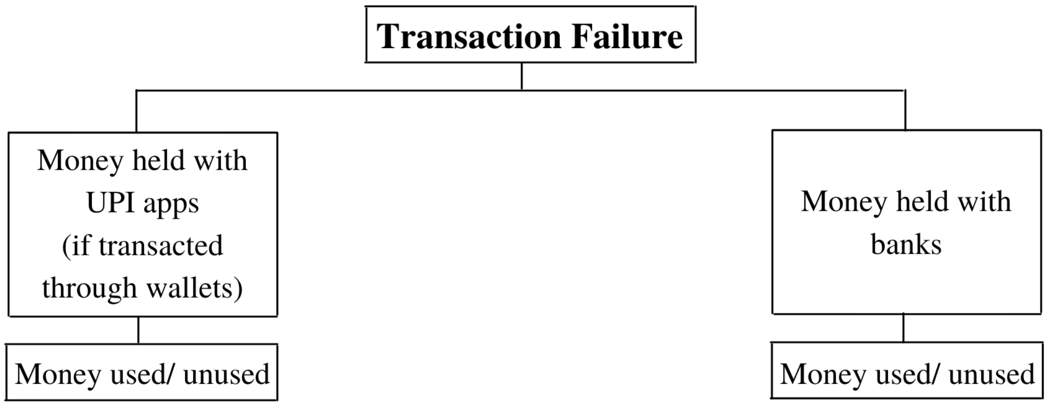
- For both, the existing and alternative costs, when the proportion of held amount invested by commercial banks rises, their profit increases.
- With increase in the amount held by commercial banks, their profit increases, when the cost is imposed as per the existing compensation policy.
- For higher proportion of amount invested and higher amount held, the profit of banks increases if the number of days for which the amount is held increases, when the existing cost of regulation is imposed.
- When alternative cost is imposed on banks to compensate for failed UPI transactions, with increase in the amount of money held by banks, their losses rise.
- For higher values of the amount held, if the number of days for which the amount is held by banks increases, their losses increase, when the alternative cost is imposed.

The remainder of the paper has been structured as follows. Section 2 presents two-variants of the theoretical model, each based on a different cost structure, that captures the profit function of the commercial banks. This is followed by simulation and result analysis in Section 3 which reinforces the findings obtained in Section 2. The last segment, Section 4 concludes the paper.

2 The Model

When an online transaction fails, the money can get held only at two possible points - with the UPI application of the payer or the receiver (if transacted through e-wallet[4]), or with the Bank of the payer or the receiver (Cook and Raman, 2019).

Figure 2: What can possibly happen when an online transaction fails?



The present model is based on following assumptions - (i) The money gets held with commercial banks only. (ii) There is only one transactor and only one receiver in the economy, who are both UPI users. (iii) The transactor's money is deposited in Bank X. (iv) The held money lying with the bank can be loaned out to third parties, like - business firms, and manufacturing firms, in order to generate revenue. (v) Number of days for which the amount is held is equal to the number of days for which the amount is invested. (vi) Time (t) is continuous, and $t \geq 1$.

Let A (A > 0) be the amount of the transactor that gets held with his commercial bank for t number of days, and let $\Pi(A, t)$ be the profit that Bank X generates using the held money, such that,

$$\Pi(A, t) = R(A, t) - C(t). \tag{1}$$

where, $R(A, t)$ is the total revenue generated by the bank, such that,

$$R(A, t, k, p; \alpha) = L(A, t, k; \alpha) + M(A, t, p). \tag{2}$$

Here, $L(A, t, k; \alpha)$ denotes the net interest income that Bank X generates by loaning out α pro-

[4] *E-wallet*:- E-wallet is a type of electronic card which is used for transactions made online through a computer or a smartphone. *The Economic Times*.

portion of transactor's held amount for t number of days at a constant interest rate k per day where $\alpha \in [0, 1]$, and αA is the principal amount that the Bank has to return. $M(A, t; p)$ denotes the net interest income that Bank X is able to generate by not paying the interest income to the transactor for t number of days at a constant interest rate p per day, here A signifies the principal amount on which the interest is forgone. In general, the rate at which banks lend is always greater than the savings interest rate, implying $k > p$. $L(A, t, k; \alpha)$ and $M(A, t, p)$ can be defined as-

$$L(A, t, k; \alpha) = \alpha A(1 + k)^t - \alpha A. \tag{3}$$

$$M(A, t, p) = A(1 + p)^t - A. \tag{4}$$

Combining eqs. (2), (3), and (4), we get-

$$R(A, t) = \alpha A(1 + k)^t - \alpha A + A(1 + p)^t - A; \tag{5}$$

where,

$$\frac{\partial R}{\partial A} = \alpha[(1 + k)^t - 1] + (1 + p)^t - 1 > 0, \;\; \forall \;\; t \geq 1, \;\; k > 0, \text{ and } p > 0; \tag{6}$$

and,

$$\frac{\partial R}{\partial t} = \alpha A(1 + k)^t \ln(1 + k) + A(1 + p)^t \ln(1 + p) > 0, \;\; \forall \;\; A > 0, \; t \geq 1, \;\; k > 0 \text{ and } p > 0. \tag{7}$$

The revenue function is an increasing function of both the amount held A and the time for which the amount is held t. It is convex with respect to t (left panel of figure 3), and linear with respect to A (right panel of figure 3), unlike the general revenue functions which are concave.

Figure 3: Relation between $R(A, t)$ and t (left panel), and $R(A, t)$ and A (right panel)

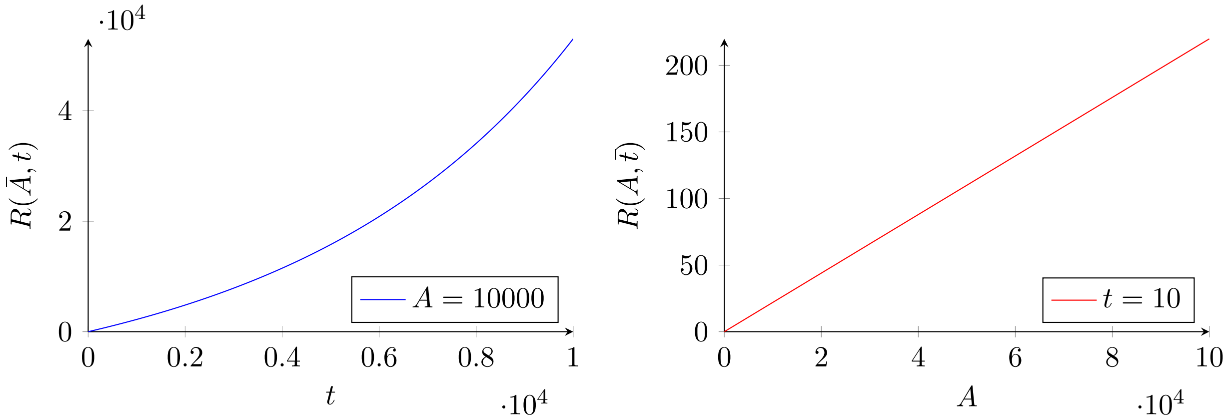


Figure 4: Level Curves of $R(A,t)$

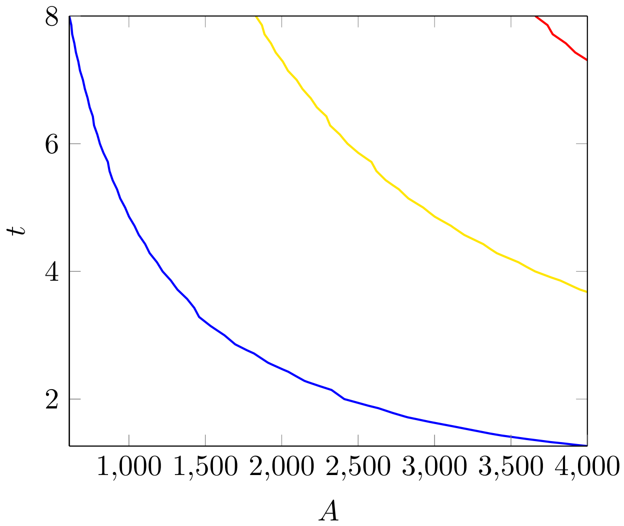


Figure 4 shows the level curves of revenue function which are convex and downward sloping. This implies that if the bank increases the amount held, in order to earn the same level of revenue, it has to lower the number of days for which the amount is invested. However, the rate at which the number of days fall decreases as the amount held by the bank increases. These two factors lead to a downward sloping convex level curve of revenue function. Furthermore, from the perspective of the customer also, who got his money held in the UPI system, the negative relation between t and A is justified. This is because if higher amount is held with the bank, the customer would be putting in more efforts to get his amount back, forcing the bank to return the amount in a relatively shorter duration. On the other hand, if the customer got a lower amount held, he would be putting relatively lower efforts, giving the bank an opportunity to hold his amount for relatively a longer duration.

In the subsequent section we discuss the existing penalty imposed by the RBI for UPI failed transactions.

2.1 Existing Cost Function

From eq. (1) consider the cost function $C(t)$ which the commercial bank has to bear on account of compensatory policy adopted by the RBI (RBI, 2019).

$$C(t) = \begin{cases} 100(t-1), \forall \ t \geq 1 \\ 0, \ \text{otherwise} \end{cases} \tag{8}$$

Here, $\frac{\partial C}{\partial t} = 100 > 0 \ \forall \ t \geq 1$, implying cost is linearly increasing in t.

It is worth noting that the nature of revenue and cost functions is such that there is no value of A or t at which the banks can generate maximum profit, hence we cannot find values of A and t

that maximize the bank's profit which is given by-

$$\Pi(\alpha, A, t) = [\alpha A(1+k)^t - \alpha A] + [A(1+p)^t - A] - 100(t-1), \;\; \forall \;\; t \geq 1. \tag{9}$$

Eq. (9) is obtained by combining eqs. (1), (5), and (8).

In order to check how the profit function behaves when proportion of money used (α) changes, consider the following partial derivative-

$$\frac{\partial \Pi}{\partial \alpha} = A[(1+k)^t - 1] > 0, \;\; \forall \;\; A > 0, \; t \geq 1, \text{ and } k > 0. \tag{10}$$

It shows that as α increases, Π increases, keeping A and t constant. This happens because, as the proportion of the amount invested by the bank increases, it fetches higher revenue at a given amount held and number of days for which the amount is held.

Now, differentiating Π partially with respect to A to deduce how Π behaves when A changes-

$$\frac{\partial \Pi}{\partial A} = \alpha[(1+k)^t - 1] + (1+p)^t - 1 > 0, \;\; \forall \;\; t \geq 1, \; k > 0, \text{ and } p > 0. \tag{11}$$

Therefore, as A increases, Π increases, keeping α and t constant. The reason for this is that when the amount held by the bank increases it leads to an increase in the investment of the bank. With increased investment, the bank is able to generate higher profits. Further, with the existing compensation policy, the cost for the bank is independent of the amount held by the bank ($\frac{\partial C}{\partial A} = 0$), therefore, the cost for the bank does not increase when the amount held by bank increases.

Similarly, in order to observe the behaviour of the profit function Π with respect to number of days t for which the amount is held,

$$\frac{\partial \Pi}{\partial t} = \alpha A(1+k)^t \ln(1+k) + A(1+p)^t \ln(1+p) - 100. \tag{12}$$

In this case, depending upon the values of A and α, the relative change in profit with respect to the number of days for which the amount is held with banks (eq. (12)), is either positive or negative, $\forall \; t \geq 1$. However, the exact point at which the bank earns positive profit when t is changing, cannot be determined using analytical methods. Hence, the profit function is non-monotonic in nature with respect to t which we will further observe in simulation and result analysis in Section 3.

Proposition 1: *When the existing cost is imposed, the profit of the commercial bank is positively related to the proportion of money invested as well as the amount of money held by the bank. In contrast, the effect of the number of days for which the amount is held on the profit of the bank cannot be determined unambiguously unless the values of A and α are known.*

In the next section we discuss the alternative cost function and its implications on the profit of the bank.

2.2 Alternative Cost Function

The profit function depicted in eq. (9), where the cost component, based on the RBI guidelines for failed UPI transactions, depends only on the number of days for which the amount is held. With the existing cost function, if the amount is held for the same number of days then the penalty imposed on banks by the RBI is same irrespective of the amount held. Consequently, this policy of penalty does not act as a disincentive for banks to hold larger amount. Therefore, we explore the implications of an alternative cost function with stricter penalties imposed on commercial banks. One way of constructing such a cost function is-

$$C = C(A,t) > 0, \ \ \forall \ \ A > 0, \ t \geq 1, \ \frac{\partial C}{\partial A} > 0, \text{ and } \frac{\partial C}{\partial t} > 0. \tag{13}$$

Therefore the profit function can be written as-

$$\Phi(A,t;\alpha) = [\alpha A(1+k)^t - \alpha A] + [A(1+p)^t - A] - C(A,t). \tag{14}$$

Instead of taking any arbitrary cost function, we consider the regulations imposed by the RBI on RTGS operations. The regulations state that if there is any delay in providing credit to the beneficiary's account, the bank has to pay a compensation at the current repo rate[5] plus 2% to the account holder per day (RBI, 2013). The reformulated cost function is-

$$C(A,t) = (5.15\% + 2\%) * A * t = 7.15\% * A * t \tag{15}$$

Substituting eq. (15) in eq. (14), we get-

$$\Phi(A,t;\alpha) = [\alpha A(1+k)^t - \alpha A] + [A(1+p)^t - A] - 7.15\% * A * t. \tag{16}$$

[5]Current Repo Rate (approx.) = 5.15% as on February 14, 2020 (RBI, 2020).

In order to compare the profit accrued between eq. (16) and eq. (9) due to cost differential, we partially differentiate Φ with respect to α, A, and t.

The marginal change in Φ with respect to α is given by,

$$\frac{\partial \Phi}{\partial \alpha} = A[(1+k)^t - 1] > 0, \ \ \forall \ \ A > 0, \ t \geq 1 \text{ and } k > 0. \tag{17}$$

Hence, as α increases, Φ increases, keeping A and t constant. This is true because the bank is able to earn higher revenue as the proportion of the amount invested by it increases, keeping other things constant.

Now, in order to capture the behaviour of the profit function Φ when A changes, we have-

$$\frac{\partial \Phi}{\partial A} = \alpha[(1+k)^t - 1] + (1+p)^t - 1 - 0.0715t < 0, \ \forall \ p = \frac{0.04}{365}[6], \ k = \frac{0.08}{365}[7], \ \alpha = 1[8], \ t \in [1, 35710.697)[9]. \tag{18}$$

It is reasonable to say that in reality $\frac{\partial \Phi}{\partial A}$ is less than zero because it is impractical that t is greater than 35710.697 days $\sim$ 98 years, i.e. the commercial bank held the money of a person for more than 98 years. Hence, as A increases, Φ decreases, keeping α and t constant. Intuitively, as the amount held by the bank increases, the cost for the bank also increases. In addition to this, there is a rise in the revenue of the bank. However, the rise in revenue is outweighed by the rise in cost which pulls down the profits of the bank. Therefore, $\forall \ t \in [1, 35710.697)$, the losses of the bank increase as the amount held by the bank increases.

Similarly, partially differentiating Φ with respect to t to see what relation exists between these two variables, we get-

$$\frac{\partial \Phi}{\partial t} = \alpha A(1+k)^t \ln(1+k) + A(1+p)^t \ln(1+p) - 0.0715A. \tag{19}$$

Eq. (19) is similar to eq. (12). However, in this case the critical value at which the slope of the function changes is different.

Proposition 2: *When stricter penalties are imposed, the profit of the commercial bank is positively related to the proportion of money invested. Further, the amount of money held by the bank,*

[6] Rate of interest on savings (p) = 4% p.a. as on February 15, 2019 (RBI, 2020).

[7] Rate at which the commercial banks lend (k) = 8% p.a. (approx.) as on February 14, 2020 (RBI, 2020).

[8] α is assumed to be 1 because $\frac{\partial \Phi}{\partial A}$ is positively related to α, and $\forall \ \alpha$ lower than 1 (highest attainable value of α), $\frac{\partial \Phi}{\partial A}$ would also be relatively lower

[9] The upper bound of t has been found by drawing a graph of the curve $\frac{\partial \Phi}{\partial A}$ with respect to t and finding the critical point where $\frac{\partial \Phi}{\partial A} > 0$ for $\alpha = 1$, $p = 0.04/365$, and $k = 0.08/365$.

$\forall\ t \in [1, 35710.697)$, *has a negative impact on the profit of the bank. However, the relationship between the profit of the bank and the number of days for which the amount is held cannot be determined unambiguously unless the values of A and α are known.*

In the next section, this paper simulates both eqs. (9) and (16) to graphically determine the impact of α, t and A on the profit of banks.

3 Simulation and Result Analysis

In this section the analysis involves comparing eqs. (9) and (16) graphically by considering different values of α to demonstrate how the commercial bank's profit behaves. Figure 5 contains six plots which show the behaviour of the profit function along a finite period of time, say 10 days[10], for different amounts held. Figure 5 in Case I depicts the situation where cost is only a function of t, whereas cost is a function of both A and t in Case II. In addition, the change in proportion (α) of held amount (A) used by commercial banks is reflected in Figures 5(a)-5(c), in both, Case I and Case II. Figure 5(a)-5(c) represent $\alpha = 0$, $\alpha = 0.5$, and $\alpha = 1$, respectively. Table 2 presents the configurative values of A. The exact values of A are increasing and have been arbitrarily chosen.

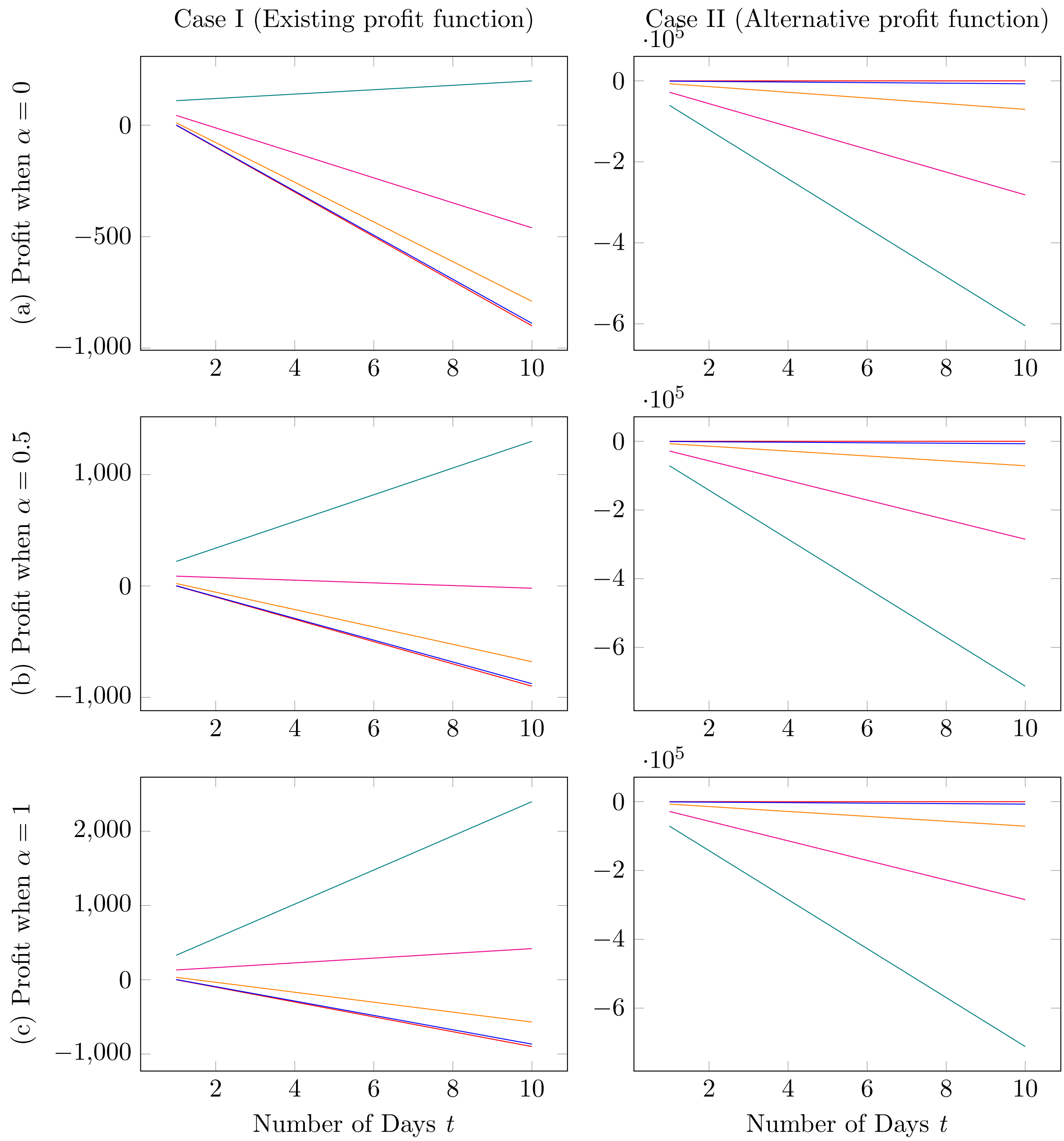
In Figure 5, Case I plots are associated with the cost structure based on the RBI compensation policy for UPI failed transactions. We observe that, across Figure 5(a)-5(c), with constant A and t, when α rises, Π also increases. This validates the result we obtained in eq. (10). Furthermore, in Figure 5 Case I (a), as A increases, along a specific value of t, Π also increases. This also holds for Case I (b) and Case I (c), which verify the result we obtained in eq. (11). Also, in Case I (c), when the values of A are relatively small, as t increases for a given A, Π decreases. However, for relatively larger values of A, as t increases for a specific A, Π increases. This holds for Case I(a) and Case I(b) as well. Moreover the slope of the profit function with respect to t increases with a rise in α (Observe the slope of the Π curve with respect to t at $A = 400000$. Notice that, as α varies from $\alpha = 0$ to $\alpha = 1$ in respective Case I(a)-I(c), the slope of this curve changes from negative to positive.). This happens because the compensation that the bank is liable to pay is only linearly dependent on the time for which the amount is held by the bank while the revenue that the bank is able to generate is exponentially dependent on that time period. Hence, higher the amount held and higher the proportion of amount invested, the profit of the bank increases as the time period for which the amount is held increases.

[10] 10 days have been arbitrarily chosen. Any finite number of days, provided they are not too large to be impractical, can be used instead of 10 days.

Table 2: Amount held by the commercial bank

Π1/Φ1	Π2/Φ2	Π3/Φ3	Π4/Φ4	Π5/Φ5
—$A = 100$	—$A = 10000$	—$A = 100000$	—$A = 400000$	—$A = 1000000$

Figure 5: Relationship of profit of the bank with respect to α, A and t for two different cost functions



Proposition 3: *When the cost is linearly dependent on time, for relatively higher values of A and α, the marginal profit of the bank with respect to time increases.*

We now examine Figure 5 Case II, where the cost structure is based on RBI regulations for RTGS failed transactions. It is evident that, across Figure 5 Case II(a)-II(c), where A and t are constant, the losses are falling. This validates the result derived in the analytical model in eq. (17), that is, $\frac{\partial \Phi}{\partial \alpha} > 0$. Also, in Case II (a), as A increases, along a specific value of t, Φ decreases. This also holds for Case II (b) and Case II (c) as well. This verifies the result obtained in eq. (18). Furthermore, in Case II (a), as t increases, along a specific A, Φ decreases. This holds for Case II (a) and Case II (b) as well. Since, the analysis of eq. (19) is not theoretically possible, using these figures notice that, for relatively higher values of A, and $\forall\, t \in [1, 10]$, $\frac{\partial \Phi}{\partial t} < 0$. Although there is a rise in the revenue of the bank as the number of days for which the amount invested increases, the bank suffers losses. This is because the alternative cost function for the bank with respect to the number of days for which the amount is held is increasing ($\frac{\partial C}{\partial t} > 0$). Moreover, the marginal cost of the held amount with respect to time increases as the held amount increases ($\frac{\partial C}{\partial t} = 0.0715A$). Therefore, at relatively higher values of amount held, the rate at which the cost increases exceeds the rate at which the revenue rises, which results in increase in losses for the bank.

Proposition 4: *For relatively higher values of A with stricter penalty imposed on the bank, the marginal profit of the bank with respect to time decreases.*

Drawing a comparison between the profit that the bank earns when the cost imposed is as per the RBI compensation policy for UPI failed transactions and when it is as per the RBI policy for RTGS failed transactions we conclude that - first, for given values of amount held and time, the proportion of money that the bank invests for revenue generation purpose positively effects the bank's profit in both cases. This happens because the cost that the bank is liable to pay in both the cases is independent of the proportion of money that it invests. Second, if the amount held by the bank increases when the compensation is as per the RBI policy for UPI failed transactions, the profit that the bank is able to generate also increases, keeping α and t constant. However, when the compensation is as per the RBI policy for RTGS failed transactions, keeping α and t constant, the bank's losses increase if the amount held increases. This happens because in the former case the cost that the bank is liable to pay is independent of the amount held by the bank ($\frac{\partial C}{\partial A} = 0$). In contrast, in the latter case, the cost of the bank depends on the amount held ($\frac{\partial C}{\partial A} > 0$). Third, in the former case, the profit of the bank increases if the number of days for which the amount invested by the bank increases, for relatively higher amount held and proportion of amount invested. On the other hand, in the latter case, for relatively higher amount held, if the number of days for which the amount is held increases, the bank's profit decreases. The reason for this is that despite the cost in both the cases is dependent on the number of days for which the amount is held ($\frac{\partial C}{\partial t} > 0$), in the former case, the cost is linearly dependent on time ($\frac{\partial C}{\partial t} = 100$). However, in the latter case, the cost of the bank is non-linear in the number of days for which the amount is held ($\frac{\partial C}{\partial t} = 0.0715A$).

Proposition 5: *The marginal profit of the bank with respect to the proportion of amount invested increases when either existing cost is imposed or alternative cost is imposed. With the existing cost, the marginal profit of the bank with respect to the amount of money invested increases, while with the alternative cost, it decreases. For higher values of A and α, the marginal profit of the bank increases with respect to the number of days for which the amount is held, when the existing cost is imposed. When the alternative cost is imposed, for higher values of A, the marginal profit of the bank with respect to the number of days for which the amount is held decreases.*

The analysis of these figures indicates how large the profit can be for a commercial bank at the existing cost of regulation for a failed UPI transaction, while if the cost is dependent on the amount held, the commercial banks can run into huge losses. This also proves that the non-uniform penalty policy imposed by the RBI creates a cost differential which, if exploited by the commercial banks, helps them in earning higher profits.

4 Conclusion

The paper presents the analysis for failed UPI transactions. Two-variants of the profit model of commercial banks are developed and corroborated with simulations. These profit variants occur due to a non-uniform compensatory policy of the RBI with respect to UPI failed transactions and RTGS failed transactions. For a failed UPI transaction at the existing cost, if the amount held by banks increases, their profits increase, given the proportion of amount invested and the time period for which the investment takes place. Longer the investment time period, higher are the profits that the banks are able to generate, keeping α and A constant. If the proportion of amount invested by banks increases, their profits increase for a given held amount invested for a specific time period. In contrast, banks run into losses if the cost that they have to incur is non-linear and depends on both, the amount held and the time period for which the amount is held. Moreover, their losses increase if either the amount held increases,keeping α and t constant, or the time period for the amount is held increases, keeping α and A constant. However, if the proportion of amount they invest increases, their losses fall, given the amount held and the time period of the investment. Therefore, commercial banks can generate profits if they invest the amount held in a failed transaction provided they have to compensate the beneficiary at the existing cost imposed by the RBI. However, if the RTGS compensation policy for failed transactions is pursued by the RBI with respect to UPI failed transactions as well, profits of commercial banks falls.

The paper suggests that the online payment failures can actually help the commercial banks to generate profit at the existing cost. Under such circumstances, the banks can optimally decide the amount as well as the time for investment purposes such that they can recover the costs. However, this can be viewed as a trade-off between the benefit of the consumer and the bank as the former has to bear financial as well as non-pecuniary costs.

Also, since no clear evidence of whether the transacting banks use the parked money or not, could be drawn, the above model is just a possibility of what could potentially happen to the held money. Moreover, this research is not sufficient to draw any strong conclusion on the implications of online payment failure on the economy as a whole since the study is undertaken in a partial equilibrium setting.

Further extensions of this study include considerations for present discounted value models and other types of non-linear cost functions. This paper also aims to address the problem with multiple commercial banks.

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Appendix

I] Cost $= 100(t-1)$

Case a: For $\alpha = 0$

Table 3: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	0.0109	−99.97819881	−199.9672964	−299.9563929	−399.9454881	−499.9345822	−599.923675	−699.9127667	−799.9018572	−899.8909465

Table 4: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	1.09	−97.81988119	−196.7296436	−295.6392871	−394.5488118	−493.4582176	−592.3675045	−691.2766726	−790.1857218	−889.094652

Table 5: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	10.9	−78.1988119	−167.2964356	−256.3928709	−345.4881177	−434.5821759	−523.6750454	−612.7667259	−701.8572175	−790.94652

Table 6: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	43.6	−12.7952476	−69.18574228	−125.5714835	−181.9524708	−238.3287036	−294.7001815	−351.0669038	−407.4288701	−463.7860798

Table 7: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	109	118.011881	127.0356443	136.0712912	145.118823	154.1782409	163.2495463	172.3327405	181.4278248	190.5348004

Case b: For $\alpha = 0.5$

Table 8: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	0.02185	−99.95629641	−199.9344392	−299.9125785	−399.8907141	−499.8688462	−599.8469747	−699.8250996	−799.8032208	−899.7813385

Table 9: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	2.185	−95.62964139	−193.4439241	−291.257848	−389.0714132	−486.8846195	−584.6974668	−682.5099551	−780.3220844	−878.1338545

Table 10: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	21.85	−56.29641385	−134.4392409	−212.5784805	−290.714132	−368.8461947	−446.9746679	−525.0995511	−603.2208436	−681.3385447

Table 11: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	87.4	74.8143446	62.24303642	49.68607808	37.14347219	24.61522138	12.10132827	−0.398204517	−12.88337436	−25.35417865

Table 12: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	218.5	337.0358615	455.607591	574.2151952	692.8586805	811.5380535	930.2533207	1049.004489	1167.791564	1286.614553

Case c: For $\alpha = 1$

Table 13: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	0.0328	−99.93439402	−199.901582	−299.8687641	−399.8359401	−499.8031102	−599.7702743	−699.7374324	−799.7045845	−899.6717306

Table 14: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	3.28	−93.43940158	−190.1582046	−286.876409	−383.5940146	−480.3110213	−577.027429	−673.7432376	−770.458447	−867.1730569

Table 15: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	32.8	−34.3940158	−101.5820462	−168.7640901	−235.9401462	−303.1102134	−370.2742905	−437.4323763	−504.5844697	−571.7305694

Table 16: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	131.2	162.4239368	193.6718151	224.9436397	256.2394152	287.5591464	318.902838	350.2704948	381.6621214	413.0777225

Table 17: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	328	556.059842	784.1795378	1012.359099	1240.598538	1468.897866	1697.257095	1925.676237	2154.155303	2382.694306

II] Cost $= 7.15\% * A * t$

Case a: For $\alpha = 0$

Table 18: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7.1391	−14.27819881	−21.41729644	−28.55639287	−35.69548812	−42.83458218	−49.97367505	−57.11276673	−64.25185722	−71.39094652

Table 19: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−713.91	−1427.819881	−2141.729644	−2855.639287	−3569.548812	−4283.458218	−4997.367505	−5711.276673	−6425.185722	−7139.094652

Table 20: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7139.1	−14278.19881	−21417.29644	−28556.39287	−35695.48812	−42834.58218	−49973.67505	−57112.76673	−64251.85722	−71390.94652

Table 21: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−28556.4	−57112.79525	−85669.18574	−114225.5715	−142781.9525	−171338.3287	−199894.7002	−228451.0669	−257007.4289	−285563.7861

Table 22: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−71391	−142781.9881	−214172.9644	−285563.9287	−356954.8812	−428345.8218	−499736.7505	−571127.6673	−642518.5722	−713909.4652

Case b: For $\alpha = 0.5$

Table 23: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7.12815	−14.25629641	−21.38443924	−28.51257848	−35.64071413	−42.76884619	−49.89697467	−57.02509955	−64.15322084	−71.28133854

Table 24: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−712.815	−1425.629641	−2138.443924	−2851.257848	−3564.071413	−4276.884619	−4989.697467	−5702.509955	−6415.322084	−7128.133854

Table 25: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7128.15	−14256.29641	−21384.43924	−28512.57848	−35640.71413	−42768.84619	−49896.97467	−57025.09955	−64153.22084	−71281.33854

Table 26: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−28512.6	−57025.18566	−85537.75696	−114050.3139	−142562.8565	−171075.3848	−199587.8987	−228100.3982	−256612.8834	−285125.3542

Table 27: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−71281.5	−142562.9641	−213844.3924	−285125.7848	−356407.1413	−427688.4619	−498969.7467	−570250.9955	−641532.2084	−712813.3854

Case c: For $\alpha = 1$

Table 28: Amount held(A)= 100

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7.1172	−14.23439402	−21.35158205	−28.46876409	−35.58594015	−42.70311021	−49.82027429	−56.93743238	−64.05458447	−71.17173057

Table 29: Amount held(A)= 10000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−711.72	−1423.439402	−2135.158205	−2846.876409	−3558.594015	−4270.311021	−4982.027429	−5693.743238	−6405.458447	−7117.173057

Table 30: Amount held(A)= 100000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−7117.2	−14234.39402	−21351.58205	−28468.76409	−35585.94015	−42703.11021	−49820.27429	−56937.43238	−64054.58447	−71171.73057

Table 31: Amount held(A)= 400000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−28468.8	−56937.57606	−85406.32818	−113875.0564	−142343.7606	−170812.4409	−199281.0972	−227749.7295	−256218.3379	−284686.9223

Table 32: Amount held(A)= 1000000

X	Subcase 1	Subcase 2	Subcase 3	Subcase 4	Subcase 5	Subcase 6	Subcase 7	Subcase 8	Subcase 9	Subcase 10
t	1	2	3	4	5	6	7	8	9	10
Π1	−71172	−142343.9402	−213515.8205	−284687.6409	−355859.4015	−427031.1021	−498202.7429	−569374.3238	−640545.8447	−711717.3057