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9th Academic International Conference on Business, Marketing and Management-AICBMM 2019
2nd Academic International Conference on Economics, Accounting and Finance-AICEAF 2019

AICBMM-AICEAF 2019 May (Cambridge) | 20th-22nd May 2019
Conference Proceedings

AICBMM Cambridge

AICEAF Cambridge

ISBN: 978-1-913016-07-4 (Online)

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Format for citing papers
Author surname, initial(s). (2019). Title of paper. In Conference Proceedings of the Cambridge Conference Series – May 2019 (pp. xx-xx). Cambridge, May 20th-22nd, 2019.

AICBMM-AICEAF 2019 © 2019 FLE Learning Ltd
ISBN: 978-1-913016-07-4 (Online)
These proceedings have been published by the FLE Learning Ltd trading as FLE Learning.
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1-CT03-7237

PROOF OF WORK AS A MULTI-LEADER STACKELBERG GAME

DR. CRAIG S WRIGHT[1]

ABSTRACT

Stackelberg strategies within a nonzero game allow for a non-competitive equilibrium solution where no player can achieve an improvement in performance through the deviation of the base strategy (cheating). Bitcoin is designed to exhibit a Stackelberg solution that dominates any Nash solution. The default strategy thus remains as the more favourable players strategy within bitcoin. Attacks and related noncooperative strategies have been proposed as a method to gain additional profitability within bitcoin mining firms under an assumption of a static game model. We demonstrate that the assumption of Cournot equilibria in nonsequential games does not apply and hence, in action taken by a party seeking to defect results in a non-static sequential game. In standard form, bitcoin mining acts as a zero-sum competition. Where players diverge from the standard strategy, this becomes a non-zero-sum game where the Stackelberg follower can alter the expected results from the standard game strategy.

Keywords: Bitcoin, Smart contracts, Game theory, Uncoordinated cooperation, Blockchain.

INTRODUCTION

Multi-leader, multi-follower games form part of a subset of all hierarchical games in which a group of potential leaders compete through a constrained equilibrium. The leaders seek to increase in market share where the follower groups act to limit the growth of the dominant player. In this paper, we explain Bitcoin as a multi-leader multiparty Stackelberg game in order to analyse the interaction between bitcoin miners in seeking solutions to blocks. In this, we demonstrate that the oft quoted problems with the network stems from a misunderstanding of the competitive process enabled through proof of work. It is not the discovery of a block, but rather the process of communicating the discovery to other nodes that satisfies the necessary conditions to secure the network in bitcoin. Accordingly, nodes act to invalidate other nodes when errors are discovered. The two-week average block discovery implemented within bitcoin delivers a fixed return across all players and forms a zero-sum pool when players do not diverge. Where bitcoin miners diverge from the optimal strategy, the game is no longer zero-sum. For instance, in the selfish-mining strategy (Grunspan and Perez-Marco, 2018) and associated game divergences, the market increase in the number of orphans alters the earning potential of other players. In effect, this changes bitcoin from a zero-sum to a non-zero-sum game in mining terms.

Nodes are incentivised to discover and report errors on the network such as the occurrence of invalid blocks propagated from an alternative and competing node. We investigate the scenario where nodes cannot coordinate with each other prior to the discovery of a block and call this the non-cooperative scenario. We may compare this with a sub gradient approach with each node acting to decide its best response action based on the likely behaviours of other nodes weighted according to economic power. It can then be demonstrated that the game theoretic system within bitcoin acts through a structure of shared constraints. These game forms are best modelled as a Stackelberg game (compared to a multi-leader multi-follower Cournot game). Bitcoin may thus be modelled as a modified formulation of a multi-leader multi-follower competition where a common or shared constraint acts to limit each player's (node's) returns and limits the potential of monopoly as well as undermining the proposed attack methods.

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It is possible to extend this to demonstrate that all proof of work blockchains are in direct competition. It is not a great leap to extrapolate how a dominant blockchain will increase in value and security at the expense of all other systems. As the dominant system becomes larger, the value returned in mining on the dominant chain grows with the expended power being modelled as a zero-sum game (Hwang and Rey-Bellet, 2016). The natural outcome being the collapse of all competing systems when a use-based inflection point is attained.

It is known (Simaan and Cruz, 1973) that in "*games where one of the two players does not know the other's performance criterion or games with different speeds in computing the strategies, are best modeled and solved within this solution concept*". The more commonly used Nash strategy assumes that each player knows the other player's performance function. Whereas it is possible for a miner to estimate the currently deployed hash-rate and overall market share for the currently competing miners, it is not feasible to understand the amount of reserve hash-power or to model potential players who will enter the market as miners if the overall hash-rate drops.

MULTI-LEADER, MULTI-FOLLOWER GAMES

Bitcoin forms a dynamic multi-leader, multi-follower game. The Stackelberg leader and Stackelberg follower can be independently modelled based on the dominant mining pools when compared to all other miners. As part of a subset of all hierarchical games in which a group of potential leaders compete through a constrained equilibrium, it is necessary to determine if the miner’s actions will result in zero-sum or non-zero-sum consequences (Hwang and Rey-Bellet, 2016). As in other games of market share, leaders seek to increase in dominance whilst being constrained the follower groups as sequential players act to limit the growth of the dominant player and possibly to increase dominance.

Bitcoin as a competitive mining process follows both zero-sum and competitive non-cooperative games depending on the action of the players. If a player chooses to defect, for instance by engaging in action outside the standard rules, other players can punish the defector. In a Stackelberg duopoly, we can model bitcoin as a dynamic sequential game. At any point we have two major firms selling homogenous product, in this we are taking the outcome as a miner subsidy and any associated transaction fees earned. Miners may also differentiate and provide additional services such as the verification of specialised transactions or the provision of guarantees. Each miner in the group is subject to the same demand and cost functions. At any point, a mining pool or group acting as a leader can help determine pricing through the withholding or strategic sale of bitcoin to market, though this effect is limited. A miner that abuses its position while acting as a pool will impact on its brand and lose effective market share.

A simplified model of the dominant pools and all others provides a starting point in analysing a point function but could be equivalent to a Nash equilibrium that will vary dynamically across time. This allows us to use backward induction in an analysis of the current sequential game which is determined at a point in time. We begin in an analysis of the decisions of the follower miners rather than the leading mining pools. Multi-leader multi-follower games incorporate a collection of leaders in a Nash simultaneous move game with multiple followers who participate in a subsequent simultaneous move game reacting to the strategies of the leaders. The leaders act to set rules, making decisions that subject all parties to an equilibrium condition that arises between both leaders and followers. A follower equilibrium may not exist with a function of the leader strategy altering the following response through a continuum of possible strategies. The point function equilibrium of the game between leaders is an analytically difficult problem. At a point in time, the model for leaders can be created using an equilibrium program with equilibrium constraints (EPEC).

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These games can be used to model scenarios of rule changes within the protocol. Various games arise organically through the modelling of sequences of block discovery and the inclusion of transactions that follow rules that a selected miner chooses to enforce. In modelling the forks in the protocol that occur naturally in real-time and those that occur through the strategic decisions of miners, “rational" mining pools may engage in decisions over longer time horizons and which incorporate the profit making or losing scenarios that may occur by allowing or blocking selected rules or transaction types. Each miner can then create a model of strategic interactions. Such interactions require the miner to incorporate strategic decisions while incorporating the expected decisions of other firms as they exist now and in consideration of the potential strategies that may follow. The main pools and large miners may then be modelled as Stackelberg leaders. These players participate in a distributed game where the equilibrium results are modified through the actions of followers. The resulting scenario is a set of multi-leader multi-follower games that vary dynamically. The creation of such competitive games leads to short-term dynamical equilibria that vary widely over time.

As with Cournot equilibria, Stackelberg game models remain stable when seen as a static model of a single time period (Huck, Müller and Normann. 2001). When this is extended to a dynamic context (repeated games), the resulting models need to be reconsidered. Stackelberg's model is a sequential game. Followers may decide to only enforce certain rules but if they reject the rules set by the leaders, the follower group will be isolated and those blocks orphaned. Consequently, although a follower strategy miner can decide to limit the size of blocks that they will process through not including transactions, this will be generally a profit losing strategy. As the block subsidy decreases with each halving, miners will earn more fees through transaction inclusion in blocks. Consequently, the follower strategy would be to selectively choose only the more profitable transactions lowering the number of transactions that need to be saved. The leaders would then incorporate such transactions as would be profitable for the lead strategy and a subsequent block earning more profit whilst also mitigating the follower strategy and requiring the follower to save those transactions.

In strategic systems of this form, the Nash solution is desirable only if it is not dominated by any of the Stackelberg solutions. Otherwise a Stackelberg strategy is always more favourable to both players (Simaan, 1977).

The 2-period Stackelberg model uses the same assumptions as the Cournot model only altering that firms decide sequentially. In the first period, the leader group selects how much quantity will be supplied. For a given rate of bitcoin purchase and price at market, the leader groups will select how much hash-power will be supplied. The decision is irreversible and cannot be changed within a block discovery. The model differs somewhat from real-life in that miners can add more hashing power between blocks. Given the difficulty rate being set, and the nature of hashing, this does not change the strategic advantage of the miner. Leader groups dominating mining may emerge in a market due to historical precedents, size of capital investment, reputation and payment rates as a pool miner, technical innovation or advances in connectivity as well as any other strategic profit advantage.

In the second period, the smaller mining groups seeing the actions of the larger mining pools select a response. Each minor pool reacts to the expected returns and profitability after observing the actions of the leader pools. If price and market remain stable and costs remain constant the follower pools will add more hash-power at times while the leader may reduce hash-power and conversely lower hash-rates as miners in the leader group increase hashing power. Smaller pools thus react as a reactionary function. A follower level miner may react to the previous expansion by the leader group with an expansion if the follower believes that the leader will have to lower hash-rate in the subsequent round. In expanding, bitcoin miners have a multi-leader multiparty Stackelberg game where the majority of miners set a rate that the group will allow.

EXAMPLE RULE CHANGE: BLOCK CAPACITY

Where most miners desire an increase in the allowed block capability, the decision becomes simple. We set variables as:

m_L → Large block miner
m_S → Small block miner
m_n → Neutral miner.

In this, if the large miner (m_L) plus the neutral miner (m_n) together form over 50% of the hash-rate the network will expand. The network is a competitive system where the winner is rewarded but the costs of an expansion need to be considered. If the cost of expanding the maximum block size exceeds the profit gained, a small block miner (m_S) will either "choose to stop mining" and lose their capital investment or fight to maintain it. In a scenario where: there is a competition where miners can leave for an alternative, such as with the BTC/BCH Bitcoin split, this is more complex, but we will model that at a later point.

We start with the active hash-rate of (α) and any inactive hash-rate of (β). With this, a neutral miner will prefer to upgrade if the costs are not excessive. That is, the cost of upgrading the system is in line with remaining profitable and does not lead to a loss. A miner selecting to stop scaling will understand that at a point where there is a large block, they will lose money. Hence:

m_L → remains profitable.
m_n → is profitable other than rare events and peaks.
m_s → is going to lose profit in any new increase in cap.

In any capacity increase, there is a cost associated to allowing this increase. The increase of a blocksize has two main aspects:

1. A loss on extra-large blocks that are abnormal and can be validated over a long time without costs of more than storage and bandwidth. These have an immediate loss if more than 50% of miners accept and build on them and an incremental bandwidth cost if most miners reject them.
2. A loss on ongoing blocks that now exceed the levels a miner can handle. These increased averages will lead to increased fees for all miners able to handle the increased traffic. Here a miner will lose money the longer they mine leading to a choice – to either stop mining or liquidate, likely at a loss.

Mining is competitive and is not about discovering a block, but rather in ensuring most miners know of your block before a competing block is found and broadcast to many miners. Bitcoin mining is not a mere function as many believe of miners (ASICS and so on) alone but of the verification system coupled with the network. To ensure that other miners get a block as fast as possible where the longer a block takes to propagate, the longer an alternative miner with a fast link must work on an alternative block and to win. Hence, Bitcoin incentivises the network to grow, but not at a rate which other miners are forced out. It is a rate where miners can remain competitive and secure the network. The aim is to expand to a point where blocks are large but not full and most miners can handle any increase or peak traffic. Here if $(m_L + m_n) > 50\%$ of the hash-rate and the profit for an expansion p_e is greater than that of maintaining the existing level p_C or $p_e > p_c$ then miners will always expand. Over time as the costs of network and computer systems decrease (see Moore's law) the rate of growth will increase. Hence, miners will seek to increase the capacity over time.

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For example, if 60% of miners seek to expand the network to a level that is profitable for those miners but is equal or slightly lossmaking for some (say 20%) of miners and highly loss making for the other (20%) of miners, we end in a scenario where:

$(m_L + m_n)$ expand (60%).

(m_{s1}) make a loss and drop from the network.

(m_{s2}) make a loss and liquidate.

Next, the miners are now earning a new level of profit. As $m_{s(1)}$ and $m_{s(2)}$ are no longer able to compete profitably, these miners stop computing leaving the $(m_L + m_n)$ miners to gain more block as the hash-rate does not adjust instantly. Hence profit is,

$$P_{(L+n)1} = p_O \times \frac{1}{60\%} = \frac{5}{3} p_O$$

At this rate, m_{s2} can return to mine profitably. Hence, the next level of profit becomes:

$$p_2 = (L + n + m_{s2})$$

$$p_1 \times \frac{4}{3} = \frac{5}{4} p_O$$

At this rate, $m_{s(1)}$ can no longer compete for the increased bandwidth and network levels, but the other parties can. We now come to a state where the remaining miners are earning 1.25 times the original revenue. As costs decrease for network and computer hardware even if the revenue leads to an immediate profit equalisation at the time of the miner upgrade, the costs of new equipment will diminish allowing new miners to come into the system and convert the increased overall revenue to a further division. New miners will now enter the "*game*" up to a point where the marginal cost of mining is returned to zero and any new additional miners leads to loss. The next state to incorporate into an economic model of bitcoin is price. As the transactional volume is increased, the use of the system can also increase allowing a balance to be between use and growth where system scales to the marginal utility level against other competing systems. Hence, it is other payment systems and the ability to be more competitive that limits the growth rate of Bitcoin.

As long as the overall cost of a transaction in Bitcoin is lower than that of a competitive and comparable system, the cost of scaling will decrease to the point of marginal utility with old systems slowing moving into Bitcoin and new systems using it as long as the overall transaction costs are lower than an alternative. We can generalise this as:

Profit = Revenue – Cost

P_O = Initial Miner Profit

$P_O \geq \ \forall$ miners

$P_{(L+n)1} = p_O \times \frac{1}{1-\alpha_{ms}}$And

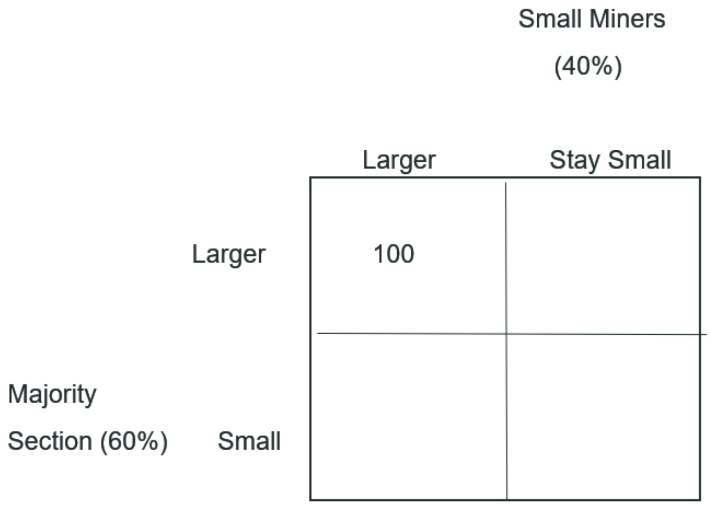
α_{ms} = ratio of small miners.

That is, 40% small miners $\Rightarrow \alpha_{ms} = 0.4$

α_{ms1} = ratio of small miners to liquidate.

α_{ms2} = ratio of small miners to stop mining.

The cost of a small miner includes sunk costs only if capital has been leased or a capital load exists where rent and other ongoing charges lead to an ongoing cost if the system is left not mining and not liquidated.



Cournot and Stackelberg

Stackelberg competition differs from Cournot models in that the leading firm selects the amount of hash-power that will be dedicated to mining based on the reaction curve of the following firms (Vogel and Jurafsky, 2011). A Cournot leader firm on the other hand selects its quantity of supply based on the quantity delivered by the following firm. The assumption in this is that a leader cannot revise its decision as it does not know the deployed decision of the followers until after multiple block discoveries. The effect is that even if multiple blocks are discovered quickly, this can occur probabilistically following the overall reduction of hash-power. All parties within a bitcoin mining competition act on probabilistic knowledge. The miners can use a Bayesian prior to guess a range of hash-power supplied by the competing firms. For a large miner, for example a pool that controls 30% of the overall mining hash-power at any time, it could be possible to model this as a Stackelberg duopoly with the single large miner competing against a group that acts as a follower miner even though the combined hash-power of the following group exceeds the leader.

Where firms are symmetric in cost, a Stackelberg solution is far more effective than a Cournot problem. Unfortunately, although distributed markets allow for symmetric sales costs, that is all miners can achieve a similar bitcoin price at a given time, input costs are likely to vary significantly both on time and the location of miners.

Choosing rules: Selfish-Mining explained

In assessing the rules, the leader can choose an update and signal an intent to alter the game. Alternatively, a leader can seek a competitive advantage by acting on a set of rules and not telling other players until these have changed (Gan et. al., 2019). The risk is that most miners (by hash-power) may not follow the leader. Here, the leader strategy decreases profitability. In pool mining, this could lead to a defection and loss of hash-power. The lead miner uses backward induction to account for firm two is expected response at stage 2. That is, the second block discovered after the current one.

Consequently, players cannot treat the second round as being analogous to the first. If we assume a 40% selfish-miner, and they start hiding blocks, you end up with orphan blocks and chains of unseen blocks and ignored blocks. The argument that remains for Selfish-mining (Grunspan and Perez-Marco, 2018) is that on the difficulty change that the miner hiding blocks will gain an advantage. Bitcoin is not a static game. Miners do not throw 100% of the hash-rate that they control to mining at any time. They turn machines on or off based on the current difficulty and reward. That is, they act on incentives and profitability. A selfish-miner at 40%

ISBN: 978-1-913016-07-4 (Online)

will be acting at 100% of their hash-rate. The reason to explain this is simple, if the selfish-miner had 50% of the hash-rate already, they would not need to do selfish-mining as the process of controlling the network with 50% is more cost-effective. That is, it is more profitable to add hash where it is available and thus the selfish-miner will be acting at the complete hash-rate they control. Alternatively, other hash will be idle. This is simple to explain. At any point in bitcoin's history, the total hash-rate available has always been more than double the hash-rate deployed. This includes older machines as well as machines that are turned off for reasons including maintenance or simply lower profitability. These machines would be re-enabled where the players see a lower hash-rate and where the price remains stable.

During the attack, the hash-rate will vary.

For a 40% selfish-miner, the selfish-miner now earns 51.52 blocks of the original 144. The problem is that this assumes a stable hash-rate. The reality is that 44% of the hash-rate has been turned into orphans. To an external miner not paying attention this would appear to be simply a massive opportunity. Where we before had 100 units of hash-power, these are now turning out 56 units. As such, it would be expected that the remaining units start to come online to their profitability level. If these disabled units are profitable at 80% of the machines that are turned on for the main pool of non-selfish-miners, we will have lower overall hash-rate that is creating blocks but still increase overall. In this case, 0.80x44 units will come online. This now creates a scenario for the follower group where they are profitable with an additional 35.2 mining units for a total act of hash-rate of 132.2 mining units.

The selfish-miner is not profitable under 30% of the hash-power even with a selfish-mining attack. The assumption is that the selfish-miner force the hash-rate to change based on the difficulty adjustment. However, as bitcoin is a Stackelberg game, the followers or in this case the honest miners will react, and the total mining power will increase. The selfish-mining calculations assume a static system and a 44% orphan rate for a 40% selfish-miner. This leads to an overall difficulty adjustment in those calculations based on a severe drop in difficulty to only 56% of the original. Due to the additional miners, the difficulty only adjusts to 95.2% of the original given the new miners are 80% as efficient as those that they are competing with.

The argument made on the selfish-mining attack is that the attacker will recoup lost profit after the difficulty change. Unfortunately, the non-static nature of bitcoin leads to a follower reaction. That is, the leader has a choice of acting profitably in a Stackelberg game or defecting and losing their advantage. If the leader decides to act outside the rules, the system reacts as the follower miners are sequential. That is, the total hash-power is deployed publicly in round one and in round two all other miners act. If hash-power is hidden, the follower miners act as if the hash-power has been turned off or removed in some other way.

As such, we can show that mining is not profitable within the difficulty change period and is also restrained following this. More importantly, the cost of attacking the network is far greater in a dynamic network than a static one. In a static network, the selfish-miner can only start to recover after a difficulty adjustment. However, miners will quickly see the difference in orphans and lost hash-rate and react to this. The reaction would occur in as little as 1 to 2 hours which is a small fraction of the two-week difficulty period.

The network is self-resilient. As miners move hash, other miners react. This creates an efficient market within bitcoin. It is not possible to have pseudonymous mining groups act in full collusion and remain secret doing this. As with other attacks, a selfish-mining scenario can be modelled as a simple Stackelberg duopoly. In this, the selfish-miner acts as the leader and all others who are mining or potentially mining act as the follower group. This is important to note, as with Daughety (1990), we can show that asymmetry and concentration affect the results and can lead to beneficial societal consequences. These consequences come from noncooperative firm interactions. In reacting, the Stackelberg followers ensure that a leader acts within a socially and individually optimal range. Focusing on concentration is misguided. The actions within the system that reduce and increase concentration based on profitability are welfare enhancing for the overall bitcoin system. Nodes within the bitcoin system increase and reduce the amount of investment and the amount of hash-power deployed dynamically.

The difference with a Stackelberg market from a Cournot is the increase in aggregate output. Daughety (1990) demonstrated that in an n-firm Stackelberg oligopoly with (m<=n) Stackelberg leaders and (n-m) Stackelberg followers, the market will compensate in a way that can be revealed to generate a reduced profitability and customer surplus. In bitcoin mining, an action such as selfish-mining increases losses to the Stackelberg leader who seeks to alter the consensus process through hiding blocks. The reaction of the followers in increasing the total hash-power delivers the followers more profit while reducing the profitability of the leader or selfish-miner even further.

The perceived Nash equilibrium that would result in a static system that acts more like a Cournot market does not exist due to the dynamic nature of bitcoin mining. As soon as the leader sets a strategy, the followers will react. The reason selfish-mining does not exist derives from the strategic process. The selfish-miner will take the strategy of the follower into account. The leader back propagates its actions based on the expected action of the follower. The selfish-miner as leader recognises that if they hide blocks and increase the orphan-rate the result is to simultaneously make mining more blocks at a higher hash-rate more attractive to the followers. Hence, the result is an increased total hash-rate. The increase in hash-rate significantly reduces the profitability of the selfish-miner even as they start to try and orphan other blocks. This increase in hash-rate also decreases the benefit of hiding blocks. As the 40% miner drops to under 30% of the total hash-power, the selfish-mining strategy changes from one that produces more blocks to one that becomes increasingly less profitable (Wright, 2018a). The breakeven point for a selfish-miner is 33% of the resulting network (Grunspan and Perez-Marco, 2018). To achieve this the selfish-miner needs to have 50% of the original network in which case, there is no benefit from selfish-mining.

The problem that has been common when analysing bitcoin as a system is to erroneously treat it as a static and not dynamic game (Singh, Dwivedi and Srivastava, 2018). Bitcoin is non-static (Wright, 2018b). As the profitability increases and discovery rate drops, other miners enter and start to compete. As the profitability decreases, miners remove hash-power. Bitcoin is a Stackelberg (or dynamic game), not a Cournot game and does not have a single static Nash equilibrium. Bitcoin is far more complex in nature than a Nash game. The only equilibrium is honest mining. Every other state is a loss. The assumption made is of static hash-power. At any point there are additional mining systems that are not profitable with the current hash-rate. These might be older S7s or even new machines that are on higher power cost-based facilities. It could even be that these miners have differential pricing based on the amount of power used. E.g. they use 10 units they pay a profitable rate but if they need more power and use 12 units the incremental power costs for the additional two units would be at a higher cost.

Where the total hash-power is perceived (by followers) as reduced, then other miners will increment hash-rate. The consequence is a loss of the perceived game. Strategically, a miner acts on seen blocks as propagated. The selfish-miner signals by withholding. Hiding hash-rate results in the leader (selfish-miner) signalling a reduction in hash-rate. The reaction to a follower seeing this now profitable scenario where the hash-rate has dropped significantly is to react by increasing hash-rate. Miners will initially overshoot. The initial additional hash-rate will exceed the amount lost through orphan and hidden blocks but will then start to come to an equilibrium as the isolation process of over and under shooting based on a probabilistic and not known true hash-rate starts to be found following a Bayesian process. The result is that

ISBN: 978-1-913016-07-4 (Online)

reacting to hidden blocks is not seen as a selfish-mining attack until it has been countered through the reaction of the follower miners who expect higher profits. The reaction of the leader in this instance delivers enhanced profits to followers. The leader miner who acts to reduce their lead through dishonest processes in effect reduces their leadership by reducing their overall hash-rate on an ongoing basis.

CONCLUSION

We demonstrated that even in scenarios of concentration, bitcoin acts in a socially optimal manner even in conditions of extensive asymmetry. Posner (1968, pp. 1563-4) defends the condition where diverse markets act outside the whims of individual players. The distinction comes from an argument that the pricing model of Oligopolists interact in a manner that shows a level of dependence between the parties. The result is argued to be a collusive pricing model. Equilibria in bitcoin mining arises as consequential to being mutually advantageous to the firms within the industry. Due to the sequential nature of strategies within any Bitcoin game and the inability to exactly identify deployed hash-rates at any point in time, bitcoin miners act in a Stackelberg game where any defection can be modelled in the Stackelberg duopoly and the defector can be shown to be at a disadvantage.

REFERENCES

Daughety, A. (1990) Beneficial Concentration. *American Economic Review*, 80 (5), 1231-37

Gan, G. et al. (2019) Imitative Follower Deception in Stackelberg Games. [Online]. Available from: https://arxiv.org/abs/1903.02917 (accessed 11 March 2019).

Grunspan, C. and Perez-Marco, R. (2018) On Profitability of Selfish-Mining. [Online]. ArXiv 2018. Available from: https://arxiv.org/abs/1805.08281 (accessed 11 March 2019).

Huck, S., Müller, W. and Normann, H. (2001) Stackelberg Beats Cournot: On Collusion and Efficiency in Experimental Markets. *The Economic Journal*, 111 (474), 749-765

Hwang, S. and Rey-Bellet, L. (2016) Strategic Decompositions of Normal Form Games: Zero-sum Games and Potential Games. [Online]. Available from: https://arxiv.org/abs/1602.06648 (accessed 11 March 2019).

Posner, R. (2001) *Antitrust Law*. 2nd ed., Chicago: University of Chicago Press.

Singh, R., Dwivedi, A. and Srivastava, G. (2018) Energy consumption in Bitcoin Mining: A Game Theoretic Analysis. [Online]. IACR. Available from: https://eprint.iacr.org/2018/780.pdf (accessed 11 March 2019).

Simaan, M. and Cruz, J. B. (1973) On the Stackelberg strategy in nonzero-sum games. *Journal of Optimization. Theory and Applications*, 11(5), 533-555.

Simaan, M. (1977) Equilibrium properties of the nash and stackelberg strategies. *Automatica*, 13(6), 635-636.

Vogel, A. and Jurafsky, D. (2011) Partially Observable Stochastic Reference Games. [Online]. Available from: UTX.nl https://pre2011.uvt.nl/pdf/vogel-jurafsky-cogsci.pdf (accessed 11 March 2019).

Wright, C. (2018a) The Fallacy of the Selfish Miner in Bitcoin: An Economic Critique. *International Political Economy: Monetary Relations eJournal*, 6(31), May 02, 2018

Wright, C (2018b). Bitcoin: SEIR-C Propagation Models of Block and Transaction *Dissemination Computational Biology eJournal*, 2(13), April 10, 2018

2-CT05-7406

DOES INTERNAL CONTROL IMPROVES ASSURANCE SERVICES?

DR. LINVAL FRAZER[1]

This paper demonstrates that internal control can be successfully applied to any company to foster accurate financial reporting, non-financial information, compliance with laws and operational efficiency. Furthermore, it bolsters the assurance process, in that it helps to give credibility and authenticity of information. The paper asserts that an effective internal control system reduces inherent, control and detection risks. This leads to less substantive audit procedures and lower audit fees. It also reduces compliance audits from federal, state and local authorities and garners less unethical behaviors. The paper concludes that companies that have effective internal control systems solicit more respect from stakeholders for transparency and objective reporting.

Keywords: Attestation, Assurance, Audit, Internal Control

3-CR05-7260

DIVERSITY MANAGEMENT: BEST PRACTICES CASE STUDY.

PROF. TAMARA EDITH PAWLUK[2]

Diversity Management: Best Practices Case Study Summary: Current business trends have identified diversity as a key source for innovation, competitive advantages and improved problem solving within any organization. Diverse teams have shown to be more productive and innovative than non-diverse teams. However, a diverse workforce within an organization can also be the source for misunderstandings, failed projects, discomfort and financial losses. As a consequence, it has been established that diversity needs to be managed if it is to result in success. This case study shows an organization that chose to incorporate diversity to its strategy and has dedicated strong efforts and financial resources to this topic. The aim is to extract best practice as well as to identify current challenges.

Keywords: Diversity Management – Organization – Business – Workforce – Organizational Strategy

4-CR01-7251

TO DETERMINE THE EFFECTIVENESS OF THE FOUR WHEEL MODEL WITH REGARD TO BRAND CONSOLIDATION. A CASE STUDY FOR THE BUCO BRAND IN SOUTH AFRICA

MS. JUDY GOUNDEN[3]

In today's world, many leaders are attempting to manage an increase in responsibility while at the same time attempting to make sense of an organization that is not familiar any longer. Many leaders are also in a position whereby they are finding their well known business changing, either unintentionally or intentionally. According to a study done by Alexander (2017), the abilities from leadership are known as transitional type of leadership. Brand consolidation is an opportunity to rationalize costs, strengthen the best brand, and support profitable brand growth and expansion. Brand loyalty may not necessarily create brand sustainability, however, this is a key component in the development of a brand, according to the research done by

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Schultz (2015). Brand consolidation is becoming a common business strategy due to this making economic sense and usually takes place when a merger or acquisition is underway or when a business is finding the need to consolidate brands within a portfolio.This study will provide an in depth view of the effects of organisational strategies, organisational culture and leadership in a brand consolidation for a retail business, namely, Steinbuild in South Africa. The various approaches to leadership and change management techniques will be explored. (Hughes, 2007) by using key components of the four wheel model (Jacob & Hoque, 2017), Namely : (a) Organisational strategies, (b) Organisational structure and Culture, (c) Leadership dimensions (d) Expertise/Efficient key Departments of knowledge management.

Steinbuild has posted no real growth since 2012, having an EBIT margin of 3% since 2012 to date. A staff survey that was completed by an external vendor, indicated a disconnect between senior management and staff. In addition, a brand research study was conducted which showed that the consolidated brand had not grown or produced the expected returns as significantly as was intended. The future of Steinbuild as a retail business is at stake, whereby in excess of 4000 employees could be made jobless, should the business not be sustainable into the future.

In order for this study to be relevant for the South Africa demographic context and culture, the case study of ABSA bank was reviewed.

There is no prior study that has been undertaken within South Africa, that is able to holistically evaluate the impact of brand consolidation, within an organisation, hence this study sought to close this gap. The analysis of the four wheel model will give a clearer indication as to which areas in the business need attention in order to achieve the required success of Steinbuild in its brand consolidation efforts.

Research is therefore needed to develop a strategic framework that will enhance the outcome of brand consolidation efforts within organisations.

The five wheel model was developed by Jacob & Hoque (2017), which was used for LINK Healthcare as a model to measure organisational success. The five-wheel model was developed with the key findings from the study that identified important areas for the organizational success of LINK Healthcare, namely: Global Expansion (Market Identification for Entry), Leadership Dimensions, Organizational Strategies (Portfolio Diversification and Product Specialization), Organizational Structure and Culture and Expertise/Efficient Key Departments.

Each wheel represents a specific important area within the model. Within each area, are sub-components. The study results showed that some components were rated higher than others in terms of their relevance in achieving organizational success.

This model is highly valuable for businesses that are struggling to achieve success. The Steinbuild business is very much in this position and the pillars of measurement are directly linked to the specific areas that need to be investigated, post a brand consolidation.

The aim of the study is to determine the effectiveness of the 4 wheel model with regard to brand consolidation for Steinbuild in South Africa. The specific research objectives (RO) of this study which will help to achieve the research goals, when taking into account the following pillars of the 4 wheel model

(a) Leadership dimensions
(b) Organisational structure and culture
(c) Organisational strategies
(d) Expertise/Efficient Key Departments

Research Objectives and Research Questions

1. To investigate organisational strategies during brand consolidation
   What are the most suitable strategies brand consolidation?

2. To analyse the role of the leadership and its effects during brand consolidation
   What are the types of leadership characteristics that are required for successful brand consolidation?
3. To find the effectiveness of the 4 wheel model for brand consolidation
   To determine the effectiveness of the 4 wheel model for brand consolidation

The population of this study comprises of all General Building Material (GBM) retail stores within Steinbuild in South Africa as at 30 November 2017. There are 98 retail outlets in total. The sample frame will include 2449 staff which are active employees. The sample will also include suppliers and customers purchasing and selling to these retail stores during the same period.

The researcher aims to develop a framework by testing the four wheel model, to successfully implement brand consolidation in an organisation. The literature review will focus on current research relating to leadership, brand consolidation and organisational culture, locally within South Africa, as well as gain a thorough understanding of such issues from a global perspective. In South Africa, there is an increasing emphasis on the crisis of leadership and change management interventions. It is particularly important that leaders in organisations are able to mobilise and inspire their teams in order to respond to change at grassroots level. The literature review will undertake to identify key advantages and impediments of brands that have consolidated within South Africa, which will underpin insights into the cultural dimensions that South Africans face during such change interventions.

This study will be conducted in South Africa, a developing country that has different social–cultural values from those of the developed countries. This study will be a pioneer work on the impact of leadership roles, structural and cultural dynamics, organisational strategies and knowledge management, during a brand consolidation period in an organisation.

Keywords: - Leadership, Organisational Culture, Organisational Structure, Brand consolidation, Leadership, Knowledge Management, Business Strategy

5-CT01-7329

ANTI MONOPOLY AND COMPETITION REGULATION CHALLENGES ON THE EXAMPLE OF GEORGIA

DR. GIORGI KUPARADZE[4]

Recently, reforms have been undertaken in Georgia in the field of competition regulation. Presented comparative analytical study analyzes institutional issues of free competition regulation in Georgia, Poland and Lithuania.

Currently, there are several international rankings published, the World Competitiveness Index of the World Economic Forum, is the one of reliable source. Competitiveness of the country is determined by the effectiveness of the institutions, effective policies and other factors that further impact the volume of production in a particular country . Out of given index components we highlight the 6th - Good Markets Efficiency component . Georgia ranks 112th in the performance of the Anti-monopoly regulatory policy among 137 countries, while Lithuania occupies 68th and Poland 49th place. To compare Georgia to Lithuania and Poland the most significant difference is observed in the component of the effectiveness of anti-monopoly regulation policy. The reason for this gap is to be searched in the existing institutional framework of regulation of competition in the listed countries.

By comparing the essential features of competition regulation legislations in Georgia, Poland and Lithuania had revealed the differences and gaps that leads to the different outcomes in terms policy efficiencies:

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ISBN: 978-1-913016-07-4 (Online)

There is no separate unit in Georgia concentrating on consumer protection issues, that is essential but not sufficient for effective regulation. In case of Poland and Lithuania consumer protection is one of the main direction of work of competition regulation bodies;

One centralized body without the regional branches limits the coverage of the activities in terms of undeveloped internet technologies. Lithuania and Poland has the complex structures covering the regional scope that leads to equal effects of anti-monopoly and completion regulation;

Lack of some important thematic concentrations: Tax privileges and guarantees issued by the state has not been yet the thematic concentrations for competition agency of Georgia

Competition Agency of Georgia has rather limited power in terms of defining the executive orders and imposing fines compared to Poland and Lithuania, that leads to institutional weakness of the agency. The changes in legislation shall be made in accordance of EU countries Practice. is regard in comparison with the European Union members Poland and Lithuania.

Keywords: Competition Policy, Competition and Antimonopoly Regulation, Policy Effectiveness, free market development

6-CR06-7379

THE EFFECT OF CUSTOMERS' GENDER, EDUCATION AND AGE ON THEIR E-BANKING EXPERIENCE AND WORD-OF-MOUTH ONLINE: A CRM APPROACH

DR. AHMAD KHALDI[5] DR. ARTHUR KING; AND DR. HAMAD HASAWI

The aim of the current research paper is to investigate the effects of customer demographics, (mainly gender, age and education), on the perception of customer experience of e-banking services and on customer's eWOM about e-banking services. A convenience sample of 564 e-banking customers in Kuwait was asked to participate in a survey measuring their demographics, perception of e-banking experience and their eWOM about e-banking.

In regard to the perception of customer experience of e-banking services gender has no effect on the perception of customer experience and there are no significant differences between male and female respondents in the mean values of perceived customer experience in e-banking, Whereas, each of the variables of age and education has a moderate effect on the perception of customer experience of e-banking services with more positive perceptions for customers who are aged 45 years or older and for customers who have less than a university degree, respectively.

In regard to customers' eWOM about their e-banking services, the findings indicate that each of the variables of gender, age and education has a relatively weak but significant effect on consumers' eWOM about their e-banking services. Female customers, as well as customers who are 45 years of age and older, and customers who have less than a university degree, were all found to have a stronger tendency for spreading eWOM about their e-banking experiences than their peers.

The managerial implications of the findings draw the attention to the importance of concentrating on the, usually ignored, demographical characteristics of customers when marketers are planning and implementing their buzz marketing campaigns and supporting opinion leaders online. The effect becomes even more important when we are talking about marketing innovative services like e-banking to the new digital consumer where relationship building is the only way up, especially in a highly competitive market like Kuwait where the majority of the population is young and highly educated.

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Academically, the findings represent a step towards deepening our understanding of the factors that might lead consumers to more favorable perceptions of their online experiences of services and to induce them to spread positive eWOM about it.
Keywords: Word of Mouth, Customer Experience, Online Demographics, E-banking Services, Arab Consumers

8-CR05A-7259

DIVERSITY MANAGEMENT: SKILL TRAINING IN HUMAN RESOURCES MANAGEMENT

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Summary: Intercultural Skills have become key differentiators for professionals and leaders. And intercultural teams have become a strong source of competitive advantages for companies and organizations worldwide. The key difficulty relies mostly in turning organizational statements on diverse workforce in effective teamwork and leadership. Effectively training employees on intercultural skills and topics is therefore a recurrent need for organizational management. The aim of my research is to define the most effective way of training employees and leadership in intercultural and diversity management topics and turn organizational objectives on this into a reality. It compares different training strategies implemented by a company in order to allow diverse teams to work effectively.
Keywords: Diversity Management – Training – Skills – Organizational Training – Training Strategy

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