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Who Gained from India's Demonetization? Insights from Satellites and Surveys.*

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Abstract

On November 8, 2016, the Indian government abruptly demonetized 86% of its currency in circulation in an attempt to reduce black money, corruption, and counterfeiting. Yet, 99% of the currency was eventually returned to banks. We exploit large regional variations in deposit growth as a result of demonetization to study the medium term effects of this policy. Using night-light data, we show that districts which experienced higher deposit growth during the demonetization period, recorded higher levels of economic activity in the year and a half that followed. We estimate a one standard deviation increase in deposits is associated with a 5% increase in district GDP per capita. Further, districts with larger rural population, agricultural and non-agricultural informal labor shares also recorded an increase in nighttime light activity. The results are also supported by household level surveys on income and expenditures.

JEL-Classification: E2, E6, O17, O40, O47, R11
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1 Introduction

On November 8, 2016, the Indian government announced large currency denomination notes would no longer be considered legal tender and, with few exceptions, had to be deposited into banks by the end of the calendar year. These notes (in 500 and 1000 INR denominations) accounted for 86% of currency in circulation. For a country like India, where almost ninety percent of transactions take place in cash, such an abrupt announcement threw the economy into chaos. The avowed goals of the policy were reducing the volume of the "black economy", increasing the tax base, and reducing funding sources for terrorist activities. There is considerable, if not outright skepticism, whether the policy achieved any of these. It is generally accepted that it reduced economic growth in the last quarter of 2016 and also to some extent in the first quarter of 2017. In this research, we investigate the regional and household level effects over approximately a year and a half (till May 2018) since demonetization. We document that districts that recorded higher deposit growth during the last quarter of 2016 also experienced faster growth in night time lights over the next one and a half years. We also show that this is true for districts that have larger rural population shares, larger agricultural labor force shares, and a larger fraction of non-agricultural labor force employed in small firms (less than ten employees). Using a household panel survey, we also document that rural and agricultural households residing in districts with higher deposit growth also experienced a relative increase in real incomes and expenditures.

There are three sources of motivation for this research. First, as shown in Figure 1, the monthly night light data exhibit a clear upward trajectory during most of 2017 despite having been relatively stagnant between 2014 and 2016. This might be purely coincidental, but is hard to ignore given the context. Second, contrary to expectations, 99% of the demonetized currency notes were returned. This was despite the fact that, in an effort to punish those with unaccounted cash, the Indian government introduced additional rules regarding the amount of discontinued currency that could be deposited into a bank account.[1] Those who had black money clearly figured out ways to "launder" their cash.[2] These methods, which emerged quickly and were widespread, included channeling cash through accounts of employees, brokers who found low income households or zero balance

[1]Broadly, the maximum amount a single individual could deposit without the potential danger of further scrutiny was 250000 Indian Rupees, equivalent to 3740 US dollars on November 8th.

[2]In this paper, we use adjectives such as "black", "shadow", and "unaccounted" interchangeably. Medina and Schneider (2018), noting the interchangeability of these terms, define the shadow economy to "include all economic activities which are hidden from official authorities for monetary, regulatory, and institutional reasons". It generally does not include purely criminal and illegal activities, though that might be hard to distinguish in practice, especially the extensive use of bribes which facilitate the avoidance of regulatory burdens.

account holders, advance salary payments to employees, settlement of debts, or even finding businesses (usually informal) who were willing to sell goods at a markup if purchased with the defunct notes. Invariably, all of these methods involved paying a premium or a commission to the intermediaries and the ultimate depositor.[3] In effect, what transpired was a one time widespread reallocation or redistribution of wealth, but not the kind the government had in mind.[4] An obvious question that follows is whether redistribution through such channels could be sizable enough to actually have any expansionary effect. An accurate calculation would require knowledge regarding the amount of unaccounted cash in the country preceding demonetization - still very much an unknown; however, we can make a calculated guess. In an update to their earlier widely cited studies, Medina and Schneider (2018) estimate India's shadow economy to be on average almost 25% of GDP for the period 2004-2015. Assuming that the cash-GDP ratio in the shadow economy is the same as that of the regular economy–i.e., 12%–unaccounted cash would amount to approximately 3% of GDP.[5] If approximately 30% was redistributed during the money laundering process, this amounts to 1% of GDP. As a point of reference, refundable tax credits and assistance to households in 2010 as part of the American Recovery and Reinvestment Act (ARRA) stood at 0.36% of GDP. Thus even if only 10% was redistributed, the relative value would be similar to ARRA rebates.[6] Third, we are also interested in investigating whether the some of the sudden influx of deposits during this time was accompanied by subsequent increases in lending by the banking system, and thus possibly creating an expansionary effect in the medium term despite the decline in output in the short term. While all of these three factors suggest there might be an aggregate expansionary effect, in our research we focus on the regional effects where variations in the shocks are both more apparent, and the sample size lends itself to easier empirical analysis and causal inference.

To examine the effects of demonetization, we use a difference-in-difference strategy.

[3]See Huffington Post (2016) and KPMG (2016) for a description of these methods. During that time the government also introduced certain schemes for declaring black money, but this money was subject to tax rates of 45-50%, which would likely be the de facto maximum "fee" for any money laundering method. First hand anecdotes indicate that the going rate could be as high as 40% of the amount being deposited. In situations where someone received a fee for depositing the money, the remaining amount was usually returned during that quarter or the next depending on currency availability.

[4]The government counted on a substantial fraction of notes never being returned leading to a reduction in liabilities of the Reserve Bank. Bhagwati et al (2017) and Koning (2017) are early essays speculating on unintended redistribution.

[5]These numbers are conservative. According to a government sponsored but unreleased report in 2013 titled "Study on Unaccounted Incomes in India", the National Institute of Public Finance and Policy estimates that the shadow economy was about 45% of GDP (Table 4.16) for 2000-2010. The money to GDP ratio in the shadow economy is also certainly higher than 12% since the formal banking sector is avoided for these transactions.

[6]Bhagwati et al (2017) also view 30% as the eventual equilibrium laundering fee. The numbers for ARRA reflect the sum of outlays for Title 1 (Tax Provisions) and Title 2(Assistance for Unemployed Workers and Struggling Families) in CBO (2009).

Though the implementation of demonetization was exogenous, it also occurred simultaneously across the country, allowing no time variation. Thus, we have to rely on a source of cross-sectional variation. To capture heterogeneous treatment at the district level, we calculate the growth (i.e., the percent change) in total outstanding bank deposits between the end of the third quarter of 2016 (i.e the quarter before demonetization was implemented) and the end of the fourth quarter of 2016 (the deadline for depositing discontinued notes). Since both the reallocation channel and the credit channel requires us to "follow the money", this growth in deposits is well suited for our exercise. In particular, it picks up a useful geographic element: if notes were being laundered through rural branches or via migrant workers making remittances to their home villages, this would be recorded as deposit growth in those areas, and not at the source location of the cash.

Using monthly nighttime lights as our outcome variable, we show that districts that experienced a higher growth in deposits from demonetization had a) lower values of log night time lights during the two months when currency restrictions were in place, and b) recorded higher values of log nighttime lights in the post demonetization period (ie from January 2017 to May 2018). We subject our estimation to a range of robustness checks including checking for parallel trends, time trends, month effects, placebo tests, geography based post trends, etc.

Much of the debate about asymmetric effects of demonetization has centered around how the rural and informal economy bore the brunt of the chaos that followed. Therefore, in lieu of deposit growth during the demonetization quarter, which can be viewed as a proximate measure of treatment intensity, we also use other, more ultimate district characteristics from the pre-demonetization period to capture treatment intensity. These include (a) rural population shares of each district, (b) agricultural labor share in each district, and (c) Share of non-agricultural laborers employed in small firms (less than ten employees). For all of these too, we find negative effects during the demonetization months followed by positive and significant effects on nighttime lights for the subsequent months.

We supplement our regional analysis, by exploring a household panel on income and expenditures. The Consumer Pyramids survey, which we describe in detail later follows approximately 160,000 households and records income and expenditure details as well as other household characteristics. Despite sampling challenges such as over-representation of urban households and lack of coverage of all districts, we document that rural and agricultural households in districts that had higher deposit growth also recorded higher values of real income and expenditures following demonetization.

In the last part of the paper, we explore a couple of possible mechanisms. First, using the household survey, we show that there is some evidence private transfers were greater during the post demonetization period and this disproportionately benefited agricultural and rural household living in districts more exposed to demonetization (measured by deposit growth from demonetization). The event study analysis indicates that the effects manifest themselves well into 2017 and not earlier as one would expect. It's not surprising that it is difficult to get clear evidence. It is unlikely that recipients of one time payments would be forthcoming in surveys. Second, we examine the credit channel. The estimates indicate that districts with higher deposit growth also saw statistically significant increases in credit. Nevertheless this finding is tempered by the event study which shows rural areas were seeing an increase in credit flow before demonetization. The result is not surprising given that lending by banks in India is already subject to many government schemes and policy priorities. Overall, our mechanisms section indicate that a lot more research needs to be done to square the sustained increases in economic activity after the initial shock.

The rest of the paper is organized as follows. In the next subsection, we discuss demonetization in a little bit more detail and the related literature. In Section 2, we discuss the various data sources and provide an overview some of the important patterns. We cover the empirical specifications and also present our results for both regional and household analysis in Section 3, while 4 covers the mechanisms. Section 5 concludes.

1.1 Background and Related Literature

India's demonetization has been widely covered and discussed in the media and academic blogs. A reading of the Indian prime minister, Narendra Modi's, speech from November 8th, 2016, clearly indicates two rationales, corruption and terrorism, both fueled by black money.[7] The use of counterfeit notes is also mentioned in the initial announcement. Other rationales such as increasing the tax base and steering individuals towards traceable methods of transacting are not mentioned in the speech, and were enunciated later. While it is widely acknowledged that black money is a real problem in India, it is also true that most residents rely on cash for their daily transactions. For example Mazzotta et al (2014) note that almost 87% of transactions in India used cash in 2012, and Indians with access to formal banking also tend to transact in cash and carry high denomination notes.[8] The unusual hardship that this caused the general population combined with skepticism about its success led to widespread criticism. This was validated later when in 2017, the Reserve Bank released statistics indicating that 99% of the high denomination notes made its way

[7] See Modi (2016).

[8] While India's currency to GDP ratio of approximately 12% was higher than average for a sample of countries in 2014, it was not that much higher than that of the Euro Area (10.33%). As a share of M1, at 65% it was the highest in the sample of countries recorded by the Bank of International Settlements (2015). However this too might be misleading since most households and businesses in India use savings accounts making M3 the more appropriate yardstick.

back to the banking system.[9] In terms of the macroeconomic effects of demonetization, the Government of India speculated that it would reduce real GDP growth by about a half a percentage point.[10] Figure 2a displays the seasonally adjusted annualized growth in quarterly real GDP. One can observe a spike in growth during 2016 before demonetization, and if anything, slightly above trend growth during the demonetization quarter and the one following it. Any unusual decline in growth rates seemed to have occurred only later during the second and third quarter of 2017. In Figure 2b, we track some nominal macroeconomic variables - the Consumer Price Index, currency in circulation, total deposits and M3. The variables are normalized to 1 for the third quarter preceding the policy. As is clear, currency in circulation declined dramatically while prices and M3 stagnate temporarily before continuing to increase suggesting that the effects were largely temporary. M3 stagnates because the currency in circulation is offset by the increase in deposits.

Related Literature. Given the nature of the policy, most of the literature on demonetization so far has exploited household, regional, or sectoral variations. Aggarwal and Narayan (2017), probably the earliest empirical paper, employ difference in difference specifications to examine the effect on trade in 35 agricultural commodities across 3000 locations. They find that after 90 days the value of trade was still lower by 7% with most of the decline being due to prices. Beyer et al (2018), Bhavnani and Copelovitch (2018) and Chodorow-Reich et al (2018) are the closest to our research - all of which exploit district level data. Beyer et al (2018) apply different measures of district level informality - urbanization, banking access and wage earners - and show that night lights growth was lower in informal districts during the demonetization quarter.[11] Chodorow-Reich et al (2018) are to our knowledge the only paper to develop a macro model to calibrate the aggregate effects. They too rely on district level estimates of night lights data and use elasticities from Henderson et al (2012) to impute aggregate output reductions. To arrive at a measure of district level exposure to demonetization, they use confidential Reserve Bank of India data on currency note transactions. They calculate a rate of replacement of new currency during November and December 2016 relative to old currency as a measure of district level demonetization shock (higher values mean less adverse effects), which they argue is random

[9] As far as the tax base is concerned, taxes grew faster than GDP by 8.07 percentage points in the fiscal year of April 2017-March 2018. For comparison, the average growth difference during 2000-01 to 2009-10 was 8.32 percentage points. With regards to counterfeit notes, while there was indeed a jump in the growth of number of notes detected from 6% to 20%, the fraction that were considered counterfeit was only 0.000008% preceding demonetization.

[10] Ministry of Finance, Govt. of India, (2017), p73. Complicating matters further, the government revised its methodology to calculate GDP growth. Subramanian (2019) argues that these revised measures seem more like outliers compared to other independent macroeconomic indicators.

[11] Their findings are part of a larger research project on the applicability of using night lights to measure short run variations. They also look at the 2015 earthquake in Nepal and conflict in Afghanistan.

across districts. They show that demonetization had negative effects during the quarter of demonetization on light growth, credit growth, and employment. They also show other indicators such as electronic payments and our measure of treatment intensity - growth in deposits - increased during the demonetization period, but these effects are temporary, disappearing (or becoming insigificantly different than zero) by the first half of 2017. Bhavnani and Copelovitch (2018) use the number of bank branches as a measure of exposure to demonetization at the district level and show that while economic activity, as captured by new investment projects, was lower during that quarter, political support for Narendra Modi's Bhartiya Janta Party actually increased in the first half of 2017. They attribute this to the overall framing of demonetization as an all out attack on corruption.[12] While these papers generally focus on the contractionary aspects, Agarwal et al (2018) examine granular data on digital payments from various sources. They show that there was a significant rise in the use of digital technologies going into the first half of 2017. However, the effects are stronger for regions that already had pre-existing digital infrastructure in place.

In comparison, our research contributes to the understanding of how regions and households were affected well after the note withdrawal phase was over in light of a possibly substantial reallocation of liquidity involving multiple mechanisms. In this respect our research is also closely related to the large literature on the regional and household effects of aggregate shocks. These include research on the housing crisis and its effects on regional growth in the US (Mian and Sufi, 2014), the shale boom on local wages and employment (Feyrer, et al, 2017), and a large emerging research on fiscal policy shocks and regional multipliers (see Chodorow-Reich, 2019 and Nakamura and Steinsson, 2018). A key difference between much of this research and our work is that we document two distinct phases: (1) the chaotic contractionary phase during the last two months of 2016 followed by (2) an expansionary period over the next 15 months. As far as we know, we are the first to document this expansionary effect from India's demonetization.

Our research is also tied to the literature on unanticipated shocks and their effects on consumption. For example, Aldangady (2015) exploits regional shocks in home prices in the US to study individual consumption patterns, and Agarwal and Qian (2014), Angrisani et al (2019), and Japelli and Padula (2015) study consumption responses to unanticipated wealth shocks. In the case of demonetization, at the individual level, there are several confounding factors. Given that there is a general consensus that there was a short term decline in income and employment, it would have led to a negative transitory shock, which would affect groups that are liquidity constrained–i.e., poorer households. On the other hand, any redistribution of wealth would be a positive transitory shock to low income households, which would manifest itself in the medium term. Finally, such redistribution

[12] Their analysis is limited to 75 districts.

would mean negative transitory shocks to the wealthy (who are not liquidity constrained and their consumption would be unaffected).

Japelli and Pistaferri (2010) provide a useful diagnostic discussion about the links between various types of shocks and their asymmetric effects on consumption. As they note, in the presence of borrowing constraints the marginal propensity to consume can be high and thus could lead to a significant reduction in consumption with negative transitory shocks. On the other hand, a positive shock can lead to higher savings (which can include purchases of non-durables and physical assets).[13] Unfortunately, we do not have direct data on who received payments and which individuals suffered wealth shocks. Since we rely on district level deposit growth and other broad classifications such as rural/urban and agriculture/non-agriculture, we cannot disentangle the individual effects on incomes and expenditures from local general equilibrium effects. Indeed our estimation with household data should really be viewed more as corroborating the regional analysis.

2 Data

In this section we provide a brief overview of the various measures and their sources both at the regional and household level. Mainly, we focus on the night time light data, our measure of deposit growth, the census variables capturing rural population and agricultural labor force, and finally the household data from the consumer pyramid survey. Appendix Table A1 provides summary statistics of the key variables.

Night Lights Since 2012, the Earth Observation Group (EOG) at the NOAA National Center for Environment Science has been processing and sharing global low light imaging data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) on a monthly basis. This supersedes the earlier annual night light data that has been widely used by economists beginning with Chen and Nordhaus (2011) and Henderson et al (2012). One of the key advancements of the newer data, apart from the monthly frequency, is four times greater resolution (at the equator each pixel is now 0.214 sq km). Other major advancements include no saturation, lower detection limits, wider dynamic range, and 45 times smaller pixel footprints.[14] The version we use is the monthly average filtered by EOG to exclude data impacted by stray light, lightning, lunar illumination, and cloud-cover. Figure 1 portrays the path of log lights for India as whole after controlling for cloud

[13]The absence of access to formal credit does not mean that individuals do not have access to other more costly means of acquiring credit.

[14]For a more technical discussion see Elvidge et al (2017). We should note that while earlier the data was captured at around 10:30 in the night, the newer data is captured at 1AM which could potentially weaken the correlation with economic activity

free days and month effects. A problem that arises with monthly data, and particularly for a country like India, is that extensive cloud coverage might lead to very few or even zero daily observations for a pixel during the monsoon months. The monthly average has a non-missing value only if there was at least one day with no cloud coverage. The light extraction algorithm after removing clouds has only 84% accuracy.[15] To deal with these issues, we control for cloud free days in our econometric work. Further, it serves as a proxy for precipitation, an important source of variation in economic activity. Despite controlling for month effects and cloud free days, one can see there is still considerable month to month variation in the data. When conducting robustness tests, we repeat our estimation but restrict the pixels to only those that were lit in the annual composite data created by EOG for 2015, i.e. by looking at an intensive margin rather than an extensive margin.[16] We aggregate (the unweighted sum) the pixel level data to the district level. The unusual spike in lights in 2017 clearly stands out in Figure 1, particularly compared to the relative stagnation preceding it.

District Level Deposit Data Our primary measure of capturing the exposure to demonetization is the percentage change in total deposits between the end of the fourth quarter of 2016 and end of the third quarter of 2016. This captures deposit growth during the last quarter of 2016, of which almost two months, November and December, were what we loosely refer to as the demonetization period. This data is publicly available from the Reserve Bank's website.[17] Since the Reserve Bank publishes total deposits, the percentage change is the net growth in deposits. If an account holder deposited a certain amount in old currency and replaced it with new currency, the growth in deposits would be zero. In reality, due to the severe restrictions in place, the amount of currency in circulation during those two months fell dramatically to almost half of its pre-demonetization value making this less of a concern.[18]

In our econometric analysis, we use this raw deposit growth measure. The mean value across districts during that quarter was almost 14% with a standard deviation of 7%. This stands in sharp contrast to preceding five years when the mean growth was 1.8% with a standard deviation of only 2.5% for the same quarter. Figure 3 displays the time series of

[15] See Elvidge, et al (2017).

[16] Beyer et al (2018) and Chodorow-Reich et al (2018) post-process the light data and remove some of these variations. Since we use lights as a dependent variable, there is no reason to make such corrections. Further, despite applying smoothing procedures, the jump in aggregate lights is clearly visible in Figure 6 of the latter paper.

[17] Statement 4A of the Quarterly Statistics on Deposits and Credit of Scheduled Commercial Banks. Total deposits usually reflect values for the last day of the quarter.

[18] Initially, daily cash withdrawals were restricted to INR 10,000 (US$150) per day with a weekly limit of 20,000.

the unweighted mean of the district deposit growth after subtracting the five year (2011-15) average for that district-quarter.[19] Figure 4 provides a glimpse of the spatial variation of the same growth rate for the demonetization quarter. At the upper end of the distribution, there were many districts recording more than 30% growth in deposits. An unusually large share of these belong to the northeast states of India, particularly, Nagaland and Manipur. This should not come as a surprise for those closely following developments in India during that time. The news media reported that the area has many districts that are officially "scheduled tribes" designated populations who benefit from income tax exemptions. This made them an important conduit for money laundering with reports of chartered planes flying in with cash from districts close to New Delhi. A second possibility is that the undeclared cash being used by separatist groups that operate in this area made its way back to the banks.[20] Other than the northeast, the northern states of India had many districts with high levels of deposit growth.

While large increases in deposits are to be expected, there are at least a dozen districts that experienced declines during that time period. These are concentrated in metropolitan areas. Particularly striking are Mumbai (-16%) and Suburban Mumbai (-2%). Chennai also experienced a decline of -0.4%. More generally, at the lower end of the distribution we see a predominance of major urban areas such as Bangalore, Delhi, Hyderabad, Kolkata, etc.[21] The fact that these are all urban areas could mean that there was less dependence on cash to begin with. Second, in keeping with our motivation, it is also possible that a large chunk of the undeclared cash was redirected to adjoining rural districts or to other parts of the country. Nevertheless, neither of these can explain a decline in total deposits. It is likely that Reserve Bank was more responsive, consciously or not, to the cash needs in these places which facilitated greater withdrawals compared to the rest of the country. Figure 3 also indicates that the rapid growth in deposits in the fourth quarter was largely, but not completely, reversed in the first quarter of 2017 as more liquidity flowed into the economy. We show that our results remain robust if we use instead the growth in total deposits between end of the third quarter of 2016 and end of the first quarter of 2017.

Census Data In addition to deposits, we also construct district level measures of (a) rural population shares, and (b) share of workers in agriculture from the 2011 population census. We also use the sixth economic census conducted in 2013-14 to construct a measure of the share of workers in small firms to gauge non-agricultural informal activity. We

[19]For each district-quarter we calculate: $\ln\left(\frac{deposit_{y,q}}{deposit_{y,q-1}}\right) - \frac{1}{5}\sum_{y=2011}^{2015}\ln\left(\frac{deposit_{y,q}}{deposit_{y,q-1}}\right)$.

[20]See Huffington Post (2016) on chartered planes flying to Nagaland. India Today (2016) reports on effects of insurgency outfits. Interestingly, there is no unusual growth in deposits in the Kashmir region.

[21]Because of our use of district FE, time-invariant unobservables associated with these more urban districts are not a threat to our identification strategy.

define firms that have less than ten workers (hired and owners) as small firms.[22] These additional district-level variables are used in the analysis of Section 3.2, which examines the characteristics of districts that experienced large deposit growth from demonetization.

Household Data While the first part of the paper focuses on district level variations in outcomes, we supplement this by looking at household incomes and expenditures from Consumer Pyramids, a proprietary panel survey published by the Centre for Monitoring Indian Economy (CMIE). The survey follows almost 160,000 households since 2015 and is designed to provide an overview of incomes, expenditures, assets, demographics and more recently, employment and sentiments and is representative at the national level.[23] Households are interviewed tri-annually (once every four months) about their economic situation over the previous four months. Even though India is about 30% urban and 70% rural, the survey is flipped in that 70% of the respondents are urban and 30% rural. The rationale is the greater heterogeneity in urban households than in rural households. We use the survey data to see if household income and expenditures were differentially affected post-demonetization. Figure 5 displays the logarithm of the weighted mean of household real income and real expenditures based on the survey. Even here, there is a clear increase in the slope around the time of demonetization. In addition to looking at aggregated income and expenditures, we also examine a particular component of income– private transfer income (i.e., remittances from members or other sources). In keeping with our regional specifications, we also distinguish between rural and urban households, and also between agriculture and non-agricultural households.

3 Empirical Specifications and Results

3.1 Regional Effects

We begin our analysis by looking at the district level variation covering the period from January 2015 to May 2018.[24] The starting month is chosen based on the availability of data for the household level analysis in section 3.3. Additionally, it provides a reasonable

[22] The economic census, which surveyed 58.5 million firms, excludes establishments that engage in crop production and plantation (i.e. most of the agricultural sector), and public services. However, it includes allied agricultural activities and also government owned production units. Firms may be registered or unregistered.

[23] To get real measures of income and expenditures, nominal measures from the Consumer Pyramids are deflated by state-level, rural/urban measures of CPI from the Consumer Price Indices Warehouse provided by the Government of India. We use the most recent, general data (2012 base), which can be found here: http://164.100.34.62:8080/.

[24] Extending the sample back to 2014 does not alter our results.

balance between the length of pre and post periods. We are able to create consistent data for 625 of the 640 districts in the 2011 census.[25]

3.1.1 Preliminary Analysis: Testing for Parallel Trends

The first step of our analysis is to establish that the growth in deposits between quarters 3 and 4 of 2016 (referred to as "demonetization-centered deposit growth") is not related to pre-trends in nighttime lights. We show this absence of differential pre-trends in two ways. First, we examine the interaction between a simple time trend and demonetization-centered deposit growth on nighttime lights in the pre-period. This tests whether there are differential linear trends in the pre-period from a district's 2016q3-2016q4 growth in deposits. In particular, we limit our sample period to that prior to demonetization and estimate:

$$\ln Lights_{it} = \alpha + \beta_{Tr.} Trend_t + \beta_{Tr.\times g} Trend_t \times DG_i^{2016q3-q4} + \beta_{Tr.\times x} Trend_t \times X_i + \gamma_i + \epsilon_{it} \quad (1)$$

where our focus is on the coefficient $\beta_{Tr.\times g}$, which estimates whether there are trend differences associated with demonetization-centered deposit growth, ($DG_i^{2016q3-q4}$).[26] This test is estimated in Table 1. All specifications of the table include district fixed effects (γ_i) with standard errors clustered at the district level. Controls are entered as follows: column (1) estimates the simple within-district trend and its interaction with demonetization-centered deposit growth; columns (2)-(5) add in the natural log of cloud free days and state-specific time trends; column (3) controls for trend differences from population; column (4) includes trend differences from district geo-climatic conditions; and column (5) includes all controls. As shown, in no specification of Table 1 do we estimate statistically different trends associated with the change in deposits, and magnitudes of the interaction are close to zero. The negative coefficient on the interaction of interest also suggests that our measure of exposure to demonetization is not associated with positive trends in nighttime lights prior to treatment.

To further show parallel trends in the effect of demonetization-centered deposit growth on nighttime lights prior to the shock in November 2016, Figure 6 plots the monthly β_t from the following estimating equation, using (i.e., omitting) October of 2016 as the base

[25] The Reserve Bank of India updates its tables periodically following the formation of new districts. We lose some districts that were split after the 2011 census for which no clear parent district could be assigned. Additionally, the Bank does not collect data for the nine separate districts of Delhi. As a result, Delhi, and also the union territories of Chandigarh and Dadra and Nagar Haveli are automatically dropped during estimation since they have no within region variation.

[26] For all districts, $Trend_t$ takes the value of 1 for the first month of our analysis, 2 for the second month, etc.

month:

$$\ln Lights_{it} = \alpha + \sum_{t=Jan.2015}^{May2018} \beta_t Month_t \times DG_i^{2016q3-q4} + \gamma_i + \gamma_{st} + \epsilon_{it} \quad (2)$$

Equation (2) tests for differential monthly effects of demonetization-centered deposit growth on nighttime lights relative to the month prior to demonetization, and in order to test the simple relationship over time, only district (γ_i) and state-year-month (γ_{st}) are included.[27] In other words, if demonetization-centered deposit growth is accounting *only* for spatial differences in the effect of demonetization as we hypothesize, then there should be no consistently estimated effect of 2016q3-2016q4 deposit growth on nighttime lights prior to demonetization. Indeed, monthly effects of demonetization-centered deposit growth in Figure 6 show a noisy, but inconsistent association with nighttime lights prior to demonetization. Coupled with the findings Table 1, we interpret no observable differences in the trend of nighttime lights from our measure of demonetization intensity prior to November 2016.

Following demonetization in November 2016, however, two patterns emerge. First, districts that exhibited larger deposit growth during demonetization, or districts that we interpret to have been more exposed to demonetization, have relative declines in nighttime lights in the months during and immediately after demonetization. After this initial decline, however, these districts that were more exposed to demonetization show relative increases in nighttime lights. Monthly coefficients of 2016q3-2016q4 deposit growth for the post-demonetization period are consistently positive, statistically significant, and larger in magnitude than in any month during the noisy pre-period, suggesting a clear break from the macroeconomic shock under study. We next study these during- and post-demonetization effects through difference-in-differences analysis.

3.1.2 Short and Medium Term Impacts of Demonetization

Our baseline analysis explores the relative within-district aggregate impacts of demonetization using nighttime lights. To do so, we estimate district-level difference-in-differences in nighttime lights from spatial variation in the pre/post quarterly change in deposits following the enactment of demonetization in November of 2016. This is given formally by the following estimating equation:

$$\begin{aligned} \ln Lights_{it} = \alpha + \beta_D I_{During} \times DG_i^{2016q3-q4} + \beta_P I_{Post} \times DG_i^{2016q3-q4} \\ + \beta'_{\mathbf{X}} \mathbf{X_i} + \gamma_i + \gamma_{st} + \epsilon_{it} \end{aligned} \quad (3)$$

[27] Coefficients from Equation (2), which are shown in Figure 6, are slightly attenuated with similar statistical significance when including baseline controls of Equation (3).

The base district panel is monthly (t), running from January 2015 to May 2018, and is comprised of 625 (i) districts. District (γ_i) and state-year-month (γ_{st}) are included in all specifications, suggesting our coefficient is capturing state-specific within-district variation over time.[28] Our coefficients of interest β_D and β_P measure the differential change to night time lights during and following demonetization by relative exposure to demonetization–measured by the influx in deposits due to demonetization ($DG_i^{2016q3-q4}$). We separately estimate the immediate effect of demonetization (November and December of 2016) to account for initial disruptions due to the large reductions in currency and its impacts on transactions, suggesting $\beta_D < 0$. As argued in the introduction, the raw aggregate data portray not only the absence of negative economic effects, but a consistent positive effects; therefore, we hypothesize $\beta_P > 0$. The dual inclusion of during and post interactions implies the coefficients of these interactions is accounting for the relative effect demonetization compared to the pre-period of January 2015 to October 2016.

Table 2 formally tests this idea by estimating our base DD equation given by Equation (3). All estimations include district and state-year-month fixed effects, and standard errors are clustered at the district level.[29] Column (1) estimates the DD bivariate equation, omitting other controls. Columns (2)-(5) include the natural log of cloud free days. Since lights are strongly correlated with population, column (3) includes the district-level population (2011 Census). Our final set of controls comprises a large range of district-level geoclimatic conditions that are piecemeal included in column (4); these include the average and standard deviations for temperature, precipitation, malaria ecology, ruggedness, agricultural land suitability, the average distance to the coast, land area, and indicators for biomes.[30] Both the population controls of column (3) and the geoclimatic controls of column (4) are time invariant, so to include them in our within-district estimations, we interact all controls with a during-demonetization indicator and a post-demonetization indicator; this is identical to how our regressor of interest (deposit growth Q3-Q4, 2016) is treated. Doing so allows us to control for differential post-demonetization trends that may be correlated with 2016q3-2016q4 deposit growth. All controls are included in column (5).

For all specifications of Table 2, a clear pattern exists: there is a statistically significant ($p < 0.01$) negative relationship between night time lights and demonetization-centered

[28] Our results are not dependent on using state-year-month FE. When using year-month FE, the post-demonetization increases associated with demonetization-centered deposit growth remains roughly similar in magnitude and statistical significance.

[29] Table 2 also includes within district spatially adjusted standard errors for 30km (in brackets, "[ ]") and 200km (in braces, "{ }") (Fetzer, 2014; Hsiang, 2010). Given the close similarity between the district-clustered standard errors and the standard errors with spatial adjustments, we simply report district-clustered standard errors after Table 2.

[30] All geographic variables are taken from Chanda and Kabiraj (2018) except for the biome indicators which are taken from Henderson et al (2018).

deposit growth in the immediate months during demonetization, but this initial negative relationship is offset by a rebounding statistically significant ($p < 0.01$) positive effect throughout 2017 and mid-2018. From the simple estimation of column (1) to our full baseline model of column (5), there is very little variation in either the magnitude or the significance of our main coefficients. Magnitudes are slightly attenuated in column (3) when separately controlling for the pre-period level of population, but the estimated effects remain statistically significant at the 1% level. Using the range of estimated magnitudes from column (2), a standard deviation increase in a district's deposit growth from demonetization (s.d.=0.07) is associated with an average monthly decrease of 4-6% in nighttime lights during demonetization (i.e., November and December 2016) and an average monthly increase of 3-5% from January 2017 to May 2018.[31] Since lights by themselves are difficult to interpret, one can use estimated measures of elasticity between lights and GDP. Hu and Yao (2019) estimate the elasticity of VIIRS nighttime lights and GDP to be unity.[32] In other words, a one standard deviation increase in deposit growth during demonetization is associated with a 3-5% increase in GDP as well.

3.1.3 Placebo Tests and Robustness

Alternative Timing We next show that our measure of intensity–the growth rate of deposits centered around demonetization–is indeed accounting for district level exposure to demonetization. To do so, we alternate both the treatment date of demonetization and look at potential effects from the quarterly change in deposits in other periods.

Table 3 re-estimates our baseline findings of Table 2 but shifts the treatment date one year early to November of 2015. This shift generally causes all significant estimates to dissipate. The decline during demonetization in Table 2 is now estimated to be close to zero and is statistically insignificant in all specifications. The same holds true for the previously estimated post-December increase, which is now negative and statistically insignificant for all specifications. Given that demonetization is considered to be a true macroeconomic shock, it is no surprise that the true date of the treatment is associated with changes to nighttime lights.

Alternative Intensity In addition to confirming the treatment date, Figure 7 shows that it is indeed the change in deposits around demonetization that is driving our results. Figure 7 plots the during-demonetization (subfigure a) and the post-demonetization coefficients

[31] Effects are relative to the pre-period.

[32] Commonly referred estimates such as those of Henderson et al (2012) and Pinkovskiy and Sala-i-Martin (2016) are based on the older DMSP satellite program, which used an entirely different measurement scale and is thus not suitable here.

(subfigure b) by each quarterly growth rate of deposits. That is, we re-estimate Equation (3) substituting the quarterly deposit growth around demonetization (2016q3-2016q4) with all other quarterly changes to deposits.[33]

For the during-demonetization interaction, the quarterly change in deposits one year prior to demonetization (2015q3-2015q4) also has a statistically significant negative effect on nighttime lights, suggesting a potential alternative channel between deposit growth in quarters 3 and 4 and the decline in nighttime lights immediately following demonetization. With this in mind, we next control for average quarterly deposit growth and deposit growth one year and one quarter prior to demonetization in Table 4. The inclusion of early deposit growth measures does not alter the estimated effect of demonetization-centered deposit growth found in Table 2. For the post-demonetization increase, however, the only quarterly change in deposits that has a positive and statistically significant association with nighttime lights is the change centered around demonetization, providing further evidence that our use of deposit growth rates from demonetization are indeed measuring (at least in part) the spatial intensity of demonetization. In Section 3.2 we further explore the characteristics of district exposure to demonetization.

Robustness to Pretrends Table 4 controls for a number of potential trends in the pre-period (January 2015-October 2016); specifically, the *average* pre-period quarter-to-quarter percent change in deposits, the average growth of nighttime lights, and the growth of deposits one quarter (2016q2-2016q3) and one year (2015q3-2015q4) prior to demonetization. All estimations include the baseline set of controls given by column (5) of Table 2.

Some districts may be subject to either more variation in quarter-to-quarter deposit growth or may be more vulnerable to changes in deposits that could potentially lead to a spurious association with post-demonetization increases in nighttime lights. Therefore, we control for the average quarter-to-quarter growth of deposits in column (1). The inclusion of average deposit growth does not substantially affect our coefficients of interest, again suggesting that our baseline measure of deposit growth is measuring spatial differences in demonetization.

Although pre-trends in nighttime lights appear to be absent in Table 1 and Figure 6, we also control for the post-demonetization change in nighttime lights associated with pre-demonetization trends to show that our main finding is independent of ongoing trends in night-tme lights. To do so, column (2) controls for during/post-demonetization indicators interacted with the average monthly district-level growth rate in lights from January 2015-October 2016. The inclusion of this control leads to a slight attenuation in the effects both during and after demonetization, with the during-demonetization decline becoming

[33]The estimated coefficients follow the specification of column (5) of Table 2.

statistically indistinguishable from zero. The post-demonetization increase in nighttime lights, however, remains both positive and statistically significant.

Column (3) includes both the pre-period average growth rate of lights and deposits. The joint inclusion of these controls does not alter the estimated post-demonetization increase, further suggesting that our spatial measure of intensity is not being driven by pre-period trends in either our outcome or regressor of interest.

While Figure 7 shows that no other quarter-to-quarter growth rate is associated with the post-demonetization increase in nighttime lights, we take this one step further by controlling for the quarterly change in deposits one quarter and one year early in column (4) of Table 4. The inclusion of additional quarterly deposit growth measures does not alter the coefficient of demonetization-centered deposit growth.

Additional Robustness Checks We perform a number of additional robustness checks that follow the format of Table 2; these tables are found in the appendix. To quickly summarize: (1) we extend the sample period back to 2014 in Table A2; (2) we examine the relationship between nighttime lights and deposit growth one quarter longer (2017q1) in Table A3; (3) we mask the nighttime lights measure by whether lights were present in 2015, thereby testing the extensive margin in Table A4; (4) in place of the log of nighttime lights, we examine the monthly growth rate (or the log difference) in Table A5; (5) we also examine the growth rate with the longer growth rate of deposits of Table A3 in Table A6, and (6) re-estimate our base results with the growth rate of the masked light data in Table A7. For all specifications, a statistically significant positive post-demonetization effect is estimated, providing further support our baseline findings of Table 2.

3.2 Saliency of Demonetization: Rural, Agricultural, and Informal Sectors

The National Commission for Enterprises in the Unorganised Sector estimated that in 2004-05, 92.3% of India's workforce was informal.[34] By definition, almost 100% of agriculture is informal, whereas about 72% of non-agriculture was informal in 2004-05. They note that this was higher than in 1999-2000.[35] One of the major concerns during demonetization was the asymmetric costs borne by the rural and the informal sectors of the economy which

[34] See NCEUS (2009). The commission defines the informal sector as consisting of all unincorporated private enterprises owned by individuals or households engaged in the sale and production of goods and services operated on a proprietary or partnership basis and with less than ten total workers. This includes all of agriculture except for corporate ownership and plantations The report also differentiates between informal sector and informal workers. The latter can include workers in the formal sector but those that do not receive employee and social security benefits (ibid, p12).

[35] This persistence is also confirmed by Ghani et al (2013) for the non-agricultural sector.

did not have easy access, if any at all, to the formal financial system. On the other hand, the government itself was of the view that demonetization would push more economic activity and workers towards the formal sector. A natural extension of this research is to examine the relationship between a district level measures of the rural and informal sectors, and the change in deposits centered around demonetization. In particular, we look at three variables, (a) agricultural labor share, (b) a district's rural population share and (c) share of the non-agricultural labor force in firms with less than ten employees. Table 5 lists the correlation between deposit growth and the three measures. Not surprisingly, the correlation between the agricultural labor share and rural population shares is high. The correlation between the three structural variables and demonetization quarter deposit growth is also evident, but is not so high as to make one wonder if they capture essentially the same thing. In Figure 8, we plot the coefficient of a district's measures for these variables when regressing the quarterly change in deposits for every quarter. All three measures are generally unrelated to the change in deposits, except for the change around demonetization the coefficient of each measure shows a clear, positive, and statistically significant spike. This is expected. The rural and informal sector are predominantly currency driven, and the overnight effort to remove the most common Rupee notes is expected to be more pronounced in these rural districts. Indeed, that is what is borne out in the data.

Further exploring the effects of rural/informal districts, Figure 9 plots event figures similar to that of Figure 6, replacing the log change in deposits with - agricultural labor (subfigure a), rural shares (subfigure b), and non-agricultural informal share (subfigure c). The effect of each is remarkably similar to that of demonetization-centered deposit growth: there is no clear pattern prior to demonetization; during demonetization all measures of intensity have statistically significant negative associations with nighttime lights; and throughout 2017 and early 2018 a statistically significant positive effect is estimated.

Table 6 replaces the quarterly change in deposits of Table 2 with the share of agricultural laborers in Panel A, informal share of labor force in Panel B, and the rural share of the population in Panel C. The estimated effects are consistent with the deposit change estimates of with lights. All three mirror the event plots of Figure 9 by estimating a negative effect of demonetization in the immediate months during/after the announcement, but this negative effect is short lived with the post-demonetization period showing improvements in output (proxied by lights) in the following 17 months. The magnitude of the point estimates is remarkably similar to each other and to our base measure of deposit change. For the column (5) specification, a one standard deviation increase in the agricultural share is associated with an 8.1% monthly increase in nighttime lights ;a one standard deviation increase in the share of labor working in small firms is associated with a 4.8% increase; and a one standard deviation increase in the rural share of the population leads to a 7.8%

monthly increase.

To summarize, our measures of rural, and the agricultural and informal economy, reflect the same effects as the proximate measure of deposit growth. While the negative effects during the months of demonetization are indeed in keeping with concerns about the asymmetric burden of the policy, the medium term effects are quite the opposite. While it is possible that this reflects increases in formalization, we do not have compelling data on formalization per se. In any case, light data should not be as sensitive to the economy moving from informal activity to formal activity. After all, one of the widely recognized advantages of using lights is that it captures informal activity.

3.3 Household Survey Analysis

As a complement to our aggregate analysis, we also examine the effects of demonetization using a monthly longitudinal household panel. The panel allows us to independently verify our aggregate findings while also providing a rich source of data to examine potential mechanisms. Given our finding on nighttime lights, which proxy output, our primary focus in the household panel is in examining the effect on income and expenditures. Specifically, we are interested in seeing whether (1) that following demonetization income and expenditures *increased*, and (2) this increase is more pronounced in rural, agricultural households that live in districts with greater exposure to demonetization. We will also use this survey (along with other aggregate data) to explore mechanisms, but as discussed in detail in Section 4, we find no single cause for the post-demonetization increases.

Figure 10 plots the effect of year-month indicators, relative to the month prior to demonetization (October 2016). Subfigure (a) plots the effect of these time-period effects on the natural log of total household income, while Subfigure (b) plots the same for the natural log of total expenditures. From (a), there are no trends prior to our omitted month of October 2016; however, following demonetization in November 2016, there is a clear and stark increase in a household's reported income. This figure corroborates the increase in lights from Figure 1 and the estimated increase of our baseline findings. For expenditures in Subfigure (b), a similar pattern is observed; although, there are statistically significant differences occurring throughout the pre-period that suggest some seasonality or higher relative spending during 2015 compared to 2016. Nevertheless, both measures show clear increases following demonetization, a finding consistent with our aggregate analysis.

The clearest replication of our baseline finding would be to aggregate households to the district level, then repeat our district estimations of Table 2. This district-level aggregation, however, is problematic due to characteristics of the household sample, which oversamples urban households and omits districts in the northeast.[36] This is especially problematic

[36] We perform a number of tests using the weights provided by CMIE. Weighting generally brings estimates

for our analysis because as shown in Section 3.2, the effects of demonetization are more pronounced for rural, agricultural populations.

To overcome this sampling issue, we focus on household characteristics associated with demonetization: rural and agricultural occupation households.[37] In so doing, our primary estimation strategy for the household panel is of the following form:

$$y_{hit} = \alpha + \beta_D I_{During} \times R_h + \beta_P I_{Post} \times R_h + \beta'_{\mathbf{X}} \mathbf{X_{hit}} + \gamma_h + \gamma_{st} + \epsilon_{hit} \tag{4}$$

We regress monthly (t) total income and expenditures (y) for h households in i districts on the interaction between rural or agricultural occupation households (R_h) and the inital (I_{During}) and post (I_{Post}) demonetization periods. In other words, we estimate the differential effect in income/expenditure from rural or agricultural occupation households by month across relevant time periods. Our hypothesis is that the increases following demonetization in income and expenditures observed in Figure 10 are more pronounced among these groups, so that these groups should have relative increases compared to urban or non-agricultural households. All household-level regressions also include household (γ_h) and state-by-year-month (γ_t) fixed effects, all district-level controls considered in Table 2 (interacted with during- and post- demonetization indicators), and fixed effects for household size, earning members in the household, and months prior to interview.[38]

We are also interested in whether household effects are uniform by district. We expect to see large effects in rural/agriculture households in districts that were more exposed to demonetization (measured by demonetization-centered deposit growth). In other words, the hypothesized increase in income/expenditures for rural households should be larger if that household lives in a district that is more exposed to demonetization. To do so, we estimate an interaction of the following form:

$$\begin{aligned} y_{hit} = \alpha &+ \beta_{D1} I_{During} \times R_h + \beta_{P1} I_{Post} \times R_h \\ &+ \beta_{D2} I_{During} \times DG_i^{2016q3-q4} + \beta_{P2} I_{Post} \times DG_i^{2016q3-q4} \\ &+ \beta_{D3} I_{During} \times R_h \times DG_i^{2016q3-q4} + \beta_{P3} I_{Post} \times R_h \times DG_i^{2016q3-q4} \\ &+ \beta'_{\mathbf{X}} \mathbf{X_{hit}} + \gamma_h + \gamma_{st} + \epsilon_{hit} \end{aligned} \tag{5}$$

Where R is an indicator for either rural or agricultural occupation households, $DG_i^{2016q3-q4}$

more in line with our findings from nighttime lights, but the supplied weights are for national representation, not district aggregations.

[37] Agricultural households are defined as those where at least one member of the household reports their occupation as an agricultural laborer, a small farmer (those engaged only in subsistence farming), or an organized farmer (farmers that sell their produce).

[38] The CMIE samples households 3 times per year. Households then report their monthly income, etc. for the past 4 months.

is district-level, demonetization-centered deposit growth used in the previous regional analysis, and all other notation is identical to Equation (4). Again, our hypothesis is that β_{P3}, which measures the differential effect in income/consumption for rural/ag. households by district level exposure to demonetization, is positive. This positive coefficient suggests relative increases for rural or agricultural households in more exposed districts compared to the pre-demonetization period.

Estimates from Equations (4) and (5) are given for rural households in Table 7 and agricultural occupation households in Table 8. Columns (1) and (2) regress the natural log of household income, while columns (3) and (4) regress the natural log of household expenditures. Equation(4), which estimates direct household effects, is given by odd-numbered columns, and the interaction model of Equation (5) is estimated in even numbered columns. All household estimations include household and state-year-month FE, controls for household characteristics, and district controls (interacted with I_{During} and I_{Post}). While not shown, the piecemeal introduction of controls does not affect our coefficients of interest. As with our base analysis, standard errors are clustered at the district level.

Column (1) of Table 7 shows that rural households did have a relative increase in income compared to urban households. The average monthly income is roughly 2% larger, but statistically insignificant for rural households during the demonetization period of November and December 2016, and 4% larger following demonetization (weakly significant). Looking at the interaction between rural households and district deposit growth in column (2), the post-demonetization monthly increase in income is driven by rural households living in exposed districts. The increase for rural households in districts with a median demonetization-centered deposit is 3% for post-demonetization months. Considering districts that were more exposed to demonetization (90^{th} percentile), the average monthly increase in income becomes 9.4% following demonetizaton.

For expenditures, a similar pattern is observed, but the post-demonetization increase is now statistically insignificant on average. When examining the effect by district exposure, however, we see statistically significant increases in expenditures in the post-demonetization months for rural households. This relative increase in expenditures increases from an average monthly increase of 1.2% for the median district (statistically insignificant) to 4% for district's at the 90^{th} percentile of our exposure variable ($p < 0.01$).

By-month estimates of Table 7 are given in Figure 11. Figure 11 plots the monthly coefficient from regressing the natural log of income and expenditures on an indicator for rural households for either households either above or below the median district deposit growth. As seen, there is no clean increase in income for rural households post-demonetization. Expenditures show a clearer story. For rural households in exposed districts, there is a clear increase in expenditures in the post-demonetization period. This effect, however, is absent for those rural households in districts with less exposure.

The estimates of Table 7 are replicated in Table 8, but in place of rural households we consider agricultural households. Agricultural households are defined as those where at least one member of the household reports their occupation as an agricultural laborer, a small farmer (those engaged only in subsistence farming), or an organized farmer (farmers that sell their produce). The estimates are very similar to rural households. Agricultural households had relative increases in income after demonetization, and these increases are driven by households in exposed districts. On average, agricultural households had an estimated monthly income increase of 12.6% in the months following demonetization (column 1). Moreover, this increase in expenditures is tied to a district's demonetization-centered deposit growth (column 2), from which those in the 90^{th} percentile of district exposure had monthly increases of 21.4%. Expenditures show a similar, but smaller in magnitude effect as income: an average post-demonetization monthly increase of 1.6%, and households in highly exposed districts have an estimated increase of 4.4%. To summarize our results, rural and agricultural households have greater increases in income following demonetization, and this increase is driven mostly by households in more demonetized districts, a finding consistent with our base nighttime lights analysis of Table 2.

Figure 12 replicates Figures 11 , replacing the rural household indicator with an indicator for the head of the household having an agricultural occupation. The estimated effects for agricultural households are similar to those for rural households. While there is a clear increase in expenditures following demonetization, the income results are not clear.

4 Mechanisms

Our main finding is that demonetization led to longer term increases in output–measured by nighttime lights, income, and expenditures. This increase occurred after an initial decline due to chaos from eliminating the most commonly used currency notes in a cash-heavy economy. As far as we know, we are the first to show this increase, which runs counter to other research papers in addition to the common narrative in the media. In the introduction we highlighted two channels that motivate this research. In particular, in this section we discuss these two further. First, we use the household survey to in an effort to gain insights on the reallocation and redistribution mechanism. Second, we examine the regional dynamics of credit. The evidence presented here provides limited support for both of these rationales.

Redistribution/Money Laundering As discussed already, money laundering involved various channels. One potential mechanism for the post-demonetization increase could be tied to redistribution effects from wealthy hoarders of cash. In order to avoid taxes on large cash holdings, cash may have been redistributed to either family members or employees or even rerouted through brokers who found other individuals with low account balances. This in effect would be a transitory income shock for mostly poor households. Similarly other potential mechanisms would be receiving salaries in advance and the settlement of unpaid debt. In these situations, poorer household would likely have been the main beneficiaries.

To examine this potential redistribution, Table 9 examines the effect of rural and agricultural households on income derived from private transfers, which is defined as "income a household receives from a family member as a remittance, or as a gift or donation from any non-government agency". This measure of income directly accounts for the potential redistributive effects from demonetization. In other words, increases in income from private transfers would be indicative of increased redistribution, which can be seen as a transitory income shock.

Indeed, we do find that rural/agricultural households have statistically significant increases in income from private transfers in Table 9; however, this increase occurred *after* demonetization, not during. Columns (1) and (2) respectively examine the direct and interactive effects for rural households, while columns (3) and (4) mirror the estimates of (1) and (2) for agricultural households. On average, rural households show a statistically significant *decline* of 3% per month in income from private transfers during demonetization that is followed by a 3% increase following demonetization. As with income and expenditures, this effect is driven by households in more exposed districts (measured by district demonetization-centered deposit growth), with the during-demonetization decline and post-demonetization increase increasing in magnitude with district exposure–i.e., a during demonetization decline of 3% at the median versus a 5% decline at the 90^{th} percentile, and a post-demonetization increase of 3% at the median versus a 7% increase at the 90^{th} percentile. A similar pattern is seen for agricultural households, which show on average a 3% monthly decline during demonetization, followed by a post-demonetization monthly increase of 2%. As with rural households, the magnitude of this average effect is increased by the household's district's exposure to demonetization.

While an increase in income from private transfers is suggestive of redistribution, this increase should have occurred during demonetization, not months after. Going further, Figure 13 shows the month by month association of rural and agricultural households with private transfers. As seen, the post-demonetization increase from private transfers begins almost a year after demonetization in September 2017, a time well after we would expect. Given that these are self-reported measures of income, there may be some recollection or reporting bias–either accidentally or deliberately given potential legal issues from tax avoidance. Nevertheless, it makes the evidence less compelling.

Credit Our primary way of measuring the spatial intensity of demonetization is to use the increase in banking deposits as shown in Figure 3. While banks were initially flush with deposits, these were obviously temporary. This is seen by the immediate outflow of deposits the quarter after demonetization in the same figure. Given this short term influx of available funds, banks would not be incentivized to make longer term loans.[39]

What is of greater interest is whether there could be medium term effects of district variation in the influx of deposits, i.e. individuals did not feel the need to withdraw all of their deposits and the government was thus possibly partly successful in channeling cash back into the formal banking system. Also, if a portion of the deposits could be attributed to the redistribution channel, there is even less reason for all deposits to be withdrawn. Figure 3 suggests that these might have been at play. To better account for this longer term increase in deposits and any potential effects on credit, we again perform a DD estimation. However, more appropriately, we the use longer term deposit increases - the growth in deposits between Q3 2016 and Q1 2017 as our measure of treatment intensity.

Table 10 replicates our base analysis of Table 2, regressing the natural log of quarterly district-level credit on longer run deposit growth (2016q3-2017q1) - during demonetization (i.e., 2016q4) and post-demonetization. As shown, we estimate no changes to credit associated with this longer term deposit growth during demonetization, but in the quarters after, we observe a statistically significant increase in credit. In other words, districts that had longer-term increases in deposits also had increases in credit. In particular, the estimates of Table 10 suggest a 10 percentage point increase in longer run demonetization-centered deposit growth is associated with a 1.5-2.2% quarterly increase in credit following demonetization. This effect is also seen in Figure 14, which plots the quarterly association between the 2016q3-2017q1 deposit growth and credit. There is a clear increase following demonetization that is absent in the pre-period.

Appendix Table A8 replaces the longer term growth in deposits with our base measure (2016q3-2016q4; Panel A), the share of employment in the agricultural sector (Panel B), the share of small firms in non-agricultural employment (Panel C), and the rural share of the population (Panel D). In general, effects are similar; although, not always statistically significant.

In short, it appears that districts that were more exposed to demonetization did experience a subsequent growth in credit. One concern is that districts that were more exposed to demonetization, had differential pre-trends in credit. In subfigures (b) of A1, and (a) and

[39] Indeed, the Reserve Bank of India (RBI) required this initial influx of deposits to be held as reserves, requiring all additional deposits between September 16^{th} and November 11^{th} to be held as reserves. To compensate interest paid on deposits, however, the 100% reserve ratio period was ended and followed by the RBI issuing short-term debt (Chodorow-Reich et al. 2018). As a result of these actions, the stock of money (i.e., M3) remained relatively constant (Figure 2b)

(b) of A2 of the appendix, we plot the quarterly effect of agricultural employment share, non agricultural small-firm share, and the rural share of the population on district credit. Prior to demonetization, there is a clear increasing trend for districts among all three dimensions, suggesting the post-demonetization increase estimated in Tables 10 and A8 is simply a continuation of this trend and not an increase from the demonetization shock. Nevertheless it does not completely refute our hypothesis. First, most banks in India are state owned, and credit often follows state directed priorities such as lending to agriculture and small scale industry on lenient terms, over and above meeting targets to these and other priority sectors. Cole (2009) also notes that agricultural credit tends to follow election cycles. Gupta et al (2015) note that, despite the removal of various restrictions since the onset of economic reforms in 1991, banks have continued to lend to state governments and state operated entities. Given this backdrop, it is not surprising that while we do see a significant effect, the parallel trends assumption is questionable.

5 Conclusion

If there is one thing that is clear from our analysis, it is that the medium term regional effects of India's demonetization experiment was quite different, if not the polar opposite of the short run disruption. Along with work by others, we find that initial chaos from the shock led to a temporary reduction in economic activity. Throughout 2017 (and to the most recent periods for which data is available) the initial declines were overcome and surpassed by increases in economic activity. These expansionary effects of demonetization are seen in a number of raw statistics, from night time lights (Figure 1) to household income and expenditures (Figure 5).

To identify spatial variation in the effects of demonetization, we focus on deposit growth between the quarters preceding and following demonetization. While capturing the regular deposit of notes, this is also conducive to picking up the spatial aspects of money laundering. Ideally, one would like to have even more granular account data. Nevertheless, deposit growth turns out to be quite informative on its own. To measure differences in economic activity within India, we used a monthly panel of unsaturated nighttime lights from 2015 to the most recently available data of mid-2018. Taken together and given the nature of demonetization—an unanticipated macroeconomic shock, our primary analysis examines differential trends following demonetization from differences in demonetization-centered deposit growth.

Our primary evidence for the effects of demonetization are given by Figure 6 and Table 2, where we show that compared to the months preceding demonetization, there is a clear decline during the enactment of demonetization in November and December of 2016, but after this initial disturbance, there is a clear positive impact. The positive effect is robust to many specifications and controls. Next, we show, best captured in Figure 8, strong associations between demonetization-centered deposit growth and characteristics of districts that would be expected to have more informal, cash heavy activity: districts with a greater share of the labor force in either agricultural work or in small firms and generally more rural districts. Table 6 confirms the use of the alternative measures of intensity of demonetization by showing each measure has the same pattern as our base analysis of Table 2

We extend our analysis to a panel of households. Supporting our district analysis, we estimate relative increases in income and expenditures for rural and agricultural households following demonetization. We also show substantial heterogeneity by district-level exposure to demonetization: rural/agricultural households in districts with greater exposure to demonetization had significantly larger increase in both expenditures and income.

In a preliminary analysis, we explore two potential channels: redistribution and credit. The evidence is only suggestive due to issues such as timing and parallel trends. Thus, while we are confident in the increase in economic activity, more work needs to be done to find the precise causes. The increase can hardly be attributed to the avowed gains from demonetization. While the government might have counted on large scale wealth shocks, increased tax base, and reduction in counterfeit currency, the evidence indicates that the effects of these, at least at the time of writing were minimal. Finally, while we have discussed unintended redistribution, one cannot rule out another crucial aspect of intertemporal optimization- the role of expectations. Jappelli and Pistaferri (2010) note that transitory shocks might have different implications if they also alter expectations about future policy.This might very well have been the case, especially in light of the resounding election success of the incumbent party, the Bharatiya Janata Party (BJP) in 2019.[40] To conclude, India's experiment with demonetization was a unique episode in macroeconomic policy making. Our findings highlight the fact that much more research is needed to understand both intended and unintended consequences.

References

1. Agarwal, Sumit, and Wenlan Qian. 2014. "Consumption and Debt Response to Unanticipated Income Shocks: Evidence from a Natural Experiment in Singapore." American Economic Review, 104 (12): 4205-30. http://dx.doi.org/10.1257/aer.104.12.4205

2. Agarwal, Sumit and Alok, Shashwat and Ghosh, Pulak and Ghosh, Soumya and

[40]Bhavnani and Copelvitch (2018) also document that voters in unbanked districts did not punish the BJP in 2017 state elections.

Piskorski, Tomasz and Seru, Amit, 2017, "Banking the Unbanked: What Do 255 Million New Bank Accounts Reveal about Financial Access?" Columbia Business School Research Paper No. 17-12; Georgetown McDonough School of Business Research Paper No. 2906523; HKUST Finance Symposium 2017; Indian School of Business WP 2906523. Available at SSRN: https://ssrn.com/abstract=2906523

3. Agarwal, Sumit and Basu, Debarati and Ghosh, Pulak and Pareek, Bhuvanesh and Zhang, Jian, 2018. "Demonetization and Digitization." Available at SSRN: https://ssrn.com/abstract=3197990

4. Aggarwal, Nidhi and Sudha Narayanan, 2017, Impact of India's demonetization on domestic agricultural markets, Indira Gandhi Institute of Development Research, Mumbai. http://www.igidr.ac.in/pdf/publication/WP-2017-023.pdf

5. Aladangady, Aditya. 2017. "Housing Wealth and Consumption: Evidence from Geographically-Linked Microdata." American Economic Review, 107 (11): 3415-46. 10.1257/aer.20150491

6. Angrisani, M. , Hurd, M. and Rohwedder, S. 2019. The Effect of Housing Wealth Losses on Spending in the Great Recession, Economic Inquiry, 57: 972-996. https://doi.org/10.1111/ecin.12753

7. Bank of International Settlements, Statistics on payment, clearing and settlement systems in the CPMI countries -Figures for 2014, December 2015, https://www.bis.org/cpmi/publ/d142.pdf

8. Beyer, Robert C. M., Chhabra, Esha, Gado, Virgilio, and Rama,Martin G., 2018. Measuring districts' monthly economic activity from outer space, Policy Research Working Paper Series 8523, The World Bank, Washington, D.C. Link to paper.

9. Bhagwati, Jagdish, Vivek Dehejia, and Pravin Krishna, 2017, "RBI data isn't enough to argue if demonetisation was a success or failure." The Print, November 7. Link to article

10. Bhavnani, Rikhil R and Copelovitch, Mark, 2018, The Political Impact of Monetary Shocks: Evidence from India's 2016 Demonetization, January. Available at SSRN: https://ssrn.com/abstract=3095228

11. Chanda, Areendam and Sujana Kabiraj, 2018, "Shedding Light on Regional Growth and Convergence in India," Available at SSRN: https://ssrn.com/abstract=3308685

12. Chen, Xi and William D. Nordhaus, 2011, "Using luminosity data as a proxy for economic statistics." Proceedings of the National Academy of Sciences, 108 (21) 8589-8594; DOI:10.1073/pnas.1017031108

13. Chodorow-Reich, Gabriel, Gita Gopinath, Prachi Mishra, and Abhinav Naraynan, 2018, Cash and the Economy: Evidence from India's Demonetization", Working Paper, Harvard University, Cambridge. https://scholar.harvard.edu/files/crgmn_demonetization.pdf

14. Chodorow-Reich, Gabriel. 2019. "Geographic Cross-Sectional Fiscal Spending Multipliers: What Have We Learned?" American Economic Journal: Policy 11 (2): 1-34. https://doi.org/10.1257/pol.20160465

15. Cole, Shawn. 2009, "Fixing Market Failures or Fixing Elections? Agricultural Credit in India." American Economic Journal: Applied Economics, 1 (1): 219-50.http://www.aeaweb.org/articles?id=10.1257/app.1.1.219

16. Congressional Budget Office (CBO), 2009, "Cost estimate for the conference agreement for H.R. 1", February 13, 2009, Congressional Budget Office, Washington, D.C.https://www.cbo.gov/publication/41762?index=9989

17. Elvidge, Christopher D, Kimberly Baugh, Mikhail Zhizhin, Feng Chi Hsu and Tilottama Ghosh, 2017, VIIRS nighttime lights, International Journal of Remote Sensing, DOI: 10.1080/01431161.2017.1342050

18. Fetzer, T. (2014). Can workfare programs moderate violence? Evidence from India. STICERD Working Paper.

19. Feyrer, James, Erin T. Mansur, and Bruce Sacerdote, 2017,"Geographic Dispersion of Economic Shocks: Evidence from the Fracking Revolution." American Economic Review, 107 (4): 1313-34. http://www.aeaweb.org/articles?id=10.1257/aer.20151326

20. Ghani, Ejaz; Kerr, William R.; O'Connell, Stephen D.. 2013, "The exceptional persistence of India's unorganized sector" (English). Policy Research working paper ; no. WPS 6454. Washington, DC: World Bank. http://hdl.handle.net/10986/15593

21. Gupta, Poonam, Kalpana Kochhar and Sanjaya Panth, 2015,"Bank ownership and the effects of financial liberalization: evidence from India," Indian Growth and Development Review, vol. 8(1), pages 109-138, April. https://doi.org/10.1108/IGDR-08-2014-0028

22. Henderson, J Vernon , Tim Squires, Adam Storeygard, and David Weil, "The Global Distribution of Economic Activity: Nature, History, and the Role of Trade," The Quarterly Journal of Economics, Volume 133, Issue 1, February 2018, Pages 357–406. https://doi.org/10.1093/qje/qjx030

23. Henderson, J. Vernon, Adam Storeygard, and David N. Weil. 2012. "Measuring Economic Growth from Outer Space." American Economic Review, 102 (2): 994-1028. DOI:10.1257/aer.102.2.994

24. Hsiang, S.M. (2010). Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. PNAS, 107(35), 15367-15372.

25. Hu, Yingyao and Jiaxiong Yao, 2019, Illuminating Economic Growth, IMF Working Paper No. WP/19/77, Washington, D.C. Link to paper

26. Huffington Post India, 2016 (a),"13 Ways In Which Indians Will Convert Their Black Money Into White Even After Demonetisation", November 14th. Link to article

27. Huffington Post India, 2016 (b), “Exclusive: Four Chartered Jets With INR 18 Crore In Cash Landed In Dimapur From Hissar”, November 25th. Link to article

28. India Today, 2016, “Manipur: Insurgent outfits hit by demonetisation, civil bodies apprehensive of possible retaliation”, Link to article

29. Jappelli, Tullio and Luigi Pistaferri, 2010, “The Consumption Response to Income Changes.” Annual Review of Economics 2010 2:1, 479-506 , 10.1146/annurev.economics.050708.142933,

30. Koning, J. P. , 2017, “No Rupees Left Behind.” Moneyness, September 5th. https://jpkoning.blogspot.com/2017/09/no-rupees-left-behind.html

31. KPMG, 2016, “The Colour of Money: Black or White?”, White Paper, KPMG India. Link to paper.

32. Mian, Atif, and Amir Sufi. 2014. “What Explains the 2007–2009 Drop in Employment?” Econometrica, 82 (6): 2197–2223. https://doi.org/10.3982/ECTA10451

33. Ministry of Finance, Government of India, 2017, Economic Survey 2016–17, https://www.indiabudget.gov.in/budget2017-2018/survey.asp

34. Nakamura, Emi, and Jón Steinsson. 2018. “Identification in Macroeconomics.” Journal of Economic Perspectives, 32 (3): 59-86.10.1257/jep.32.3.59

35. National Commission for Enterprises in the Unorganised Sector (NCEUS), 2009, “The Challenge of Employment in India: An Informal Economy Perspective,” Ministry of Micro, Small and Medium Enterprises, Govt of India, New Delhi. http://dcmsme.gov.in/The_Challenge_of_Employment_in_India.pdf

36. Mazzotta Benjamin D., B. Chakravorti, R. Bijapurkar, R. Shukla, K. Ramesha, D. Bapat and D. Roy, 2014, “The Cost of Cash in India,” The Institute for Business in the Global Context, Fletcher School of Law and Diplomacy, Tufts University, Somerville. Link to report

37. Modi, Narendra, 2016, “India takes historic step to fight Corruption, Black Money and Terrorism,” Government of India. Link to speech

38. Pinkovskiy,Maxim and Xavier Sala-i-Martin, 2016, “Lights, Camera … Income! Illuminating the National Accounts-Household Surveys Debate,” The Quarterly Journal of Economics, Volume 131, Issue 2, May, Pages 579–631, https://doi.org/10.1093/qje/qjw003

39. Subramanian, Arvind, 2019, “India’s GDP Mis-estimation: Likelihood, Magnitudes, Mechanisms, and Implications”, CID Faculty Working Paper No. 354, Harvard University. Link to paper

Tables and Figures

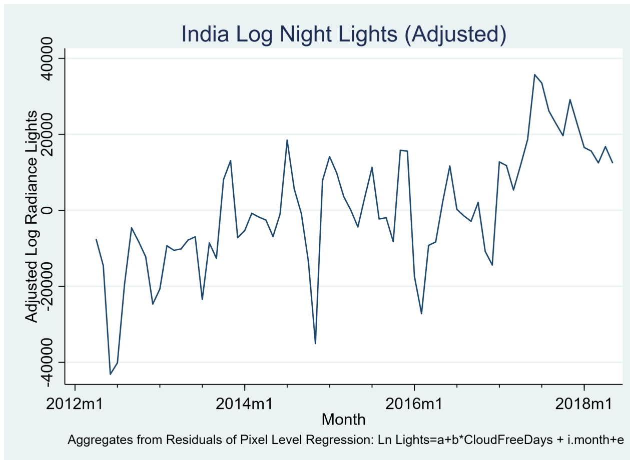
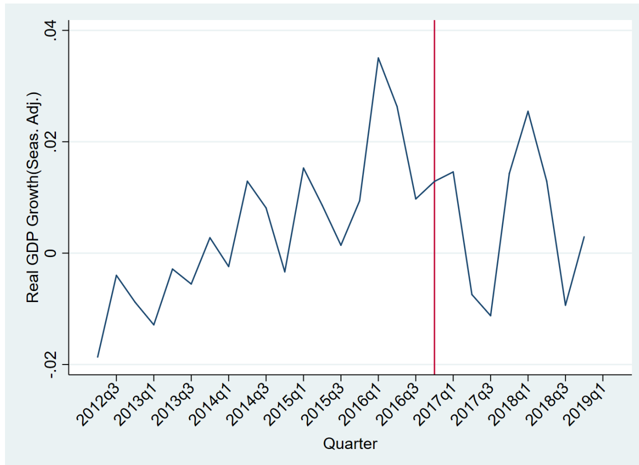
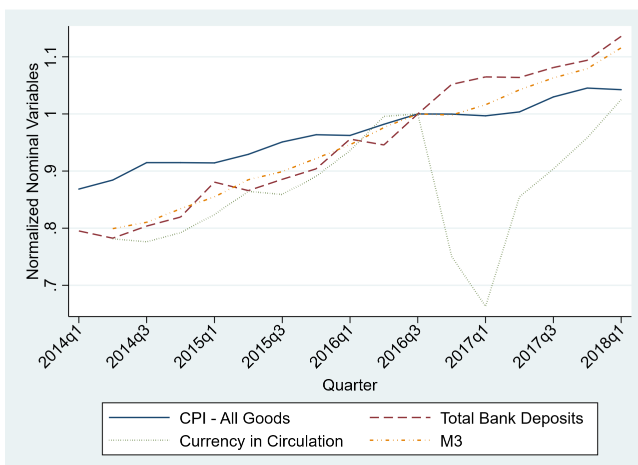


Figure 1: Nighttime Lights (India, demeaned)

Summary & Notes: This figure plots nighttime lights–demeaned by month and cloud free days–by month. As seen, this relatively unaltered data shows a clear increase in nighttime lights following demonetization in November of 2016.



(a) Growth in Quarterly Real GDP



(b) Trends in Nominal Variables

(c) Trends in Macroeconomic Variables

Summary & Notes: Sub-figure (a) plots the annual growth rates in quarterly real GDP after subtracting the 2012-15 mean growth for the corresponding quarter. The red vertical line marks the demonetization quarter (2016q4). Sub-figure (b) plots the normalized values for the four series. All series are normalized with respect to the quarter preceding demonetization (2016q3).

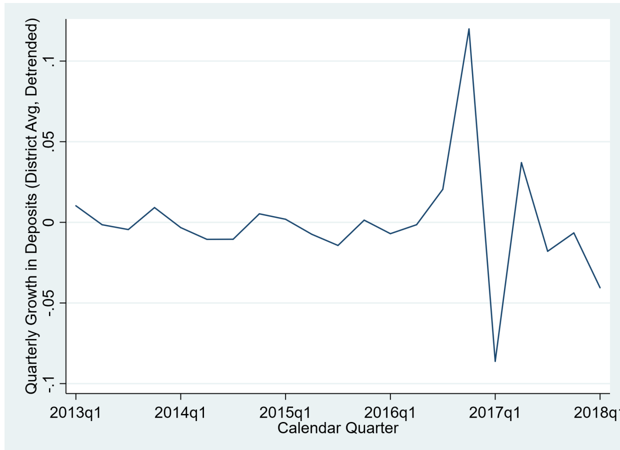


Figure 3: Quarterly Growth in Deposits

Summary & Notes: This figure plots the mean of district level quarterly growth rate of deposits relative to the quarterly mean (2011-2015 average of corresponding quarters). As shown, there is a large relative increase in deposits centered around demonetization.

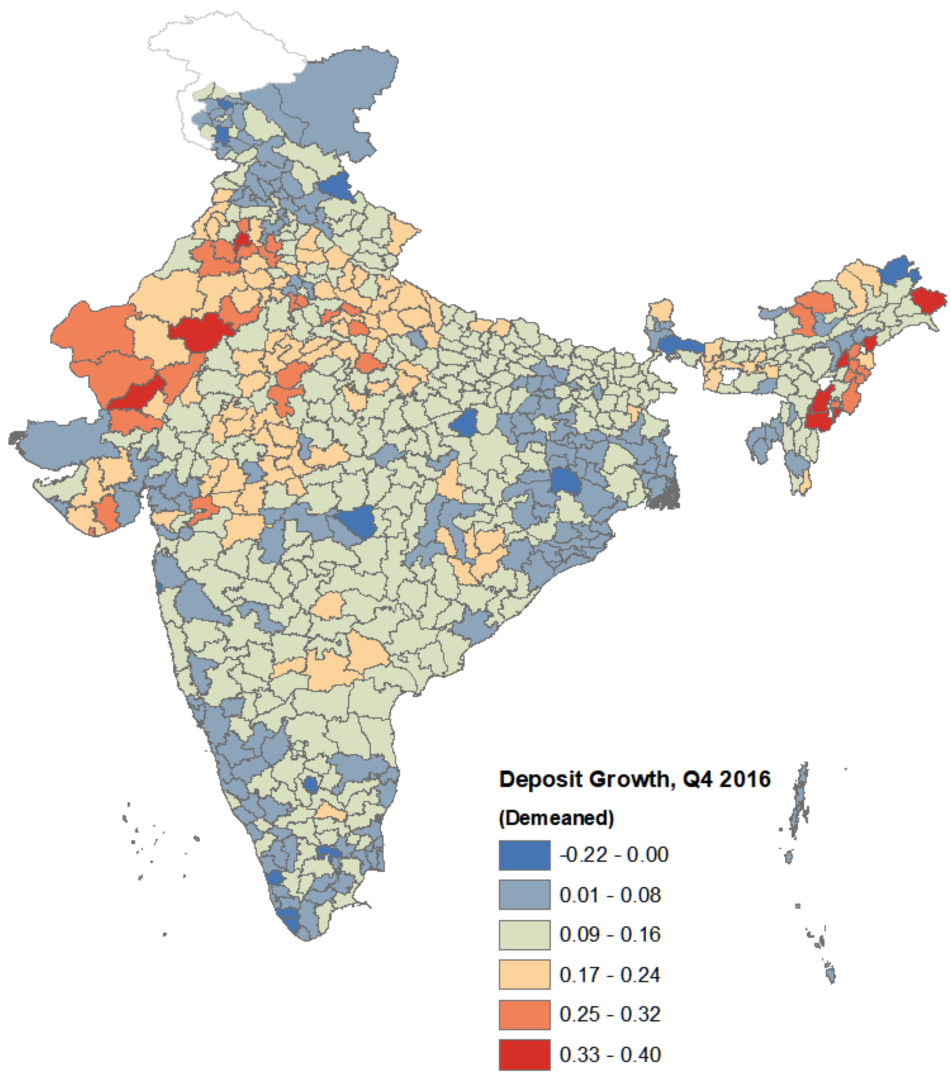


Figure 4: 4th Quarter Deposit Growth by District

Summary & Notes: This map shows the district level quarterly growth rate of deposits between the 3rd and 4th Quarter of 2016 relative to the quarterly mean (2011-2015 average growth for the corresponding district and quarter). Districts are based on the 2011 census.

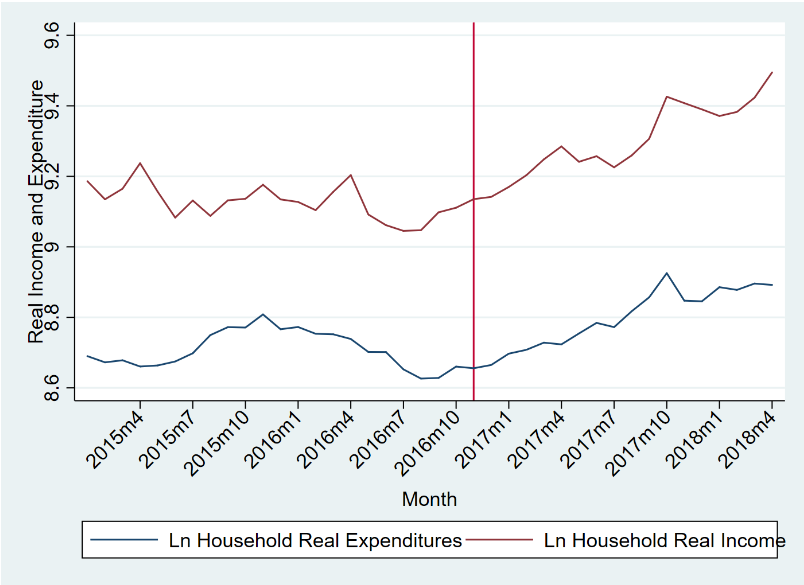


Figure 5: Real Household Income and Expenditures (Consumer Pyramids)

Summary & Notes: The figure shows household expenditures and incomes from the Consumer Pyramid survey. It only includes households used in our empirical analysis- those with responses for at least 12 months each, preceding and following demonetization. The values are deflated using the CPI (base 2012=100). Survey weights were used to arrive at the mean values depicted in the figure.

Table 1: Parallel Trends?

Dependent variable: ln of monthly night time lights, Jan. 2015 - Oct. 2016	(1)	(2)	(3)	(4)	(5)
Trend × Deposit Growth, 2016q3-2016q4	0.001	-0.001	0.004	-0.010	-0.006
	(0.011)	(0.008)	(0.008)	(0.007)	(0.008)
Trend	-0.008***	0.001	-0.041***	0.028**	0.003
	(0.002)	(0.006)	(0.011)	(0.013)	(0.015)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × Trend	N	N	Y	N	Y
Geoclimatic Controls × Trend	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State trends	N	Y	Y	Y	Y
Observations	13750	13750	13750	13750	13750
R Sqr.	0.842	0.883	0.883	0.884	0.884

Summary & Notes: The insignificant interaction between the trend variable and the growth of deposits from demonetization is suggestive that linear trends were indeed parallel prior to treatment. Growth of Deposits is the district-level percentage change in deposits from quarter 3 to quarter 4 of 2016; a time range that captures demonetization. Standard errors are clustered by district, and statistical signficance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

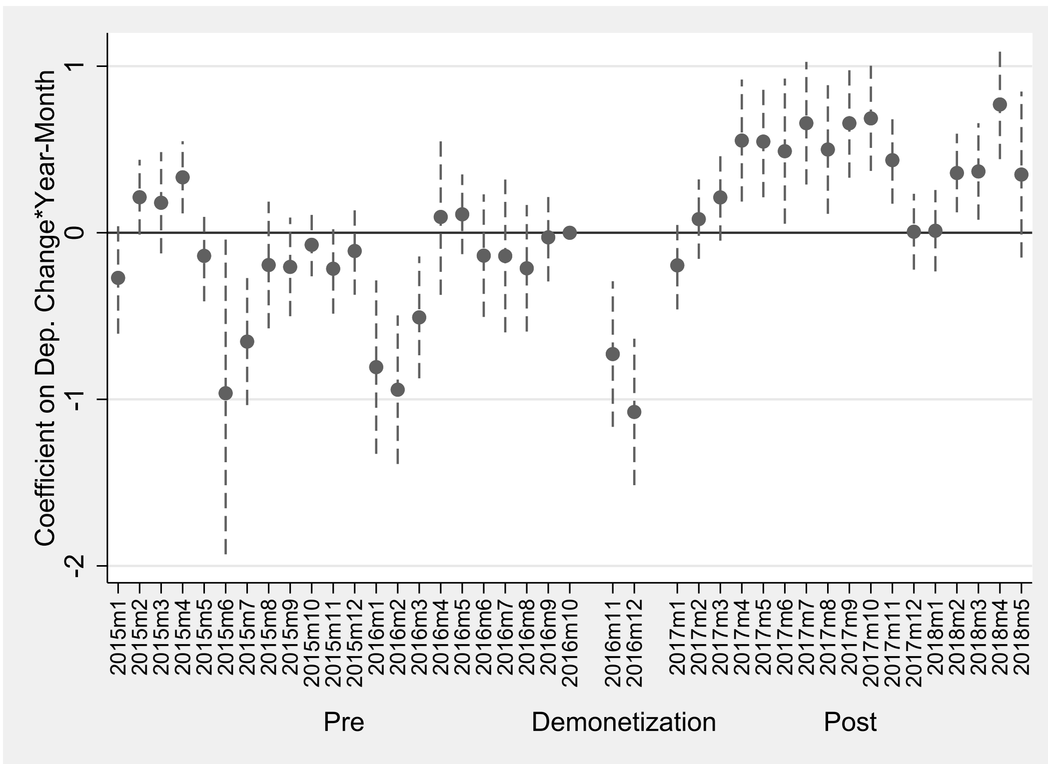


Figure 6: Event Figure- Growth of Deposits 2016q3-2016q4

Summary & Notes: This figure plots the relationship between our primary measure of demonetization intensity and nighttime lights by month, omitting the period prior to demonetization (Oct. 2016). No clear relationship exists prior to demonetization; during demonetization a negative coefficient is estimated; and after demonetization a general positive relationships is seen.

Table 2: Base estimation
The change in nighttime lights from demonetization

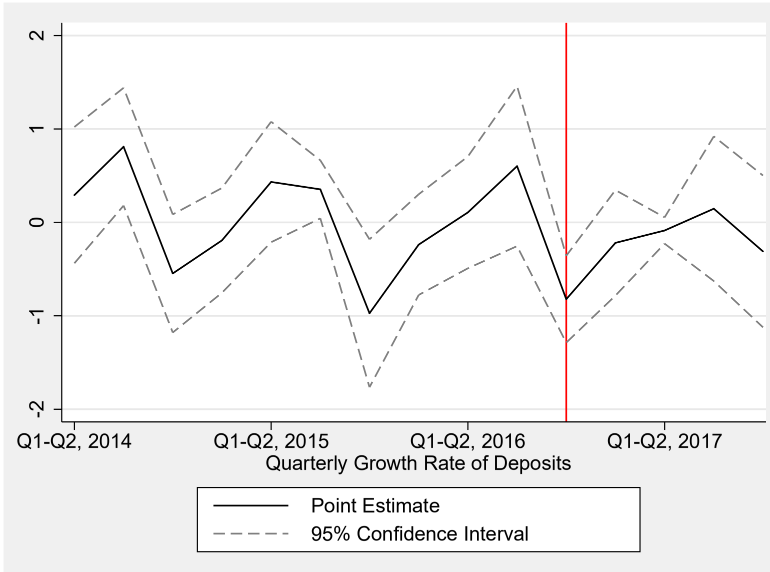
	Dependent variable: ln of monthly night time lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During} \times$ Deposit Growth, 2016q3-2016q4	-0.689***	-0.691***	-0.366**	-0.742***	-0.313*
	(0.221)	(0.222)	(0.159)	(0.214)	(0.168)
	[0.222]	[0.224]	[0.156]	[0.209]	[0.164]
	{0.224}	{0.228}	{0.168}	{0.214}	{0.175}
$I_{Post} \times$ Deposit Growth, 2016q3-2016q4	0.533***	0.594***	0.427***	0.764***	0.558***
	(0.126)	(0.127)	(0.113)	(0.112)	(0.115)
	[0.089]	[0.089]	[0.080]	[0.079]	[0.081]
	{0.091}	{0.092}	{0.084}	{0.081}	{0.086}
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.941	0.945	0.946	0.947	0.947

Summary & Notes: This table represents our baseline estimation. We use the quarterly growth in deposits from demonetization to measure a district's intensity of exposure to demonetization. We then look at the relative difference on nighttime lights for the initial implementation period–i.e., $I_{During} = 1$ for November and December 2016–and at the longer term effects of demonetization–i.e., $I_{Post} = 1$ for January 2017 till May 2018. Geoclimatic controls include the district-level mean and standard deviation of agricultural suitability, precipitation, temperature, malaria suitability; and mean of ruggedness, area, coastal land, and indicators for each biome. Time invariant controls are interacted with I_{During} and I_{Post}. Standard errors are clustered by district in parentheses–"( )"–and by spatially adjusted district for 30km in brackets–"[ ]"–and 200km in braces–"{ }". Statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

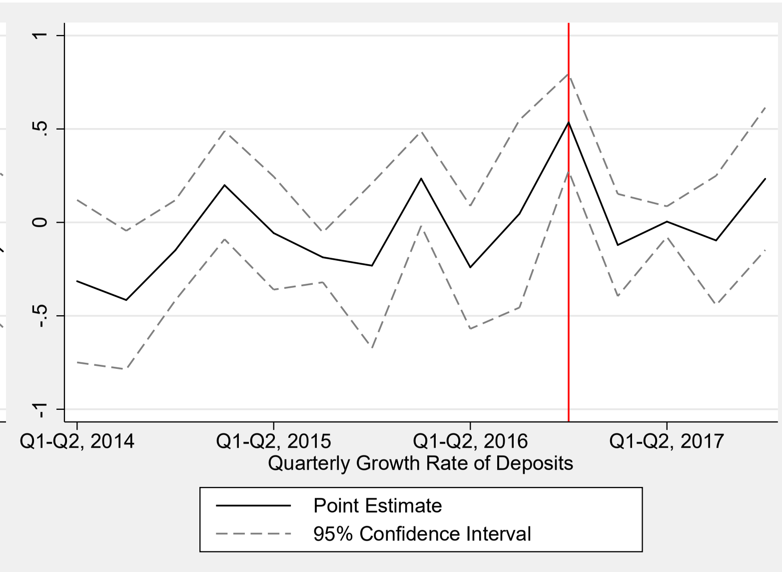
Table 3: Placebo test: Alternative treatment date

	Dependent variable: ln of monthly night time lights, Jan. 2014 - Oct. 2016				
	(1)	(2)	(3)	(4)	(5)
$I_{During,t-12} \times$ Deposit Growth, 2016q3-2016q4	0.036	0.040	0.114	0.031	0.142*
	(0.098)	(0.098)	(0.111)	(0.087)	(0.086)
$I_{Post,t-12} \times$ Deposit Growth, 2016q3-2016q4	-0.052	-0.054	-0.006	-0.120	-0.094
	(0.085)	(0.083)	(0.090)	(0.084)	(0.091)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	21250	21250	21250	21250	21250
R Sqr.	0.942	0.945	0.945	0.946	0.946

Summary & Notes: This table moves the treatment date back by a year to November of 2015. Compared to the coefficients of Table 2, the magnitudes are generally lessened and the opposite sign, and no statistically significant coefficients are estimated. This table confirms November 2016 as the true treatment date. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.



(a) $I_{During} \times Qtr.Growth$



(b) $I_{Post} \times Qtr.Growth$

Figure 7: Effects from Quarterly Growth in Deposits for All Quarters

Summary & Notes: This figure plots coefficients from the regression specification of column (5) of Table 2, replacing the change in deposits centered around demonetization with the specified quarterly change. Sub-figure (a) plots the effect of the specified quarterly growth of deposits on nighttime lights in the immediate months of demonetization (Nov. and Dec. 2016), and sub-figure (b) plots the same effect for the subsequent months. The red reference line marks 2016 Q3-Q4 growth in deposits. As seen the largest estimated effect on nighttime lights is seen for the change in deposits around demonetization. This supports our use of the 2016 Q3-Q4 growth in deposits as a proxy for the saliencey of demonetization.

Table 4: Controlling for Pretrends

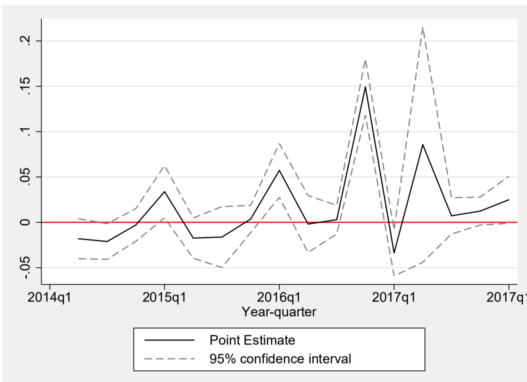
Dependent variable: ln of monthly night time lights, Jan. 2015 - May 2018	(1)	(2)	(3)	(4)
During Demonetization Indicator ×				
Deposit Growth, 2016q3-2016q4	-0.3190*	-0.1948	-0.2093	-0.1656
	(0.1681)	(0.1879)	(0.1800)	(0.1735)
Mean Deposit Growth, 2014q1-2016q3	-0.3618		-0.9665	-0.8340
	(0.8017)		(0.7854)	(0.7567)
Mean Light Growth, Jan. 2014-Oct. 2016		-12.8481***	-12.9554***	-12.6173***
		(1.9896)	(1.9739)	(1.9564)
Deposit Growth, 2016q2-2016q3				0.4849
				(0.2989)
Deposit Growth, 2015q3-2015q4				-0.5834*
				(0.3373)
Post Demonetization Indicator ×				
Deposit Growth, 2016q3-2016q4	0.5470***	0.4643***	0.4609***	0.5054***
	(0.1133)	(0.0867)	(0.0874)	(0.0881)
Mean Deposit Growth, 2014q1-2016q3	-0.6980		-0.2280	-0.2433
	(0.5221)		(0.4135)	(0.4025)
Mean Light Growth, Jan. 2014-Oct. 2016		10.1052***	10.0799***	10.1913***
		(0.7484)	(0.7509)	(0.7397)
Deposit Growth, 2016q2-2016q3				-0.0925
				(0.1532)
Deposit Growth, 2015q3-2015q4				-0.4613***
				(0.1777)
Controls:				
ln Cloud Free Days	Y	Y	Y	Y
ln Population c.2011 × During & Post	Y	Y	Y	Y
Geoclimatic Controls × During & Post	Y	Y	Y	Y
District FE	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y
Observations	25625	25625	25625	25625
R Sqr.	0.9482	0.9497	0.9497	0.9497

Summary & Notes: This table controls for the effect from differing quarterly changes in deposits to show that our base measure–i.e., the change in deposits centered around demonetization–is what is driving the findings of Table 2. We also explicitly control for the average growth rate of nighttime lights during the pre-period. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

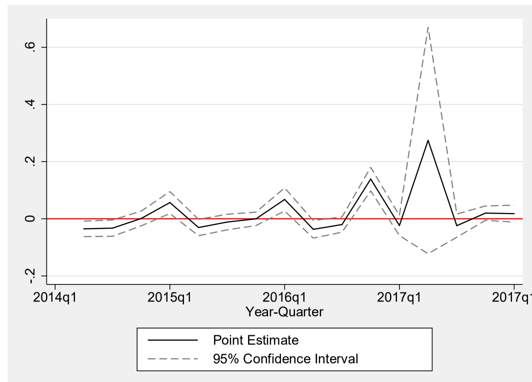
Table 5: Correlation Between Different Treatment Measures (n=625)

	Deposit Growth	Rural Pop Sh.	Small Firm Share	Agr. Labor Share.
Deposit Growth	1.00			
Rural Pop Share	0.27	1.00		
Small Firm Share	0.21	0.43	1.00	
Agric. Labor Share	0.33	0.79	0.51	1.00

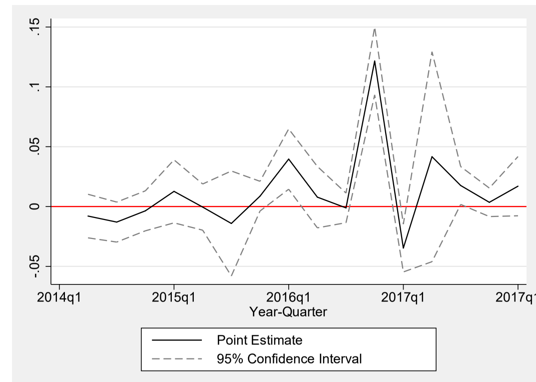
Summary & Notes: This table provides the correlation between our main measure of exposure to demonetization, the growth rate of deposits between Q3 and Q4 of 2016 with other district characteristics - the rural population share (2011 Census), the share of agricultural labor in the workforce (2011 Census), and the share of non-agricultural workers in firms with less than 10 workers (6th Economic Census, 2013-14).



(a) Agr. Share



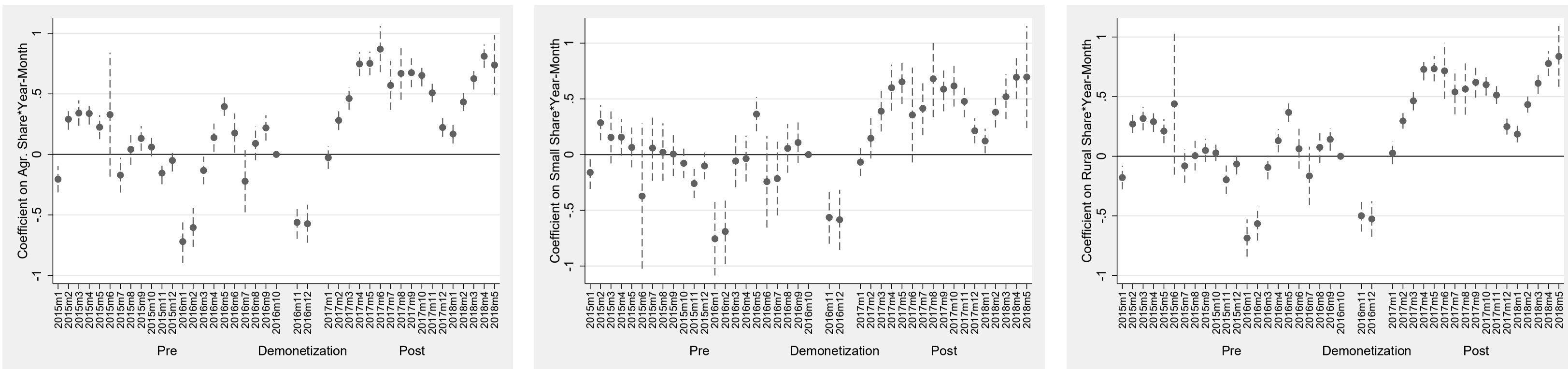
(b) Non-Ag Small Firm Share



(c) Rural Pop. Share

Figure 8: Agriculture, Rural, and Small Firms District Exposure to Demonetization

Summary & Notes: This figure plots the estimated relationship between the share of the workforce in agriculture (a), non-agricultural labor force share (b) and a district's rural population share (c) and the quarterly growth in deposits. As seen, a statistically significant and positive association with the growth of deposits is only seen during demonetization. As we expect, demonetization is more salient for these populations, who have greater involvement in informal markets.



(a) Agr. Labor Share **(b)** Non-Ag Small Firm Labor Share **(c)** Rural Pop. Share

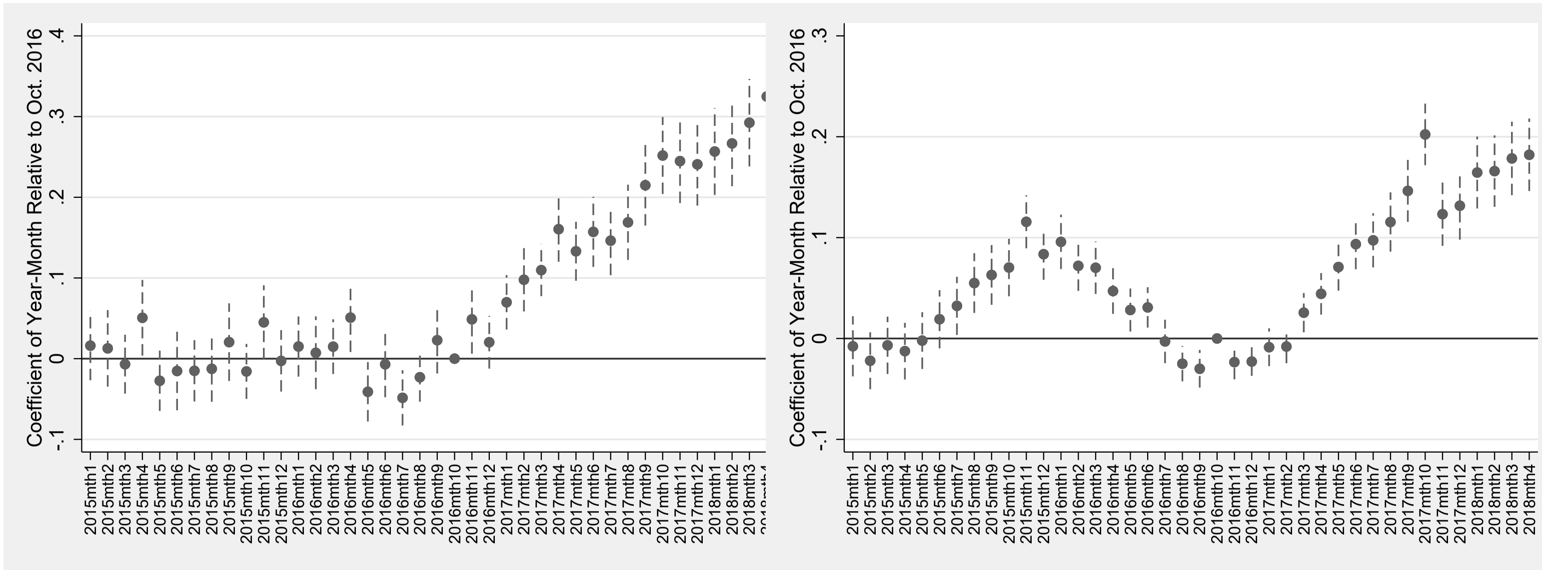
Figure 9: Monthly Effect of Agr./Small Firms/Rural on nighttime Lights

Summary & Notes: This figure plots the monthly effect of share of the workforce in agriculture (a), non-agricultural labor force share (b) and a district's rural population share (c) on the natural log of nighttime lights, omitting October 2016. The effects mirror those of Fig. 6, which uses Q3-Q4 deposit growth.

Table 6: Effect from alternative measures of informality

	(1)	(2)	(3)	(4)	(5)
Dependent variable: ln of monthly night time lights, Jan. 2014 - May 2018					
Panel A. Agricultural Labor					
$I_{During}\times$ Share of workforce in agriculture (c.2011)	-0.594***	-0.584***	-0.299***	-0.583***	-0.260***
	(0.068)	(0.070)	(0.071)	(0.072)	(0.085)
$I_{Post}\times$ Share of workforce in agriculture (c.2011)	0.516***	0.519***	0.407***	0.523***	0.421***
	(0.039)	(0.038)	(0.044)	(0.034)	(0.045)
Observations	25625	25625	25625	25625	25625
R Sqr.	0.942	0.947	0.947	0.948	0.949
Panel C. Small Firm Share					
$I_{During}\times$ Share of workforce in small firms (c.2011)	-0.485***	-0.458***	-0.251**	-0.447***	-0.220*
	(0.137)	(0.144)	(0.113)	(0.146)	(0.115)
$I_{Post}\times$ Share of workforce in small firms (c.2011)	0.516***	0.532***	0.430***	0.516***	0.408***
	(0.077)	(0.075)	(0.072)	(0.067)	(0.064)
Observations	25625	25625	25625	25625	25625
R Sqr.	0.941	0.945	0.947	0.947	0.948
Panel C. Rural Share					
$I_{During}\times$ Rural Share (c.2011)	-0.523***	-0.498***	-0.224***	-0.478***	-0.189**
	(0.067)	(0.069)	(0.070)	(0.065)	(0.075)
$I_{Post}\times$ Rural Share (c.2011)	0.507***	0.506***	0.406***	0.484***	0.394***
	(0.040)	(0.038)	(0.040)	(0.034)	(0.040)
Observations	25625	25625	25625	25625	25625
R Sqr.	0.942	0.947	0.947	0.948	0.949
Controls (all panels):					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y

Summary & Notes: Given the relationship between the share of labor in agriculture and the district-level rural share and our primary measure of demonetization intensity in Figure 3, Table 7 replaces the Q3-Q4 growth in deposits with the agricultural share (Panel A) and the rural share (Panel B) and re-estimates our baseline findings of Table 2. Results remain similar to those of Table 2. Districts more exposed to demonetization are shown to have an initial decrease that is quickly overcome in the following months. Standard errors are clustered by district, and statistical signficance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

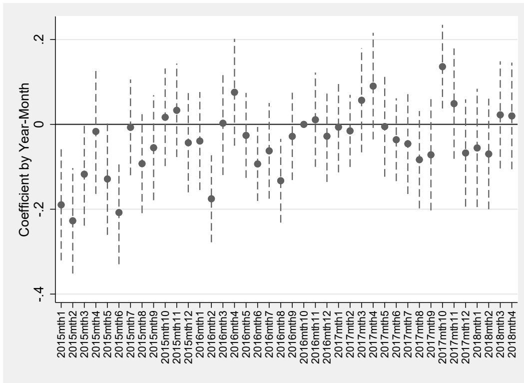


(a) ln Income

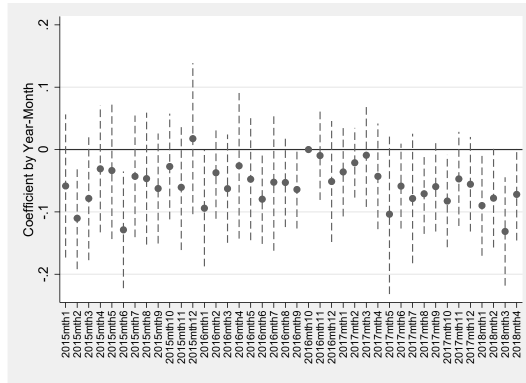
(b) ln Expenditures

Figure 10: Plot of Year-Month FE in HH Survey

Summary & Notes: This figure plots the coefficient from year-month indicators (or year-month FE) relative to the omitted month, October 2016. No clear differences in income are seen relative to October 2016, the month prior to demonetization, but after demonetization there is a clear estimated increase in reported income. Expenditures were generally higher in the pre-period but also show a clear rise following demonetization.

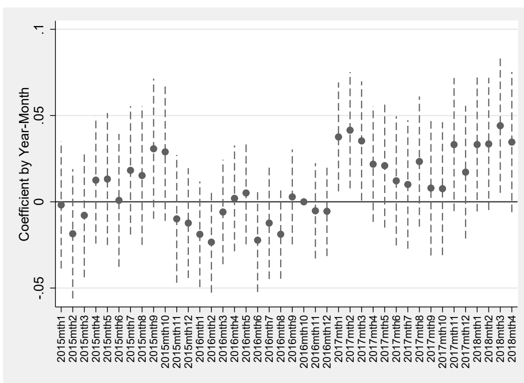


(a) $\geq 50^{th}$ percentile

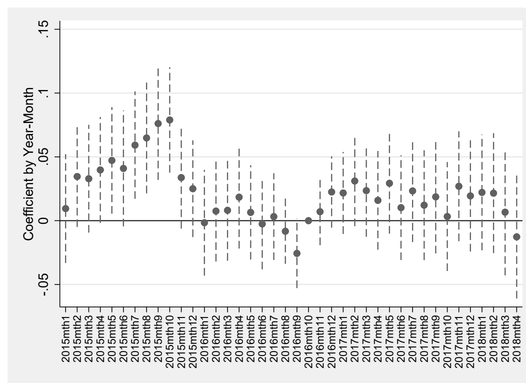


(b) $< 50^{th}$ percentile

ln HH Income



(c) $\geq 50^{th}$ percentile



(d) $< 50^{th}$ percentile

ln HH Expenditures

Figure 11: Rural HH by Month

Summary & Notes: This figure plots the monthly effect of rural households in districts above and below median 2016q3-2016q4 deposit growth. Coefficients are estimated using all controls specified in Table 7, and all coefficients are relative to the month prior to demonetization (October 2016).

Table 7: Demonetization's Effect on Rural Households

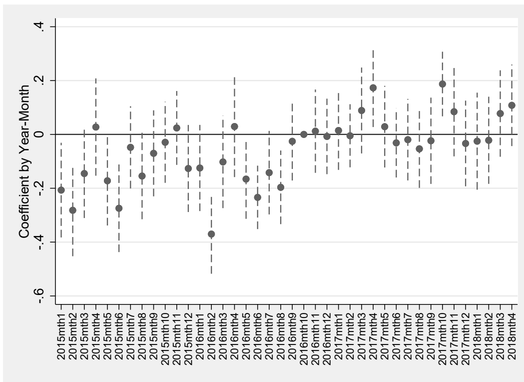
Dependent variable:	ln HH Income		ln HH Expenditures	
	(1)	(2)	(3)	(4)
$I_{During}\times$ Rural HH	0.017	0.092**	-0.022**	-0.011
	(0.019)	(0.046)	(0.011)	(0.026)
$I_{Post}\times$ Rural HH	0.035*	-0.065	0.014	-0.040
	(0.018)	(0.041)	(0.010)	(0.028)
$I_{During}\times$ Dist. Dep. Growth		0.095		0.083
		(0.203)		(0.192)
$I_{Post}\times$ Dist. Dep. Growth		-0.324		-0.303*
		(0.208)		(0.178)
$I_{During}\times$ Rural HH $\times$ Dep. Growth		-0.585*		-0.308
		(0.344)		(0.210)
$I_{Post}\times$ Rural HH $\times$ Dep. Growth		0.787***		0.412**
		(0.292)		(0.186)
Controls				
Household FE	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y
Months Prior to Interview FE	Y	Y	Y	Y
Total HH Member FE	Y	Y	Y	Y
Total Earning Member FE	Y	Y	Y	Y
HH Characteristics $\times$ During & Post	Y	Y	Y	Y
District Characteristics $\times$ During & Post	Y	Y	Y	Y
Marginal Effect, Dep. Growth = 50th percentile:				
$I_{During}\times$ Rural HH		0.021		-0.021*
		(0.019)		(0.011)
$I_{Post}\times$ Rural HH		0.030*		0.012
		(0.018)		(0.010)
Marginal Effect, Dep. Growth = 90th percentile:				
$I_{During}\times$ Rural HH		-0.024		-0.027
		(0.033)		(0.016)
$I_{Post}\times$ Rural HH		0.090***		0.039***
		(0.028)		(0.015)
Observations	4385805	4385805	4385805	4385805
R Sqr.	0.516	0.516	0.603	0.603

Summary & Notes: Using a household panel, this table confirms the findings our baseline aggregate analysis. Columns (1) and (3) show directly that rural households have relative increases in both income and expenditures following demonetization. Columns (2) and (4) explore an interaction framework to show that this increase is driven by households in districts that were more exposed to demonetization. The household panel is weakly balanced to include only households with 12 months of data both pre and post demonetization. Household characteristics include the average age of the household, the number of household members under 16 years of age, and the mean years of schooling for household members 25 and older. Geoclimatic controls include the district-level mean and standard deviation of agricultural suitability, precipitation, temperature, malaria suitability, ruggedness, area, coastal land, and indicators for each biome. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

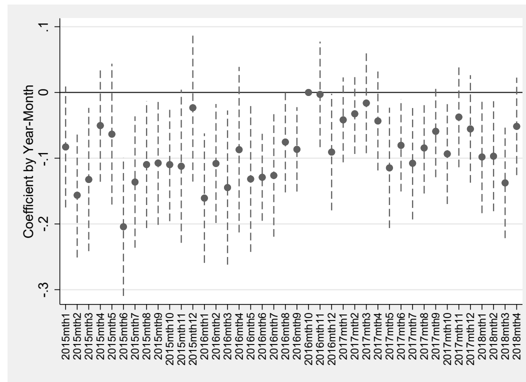
Table 8: Demonetization's Effect on Agricultural Households

Dependent variable:	ln HH Income		ln HH Expenditures	
	(1)	(2)	(3)	(4)
$I_{During} \times$ Agr. HH	-0.008	0.040	-0.016*	0.017
	(0.021)	(0.050)	(0.008)	(0.022)
$I_{Post} \times$ Agr. HH	0.119***	-0.023	0.017**	-0.039
	(0.021)	(0.044)	(0.008)	(0.024)
$I_{During} \times$ Dist. Dep. Growth		0.014		0.039
		(0.197)		(0.179)
$I_{Post} \times$ Dist. Dep. Growth		-0.346*		-0.272
		(0.201)		(0.169)
$I_{During} \times$ Agr. HH $\times$ Dep. Growth		-0.370		-0.249*
		(0.362)		(0.151)
$I_{Post} \times$ Agr. HH $\times$ Dep. Growth		1.098***		0.436***
		(0.315)		(0.158)
Controls				
Household FE	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y
Months Prior to Interview FE	Y	Y	Y	Y
Total HH Member FE	Y	Y	Y	Y
Total Earning Member FE	Y	Y	Y	Y
HH Characteristics $\times$ During & Post	Y	Y	Y	Y
District Characteristics $\times$ During & Post	Y	Y	Y	Y
Marginal Effect, Dep. Growth = 50th percentile:				
$I_{During} \times$ Agr. HH		-0.005		-0.014
		(0.021)		(0.008)
$I_{Post} \times$ Agr. HH		0.110***		0.014*
		(0.021)		(0.008)
Marginal Effect, Dep. Growth = 90th percentile:				
$I_{During} \times$ Agr. HH		-0.033		-0.024**
		(0.034)		(0.012)
$I_{Post} \times$ Agr. HH		0.194***		0.043***
		(0.031)		(0.011)
Observations	4385805	4385805	4385805	4385805
R Sqr.	0.517	0.517	0.603	0.603

Summary & Notes: This table replicates Table 8, replacing the indicator for rural households with an indicator for the head of the household being an agricultural worker. Agricultural laborers are defined as the head of the household reporting either agricultural labor or small farmer as his/her primary occupation. Household characteristics include the average age of the household, the number of household members under 16 years of age, and the mean years of schooling for household members 25 and older. Geoclimatic controls include the district-level mean and standard deviation of agricultural suitability, precipitation, temperature, malaria suitability, ruggedness, area, coastal land, and indicators for each biome. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

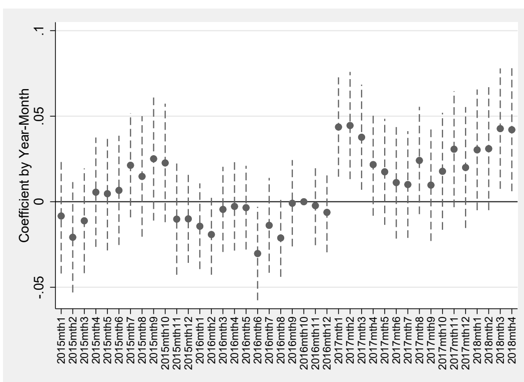


(a) $\geq 50^{th}$ percentile

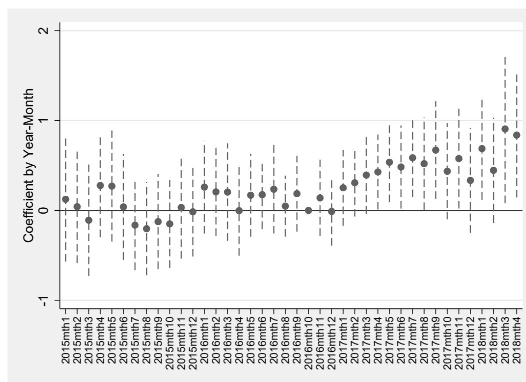


(b) $< 50^{th}$ percentile

ln HH Income



(c) $\geq 50^{th}$ percentile



(d) $< 50^{th}$ percentile

ln HH Expenditures

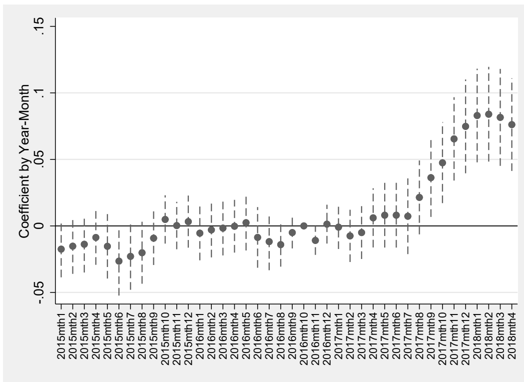
Figure 12: Agriculture HH by Month

Summary & Notes: This figure plots the monthly effect of agricultural households in districts above and below median 2016q3-2016q4 deposit growth. Agricultural households take the value of 1 if at least one household member has an occupation of agricultural laborer, small farmer, or organized farmer, and 0 otherwise. Coefficients are estimated using all controls specified in Table 8, and all coefficients are relative to the month prior to demonetization (October 2016).

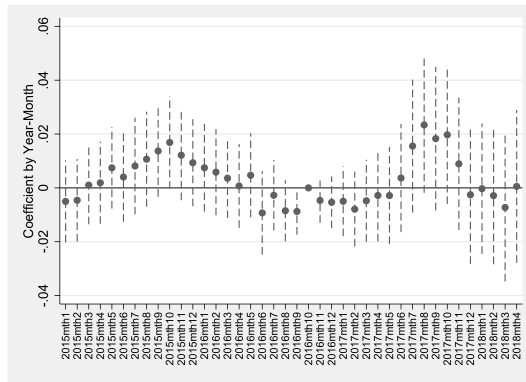
Table 9: Effect on Private Transfers

Dependent variable: ln monthly income from private transfers, Jan. 2015-Apr. 2018				
	Rural HH		Agr. HH	
	(1)	(2)	(3)	(4)
$I_{During} \times$ HH	-0.031***	0.012	-0.029***	0.008
	(0.007)	(0.016)	(0.007)	(0.019)
$I_{Post} \times$ HH	0.029***	-0.034**	0.017***	-0.027
	(0.007)	(0.016)	(0.006)	(0.019)
$I_{During} \times$ Dist. Dep. Growth		0.050		0.000
		(0.082)		(0.076)
$I_{Post} \times$ Dist. Dep. Growth		-0.218**		-0.126
		(0.092)		(0.092)
$I_{During} \times$ HH $\times$ Dep. Growth		-0.335***		-0.282**
		(0.116)		(0.134)
$I_{Post} \times$ HH $\times$ Dep. Growth		0.501***		0.341***
		(0.113)		(0.127)
Controls				
Household FE	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y
Months Prior to Interview FE	Y	Y	Y	Y
Total HH Member FE	Y	Y	Y	Y
Total Earning Member FE	Y	Y	Y	Y
HH Characteristics $\times$ During & Post	Y	Y	Y	Y
District Characteristics $\times$ During & Post	Y	Y	Y	Y
Marginal Effect, Dep. Growth = 50th percentile:				
$I_{During} \times$ Agr. HH		-0.029***		-0.026***
		(0.007)		(0.007)
$I_{Post} \times$ Agr. HH		0.027***		0.014**
		(0.007)		(0.007)
Marginal Effect, Dep. Growth = 90th percentile:				
$I_{During} \times$ Agr. HH		-0.054***		-0.048***
		(0.011)		(0.011)
$I_{Post} \times$ Agr. HH		0.065***		0.040***
		(0.010)		(0.009)
Observations	4385805	4385805	4385805	4385805
R Sqr.	0.560	0.560	0.560	0.560

Summary & Notes: This table replicates Table 8, replacing the indicator for rural households with an indicator for the head of the household being an agricultural worker. Agricultural laborers are defined as the head of the household reporting either agricultural labor or small farmer as his/her primary occupation. Household characteristics include the average age of the household, the number of household members under 16 years of age, and the mean years of schooling for household members 25 and older. Geoclimatic controls include the district-level mean and standard deviation of agricultural suitability, precipitation, temperature, malaria suitability, ruggedness, area, coastal land, and indicators for each biome. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

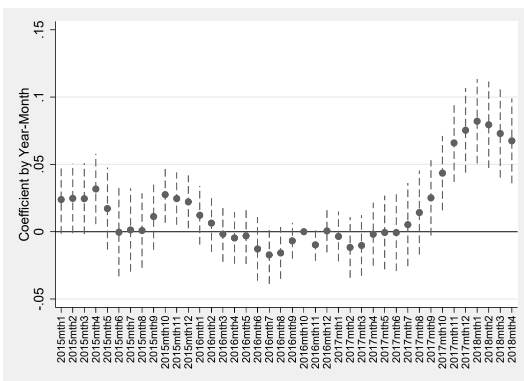


(a) $\geq 50^{th}$ percentile

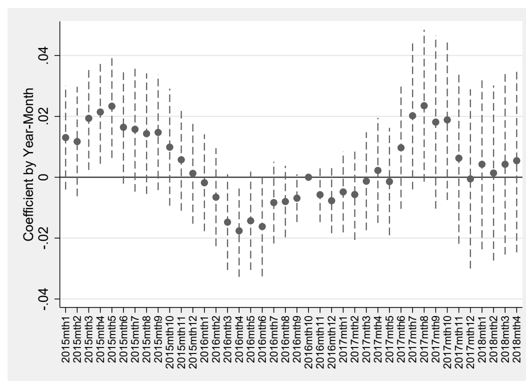


(b) $< 50^{th}$ percentile

Rural HH



(c) $\geq 50^{th}$ percentile



(d) $< 50^{th}$ percentile

Agricultural HH

Figure 13: Effect on Private Transfers by Month

Summary & Notes: This figure plots the monthly effect of rural and agricultural households in districts above and below median 2016q3-2016q4 deposit growth. Subfigures (a) and (b) consider rural households, while subfigures (c) and (d) consider agricultural households. Agricultural households take the value of 1 if at least one household member has an occupation of agricultural laborer, small farmer, or organized farmer, and 0 otherwise. Coefficients are estimated using all controls specified in Table 7 and 8, and all coefficients are relative to the month prior to demonetization (October 2016).

Table 10: Credit Post Demonetization

	Dependent variable: ln of quarterly credit, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During} \times$ Dep. Growth, 2016q3-2017q1	0.039	0.037	0.021	0.037	0.021
	(0.046)	(0.046)	(0.048)	(0.038)	(0.039)
$I_{Post} \times$ Dep. Growth, 2016q3-2017q1	0.222^{**}	0.222^{**}	0.171^{*}	0.222^{**}	0.171^{*}
	(0.105)	(0.105)	(0.094)	(0.101)	(0.088)
Controls:					
ln Cloud Free Days (quarterly avg.)	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-quarter FE	Y	Y	Y	Y	Y
Observations	8124	8124	8124	8124	8124
R Sqr.	0.995	0.995	0.995	0.995	0.995

Summary & Notes: This table estimates the during/post differences in the natural log of district level credit with the longer run change in deposits from demonetization. Standard errors are clustered by district, and statistical signficance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

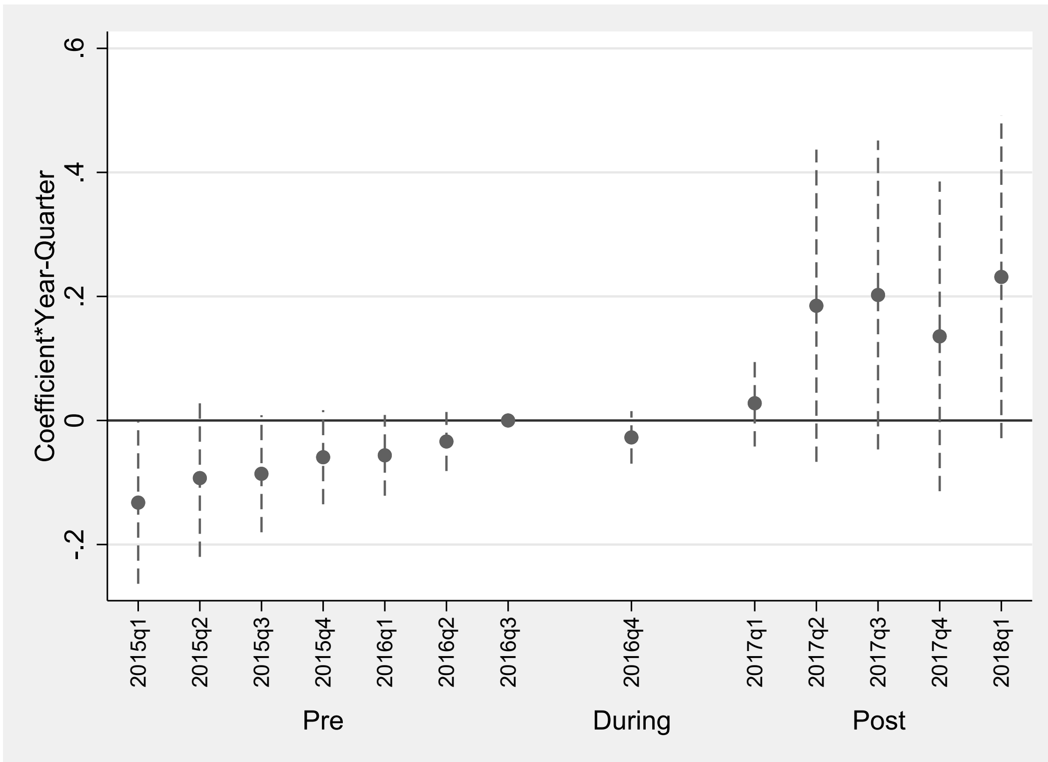


Figure 14: Credit by Quarter: Deposit Growth, 2016q3-2017q1

Summary & Notes: This figure plots the quarterly relationship between the natural log of district-level credit and longer run (2016q3-2017q1) deposit growth from demonetization. As shown, deposit growth, which serves as a proxy for the intensity of demonetization, has a close to zero effect prior to demonetization (2016q4) but a positive effect in the months after demonetization.

Appendix Tables and Figures

Table A1: Summary Statistics

Variable	Obs.	Mean	Std Deviation	Min	Max
ln nighttime lights	25,625	9.426	1.060	0	12.334
Pre-demonetization	13,750	9.261	1.098	0	12.334
During-demonetization	1,250	9.239	1.189	4.380	12.257
Post-demonetization	10,625	9.660	0.944	0	12.327
District Intensity					
Deposit Growth, 2016q3-2016q4	625	0.139	0.075	-0.246	0.583
Deposit Growth, 2016q3-2017q1	625	0.142	0.086	-0.110	1.087
Share of labor in agriculture, 2011	625	0.607	0.185	0.012	0.905
Share of labor in small firms, 2011	625	0.819	0.118	0.227	0.983
Share of rural population, 2011	625	0.748	0.191	0	1
Household Outcomes (in 100s of R)					
Income	4,385,955	133.901	133.874	0	14,981.27
Expenditures	4,385,955	80.62	55.997	0	10,485.99
Private Transfers	4,385,955	1.381	11.843	0	1,212.61
Household Intensity					
Rural	109,284	0.308	0.462	0	1
Agriculture	109,284	0.201	0.401	0	1

Table A2: Base estimation including 2014

Dependent variable: ln of monthly night time lights, Jan. 2014 - May 2018	(1)	(2)	(3)	(4)	(5)
$I_{During}\times$ Deposit Growth, 2016q3-2016q4	-0.684***	-0.686***	-0.381**	-0.722***	-0.326*
	(0.212)	(0.213)	(0.154)	(0.207)	(0.167)
$I_{Post}\times$ Deposit Growth, 2016q3-2016q4	0.538***	0.596***	0.410***	0.781***	0.543***
	(0.137)	(0.138)	(0.121)	(0.118)	(0.120)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	33125	33125	33125	33125	33125
R Sqr.	0.941	0.945	0.946	0.946	0.947

Summary & Notes: This table re-estimates the base analysis of Table 2 while extending the sample period back one year to 2014. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

Table A3: Longer Change in Deposits: 2016q3-2017q1

	Dependent variable: ln of monthly night time lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During}\times$ Deposit Growth, 2016q3-2017q1	-0.544***	-0.577***	-0.339**	-0.577***	-0.327*
	(0.174)	(0.176)	(0.147)	(0.192)	(0.168)
$I_{Post}\times$ Deposit Growth, 2016q3-2017q1	0.320**	0.343***	0.217*	0.376**	0.248*
	(0.132)	(0.128)	(0.117)	(0.148)	(0.134)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.941	0.945	0.947	0.947	0.948

Summary & Notes: This table re-estimates the base analysis of Table 2, replacing the growth in deposits between quarters 3 and 4 of 2016 with the longer run growth rate between quarter 3 of 2016 and quarter 1 of 2017. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

Table A4: Base estimation using only 2015 lit areas (Intensive margin)

	Dependent variable: ln of monthly night time lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During}\times$ Deposit Growth, 2016q3-2016q4	-0.148	-0.150	-0.101	-0.104	-0.041
	(0.122)	(0.125)	(0.122)	(0.136)	(0.135)
$I_{Post}\times$ Deposit Growth, 2016q3-2016q4	0.221*	0.289**	0.213*	0.402***	0.296***
	(0.119)	(0.119)	(0.108)	(0.110)	(0.107)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.973	0.975	0.975	0.976	0.976

Summary & Notes: This table re-estimates the base analysis of Table 2, replacing the unsaturated nighttime lights measure with a measure of nighttime lights that only covers areas which were lit in 2015, effectively testing on the intensive margin. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

Table A5: Monthly growth rate of lights

	Dependent variable: monthly growth rate of night time lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During} \times$ Deposit Growth, 2016q3-2016q4	-0.507***	-0.509***	-0.351***	-0.536***	-0.325***
	(0.111)	(0.116)	(0.105)	(0.111)	(0.106)
$I_{Post} \times$ Deposit Growth, 2016q3-2016q4	0.046**	0.107***	0.084***	0.114***	0.087***
	(0.022)	(0.025)	(0.022)	(0.021)	(0.020)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.529	0.552	0.553	0.553	0.554

Summary & Notes: This table re-estimates the base analysis of Table 2, replacing the natural log of the level of nighttime lights with the month-to-month growth rate of nighttime lights. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

Table A6: Growth rate of lights and longer deposit growth

	Dependent variable: monthly growth rate of night time lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During}\times$ Deposit Growth, 2016q3-2017q1	-0.362***	-0.395***	-0.278**	-0.393***	-0.268**
	(0.118)	(0.122)	(0.116)	(0.132)	(0.128)
$I_{Post}\times$ Deposit Growth, 2016q3-2017q1	0.052***	0.075***	0.057***	0.084***	0.067***
	(0.016)	(0.020)	(0.019)	(0.017)	(0.017)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.529	0.552	0.553	0.553	0.554

Summary & Notes: This table combines the extensions of Table A5 and Table A3, regressing the monthly growth rate of nighttime lights on the longer run growth in deposits interacted with during and post demonetization indicators. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

Table A7: Monthly growth rate of lights along the intensive margin (2015 lit areas)

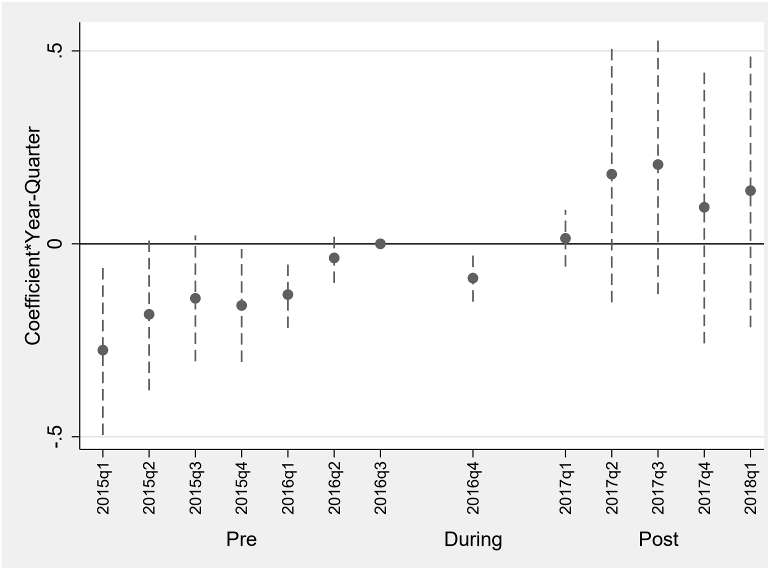
	Dependent variable: monthly growth rate of lights, Jan. 2015 - May 2018				
	(1)	(2)	(3)	(4)	(5)
$I_{During}\times$ Deposit Growth, 2016q3-2016q4	-0.096	-0.097	-0.073	-0.116	-0.103
	(0.093)	(0.095)	(0.092)	(0.086)	(0.088)
$I_{Post}\times$ Deposit Growth, 2016q3-2016q4	0.003	0.070^{***}	0.064^{***}	0.069^{***}	0.062^{***}
	(0.018)	(0.020)	(0.020)	(0.020)	(0.020)
Controls:					
ln Cloud Free Days	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-month FE	Y	Y	Y	Y	Y
Observations	25625	25625	25625	25625	25625
R Sqr.	0.502	0.531	0.531	0.532	0.532

Summary & Notes: This table combines the extensions of Table A5 and Table A4, replacing our primary outcome with the monthly growth rate of lights only in those areas that were already lit in 2015, i.e. along an intensive margin. Sets of controls are listed in Table 2. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.

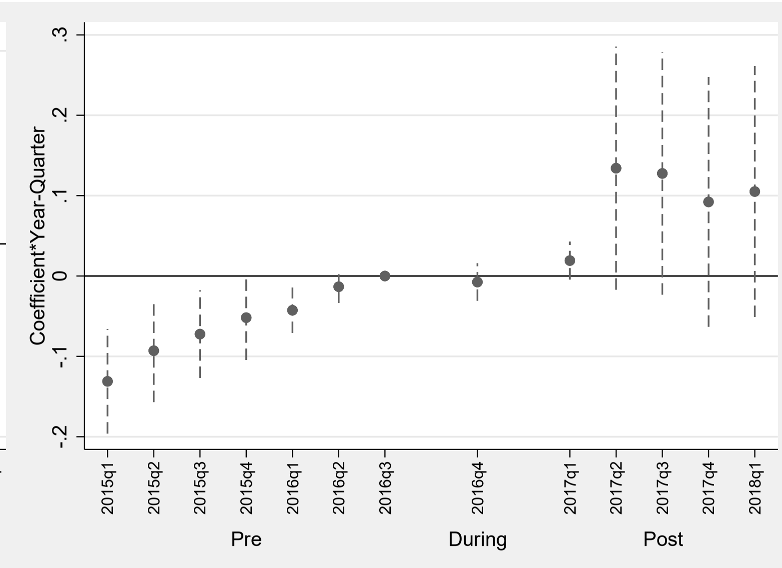
Table A8: Credit Post Demonetization: Other Measures of Exposure

Dependent variable: ln of quarterly credit, Jan. 2015 - May 2018	(1)	(2)	(3)	(4)	(5)
Panel A. Deposit Growth, Q3-Q4 2016					
$I_{During} \times$ Dep. Growth, 2016q3-2016q4	0.044	0.044	0.022	0.063	0.035
	(0.061)	(0.061)	(0.059)	(0.055)	(0.053)
$I_{Post} \times$ Dep. Growth, 2016q3-2016q4	0.259*	0.259*	0.190	0.293**	0.208*
	(0.149)	(0.149)	(0.137)	(0.139)	(0.124)
Observations	8124	8124	8124	8124	8124
R Sqr.	0.995	0.995	0.995	0.995	0.995
Panel B. Agr. Share					
$I_{During} \times$ Agr. Share of Employment, 2011	0.050**	0.050**	0.032	0.046**	0.027
	(0.020)	(0.020)	(0.021)	(0.023)	(0.024)
$I_{Post} \times$ Agr. Share of Employment, 2011	0.153**	0.153**	0.095*	0.178**	0.125*
	(0.064)	(0.064)	(0.056)	(0.074)	(0.064)
Observations	8124	8124	8124	8124	8124
R Sqr.	0.995	0.995	0.995	0.995	0.995
Panel C. Small Share					
$I_{During} \times$ Share of workforce in small firms (c.2011)	0.025	0.025	0.011	0.014	-0.002
	(0.029)	(0.029)	(0.028)	(0.029)	(0.028)
$I_{Post} \times$ Share of workforce in small firms (c.2011)	0.314*	0.314*	0.274	0.368*	0.330*
	(0.189)	(0.189)	(0.181)	(0.198)	(0.189)
Observations	8124	8124	8124	8124	8124
R Sqr.	0.995	0.995	0.995	0.995	0.995
Panel D. Rural Share					
$I_{During} \times$ Rural Share of Pop., 2011	0.042**	0.042**	0.024	0.037*	0.019
	(0.020)	(0.020)	(0.020)	(0.021)	(0.022)
$I_{Post} \times$ Rural Share of Pop., 2011	0.110**	0.110**	0.049	0.121**	0.064
	(0.047)	(0.047)	(0.040)	(0.055)	(0.045)
Observations	8124	8124	8124	8124	
R Sqr.	0.995	0.995	0.995	0.995	
Controls:					
ln Cloud Free Days (quarterly avg.)	N	Y	Y	Y	Y
ln Population c.2011 × During & Post	N	N	Y	N	Y
Geoclimatic Controls × During & Post	N	N	N	Y	Y
District FE	Y	Y	Y	Y	Y
State-year-quarter FE	Y	Y	Y	Y	Y

Summary & Notes: This table re-estimates the findings of Table 10, replacing our regressor of interest, deposit growth between 2016q3 and 2017q1 with (Panel A) 2016q3-2016q4 deposit growth, (Panel B) the district-level share of agricultural employment, (Panel C) the district-level share of those working in small firms (i.e., less than 10 employees), and (Panel D) the district-level share of the population that is rural. Estimated coefficients generally mirror those of Table 10. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.



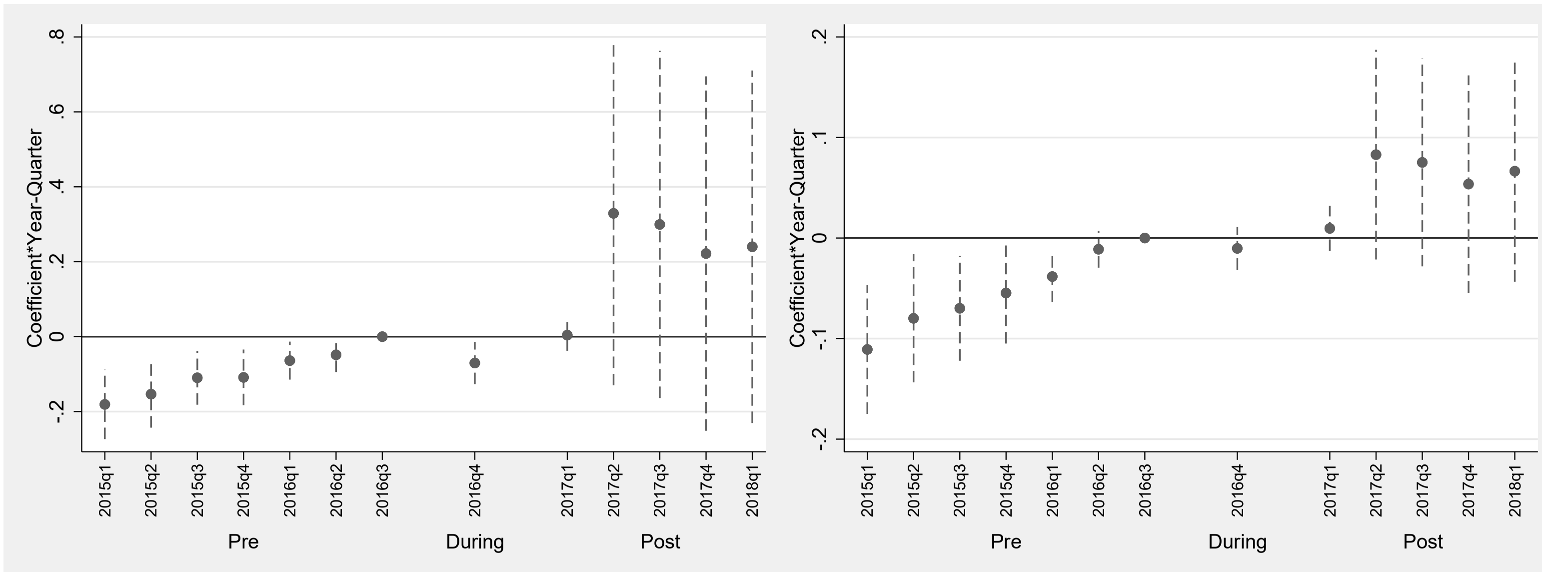
(a) Deposit Growth, 2016q3-2016q4



(b) Agr. Share

Figure A1: Credit by Quarter: Agr. and Rural Share

Summary and Notes: This figure plots the quarter-by-quarter effect (relative to 2016q3) of 2016q3-2016q4 deposit growth in sub-figure (a) and for district-level agricultural share in sub-figure (b), corresponding to Panels A and B of Table A8. As seen, the effect of each regressor appears to be increasing over time, suggesting differential trends prior to demonetization. That said, there also appears to be a discrete jump in the estimated coefficients post-demonetization.



(a) Small-firm Share

(b) Rural Share

Figure A2: Credit by Quarter: Agr. and Rural Share

Summary and Notes: This figure plots the quarter-by-quarter effect (relative to 2016q3) of district-level share of employment in non-agricultural small firms in sub-figure (a) and the district-level rural share of the population in sub-figure (b), corresponding to Panels C and D of Table A8. As seen, the effect of each regressor appears to be increasing over time, suggesting differential trends prior to demonetization. That said, there also appears to be a discrete jump in the estimated coefficients post-demonetization.

Table A9: Pre-Demonetization Trends in Credit

	Dependent variable: ln of quarterly credit, 2015q1 - 2016q3				
	(1)	(2)	(3)	(4)	(5)
Trend	0.068**	0.051*	0.035	0.048*	0.039
	(0.029)	(0.028)	(0.027)	(0.029)	(0.027)
Trend × Dep. Growth, 2016q3-2017q1	0.017				
	(0.011)				
Trend × Dep. Growth, 2016q3-2016q4		0.040**			
		(0.017)			
Trend × Agr. Share, c.2011			0.019**		
			(0.007)		
Trend × Small Share, c.2011				0.021***	
				(0.008)	
Trend × Rural Share, c.2011					0.015**
					(0.007)
Controls:					
Level of deposits, 2016Q3 × Trend	Y	Y	Y	Y	Y
Population c.2011 × Trend	Y	Y	Y	Y	Y
Geoclimatic Controls × Trendt	Y	Y	Y	Y	Y
District FE	Y	Y	Y	Y	Y
State × Trend	Y	Y	Y	Y	Y
Observations	4374	4374	4374	4374	4374
R Sqr.	0.999	0.999	0.999	0.999	0.999

Summary & Notes: This table looks at trend differences in credit prior to demonetization from our district characteristics associated with a more pronounced effect of demonetization. The positive coefficient on the interaction between the trend and the demonetization proxy suggest that credit was increasing in these districts prior to demonetization, bringing into question the assumption of parallel trends. Standard errors are clustered by district, and statistical significance at the 1, 5, and 10% levels is respectively denoted by ***, **, and *.