Deposit Flight, Precautionary Consumption, and Capital Controls: A Tale from Greece

Romanos Priftis†  Michael Rousakis‡

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Abstract

This paper presents an analytical narrative of the later stages of the Greek crisis, focusing on two key events that unfolded during 2014-2016 and set Greece apart from other episodes of sovereign debt crises: the risk of Grexit and the imposition of capital controls on the banking sector. To account for them both, we extend the standard small open economy environment along three dimensions. First, we allow for an informal sector. Second, we allow for a richer menu of assets that include cash, which is needed for informal consumption and is costly to hold. Third, we introduce a banking sector that turns households’ deposits into capital. We show that, as evidenced by the data, a risk of Grexit leads households to run down their deposits to the detriment of bank balance sheets, increase their demand for cash, and increase their consumption—we call this behavior “precautionary consumption”. We further show that capital controls mitigate the deposit flight and induce the reallocation of consumption towards formal goods.

Keywords: capital controls, small open economy, exit from a currency union, cash, precautionary consumption, informal economy, financial intermediaries, Greece

JEL Classification: E2, E4, F41, G11, G28

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†Bank of Canada; e-mail: rpriftis@gmail.com
‡University of Oxford and CfM; e-mail: michael.rousakis@economics.ox.ac.uk - Corresponding author
1 Introduction

Amidst growing fears of Grexit that were threatening Greek banks with a deposit dry up and an extraordinary political turmoil, on June 28, 2015 the Greek authorities mandated a series of measures to avoid an uncontrolled bank run, mitigate the risk of Grexit, and stabilize the economy. To prevent euros from flowing out of Greek banks and into overseas financial institutions, foreign currencies, or simply under the mattresses, households were faced with strict limits on daily cash withdrawals, €60 a day per cash card, and businesses were left with a shortage of liquidity to finance purchases of imported intermediate and final goods.

This series of measures have been labelled by the parties involved and the news headlines as capital controls, a term which the international finance literature typically associates with only a subset of the policy tools implemented in Greece. In particular, the relevant literature usually considers capital controls as policy measures whose “defining feature ... is that they apply exclusively to financial transactions between residents and non-residents, i.e. they discriminate based on the residency of the parties involved in a financial transaction” (p.S27, Korinek and Sandri, 2016). The Greek manifestation (as well as the Cypriot one) of capital controls, however, has extended well beyond the usual “capital inflow-outflow” dimension. With Greek households and firms alike being heavily reliant upon cash, a new, “domestic”, dimension has gained importance and has been reflected upon the cash shortages that domestic agents have suffered. At the same time, although a nascent recovery was derailed, the economy exhibited remarkable resilience, contracting much less than expected. It is precisely these dimensions, that set Greece apart from other crisis-hit economies, which we deem novel and distinctive, and which we therefore discuss here.

We provide an analytical narrative of the effects of the risk of Grexit and the imposition of capital controls on the domestic banking sector. We approach this task by building a stylized model with detailed macro-financial linkages. Our model is tailored to explain the theoretical channels through which a risk of Grexit and a restriction on cash withdrawals have spilled over to the aggregate economy, while at the same time replicating
the major features of the Greek data over the period 2014-2016. Two forces seem to have been at play: in the face of a potential exit from the Eurozone (“Grexit”) and/or under the threat of outright deposit haircuts, households started running down their deposits and spending part of them, which we call a “precautionary consumption” behavior, while the imposed limits on cash withdrawals, together with the absence of restrictions on card payments and bank transfers facilitated the reallocation of consumption from the informal to the formal economy.¹

To this end, we extend the standard small open economy environment along three dimensions. First, we allow for two sectors, a formal one and an informal one. Second, we allow for three assets: capital, deposits and cash. Cash is costly to hold and it is exclusively used for the consumption of goods produced in the informal sector of the economy, and we motivate its use via a cash-in-advance (CIA) constraint. Third, we assign a role to financial intermediaries, which receive deposits from households and turn them into capital in a more efficient way than households.

Fluctuations in the model are driven by two sources of uncertainty: Grexit risk and an exogenous policy of capital controls. We interpret “Grexit risk” as concerns that households may have regarding a potential redenomination, or an outright haircut of their deposits. We model this process as a sequence of negative shocks that affect only the expected return to deposits, but not the realized return, so as to be in line with the actual events—Grexit after all never materialized, nor did any deposit haircuts happen. As a result, a “Grexit shock” only affects the households’ consumption and savings decisions, but not their budget constraint. We show that “fears of Grexit” lead households to run down their assets, substitute their savings away from deposits and towards cash and capital as well as to increase their consumption. This precautionary consumption behavior is the paradoxical result of heightened uncertainty regarding a potentially massive shock of Grexit, which would typically produce precautionary savings, and the lack of a reliable savings technology. Let us stress that these incentives are only operative as long as a Grexit risk exists. Since the deadline for reaching an agreement with creditors and avert the risk was well-

¹Notably, we abstract from commenting on factors like tourism and low energy prices that may have contributed to amplifying certain mechanisms we propose, such as the resilience of private consumption.
known for months in advance, forward-looking agents would only engage in precautionary consumption behavior until the risk was resolved. In fact, using a novel proprietary dataset of the universe daily and monthly new car registrations, which covers the most salient durable-goods market, we document a clear increase in consumption in the run-up to the capital control announcement, and a respective decrease afterwards.

The household decisions, in turn, not only cause a reallocation of capital from the financial intermediaries to households, but also lead to a drop in both the value and the aggregate stock of capital, negatively affecting thereby the financial intermediaries’ dividends and lowering aggregate output. In turn, we model capital controls as an increase in the households’ cost of holding cash and capital. We show that capital controls bring down cash holdings, inducing thereby a switch to formality, as well as stabilize the banking sector by preventing deposits from falling further and mitigating the reallocation of capital from financial intermediaries to households. All these results are in line with the stylized facts that have emerged during the post-2014 stages of the still-unfolding Greek crisis.

We argue that the resilience of the Greek economy in 2015 can in part be attributed to these novel dimensions. In particular, Greek real GDP contracted by just 0.3% in 2015, falling significantly less than forecast after capital controls had been imposed, and its surprising endurance seems to have drawn at least in (good) part upon that of private consumption (see also Figure 1). In particular, private consumption rose by 0.3% in 2015, having performed particularly well in in the first two quarters (Q1: +1.7%, Q2: +1.6%) and been strongly resilient in the final two (Q3: -1.4%, Q4: -0.6%), which followed the imposition of capital controls. This came at a time when households withdrew about 25% of their deposits and the amount of cash in circulation rose to ca 28% of GDP, whereas the Eurozone average is ca 10% (see also Figure 2). Moreover, from November 2014 to June 2015, “extra cash” increased by nearly 5 times, when it stood at zero in February 2010.

\footnote{In July 2015, IOBE, a Greek non-profit research organization, forecast GDP in 2015 to contract by 2-2.5%, the IMF in October 2015 (World Economic Outlook) forecast GDP to contract by 2.3%, and the European Commission in November 2015 (ECFIN 2015) forecast GDP to contract by 1.4%.}

\footnote{Consumption growth is seasonally and calendar adjusted. Source: Elstat.}

\footnote{See also Monokroussos et al. (2015) for more details.}

\footnote{See next section for a detailed explanation.}
We can get a more granular view of consumption by considering the time series behavior of the index of retail trade turnover, which is updated at a monthly frequency. The series is given in the left panel of Figure 1. The index is overall quite volatile at high frequencies, but one can still see that after a fall in late 2014, it stabilizes and modestly rises in early 2015, and then rises sharply in May 2015, during the concurrent run on deposits. This is not driven by Easter effects, as Easter in the year fell in early April.

The figure presents chain linked gross domestic product and household and NPISH final consumption expenditure for Greece, at quarterly frequency, seasonally adjusted. Annual percent changes. Source: Eurostat.

Currency greatly increased the premium of holding euro banknotes, compared to the standard cost of warehousing cash, leading to a sharp increase in cash balances, and the proverbial storing of “cash in mattresses”. Following the imposition of capital controls, we see cash slowly returning to bank accounts, which likely reflects a combination of the switch to the formal sector and the reduction of the redenomination risk, which reduces the premium value of cash. The switch to formality that started in the second half of 2015 is also reflected in the increasing use of payments using debit or credit cards. The left hand side of the right panel of Figure 3 shows the annual number of card transactions in the Greek economy. During the 2014-2016 period approximately 80% more transactions were carried out using cards, around 80% of which consists of debit cards. The value of these transactions (right hand side) rose by less (around 16%), and hence the average value per card transaction fell, indicating that consumers started using cards for small-ticket purchases that used to be cash-based.

In a development related to the path of payment behavior, the capital control era in Greece has also notably coincided with a substantial increase in the collection of consumption taxes (Figure vi). Revenue from VAT recorded year-on-year real growth of 9.3%, 18.5%, 16.7%, and 16.1% from 2015Q4 to 2016Q3, at a time of a shrinking tax base (Hondroyiannis and Papaoikonomou, 2017), and with the VAT rate schedule unchanged (with the top rate at 23%) until a 1pp rise in 2016Q3. This was all the more surprising given that Greece performs very poorly by international standards in VAT collection. This change in payment mode was facilitated by a concurrent proliferation of POS devices in retail establishments.

At the same time, there is a large amount of evidence on the effects of capital controls on the informal economy. In particular, based on data from the Bank of Greece, in 2015H2,

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**Figure 1: Real GDP and private consumption (annual percent changes)**

![Graph showing Real GDP and private consumption](image)

**Figure 2: Currency in circulation and card usage**

![Graph showing currency in circulation and card usage](image)

Source: Bank of Greece.

Source: Bank of Greece.
i.e. right after the enforcement of capital controls, the number of new (debit) cards issued rose by 11.26% (12.9%) relative to 2015H1, the number of transactions increased by 59% (71%), the value of transactions increased by 12% (14%), while the number of transactions per card increased by 33.3% (41.7%) (see also Figure 2 as well as Mylonas et al. (2016) for an extensive analysis). Since it is typical of the literature on the informal economy (see, e.g., Schneider et al. (2010), Schneider and Buehn (2012), Rogoff (2016)) to assume that informal activities are facilitated by the use of cash, it follows that the surge in the use of cards must have facilitated a shift from the informal to the formal economy (more on this below), which is exactly what our model predicts. Finally, the surge in VAT revenues (Figure 3) lends further support to the idea that the Greek economy experienced a sectoral reallocation (see also Mylonas et al. (2016)).

This paper comes to complement the recent study by Gourinchas et al. (2016), who estimate a DSGE model in an attempt to account for the causes of the first stage of the Greek

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6The informal economy as percent of GDP in Greece has been of the highest among OECD countries according to, e.g., Schneider et al. (2010). Likewise, cashless transactions accounted for less than 5% of GDP until 2014 versus an average of 15.5% in the Eurozone (see also Mylonas et al. (2016)). This suggests that there is ample space for a shift from the informal to the formal economy.
crisis as it developed until 2014. We instead opt to focus on the second stage of the crisis, the period 2014-16, when output had stabilized and the fear of Grexit risk and capital controls once the risk dissipated had replaced sovereign debt risk.

Our modelling strategy draws on the literature on sudden stops that was pioneered by Mendoza (2001) and developed further by Mendoza (2010), Bianchi (2011), Korinek (2011), Benigno et al. (2012), and Korinek and Sandri (2016) among others (see Korinek and Mendoza (2014) for an overview). The specification of the financial intermediaries’ sector in our model builds on insights offered by Gertler and Karadi (2011) and Gertler and Kiyotaki (2015), while works related to ours that also require a financial asset to facilitate transactions are those of Grilli and Roubini (1996) and Jaccard (2013).

Finally, while the usefulness of controls on capital inflows as a prudential measure has been long recognised, dating at least to the aftermath of the Asian financial crisis (for instance, Mussa (2000)), a view that has been reinforced in the aftermath of the Global Financial Crisis (see for instance Korinek (2011)), this has not been the case for controls on outflows. Controls on capital outflows, under the umbrella of which the Greek case falls, fundamentally serve a crisis-fighting purpose, not a prudential one, have been rarer, less studied, and more controversial, as argued in Kaplan and Rodrick (2002), who study one of the most well-known capital-outflow restriction episodes, that of Malaysia.

The remainder of this paper is structured as follows. Section 2 discusses some stylized facts. Section 3 presents the model. Section 4 characterizes the equilibrium. Section 5 performs a quantitative analysis and presents the paper’s results. Section 6 concludes.

2 Some stylized facts

In this section, we discuss some of the salient stylized facts about the Greek economy in 2014-2016. This period can naturally, in our view, be broken down into two phases, one right before and one right after the announcement of the referendum and the imposition of capital controls in late June 2015. We conveniently refer to these periods as 2015H1

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7See also Petroulakis (2017), who studies the export performance of the euro periphery during the same period, with a particular emphasis on Greece.
and 2015H2, respectively. We also place this period in the broader context of the Greek crisis that began in 2010, and has turned out as one of the deepest and most protracted downturns an advanced economy has experienced in the post-WW2 era.

2.1 Money balances

The first interesting stylized fact emerges from the deposit-holding behavior of firms and households. Figure 4 shows overnight deposits (equal to M1 less currency) and longer-term deposits (the part of M2 that is in excess of M1).\footnote{The part of M2 in excess of M1 includes deposits with agreed maturity up to 2 years (2y) and deposits redeemable with notice up to 3 months (3m), with the former being orders of magnitude larger. The ECB monetary pillar uses the M3 definition of money. The M3 portion that is in excess of M2 (repos, money market fund shares, and debt securities up to 2 years) was trivial in Greece for the period under study, and M2 typically comprised upwards of 99% of M3, so for all intents and purposes, overnight and longer-term deposits comprise the totality of the deposit part of money.} We can see that after a protracted downward trend that started in 2010, longer-term deposits started rising after the summer of 2012 and remained fairly stable during 2013 and 2014, before starting to sharply fall again in November 2014. This fall slowed down with the imposition of capital controls (as it was meant to), and was succeeded by a switch from longer-term to overnight deposits. As such, the most obvious manifestation of the risk of Grexit was reflected on the run on longer-term deposits.

Overnight deposits, in turn, displayed a very similar behavior in the early stages of the crisis, stabilizing in the summer of 2012, and then slowly drifting upwards. In contrast with longer-term deposits, however, not only did overnight deposits exhibit a much shallower fall in 2015H1 (7\% compared to 29\% from October 2014 to May 2015), but they even started rising before the imposition of capital controls and they continued rising sharply until the end of 2015, when they finally stabilized.
The relative behavior of the two types of deposits starting in 2015H2 can be straightforwardly explained as the immediate result of a reduction in the intensity of cash transactions. As for their relative behavior in 2015H1, which stands in sharp contrast to that in the 2010-2013 period when the correlation of the two series was almost perfect, a possible explanation is that households and firms needed a minimum amount of deposits. A similar conclusion can be reached if we consider the sectoral breakdown of deposits; overall, households hold 85-90% of total deposits over the period studied, but the behavior of both households and firms is similar (see Figure 11 in the appendix).

### 2.2 Cash and payments

The run on longer-term deposits released large amounts of liquidity from the system. The left panel of Figure 2 shows the evolution of banknotes issued by the Bank of Greece, which is the most reliable indicator of cash holdings. After gradually falling following

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9The plotted figure shows the total value of currency issued by the Bank of Greece, which is split into three parts. The first part is the Greek allocation of all currency issued by the Eurosystem (according to the capital key for the Bank of Greece). The second part is related to the responsibility of the Bank of Greece to issue an additional 8% of its capital key allocation on behalf of the ECB. The third part is what the Bank of Greece has issued in excess of what is required, and reflects currency in excess of what is expected (“extra cash”).
a peak in June 2012, cash holdings started rising again in December 2014, with their total increase amounting to approximately 20 billion euros, a 67% increase. This is the most salient depiction of the run in deposits that took place in the first half of 2015. The risk of Grexit, which would imply a possible redenomination of bank deposits into a less valuable currency, greatly increased the premium of holding euro banknotes, leading to the proverbial “stashing of cash under mattresses”. After the imposition of capital controls, we can see that cash started slowly returning to bank accounts, which likely reflects the switch to the formal sector as well as the reduction of the redenomination risk.

The switch to formality that started in the second half of 2015 is also reflected in the increasing use of debit and credit cards. The left hand side of the right panel of Figure 2 shows the annual number of card transactions in the Greek economy. During the 2014-2016 period approximately 80% more transactions were carried out using cards (around 80% of which with debit cards). The value of these transactions (right hand side) rose by less (around 16%), hence the average value per card transaction fell, suggesting the use of cards for small-ticket, and until then cash-based, purchases.\footnote{This change in the means of payment was facilitated by a concurrent proliferation of POS devices in retail establishments.}

In a closely-related development, the post-capital controls era has also been characterized by a substantial increase in the collection of consumption taxes (Figure 3). In particular, VAT revenue recorded year-on-year real growth rates of 9.3%, 18.5%, 16.7%, and 16.1% from 2015Q4 to 2016Q3, at a time of a shrinking tax base (Hondroyiannis and Papaoikonomou (2017)) and an unchanged VAT-rate schedule (with the top rate at 23%) until a 1 percentage point (pp) rise was introduced in 2016Q3.\footnote{The effective rate is more complicated to measure due to a number of exemptions that were phased out. Nevertheless, Hondroyiannis and Papaoikonomou (2017) report that the average rate also increased by one percentage point.} This was all the more surprising given that Greece performs very poorly by international standards in VAT collection.\footnote{According to the VAT gap, which measures the distance of actual VAT revenue from a hypothetical maximum in the absence of tax evasion, Greece scored poorly for 2014 (25% versus an EU average of 14%). The VAT gap increased in 2015 (partly mechanically due to the elimination of deductions), but that was before the effects of the increased use of cards became realized. 2016 data are not available yet.}

Hondroyiannis and Papaoikonomou (2017) hypothesize that this improvement in tax collection is a direct result of the switch to card payments. Using a long time series for Greece, they indeed find that an increased use of cards leads to higher VAT revenue, with
an estimated elasticity of around one. Moreover, they find that, in this specific episode, the
growth in revenue can be fully accounted for by factors other than the tax base and the tax
rate (which have a negative effect). What they call “compliance”, then, fully drives this
outcome. While there is little other direct evidence on the issue, it seems intuitive that,
ceteris paribus, card payments, by virtue of the fact that they are electronically cleared
and hence easily observable to the tax authorities, would be beneficial to sales tax col-
lection. In the US and Turkey, for instance, tax authorities have explicitly exploited the
use of electronic means of payment to monitor the evasion of consumption taxes by firms
(Madzharova (2014)).

![Figure 5: Aggregate Consumption (EUR billions)](image)

Data are seasonally and calendar adjusted; chained linked 2010 prices. Source: Eurostat.

### 2.3 Consumption

Turning to consumption, Figure 5 shows the evolution of chain-linked aggregate con-
sumption using quarterly national accounts data. The left panel shows the time series
from 2010 onwards, while the right panel focuses on the shorter 2014-2016 period so as to
isolate the local cycle. As is well known, there was a dramatic fall in consumption dur-
ing the first years of the crisis, with a much steeper fall in durables, which fell from their
peak in 2009Q3 to their trough in 2013Q2 by 62% in real terms (52% in nominal terms). Consumption of semi- and non-durable goods and services, on the other hand, fell by a comparatively modest 22% in real terms and reached its trough two quarters earlier. Aggregate consumption registered modest gains during 2013 and 2014 and, surprisingly, rose during the first two quarters of 2015 despite the run on longer-term deposits. In 2015Q3, right after the introduction of capital controls, there was a sharp fall in durables (11.5% in real and 15% in nominal terms), but one that was short-lived as durable consumption fastly returned to its local upward trend. Consumption of non-durables, on the other hand, fell only slightly (1.9% and 1.3% in real and nominal terms, respectively), but it did not recover once Grexit uncertainty started waning and remained rather flat instead.\footnote{While the consumption data are not available at higher frequencies, a close substitute of theirs is the retail trade turnover index, which exhibited a very similar pattern (Figure 12 in the appendix). The retail trade turnover index, however, is not split into durables and non-durables.}

**Figure 6: Monthly Passenger Car Registrations**

We use the JDemetra+ software of Eurostat to perform the adjustment, using the X13-Arima methodology. We focus on the period 01/2012-08/2017 because of the clear break in the series since the crisis. Using data until 2017 helps to reduce end-of-sample-bias. Source: Hellenic Association of Motor Vehicle Importers-Representatives.

A convenient proxy for durable consumption, available at high frequencies, are the sales of passenger cars. Cars typically comprise the largest single item of durable goods con-
sumption for median households, and car purchases have been frequently used in studies focusing on durable consumption (for instance, Eberly (1994) and Mian and Sufi (2012)). Figure 6 shows monthly registrations for all passenger cars. Due to the highly volatile nature of car purchases, we show both the actual and the seasonally and calendar adjusted series, along with the underlying trend. The left panel shows the series from 2000 until 2016, and we can see that the collapse occurred in three stages, with the trend reaching a trough in early 2012.

Because of the clear change in the seasonal pattern after 2010, the right panel shows the 2012-2016 period separately estimated. While the raw data are highly volatile, we can see a clear pick-up in registrations at the end of 2015Q1 that lasted until June 2015. Throughout this period, car registrations recorded year-on-year increases of 11%, 43%, 21%, and 11% for the months of March, April, May, and June, respectively. This confirms that durable consumption was rising while the uncertainty was mounting and the run on deposits was in full play. The adjusted data show, further, that the upward trend continued relatively unabated (with registrations above trend in 2015Q2) before flattening once the capital controls had been installed.

A factor that can have accounted for the persistence of consumption in the face of a bank run is simply the consumers’ response to intertemporal incentives: fearing Grexit or a deposit haircut, i.e. expecting a lower than usual return to savings, in the absence of safe assets (like foreign deposits or securities) and the presence of an increasing cost to storing/withdrawing cash, consumers may have simply frontloaded consumption purchases, particularly those of durable goods. That is, households may have just self-insured against a potential revaluation of their deposits, viewing cars as a store of value and/or frontloading already planned car purchases, which would become more expensive were redenomination to materialize.

Figure 7 comes to shed more light by showing the universe of daily new car registrations for the period of June 2-August 31 in 2014 and 2015, obtained from a proprietary dataset from the Association of Motor Vehicle Importers-Representatives. Note that a referendum was announced late on Friday, June 26, and capital controls were imposed on Sunday, June 28 (day 27 on the horizontal axis). In light of the above, one would perhaps expect
such “precautionary-consumption” behavior to intensify once the capital controls were in place, i.e. during the period to the right of the green bar in Fig. 7, especially since new cars are (normally) bought on credit or electronically. Yet, no such behavior seems to have taken place then. On the contrary, we see a substantial year-on-year increase in new car registrations on almost every day of June, i.e. in the run-up to the capital controls, which were followed by a fall, both compared to the previous month and the previous year.

**Figure 7: New Car Registrations (Jun 2-Aug 31)**

We find this behavior in line with the forward-looking behavior hypothesized earlier. There was a well-known sharp deadline for a deal on Tuesday, June 30. It was then that a large payment to the IMF was due and, without a deal in place, Greece could not afford to pay. As such, rational agents could foresee that the redenomination risk would have to be dealt with until the weekend before that deadline, hence any incentive to bring consumption forward would no longer be operative after that moment. Put differently, the implicit decision tree agents were faced with had already been known a few months before the events in late June 2015.

To complete the picture, Figure 8 lends further support to this discussion by showing the
evolution of consumer and industrial confidence from January 2012 onwards. Starting with consumer confidence, even though it rose by almost 20 points within a month following the January 2015 election, it started to decline sharply after March 2015.\footnote{In European countries, consumer confidence typically rises before elections and then falls by equal amounts, as shown by Hardouvelis and Thomakos (2007) for the EU-15 countries during the 1985-2007 period. It is noteworthy that Greece is characterized by far the largest pre-election increase in confidence in their sample, and a comparatively modest fall. Instead, here we see pre-election volatility, with a fall in confidence in December 2014 (possibly due to the uncertainty surrounding the presidential election), followed by the aforementioned sharp increase.} Industrial confidence, on the other hand, exhibited a protracted decline throughout the entire period leading to the imposition of capital controls, starting in late 2014 when it had become clear that a new election was forthcoming.\footnote{This suggests a stark disconnect between the perceptions of consumers and firms, which is a historical anomaly since the two series typically track each other very closely: from 2002 to 2014 their correlation is 0.72.} Note that both consumer and industrial confidence stabilized after the imposition of capital controls and the new deal signed by the Greek government shortly afterwards, which provides further support to our argument that fears of Grexit were particularly intense in 2015H1.

Figure 8: Consumer and Industrial Confidence

Series have been rescaled to equal zero in January 2014. Source: European Commission.
2.4 Credit and investment

Finally, we consider the behavior of credit and investment. The run on deposits documented previously had, as expected, an effect on the banking system, with all the major banks eventually having to be recapitalized in November 2015. As expected, credit supply fell substantially during the period under study, with credit to non-financial firms (left panel of Figure 9) falling sharply after May 2015, despite registering a small increase earlier in the year. The credit squeeze, together with the heightened uncertainty, had a corresponding effect on investment (right panel of Figure 9), which, fell from 12 to 10% of GDP in 2015Q2. Although it spiked later in 2015 (probably reflecting already planned projects that froze immediately following the imposition of capital controls), it reverted to levels lower than in 2014Q2 afterwards.

Given the large disruption of credit, it may be surprising that investment did not fall further, but it should be noted that it was supported by tourism-related construction (which rose by 3.2% in 2015 and another 22.7% in 2016, driven to a large extent by foreign investors), while the manufacturing investment rate fell from 16% in 2014 to 13.3% in 2015.\textsuperscript{16} Furthermore, the collapse of investment has been the most salient feature of the Greek crisis, as it stood at around 25% of GDP pre-crisis. The point is that, were it not for exogenous factors, such as tourism, investment would most likely have fallen by more, and so we argue that consumption is the main driver behind the resilience of the Greek economy during the period under study.

\textsuperscript{16}Investment rate is investment over value added at factor costs. Source: Eurostat.
Figure 9: Credit and Investment

Left panel - Nominal, not adjusted. Source: Eurostat. Right panel - Gross Fixed Capital Formation over GDP at a quarterly level, seasonally and calendar adjusted. Source: Elstat.

3 Model

We consider a small open economy populated by a continuum of households, a continuum of financial intermediaries, and a continuum of firms each producing "formal" and "informal" goods; all agents are of unit measure.

3.1 Households

Households supply labor to firms in both sectors, consume formal and informal goods, and can save in three real assets: cash, deposits, and capital.\(^\text{17}\)

The households’ preferences are given by

\[
E_{-1} \sum_{t=0}^{\infty} \beta^t \left[ u(c_{f,t}, c_{i,t}) - v(n_{f,t}) - v(n_{i,t}) \right]
\]

where \(c_{f,t}\) and \(c_{i,t}\) denote consumption of formal and informal goods, and \(n_{f,t}\) and \(n_{i,t}\)

\(^{17}\)Inflation (of all items less food and energy) has not played a noteworthy role throughout the Greek crisis, hence we opt to express everything in real terms and keep the analysis tractable.
denote labor in the formal and the informal sector. We require \( u(c_{f,t}, c_{i,t}) \) to be increasing in both arguments, quasi-concave, satisfy the Inada conditions, and exhibit constant-relative-risk-aversion (CRRA), \( v(\cdot) \) to be increasing and quasi-convex, and both functions must be twice-continuously differentiable.

The period budget constraint is expressed in units of the formal good and is given by

\[
c_{f,t} + p_t c_{i,t} + m_{t+1} + f(m_{t+1}) + d_{t+1} + k_{t+1}^h + f(k_{t+1}^h) = \sum_{j=\{f,i\}} (w_{j,t} n_{j,t} + \Pi_{j,t}) + m_t + R_t d_t + (Q_t + 1 - \delta) k_t^h
\]

Period expenditure is on the LHS of (2). We can see that part of period income is spent on formal and informal goods, where \( p \) denotes the relative price of informal goods, and part of period income is saved in cash, deposits, and capital, which we denote by \( m, d, \) and \( k^h \), respectively. Saving in deposits, which one can think of as one-period bonds, is costless, however saving in cash and capital is costly and their respective costs, given by \( f(m) \) and \( f(k^h) \), could be thought of as reflecting a storage cost in the case of cash and a management cost in the case of capital. We assume that the costs to holding cash \( f(m) \) and capital \( f(k^h) \) are stochastic and we specify their stochastic processes below. An increase in the values of \( f(m) \) and \( f(k^h) \) functions as a policy shock, hindering households from saving in cash and capital and, in our setting, is a proxy for the exogenous imposition of capital controls. Period income in turn is on the RHS of (2), and it consists of labor income, firms’ profits, and the gross returns to the assets carried over from the period before: the gross return to cash is one, the gross return to deposits is \( R \), and the gross return to capital is \( Q + 1 - \delta \), where \( Q \) denotes the price of capital and \( \delta \in (0, 1) \) its depreciation rate.

Importantly, we assume that households need to hold cash for their purchases of informal goods. As such, we let their informal consumption be subject to a real cash-in-advance constraint:

\[
p_t c_{i,t} \leq m_t
\]
3.2 Financial intermediaries

Financial intermediaries obtain funds from households in the form of deposits as well as from other sources and lenders, including potentially foreign lenders. They transform them into next-period capital in a one-to-one fashion. Holding (managing) capital is costly to financial intermediaries too, but less costly compared to households, an assumption in line with Gertler and Kiyotaki (2015). Financial intermediaries are risk-neutral and maximize the discounted sum of their expected lifetime dividends:

$$E_{t-1}^{f} \sum_{t=0}^{\infty} \beta^t D_t$$  (4)

Period dividends are in turn given by

$$D_t + R_t (d_t + d^o_t) + f(k^{b}_{t+1}) = (Q_t + 1 - \delta) k^b_t$$  (5)

where $d^o$ denotes net borrowing via means other than deposits and $f(k^b)$ denotes the financial intermediaries’ cost to holding capital. The marked-to-market financial intermediaries’ assets are on the RHS of (5), while their liabilities are on the LHS of (5).

To simplify matters, we assume that financial intermediaries consume their period dividends entirely, i.e. they do not reinvest them, which lets their problem yield a simple, period-by-period solution. This implies that financial intermediaries start building capital afresh each period, which they finance entirely by borrowing from households and other sources, i.e.

$$k^b_{t+1} = d_{t+1} + d^o_{t+1}$$  (6)

3.3 Firms

Finally, there are two types of competitive firms in operation, one for the production of the formal good and one for the production of the informal one. The formal-sector firms use capital and labor as inputs, while following Busato and Chiarini (2004) and Pappa et
al. (2015) we assume that the informal-sector firms only use labor:

\[ y_{f,t} = \phi(k_t, n_{f,t}) \]  

(7)

\[ y_{i,t} = g(n_{i,t}) \]  

(8)

where \( k_t = k_{h}^f + k_{b}^f \). We require both \( \phi(\cdot) \) and \( g(\cdot) \) to be increasing in their arguments, concave and satisfy the Inada conditions.

The firms’ profits are then given by

\[ \Pi_{f,t} = \phi(k_t, n_{f,t}) - Q_t k_t - w_{f,t} n_{f,t} \]  

(9)

\[ \Pi_{i,t} = p_t g(n_{i,t}) - w_{i,t} n_{i,t} \]  

(10)

4 Equilibrium

In equilibrium, (i) households choose their consumption \( \{c_{f,t}, c_{i,t}\} \), labor \( \{n_{f,t}, n_{i,t}\} \), and asset holdings \( \{m_{t+1}, d_{t+1}, k_{h}^{i+1}\} \), to maximize their expected lifetime utility (1) subject to their budget constraint (2) and the real cash-in-advance constraint given by (3); (ii) financial intermediaries choose capital, deposits, and net borrowing from other sources \( \{k_{b}^{i+1}, d_{t+1}, d_{o}^{i+1}\} \), to maximize their lifetime dividends given by (4) and (5) subject to their balance-sheet constraint (6); (iii) formal- and informal-sector firms choose the amount of inputs \( k_t \) and \( n_{f,t} \) and \( n_{i,t} \), respectively, to maximize their profits given by (9) and (10); (iv) all markets clear; (v) agents optimize and markets clear at a deposit-elastic interest rate, which we specify below.

The first-order conditions are:

\[ u'(c_{f,t}) = \lambda_t \]  

(11)

\[ u'(c_{i,t}) = p_t (\lambda_t + \nu_t) \]  

(12)
\[ \nu_t \geq 0 \text{ and } p_t c_{i,t} \leq m_t \text{ w.c.s.} \quad (13) \]

\[ v'(n_{j,t}) = \lambda_t w_{j,t}, \ j = \{f, i\} \]

\[ \lambda_t [1 + f'(m_{t+1})] = \beta E_t (\lambda_{t+1} + \nu_{t+1}) \]

\[ \lambda_t = \beta E_t R_{t+1} \lambda_{t+1} \]

\[ \lambda_t [1 + f'(k^h_{t+1})] = \beta E_t [\lambda_{t+1} (Q_{t+1} + 1 - \delta)] \]

\[ f'(k^b_{t+1}) = \beta E_t^f [Q_{t+1} + 1 - \delta - R_{t+1}] \]

\[ Q_t = \phi'_k(k_t, n_{f,t}) \]

\[ w_{f,t} = \phi'_{n_f}(k_t, n_{f,t}) \]

\[ w_{i,t} = g'(n_{i,t}), \]

where \( \lambda \) and \( \nu \) are the Lagrange multipliers associated with the budget constraint (2) and the real cash-in-advance constraint (3).

Eqs. (11)-(17) follow from the households’ optimization problem. Eqs. (11) and (12) are the households’ FOCs with respect to formal and informal consumption. Eq. (13) follows from the real cash-in-advance constraint (3) and it will be binding for all the parametrizations we consider here, which suggests that households are forced to save in cash, i.e. they hold cash only in order to finance their consumption of informal goods.\(^{18}\) Eq. (14) is

\(^{18}\)To see this, use eqs. (15) and (17) and note that, for the real cash-in-advance constraint to be binding in the steady state, it has to be that \( \beta (Q_{ss} + 1 - \delta) - f'(k^h_{ss}) > \beta - f'(m_{ss}) \), where the LHS is the net marginal
the households’ FOC with respect to labor, while (15)-(17) are the households’ FOCs with respect to their holdings of cash, deposits, and capital. Regarding the latter set of conditions, (16) specifies how much of the formal good households save and, together with (13) and (15), it helps pin down the households’ cash holdings, while together with (17) for a given price of capital $Q$, it helps pin down the amount of capital households hold. Eq. (18) follows from the financial intermediaries’ problem and, at given prices, it pins down their capital stock holdings. Finally, eqs. (19)-(21) are the firms’ FOCs with respect to their inputs.

Eq. (16) is central to the paper. A fall in the expected return to deposits, which we below call a "Grexit shock", induces, by a no-arbitrage argument, a concurrent increase in the households’ holdings of cash and capital so that their expected returns become equal to that of deposits, while, at the same time, it leads households to save less, hence consume more.

Turning to market clearing, the market-clearing conditions of the informal- and the formal-good markets are given by

$$c_{i,t} = y_{i,t}$$

$$D_t + R_t d^o_t + c_{f,t} + m_{t+1} + f(m_{t+1}) + d_{t+1} + k_{t+1}^h + f(k_{i,t+1}^h) + f(k_{i,t+1}^b) = y_{f,t} + m_t + (1 - \delta) k_t$$

The market-clearing condition of the formal-good market (23) follows from the households’ budget constraint (2) after taking into account the financial intermediaries’ dividends given by (5), the profit functions (9) and (10), and the market-clearing condition of the informal sector (22). Of the remaining market-clearing conditions, we need the financial intermediaries’ balance-sheet constraint (6) to pin down net borrowing from sources other than deposits.

Benefit of investing in an extra unit of capital in the steady state and the RHS is the net marginal benefit of investing in an extra unit of cash. That is, for the real cash-in-advance constraint to be binding, households must prefer to save in capital than cash. Along these lines, the real cash-in-advance constraint is binding (in expectation) when the expected return to capital exceeds that to cash, which will always be true for the parameters we choose here.

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Finally, following Schmitt-Grohe and Uribe (2003) we let a deposit-elastic interest rate close the model (and induce stationarity). The deposit-elastic interest rate is given by

\[ R_{t+1} = \bar{R} + \psi (e^{\bar{\alpha} - d_{t+1}} - 1) + \xi_t \]  

(24)

where \( \bar{R} = 1/\beta \) is the steady-state value of the interest rate which follows from (16), \( \bar{\alpha} \) denotes the steady-state level of deposits, and \( \psi \) parametrizes the elasticity of the interest rate with respect to deviations of deposits from their steady-state level. It follows from (24) that when the level of deposits falls below its steady-state value, financial intermediaries become less solvent and households demand a real interest-rate premium in return, which increases in the value of \( \psi \).\(^{19}\)

Importantly, we also introduce a stochastic term \( \xi_t \) which follows an AR(1) process. Negative realizations of \( \xi \) push the interest rate below its steady-state level, and we will interpret them as (part of) a Grexit shock. We become more precise about this in the following section.

5 Quantitative Analysis

In this section we undertake a quantitative analysis of the model in order to illustrate its key mechanisms. We do so by exploring the response of the economy to exogenous shocks that replicate the effects of an anticipation of Grexit and the imposition of capital controls in the Greek economy as outlined in the Introduction.

\(^{19}\)This is in line with Schmitt-Grohe and Uribe (2003). In our case, households assume the role of foreign lenders and deposits should be thought of as bonds (minus debt in theirs).
5.1 Functional forms and calibration

We let the functions $u(c_{f,t}, c_{i,t})$ and $v(n_{j,t})$ in the period utility (1) assume the following forms:

$$
u(c_{f,t}, c_{i,t}) = \left\{ \frac{\omega c_{f,t}^{\frac{n-1}{n}} + (1 - \omega) c_{i,t}^{\frac{n-1}{n}}}{1 - \gamma} \right\}^{1-\gamma} \quad \text{and} \quad v(n_{j}) = \frac{n_{j,t}^{1+\zeta}}{1 + \zeta} \quad \text{with} \quad j = \{f, i\},$$

where $\omega \in (0, 1)$ denotes the weight of formal goods in the households’ consumption basket, $\eta > 0$ denotes the elasticity of substitution between formal and informal goods, and $\zeta > 0$ denotes the inverse Frisch labor elasticity.

In addition, we fix $\phi(k_{t}, n_{f,t}) = k_{t}^{\alpha} n_{f,t}^{-\alpha}$ and $g(n_{i,t}) = n_{i,t}^{\theta}$, where $\theta \in (0, 1]$ and we let the cost to holding cash and capital be given by $f_{s}(s) = a_{s} s^{2}$, where $a_{s} > 0$ and $s = \{m, kh, kb\}$. We assume that $\alpha_{m}$ follows an AR(1) process, with drift equal to $\sigma_{m}$ and persistence given by $\rho_{m}$. Shocks to this process are policy shocks and we will use positive values of them, which increase the cost to holding cash, to replicate the effects of capital controls.

The calibrated parameters for our quarterly model can be seen in Table 1. Following standard parameterizations in the literature (see, e.g., Mendoza (1991)), we set the coefficient of relative risk aversion to 2, the Frisch elasticity of labor supply to 0.5, the discount factor to 0.99, the depreciation rate of capital to 0.025, and the capital share in the formal sector to 0.36. The share of formal goods in consumption $\omega$ is set to 0.7, which is broadly in line with the 28% size of the Greek shadow economy (as a % GDP) found in Bitze

nis et al. (2016). Regarding the values reflecting the cost to households of holding cash $\alpha_{m}$ and capital $\alpha_{kh}$, we choose them to target a share of cash-to-household assets of 1% and deposits-to-household assets of 98%. Regarding the value reflecting the cost to financial intermediaries of holding capital $\alpha_{kb}$, it is such that the capital stock in the steady state is nearly entirely (in particular, 99.5%) held by financial intermediaries rather than households, which is in line with Gertler and Kiyotaki (2015). Finally, the deposit-elastic interest rate parameters $\{d, \psi\}$ are set to obtain a response of deposits following an anticipated “Grexit” shock that is in line with the evidence laid out in the Introduction, namely
Table 1: Parameter values

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>0.99</td>
<td>Discount factor</td>
</tr>
<tr>
<td>ζ</td>
<td>0.5</td>
<td>Inverse Frisch elasticity of labor supply</td>
</tr>
<tr>
<td>γ</td>
<td>2</td>
<td>Coefficient of relative risk aversion</td>
</tr>
<tr>
<td>ω</td>
<td>0.7</td>
<td>Share of formal goods in consumption basket</td>
</tr>
<tr>
<td>η</td>
<td>2</td>
<td>Elasticity of substitution between formal and informal goods</td>
</tr>
<tr>
<td>δ</td>
<td>0.025</td>
<td>Depreciation rate of capital</td>
</tr>
<tr>
<td>α</td>
<td>0.36</td>
<td>Capital share in formal sector</td>
</tr>
<tr>
<td>θ</td>
<td>0.7</td>
<td>Labor share in informal sector</td>
</tr>
<tr>
<td>α_{kb}</td>
<td>0.00025</td>
<td>Cost to financial intermediaries of holding capital</td>
</tr>
<tr>
<td>α_{kh}</td>
<td>0.05</td>
<td>Cost to households of holding capital in steady state</td>
</tr>
<tr>
<td>α_{m}</td>
<td>0.05</td>
<td>Cost to households of holding money in steady state</td>
</tr>
<tr>
<td>{d, ψ}</td>
<td>{20, 0.001}</td>
<td>Deposit-elastic interest rate</td>
</tr>
</tbody>
</table>

A decline by roughly 20% in real terms after 3 quarters (average monthly inflation in 2015 was -1.7%). It follows that the lower the value of ψ, the more deposits respond.

5.2 Simulation experiment

We first explore the response of the economy to a sequence of negative ξ shocks to the interest rate (24), which we interpret as a "Grexit shock." Crucially, we assume that the Grexit shock is a sequence of shocks that affect negatively only the real interest rate that households expect, not the realized one. By doing so, we let a Grexit shock affect the households’ savings and consumption decision (Euler equation (16)) but not their budget constraint (2), so as to be in line with the actual events—Grexit after all never materialized, nor did any deposit haircuts happen. Further to this, we assume that a negative interest-rate shock does not affect the financial intermediaries’ decision, captured by (18), either. This is so because we implicitly assume that after a potential Grexit both the assets (capital) and the liabilities (deposits, other borrowing) of the financial intermediaries would be denominated in a new currency, turning Grexit into a mere accounting issue for the financial intermediaries and thus leaving their decision unaffected. Finally, we model the risk of Grexit as an independent, exogenous process since it is widely perceived to have been caused by factors that remain exogenous to our model, e.g., political instability.
We experiment with two different specifications for the Grexit shock, taking the forms shown in Figure 10: in the top panel we consider a series of stochastic shocks that hit the economy for four consecutive periods, with persistence $\rho_\xi = 0.93$. In the middle panel, we consider an anticipated version, whereby households have perfect foresight over the path of the shock. It is designed to hit the economy for six periods and has persistence $\rho_\xi = 0.8$.

Next, we perform a different set of experiments, this time exploring the response of the economy, first, to a one-off unanticipated positive shock to the cost of holding cash $\alpha_m$ and, second, to both a one-off unanticipated positive shock to the cost of holding cash $\alpha_m$ and to the cost of holding capital $\alpha_{kh}$. Via these experiments we wish to model the difficulty with which households can turn their deposits into cash in the former case, and both cash and capital in the latter one. These shocks reflect the key and distinctive domestic dimension of the Greek episode of capital controls, and we therefore label them “capital controls shocks.” They have a size equal to 0.3 and persistence $\rho_m = 0.8$ and are shown in the bottom panel of Figure 10. We have calibrated their size and persistence to obtain a fall in cash holdings of roughly 25% in the same period, which is consistent with the data presented in Section 2.

20 An anticipated Grexit shock is effectively a news shock as in Beaudry and Portier (2004) and the pertinent literature.
5.3 Results

Figures 13 and 14 plot the response of the economy’s key variables to a Grexit shock. As expected, in response to a Grexit shock, households run down their deposits and reallocate their savings towards cash and capital, whose holdings they increase substantially. Households’ total asset holdings (i.e. the sum of deposits, cash and capital), however, fall because of the lower expected return to saving and, instead, households increase their consumption. Interestingly, in response to a Grexit shock, households also choose to reallocate their consumption towards formal goods, which (also) appears in market-clearing condition (23). This is important as it is formal consumption that GDP accounts for. Informal consumption, on the other hand, falls despite the households’ increased cash holdings and this is because a higher amount of cash results in a less tight cash-in-advance constraint which, as we can also see from eqs. (11) and (12), causes the relative price of informal goods to increase. Put differently, households prefer to consume using their electronic money (deposits), not their paper money (cash). Employment, formal and informal alike, falls and so does the price of capital, which leads financial intermediaries to lower
their capital holdings and suffer lower dividends. Since capital is mainly held by financial intermediaries, its aggregate level falls too, causing formal output to fall further. With the exception of informal consumption on which there is no available evidence, all the results are fully in line with the evidence presented in Section 2.

Figure 15 plots the responses following a capital control shock targeting only the cost of holding cash. We see that as soon as it hits, households lower their cash holdings and reallocate their savings towards capital. This results in a less tight cash-in-advance constraint, reflected in a lower relative price of informal goods, whose consumption falls—and, consequently, so does informal employment. The financial intermediaries’ dividends increase whereas, importantly, all the other variables remain fairly stable, except for formal consumption which increases slightly.

Figure 16 plots the responses following a capital control shock targeting both the cost of holding cash and the cost of holding capital, i.e. effectively targeting the difficulty with which households can convert their deposits into cash and capital. Consequently, as soon as the capital controls shock hits, households lower both their cash and capital holdings substantially, and reallocate their savings towards deposits. For the reasons outlined above, the relative price of informal consumption falls and so does informal consumption, while formal consumption increases moderately. Despite the increased amount of capital held by financial intermediaries, aggregate capital falls, causing output to also fall. All the other variables remain fairly stable, except for the financial intermediaries’ dividends which fall because the substantial increase in deposits does not match that of the value of their capital stock.

Figures 17 and 18 bring the previous experiments together. We allow then for both a Grexit shock and a capital controls shock in order to mimic the economic environment in Greece in 2015 when, amid mounting fears of Grexit, capital controls were imposed in order to prevent an uncontrolled bank run. In particular, we consider an unanticipated Grexit shock that hits in period 1 and a capital controls shock that hits in period 5 (see Figure 10 for the shock paths), with capital controls only referring to the cost of holding cash in the experiment shown in Figure 17 and both cash and capital in that shown in Figure 18. As can be seen from Figure 17, relative to a baseline of Grexit, the primary effect of
the exogenous policy of capital controls when it only targets the cost of holding cash is to mitigate the surge in cash and lower the consumption of informal goods. More interestingly though, Figure 18 shows that, when capital controls affect the costs of holding both cash and capital, i.e. the cost of converting deposits into cash and capital, the financial sector of the economy gets stabilized as intended, again relative to a baseline of Grexit: the surge in cash is mitigated, the reallocation of capital from financial intermediaries to households is hindered, and the decline in deposits is dampened. In addition, a further switch to formality is incentivized, while all the remaining variables remain fairly stable. Once again, these results are in line with the evidence presented in Section 2.

5.4 Sensitivity

We repeat our experiments in Section 5.2 for different values of \( \eta \), which measures the elasticity of substitution between formal and informal goods. This elasticity affects the dynamics of formal and informal consumption and its value is key in replicating the stylized facts on private consumption reported in the Introduction. With no loss of generality, in this exercise we restrict attention to an anticipated Grexit shock and a capital controls shock that only affects the cost to holding cash.

In the case of a Grexit shock (Figure 19), as \( \eta \) increases, cash holdings increase by less (or can even fall) as households can rely less on informal goods, whose relative price increases by less and consumption falls more. Formal consumption in turn increases by less—even though it remains fairly stable—reflecting in part households’ lower labor income. Deposits and all the remaining variables are insensitive to changes in \( \eta \).

Under a capital controls shock (Figure 20), a higher \( \eta \) implies that cash holdings need to drop less again because households rely less on informal goods, whose consumption and relative price also fall less. Interestingly, the lower \( \eta \) is, the more dividends increase, which implies that capital controls are needed the most when households find it hard to substitute their consumption away from informal goods and are therefore more cash-reliant. All the remaining variables are insensitive to changes in \( \eta \).
6 Conclusion

This paper formalizes the later part of the Greek crisis, which was characterized by the heightened fears of an exit from the Eurozone and culminated in the imposition of capital controls. We are able to reproduce and account for a number of stylized facts: the deposit dry up and the surge in cash holdings, the resilience of consumption and its reallocation from the informal to the formal sector which, at least in part, underscored the resilience of the Greek economy in 2015, the reallocation of capital from financial intermediaries to households as well as the subsequent fall in the price and the aggregate stock of capital and the squeeze of the financial intermediaries’ dividends. We are able to do so by extending the standard small open economy model to allow for both a formal and an informal sector, a richer set of assets including cash, and financial intermediation.

A limitation of our framework is that it cannot account for the events prior to 2015H1, when the Greek economy was emerging from a five-year slump, posting small positive growth for 2014, and it was expected to grow more in 2015. As such, we cannot account for the counterfactual of no shocks. Instead, our analysis focuses on why during and in the aftermath of these shocks, aggregate effects were so muted. A more detailed model that also allows for imports and exports, capital inflows and outflows, and endogenizes the interest-rate premia will permit a full-blown empirical assessment of the later parts of the Greek crisis and would be an interesting direction for future research.

We conclude by highlighting that the Greek case bears some similarities to the recent demonetization experience of India. In November 2016, the Indian government unexpectedly announced that the largest banknotes were no longer consisting legal tender, and consumers were given until the end of the year to exchange them with newly-issued notes. The stated intent of the policy was to battle forgery and illicit activities, and to facilitate a shift to the formal economy, which was aided by increased tax-auditing efforts. The initial disruption was strong (due to delays in issuing the new notes), with the monetary base initially contracting sharply, hitting particularly hard cash-intensive sectors, such as real estate (Reserve Bank of India (2017)), with evidence that sales of durable goods fell sharply.

\[21\text{See, for instance, } http://ec.europa.eu/economy_finance/publications/european_economy/2014/pdf/ee7_en.pdf.\]
before rising again. Although the policy seems to have ultimately failed in its main goal of battling forgery, with virtually all of the discontinued notes eventually returning to the banking system, it had benign medium-term economic effects, with consumption being particularly strong and supporting growth (RBI (2017)). A key difference regarding the path of consumption between the Greek case (until the Grexit risk waned) and the Indian case (until notes were exchanged) is that the value of cash increased in the former and fell in the latter, while the opposite was true for deposits. This could explain why consumption rose in Greece in 2015H1, but fell upon the announcement of demonetization in India. In both cases, however, the direct medium-term effect seems rather muted.
References


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A Appendix

Figure 11: Deposits in Greek Banks - Sectoral Breakdown, 2010-2016 (EUR millions)

One possible explanation is that households and firms needed a minimum of deposits, either as cash storage or as a way of handling official transactions, which persisted through 2015H1.

Next we consider the sectoral breakdown of these deposits between households and firms. By and large, aggregate deposits reflect those of households, which comprise 85-90% of the total for the period studied. To the extent that deposits are fungible between corporate and personal accounts, particularly for micro firms or sole proprietors, the household sector may also reflect some of the firm behavior, but overall the two track each other quite well. It is interesting to note that overnight deposits of firms were relatively stable in the earlier stages of the crisis, even while longer-term deposits were falling, and following a steep fall starting in late 2014, they started rising soon before the imposition of capital controls. These two observations support the notion that there is a minimum of deposits needed to fulfill official functions (and that firms try and minimize that, possibly given the lack of overnight savings options for firms), and also confirm the fall in the intensity of cash transactions.

Cash and Payments

The run on longer-term deposits released large amounts of liquidity from the system. The left panel of Figure 3 shows the evolution of banknotes issued by the Bank of Greece, which is the most reliable indicator of cash holdings. After gradually falling following a peak in June 2012, cash holdings started to rise again starting in December 2014, with consumers withdrawing a total of approximately 20 billion euros from their bank accounts until the imposition of capital controls, a rise of 67% in cash holdings. This is the most salient depiction of the run in deposits that took place in the first half of 2015. The risk of Grexit and the possible redenomination of bank deposits into a less valuable currency also played a role.

Figure 12: Retail Trade Turnover (deflated)

Data are monthly, seasonally and calendar adjusted. Source: Eurostat.
Figure 13: Simulation following an anticipated GREXIT shock

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 14: Simulation following an unanticipated GREXIT shock

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 15: Simulation following a Capital Controls shock - cost of holding cash

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 16: Simulation following a Capital Controls shock - cost of holding cash and capital

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 17: Simulation following both a GREXIT and a Capital Controls shock - cost of holding cash

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 18: Simulation following both a GREXIT and a Capital Controls shock - cost of holding cash and capital

One period is a quarter. All variables are reported in % deviations from their steady state.
Figure 19: Impulse responses following a GREXIT shock for different values of $\eta$

One period is a quarter. All variables are reported in % deviations from their steady state with the exception of dividends, which are reported as absolute deviations from their steady state.
Figure 20: Impulse responses following a Capital Controls shock (cost of holding cash) for different values of $\eta$

One period is a quarter. All variables are reported in % deviations from their steady state with the exception of dividends, which are reported as absolute deviations from their steady state.