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The "Modi Effect": Investigating the Effect of Demonetization on Currency Demand and the Size of the Underground Economy in India

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Abstract

Demonetization is an economic tool used to reduce the size of an underground economy. Though studies on the effectiveness of demonetization have increased over the past 50 years, there is little literature on the ineffectiveness of demonetization and subsequent factors that could explain a lack of change, or an increase, in illegal activity. This paper examines past cases of demonetization to determine the effectiveness of demonetization, and investigates the incentive for foreign currency substitution as a mechanism for criminals to circumvent regulatory scrutiny. Major findings of this paper include a positive but statistically insignificant correlation between demonetization and growth in the shadow economy, and a statistically significant positive relationship between exchange rate appreciation and demonetization. Finally, this paper applies these findings to test the "Modi effect" of Indian Rupee (INR) demonetization.

Keywords: Demonetization, Underground Economy, India, Currency Substitution

I.   Introduction

Demonetization is the retraction of specific currency denominations in circulation and the subsequent replacement with new notes and coins. Initially, demonetization took the form of replacing an existing currency with a new one, and was enacted to mitigate cases of hyperinflation or to reduce large-denomination cash in circulation. Over time, governments have extended the objectives of demonetizing local currency to address the menaces of the underground economy[1] - of black money, activity, corruption, and counterfeit production.

Demonetization is a powerful policy tool for reducing the size of the underground economy. The underground economy hinges on cash transactions. 95% of transactions in the underground economy are executed using cash. The benefit of a cash payment is the "hidden" component of the transaction – that is, the parties involved are not obligated to report the transaction officially. Given the difficulty of monitoring transactions in cash, promoting alternative payment methods, and reducing the demand for cash, could help to reduce the incidence of shadow economies. Thus, a tool like demonetization to replace existing currency can be utilized to reduce the prevalence and reliance on cash by making it inconvenient to obtain cash. As a result, more individuals are pushed into the formal banking sector which requires official documentation of transactions. Furthermore, nullifying the value of certain denominations of currency will bring forth "black marketeers" who will need to exchange their existing notes for new notes, and will consequently turn in their black money to be formally documented and destroyed. The

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[1] In this thesis, the underground economy is also referred to as the shadow economy, black economy and informal economy.

origin of these notes would be documented and withdrawn from circulation, thereby reducing the supply of black money in the economy.

Demonetization thus subjects individuals who hold black money to regulatory scrutiny, as they are forced to exchange existing notes for new legal tender at state banks that document the origins of currency. Consequently, heightened regulation makes it more difficult for individuals to engage in the underground economy. However, there could be ways to circumvent such regulation imposed by demonetization, such as through currency substitution. The theory behind this is that if demonetization has an effect on exchange rates, individuals could be incentivized to substitute locally demonetized currency with new or foreign forms of currency, which would keep the quantity of money in circulation unchanged, and even increase, illegal transactions and activity. Furthermore, regulatory barriers imposed by demonetization could incentivize people to look to international currency markets and substitute existing currency with foreign currency. This brings into question the overall effectiveness of demonetization in reducing black market activity.

An argument can be made against the effectiveness of demonetization in reducing black market activity. For one, many countries do not formally monitor and document the transfer of old currency to new when such policies have been executed. As a result, reducing the size of the underground economy can be a difficult, and impractical, endeavor. Many economists have explored factors that contribute to the incidence of an underground economy. However, few studies have examined the success of demonetization in reducing the size of the informal economy and factors, such as currency substitution, that could explain any failures of demonetization in reducing the size of the underground economy.

Several examples reveal successes and failures of demonetization. A success story pertains to the case of the Nigerian Naira. In 1984, the Naira was demonetized, whereby the government changed the color of all currency notes in circulation. The objective of this policy was to monitor currency in circulation within and outside the country, with the hope that a formal re-issuing and withdrawal system would encourage participation in the banking sector. This forced currency hoarders to exchange old notes for new legal tender at banks which documented currency that had been undocumented. Despite the negative impact on inflation and the economy, it was an instant success in reviving the banking industry and ceasing currency hoarding. An example of a failure occurred when specific denominations of the Myanmar Kyat were demonetized in 1985 with the aim of curbing illegal transactions in the informal economy. A cash floor was declared whereby those holding cash above the limit could exchange existing notes for new legal tender notes within a fixed time period. Black-market participants, however, were able to avoid the regulatory scrutiny by using proxies to exchange their money and evade being caught.

In 2002, the European Union (EU) replaced 19 local currencies with the introduction of the Euro. In this case, during the currency transition period[2], EU central banks were required to document the outflow of Euros and inflow of local currency. This form of monitoring was enacted to force holders of large amounts of local demonetized currency to document its origins. Member states were given between January 1 and February 28 to comply. This transitionary period allowed for a smoother transition to the Euro. The limit on the amount of cash that could be exchanged for Euros varied across

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[2] The currency transition period lasted from 1 January 2002 to 28 February 2002. During this time, local EU member currencies and the Euro were considered legal tender. On 28 February 2002, all local currencies were demonetized.

member states. In Germany, Greece, Luxembourg, and Spain, banks allowed people to exchange unlimited amounts of cash at a set rate. Italy, Ireland, and Austria had cash exchange ceilings of €516, €3633, and €635 per person.[3] These controls allowed for monitoring deposits and withdrawals of old currency and new Euros. In effect, deposits of black money into banks allowed the government to retract these notes from circulation, and there was an expected reduction in the size of underground economies.[4]

The lack of a formal monitoring system during a currency transition period can sometimes increase the size of an underground economy. In 1978, the Indian government enacted the High Denomination Bank Notes Act, which voided Indian Rupee (INR) 1000, INR 5000 and INR 10000 notes. The expectation of completely destroying the black economy, at that time 15% of GDP, was ambitious, and instead, the size of the underground economy increased by 18%.[5] This was due to the lack of a strong and austere monitoring system of retracting existing currency that could keep up with the rate of issuance of new currency.

Now, India's shadow economy is 46% of the country's GDP.[6] India's economy is driven by cash, and more specifically, the role of high-value bank notes is significant. More importantly, the underground economy runs on cash which fuels incentive to evade taxes and scrutiny on transactions that are illegal. On November 8, 2016, Indian Prime Minister

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[3]For more information on cash exchange limits, see
https://www.ecb.europa.eu/pub/pdf/other/cashchangeoverreport2002en.pdf
[4] The size of the underground economy in the Euro-19 is examined from the period of 1998-2015 in the latter half of this paper.
[5] For more information on the 1978 case of INR demonetization, see
http://timesofindia.indiatimes.com/city/mumbai/1978-demonetisation-law-was-not-unreasonable-SC-had-ruled/articleshow/55391335.cms
[6] Shadow economy estimate taken from https://www.bloomberg.com/news/articles/2016-12-19/modi-s-holy-city-shows-a-1-trillion-hidden-economy-has-stalled

Narendra Modi launched a movement to demonetize INR 500 and INR 1000 currency notes with the aim of tackling counterfeit, corruption, and black market activity. In place of existing INR 500 and INR 1000 notes, Prime Minister Modi announced the creation of new INR 500 and INR 2000 notes. The move has undoubtedly captured some of the illegal cash in circulation, as illegal notes are turned in to banks to be exchanged for legal tender notes and are therefore withdrawn from circulation. The Modi government has used evidence of India's expedient growth rate of 7% in Q4 2016 to illustrate the positive result of demonetization.[7] Moreover, the administration attributes GDP growth to the abrogation of these notes that the black market is centered on.

The reality, however, is not as simple as a GDP growth figure. It is important to consider the real effectiveness of demonetization as a tool given its associated costs and impact on an economy. By nullifying 86% of the cash in circulation, Modi's currency reform has severely impacted a significant portion of the population. Namely, low-income and middle class households have been hit hard, as these classes use denominations of INR 500 and INR 1000 in daily transactions. A 50-day redemption period was set for people to exchange notes at banks before the value of existing notes disappeared, which caused millions of people to rush to banks, ATMs, and foreign exchange counters to exchange their cash.[8] Moreover, with an estimated population of 600 million unbanked Indians, and a scarcity of ATMs throughout the country, long-term effects of

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[7] For more information on the impact of INR demonetization, refer to
https://economics.rabobank.com/publications/2017/march/india-where-is-the-negative-impact-of-demonetization/.

[8] For more information on the redemption period, see
https://www.forbes.com/sites/wadeshepard/2016/12/10/indias-central-bank-denied-its-big-payday-as-demonetization-flops/#6892b97e5494

demonetization appear bleak. The scramble to exchange existing notes for new notes from state banks continues to be an issue. Prime Minister Modi believed that forcing people to exchange existing currency for new legal tender at banks or official ATM machines would subject participants of the black market to regulatory scrutiny, and as a result, reduce the size of the underground economy. If a person wishes to exchange more than INR 250,000, they must have suitable reasons as to why they are holding case in such large denominations. Subjecting people to this sort of regulatory scrutiny is a disincentive for cash hoarding, which could reduce the incidence of a shadow economy. However, these stringent policies for exchanging old note for new notes have presented an obstacle for a smooth transition instead, especially given the shortage of new notes to supplement existing nullified notes. The run on cash could be drawn out if the government does not take steps to print new notes to supplement all existing, void ones in circulation. Additionally, with the majority of cash in circulation ceasing to be legal tender, economic growth could plummet, and there is speculation of currency depreciation as investors are incentivized to substitute foreign, stronger currencies. However, these costs are sometimes necessary in the short-run to guarantee a reduction of the informal economy in the long-run after exchange rate recovery. Otherwise, demonetization could fail to significantly reduce the size of the black economy, as currency substitution or continued hoarding of new notes will sustain the size of this economy. Thus, the objective of this thesis is to investigate Prime Minister Modi's theory behind demonetization and to examine any incentives for foreign currency substitution to avoid regulatory scrutiny during local currency demonetization.

To test this theory, it is important to first examine whether demonetization reduces the size of the underground economy. Data on the underground economy is hard to collect due to the hidden nature of transactions in the underground economy. In this thesis, I will examine various factors that affect the size of the underground economy, and the impact of demonetization on its size. This will be accomplished through a panel regression analysis with fixed effects. I investigate the case of 2002 "Euroization" and consequent demonetization of 19 member state currencies using a panel regression with fixed effects from 1998-2015. The Euro is a viable case study for three reasons. For one, the European Central Bank (ECB) required all national central banks to provide issuance and collection information on local currencies and the Euro banknote on a daily basis. Monitoring the exchange of currency during the transition period was a concern, given that many individuals held local currency abroad which complicated the exchange process. However, the efficiency and preparedness of the ECB for the conversion period prevented any shortages of currency and misreporting of exchanges. Additionally, the limited transition period of 2 months prevented any possibility of converting hoarded cash to Euros in small deposits. As a result, this allowed for further success in eliminating recurring circulation of black money.

To understand any incentive for currency substitution to avoid the formal banking sector, I will examine the effect of demonetization on exchange rates to examine the motivation for foreign currency substitution in the informal sector. This analysis will be conducted through a series of multivariate regressions for different episodes of demonetization in 3 different countries. For the purpose of this thesis, I narrow the

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definition of demonetization to be the reissuing of notes of a specific currency, and/or the nullification of existing currency.

This thesis proceeds as follows. First, I provide background information on the framework and ideas that motivate the intent of this thesis. I incorporate past quantitative and qualitative literature on the subject matter in order to motivate my empirical analysis that follows after. The background section of this thesis focuses on three key themes: the study of the informal economy, the impact of exchange rate fluctuations on underground economy currency demand, and key cases of large-denomination demonetization. Following this, I outline my hypothesis, data, and methodology, and conclude with an analysis of the empirical results.

II.   Background

A. Understanding the Underground Economy

It is important to study the impact of demonetization on the underground economy. The underground economy runs on illegal money, which effectively means any form of income that has escaped taxation. Currency used in the underground economy is termed "black money" because of its role in an illegal, or "black", transactions. Illegal activities that take place in the underground economy include bribery, drug trafficking, prostitution, and fraud. Also termed the shadow economy, it includes not only illegal activity but also unreported income for the purpose of tax evasion. Activities in the shadow economy rely on physical cash, as transactions in the underground economy are typically settled with

cash to evade tracing, as well as the "store of value" appeal that encourages currency hoarding.

Demonetization has evolved as a tool to reduce the incidence of the illegal activities conducted in the underground economy, given that the majority of black market transactions are executed in cash. To understand the effectiveness of demonetization, it is crucial to examine the evolution of the underground economy during a period of demonetization. Estimating the size of the shadow economy is a difficult endeavor due to the difficulty of tracing transactions hidden from the official economy. However, economists have identified several ways to best estimate the underground economy. When analyzing the effect of demonetization, it is imperative to look at cases where the underground economy was successfully reduced, and where it was not. Furthermore, it is important to understand any incentive for foreign currency substitution during demonetization in order to circumvent exchanging cash at banks and being subjected to regulatory scrutiny. This can be achieved through examining exchange rates.

B. Exchange Rates, Currency Demand, and the Size of the Underground Economy

As explained by Feige (2003), "cash stocks and flows are a natural starting point in the search for knowledge concerning the underground economy...since the production and distribution of currency by the government is strictly monitored and carefully recorded." The quantity of currency in circulation can impact exchange rates and demand for currency. Thus, in testing Prime Minister Modi's theory of the effectiveness of demonetization, it is important to understand the relationship between demonetization, the money supply, and exchange rates. Traditionally, demonetization causes a contraction in the money supply.

This occurs when specific denominations of currency are nullified and withdrawn from the economy, thereby reducing the quantity of cash in circulation. When the quantity of cash in circulation is reduced, the value of one unit of a local currency increases, incentivizing individuals to hold onto it. In contrast, when a local currency depreciates, people may look to stronger foreign currencies as a substitute. This form of de facto currency substitution can take place in the informal and formal economy. According to Feige (2003), de facto currency demand arises as a result of a loss of confidence in the domestic currency due to currency devaluations, as foreign currency is usually the preferred medium of exchange for illegal transactions. Thus, an increase in the demand for foreign currency after an episode of demonetization can incentivize black marketeers to use foreign currency, leaving the size of the black market unchanged.

In cases of demonetization where a new currency is introduced and an existing currency is demonetized, people are incentivized to convert to the new currency as existing currency is no longer legal tender, and the new currency appreciates in value due to the increase in the money supply. Similarly, in cases where denominations of notes are nullified, the reduction in the quantity of money causes an appreciation of the currency and will also encourage people to hold on. In the case of India, the INR remained the local currency, but INR 1000 notes were completely voided, and therefore withdrawn from circulation, thereby decreasing the money supply. In its place, INR 2000 notes were issued. An immediate appreciation of the INR against the US Dollar followed this policy change. However, despite currency appreciation, and given the difficulty of obtaining these new denominations of legal tender, there may have been incentive to substitute INR with other foreign currency. This would have allowed for the continuation of black market

transactions. The only difference would be the currency used to execute such transactions, thus leaving the size of the informal economy unchanged.

Understanding the relationship between exchange rates, currency demand, and the underground economy can provide additional insight into the case and effects of Prime Minister Modi's INR demonetization in India. If exchange rate fluctuation encourages currency substitution, a case can be made for the stagnation of the size of an underground economy. Hellersten and Ryan (2011) found that 2002 "Euroization" resulted in a surge in demand for the Euro instead of Dollars. They cite Stix (2007), who examined currency demand in Croatia, Slovenia, and Slovakia, and found that more households held Euros. Additionally, they found a weak relationship between the size of the informal economy and currency flows. Their findings specifically indicate that a 1-percent higher level of underground activity results in a 1-percent higher level of banknote flows. Thus, there appears to be a unit elastic increase in dollar use with every percent increase in underground economy activity. This indicates that an increase in the demand for dollars is a reflection of the success of demonetization in incentivizing the use of foreign currency, but does not necessarily change the size of the black market economy.

One of the earliest studies of the underground economy was by Phillip Cagan (1958), who proposed the currency ratio method in 1958 as a form of sizing an informal economy. His analysis of currency flows during and after World War I and II showed that black market activity increases the demand for currency - between 1940-45 the share of twenty dollar bills of and over surged from 49 to 60% of the total value of the currency. The currency demand method was furthered by Tanzi (1983), who argued that measuring total currency in circulation would lead to an estimate of the underground economy.

Additionally, black market rates could be beneficial in examining demand of currency in the underground economy, as black marketeers may rely on these rates as opposed to official rates. For example, Btejer (1978) examined the effects of black market exchange rate expectations on the domestic demand for money in Brazil, Chile, and Columbia. He found that a depreciation in the black market exchange rate decreases demand for currency and as a result, decreases local money supply. A decrease in money demand in the underground economy could reflect a decrease in its size.

A consideration of the multi-faceted relationship between exchange rates, currency demand, and the shadow economy is beneficial in assessing the net impact of Modi's demonetization. Currency exchange restrictions could result in a shortage of local or foreign currency which provides an opportunity for black market arbitrage. More recently, the INR has depreciated with respect to the US Dollar, due to a reduction in foreign-exchange holdings by the central bank. Given that the local currency was not replaced with a new one, currency depreciation could explain an unchanged underground economy in the future despite currency demonetization, as depreciation in the INR could just encourage foreign currency substitution and an overall unchanged volume of black cash in circulation.

C. The Effect of Demonetization on the Size of the Underground Economy

The main objectives of demonetization are to combat inflation, corruption, and unreported income. In India, Prime Minister Modi had a vision to completely destroy the underground economy through demonetization. The size of the informal economy in India is large. In 2010, according to Schneider et al. (2010), the estimated size of the shadow economy in India is 19% of its GDP. Now, it is almost 50% of its GDP. This is due to the large creation of informal jobs, further propagated by expansion in industries like

construction, textiles, and retail. Additionally, asset hoarding, in the form of real estate, jewelry, or assets stashed abroad, cater to the large presence of underground activity.[9] In India, 98% of transactions are completed in cash. Given that a large amount of transactions are cash-based in the underground economy, eliminating high-denomination notes could help curtail illegal transactions. Additionally, the underground economy is driven by tax evasion, as it is a massive lost tax haven since those engaged in this parallel economy misreport or do not report their income in order to evade income tax.

 Demonetization succeeds when a strong regulatory system in banks is implemented to document the origins of cash and income. In the case of Prime Minister Modi's INR demonetization program in 2016, it is vital to examine the effect of demonetization in forcing people into the banking sector, and consequently, subjecting them to regulatory scrutiny. Prime Minister Modi retracted INR 500 and INR 1000 notes and replaced them with new INR 500 and INR 2000 notes. 47.8% of all notes were in denominations of INR 500, and INR 1000 notes accounted for 38.6%. A "cleaning" of black money through demonetization as enacted by Prime Minister Modi has required the exchange of INR 500 and 1000 notes via official banks. This has forced people to go through the formal banking system in order to obtain legal tender notes. As a result, unreported income is documented and therefore taxable. Through forcing people under regulatory scrutiny, Prime Minister Modi predicted a sharp retraction of black money in circulation. As Prime Minister Modi argues, demonetization complements the country's Swachh Bharat Abhiyan, or Clean India Campaign, a campaign that envisions a clean and hygienic India. As Modi stated on

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[9] For more information on what constitutes the underground economy, see
http://www.nipfp.org.in/media/medialibrary/2016/12/WP_2016_184.pdf

November 8, 2016, "to break the grip of corruption and black money, we have decided that the currency notes presently in use will no longer be legal tender from midnight tonight", with the Finance Minister Arun Jaitley claiming that "the goal of this is to clean transactions, [to] clean money."[10]

It is crucial to ensure the success of demonetization given the immense costs. In India, the economic costs have been extreme. Retail markets have been largely affected throughout the country. For example, in the retail sector, Hindustan Unilever Limited, a subsidiary of Unilever, saw its sales fall 1.2 % between October and December.[11] This has been exacerbated by the volatility of government policy on ATM exchange limits. Initially, the exchange limit had been imposed as INR 4,000 per person per day. This increased to INR4,500 per person per day one week after Modi's announcement, and then fell to INR 2,000 the week after. Shortly after, people were forced to exchange their cash at banks once the government halted over-the-counter exchanges of notes altogether.[12] The limited options of exchanging currency has resulted in a widespread cash crunch, where consumers are coping with never-ending lines outside banks due to empty ATM machines. This has significantly affected segments of the population that remain unbanked. Several factors, such as regulatory constraints, high banking fees, and lack of accessibility to banks, explain the prevalence of an unbanked population that continue to rely on physical cash for day-to-day transactions.

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[10] For more information, see http://knowledge.wharton.upenn.edu/article/demonetization-india-will-pay-price/.

[11] Impact on Hindustan Unilever: http://www.forbesindia.com/article/q3-earnings-2017/volume-growth-at-hul-stalls/45537/1

[12] For more information on cash exchange limits in India, see http://www.washingtontimes.com/news/2017/jan/4/indias-rupee-demonetization-policy-creates-cash-cr/

Similarly, the transition to the Euro in 2002 was in actual fact not wholly smooth. Shortly after the introduction, output and productivity growth slumped. Meanwhile, uneven inflation and labor costs resulted in a lack of competitive edge in some member states, given the need to adjust to the new unionized currency. Other past cases of demonetization are the 1984 demonetization of the Nigerian Naira, and the 1985 demonetization of specific denominations of the Myanmar Kyat. These cases will be discussed later.

I. European Union and the Euro

The introduction of the Euro in 2002, and the consequent demonetization of local EU member currencies during the transition period, is important to examine in order to understand the effect of demonetization on the size of an underground economy. Investigating the transition period from 1 January 2002 to 28 February 2002, and the years thereafter can aid an exploration into the effectiveness of demonetization on the size of the underground economy. By examining various factors that affect the underground economy during demonetization, we can explore the effect of Euro adoption on the size of EU underground economies, which can shed light on whether Prime Minister Modi's theory of demonetization and if the reducing effect on the underground economy holds true.

On January 1, 1999, the European Union (EU) introduced the Euro as a standard, unionized form of currency for EU member states. In its first 3 years of existence, the Euro was utilized for accounting purposes and acted as an invisible currency. Euro notes and coins were only introduced on 1 January 2002, which marked the beginning of the transitional period for EU countries. By February 28, 2002, all of the Euro-19 members

were required to adopt the Euro as a national currency, thereby demonetizing the existing local currency available in each country.

Since its introduction, the Euro has been in high demand. As the years have passed, there has been a gradual increase in the number of banknotes in circulation. According to the European Central Bank, "cash is by far the most widely used means of payment for retail transactions in the euro area in terms of number of transactions."[13] Following Euro adoption, the Euro area saw a growth rate of cash demand of over 10%, and more specifically, with demand for 500 Euro notes skyrocketing at a growth rate of 20%.[14] Moreover, as Figure 1 in my Appendix illustrates, the growth rate of cash usage and the growth of shadow economy proportionally increased immediately after the introduction of the Euro in 2002. This provides evidence for a correlation between the cash supply and the size of the underground economy. Thus, a reduction in the money supply through demonetization would intuitively reduce the size of the underground economy. This relationship should be considered in testing Prime Minister Modi's theory, given that his policy called for demonetization of 86% of the money supply.

In many EU member states, the size of the underground economy was significant. According to an ECB report, during this period, roughly half the circulating €50 notes were hoarded cash, and 40% of total cash was held as a store of value.[15] In 2002, the self-liquidating nature of local currencies incentivized higher spending of currency, thereby

reducing the appeal of hoarding. This could have further encouraged those holding cash to put hoards in banks given the loss of value of the cash in possession.

Having said that, there are ways in which individuals can side-step exchanging cash via the formal banking sector. For example, an examination of the effect of demonetization on exchange rates could explain motives for currency substitution through international markets. In turn, this would allow us to explore any changes to the size of the underground economy post-demonetization that can be attributed to foreign currency substitution, thereby either keeping the volume of cash in circulation unchanged or causing an increase. We can draw this conclusion from cash in circulation on the basis that 95% of transactions in the underground economy are cash-based.

It is important to additionally consider the exchange policy in the case of the Euro. The transitional, dual circulation period in which local European currencies and the Euro were considered legal tender was between 1 January, 2002 and February 28, 2002. On 28 February, 2002, all local European currencies were nullified, and the Euro was the only official legal currency. The process of banknote and coin conversion was facilitated through three channels public will receive banknotes and coins from three main channels. ATMs dispensed 20 and 50 Euro notes, while banks supplied larger denominations of notes. Additionally, coins would be exchanged through in-store transactions. Local currencies were removed from circulation when they are used for payment or taken to banks for deposit during the transitional period.[16] By 4 January 2002, 80 % of ATMs were dispensing solely Euros. Shortly after the announcement on 1 January, people scrambled

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[16] For more information, see http://ec.europa.eu/avservices/avs/files/euro/092-euro-fi/plan_for_adoption.pdf

to exchange existing currency for Euros, resulting in a large-scale cash run and a surge in ATM queues.[17] Thus, the dates of interest when analyzing the case of the Euro are 1 January 2002, and 28 February 2002.

The relevance of this case study in understanding the effect of Modi's INR demonetization is multifold. A panel regression reveals the effect of various contributing variables on the size of the underground economy over a fixed time period. This allows us to understand possible factors that influence the size of the underground economy which we can extrapolate to the India case. More importantly, adoption of the Euro by member countries and the effect of this on the size of the underground economy is an important metric. This shows whether adoption of a new currency, and demonetization of an old currency, has any significant effect in reduces the size of the underground economy. We can use these results to further understand the outcome of Indian demonetization.

II.   Nigeria and the Naira

Examining the case of the Naira is value-adding to an analysis of demonetization and the underground economy. Naira demonetization was similar in nature to that of the case in India because the local currency was not replaced but rather the appearance of certain notes was changed. In April 1984, General Buhari launched a demonetization of the Nigerian Naira and ordered the change of the color of the notes in circulation. No new currency denominations were introduced. The 20 Naira note was changed from yellow to green, while the 5 Naira note was changed from green to pink. Additionally, the 10 note

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[17] See http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=cellar:bb43afaa-4203-45a2-be1d-abc1e22c58cf

was changed from pink to red while the 1 Naira note, which was red was changed to yellow.[18]

This move of demonetization was propelled by the objective of deterring corrupt officials and businessmen from hoarding large amounts of cash or engaging in illegal cash-based transactions. As people were forced to exchange existing notes for new notes at official banks, currency in circulation that had been unaccounted for emerged, and counterfeit currency was eliminated.

While the move resulted in a significant reduction in the underground economy, regulatory scrutiny could have encouraged people to simply replace existing currency with foreign currency. Therefore, it is important to consider incentives for currency substitution and the continued prevalence of shadow activity. Extending the analysis further, an examination of exchange rate patterns centered on the event of demonetization in 1984 would allow for an analysis of the impact of demonetization on exchange rates. Exchange rate fluctuations can explain currency demand patterns. Given the volatility of the Naira during this time, there can be a case made for currency substitution incentive. With the depreciation of the Naira following demonetization, individuals could have been incentivized to acquire stronger, more stable foreign currency as a more reliable store of value. Furthermore, a strong, stable currency would allow minimization of any losses in a transaction. Finally, given that 95% of transactions in the underground economy are cash-based, possessing a strong form of currency is vital for profitability. We can use the results

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[18] 1984 Nigerian Naira demonetization:
http://dspace.africaportal.org/jspui/bitstream/123456789/32390/1/RP55.pdf?1

from this study to understand potential for any currency substitution in the underground economy, and whether this is a fair consideration for future impact in India.

III.   Myanmar and the Kyat

The case of Kyat demonetization is also important to consider in exploring the effectiveness of demonetization in reducing the incidence of the underground economy. On November 4, 1985, the Myanmar government devalued all 20, 25, and 100 Kyat notes without warning, and introduced new 75 Kyat notes in limited quantity. The transition period for exchanging notes, as well as the number of new notes available for exchange, was extremely limited. The demonetization regime was launched in an effort to decrease the money supply, reduce inflation, and identify corrupt, illegal individuals who were hoarding large amounts of currency.[19] As Than (1987) writes, the objective of this demonetization episode, which affected 80% of the money supply, was "to uncover black money in the hands of money hoarders who are hindering socialist economic construction". The result of this move was unsuccessful, as participants of the black market found ways to avoid regulatory scrutiny through using proxies to exchange cash in different amounts at banks, thereby allowing them to continue engaging in black market activity.

The Myanmar Kyat demonetization resembles the recent episode in India, whereby certain denominations of notes were extracted from circulation and replaced with new notes. The result of this case forces us to turn to other factors that explain why the size of the informal economy remained unchanged. An analysis of exchange rate patterns around

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[19] 1985 Kyat demonetization:
http://calhoun.nps.edu/bitstream/handle/10945/48478/16Mar_Stein_Pamela.pdf?sequence=1

the time of the event would be beneficial to consider in understanding the impact of demonetization of this kind on exchange rates. Furthermore, I extend my analysis to analyze the incentive for foreign currency substitution in the case of exchange rate depreciation. This is especially important to consider in light of the limited exchange period during demonetization, as this could have incentivized a move towards foreign currency substitution. Similar to the case of Nigeria, we can apply these findings to test Prime Minister Modi's theory, and determine if there is any scope for currency substitution in the underground economy in the future in India, and whether this would leave the size of the underground economy unchanged.

In the next section, I will outline my hypothesis and then outline the methodology and data of my empirical studies.

III.   Hypothesis

The size of the underground economy is largely affected by several independent variables, and specifically, inflation, income tax, unemployment, interest rates, corruption, and GDP growth. Demonetization should have a decreasing effect on the size of an underground economy, given that the supply of money reduces. This hinges on the strength of monitoring systems and regulatory scrutiny in the formal banking sector that would require black market participants to turn money in. With respect to INR demonetization, the inconvenience and difficulty of exchanging cash through the formal banking sector could impede the effectiveness of demonetization, thus leaving the underground economy

remains unchanged. Thus, there could be incentive to look to foreign currency substitution as an alternative to continue executing illegal transactions.

I predict that in the case of an unchanged or growing size of an underground economy, there is much that can be explained by the incentive to substitute currency as a result of the effect of demonetization on exchange rates.

IV.   Data Sources

A.   Panel Regression Data

The panel regression includes all Euro-19 countries from 1998-2015, totaling 17 years. The objective of the panel regression is to examine the relationship, if any, between currency demand, the size of the underground economy, and currency demonetization after the introduction of the Euro in 2002. The data collected for size of underground economies in Europe is from Schenider (2010) from 1999 to 2016. Countries included are: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Spain, Slovakia, Sweden, and the United Kingdom.

The dependent variable in this model is the size of the underground economy. The dependent variable is represented as a percent of GDP figure. The data for this variable was collected from Schneider (2006). These figures were calculated using the Multiple Indicators and Multiple Causes (MIMIC) model.[20] MIMIC estimates are more precise as it

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[20] The MIMIC model examines the relationship between causal variables and a latent variable, and additionally examines the impact of the latent variable on each independent variable.

treats the shadow economy as a latent variable and identifies various causes of the shadow economy by differentiating indicators and causes. Additionally, the MIMIC model is most applicable to time series data to trace the development of the shadow economy over time.

The independent variables include GDP per capita, GDP per capita growth, income tax rates, long-term interest rates, corruption ranking, unemployment rates, and inflation rates. Data for these variables in this regression were collected from an array of sources. Tax and interest rates were drawn from the World Bank DataBank database. Exchange rates were drawn from the Global Financial Data Exchange Rate Database. GDP per capita and per capita growth figures were obtained from the IMF Database. The Corruptions Perception Index (CPI) rankings were collected from the Transparency International. Inflation rates were extracted from the World Bank DataBank.

B.   Exchange Rate Multivariate Regression Data

A series of multivariate regressions were conducted to analyze the effect of demonetization on exchange rates in order to understand the likelihood of foreign currency substitution in underground economies.

For the regressions focusing on the Euro, weekly, daily, and monthly 3-month forward Euro-USD exchange rates were collected. These data sets were drawn from the Global Financial Data Exchange Rate Database. I chose to use three sets of data to identify consistencies, or differences, across different types of data. Daily exchange rates provide higher frequency data, allowing for more degrees of freedom and a more precise fix on the event dates, but at the expense of significant day-to-day noise that could confound estimates. On the other hand, weekly and monthly data are less precise but reduce the amount of noise.   I chose to use forward rates given that forward rates are future oriented

and could shed light on expected future impact of demonetization. Monthly black market spot rates for the Kyat-USD and Naira-USD were also drawn from the Global Financial Data Exchange Rate Database for Myanmar and Nigeria respectively. While official rates were extractable for the Eurozone for the event window, black market exchange rates were the only available rates for the Nigerian Naira and Myanmar Kyat around the respective event windows.

For the Euroization event, the 2 event dates are the official circulation of Euro notes and coins on 1 January 2002, and the completion of the changeover of all European Union members on 28 February 2002. For the demonetization of the Nigerian Naira in 1984, there is no literature that indicates a specific date on which the demonetization policy was issued. Instead, the key month of focus is April 1984. Lastly, for the case of Myanmar, the key date is 3 November, 1985, when the 20,25 and 100 Kyat notes were demonetized.

In the next section, I will proceed to outline the econometric methods I have used in this paper. First, I will explain the panel regression for the case of the 2002 Euroization, and will follow with an explanation of the exchange rate multivariate regressions for the 2002 Euro case, the 1984 Naira case, and the 1985 Kyat case.

V.   Methodology

A. Panel Regression

A panel regression allows for observing the behavior of several entities across a window of time. The merits to a panel method are that it allows for controlling variables that are unobservable or differences across entities.

A time-series panel regression is a macroeconomic approach to estimating the size of an underground economy over a specified time frame. The objective of conducting a time-series panel regression is to examine any possible attributions of growth in the size of underground economies to the explanatory variables in the model. I will analyze two different panel regression: a regression that includes all independent variables, and a stacked panel that gradually incorporates each independent variable. The panel regressions accounts for fixed effects for the variables that represent the year from 1998-2015 (*year)* and country *(country).* The variables included in the panel regressions can be found in Table 4.

In order to evaluate any possible correlation between the size of the underground economy and GDP, tax rates, unemployment, exchange rates and corruption, this thesis will utilize a panel regression method. The equation for my panel regression is:

$$under\_econ = \beta_0 + \beta_1 inflation + \beta_2 tax + \beta_3 intrate + \beta_4 unemp +$$

$$\beta_5 corrupt + \beta_6 gdppc + \beta_7 gdpgrowth + \beta_8 joined \times eurojoin + u \text{ (1)}$$

where *under_econ* represents the size of the underground economy, *inflation* represents the inflation rate as a percent of the GDP deflator, *tax* represents the tax on capital gains and income as a percent of GDP, *intrate* represents the long-term interest rates as a percent of GDP, *unemp* represents the rate of unemployment as a percent of the labor force, *corrupt* represents the ranking on the CPI scale from 1-9, *gdppc* represents GDP per capita in US Dollar figures, *gdpgrowth* represents the per capita growth rate, and a variable with an interactive dummy to account for the year that a specific country adopted the Euro (*joined* and *eurojoin (*dummy*)).* These explanatory variables have been incorporated into the model from Feige (1979), Schneider (2005), Tanzi (1983), Bordo and Choudhri (1982),

Btejer (1978), and Frey and Weck-Hanneman (1984). Finally, *joined* represents the year that each country joined the EU, and *eurojoin* is a dummy variable that signifies every year including and thereafter that each country fully implemented the Euro.

In this model, the dependent variable is the size of the underground economy. Over the past few decades, economists have identified various econometric methods to estimate this. These include the currency demand method pioneered by Cagan (1958) and further developed by Tanzi (1983) and Bhattacharyya (1990), the transactions method (Feige, 1979) and MIMIC (Multiple Indicators Multiple Causes) proposed by Frey and Weck-Hannemann (1984) and further modified by Schneider (1997). Given that my panel regression is based on time-series data, I obtained estimates for the size of the EU underground economies using the MIMIC approach. The MIMIC approach was further developed by Schneider (2005), who identifies taxation, intensity of state regulations, labor market regulations, and public sector services as key explanatory variables that determine the size of the underground economy in a specific country. The following paragraph provides a rationale for the independent variables included in my model.

First, the income tax burden significantly influences the underground economy. Allingham and Sandmo (1972) argue that underground economic activity tends to imply tax evasion, which allows us to conclude that factors affecting evasion of taxes will impact the shadow economy. The role of tax in the size of underground economy has been analyzed by Tanzi (1983), who found that as higher taxes incentivizes cash-based tax-evading activities. Feige (2003) identifies interest rates and inflation as key influencing variables, as rising interest rates and declining inflation encourage an increase in cash holdings, especially in many developing countries with large underground economies.

Easton (2001) claims that electric power consumption is a strong measure of economic activity. Furthermore, by using electricity consumption as a proxy for official and unofficial activity combined, unofficial activity can be singled out and estimated as the size of the underground economy. As Frey and Weck-Hanneman (1984) argue, the unemployment rate is a key determinant of the underground economy, as an unemployed person has more incentive to find work in the shadow economy. Finally, Schneider (2006) highlights regulation as a key explanatory variable, whereby lack of stringent regulations encourages higher corruption in the form of cash-based illicit activities.

I have included a few of many explanatory variables that could affect the size of an underground economy. An additional factor that is excluded from the model. An examination of exchange rate fluctuations would be valuable in understanding currency demand during monetary reforms such as currency demonetization. For example, foreign cash transactions reduce the costs of tax evasion and facilitate illegal activity, as foreign currency can be obtained through international exchange markets to evade documentation. It is therefore important to understand how demonetization affects exchange rates and if there is any consequent effect on currency demand and the size of the underground economy. This is achieved through a multivariate regression analysis.

B. Exchange Rate Multivariate Regression

In this thesis, I have employed a multivariate regression method to analyze the statistical significance of key dates of demonetization with respect to exchange rates for three case studies. These cases are the introduction of the Euro in 2002, the demonetization of the Nigerian Naira in 1984, and the demonetization of specific denominations of the

Myanmar Kyat in 1985. Key dates of interest and time frames for each case are outlined in Table 1.

Appreciation or depreciation of exchange rates can illuminate foreign currency demand patterns in the formal and informal economy. Many economists have studied the impact of currency substitution on demand for money in the formal economy. Bordo and Choudhri (1982) investigated the impact of exchange rate fluctuations on money demand and subsequently, the likelihood of currency substitution in Canada. They found proportionality between the expected rate of return on foreign money and the expected appreciation of the exchange rate. However, in the case of Canada, their findings indicated statistical insignificance, and as such, that even if significant amounts of foreign currency are held, currency substitution does not impact demand for money function.

Additional studies indicate a weak relationship between currency demand and official exchange rates. Ortiz (1983) further investigates the relationship between foreign currency demand and exchange rates in Mexico during the "dollarization" surge after 1954 through a system of regressions. His findings indicate that money demand estimations show that foreign exchange rates do not significantly affect the demand for pesos, so there is no evidence of currency substitution.

Others have examined the effect of black market exchange rate fluctuations on demand for money. Black market exchange rates could be beneficial to examine when estimating the foreign currency demand in the underground economy, as individuals may rely on these rates as opposed to official rates. It is important to consider the relationship between official and black market exchange rates in examining patterns of currency demand. Goldberg and Karimov (1997) argue that a devaluation of the official exchange

rate increases the likelihood of depreciation of the black market exchange rate since the official devaluation increases the attractiveness of foreign currency circulation in the underground economy.

Furthermore, case studies examining competition between the strength of the dollar and euro have revealed a reduction in reliance on US Dollars abroad. The size of the underground economy does not greatly increase the likelihood of de facto currency adoption, but there appears to be a unit elastic increase in dollar use with every percent increase in underground economy activity (Stix 2007). Therefore, it is important to consider exchange rate fluctuations and the effect on currency demand.

The first study examines the effect of European currency demonetization on the official Euro-US Dollar exchange rate with respect to the introduction of the Euro in 2002. Exchange rate data spanned from 4 January 1999 to 4 January 2005. Two potentially significant dates of the transition period during Euroization were 1 January 2002, and 28 February 2002.[21] Weekly, monthly, and daily 3-month forward exchange rates were used. The second study examines the effect of demonetization of the Nigerian Naira in 1984 on the monthly black market exchange rate of the Naira-US Dollar. The time frame examined begins 1 November 1982 to 1 November 1985, focusing on April 1984 as the key month in which the policy change took place. The final study examines the 1985 demonetization of 20, 25 and 100 denominations of the Myanmar Kyat on the monthly black market exchange rate of the Kyat-US Dollar, with an event window of 1 April 1983 to 1 April 1986. Event windows of ± 3 years were applied to assess the longer-term impact of demonetization events. In each case, three different regressions were conducted to compare

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[21] 1 January 2002 is represented by *event1*, 28 February 2002 is represented by *event2*

immediate, short-term, and long-term impact of demonetization on exchange rates through variations in the dummy variable specification. These specifications are described in Table 2.

The equation for this model is:

$$exchrate = \beta_0 + \beta_1 exchrate_{t-1} + \beta_2 time + \beta_3 event(1\ or\ 2) + \varepsilon\ ^{22}\ (2)$$

The dependent variable is the daily fluctuation in the exchange rate (official or black market) and the independent variables are $exchrate_{t-1}$, a lag on the exchange rate, *time,* and *event1* or *event2*. A description of the variables can be found in Table 3.

VI. Results

A. Main Panel Regression Results

The first empirical method I used was a panel regression of the size of the underground economy of the Euro-19 against the following variables: inflation rates, long-term interest rates, income tax rates, unemployment rates, corruption rankings, GDP per capita, and GDP per capita growth rates. A panel regression was conducted to examine the effects of each of these variables on the size of the underground economy. Table 5 illustrates the results of the main panel regression, incorporating all independent variables with year and country fixed effects. Figure 2 illustrates a trend of the size of the underground economy for each of the Euro-19 members over the period of 1998-2015. Most of these countries illustrate a downward trend on the size of the underground economy. It is noteworthy to highlight the downward trend post-2002 (represented by a

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[22] For Euro regressions, I used the variables *discount_exch* (difference between forward and spot rate over the spot rate) *and lag1* (first lag of *discount_exch*) instead of *exchrate* and *exchrate_{t-1}*.

red line in each graph). This could reflect a simple decreasing effect of demonetization on the size of EU underground economies. Additionally, Figure 3 is a chart that illustrates average annual figures of the size of the underground economy of the Euro-19 from 1998-2015.

A 1% increase in inflation results in a 1.026% decrease in the size of the underground economy. This is consistent with my prediction of a negative relationship, but runs contrary to the idea that an increase in inflation results in lower purchasing power and strengthens incentive to enter the hidden economy to reduce the risk of high costs. (Asiedu and Stengos, 2014)

A 1% increase in the income tax rate results in a 0.254% increase in the size of the underground economy. This is consistent with my prediction of a positive sign. An increase in tax encourages more tax evading behavior, as individuals are more incentivized to find ways to avoid tax burden.

A 1% increase in the unemployment rate results in a 1.111% decrease in the size of the underground economy. This is consistent with my prediction of a negative relationship because an increase in the unemployment rate could indicate a rise in the number of people who work in the underground economy. (Giles and Tedds, 2002)

A 1 kWh unit increase in electric power consumption results in a 0.0122-unit increase in the size of the underground economy. My prediction for this metric runs contrary to the evidence provided. Kaliberda (1996) claims that electric power consumption is regarded as the single best physical indicator of official and unofficial economic activity. Thus, looking at the unofficial economy portion of electric power consumption can shed light on the size of an underground economy.

A 1-unit increase in the ranking of a country on the Corruption Perceptions Index results in a 51.44-unit decrease in the size of the underground economy. This contrasts my prediction of a positive correlation. Rose-Ackerman (1997) claims that corruption perceptions could influence attitudes towards institutional credibility and can thus incentivize or deters illicit activity.

A $1 increase in GDP per capita results in a 0.000257-unit increase in the size of the underground economy (Ene and Stefanescu, 2011). This parallels my prediction of a positive sign.

A 1% increase in the GDP per capita growth rate results in a 2.51% increase in the size of the underground economy. This evidence supports my prediction of a positive relationship.

B. Stacked Panel Regression Results

The second panel regression conducted is a stacked regression, gradually incorporating one variable at a time into the model. These results are also shown in Table 5.

The results of interest in this regression are the coefficient and standard errors corresponding to the dummy variable, *eurojoin*. When *eurojoin* is the only variable included in the model, a coefficient of 17.52 with a standard error of -38.02 is produced. This indicates that for every additional earlier year that a country adopts the Euro, there is a 17.32% increase in the size of the underground economy. When *inflation* is added, the coefficient decreases to 16.74. After *tax* is included in the model, the coefficient rises to 17.78. Adding *intrate* results in a coefficient of 17.49. *Unemployment* included in the model produces a coefficient of 18.52. Once *eleccons* is included, the coefficient rises to

19.1. Following thereafter, as *corrupt, gdppc and gdpgrowth* are included, the coefficients gradually rise at 28.62, 28.54 and 30.44 respectively. Results are not significant for any of the iterations. Thus, there is no evidence of a significant effect of Euro adoption on the size of the underground economy in this regression.

What the overall trend suggests is that as more control variables are added to the model, there appears to be an overall increase in the strength of the correlation between *eurojoin* and *under_econ*. This suggests that if other conditions such as high interest rates, high inflation, and low GDP per capita growth (to name a few) exist, and if *eurojoin* is included in the model, there is an increase in the size of the underground economy as a percent figure of total GDP. While this appears to be the trend, we cannot establish causality due to insignificance of the coefficients.

C. Exchange Rate Multivariate Regressions Results

I. Euro

A series of regressions were conducted on the Euro to USD exchange rate over the period of 1999-2005. I conducted regressions using weekly, monthly, and daily exchange rate data for comprehensiveness. In each regression, the two event dates are 1 January 2002, and 28 February 2002. On 1 January 2002, Euro banknotes and coins were introduced and circulated. On 28 February 2002, the Euro was recognized as the sole currency holding legal tender throughout the euro area. 19 European countries demonetized their respective local currencies and adopted the Euro. These regressions are distinguished by different specifications of the dummy variable included in the model, *eurojoin*. The specifications for each regression can be found in Table 4. These specifications allow for

analysis of the immediate, short term, and long term impact of demonetization of local currency and adoption of the Euro.

All Euro regressions follow a standard model of regressing the 3-month forward discount rates (*discount_exch*)[23] against the first lag of this variable (*lag1)* and the dummy variable for the events of interest (*event)*. The time trend variable (*time)* is included and excluded in different iterations to observe differences. In these regressions, the coefficient of interest is for the variable *event1* or *event2*. For each set of regressions, the specification of interest is test 2, where *event1* or *event2* is set to one for the date of interest and all dates thereafter. I will describe the results for the weekly, monthly, and daily regressions for *event1* and *event2*. All results can be found in Table 6. For a graphical representation of Euro-USD exchange rate patterns, refer to Figure 5.

Event 1

The first set of regressions that I conducted were for *event1*. The results for the regressions using weekly data are illustrated in Table 6. The t-values for *event1* in both regressions are insignificant at all levels.

Monthly data results are also found in Table 6. Without *time* included, *event1* has a 0.00803 coefficient. This shows that following 1 January 2002, the Euro-USD discount premium rate saw a 0.008029 increase. With the time trend included, the coefficient on *event1* is -0.01687, which translates to a depreciation in the rate following the first event of demonetization. The t-values for *event1* in both regressions are significant at the 1%,

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[23] *Discount_exch*, the 3-month forward discount rate, can be calculated as $\frac{forward\ rate - spot\ rate}{spot\ rate}$.

5%, and 10% level. This provides evidence of a significant effect of Euro adoption on exchange rates when examining monthly data.

The daily rate regression results are listed in Table 6. T-values for *event1* in both regressions are insignificant at all levels.

Event 2

The following set of regressions were conducted to investigated *event2,* which corresponds to the date 28 February 2002.

The weekly rate regression results can be found in Table 6. Examining the results when *time* is excluded from the model, I obtained a coefficient of -0.00128 on *event2*. This indicates a 0.00128-unit decrease in the discount premium rate following the official nullification of local member currencies. With *time* included, I obtained a 0.004505 coefficient on *event2* that is significant at the 10% level. This translates to an appreciation of the exchange rate following 28 February 2002. The coefficient for the model without time is insignificant. The significant test reveals an effect of local EU member currency demonetization on the Euro-USD exchange rate. This allows us to infer a potential relationship between demonetization, currency appreciation, and the size of the underground economy.

Monthly rate regressions were calculated. For the model that excludes *time, event2* has a 0.00829 coefficient, which means that following the second date of Euroization, the Euro-USD discount premium rate appreciated by 0.00829 units. Including *time, event2* has a coefficient of -0.01498. This means that following the second date of interest, the rate dropped by 0.01498 units. T-values for *event2* in both regressions are significant at the 10% level. This indicates concludes a relationship between demonetization and exchange

rate appreciation. When the currency appreciates, individuals are incentivized to substitute existing currency – in this case, local currency – with the new, stronger currency – the Euro.

Finally, the daily rate regression results were collected. With *time, event2* is significant at the 10% level and has a coefficient of 0.006405, which explains an appreciation in the rate following 28 February 2002. The t-value for the model without *time* shows insignificance, however.

II. Naira

Buharinomics was General Buhari's economic currency reform program in 1984 to revive the economy.[24] In April 1984, Buhari conducted a demonetization of the Naira by voiding all existing notes in order to change the color schemes of all currency in circulation. The empirical analysis for this event was constrained by the absence of official Naira-USD exchange rate data. As a result, monthly Naira-USD black market exchange rates were utilized in this analysis.

All Naira regressions follow a standard model of regressing the exchange rate (*exchrate*) against four lags of this variable (*L(1/4). exchrate*) and the dummy variable representing April 1984 (*event1*). The time trend variable (*time*) is included and excluded in different iterations to observe differences. Specifications for each regression can be found in Table 3. The specification of interest is Test 2.

The results can be found in Table 7. I began by first excluding *time* from the model. This regression produced a resulting 3.81823 coefficient on *event1*. In the second

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[24] For more information on Buharinomics, see http://www.afriheritage.org/ar/late-new/147-can-a-new-buharinomics-save-nigeria

regression, which included the time trend variable *time, event1* has a coefficient of 0.615.

The t-value for the first regression is extremely significant at the 1%, 5%, and 10% levels.

This suggests that there is a gradual increase over time that could be distinguished from

any discrete effect of the policy move. On the other hand, the t-value for the second

regression is insignificant at all levels. For a graphical illustration of the exchange rate data,

refer to Figure 6.

III. Kyat

On November 3, 1985, the Burmese government embarked on a demonetization

reform for specific Kyat notes. The empirical analysis for this event was constrained by

the absence of official Kyat-USD exchange rate data. As a result, monthly Kyat-USD black

market exchange rates were utilized in this analysis.

Similar to the Naira regressions, all Kyat regressions follow a model of regressing

the exchange rate (*exchrate)* against four lags of this variable (*L(1/4).exchrate)* and the

dummy variable representing April 1984 (*event1).* The time trend variable (*time)* is

included and excluded in different iterations to observe differences. Specifications for each

regression can be found in Table 3. The specification of interest is Test 2. Results are shown

in Table 7.

The first regression I conducted was without the *time* variable. This regression

produced a coefficient of 5.927 for *event1*. This indicates a strong appreciation of the black

market exchange rate following the 1985 Kyat demonetization case observed. The second

regression incorporates the variable *time.* In this regression, the coefficient on *event1* is -

14.807. This translates to a sharp decrease in the black market exchange rate following

November 1985. In both regressions, the t-value for *event1* is extremely significant at the

1%, 5% and 10% levels. For a graphical illustration of the exchange rate data, refer to Figure 7.

VII. Analysis

The panel regression that I conducted examined the effect of various explanatory variables on the size of the underground economy from 1998 to 2015. I was interested in specifically understanding the impact of demonetization on the size of the underground economy. The variable of interest in this regression is *eurojoin,* which indicates when each member state adopted the Euro. While the coefficient indicates a potential 17.52% increase in the size of the underground economy if a country adopts the Euro, we cannot confirm that this is the case because of statistical insignificance. Additionally, as other explanatory variables, such as inflation rates, interest rates, unemployment rates, corruption rankings, GDP per capita, electric power consumption, and GDP growth rates are added to the model, the effect of adopting the Euro on the size of the underground economy rises to 30.44%, but this coefficient remains statistically insignificant. These findings run contrary to the notion that demonetization reduces the size of the underground economy, as adopting the Euro leads to an apparent growth in the size of the shadow economy. However, it is worth noting that the panel regression runs over 18 years, with a majority of member states adopting the Euro in 2002. This motivates an exploration into other factors, such as de facto currency substitution, that could have catered to an increase in the years following adoption. Moreover, looking at currency substitution incentive is crucial given the possibility of an increase in illegal activity despite strong monitoring during

demonetization that would have subjected criminals to regulatory scrutiny. De facto currency demand arises when a population loses faith in the credibility of a local currency and opts to obtain foreign currency in forms of cash.

Investigating currency demand requires an exploration of exchange rate. I achieved this through running exchange rate multivariate regressions for the cases of demonetization of the Euro, Naira, and Kyat, to understand the role that foreign currency substitution can play in explaining an increase or lack of change in the size of an underground economy. The first set of regressions were carried out to examine the effect of 2002 Euroization. The two dates important to Euroization were 1 January 2002, and 28 February 2002, represented by *event1 and event2* in the models. By identifying various specifications to understand the short-term, long-term and immediate impact of demonetization, I was able to investigate the effect of demonetization policy on these two dates on the Euro-USD forward discount premium rate. I utilized weekly, monthly, and daily data. My findings indicate that the introduction of the Euro on 1 January 2002, and the demonetization of local currencies on 28 February 2002, resulted in an overall appreciation of the Euro-USD forward discount premium, given the statistical significance of many of the resulting coefficients. This is consistent with the idea that currency appreciation occurs as a result of a reduction in the money supply. The introduction of a new, unionized currency encourages replacement of old currency, and a wider usage of the Euro. The efficient and effective execution of Euro introduction allowed the EU to replace existing local currency in circulation with Euro banknotes and coins, which could have minimized the effects of a contraction in the money supply. This could explain the increase in the size of the underground economy, given the surge of Euro circulation and the smooth replacement of

currency in circulation. Despite regulatory requirements for Euro exchange, criminals may have been able to exchange existing local currency for Euros and could have continued to engage in illegal activity with Euros. Extending this to the demonetization in India, the depreciation of the INR to the US Dollar, and the added inconvenience and shortage of new INR availability, could incentivize participants of the black market to look to foreign currency alternatives to continue illegal activities. Therefore, Modi's demonetization theory is doubtful, given that the size of the black market could remain unchanged, or increase, in the future.

In the case of the Nigerian Naira and Myanmar Kyat, there is evidence of statistical significance and an appreciation in the black market monthly exchange rate for the Naira-USD and the Kyat-USD. The dates of interest, April 1984 and 3 November 1985 respectively, are represented by the variable *event1* in each model. In the case of the Naira, both regressions produce significant positive coefficients on the variable *event1*. This indicates an appreciation of the exchange rate following an episode of demonetization. This is in line with the belief that currency appreciation is a product of currency demonetization. It is important to consider the nature of this case of demonetization in understanding these results. Naira demonetization was executed through a re-coloring of all existing Naira notes in circulation. What this meant was that no denominations were nullified, but rather replaced by notes with a new look. Thus, this could have had little impact on the overall money supply, given that it was a total replacement of all notes in circulation. With regards to Myanmar, the model that excluded the time trend produced a positive coefficient, whereas the model that included the time trend resulted in a negative coefficient. This reveals that the immediate impact of Kyat demonetization resulted in exchange rate

appreciation, whereas the longer-term effect resulted in currency depreciation. The results of this regression are intuitive. Short-term appreciation occurred due to the government announcing that 50 and 100-kyat denominations were no longer legal tender, which would have reduced the money supply given that these notes were not replaced. Eventually, as money supply levels were normalized, a depreciation in the exchange rate is an expected result. In the case of the Naira, the result indicates that introduction of new Naira notes produced an appreciation of the Naira to the US Dollar. The success of this case of demonetization is intuitive, as the local currency was not replaced by a new form of currency, and people were incentivized to exchange black money for new notes of legal tender. In the case of the Kyat, there was a limited time period, and a limited quantity of new notes, that could be exchanged. The lack of monitoring via the banking system, paired with a disorganized and short transitionary period, resulted in a longer-term effect of currency depreciation of the Kyat to the US Dollar. This could have incentivized those involved in the informal economy to look to stronger foreign currencies, thereby evading regulatory scrutiny and continuing illegal transactions using foreign currency instead. This could explain a lack of reduction, or an increase, in the size of the underground economy, and the lack of effectiveness of demonetization. In testing Prime Minister Modi's demonetization theory, it is important to consider the results of this case, and the possibility of this result in the future for India, given the lack of regulatory scrutiny, and the shortage of supply of new INR notes available for withdrawal.

VIII. Conclusions and Limitations

Demonetization is a policy tool that governments utilize in an effort to reduce the incidence of an underground economy. Given that the shadow economy operates on cash, and demonetization nullifies existing notes and coins in circulation, many scholars find it intuitive that targeted demonetization of large-denomination currency would reduce the size of an underground economy. This follows because demonetization reduces the quantity of money in circulation by forcing individuals to exchange existing voided notes for new legal tender through the formal banking system. As a result, old notes are brought in and withdrawn from circulation, including black money. However, in countries where poor monitoring systems in banks exist, the effectiveness of demonetization can be ambiguous.

In 2016, Prime Minister Modi embarked on a program of demonetization and extracted INR 500 and 1000 denominations out of the economy, which made up 86% of the total cash in circulation in India. He replaced these denominations with new INR 500 and 2000 notes, envisioning a move towards destroying the black economy, corruption, and counterfeit. Prime Minister Modi launched this policy with the belief that black market participants would be brought forth through the requirement of exchanging currency through the formal banking sector, thereby subjecting them to regulatory scrutiny. Consequently, these deposits of black money would reduce the prevalence of the underground economy. However, given that India remains an economy that relies on cash, demonetization has wreaked havoc on the country. The speed of extraction exceeded the speed of replacement, thereby resulting in endless queues outside ATMs and banks comprised of scores of people waiting to exchange their existing notes for new ones. The

effects of demonetization have brought the overall policy into question. With severe costs associated with demonetization, economists have hotly debated whether the means justify the ends, and more specifically, if the ends have even been met.

In this thesis, I looked at Prime Minister Modi's theory of demonetization and the effects on the shadow economy in India. Prime Minister Modi believed that by forcing individuals to exchange hoards of cash at banks and ATM machines, he could successfully document unreported money and retract black money from circulation. For this to be successful, however, a strong monitoring system in the formal banking sector should be in place, which should discourage cash hoarding and encourage income reporting. Prime Minister Modi has attempted to establish this in a country that is largely dependent on cash, and where scores of people continue to remain unbanked. As a result, demonetization has had dire consequences; the nullification of 86% of notes in circulation has impacted the economy negatively. Prime Minister Modi, however, justifies the negative economic effects with the expectation of a great reduction, and ultimate destruction, of the shadow economy, given that large-denomination notes are most frequently used in this economy. I tested this theory by first examining whether demonetization reduces black market activity for the case of the 2002 introduction of the Euro, and the consequent demonetization of local EU member currencies. By aggregating explanatory variables identified by Feige (1979), Schneider (2005), Tanzi (1983), Bordo and Choudhri (1982), Btejer (1978), and Frey and Weck-Hanneman (1984), I estimated a panel regression from 1998 to 2015 to explore the significance of adopting the Euro on the size of EU underground economies. My study finds no evidence that supports the view that demonetization reduces the size of the underground economy. I find that, on its own, joining the European Monetary Union

increases the size of the underground economy. Having said this, the insignificance of this coefficient does not allow for a confirmation or denial of this claim. Furthermore, accounting for other explanatory variables, the effect of adopting the Euro could lead to a further increase in the size of the underground economy. This result contrasts the theory that demonetization results in a reduction in the size of the underground economy. Thus, in order to understand these results, albeit the insignificance, it is necessary to investigate other factors that affect cash demand, given that the underground economy hinges on cash in circulation. Examining exchange rate patterns could illuminate any incentive for currency substitution and an increase in cash in circulation.

To motivate this exploration, I examined the impact of demonetization on exchange rates to understand the potential for currency substitution in the shadow economy. Incentive for currency substitution could explain any lack of change, or an increase, in the size of the underground economy, given currency demonetization. I explored this in the second portion of my empirical analysis through a series of multivariate regressions that examine the impact of demonetization on the exchange rates for three different cases: Europe in 2002, Nigeria in 1984, and Myanmar in 1985. In the first two cases, my findings indicate a long-term appreciation of the exchange rate against the USD following the event of demonetization. These results are consistent with the notion that demonetization results in a contraction of the money supply and thus, results in an appreciation of the exchange rate. These results can be contextualized by the nature of these cases of demonetization. In the case of Euro introduction in 2002, however, a new currency was introduced, and existing local currencies were nullified. This may have left the money supply largely unaffected given the effective replacement of cash in circulation. In the case of the Naira,

Buhari's move to change the color of all notes in circulation was seen as an episode of demonetization. In effect, changing the color of all notes is simply a nullification of existing currency but an immediate replacement of all denominations in circulation, which could insignificantly impact the money supply. In the case of Myanmar, the long-term effect of demonetization resulted in a depreciation of the exchange rate. The long-term impact contrasts the traditional notion of the effect of demonetization, but the short-term impact is intuitive given the episode of demonetization destroyed 50 and 100-kyat denominations and reduced the effective money supply.

The results of this paper reveal that in past cases, demonetization has resulted in an increase in the size of an underground economy. The introduction of a new INR 2000 note can be likened to the introduction of the Euro as a new currency. Even though I was unable to establish a causal effect, the results of the panel regression indicate some correlation between the introduction of a new currency and the growth of underground economies. From examining the effect of demonetization on the exchange rate, we can infer that the resulting exchange rate appreciation revealed in the results can provide evidence of an unchanged money supply. If all else is held constant, this could allow for a continuation, and increase, in illegal activity. This case can be made in predicting the long-term impact of demonetization in India, which adds to the skepticism that economists have of the effectiveness of demonetization. Thus, I conclude that Prime Minister Modi's theory of demonetization lacks substance, and there is a case that can be made for an incentive to substitute foreign currency for local currency and dodge regulatory scrutiny during demonetization.

There are limitations to my empirical analysis that explain the statistical insignificance of some of my regression results. With respect to my panel regression, I included a few of many explanatory and control variables that explain the incidence of an underground economy. For the purpose of this thesis, however, I limited the regression to include 7 explanatory variables. However, as a result, this leaves room for omitted variable bias, and thus, the model could be over-estimating or under-estimating the effect of one of the included variables on the dependent variable, the size of the underground economy. For example, there could exist a relationship between higher social security contributions and incentive for starting a business in the underground economy to reduce the cost of production. Secondly, in the multivariate exchange rate regressions that I conducted, I limited the independent variables to be a few lags of the dependent variable, a time trend variable, and a dummy variable to represent the event of demonetization and the time thereafter. This also leaves room for omitted variable bias, given that there could be a plethora of other factors that could influence exchange rate patterns. For example, inflation rates, interest rates, and current account deficits are a few variables that could have been included in the model, as they directly affect exchange rates. I chose to exclude these variables given that the focus of my analysis was on the specific effect of demonetization on exchange rates.

Future studies could look to include additional variables in each of these empirical methods in order to establish higher causal relationships. There are many opportunities to further analyze the long-term impact of demonetization on the Indian economy. For example, one could explore other explanatory variables that simultaneously affect exchange rates and the size of the underground economy to identify a strong link between

these entities. Alternatively, an exploration of cases of de facto currency substitution in the underground economy following episodes of demonetization can shed light on the future of the Indian shadow economy. These studies would be value-adding in understanding the real outcome of the demonetization and the "Modi effect".

Tables

Table 1: Key Dates, Tests and Time Window for Euro, Naira, and Kyat Demonetization

Case	Tests	Time Window	Key Dates
Euro	6	1999-2005	1 January 2002, 28 February 2002
Naira	3	1981-1987	Apr-84
Kyat	3	1982-1988	3-Nov-85

Table 2: Multivariate Exchange Rate Regression Dummy Variable Specifications

Case	Test Number	Specification
Euro	1	event1=1 for 1 Jan 2002
	2	event2=1 for 28 Feb 2002
	3	event1=1 for 1 Jan 2002 and observations thereafter
	4	event2=2 for 28 Feb 2002 and observations thereafter
	5	event1=1 for 1 Jan 2002 ± 3 observation dates
	6	event1=1 for 28 Feb 2002 ± 3 observation dates
Naira	1	event1=1 for April 1984
	2	event1=1 for April 1984 and observations thereafter
	3	event1=1 for April 1984 ± 3 observation dates
Kyat	1	event1=1 for 3 Nov 1985
	2	event1=1 for 3 Nov 1985 and observations thereafter
	3	event1=1 for 3 Nov 1985 ± 3 observation dates

Table 3: Variable Descriptions for Exchange Rate Multivariate Regressions

Case	Variable	Description
Euro	*discount_exch*	$\dfrac{Forward\ rate - spot\ rate}{spot\ rate}$
	lag1	First lag of variable *discount_exch*
	event1	1/1/2002
	event2	2/28/2002
	time	Time trend variable
Naira	*exchrate*	Monthly black market Naira-USD exchange rate
	L1/2/3/4.exchrate	First, second, third, fourth lag of variable *exchrate*
	event1	4/1/1984
	time	Time trend variable
Kyat	*exchrate*	Monthly black market Kyat-USD exchange rate
	L1/2/3/4.exchrate	First, second, third, fourth lag of variable *exchrate*
	event1	11/3/1985
	time	Time trend variable

Table 4: 2002 Introduction of the Euro Panel Regression Variable Descriptions

Variable	Description	Source	Reason for Inclusion	Expected Sign
Dependent Variable				
under_econ	Size of the underground economy (% of GDP)	EC	The best available measure for currency demand in the underground economy	Dependent Variable
Independent Variable				
inflation	Annual inflation rate (% GDP deflator)	WB	Expected to capture impact of inflation on currency demand in the underground economy	Negative sign
tax	Annual Income tax on capital gains and profits (% of GDP)	WB	Expected to capture the impact of income tax rates on currency demand in the underground economy	Positive sign
intrate	Annual Long-term interest rates (%)	OECD.Stat	Expected to capture the impact of interest rate on currency demand in the underground economy	Negative sign
unemp	Annual unemployment rate (% of total labor force)	WB	Expected to capture the impact of unemployment rates on currency demand in the underground economy	Positive sign
eleccons	Electric power consumption (kWh)	WB	Expected to capture the impact of electric power consumption on currency demand in the underground economy	Negative sign
corrupt	Corruption Perceptions Index Ranking (0-10)	Trans	Expected to capture the impact of corruption on currency demand in the underground economy	Positive sign
gdppc	GDP per capita (US$)	WB	Expected to capture the impact of GDP figures on currency demand in the underground economy	Negative sign
gdpgrowth	GDP per capita (US$) growth	WB	Expected to capture the impact of GDP growth rate on currency demand in the underground economy	Negative sign
joined	Year that specific country joined the European Monetary Union	EC	Interaction for dummy variable to indicate the year that each country adopted the Euro	

Table 5: 2002 Introduction of the Euro Panel Regression of Euro-19 Countries (1998-2015)

VARIABLES	-1 under_econ	-2 under_econ	-3 under_econ	-4 under_econ	-5 under_econ	-6 under_econ	-7 under_econ	-8 under_econ	-9 under_econ
eurojoin	17.52	16.74	17.78	17.49	18.52	19.1	28.62	28.54	30.44
	(-38.02)	(-38.14)	(-39.94)	(-40.67)	(-41.06)	(-42.35)	(-44.28)	(-44.38)	(-44.51)
inflation		-0.984	-1.43	0.656	0.754	0.529	-1.258	-1.301	-1.026
		(-2.763)	(-3.028)	(-3.697)	(-3.738)	(-3.884)	(-3.983)	(-4.009)	(-4.033)
tax			0.219	0.158	0.22	0.154	0.438	0.436	0.254
			(-1.227)	(-1.269)	(-1.305)	(-1.403)	(-1.424)	(-1.427)	(-1.453)
intrate				3.356	3.051	3.058	1.64	1.593	3.213
				(-3.124)	(-3.427)	(-3.602)	(-3.69)	(-3.721)	(-4.407)
unemp					0.667	0.471	-1.017	-1.049	-1.111
					(-2.876)	(-3.258)	(-3.333)	(-3.352)	(-3.357)
eleccons						0.00401	0.0123	0.0122	0.0122
						(-0.0259)	(-0.0264)	(-0.0264)	(-0.0265)
corrupt							-52.28***	-52.01***	-51.44***
							(-17.71)	(-17.89)	(-17.93)
gdppc								0.000221	0.000267
								(-0.00195)	(-0.00195)
gdpgrowth									2.514
									(-3.654)
Constant	125.2***	128.3***	123.7***	97.64*	91.34	71.96	381.4*	377.2*	356.6*
	-24.45	-26.04	-41.87	-50.54	-57.57	-173.7	-202.8	-206.5	-208.9
Observations	342	342	319	310	308	293	282	282	282
R-squared	0.055	0.056	0.056	0.06	0.06	0.06	0.099	0.099	0.101
Number of countries	19	19	19	19	19	19	19	19	19

Table 6: EUR/USD Multivariate Regression Results for Weekly/Monthly/Daily Data (1998-2015)

| Variables	Event1						Event2					
	EURO WEEKLY WITHOUT TIME	EURO WEEKLY WITH TIME	EURO MONTHLY WITHOUT TIME	EURO MONTHLY WITH TIME	EURO DAILY WITHOUT TIME	EURO DAILY WITH TIME	EURO WEEKLY WITHOUT TIME	EURO WEEKLY WITH TIME	EURO MONTHLY WITHOUT TIME	MONTHLY WITH TIME	EURO DAILY WITHOUT TIME	EURO DAILY WITH TIME
	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch	discount_exch
event1	0.10728	0.003927	0.008029	-0.016871	-0.002067	0.005899	-0.001282	0.004505	0.008286	-0.014981	-0.00198	0.006405
lag1	-0.001423	0.089527	-0.12542	-0.29149	-0.004865	-0.00794	0.108301	0.086066	-0.1358	-0.26562	-0.00479	-0.008254
time	-	-0.000034	-	0.000719	-	-0.000009	-	-0.000037	-	0.000672	-	-0.0000095
constant	0.001326	0.004071	-0.002973	-0.01703	0.001185	0.004608	0.001226	0.004324	-0.002984	-0.016481	0.001094	0.004884

Table 7: NGN/USD (1982-1987) and MMK/USD (1983-1989) Multivariate Regression Monthly Rate Results

| Variables	NAIRA MONTHLY WITHOUT TIME	NAIRA MONTHLY WITH TIME	KYAT MONTHLY WITHOUT TIME	KYAT MONTHLY WITH TIME
	discount_exch	discount_exch	discount_exch	discount_exch
event1	3.81823	0.615335	5.92709	-14.8073
L1	0.008461	0.01092	0.01879	0.178127
L2	-0.011388	0.004819	-0.001559	0.095583
L3	0.38126	0.05633	-0.147597	-0.180529
L4	-0.058233	0.034356	-0.33137	-0.018012
time	-	0.060103	-	0.501646
constant	0.001226	-0.160849	57.6537	26.1038

Appendix

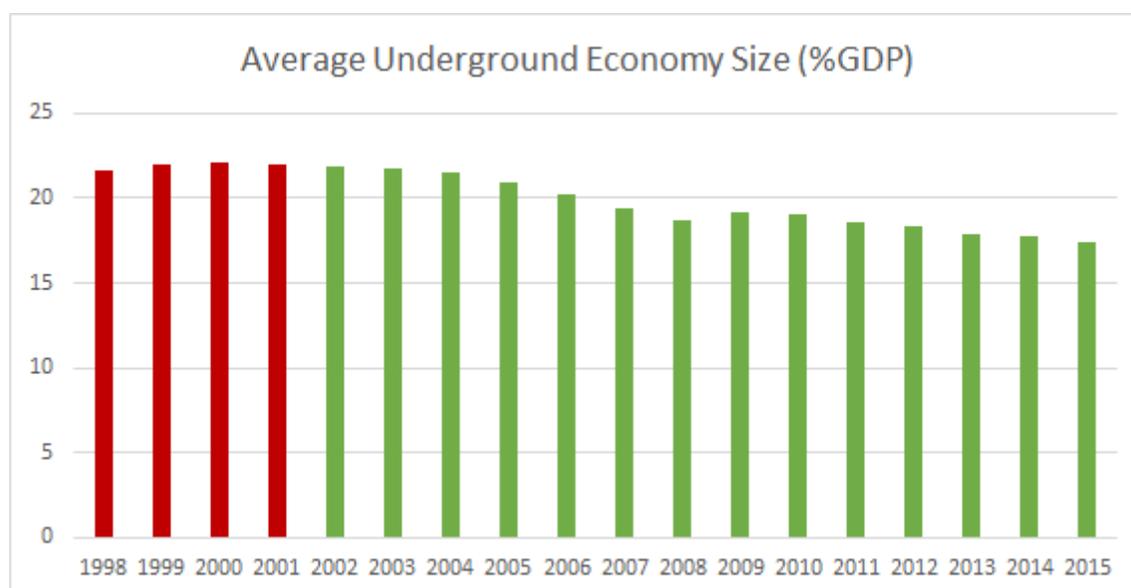**Figure 1: Shadow Economy and Growth Rate of Cash Usage**
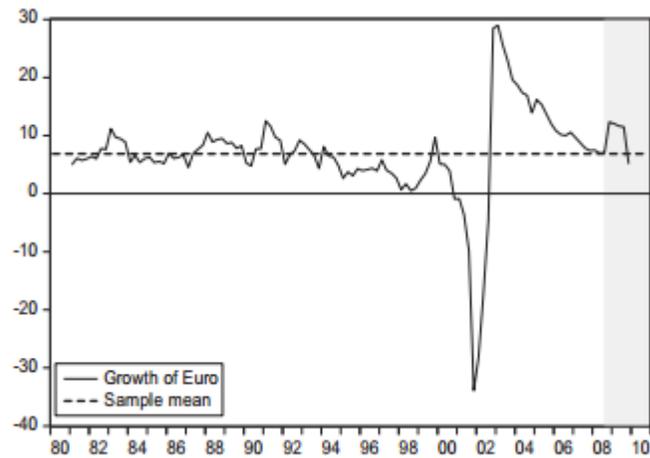
Source: Takala, Kari and Viren, Matti. "Is Cash Used in the Shadow Economy?", *International Economic Journal Vol. 24 (December 13, 2010)*:

Figure 2: Scatter Plots of Size of the Underground Economy for Euro-19 Countries (1998-2015)
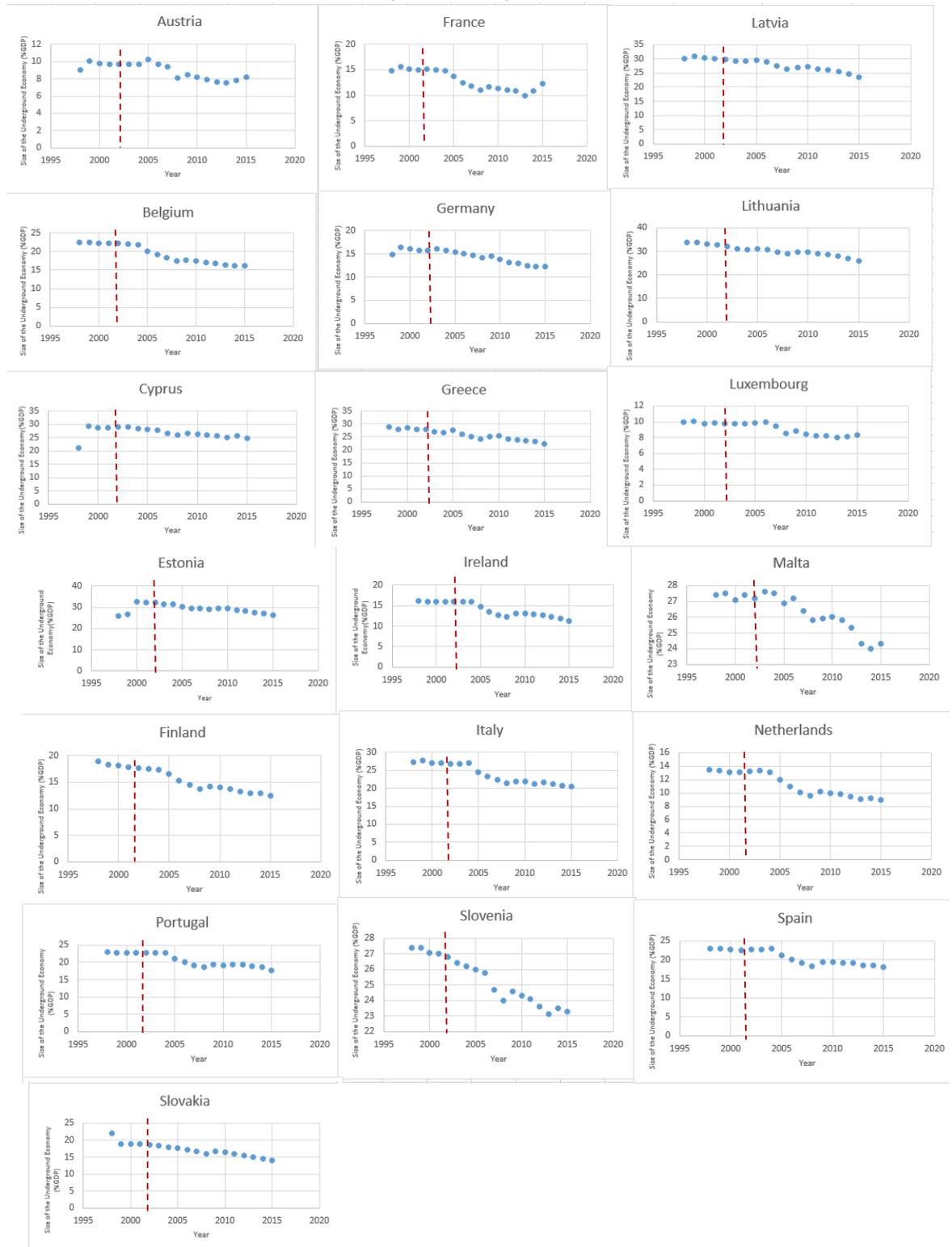
Figure 3: Year against Average Underground Economy Size for Euro-19 Countries (1998-2015)


Source: Data extracted from Schneider, Friedrich. "Shadow Economies and Corruption All Over The World: What Do We Really Know?", *IZA Discussion Paper Series No. 2315 (2006),* generated on Excel

Figure 4: Summary Statistics for Main Panel Regression of Euro-19 Countries (1998-2015)

	Euro-19 Countries				2002 Joiners				Post-2002 Joiners			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Size of the Underground Economy	25.76	107.19	7.5	1998	18.36	6.64	7.5	33.9	38.43	176.11	8	1998
Inflation Rate	2.42	2.61	-9.8	20.1	1.94	1.85	-5.3	9.7	3.26	3.41	-9.8	20.1
Income Tax Rate	31.77	12.42	5.7	59.8	34.88	11.49	5.7	59.8	26.12	12.09	10.6	57.4
Interest Rate	4.15	3.13	-7.7	22.5	4.24	3.08	-1.7	22.5	4.01	3.23	-7.7	15.4
Unemployment Rate	8.94	4.53	1.8	27.3	8.81	4.62	2.1	27.3	9.16	4.40	1.8	19.5
Electric Power Consumption	6704.73	3472.25	2072.8	17212.9	6860.30	3140.26	2516.9	17212.9	6438.04	3978.57	2072.8	16830
CPI	6.50	1.61	2.7	10	6.95	1.50	3.4	10	5.71	1.49	2.7	9
GDP per capita	25092.08	15855.26	2977.1	104841.4	25899.03	11102.94	3113.5	61388.2	23708.75	21695.68	2977.1	104841.4
GDP per capita growth	1.98	3.82	-14.6	12.9	1.63	3.27	-13.9	12.4	2.59	4.56	-14.6	12.9

Figure 5: Euro-USD Exchange Rate (1999-2003)
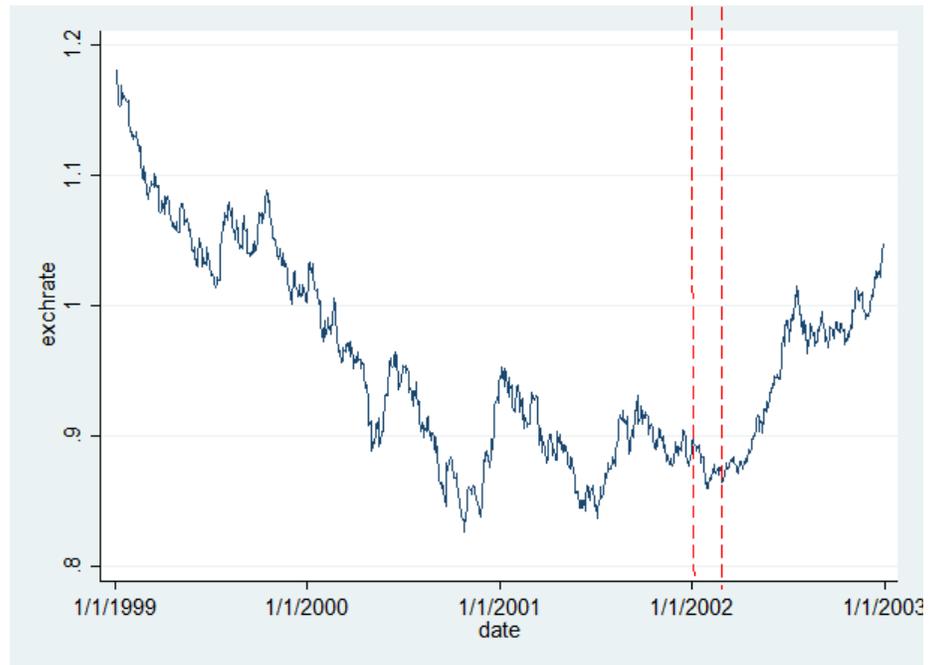
[Generated on Excel]

Figure 6: Naira-USD Black Market Exchange Rate (1981-1987)
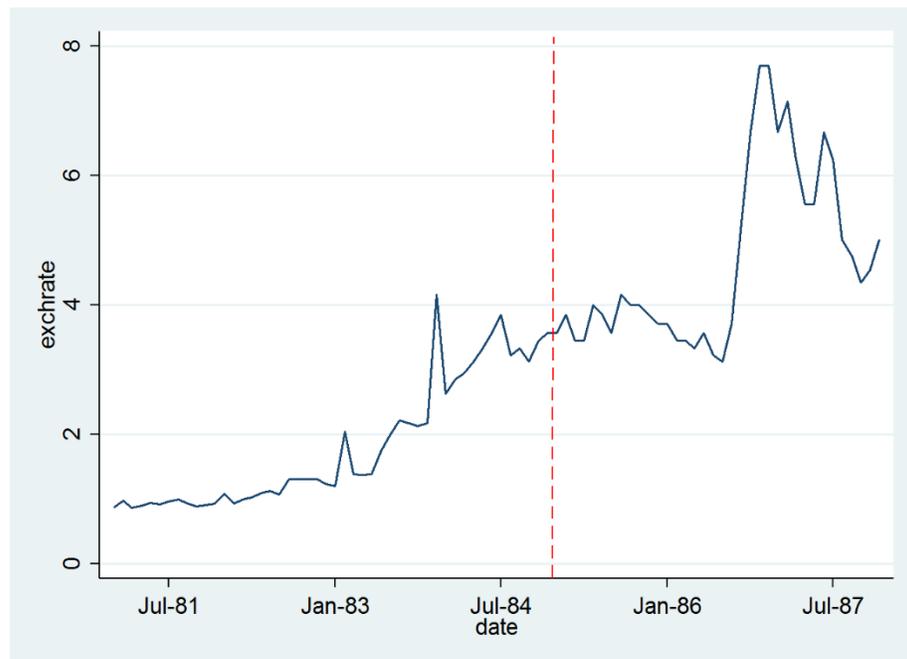
[Generated on Excel]

Figure 7: Kyat-USD Black Market Exchange Rate (1983-1989)

[Generated on Excel]

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