

DEMONETIZATION: DID INDIA FACE THE ST. PETERSBURG PARADOX AND LOSE?

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Abstract

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In 2016, India demonetized 24% of its currency notes (viz. 86% in cash value) in circulation presuming this will remove “black” (illicit) and counterfeit cash holdings, and combat money laundering. This was the largest demonetization experiment in recent history. Although demonetization has occurred several times before, no unambiguous economic argument for, or against, it exists. This was a key enabler for demonetization, yet again. This paper argues that the St. Petersburg Paradox (SPP) provides a compelling argument against demonetization. Assuming the distribution of cash is lognormal, it is shown that the probability of black cash holdings will be small. If not, the holders would: a) be irrational because they are willing to accept, contrary to the SPP, the small probability of a large loss, by effectively perceiving it as zero, without using all means to immunize themselves against it; or b) be sure their cash can be legitimized via collusion with the State; or c) be sure they can incentivize law-abiding citizens to act as agents to legitimize the cash for a reasonable fee. Assuming rationality and no bureaucratic support, large probabilities of black cash holdings imply that many more law-abiding patriotic citizens have to be corruptible than seems rational.

Keywords: St. Petersburg Paradox, India, Demonetization, Black Money, Corruption, Law-abiding Citizen, State Collusion, Rationality

1. INTRODUCTION

Keynes (1919), paraphrasing an observation by Lenin (White and Schuler, 2009), wrote: *Lenin was certainly right. There is no subtler, no surer means of overturning the existing basis of society than to debauch the currency. The process engages all the hidden forces of economic law on the side of destruction, and it does it in a manner which not one man in a million is able to diagnose.* Given the vast reach of demonetization, it is true that “not one man in a million” can diagnose the disruptiveness it may cause. There are no clear arguments for, or against, demonetization. Economists have no unambiguous answer regarding whether to demonetize cash. For example, Rogoff (2014) argues for it, in vivid contrast to Keynes’s statement. There is no mathematical support of, or protest against, demonetization. Because no compelling economic argument against demonetization exists, Governments periodically experiment with demonetization

presuming it will succeed. This paper, which is a more formal rewrite of its predecessor version (Gana, Sep. 2017), shows that the failure of demonetization is predictive.

On November 8, 2016, Prime Minister Narendra Modi demonetized about 86% of cash in circulation denominated in 500 and 1,000 rupees (INR) notes. These notes amounted to about 24% of the notes in circulation. Demonetization has occurred before in history, both in India and in other countries. India demonetized its currency in 1946 and, again, in 1978. World reaction to Modi’s move was mixed (Miyani, 2017). For example, the World Bank’s Georgieva (Hindustan Times, Mar. 2, 2017), the Chinese media and Forbes praised it; while the BBC and the New York Times (Jan. 9, 2017) did not support it.

Countries that have demonetized their currencies include the United States (1873), Ghana (1982), Nigeria (1984), Myanmar (1987), the Soviet Union (1991), Zaire (1993), North Korea (2009), and

Zimbabwe (2015). Demonetization, generally, has had profound negative effects: social, economic, and political. One of the earliest demonetization experiments was conducted in the United States when the Coinage Act of 1873 removed silver as legal tender. This was a failure (Friedman, 1990) and contributed to the subsequent 5-year economic depression in the United States. Following this, silver was remonetized in 1878. In 1982, Ghana demonetized its 50 cedi note to: *mop up excess liquidity, halt inflation and instill accountability in financial transactions* (Aryeetey et al., 2000). This destroyed confidence in the holding of currency in the formal economy; and transactions in the informal economy boomed, adversely impacting economic growth (Aryeetey and Gockel, 1991). Demonetization in the Soviet Union was a failure as well, leading to loss of confidence in its monetary system and contributing to its subsequent break-up (Abdelal, 2003). Demonetization in Myanmar also failed (Steinberg, 2013).

The key reasons Governments demonetize cash is to combat corruption (e.g., tax evasion via holding “black” or illicit cash) and crime (e.g., counterfeiting or money laundering). A survey (Veerakumar, 2017) indicates that Indians too perceived targeting these ends as the goal of demonetization. For the survey, 100 persons were randomly sampled. The top two perceptions were that demonetization combats black cash and corruption.

It is difficult to estimate the value of black cash held by Indians because it is unobservable. Thus, there is a range of estimates (Ministry of Finance, 2012) using several methods. This range suggests that the amount of black cash held is only around 5-8% of the cash supply. In contrast, fake cash is estimated to account for only about 0.003% of the demonetized cash (Reserve Bank of India, 2017). However, given black and fake cash are unobservable, it is easy to view these estimates as underestimates, and perform a demonetization experiment to unearth it.

Modi presumed that demonetization would remove black and fake cash. Under this presumption, Modi (Press Information Bureau 2016) put forward, forcefully and vividly, his reasons on why demonetization would be good for India. There is much truth in Modi’s speech of Nov. 8. In particular, Modi reiterated the problems of India’s “parallel economy” (Sarkar, 2010): avoiding taxes, purchasing houses using cash and artificially inflating their prices, making cash payments for higher education and increasing its cost, and so on. The key message in his speech is that demonetization can be used as a policy tool to alleviate poverty by eliminating black cash with the full backing of law-abiding citizens: *Time and again, I have seen that when the average citizen has to choose between accepting dishonesty and bearing inconvenience, they always choose to put up with inconvenience. They will not support dishonesty.* Such backing would be a great asset to India where inequality is quite pervasive (Dreze and Sen, 2013). This is possible if the proportion of law-abiding citizens who can be incentivized to be corrupt is quite small.

This paper shows that if black cash holders are rational agents and there is no State collusion (e.g., bureaucratic support) to facilitate the fast exchange

of demonetized cash, then the probability of holding black cash will be quite small. A rational agent will not voluntarily assume the risk of a large loss even if that loss has a very low probability of occurrence. Thus, demonetization cannot meet its presumed ends.

2. INDIAN PHILOSOPHY VS. MAINLINE ECONOMICS

India’s philosophy has, over the centuries, deeply shaped the behavior of a majority of Indians. Any economic model that ignores this behavioral or sociological focus would be misspecified. It is important to briefly touch upon India’s philosophical heritage as a driver of behavior; because Modi’s critical presumption is that it will be difficult to corrupt law-abiding citizens.

Prime Minister Jawaharlal Nehru (1954) noted: *I have received so much love and affection from the Indian people that nothing that I can do can repay even a small fraction of it, and indeed there can be no repayment of so precious a thing as affection.* And, on “affection” in the presence of “asymmetric information” born of pervasive “poverty”, while campaigning in the India of his day, Nehru (1946) noted: *I was talking about the elections ... I was getting in touch with something much bigger: the people of India in their millions ... As I saluted them ... a forest of hands went up in salutation, and a friendly, personal smile appeared on their faces, and a murmur of greeting rose from that assembled multitude and enveloped me in its warm embrace. I spoke to them ... and ... whether they understood all I said or not, I could not say, but there was a light of a deeper understanding in their eyes, which seemed to go beyond spoken words... There was poverty and the innumerable progeny of poverty everywhere ... But there was also a mellowness and a gentleness, the cultural heritage of thousands of years, which no amount of misfortune had been able to rub off.* The “mellowness” and “gentleness” that Nehru references is a product of India’s philosophical teachings (e.g., the *Upanisads*), which form the foundations on which the beliefs of many millions of Indians are anchored. President Radhakrishnan (1953) had made observations regarding these beliefs that were nurtured by the uncompromising pluralism in, and the enormous reach of, that philosophy: *The Upanisads represent a great chapter in the history of the human spirit and have dominated Indian philosophy ... and life for three thousand years ... Even doubting and denying spirits found in them anticipations of their hesitations, misgivings and negations. They have survived many changes ... Their thought by itself and through Buddhism [see Radhakrishnan and Moore 1967] influenced ... the cultural life of ... nations far beyond the boundaries of India.* Modi banked on Indians’ sense of “right” and “wrong” to make demonetization succeed.

A survey, conducted among 2,464 Indians between Feb. 21 and Mar. 10, 2017, by the Pew Research Center (2017), validates that a significant proportion ($\approx 75\%$) of Indians consider corruption (with a focus on bureaucratic corruption) a great problem in India; and approve of Modi’s handling of it. Law-abiding citizens may exhibit a level of

altruism or patriotism¹ that enables them to refuse incentives to be corrupt. Thus, black cash holders would be caught once they reveal they have it. Press reports (e.g., Business Standard, Nov. 16, 2016) pointed to stacks of demonetized notes being dumped as trash. Modi's secretiveness regarding demonetization was also essential to prevent alerting black cash holders that it was imminent: *Secrecy was essential for this action. It is only now, as I speak to you, that various agencies like banks, post offices, railways, hospitals and others are being informed.* The inefficiency and productivity losses that would result from secrecy is inevitable, but one that law-abiding Indians were willing to accept in order to rid their country of black cash. The former Governor of India's Central Bank, Rajan, had argued that the short-term costs of demonetization would outweigh any long-term benefits (Hindustan Times, Sep. 5, 2017). However, Modi's speech supersedes Rajan's argument because, given law-abiding citizens' willingness to make sacrifices to rid their country of corruption, that cost is irrelevant. Similarly, Thaler (Alt News, Nov. 18, 2017) suggested that the *concept* [of demonetization] *was good as a move to a cashless society to impede corruption but the rollout was deeply flawed.* More recently, demonetization as a facilitator for creating a cashless society has also been championed (Balaji and Balaji, 2017). However, demonetization, as conducted, would pave a steeply undemocratic, and unjust, path toward a cashless society.

It is quite clear that most Indians displayed patriotism by bearing the hardships of demonetization as anticipated in Modi's speech: *there may be temporary hardships to be faced by honest citizens. Experience tells us that ordinary citizens are always ready to make sacrifices and face difficulties for the benefit of the nation.* These hardships, as reported by the Press, were many. They included law-abiding citizens dying while waiting in queues to exchange demonetized notes (e.g., Times of India, Nov. 13, 2016); and babies dying because their parents could not access cash in time to pay for emergency medical services (e.g., Times of India, Nov. 14, 2016; Quartz India, Nov. 9, 2017). In spite of these hardships, no rebellion (e.g., riots) against demonetization occurred in India. This is a point that cannot be overemphasized because containing rebellion would have required calling in the Indian Army. Much too often, the Indian Army has been called in to contain internal rebellion (mostly communal in nature), because it is perceived that internal security forces (e.g., the police) may be sympathetic to the rebels (Baruah, 2014; Jha, 2015). Lack of rebellion strongly signals the faith law-abiding citizens had in demonetization. From the behavioral perspective, this reflects the "mellowness and gentleness", which Nehru had referenced, in the presence of hardship. It also signals that most law-

abiding citizens had no black cash to worry about. Modi winning the elections in the state of Uttar Pradesh, post-demonetization, is another strong signal in the faith (under asymmetric information) Indians had in Modi's moves to end corruption (Hindustan Times, Mar. 16, 2017).

Mainline economics will push against the statements made above regarding India's philosophy as a barrier to corruptibility of the individual. It will push against Nehru's "mellowness and gentleness" argument, which implies that Indians can subjugate "self-interest maximization", as a behavior, for the "greater good" of India. Stigler (1981) wrote that: *much of the time, most of the time, in fact, the self-interest theory ... will win.* This implies that if the "price is right", people may be corruptible regardless of the way they grew up or the "ideals" they hold dear. Stigler's statement partially echoes Smith's (1776) statement that: *he [an economic agent] intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention. Nor is it always worse for the society that it was not part of it.* Others (e.g., Greenwald and Stiglitz 1986) have suggested that there is no "invisible hand" because of the existence of pervasive information asymmetries. Simon (1992) has argued that altruism plays an important role in economics. Altruism has been observed among family and friends (Curry et al. 2013, Foster and Rosenzweig 2001, and Bergstrom 1995). However, research such as that of Andreoni (1990) rejects altruism in favor of self-interest (or intrinsic self-interest, interpreted as a "benefit"); and Slonim et al. (2014) suggest that altruism is "inefficient". Although there is much truth in these statements, a key presumption driving them is that self-interest maximization is a requirement of "rationality". Although the assumption of rational behavior as the way people *actually* behave has been questioned (Sen, 1987; Smith, 1790), self-interest maximization is presumed to be a requirement of rationality, rather than as a self-reinforcing operating principle. Problems with this presumption are discussed by Gana (2014, 2016).

The contrast between law-abiding citizens and their potential for corruption is central to this paper. Empirically, which of these behaviors was the dominant one is not yet known. If the data reveals that no behavioral regime shifts have occurred to increase the rate of corruptibility among law-abiding citizens, then demonetization should have succeeded. Having data on demonetization is of critical importance.

3. GOVERNMENT OF INDIA ACTIONS BECOME ARBITRARY

This case study reveals some of the Government of India's expectations on Indians' behavioral responses to demonetization:

An Indian citizen (Mr. X) living as an expatriate in the United States has a Non-Resident External (NRE) savings account in India. The Government of India designates persons like Mr. X, Non-Resident Indians (NRIs). An NRE account only allows for depositing monies earned outside India. Mr. X periodically wire-transfers US dollars to his NRE

¹ Under pervasive inequalities, "patriotism" can be misguided and misapplied. For example, support of the poor for demonetization generally arises out of deep information asymmetry, which prevents their anticipation of the hardships that they have to bear because of it. Tagore (1916) had cautioned India on misapplying patriotism in a moving novel (*Ghare Baire*) via the words of one of its principal characters (Nikhil): "... I am willing to serve my country; but my worship I reserve for Right which is far greater than my country. To worship my country as a god is to bring a curse upon it ..."

account so family expenses in India can be met. During frequent visits to India, Mr. X withdraws cash from the NRE account (either by ATM or by check written to self) to meet family expenses and leaves the remainder at his parents' home in a village in India. When demonetization occurred, Mr. X was outside India. The Government of India opened a short window (thru Dec. 31, 2016) so Indians could deposit demonetized notes in banks, but Mr. X could not avail of that facility as he was outside India. Furthermore, it was not "worth it" to fly to India before Dec. 31, because the amount of demonetized cash left at his parents' home was about what it would cost to fly Coach Class from the US to India. For an NRI to be able to deposit demonetized notes in a bank, a Non-Resident Ordinary (NRO) account has to be first opened. Mr. X opened an NRO account online. Subsequently, the Government of India opened another window until March 31, 2017, so "Resident" Indians (i.e., Indian citizens who are not expatriates) who were outside India when demonetization occurred and returned to India after Dec. 31 could deposit their demonetized notes. Mr. X arrived in India before March 31 and took his demonetized notes with bank statements showing it is hard-earned "white" money, to deposit it at India's central bank, the Reserve Bank of India (RBI). Mr. X was shocked to discover that the RBI would not allow NRIs to deposit demonetized currency they had left behind in India. The RBI reiterated that the Government was only allowing Resident Indians to do this. The officer at the RBI asked Mr. X to petition the Prime Minister's Office (PMO) and the Central Board of Directors of the RBI requesting that NRIs be also granted the privilege to make such deposits. Mr. X did as requested. There were no replies. So, Mr. X sent reminders. However, Mr. X did not get any meaningful response from the PMO – the response, following the reminder, simply said "Case closed. The issue may not be relevant anymore". The RBI did not respond to Mr. X. Surprisingly, the actions of these hallowed institutions had become arbitrary.

The case of Mr. X, who is obviously law-abiding, should have been one of the easiest for the RBI to resolve, given the principal intent behind demonetization: to catch black cash holders. But, instead, the RBI denied Mr. X the privilege to deposit his hard-earned cash. Why? The Government had "second thoughts" regarding the potential for corruption in law-abiding citizens. Although the RBI had no doubt that Mr. X was holding "white" (legally earned) cash (e.g., the supporting documentation spoke for itself), they doubted their capability to distinguish between "law-abiding" and "corrupt" persons, more generally. So, several avenues to block the expected laundering of black cash were taken contradicting Modi's speech: *The rights and the interests of honest, hard-working people will be fully protected*

President Pranab Mukherjee (2017), accepted the demonetization "ordinance" criminalizing the holding of demonetized notes after March 31, 2017, despite his professed belief that ordinances should only be issued as a last resort. Thus, doubts on whether Indians, in general, are law-abiding, made the President accept, without due democratic process, the ordinance to destroy the notes; some of which could be white cash. Despite the faith Modi's

speech expressed on Indians' capability to stand against corruption, Mukherjee saw no reason to draw inspiration from the words of his illustrious² predecessor, President Radhakrishnan (Agarwal 1988), uttered when the democratic process in India was in its infancy: *We are for the first time starting, under the new parliamentary system, with a Second Chamber in the Centre, and we should try to do everything in our power to justify to the public of this country that a Second Chamber is essential to prevent hasty legislation. We should discuss with dispassion and detachment proposals put before us ... A democracy is likely to degenerate into a tyranny if it does not allow the opposition groups to criticize fairly, freely and frankly the policies of the Government.*

Thus, in a "game theoretic" since the Government and the RBI signaled their willingness to pursue the perceived "greater good" (e.g., demonetization as a tool to end corruption) regardless of the sacrifices imposed on subsets of law-abiding citizens. The implementation of "justice as fairness" (Rawls, 1971, 2001) was a non-starter. At the very beginning of *A Theory of Justice*, the late John Rawls demanded: *Justice denies that the loss of freedom for some is made right by a greater good shared by others. It does not allow that the sacrifices imposed on a few are outweighed by the larger sum of advantages enjoyed by many.* But, Rawlsian requirements were irrelevant to the RBI decision. Game theory (von Neumann and Morgenstern, 1952) is about maximizing "advantage". Demonetization was about the expectation that law-abiding citizens would, as Modi said: *ignore the temporary hardships ... [to] enable coming generations to live their lives with dignity.* Game theory sharply contradicts the critical presumption underlying Modi's speech of Nov. 8.

The Supreme Court of India has not championed that Rawlsian requirements should hold in the case of demonetization. The Court did make an appeal to the Government requesting a window be opened, until Dec. 30, 2017, for persons who lacked the capability (e.g., the terminally-ill) to deposit their demonetized notes. The Government rejected the request saying (The Hindu 2017) there would be "great difficulty" in deciding between "genuine cases" and the "numerous bogus ones". Here, the Court's request touched upon the "capability approach" (Sen 1991, 2009), which enhances Rawlsian justice by examining, among other things, the relationship of persons to the opportunities given them as a collectivity; but no further follow-up action has been taken by the Court as of this writing. The RBI Act (1934) allows the Government "*from time to time give [the RBI] ... directions ... in the public interest ...*" Demonetization was one of these "directions". The Court was expected to be the arbiter of last resort to ensure that justice is done to those hurt by demonetization. However, the Court as the agent of law, independent of the State (as envisioned in the

² When Dr. Radhakrishnan was elected as the 2nd President of India in 1962, Bertrand Russell (1872–1970) declared: "*It is an honor to philosophy that Dr. Radhakrishnan should be the president of India, and I, as a philosopher, take special pleasure in this. Plato aspired for philosophers to become kings and it is a tribute to India that she should make a philosopher her president.*"

Constitution of India), did not rule on whether the “public interest” was met by jointly considering the demands of Rawlsian justice and the constitutional consistency of the RBI Act.

4. DEMONETIZATION AND THE ST. PETERSBURG PARADOX

The arbitrary actions of the Government and inaction by the Supreme Court indicates an expectation that black cash would creatively find its way back into the formal economy. And this brings us to the St. Petersburg Paradox (SPP). The SPP (Bernoulli, 1738) has remained, for more than 300 years now, an important unsolved problem in economics and philosophy. In the SPP, “rational” persons are generally only willing to pay very small fees to partake of the opportunity to win very large sums of cash with very low probability; and mainline economics fails to predict this behavior. The extraordinary simplicity of the SPP makes rational persons quickly realize they should only pay very small fees to partake of the opportunity to accumulate extraordinarily large amounts of cash; and this holds in finite versions of the SPP (Hayden and Platt, 2009) as well.

Demonetization can be seen through the lens of the SPP (or an “inverse” SPP, if you will). If black cash exists and a relatively small proportion of persons in India (with a population of about 1.3 billion) hoard it, then the probability of a large loss is low. Clearly, for a rational holder of black cash, the fact that the probability of losing it is “low” is of little comfort. Thus, the black cash holder will make sure that a trading mechanism is in place to safeguard his black cash. In other words, like in the SPP, he would be willing to pay a reasonable price to guarantee his black cash is protected. If the holder perceives the probability of having such a mechanism is low, then he will continuously, and aggressively, seek all avenues to transfer his black money into other assets that are immune to the shock of demonetization. If he did not act thus, he would surely fall into the trap laid by the SPP, because he would have staked very much more for perceiving the low probability of demonetization as effectively being zero, which is incredibly irrational given that India has demonetized cash twice before. And, to minimize risk, “large” amounts of black cash-in-hand would only be held or surreptitiously stored for short periods of time before spending or laundering it or transforming it into other assets.

In India, which is a cash-based economy (about 95% of retail payments are in cash) and where inequality remains pervasive (Chancel and Piketty, 2017), anecdotal evidence suggests that one way to retain black cash is to depend on the willingness of those who do not have white cash to act as agents to exchange the notes, for a fee, on behalf of the black cash holders. But a key question is what proportion of law-abiding persons are (or perceived to be) corruptible in this manner? This idea is explored by example.

Following Gana (2016), let the distribution of demonetized note deposits (Y) follow a lognormal (Gibrat 1931) distribution³ with mean 10.86 and

standard deviation 1.25. The Gini (1912, 1921) coefficient of this distribution of notes is about 0.62, which indicates the inequality in the distribution of Y is quite high; and this is as it should be, if black cash holders have amassed the notes by, for example, not paying taxes. Let WML be the “white” money line – that is, amounts in excess of WML are considered black cash and amounts less than or equal to WML are white cash. In India, persons having INR 250,000 or less, in cash, are generally considered white cash holders and were permitted to deposit it without question. Persons with cash exceeding INR 250,000 had to demonstrate it is licit cash. If the demonstration was deemed unsatisfactory, then such persons become “suspicious persons” subject to investigation by the Income Tax Department and other agencies.

Now, the opportunity for black cash holders ($Y > WML$) to incentivize a proportion of persons with white cash ($Y < WML$) can only exist if the total shortfall below WML is greater than the total excess over WML ⁴. If the persons with white cash of at most $K \leq WML$ are corruptible, then all of the black cash “clears” when the total shortfall below K equals the total excess over WML ; and the ratio of the number of persons below K to those below WML would be the proportion⁵ of persons corruptible in the set of persons with white money. Values of $K \leq WML$ are chosen because it is assumed that it would be more efficient for black cash holders to target the “poorer” white cash holders to speedily exchange notes. The Table below shows, by WML , the percentage of persons with white money who are corruptible; and the total proportion of persons (or unique account holders) who need to be corrupt for black cash to clear.

³ Other distributions that may be appropriate for modeling black cash are the Double Pareto-Lognormal (Reed and Jorgensen, 2004) distribution and the Singh-Maddala (1976)

or Burr (1942) distribution. This is so, because the lognormal may fit the bulk of black cash and the power law may fit the tail (Chatterjee et al., 2016).

⁴ $Pr(Y \leq WML) \times E(WML - Y | Y \leq WML) > Pr(Y > WML) \times E(Y - WML | Y > WML)$. To evaluate these expressions see Aitchison and Brown (1957)

⁵ $Pr(Y \leq K) \div Pr(Y \leq WML)$

Table 1. Percent of law-abiding citizens who need to be corrupted for black cash to clear

<i>Metric</i>	<i>Values of Metrics (as WML varies)</i>							
<i>WML in INR (lakhs; a lakh is 100,000)</i>	<i>2.5</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>9</i>	<i>10</i>	<i>16</i>
Approximate* WML in USD	3,906	4,687	6,250	7,812	9,375	14,063	15,625	25,000
Probability that $Y > WML$ [i.e., $Pr(Y > WML)$]	10.5%	8.1%	5.1%	3.5%	2.5%	1.1%	0.9%	0.3%
Proportion of black cash (in value) ¹	27%	23%	17%	13%	11%	6%	5%	2%
K in INR	80,652	73,275	62,221	54,274	48,247	36,473	33,788	23,627
Proportion of corrupt persons needed in the set of persons with white cash for black cash to clear ²	57%	56%	53%	50%	46%	38%	36%	26%
Total proportion of corrupt persons**	74%	69%	61%	55%	50%	40%	37%	27%

* Using an exchange rate of 64 INR \approx 1 USD as of the first week in September 2017, for comparison. Computations are done in Matlab.

** The percent of corrupt white cash holders plus the percent of black cash holders (i.e., $Pr(Y \leq K) + Pr(Y > WML)$). Numbers are rounded.

¹ $Pr(Y > WML) \times E(Y - WML | Y > WML) \div [Pr(Y \leq WML) \times E(Y | Y \leq WML) + Pr(Y > WML) \times E(Y | Y > WML)]$

² Black cash clears when $Pr(Y \leq K \leq WML) \times E(K - Y | Y \leq K \leq WML) = Pr(Y > WML) \times E(Y - WML | Y > WML)$

The Table indicates that the opportunities for incentivizing law-abiding persons to be corrupt become feasible for *large* values of WML. For example, the switch from “law-abiding” to “corrupt” when WML is only INR 250,000 (or 2.5 lakhs, as it is called in India) would have to involve far too many persons (74%). Additionally, the logistics of a market for corruption, under the instantaneous shock from demonetization, would be overwhelmingly difficult, if not impossible, to formulate and sustain and avoid being caught. For black cash to clear at these levels, one has to institutionalize corruption. Press reports indicated that the Government expected about INR 3 trillion (i.e., about 19% of the INR 15.4 trillion in demonetized cash) not to return to the formal economy (Times of India, Jan. 5, 2017).

A study of corruption (Bertrand et al. 2007) in a simple matter like the issuance of drivers licenses in Delhi during 2004-2005 indicates a 62% corruption rate (i.e., getting licenses without knowing how to drive), but in the presence of corruption institutionalized with bureaucratic support. Thus, if only 62% (rather than closer to 100%) is the corruption rate under State collusion, it would be likely impossible to organize high corruption rates without State support. For example, to arrive at a corruption rate of about 62% in the Table, WML is about INR 400,000; and, at this WML level, the percent of black cash holdings is about 17%. If all of the black cash clears, then 53% of persons with white cash who were corrupted would have earned fees for legitimizing the black cash. That is, a “transfer of cash” would have taken place presumably at a price below what black cash holders would have had to pay in the formal economy (e.g., a 35-40% income tax rate)⁶. If this transfer had indeed

taken place, the purchasing power of the corrupted white cash holders would have marginally increased. However, the significant slowing of India’s GDP annual growth rate (Trading Economics Aug. 31, 2017) from about 7.5% to 5.7% since demonetization casts doubt on the credibility of this assumption. In contrast, the RBI (Mar. 2017) had dismissed economic sluggishness as a “transient” phenomenon.

Press reports (e.g., Times Now, Nov. 8, 2017) indicate that about INR 3.86 trillion (in 2.32 million accounts) of the INR 15.28 trillion deposited (i.e., 24%) are “suspicious” deposits. The Table indicates that this cash will clear if about 56% (when WML \approx INR 2.5 lakhs) of white cash holders can be corrupted. If true, the total corruption rate (\approx 69%) would call into question our model’s assumptions; in particular, the absence of State collusion. However, RBI data is needed to validate this by ruling out the possibility that corruption was confined to the roughly 8.1% (i.e., $Pr(Y > WML)$) of black cash holders; by their actions such as fudging receipts or opening dummy accounts (Money Control, Nov. 15, 2017). One can argue, that given the “fear of demonetization”, black cash holders have created a market that can, within minutes, be called upon to begin the exchange of demonetized notes. Could such a seemingly invisible market exist in India without bureaucratic support? The answer is likely “no”. This is not to say there is no corrupt accumulation of wealth in India. The Table simply indicates that holding black cash is a low probability situation and, thus, demonetization must disrupt the market and punish the innocent.

5. CONCLUSION

cash after demonetization, black cash holders may very well be at a disadvantage when it comes to incentivizing white cash holders to be corrupt. If black cash holders are rational agents, they would have anticipated (in a game theoretic sense) this problem and explored all means to avoid facing it.

⁶ Of course, it is possible that white cash holders susceptible to corruption may hold the black cash holders “at ransom” by demanding a fee that is higher than what would be demanded in the formal economy. Because of the severe penalties imposed, by the Government, for depositing black

On August 30, 2017, Reuters reported: "... Indians returned almost all of the estimated 15.4 trillion rupees (\$242 billion) in high-currency bills removed from circulation in a shock move late last year, the Reserve Bank of India (RBI) said in its annual report out on Wednesday. A total of 15.28 trillion rupees was returned to the RBI ..."

The Reuters report is consistent with the results of the thought experiment conducted in this paper. If State collusion is absent, the probability of black cash holdings must be small for all of it to clear after demonetization. The possibility that a high proportion of Indians, in their individual capacities (i.e., absent State support), are corrupt and acted as intermediaries to exchange black cash appears highly unlikely. Furthermore, the Reuters report indicates that the assumption made regarding the rationality of black cash holders is reasonable. What cannot be inferred from the Reuters report is the truth in the assumption regarding the absence of State collusion (or bureaucratic support) during demonetization. As of this writing, very little data on demonetization has been released by the RBI. If RBI data is released, the theory put forward in this paper can be empirically validated or shown to fail.

When RBI data becomes available, it may allow us to infer an answer to an important question: if the USD 100 note were to be demonetized⁷, following Rogoff, would black cash holders be caught? Another important question is: if demonetization were outlawed, would the theory put forward in this paper hold? That is, to what extent does the "fear of demonetization" drive black cash holders to follow the dictate of the SPP? If demonetization were outlawed now, the cost of storing, insuring (against loss), and foregoing the interest earnable on, the black cash would still remain. Thus, policies are needed to ensure that cost would be greater than the cost of keeping it in the formal economy.

It is hoped that this paper will discourage Governments from demonetizing their currencies.

REFERENCES

- Abdelal, R. (2003). Contested currency: Russia's rouble in domestic and international politics. *Journal of Communist Studies and Transition Politics*, 19(2), 55-76. <https://doi.org/10.1080/13523270300660011>
- Agarwal, S. (1988). *Dr. Sarvepalli Radhakrishnan - a commemorative volume*. Prentice-Hall of India, New Delhi.
- Aitchison, J., & Brown, J. A. C. (1957). *The Lognormal Distribution with special reference to its uses in econometrics*. Cambridge University Press.
- Andreoni, J. (1990). Impure altruism and donation to public goods: a theory of warm-glow giving. *The Economic Journal*, 100, 1447-1458. <https://doi.org/10.2307/2234133>
- Aryeetey, E. & Gockel, F. (1991). Mobilizing domestic resources for capital formation in Ghana. *African Economic Research Consortium Research Paper 3*, Nairobi.
- Aryeetey, E., Harrigan, J. & Nissanke, M. (2000). *Economic Reforms in Ghana - The Miracle and the Mirage*. Africa World Press.
- Balaji, K. C. & Balaji, K. (2017). A study on demonetization and its impact on cashless transactions. *International Journal of Advanced Scientific Research & Development*, 4(3), 58-64.
- Baruah, S. (2014). *Routine emergencies: India's armed forces special powers act in "Civil Wars in South Asia: State, Sovereignty, Development"* edited by Aparna Sundar and Nandini Sundar, Sage Publications, New Delhi. <https://doi.org/10.4135/9789351508052.n8>
- Bergstrom, T. C. (1995). On the evolution of altruistic ethical rules for siblings. *American Economic Review*, 85, 58-81.
- Bernoulli, D. (1738): "Exposition of a new theory on the measurement of risk", Translated to English and published in 1954 in *Econometrica*, 22(1), 23-36.
- Bertrand, M., Djankov, S., Hanna, R., & Mullainathan, S. (2007). Obtaining a Driver's License in India: An Experimental Approach to Studying Corruption. *Quarterly Journal of Economics*, 122(4), 1639-1676. <https://doi.org/10.1162/qjec.2007.122.4.1639>
- Burr, I. W. (1942). Cumulative frequency functions. *Annals of Mathematical Statistics*, 13(2), 215-232. <https://doi.org/10.1214/aoms/1177731607>
- Business Standard. (2016). One week after demonetisation announcement, crores of old currency notes burned, destroyed, dumped. Retrieved from http://www.business-standard.com/article/current-affairs/demonetisation-effect-one-week-after-announcement-crores-old-currency-notes-burned-destroyed-dumped-116111600335_1.html.
- Ceriani, L., & Verme, P. (2012): The origins of the Gini index: extracts from Variabilita e Mutabilita (1912) by Corrado Gini. *The Journal of Economic Inequality*, 10(3), 421-443. <https://doi.org/10.1007/s10888-011-9188-x>
- Chancel, L., & Piketty, T. (2017). Indian income inequality, 1922-2014: From British Raj to Billionaire Raj? *WID. world Working Paper Series 2017/11*.
- Chatterjee, A., Chakrabarti, A. S., Ghosh, A., Chakraborti, A., & Nandi, T. K. (2016). Invariant features of spatial inequality in consumption: The case of India. *Physica A*, 442, 169-181. <https://doi.org/10.1016/j.physa.2015.09.019>
- Choudhury, G. (2017). 15 cash ban villains: A doctor with Rs 11 cr in banned notes, jewellers fudging sales. *Money Control*. Retrieved from <http://www.moneycontrol.com/news/business/economy/15-cash-ban-villains-a-doctor-with-rs-11-cr-in-banned-notes-jewellers-fudging-sales-2439113.html>
- Constitution of India (1949). Article 50, Government of India. Retrieved from <https://www.india.gov.in/my-government/constitution-india>

⁷ The "fear of demonetization" is likely very low in the United States. Thus, a truer "test" of the applicability of the SPP to demonetization is possible.

19. Curry, O., Roberts, S. G. B., & Dunbar, R. I. M. (2013). Altruism in social networks: evidence for a kinship premium. *British Journal of Psychology*, 104(2), 283-295. <https://doi.org/10.1111/j.2044-8295.2012.02119.x>
20. Dreze, J., & Sen, A. K. (2013). *An Uncertain Glory - India and its contradictions*. Princeton University Press.
21. Foster, A. D., & Rosenzweig, M. R. (2001). Imperfect commitment, altruism, and the family: evidence from transfer behavior in low-income rural areas. *The Review of Economics and Statistics*, 83(3), 389-407. <https://doi.org/10.1162/00346530152480054>
22. Friedman, M. (1990). The Crime of 1873. *Journal of Political Economy*, 98(6), 1159-1194. <https://doi.org/10.1086/261730>
23. Gana, R. (2014). Does the St. Petersburg paradox cast doubt on the use of expected value theory to approximate the random present value of a life annuity? *Social Science Research Network*. Retrieved from www.ssrn.com/abstract=2586609.
24. Gana, R. (2016). Does the shadow of the St. Petersburg Paradox fall upon poverty indices? *Social Science Research Network*. Retrieved from www.ssrn.com/abstract=2830945.
25. Gana, R. (2017). Demonetization: Did India face the St. Petersburg paradox and fail? *Social Science Research Network*. Retrieved from <https://papers.ssrn.com/abstract=3040034>
26. Gibrat, R. (1931). *Les Inegalites economiques*, Paris. This is discussed in English by Sutton (1997). Gibrat postulated that there are things whose proportional rate of growth is independent of its size. This postulate results in a lognormal distribution.
27. Gini, C. (1912). *Variabilita e Mutabilita*. English translation and discussion in Ceriani and Verme (2012).
28. Gini, C. (1921). Measurement of inequality and incomes. *The Economic Journal*, 31, 124-126. <https://doi.org/10.2307/2223319>
29. Greenwald, B. C. & Stiglitz, J. E. (1986). Externalities in economies with imperfect information and incomplete markets. *Quarterly Journal of Economics*, 101(2), 229-264. <https://doi.org/10.2307/1891114>
30. Hayden, B. Y. & Platt, M. L. (2009). The mean, the median, and the St. Petersburg paradox. *Judgment and Decision Making*, 4(4), 256-273.
31. Jawed, S. (2017). *Demonetisation roll-out deeply flawed, introduction of Rs 2000 notes puzzling: Richard Thaler, Nobel Laureate*. Retrieved from <https://www.altnews.in/demonetisation-roll-deeply-flawed-introduction-rs-2000-notes-puzzling-richard-thaler-nobel-laureate/>
32. Jha, U.C. (2015). *Armed Forces Special Powers Act - A Draconian Law?* Vij Books India.
33. Keynes, J. M. (1919). *The Collected Writings of John Maynard Keynes (Vol. 1) - The Economic Consequences of the Peace*.
34. Mahapatra, R. (2017). Raghuram Rajan breaks silence, says neither he nor RBI under him wanted demonetization. *Hindustan Times*. Retrieved from <http://www.hindustantimes.com/india-news/raghuram-rajan-breaks-silence-says-he-wasnt-on-board-for-demonetisation/story-6rXr8VWBpFd4w37NySulEN.html>
35. Ministry of Finance (2012). *White Paper on Black Money, Department of Revenue and Central Board of Direct Taxes*, New Delhi.
36. Miyan, M. (2017). Statistical review of the demonetization in India. *International Journal of Advanced Research in Computer Science*, 8(5), 1891-1896.
37. Mukherjee, P. (2017). Farewell Speech. Parliament of India Retrieved from <http://pranabmukherjee.nic.in/sp230717.html>
38. Murty, V. (2017). Assembly elections 2017: Modi loses no money in demonetisation gamble. *Hindustan Times*. Retrieved from <http://www.hindustantimes.com/india-news/assembly-elections-2017-demonetisation-pays-rich-dividends-to-modi/story-WrAyZ648Va8jTl9aDSFsZJ.html>
39. Nehru, J. (1946). *The Discovery of India*.
40. Nehru, J. (1954). *Will and Testament*, Nehru Memorial Museum and Library, New Delhi, India.
41. Neumann, J. von, & Morgenstern, O. (1952). *The Theory of Games and Economic Behavior*.
42. New York Times (2017). *The Cost of India's Man-Made Currency Crisis*. Retrieved from <https://www.nytimes.com/2017/01/09/opinion/the-cost-of-indias-man-made-currency-crisis.html>
43. Pew Research Center (2017). *Three Years in, Modi Remains Very Popular*.
44. Press Information Bureau, Government of India (2016). *CWC report on the issue of shutter breakdown at Krishnagiri dam on river Ponnaiyaru (South Pennar) in Krishnagiri district of Tamilnadu*. Retrieved from <http://pib.nic.in/newsite/erelease.aspx>
45. Radhakrishnan, S. (1953). *The Principal Upanisads*.
46. Radhakrishnan, S., & Moore, C. A. (1967). *A Source Book in Indian Philosophy*.
47. Rajagopal, K. (2017). Centre's 'no' to SC appeal on old notes. *The Hindu*. Retrieved from: <http://www.thehindu.com/todays-paper/centres-no-to-sc-appeal-on-old-notes/article19299106.ece>
48. Rawls, J. (1971). *A Theory of Justice*.
49. Rawls, J. (2001). *Justice as Fairness - A Restatement*.
50. Reed, W. J., & Jorgensen, M. (2004). The Double Pareto-Lognormal distribution - a new parametric model for size distributions. *Communications in Statistics - Theory and Methods*, 33(8), 1733-1753. <https://doi.org/10.1081/STA-120037438>
51. Reserve Bank of India (2017). *Annual Report 2016-2017*.
52. Reserve Bank of India (2017). *Macroeconomic Impact of Demonetization - A Preliminary Assessment*. Retrieved from <https://rbi.org.in/>
53. Reserve Bank of India Act (1934). Retrieved from <https://rbi.org.in/>
54. Rogoff, C. M. (2014). *Costs and benefits to phasing out paper currency*, NBER Macroeconomics Annual Conference paper.
55. Sarkar, S. (2010). *The parallel economy in India: causes, impacts and government initiatives*.

- Economic Journal of Development Issues*, 11-12(1-2), 124-134.
56. Sen, A. K. (1987). On Ethics and Economics.
57. Sen, A. K. (1991). On Indexing Primary Goods and Capabilities, mimeographed, Harvard University.
58. Sen, A. K. (2009). The Idea of Justice.
59. Simon, H. A. (1992). Altruism and economics. *Eastern Economic Journal*, 18(1), 73-83.
60. Singh, S. & Maddala, G. S. (1976). A function for the size distribution of incomes. *Econometrica*, 44(5), 963-970. <https://doi.org/10.2307/1911538>
61. Siva, G. (2016). Baby dies as parents had no cash to buy medicines in Vizag. *Times of India*. Retrieved from <https://timesofindia.indiatimes.com/city/visakhapatnam/Baby-dies-as-parents-had-no-cash-to-buy-medicines-in-Vizag/articleshow/55408981.cms>
62. Slonim, R., Wang, C., & Garbarino, E. (2014). The market for blood. *Journal of Economic Perspectives*, 28(2), 177-196. <https://doi.org/10.1257/jep.28.2.177>.
63. Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*, 1976 reprint.
64. Smith, A. (1790). *The Theory of Moral Sentiments*, *Economic Classics* (published in 2013).
65. Steinberg, D. (2013). *Burma/Myanmar - what everyone needs to know*. Oxford University Press.
66. Stigler, G. J. (1981). *Economics or ethics?* in S. McMurrin's Tanner Lectures on Human Values, volume II.
67. Tagore, R. (1916). *Ghare Baire*, translated from Bengali into English by Surendranath Tagore with the title "The Home and the World".
68. Times Now (2017). One year of Demonetisation: 2.32 mn suspicious bank accounts under scanner, says Gadkari. Retrieved from <http://www.timesnownews.com/business-economy/article/one-year-of-demonetisation-232-mn-suspicious-bank-accounts-under-scanner-says-gadkari/120969>
69. Times of India (2016). 96-year-old dies while waiting in bank queue. Retrieved from <https://timesofindia.indiatimes.com/city/bengaluru/Demonetisation-effect-Nonagenarian-collapses-while-waiting-in-line-at-a-bank-in-Udupi/articleshow/55393449.cms>
70. Times of India (2017). 97% of scrapped notes deposited with banks as on Dec 30: Report. Retrieved from <https://timesofindia.indiatimes.com/toi-features/business/97-of-scrapped-notes-deposited-with-banks-as-on-dec-30-report/articleshow/56344692.cms>
71. Trading Economics (2017). India GDP Annual Growth Rate. Retrieved from <https://trading-economics.com/india/gdp-growth-annual>
72. Veerakumar, K. (2017). A study of people impact on demonetization. *International Journal of Interdisciplinary Research in Arts and Humanities*, 2(1), 9-12.
73. Venkatesh, M. & Ray, R. K. (2017). Demonetisation will have positive impact on Indian economy, says World Bank CEO. *Hindustan Times*. Retrieved from <http://www.hindustantimes.com/business-news/modi-s-demonetisation-move-will-positively-impact-economy-world-bank-ceo/story-8Khb9U8UHOoEXoi75vyDfl.html>
74. Vora, P. (2017). A year after demonetisation, a mother mourns a baby because a hospital refused her old notes. *Quartz India*. Retrieved from <https://qz.com/1124883/a-year-after-demonetisation-a-mother-mourns-her-baby-who-died-after-hospital-refused-to-accept-old-notes/>
75. White, M. V., & Schuler, K. (2009). Who said "debauch the currency": Keynes or Lenin? *Journal of Economic Perspectives*, 23(2), 213-222. <https://doi.org/10.1257/jep.23.2.213>