Liquidity Creation, Investment, and Growth*

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Abstract

Liquidity creation (the transformation of liquid liabilities into illiquid assets) by banks is positively associated with economic growth at both country and industry levels. Liquidity creation boosts tangible, but not intangible investment and does not contribute to growth in countries with a high share of intangible-asset industries. These results are consistent with a model in which liquidity creation fosters investment only if it is sufficiently tangible, because intangible assets have low collateral value and are easy to divert. Together, these findings provide new insights into the function of banks, but also highlight their more limited role in supporting innovative industries.

JEL classification: E22, G21, O16, O40

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1 Introduction

A key function of banks in the economy is the provision of liquidity by funding illiquid assets with liquid liabilities (Diamond and Dybvig, 1983; Holmström and Tirole, 1998). Bank loans provide funding for long-term investments, while bank deposits serve as a safe and liquid transaction medium that forms the core of the payment infrastructure in modern economies. Prior work documents a positive relation between overall banking sector development and economic growth (Rajan and Zingales, 1998; Beck et al., 2000). However, there is little research focusing specifically on whether and how liquidity creation, as a key function of banks to foster long-term investments, contributes to growth. A few papers examine the relation between banks' liquidity creation and growth, but only in a single-country setting (Fidrmuc et al., 2015; Berger and Sedunov, 2017).

Several studies indicate that the role of banks in fostering economic activity exhibits important heterogeneity (or non-linearity) across countries and industries. Across countries, Arcand et al. (2015) find that banking sector development stops contributing to growth beyond a certain threshold, while Čihák et al. (2012) show that as economies develop, securities markets become more important for growth relative to banks. Across industries, Hsu et al. (2014) report that banking sector (equity market) development is negatively (positively) related to innovation in industries more dependent on external finance, while Aghion et al. (2004) show that R&D intensive firms are more likely to raise funds by issuing shares than through debt. Indeed, the role of banks in supporting innovation – an important channel through which finance can affect growth (Aghion et al., 2018) – is subject to debate. Dell'Ariccia et al. (2020) argue that banks have a comparative advantage in financing standardized and well-collateralized investment projects, as opposed to more innovative projects that rely on intangible assets such as R&D. None of these papers, however, focuses on the specific function of banks as liquidity creators to understand the interplay between banks, innovation, and growth.

This debate highlights the need to understand how liquidity created by the banking sector relates to overall but also industry-specific economic activity. This paper fills this gap by providing evidence that liquidity creation by banks is associated with higher economic growth at both country and industry levels. In particular, we find that liquidity creation boosts tangible, but not intangible investment both across countries and more so for industries more in need of debt financing. Our findings suggest an important non-linearity in the relation between liquidity creation and economic growth; liquidity creation does not contribute to growth in more-developed countries with a higher share of industries relying on intangible rather than tangible assets.

To examine the relation between banks' liquidity creation and the real economy, we combine bank-, industry-, and country-level unconsolidated data. Specifically, we use a sample of 18,217 commercial, savings, and cooperative banks operating in 100 countries from 1987 to 2014 and build on the work of Berger and Bouwman (2009) to measure banks' liquidity creation on and off the balance sheet. We find that global liquidity creation by banks has increased substantially since 1987, reaching \$16.1 trillion in 2014 – of which \$11.4 trillion was created on their balance sheet and \$4.6 trillion off their balance sheet. Large banks (with assets exceeding \$3 billion) consist of about 15 percent of our sample, but are responsible for 72 percent of global liquidity creation.

Next, we examine the relation between liquidity creation and economic growth.[1] We estimate dynamic panel models for GDP per capita including autoregressive dynamics as well as year and country fixed effects and time-varying controls, using both the standard within estimator and a Generalized Method of Moments (GMM) estimator. Accounting for dynamics in the GDP process allows us to distinguish short-run from long-run relations between liquidity creation and GDP. Our empirical strategy results in robust and precise estimates that indicate a 1.12 percent increase in long-run GDP per capita following a *permanent* 10-percent increase in on-balance sheet liquidity creation per capita. We verify the robustness of our results to the inclusion of various time-varying controls that could confound the effect of liquidity creation on GDP (such as financial reforms and attributes of countries' financial systems). We further find that the amount of liquidity created by banks off the balance sheet is also consequential for growth. This effect is, however, quantitatively smaller. Our estimates indicate that a permanent 10-percent increase in off-balance sheet liquidity creation per capita is associated with a 0.34 percent increase in long-run GDP per capita.

We address endogeneity concerns of these cross-country results by conducting additional tests that exploit industry heterogeneity within countries. Although we control for time-varying country-characteristics and country fixed effects, other factors may still coincide with changes in liquidity creation, meaning that we would incorrectly attribute the changes in GDP per capita to changes in liquidity creation. To address these concerns, we exploit industry variation in dependence on debt financing, thus extending the approach of Rajan and Zingales (1998) to the function of banks as liquidity creators. We find that liquidity creation has a systematically larger effect on output in industries more dependent on debt financing, consistent with our results on country-level growth.

However, the functioning of the banking sector could merely respond to changing demands from the real economy. Reverse causality cannot be ruled out easily, because liquidity creation

[1] Our baseline specifications focus on the effect of liquidity creation on the level of log GDP per capita. With some abuse of terminology, we will sometimes describe this as the effect of liquidity creation on "economic growth" or "GDP" (rather than on log GDP per capita).

by banks can be a result of economic growth, rather than a cause thereof. Although abundant research indicates that banking sector development leads to long-run growth (see our discussion of the literature below), we address this concern by exploring empirically and theoretically the channel via which liquidity creation matters for growth.

We use a rich set of data on investment to derive three further sets of results. First, liquidity creation is positively and significantly associated with net tangible investment rates at the country level, but not with net intangible investment rates. This suggests that liquidity created by banks boosts investment in tangible, but not intangible assets. Second, we again exploit within-country variation across industries over time to sharpen the identification of the effect of liquidity creation on investment. Corroborating our country-level results, we find that liquidity creation (on-balance sheet) increases net tangible investment rates in industries that are relatively more in need of debt financing, while we do not find evidence that liquidity creation affects net intangible investment rates in such industries. Third, we connect our industry-level results on tangible versus non-tangible investment with our country-level evidence on the relation between liquidity and economic growth. We show that liquidity creation has a weaker, if not insignificant, effect on growth in countries with a higher share of industries relying on intangible assets.

We propose a model of liquidity creation based on Diamond and Dybvig (1983) to illuminate the channel underlying our empirical results. While previous theoretical literature establishes a positive effect of banks' liquidity creation on investment and growth (Wallace, 1996; Allen and Gale, 2000), the novel angle of our model is that it allows analyzing the role of intangible capital in this process. To this end, we extend the baseline Diamond-Dybvig model by adding liquidity risk and a moral hazard problem, which are both affected by the (in)tangibility of long-term investments. In the model, banks can increase overall investment by providing liquidity through demand deposit contracts. However, this process may be hampered by a moral hazard problem as investors may divert assets and default on bank loans – although the bank can seize the deposit claim of diverting investors. This moral hazard problem is particularly strong if asset tangibility is low, for two reasons. First, intangible investments may be more easily diverted as they are harder to assess by outsiders. Second, failing intangible investments leave the bank with relatively low collateral value, reducing the value of claims on the bank. This makes it attractive for investors with successful projects to divert even if the bank can seize their deposit claims. Overall, these results rationalize the empirical finding that liquidity creation by banks supports economic growth through investment, and especially tangible investment.

Taken together, our analysis provides a unified framework that features liquidity creation by banks as a key mechanism to help understand a number of important findings in the finance and growth literature. We show that liquidity creation helps economies grow faster by fostering tangible investment. As economies rely more on intangible assets, the importance of liquidity creation vanishes, where traditional bank lending hits its limits. Unlike the prior literature, which has used a general size-based indicator of banking sector development, we focus specifically on an empirical gauge of one of the critical functions of banking (liquidity creation), which captures the full spectrum of banking activities on the asset side and the liability side, as well as off-balance sheet activities. We also highlight an important channel through which the banking sector supports growth (tangible investment).

Our work contributes to several strands of the literature. It is most directly related to the finance and growth literature (see Popov, 2018, for a recent survey).[2] Until recently, the literature has used crude proxies focusing on the size of the banking sector (such as the ratio of private credit to GDP) for lack of variables capturing the individual functions of the banking sector. Berger and Bouwman (2009) have made valuable progress by proposing a direct, bank-level measure of liquidity creation based on classifying all bank balance sheet items as liquidity creating or liquidity reducing.[3] However, almost all studies using this measure concentrate on the US (Chatterjee, 2015; Berger and Bouwman, 2017; Jiang et al., 2019). This paper goes beyond these studies by measuring the amount of liquidity created by banks from the late 1980s in 100 countries and uncovering first evidence on the relation between liquidity creation and economic growth at the country and industry levels.[4]

Our analysis also adds to our understanding of heterogeneity or non-linearities in the relation between banking sector development and economic activity, and of the role of banks in supporting

[2]This literature documents a positive (causal) link between financial development and economic growth at the country (Rousseau and Wachtel, 1998; Beck et al., 2000; Levine et al., 2000), regional (Jayaratne and Strahan, 1996; Guiso et al., 2004; Bertrand et al., 2007), industry (Rajan and Zingales, 1998; Fisman and Love, 2007), and firm (Love, 2003; Beck et al., 2005, 2008) levels. These studies build on research about the history of modern financial systems, which emphasizes, for instance, the emergence of banks as the key to modernization (Gerschenkron, 1962; Cameron, 1972), or the functioning of financial markets for economic development (Kindleberger, 1984).

[3]Bai et al. (2018) develop a related liquidity measure, which gauges instead the mismatch between the market liquidity of assets and the funding liquidity of liabilities. However, their measure is not feasible for our broad international setting as it requires incorporating market prices.

[4]Two exceptions are Fidrmuc et al. (2015) and Berger and Sedunov (2017), who study the impact of liquidity creation on growth in Russia and the US, respectively. Our paper complements these studies along three considerations. First, it tests in a large panel of countries the generality of the claim that liquidity creation, both on and off the balance sheet, is good for growth. Second, it underscores the importance of using dynamic panel data models to capture both short-run and long-run relations between liquidity creation and growth. Third, it explores the channel through which liquidity creation operates and identifies empirical and theoretical evidence for an investment channel. The latter consideration is particularly important, as suggested by Berger and Sedunov (2017): "While we find that bank liquidity creation impacts economic growth [...] more research is needed on the underlying mechanisms or channels through which it occurs (p. 18)." More generally, Berger and Bouwman (2015) advocate further research directly embracing these three considerations (see their Chapter 15).

innovation. The results of Arcand et al. (2015) and Čihák et al. (2012) suggest that banks become less important in supporting growth for more-developed countries. Aghion et al. (2005) show that banking sector development helps economies converge to the growth rate of the world frontier but does not help them grow beyond this frontier. The debate on the role of banks in supporting innovation (Aghion et al., 2004; Hsu et al., 2014) could shed light on these country-level results. Powerful banks can stymie innovation by extracting informational rents and protecting established firms (Hellwig, 1991; Rajan, 1992). Banks as debt issuers have an inherent bias toward conservative investments, so that bank-based systems might thwart innovation and growth (Weinstein and Yafeh, 1998; Morck and Nakamura, 1999). Related to our paper, Brown et al. (2013) find that better stock (credit) market access is associated with more R&D (fixed) investment.

In line with the channel behind our results, the corporate finance literature highlights that intangibles may reduce a firm's debt capacity due to their low collateral value (e.g., Rampini and Viswanathan, 2010; Falato et al., 2018) and because intangible assets are more easily diverted (Döttling et al., 2020). Consistent with our findings, Dell'Ariccia et al. (2020) show that banks shift their lending away from corporate lending towards real estate when firms invest more in intangible assets, and Döttling and Ratnovski (2020) find that intangible investment responds less to the credit channel of monetary policy. We contribute to these lines of research by showing how liquidity creation affects economic activity in a non-linear way by fostering tangible but not intangible investment, and thereby failing to boost growth in more-developed countries with a greater reliance on intangibles. We thus also add new insights to the long-standing debate on the relative merits of bank-based versus market-based financial systems (Allen et al., 2018).

We also build on the theoretical banking literature that has shown several benefits of liquidity creation. Banks allow consumers (Bryant, 1980; Diamond and Dybvig, 1983) and producers (Holmström and Tirole, 1998) to share liquidity risk. Banks also help overcome adverse selection problems (Gorton and Pennacchi, 1990; Dang et al., 2017) and thereby produce safe claims that satisfy a demand for safety (Stein, 2012). These functions may be further supported by deposit insurance (Hanson et al., 2015) and the ability of banks to monitor borrowers (Diamond, 1984; Holmstrom and Tirole, 1997). While this previous literature establishes a theoretical relationship between liquidity creation, investment and growth, our model contributes to it by showing how the positive effect of liquidity creation on investment may be weakened by low asset tangibility, consistent with the empirical findings.

The paper is organized as follows. The next section describes the construction of our measures of liquidity creation, and provides data sources and summary statistics for our sample of 100 countries. Section 3 first discusses the relation between liquidity creation and GDP per capita based on correlations, then presents our panel model results at both country and industry levels and robustness checks. Section 4 shows our empirical results on the investment channel through which liquidity creation affects growth. Section 5 develops a model clarifying the investment channel. Section 6 concludes the paper.

2 Liquidity Creation around the World

In this section, we present our measures of liquidity creation. We also compare our liquidity measures for US banks with those of Berger and Bouwman (2009).

2.1 Liquidity Creation Measures

To estimate how much liquidity banks provide to the economy, we combine detailed financial and demographic information from BvD/Fitch Bankscope. Our worldwide sample focuses on all commercial, savings, and cooperative banks that were in business during some period between 1987 and 2014. We discard data after 2014 because they have undergone important changes resulting from the termination of contract between BvD and Fitch. This choice is in line with recent studies using Bankscope data (Silva, 2019). Also following Silva (2019), we rely on information at the most disaggregated level and avoid double-counting within the same bank by discarding consolidated entries if banks report unconsolidated data.[5]

We then build on the work of Berger and Bouwman (2009) in creating our measures of liquidity creation, which incorporate the contributions of all bank assets, liabilities, equity, and off-balance sheet activities. As it is recognized that banks create liquidity when they engage in certain activities but reduce liquidity when they engage in other activities, their measure classifies and weights all bank activities based on the liquidity they create or destroy. The Berger-Bouwman liquidity creation measure delivers a cash-denominated amount of liquidity which is provided by a bank to the economy. Formally, the liquidity creation (LC) measure for bank b operating in

[5] Based on recommendations provided by Duprey and Lé (2016), we apply the following filter criteria from Bankscope to construct our sample. We include a bank if (i) its deposits are greater than zero, (ii) its total assets are above \$25 million, (iii) it is a commercial, savings, or cooperative bank, (iv) its consolidation code is U1, U2, or C1, (v) its variable format is different than RF, BR, DD, or NA, and (vi) it is a controlled subsidiary, a single-location company, or an independent company.

country c at time t is defined as the liquidity-weighted sum of all balance sheet items:

$$LC_{bct} = \sum_k \omega_{Ak} A_{bckt} + \sum_k \omega_{Lk} L_{bckt},$$

where ω_{Ak} and ω_{Lk} are the weights for classes k of assets A and liabilities plus equity L, respectively. The liquidity weights are assigned based on the ease, cost, and time for customers to withdraw liquid funds from the bank, and for banks to dispose of their obligations to meet these liquidity demands. There are three liquidity weights: liquid, semiliquid, and illiquid. Since liquidity is created when illiquid assets are transformed into liquid liabilities, both illiquid assets and liquid liabilities are given a positive weight. Following a similar logic, a negative liquidity weight is given to liquid assets, illiquid liabilities, and equity since liquidity is destroyed when liquid assets are transformed into illiquid liabilities or equity. Because liquidity creation is only half determined by the source or use of funds alone, we assign weights of $+\frac{1}{2}$ and $-\frac{1}{2}$. The intuition is that liquidity creation equals \$1 when a dollar of liquid liabilities (such as demand deposits) is used to finance a dollar of illiquid assets (such as commercial loans) ($\frac{1}{2} \times \$1 + \frac{1}{2} \times \$1$). However, liquidity creation equals -\$1 when a dollar of illiquid liabilities (such as long-term funding) or equity is used to finance a dollar of liquid assets (such as cash or trading securities) ($-\frac{1}{2} \times \$1 + -\frac{1}{2} \times \$1$). An intermediate weight of 0 is also applied to activities that fall halfway between liquid and illiquid activities, that is, both semiliquid assets (such as residential mortgage loans) and liabilities (such as term deposits). Subsequently, we add up all weighted items of both sides of the bank balance sheet to yield the total amount of liquidity created by a bank in a particular year. All balance sheet items are converted into \$ millions. Besides measuring how much banks create liquidity on the balance sheet, we also assess how much liquidity they create off-balance sheet. We apply the same principles to off-balance sheet items (such as committed credit lines), which are classified and weighted consistently with those assigned to functionally similar on-balance sheet activities. Since the granularity of the data is different in Bankscope and the Call Reports used in Berger and Bouwman (2009), we accordingly adapt their classifications.[6] Appendix A presents a detailed overview of our classifications and weights.

The advantage of a liquidity creation measure over a banking sector size measure is that it captures the full spectrum of banking activities on both sides of the balance sheet, as well as off-

[6]Our classification is largely consistent with Silva (2019), who calculates on-balance sheet liquidity creation for 1,584 commercial banks operating in 34 OECD countries from 1999 to 2014. Our study further considers off-balance sheet liquidity creation since banks create a significant part of their liquidity off the balance sheet (with potentially important effects on economic activity). We note, however, that Bankscope provides a less granular breakdown of off-balance sheet items compared to the Call Reports.

balance sheet activities. On the asset side, bank loans provide funding for long-term investments, while credit lines and other forms of off-balance sheet commitments provide funding liquidity to firms. On the liability side, bank deposits serve as safe and liquid transaction medium that form the core of the payment infrastructure in modern economies.

The following two examples illustrate the difference between a broader size-based measure and the liquidity creation measure used here. First, consider a fully equity-funded bank that makes long-term loans. This bank would contribute to the overall banking sector size as measured by outstanding bank credit. However, it does not create liquidity and could be replaced by any other equity-financed intermediary. Second, consider a narrow bank that offers demand deposit contracts but only holds reserves. This bank can provide payment services and would contribute to banking sector size as measured by the amount of outstanding bank deposits. But it again does not create liquidity because the same liquidity service could also be provided by a central bank, issuing fiat or digital money. Therefore, a liquidity creation measure may be better suited for capturing the impact of bank activities on economic growth.

2.2 Summary Statistics

Table 1 shows summary statistics on our bank-level liquidity creation measures. Panel A shows summary statistics for the whole sample of banks in 100 countries, while Panel B splits the sample of banks by total assets (using $1 billion and $3 billion cutoffs to define medium and large banks, respectively). We note that for our regression analysis, we will aggregate these bank-level liquidity creation measures to the country level. Panel C shows the mean on- and off-balance sheet liquidity creation for six individual years throughout our sample period.

Our sample contains 18,217 banks and 199,812 bank-year observations (Panel A of Table 1). The mean value of liquidity creation (on- and off-balance sheet) of a bank in our sample is $985 million per year. Total liquidity creation culminated to $16.1 trillion globally in 2014, broken down as follows (untabulated): $11.4 trillion on-balance sheet liquidity creation and $4.6 trillion off-balance sheet liquidity creation. These numbers highlight the importance of considering off-balance sheet activities. Indeed, on average only 61.2 percent of an individual bank's liquidity creation is on-balance sheet (mean of $603 million, see Panel A). Both the between and the within standard deviations suggest considerable heterogeneity in the degree of liquidity creation across individual banks and over time.

Panel B of Table 1 shows summary statistics of our liquidity creation measure by bank size.

Large banks only consist of 15.3 percent of our sample, but they create the vast majority (71.7 percent) of total liquidity (mean of $4,630 million). Medium banks comprise 10.0 percent of our sample and create 8.9 percent of total liquidity. Small banks account for the remaining 19.4 percent of total liquidity creation, despite the fact that they constitute the bulk of our sample of banks (75.1 percent). This pattern is consistent with Berger and Bouwman (2009).

Panel C of Table 1 reports the mean value of liquidity creation in various years. Liquidity creation (on- and off-balance sheet) steadily increases over our sample period, with a mean of $674 million in 1989 and of $1,787 million in 2014. This yearly comparison in Panel C has to be considered with caution as our sample is strongly unbalanced (limited country coverage in 1989) and our numbers are in current $. Our conclusion that liquidity creation has grown rapidly over time is, however, an overall pattern observed within our sample countries. As an example, Figure 1 exhibits the evolution of our liquidity creation measures for the US. Total liquidity created by the US banking sector has clearly increased over time – though not monotonically – and reached almost $4.8 trillion in 2014.

Although it is useful to compare our estimates of the amount of liquidity created by the US banking sector with the annual US statistics produced by Berger and Bouwman (2009), the comparison is complicated by several data limitations. First, Berger and Bouwman rely on the Call Reports which, unlike our data, are on a consolidated basis. Second, there are differences between Bankscope and the Call Reports in the breakdowns of both loan and deposit categories as well as off-balance sheet items. Third, we note that our sample periods only overlap for a few years; Berger and Bouwman (2009) focus on 1993-2003, while our US data cover 1999-2014. Fourth, we also include savings and cooperative banks (besides commercial banks) to account for the specificity of the banking sector in some countries (such as in Germany). With these caveats in mind, we can compare our aggregate statistics. For the year 2003, for instance, Berger and Bouwman (2009) report $2.843 trillion of total liquidity created by 6,969 commercial banks (using the measure they label *catfat*), while we have $3.299 trillion of liquidity created (on- and off-balance sheet) by 7,539 banks. Our investigations reveal that our numbers tend to underestimate on-balance sheet liquidity creation somewhat and overestimate off-balance sheet liquidity creation relative to Berger and Bouwman (2009). However, our numbers remain broadly comparable.[7]

[7]We also conducted line-by-line balance sheet analysis at the individual bank level to compare balance sheet data from Call Reports with Bankscope. We find that, although there is a dispersion with Berger and Bouwman (2009) due to differences in breakdowns of some balance sheet items, numbers are generally very similar.

3 Liquidity Creation and Economic Growth

In this section, we provide our empirical results on the relation between liquidity creation and economic growth at the country and industry levels.

3.1 Main Variables and Initial Assessment

We first introduce our main variables and then present preliminary assessments of the relation between liquidity creation and growth. As our main dependent variable, we use the log GDP per capita in current US$, sourced from the World Bank Development Indicators. These data on GDP are available for our annual panel of 100 countries between 1987 and 2014, which make up our baseline sample. Additional dependent variables used include investment (fixed and inventory) and the total number of patents, also drawn from the World Bank Development Indicators, and the net (in)tangible investment rate, calculated from the Klems database. We aggregate the annual bank-level data to annual country-level data of liquidity creation and divide by population to obtain our main explanatory variables of interest: on- and off-balance sheet liquidity creation per capita at the country level.[8] All other variables are discussed when they are introduced in the analysis, and are summarized and defined in Appendix B.

Table 2 contains summary statistics for the key variables. The median GDP per capita is $5,983, with a significant dispersion (standard deviation of $18,512). The median country-level on-balance sheet liquidity creation per capita is $566, with a high standard deviation of $6,366. Off-balance sheet liquidity creation per capita is smaller, with a median of $156 (standard deviation of $5,407). The two variables are correlated, with a correlation of 39.9 percent across all country-years in the sample (not tabulated). The measures are also positively but considerably less than perfectly correlated with private credit to GDP, with correlations of 48.5 percent and 32.1 percent with on- and off-balance sheet liquidity creation per capita, respectively.

For a preliminary look at the data, in Figure 2, we plot the relation between on-balance sheet liquidity creation and GDP per capita for the 100 countries in our sample in four different years: 1999, 2004, 2009, and 2014. The graph shows a strong positive correlation between these two variables, regardless of the year (and phase of the business cycle) considered. If we take the whole sample (not restricted to a specific year), the correlations are also strong: The pairwise correlation coefficients (untabulated) between the two variables in levels and first differences are 0.82 and 0.22,

[8] We follow Berger and Sedunov (2017) in using population as scaling factor for liquidity creation. However, using GDP or total bank assets does not alter our results.

respectively, and in each case statistically significant at the 1-percent level.

The picture is fairly similar for off-balance sheet liquidity creation. In Figure 3, we plot the corresponding relation but with off-balance sheet liquidity creation. Again, there is a strong and positive relation between the two variables for each of the years considered. The pairwise correlation coefficients between both variables for the whole sample are large and significant (0.73 for the variables in levels and 0.15 in first differences).

These associations are consistent with our premise that liquidity creation (on- and off-balance sheet) represents an important factor fueling economic activity. Of course, these simple cross-country correlations are not evidence of a causal relation and may reflect other relevant country differences. Therefore, we now turn to a formal analysis aimed at identifying the growth effect of liquidity creation.

3.2 Panel Estimates at the Country Level

To formally evaluate the effect of liquidity creation on growth, we estimate the following linear dynamic panel model (similar to, e.g., Acemoglu et al., 2019):

$$y_{ct} = \beta LC_{ct} + \sum_{j=1}^{p} \gamma_j y_{ct-j} + \delta X_{ct}^{'} + \alpha_c + \alpha_t + \varepsilon_{ct}, \tag{1}$$

where y_{ct} is the log of GDP per capita in country c in year t and LC_{ct} is the log of liquidity creation per capita (on- or off-balance sheet) in country c in year t. We include p lags of log GDP per capita to control for the dynamics of GDP. $X_{ct}^{'}$ is a vector of controls that prior studies show to be related to growth, including democracy (Papaioannou and Siourounis, 2008; Acemoglu et al., 2019), inflation (Barro, 1997), and private credit to GDP (Beck et al., 2000). To account for non-linearities in the relation between private credit and growth (Arcand et al., 2015), we also include the squared term of private credit. We select these controls to account for important time-varying determinants of growth, while aiming to preserve sample size. We also examine the robustness of our results (in Section 3.3) to a wide range of other determinants that could confound the effect of liquidity creation on GDP per capita. α_c and α_t represent a full set of country and year fixed effects, controlling for time-invariant country characteristics and global trends, respectively. The error term ε_{ct} captures all other time-varying omitted influences. Throughout, we report standard errors clustered at the country level.

The coefficient of interest is β, which measures the short-run effect of liquidity created both on and off the balance sheet on GDP per capita. The long-run effect of liquidity creation on GDP per capita can be derived by dividing the parameter estimate $\hat{\beta}$ by $1 - \sum_{j=1}^{p} \hat{\gamma}_j$, the estimates of the p lags of the dependent variable. Our empirical strategy thus differs from much of the finance and growth literature, which typically averages out data over a five-year or longer horizon. However, smoothing out along the time-series dimension of our panel would remove useful variation from the data (on average, each country is observed 14.1 years), which helps to identify the parameters of interest with more precision while distinguishing long-run from short-run growth relations.

Columns 1-4 of Table 3 report the within estimates of equation (1) for our whole sample of 100 countries.[9] Column 1 represents the most parsimonious specification, with as independent variables our measure of on-balance sheet liquidity creation, a single lag of GDP per capita, and the fixed effects. The within estimate of β is 0.017 ($s.e.$ = 0.005), statistically significant at the 1-percent level. We also find a significant degree of persistence in GDP, with a coefficient on lagged GDP per capita of 0.836 ($s.e.$ = 0.024). The persistence of GDP is an overall pattern in all results that we present. Column 2 reports the same specification as in column 1 with the further addition of time-varying controls. The effect of the persistence of GDP is slightly lower, but still highly significant, with a coefficient of 0.805 ($s.e.$ = 0.027). The within estimate for the coefficient on liquidity creation is higher (0.023) than in column 1 and statistically significant at the 1-percent level ($s.e.$ = 0.006). The coefficients on all controls display the sign expected based on the prior literature. In particular, we find that the effect of democracy is positive, while the effect of inflation is negative and significant. The effect of private credit to GDP is positive and significant, while its square has a negative and significant coefficient.

Column 3 of Table 3, which is our preferred specification, adds a second lag of GDP per capita. The implied dynamics are now richer, with the first lag larger and still positive and the second lag smaller and negative. The overall extent of persistence of GDP thus remains close to that found in previous columns.[10] The coefficient on on-balance sheet liquidity creation is again statistically and economically meaningful. The estimate of β in equation (1), 0.025 ($s.e.$ = 0.006), implies that a 10-percent increase in on-balance sheet liquidity creation per capita increases GDP per capita by 0.25 percent in the short run (recall that we have a log-log model). Our dynamic panel model also fully specifies how the effects of liquidity creation by banks unfold over time. From the estimates

[9] The results in Table 3 are not affected by the period 1987-2014 examined. Restricting the sample to the post 1995-, 2000-, and 2005-periods leads to similar results (not tabulated to conserve space). These results alleviate measurement concerns related to a potential sparse coverage of banks in the early years of the sample period.

[10] We have experimented with more lags of GDP per capita (up to a total of six lags). We do not report them as the overall degree of persistence and the effect of liquidity creation on GDP per capita are very similar to the estimates in column 3 of Table 3.

in column 3, we find that a *permanent* increase in on-balance sheet liquidity creation per capita of 10 percent increases GDP per capita by 1.12 percent in the long run. In the remainder of the paper, we will focus on the specification with two lags of GDP per capita as our baseline model.

The amount of liquidity created by banks off the balance sheet is also potentially consequential for growth. In column 4, we use the same specification as in column 3 and add our measure on off-balance sheet liquidity creation. The effect of liquidity creation off the balance sheet is significant, though quantitatively smaller than the effect of liquidity creation on the balance sheet. The within estimate is 0.008 ($s.e. = 0.004$), implying a 0.34 percent increase in GDP per capita in the long run following a permanent 10-percent increase in off-balance sheet liquidity creation. The other parameter estimates in column 4, including the coefficient on on-balance sheet liquidity creation, are very similar to the ones reported in column 3.

The within estimates of the dynamic panel model in columns 1-4 suffer from an asymptotic bias of order $1/T$, which is known as the Nickell (1981) bias. The Nickell bias results (by construction) from the correlation between the lagged dependent variables and the country fixed effects, making the within estimator inconsistent. However, the Nickell bias only vanishes as T tends to infinity. Arellano and Bond (1991) derive a consistent GMM estimator for the parameters of the dynamic panel model for finite T. The idea of GMM is to take the first difference of equation (1) to eliminate country fixed effects and time-invariant country characteristics. The orthogonal relation between the lagged values of the dependent variable and the new differenced error term then constitutes the moment conditions of the GMM procedure. This holds under the null hypothesis of serially uncorrelated ε_{ct}, which can be evaluated by testing for second-order serial correlation in the first-differenced residuals.[11]

In columns 5–8 of Table 3, we provide estimates from the same four specifications of columns 1–4, using this GMM procedure. The GMM estimates of on-balance sheet liquidity creation are larger, except in column 6, than the within estimates. However, the GMM estimates uncover a smaller degree of persistence of the GDP process, which in turn results in somewhat smaller estimated long-run effects. In column 8, the GMM estimate of off-balance sheet liquidity creation is still positive but fails to be significant at conventional levels. The coefficients on the controls in columns 5–8 are overall similar to those in columns 1-4.[12]

[11] In unreported robustness tests, available on request, we confirm our results using the system-GMM as proposed by Arellano and Bover (1995), which combines level and differenced regressions.

[12] We also assume that GDP is stationary and use formal tests (unreported) for the presence of a unit root in panel data settings to verify this conclusion (i.e., the Fisher-type Augmented Dickey–Fuller and Phillips–Perron panel unit root tests proposed by Maddala and Wu, 1999). Furthermore, when we depart from stationarity and present the results (unreported) from estimating a version of equation (1) in changes, our conclusions on the effects of liquidity creation on GDP per capita do not change materially.

In addition, the bottom of Table 3 shows the p-values of tests for serial correlation in the first-differenced residuals (recall that the first-differencing is because the Arellano and Bond (1991)'s estimator takes first differences). The first-differenced residuals exhibit an insignificant second-order serial correlation when we include two lags of GDP per capita as in our preferred specifications in columns 7 and 8, lending confidence to our GMM estimates. The rejection of the null hypothesis of the absence of second-order serial correlation in columns 5 and 6 is, however, not surprising as these specifications only contain one lag of GDP per capita, which does not adequately account for the full dynamics of GDP per capita.[13]

In sum, the results in Table 3 indicate a statistically significant and economically sizable effect of both on- and off-balance sheet liquidity creation on GDP per capita. In the next subsection, we further examine the robustness of our baseline result.

3.3 Additional Country-Level Controls

The validity of our estimates of the effect of liquidity creation on GDP per capita presented so far may be sensitive to the presence of time-varying determinants that simultaneously impact liquidity creation and GDP per capita. Table 4 shows the results from the same specification as in columns 3 and 4 of Table 3 with the inclusion of further covariates. To save space, we only report the within estimates of the coefficients on the liquidity creation measures and the controls of interest. The corresponding Arellano and Bond's GMM estimates produce very similar results (not tabulated).

An obvious source of bias in our estimates would come from various regulatory changes furthering both financial development and stability. In columns 1-3 of Table 4, we report results from specifications in which we include variables proxying for important regulatory changes that may affect growth directly or indirectly through their impact on financial development. We control for creditor rights in column 1 (as suggested by the findings of Levine, 1999; Djankov et al., 2007, among others), the use of macroprudendital policies in column 2 (Cerutti et al., 2017), and the equity market liberalization process in column 3 (Bekaert et al., 2005). Although these specifications tend to substantially reduce the number of observations due to missing data and although some

[13] A special feature of GMM estimation is that the number of moment conditions is quadratic in T. Because we have a fairly large T, an unrestricted set of lags can introduce a proliferation of instruments, leading to an asymptotic bias of order $1/N$ (Alvarez and Arellano, 2003). In our specifications, we thus reduce the instrument set. As instruments for past GDP per capita and liquidity creation, we use their one-period and two-period lags. The Hansen tests reported at the bottom of Table 3 never reject the null hypothesis that over-identification restrictions are valid. Using all available lags as instruments for past GDP per capita and liquidity creation leads to similar, even stronger results (unreported) to those of Table 3, but with higher p-values of the Hansen test.

of these additional controls enter the model with a significant coefficient, the liquidity creation effects continue to be statistically and economically significant.

Liquidity creation may also be driven by several attributes of countries' financial system, not already absorbed by the country fixed effects. In particular, Cetorelli and Gambera (2001) provide evidence of a general depressing effect on growth associated with a concentrated banking sector. Langfield and Pagano (2016) find that an increase in the size of the banking sector relative to financial markets is associated with lower economic growth, especially during housing market busts. Another strand of the literature shows that financial market liquidity is associated with greater economic growth (Levine and Zervos, 1998). In columns 4-6 of Table 4, we control for these attributes and find that they have a limited impact on our coefficients on liquidity creation – though they generally exhibit the expected impact on GDP per capita.

Furthermore, countries with good institutions, deepened economic and political integration, and a high human capital stock may be more likely to exhibit strong economic growth. Therefore, another concern is that the estimated effects of country-wide liquidity creation are a mere reflection of countries' level of development. To assuage this concern, we add covariates that control for the potential effect of rule of law (in column 7), globalization (in column 8), and secondary school enrollment (in column 9). Reassuringly, controlling for these growth determinants yields qualitatively similar results to our baseline results.

Further tests (not tabulated to conserve space) show that our results are also robust to using many other country determinants included in growth models, such as population growth, life expectancy, fertility rate, openness to trade, black market premium, government consumption (see Barro, 1997; Barro and Sala i Martin, 2003). By enhancing liquidity creation, bank capital is also another potential omitted factor in our growth model (Donaldson et al., 2018). Therefore, we also account for the direct effect of bank capital by aggregating annual bank-level data to annual country-level data of the equity-to-asset ratio. Controlling for bank capital (untabulated) hardly affects our baseline results in Table 3.

All in all, the robustness checks presented in this subsection bolster confidence that our results are not driven by the impact of confounding factors. The function of banks as liquidity creator seems to be more than just another aspect of more general financial or economic development, and thus worthy of more detailed study.

3.4 Panel Estimates at the Industry Level

While the country-level results in the previous subsections suggest that liquidity creation helps to enhance economic growth, endogeneity concerns remain, related to both reverse causality and omitted variable bias. In this subsection, we therefore proceed to examine the differential impact of liquidity creation on the value added of industries that vary in their reliance on debt financing, in a "smoking gun" approach to identification.

Specifically, we follow Rajan and Zingales (1998) to identify the effect of country differences in liquidity creation on growth by industry.[14] The identifying assumption is that dependence on external financing differs across industries for structural reasons. We focus, however, on dependence on debt finance instead on external finance (debt plus equity) since our focus is on the banking sector, which provides debt rather than equity financing.[15] Allen and Gale (1999) argue that equity financing is more adequate for projects with higher uncertainty, while debt financing more adequate for less risky projects. Several studies document that innovative investments such as R&D rely relatively more on equity financing and are not easily financed with debt (Hall and Lerner, 2010; Brown et al., 2012, 2013).

We estimate the equilibrium dependence on debt financing using Compustat data for listed US firms as in Rajan and Zingales (1998), measured as the ratio of net debt issuance to capital expenditures (see Appendix B). We then aggregate the firm-level Compustat data by industry i in each year t. We use this US-based ratio as a proxy for the structural share of investment that is financed by debt in industries around the world. While a higher share of corporate debt is market-financed in the US than in other countries, we take debt financing by large US firms as benchmark for the inherent demand for debt finance across different industries, under the assumption that large firms in the US face a flat supply curve for corporate debt and industry differences are thus explained by inherent demand variation.

We obtain industry-level data on value added and gross output from the OECD (STAN database), which are available for a subset of 34 of the countries (mostly OECD member countries) in our sample. The note of Table 5 lists the countries, which excludes the US as in Rajan and Zingales (1998), and Table C.1 reports the industries together with summary statistics on our measures of debt dependence and output.[16]

[14] See, e.g., Claessens and Laeven (2005), Kroszner et al. (2007), Inklaar et al. (2015), Larrain and Stumpner (2017) for related works using the Rajan-Zingales methodology.

[15] The focus on debt finance follows Chava and Purnanandam (2011), Berger and Sedunov (2017), Bucă and Vermeulen (2017), and Smolyansky (2019), among other studies.

[16] The 25 industries are the same as in Döttling et al. (2017) and Gutiérrez and Philippon (2017). That is, from the 19 ISIC Rev. 4 industries, we add industries that are further broken down (e.g., manufacturing), while we also

The model we estimate is given by:

$$Y_{cit} = \kappa LC_{ct} \times DD_{it} + \theta X_{ct}^{'} \times DD_i + \alpha_{ct} + \alpha_{ci} + \alpha_{it} + \varepsilon_{cit}, \tag{2}$$

where Y_{cit} denotes the log of value added or the log of gross output in country c in industry i at time t. As before, LC_{ct} is one of the liquidity creation measures (in log per capita) in country c at time t. DD_{it} is debt dependence of industry i at time t.[17] The specification contains the same vector of time-varying country controls as before ($X_{ct}^{'}$) interacted with debt dependence (DD_{it}). Furthermore, the specification includes country-year fixed effects (α_{ct}) to control for time-varying country shocks, country-industry fixed effects (α_{ci}) to control for country-specific industry characteristics, and industry-year fixed effects (α_{it}) to control for time-varying industry shocks. We note that, because LC varies at the country-year level and DD at the industry-year level, their individual effect is absorbed by the country-year fixed effects and industry-year fixed effects, respectively. In all specifications, we cluster standard errors at the country-year level to account for the within country-year correlation across industries.

The coefficient of interest is κ, which is identified from the within-country, cross-industry variation in debt dependence over time. It measures the effect of liquidity creation on output in industries with high debt dependence in a country (for a given amount of liquidity created) compared to industries with low debt dependence in the same country.

Table 5 presents the results from estimating equation (2). In column 1, we use value added as dependent variable, with the full set of fixed effects and interaction terms. The estimate on the interaction, κ, is 0.017 ($s.e. = 0.007$), statistically significant at the 5-percent level. To illustrate the economic effect of the interaction of liquidity creation and debt dependence, consider two industries: one at the 75$^{\text{th}}$ percentile of debt dependence (Machinery and equipment) and one at the 25$^{\text{th}}$ percentile (Telecommunications). The difference in debt dependence between the two industries is 0.29 ($= 0.44 - 0.15$). A 10-percent increase in liquidity creation increases value added in the high-debt-dependence industry by 5 basis points more than in the low-debt-dependence

drop industries for which Klems capital data are not available (e.g., wholesale and retail trade). This corresponds to 31 Klems industry segments. Then we exclude financials to focus on the corporate sector (Klems segment K), and real estate given its unique experience during the crisis (segment L). We also exclude utilities (D-E), public administration and defense (O), activities of households as employers (T), and activities of extraterritorial organizations (U) given the influence of government actions on their investment and the limited coverage of Compustat for these industries. This leaves us with 25 industry groupings for our analysis.

[17] It could be argued that demand for debt might vary over the business cycle and annual variation in debt dependence from the US might therefore reflect business cycle effects. Although our model includes industry-year and country-industry fixed effects, our results do not hinge on the assumption of time-varying debt dependence (DD_{it}). We obtain qualitatively similar results when we use instead DD_i, that is, debt dependence of industry i averaged over the sample period.

industry ($= \ln(1.1) \times 0.017 \times 0.29$). This difference represents about 10 percent of the average effect of liquidity creation on value added.[18] In column 2, we add off-balance sheet liquidity creation interacted with debt dependence. On-balance sheet liquidity creation continues to be positively associated with value added in industries more reliant on bank financing. However, off-balance sheet liquidity creation does not enter significantly. In columns 3 and 4, we replicate these tests using gross output as dependent variable. The results are very similar, both statistically and economically.

The results in this subsection indicate that on-balance sheet liquidity creation has a larger effect on output in industries that are relatively more in need of debt financing, corroborating our regression results at the country-level. However, we do not find evidence of a significant impact of off-balance liquidity creation on industry-level economic activity. More importantly, identifying a differential relationship between liquidity creation and growth across industries helps us mitigate endogeneity concerns that arise in the cross-country aggregate analysis.

4 Investment Channel

So far, we have established that liquidity creation is positively and significantly associated with economic growth. In this section, we empirically explore whether and how investment could be a channel through which liquidity creation causes growth. We test this investment channel using data at both the country and industry levels.

4.1 Country-Level Evidence

We begin by investigating whether the investment component of GDP is affected by liquidity creation. We thus estimate similar models to equation (1), except that the dependent variable is one of the components of investment expenditures (i.e., fixed investment and inventory investment) and we control for lags of the corresponding dependent variable (instead of lags of GDP per capita as in Table 3) on the right-hand side. Consistent with our previous exercises, we scale each investment component of GDP by population and take the logarithm (see Appendix B).

Table 6 shows the within estimation results for both fixed investment and for inventory investment. The results from Arellano and Bond's GMM estimations are very similar (not tabulated to preserve space). We find that liquidity creation (on- and off-balance sheet) significantly affects

[18] That is: $(0.017 \times 0.29)/0.048 = 0.103$, where 0.048 is the estimate (not tabulated) of on-balance sheet liquidity creation from a version of equation (2) without interaction terms and with year, country, and industry fixed effects.

investment through fixed investment expenditures (columns 1-2), consistent with our prediction that banks are more likely to finance fixed (tangible) assets. The controls enter with the same signs as in Table 3. For inventory investment, we find a relation with off-balance sheet liquidity creation but not with on-balance sheet liquidity creation (columns 3-4), consistent with the notion that firms tend to use credit lines for working capital management.

Columns 5-6 of Table 6 consider country-wide patent applications as a key outcome of intangible (and human capital) investment. The coefficients on on-balance sheet liquidity creation are positive but fail to be significant at conventional levels, suggesting that liquidity creation does not appear as a factor encouraging patenting. Although these results on patent applications are in line with our prediction, we would like to point out some caveats. Our estimates are indeed unlikely to capture the effect of liquidity creation on intangibles with precision. Our patent variable is a rather coarse measurement of the extent of patenting in a country. Moreover, there may be a considerable lag from the innovation stage to the patent application stage that our specifications may not adequately account for.

We therefore move on to assembling data that allow us to better distinguish tangible from intangible fixed investment. Following Döttling et al. (2017), we use two variables to measure the *net* investment rate, that is, the gross investment rate minus the depreciation rate. We define the gross investment rate as the ratio of gross fixed capital formation to lagged fixed assets and the depreciation rate as the ratio of gross fixed capital consumption to lagged fixed assets.We then use granular data on asset types (aggregated at the country level), sourced from the Klems database, to construct our measures of both tangible and intangible investment rate.[19] Klems offers a great level of detail, but only covers a subset of 22 countries in our sample (the note of Table 7 lists the countries included).

We estimate the effect of liquidity creation on the net investment rate using the following model:

$$I_{ct} = \beta LC_{ct} + \delta X_{ct}^{'} + \alpha_c + \alpha_t + \varepsilon_{ct}, \tag{3}$$

where I_{ct} represents our measures of the net investment rate in tangible and intangible assets and LC_{ct} our measures of liquidity creation (in log per capita) in country c at time t. As in standard investment regressions (Carlin and Mayer, 2003), we do not assume persistence in the investment process (i.e., by lagging the dependent variable). All the other variables, parameters,

[19]We group asset types into tangible assets and intangible assets. Tangible assets include ICT equipment, machinery and transport equipment, cultivated assets, and buildings and structures. Intangible assets are intellectual property products (i.e., research and development, computer software and databases, and other IPP assets). We refer to Appendix B for more details.

and subscripts are defined as before. Standard errors are clustered at the country level.

Table 7 reports the results from estimating equation (3), using as dependent variables the net investment rate both in tangible assets (in columns 1-2) and in intangible assets (in columns 3-4). The number of observations is considerably lower in these specifications because of more limited data coverage. The table reveals that on-balance sheet liquidity creation is associated with an increase in the net tangible investment rate (see columns 1-2), but not in the net intangible investment rate (columns 3-4). The effect of on-balance sheet liquidity creation on the net tangible investment rate is statistically significant at the 1-percent level and is also economically sizable. In columns 1-2, the estimate of 0.007 ($s.e. = 0.002$) implies that a 10-percent increase in on-balance sheet liquidity creation increases the net tangible investment rate by 6.67 basis points (or 3.03 percent relative to the mean of 0.022 reported in Table 2). In contrast, we do not find significant estimates for off-balance sheet liquidity creation across columns 1-4.

4.2 Industry-Level Evidence

The country-level results in the previous subsection suggest that liquidity creation by banks helps to boost tangible rather than intangible investment. To confirm and further understand these results, we conduct additional tests that exploit industry heterogeneity within countries, as in Section 3.4, thus also addressing endogeneity concerns arising from the aggreage cross-country analysis. Although we control for country fixed effects in Table 7, it may be possible that other factors that vary across countries over time may coincide with changes in liquidity creation. In such case, we would incorrectly attribute the changes in the net investment rate to changes in liquidity creation. Exploiting within-industry variation within countries while accounting for debt dependence in the spirit of Rajan and Zingales (1998) is a way to address these concerns.

We construct our measures of the net investment rate in both tangible and intangible assets at the industry level in the same way as the country-level measures, using Klems industry data. The note of Table 8 lists the 14 countries included in our analysis, which excludes the US as it is the benchmark. Table C.1 lists the 25 industries and gives summary statistics on our measures of debt dependence and investment.

The model we estimate is the same as in equation (2), except that the dependent variable is one of the net investment rates (in tangible or intangible assets) in country c in industry i at time t. Table 8 presents the results. In column 1, we use the net tangible investment rate as dependent variable and include the full set of fixed effects and interaction terms. The estimate on the interaction, κ, is 0.004 ($s.e.$ = 0.002), statistically significant at the 10-percent level. To gauge the economic effect, we again compare the industries at the 25^{th} and 75^{th} percentile of debt dependence (Telecommunications and Machinery and equipment, respectively). A 10-percent increase in on-balance sheet liquidity creation increases the net tangible investment rate in the high-debt-dependence industry by 1.11 basis points more than in the low-debt-dependence industry ($= \ln(1.1) \times 0.004 \times 0.29$). This difference represents about 20 percent of the average effect of on-balance sheet liquidity creation on tangible investment estimated at the country level in Table 7 ($= 0.005 \times 0.29/0.007$). This result suggests that the banking sector fosters tangible investment by providing liquidity to industries that rely more heavily on bank financing. In column 2, we augment the previous specification with the off-balance sheet liquidity creation measure interacted with debt dependence. Our results on on-balance sheet liquidity creation are now stronger. However, we do not find that off-balance sheet liquidity creation affects the net tangible investment rate at the industry level, which is in line with our results at the country level.

The next columns of Table 8 repeat these tests with the net intangible investment rate as dependent variable. In column 3, we find no statistically significant effect of on-balance sheet liquidity creation. This result expands on the findings in Table 7. Not only does on-balance sheet liquidity creation have no effect on overall intangible investment at the country level, but there also appears to be no differential effect between industries that rely more on debt financing. The further inclusion of off-balance sheet liquidity creation measure interacted with debt dependence in column 4 does not change this conclusion. Off-balance sheet liquidity creation is also insignificant in column 4.

For robustness purposes, we also run this industry-level analysis using alternative data sources. In particular, we look at fixed investment and R&D expenditures as measures of fixed tangible assets and intangible investment, respectively. These industry-level variables are sourced from the OECD (STAN and ANBERD databases). We estimate the same model as in equation (2), with either fixed investment or R&D expenditures as dependent variable (in log). The results are displayed in Table C.2 and are consistent with our main findings presented so far: on-balance sheet liquidity creation positively and significantly affects fixed investment more in industries that rely more on debt financing, while we even find negative coefficients on R&D expenditures. It is reassuring that results are consistent using Klems or OECD investment data, given the difficulty of measuring intangible investment.

4.3 Asset Intangibility and Country-Level Growth

Our empirical results on the investment channel indicate that liquidity creation by banks fosters tangible investment, but not intangible investment. To close the loop, we relate these results back to the growth results from Section 3 to confirm that the investment channel indeed feeds through to aggregate growth. Specifically, we test whether liquidity creation has a weaker effect on growth in countries with a higher share of industries relying on intangible assets.

To measure a country's intangible intensity, we start by measuring an industry's intangible-to-total capital ratio in the US using Klems data. We then aggregate the industry-level intangible-to-total capital ratio for each country, weighting by the industry's value added of the respective country. The idea is that, in the spirit of Rajan and Zingales (1998), the capital composition of US industries reflects the technological frontier. Thus, this measure is based on an industry's technological reliance on intangible capital, and therefore unlikely to be correlated with other factors that may be correlated with growth. We refer to this measure as a country's intangible ratio. The intangible ratio varies between 0.62 percent and 18.28 percent, with a mean of 8.58 percent and a standard deviation of 2.61 percent. The average intangible ratio across countries increases over time, from around 5 percent in the early 1990s, up to 10 percent in 2013, in line with a shift to intangible assets due to technological advances during this time (Corrado and Hulten, 2010).

We use this measure to examine whether liquidity creation by banks has a differential effect on growth in countries with more intangible assets. To do so, we specify a version of equation (1) including an interaction between liquidity creation and intangible intensity:

$$y_{ct} = \beta_1 LC_{ct} + \beta_2\ LC_{ct} \times IR_{ct} + \beta_3 IR_{ct} + \sum_{j=1}^{p} \gamma_j y_{ct-j} + \delta X_{ct}^{'} + \alpha_c + \alpha_t + \varepsilon_{ct}. \tag{4}$$

The dependent variable, y_{ct}, is the log of GDP per capita in country c at time t. LC_{ct} is again one of our liquidity creation measures (in log per capita) in country c at time t, while IR_{ct} is our measure of intangible ratio of country c at time t. All the other variables, parameters, and subscripts are defined as in equation (1), and standard errors are clustered at the country level.

The coefficient of interest, β_2, measures the short-run effect of liquidity creation on GDP per capita conditioned on the country's intangible intensity. Table 9 reports the within estimates (in columns 1-2) as well as the GMM estimates (in columns 3-4) of equation (4). Across columns, the coefficients on all variables are comparable to Table 3. The estimate of the key coefficient of interest

(β_2) is negative and highly significant across columns 1-4, indicating that on-balance sheet liquidity creation has a weaker impact on GDP per capita in countries with more intangible capital.[20] The effect is economically meaningful. A one standard deviation increase in the intangible ratio reduces the short-run effect of liquidity creation on GDP per capita by more than 23 percent, and the effect turns negative when the intangible ratio exceeds 11 percent, which corresponds to the 90$^{\text{th}}$ percentile of the distribution or the average intangible ratio of Germany.[21] Figure 4 illustrates that the relation between on-balance sheet liquidity creation and GDP per capita turns insignificant at an intangible ratio of 9 percent and negative (but insignificant) at 11 percent. Specifically, Figure 4 plots the slope for GDP per capita on on-balance sheet liquidity creation while holding the value of intangible ratio constant at values running from 0 to 22 percent (all observations are between these two values). It also appears that the slopes are significant for most values of intangible ratio. Off-balance sheet liquidity creation interacted with intangible intensity does not enter significantly, underscoring the weaker effect of off-balance sheet liquidity creation on growth.

Taken together, our country- and industry-level findings in Sections 3 and 4 suggest that liquidity creation, especially on the balance sheet, drives economic growth by increasing tangible investment. In contrast, liquidity creation does not appear to affect investment in intangibles, and the overall effect of liquidity creation on growth is larger in countries with industries that rely to a lesser degree on intangible assets.

These results speak to a number of non-linearities that prior research has uncovered in the relation between the banking sector and economic activity, such as the non-linear relation between banking sector development and growth (Arcand et al., 2015), the differential relation of bank financing with tangible versus intangible investment (Aghion et al., 2004; Hsu et al., 2014; Dell'Ariccia et al., 2020), and the decreasing role of banks in stimulating growth as economies develop (Čihák et al., 2012). More research is needed to fully understand these non-linearities, but our paper contributes to this debate by showing how one key function of banks – liquidity creation – contributes to economic activity through its impact on tangible but not intangible investment. To illuminate why the (tangible) investment channel may explain our findings on the relation between banks' liquidity creation and economic growth at the country and industry levels, we develop a theoretical model describing this channel in the next section.

[20] In columns 3 and 4 of Table 9, the high p-values of the Hansen test, however, indicate that we might be overfitting the model (Bowsher, 2002). We thus have to be careful when considering the validity of the reported GMM estimates. The time dimension (T) of our panel is indeed relatively long, while GMM estimators are designed for panels with short time dimension, which generate instrument sets whose number grows quadratically in T. We also conducted robustness tests with restricted time dimensions (yielding lower values of the Hansen test) and continue to find qualitatively similar results.

[21] That is: $(-0.408 \times 0.026)/0.045 = -0.236$ and $0.045/0.408 = 0.110$, using estimates from column 2.

5 A Model of Liquidity Creation and Investment

To elucidate potential theoretical channels behind our empirical results, we build here a theoretical framework based on the seminal Diamond and Dybvig (1983) model. While the baseline Diamond-Dybvig model is an ideal workhorse model to study liquidity creation, in the model banks are passive on the asset side and hence cannot affect overall investment. Since our empirical liquidity creation measure incorporates both asset-side and liability-side activities, we introduce asset liquidity risk, which give banks a role in influencing investment by mitigating liquidity risk. We also introduce asset tangibility and a moral hazard problem that may limit the extent to which banks can reduce liquidity risk to be able to speak to the empirical finding that liquidity creation boosts growth in particular via tangible investment and less so via intangible investment.

5.1 Model Setup

Consider an economy with three dates, $t = 0, 1, 2$, and a unit mass of investors. Investors are ex-ante identical but privately learn at $t = 1$ whether they are early (probability λ) or late types. Early investors need to consume at $t = 1$, while late investors can wait until $t = 2$. Utility is given by:

$$U = \begin{cases} u(c_1), & \text{if early,} \\ u(c_1 + c_2), & \text{if late,} \end{cases}$$

where c_t denotes consumption at time t and investors have log-utility $u(c_t) = \log(c_t)$.

Investors have an endowment e at $t = 0$ and access to a short-term storage technology that transfers resources one-for-one across time and resembles cash. They also have access to a long-term investment project. This project is more productive than storage, but it is risky and incurs losses if liquidated early. Investing I units in this project at $t = 0$ yields $1 + r$ at $t = 2$ with probability p and $1 - \mu$ otherwise. If the technology is liquidated at $t = 1$ it generates $1 - \mu$ with certainty. Thus, $\mu \geq 0$ is the liquidation loss incurred if the project fails or is liquidated early. We assume that $p > \frac{\mu}{r+\mu}$ to ensure the long-term project has a higher expected return than storage.

At the end of $t = 2$, after the long-term investment project pays off, investors may divert a fraction γ of the investment return for their own consumption. As shown below, this moral hazard problem may limit the extent to which liquidity creation by banks can support investment as late investors may be tempted to divert when their projects are successful.

The long-term investment is characterized by its asset tangibility k and we assume that both the liquidation cost and diversion parameter are negatively related to k:

Assumption 1 *The liquidation cost μ and diversion parameter γ are decreasing functions of investment tangibility k:*

- $\mu = \mu(k)$ *with* $\mu'(k) \leq 0$ *and* $\mu(k) \in [0, 1]$
- $\gamma = \gamma(k)$ *with* $\rho'(k) \leq 0$ *and* $\gamma(k) \in [0, 1]$

Realistically, intangible assets are harder to liquidate than physical assets such as machines and plants, reflected in a higher liquidation loss μ. Moreover, the value of intangible investments may be hard to assess by outsiders, making it easier for insiders to divert spending to pet projects. This means that intangible investments plausibly have a larger value γ so more can be diverted. Characterizing the long-term investment in terms of the technological parameter k allows us to later relate our results to the empirical findings. However, for brevity we omit the dependence of μ and γ on k through most of this section.

Finally, we assume that the liquidation cost μ is not too small to ensure that banks can play a role in over-coming liquidity risk and thereby improve investment.

Assumption 2

$$\mu \geq \frac{(1-\tilde{\lambda})r}{\tilde{\lambda} + (1-\lambda)r} \equiv \underline{\mu},$$

with $\tilde{\lambda} \equiv [\lambda + (1-\lambda)(1-p)]$.

5.2 The Role of Banks in Supporting Investment

This subsection compares the optimal investment under autarky, defined as a situation in which each investor invests in isolation, to the allocation that can be achieved if banks' liquidity creation facilitates risk sharing. Detailed derivations are relegated to Appendix D.

Under autarky, an investor who invests I in the long-term project and $s = e - I$ into storage, needs to liquidate the entire investment if he or she is an early type. In contrast, late investors optimally do not liquidate any investment at $t = 1$ and may enjoy a high level of consumption at $t = 2$ if their project succeeds. Under autarky, investors are thus exposed to liquidity risk (and credit risk).

Banks can improve upon autarky because they can reduce liquidity risks by avoiding inefficient liquidation of the long-term investment. In fact, Diamond and Dybvig (1983) show that banks can implement the first-best allocation by offering demand deposits contracts.

In Appendix D, we solve the investor problem and derive the allocation under autarky and in the first-best allocation. These allocations can be solved in closed form and readily compared:

Autarky	First Best (Bank)
$I^{aut} = \frac{(1-\tilde{\lambda})r-\tilde{\lambda}\mu}{\mu r}e$	$I^* = (1-\lambda)e$
$c_E^{aut} = \frac{\tilde{\lambda}(r+\mu)e}{r}$	$c_E^* = e$
$c_L^{aut} = \frac{(1-\tilde{\lambda})(r+\mu)e}{\mu}$	$c_L^* = Re$

Here, c_E and c_L denote the consumption levels of early and late investors, respectively. It is easy to verify that under Assumption 2 investment is higher in the first-best allocation, i.e., $I^* \geq I^{aut}$.[22] This implies that, if a bank can implement the first best allocation through demand deposit contracts, the model predicts a positive link between liquidity creation and investment – in line with our empirical results. Intuitively, in the first-best allocation liquidation costs are reduced because agents can share liquidity risks. This makes it more attractive to invest in the long-term asset.

The next subsection clarifies how demand deposit contracts can implement the first-best allocation and maps banks' liquidity creation in the model to our empirical measure. We then analyze under what conditions demand deposit contracts can be implemented depending on the long-term asset's (in)tangibility.

5.3 Demand Deposit Contracts and Liquidity Creation

Consider a bank that offers the following demand deposit contract. Investors deposit their endowment with the bank at $t = 0$ in exchange for a demandable claim. This claim allows investors to withdraw c_E^* at $t = 1$ or c_L^* at $t = 2$. The bank then invests s^* in storage and makes a long-term loan of size I^* back to investors. The loan matures at $t = 2$ and has an interest rate of r. Investors use the loan to invest I^* in the long-term investment technology.

Under this contract, the bank holds a mix of illiquid assets (loans) and liquid assets (cash), funded by short-term, liquid deposits. Investors are no longer exposed to liquidity risk because

[22] Assumption 2 ensures that the benefit from avoiding liquidation costs exceeds a minimum threshold $\underline{\mu}$. Intuitively, to induce more investment in the first-best allocation, the benefit of avoiding inefficient liquidation cannot be too small. We note that this result does not rely on the presence of credit risk in the model. Even absent any credit risk ($p = 1$ and $\tilde{\lambda} = \lambda$), the planner can increase equilibrium investment relative to autarky by reducing asset liquidity risk. With $p < 1$ the planner has the additional benefit of allowing investors to share credit risk. To see this note that the threshold $\underline{\mu}$ decreases in $\tilde{\lambda}$ and thus increases in p. If p is small, the asset is likely to fail and investors benefit more from sharing credit risk, resulting in a smaller threshold $\underline{\mu}$.

they finance the long-term investment with a long-term loan, while also holding demand deposits that allow them to consume early if desired without liquidating the long-term asset. That is, banks create liquidity.

To see more directly how the model maps to our empirical measure of liquidity creation, recall that deposits are classified as liquid liabilities and loans are classified as illiquid (or semiliquid in the case of mortgages; see Appendix A). Using the liquidity weights from our empirical measure, the bank creates liquidity of

$$LC^* = \underbrace{\frac{1}{2}e}_{\text{Liquid liabilities (deposits)}} + \underbrace{\frac{1}{2}I^*}_{\text{Illiquid assets (loans)}}$$

In contrast, under autarky there is no liquidity creation because investors operate in isolation ($LC^{aut} = 0$). Therefore, comparing the allocation under autarky to the allocation that can be achieved with demand deposits is akin to comparing an economy with little liquidity creation to an economy with much liquidity creation, underlining that the contracting arrangement described above resembles *banks' liquidity creation* while highlighting the relevance of both asset-side and liability-side activities. [The theoretical result that liquidity creation undertaken by banks allows higher investment and thus growth in the economy is also in line with our empirical findings.]

5.4 Incentive Compatibility and Asset Tangibility

Under what conditions can the bank implement the first-best allocation through demand deposit contracts? For demand deposits to be incentive-compatible, two conditions have to be satisfied. First, since an investor's type is private information, late investors have to prefer not withdrawing early. At $t = 1$ late investors prefer waiting until $t = 2$ if

$$c_L^* \geq c_E^*. \tag{IC_1}$$

This first incentive-compatibility condition is standard to Diamond-Dybvig type models and ensures that the payoff from waiting ($= c_L^*$) is larger than that from withdrawing early ($= c_E^*$).

Second, late investors may divert a fraction γ of the long-term asset's return instead of repaying their loan.[23] This temptation is particularly high if an investor's asset succeeds, in which case they can divert $\gamma(1 + r)I^*$. Upon observing diversion the bank can penalize investors by seizing their

[23]Note that early investors have no incentive to divert at $t = 2$ because they can only consume at $t = 1$.

deposit as well as the remaining $(1-\gamma)$ of the project's payoff. Thus, by diverting late investors give up the deposit claim worth c_L^*. Combining the two, a second incentive-compatibility condition requires that

$$c_L^* \geq \gamma(1+r)I^*. \tag{IC_2}$$

This condition requires that the payoff from diverting $(= \gamma(1+r)I^*)$ does not exceed the value of the deposit claim $(= c_L^*)$. Thus, if (IC_2) is satisfied, late investors prefer repaying the loan and holding on to their deposit claim over diverting.

It is straightforward to verify that the first incentive-compatibility constraint is satisfied, so that late investors wait and consume at $t = 2$. However, the bank can only implement the first-best allocation if not only (IC_1) but also (IC_2) is satisfied.

Proposition 1 *There exists a threshold $\bar{k}$ characterized by*

$$\mu(\bar{k}) = 1 - \frac{(1+r)[(1-\lambda)\gamma(\bar{k}) - p]}{1-p},$$

such that if and only if

$$k \geq \bar{k}, \tag{5}$$

then (IC_2) is satisfied and demand deposit contracts can implement the first-best allocation with a higher level of bank liquidity creation and investment than under autarky, $I^* \geq I^{aut}$.

Proposition 1 rationalizes the empirical finding in this paper that banks' liquidity creation improves tangible but not intangible investment. By transforming illiquid and risky assets into liquid claims, banks can reduce liquidity and credit risk and increase investment and consumption. Yet, Proposition 1 highlights that this positive effect of liquidity creation on investment relies on long-term investment that are not too intangible. If k is very small, then by Assumption 1 μ and γ are large. A high value of γ means that investors can divert a larger fraction of investment returns. Similarly, if the liquidation loss μ is large, the return gap between successful and failing projects is large. This makes diversion attractive relative to a claim on the bank which earns the average return of failing and successful projects. Intuitively, intangible assets exacerbate moral hazard problems because they may be easier to divert and have lower liquidation value. This makes it harder for banks to make loans against intangible assets, explaining why liquidity creation supports tangible but not intangible investment.

While the model focuses on explaining our investment results, it also relates to the growth results because investment and consumption are parts of overall GDP. Therefore, the model can also speak to the result that banks' liquidity creation supports growth more in economies that rely less on intangible capital.

If $k < \bar{k}$, investors fall back to the allocation under autarky. This case resembles an economy with mostly intangible investment opportunities, in which banks' liquidity creation cannot support investment and investors who rely on direct equity financing are exposed to liquidity risk. Beyond the scope of the model, one might expect more specialized financial intermediaries such as venture capital funds to emerge in an intangible economy. Such intermediaries can provide funding and share risks while closely monitoring entrepreneurs to mitigate moral hazard problems associated with intangible investments.

6 Conclusion

In this paper, we present theoretical and empirical evidence that banks' liquidity creation can help economic growth, but with an important non-linearity; banks' liquidity creation helps increase tangible but not intangible investment in an economy. Our findings thus stress the importance of liquidity creation by banks in economic development through overcoming market frictions in investments in tangible assets, but also the limitations of banks in supporting innovative industries that rely primarily on intangible assets.

Given the increasing importance of intangible investment in the "knowledge economy" (Haskel and Westlake, 2017), these findings also shed light on the future of banking and finance. Consistent with other evidence that innovative industries rely mostly on non-bank forms of external finance, our findings suggest the importance of moving away from a bank bias in European finance to more diversified financial systems (Langfield and Pagano, 2016).

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Figure 1: Liquidity creation in the US (1999-2014)

This figure shows the amount (in $ billion) of liquidity created by virtually every bank in the US from 1999 to 2014. The solid line represents total liquidity creation, while the dot line is on-balance sheet liquidity creation and the dash-dot line is off-balance sheet liquidity creation. We refer to Appendices A and B for details about the variables.

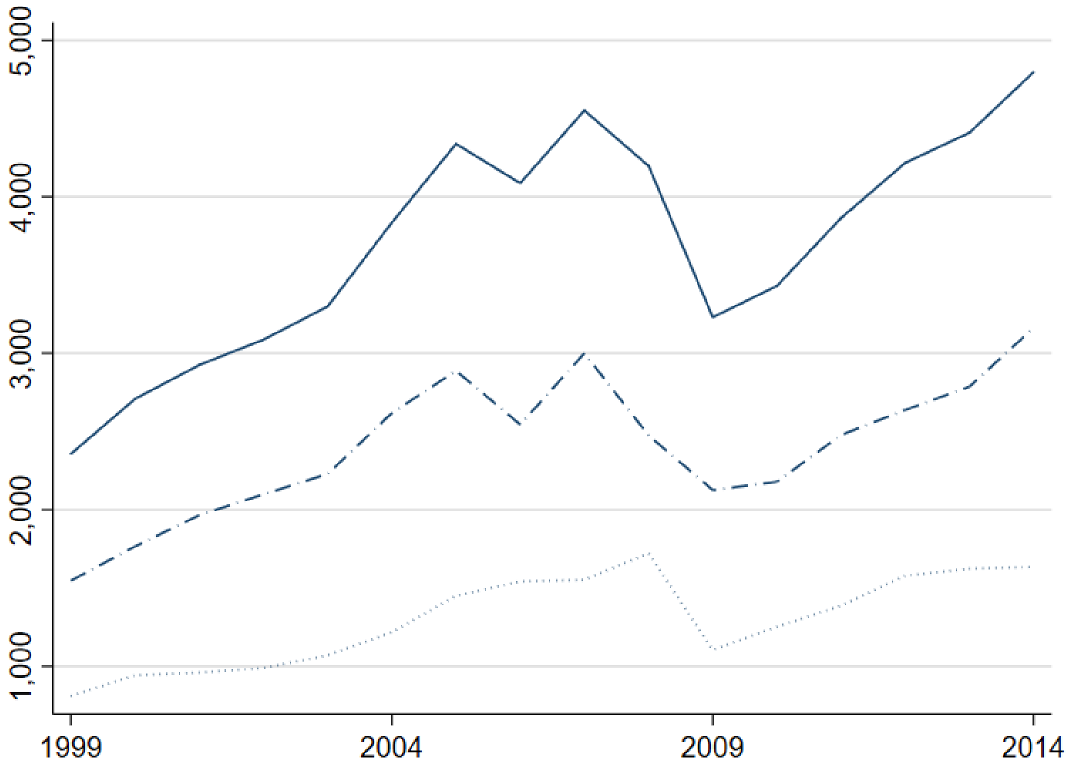

Figure 2: On-balance sheet liquidity creation and GDP per capita

This figure shows the relation between log GDP per capita on the y-axis and log on-balance sheet liquidity creation per capita on the x-axis for the whole sample comprising 100 countries in 1999, 2004, 2009, and 2014. We refer to Appendix B for a full description of the variables and their corresponding sources.

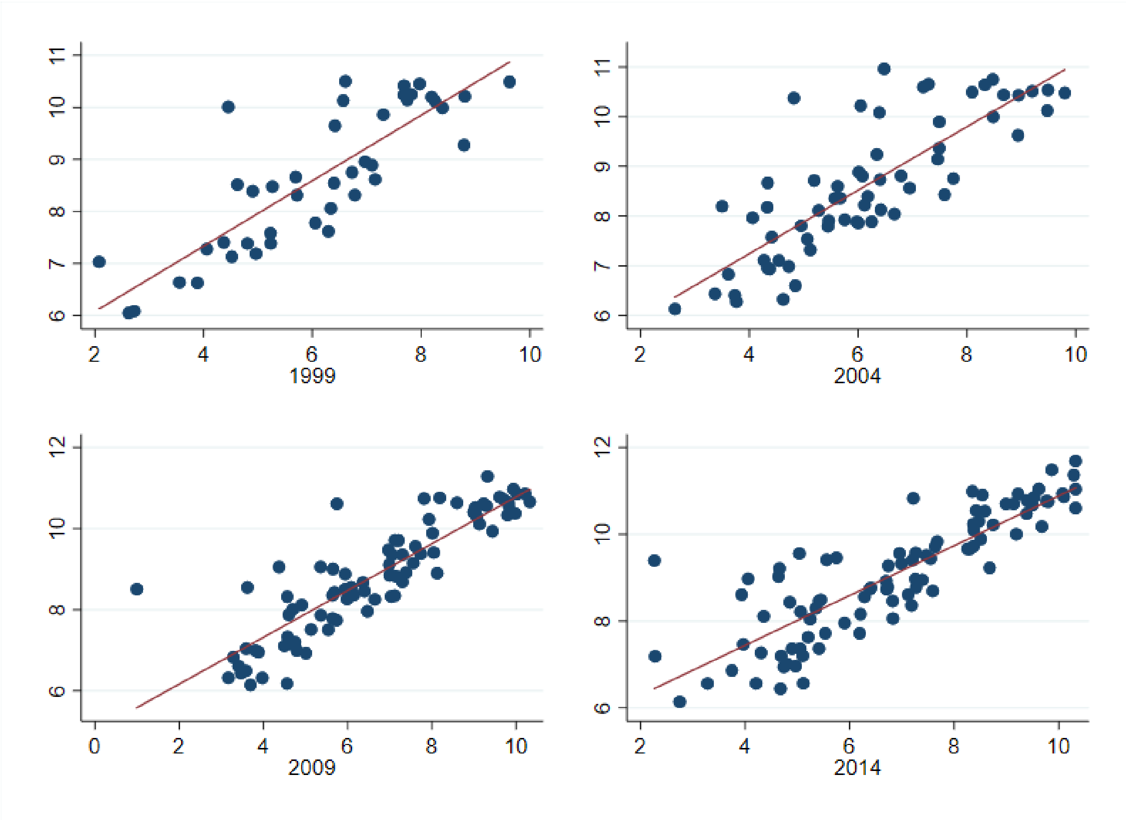

Figure 3: Off-balance sheet liquidity creation and GDP per capita

This figure shows the relation between log GDP per capita on the y-axis and log off-balance sheet liquidity creation per capita on the x-axis for the whole sample comprising 100 countries in 1999, 2004, 2009, and 2014. We refer to Appendix B for a full description of the variables and their corresponding sources.

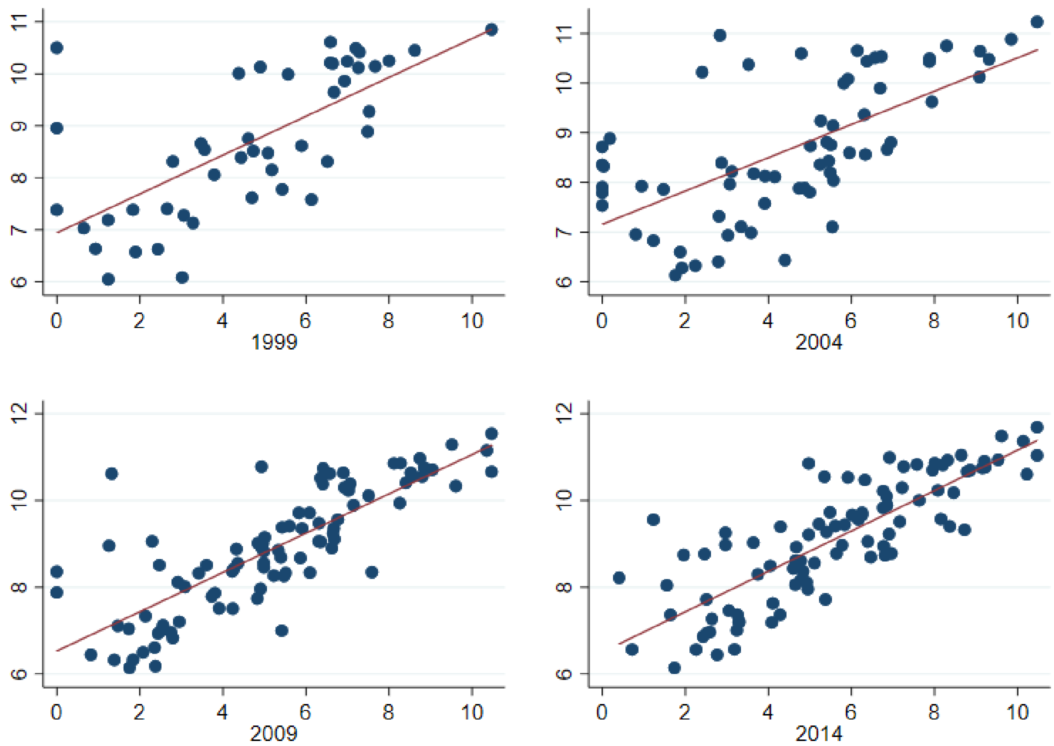

Figure 4: Marginal effects of liquidity creation on growth

This figure shows the marginal effects of on-balance sheet liquidity creation on GDP per capita, calculated from predictions of a fit model at fixed values of intangible ratio and averaging the remaining covariates. The x-axis represents the values of the variable *Intangible ratio* (the simple slopes), and the y-axis represents the effect on linear prediction (based on column 2 of Table 9). The vertical lines are 95-percent confidence intervals. We refer to Appendix B for a full description of the variables and their corresponding sources.

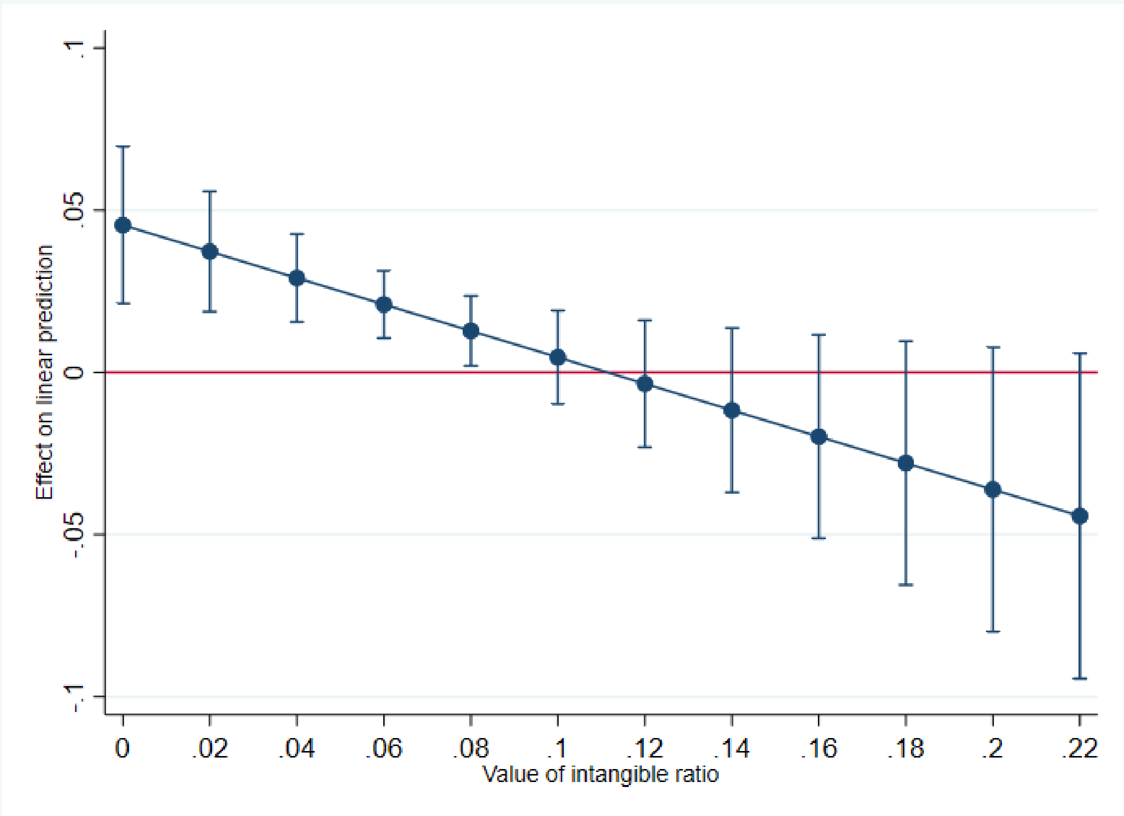

Figure 5: Marginal effects of liquidity creation on net (in)tangible investment rate

This figure shows the marginal effects of on-balance sheet liquidity creation on tangible investment rate (left graphs) or on intangible investment rate (right graphs), calculated from predictions of a fit model at fixed values of a proxy for two key parameters of the model and averaging the remaining covariates. The proxy variable for the diversion parameter γ is *Investor protection index* (top graphs) and the proxy variable for the liquidation cost μ is *Recovery rate* (bottom graphs). The x-axis represents the values of one of these proxy variables (the simple slopes), and the y-axis represents the effect on linear prediction (based on a version of equation (3) as reported in even-numbered columns of Table 7 but with the further inclusion of an interaction between our liquidity creation measures and the corresponding proxy variable for the parameter of the model, γ or μ). The vertical lines are 95-percent confidence intervals. We refer to Appendix B for a full description of the variables and their corresponding sources.

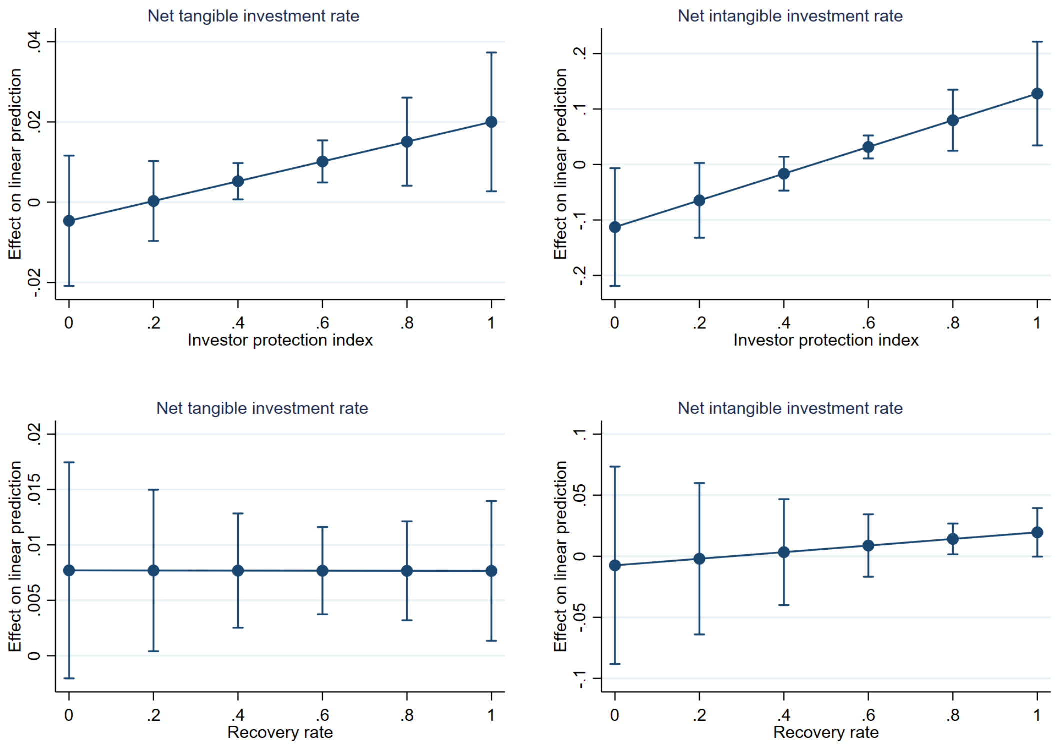

Table 1: Summary statistics on bank-level liquidity creation in 100 countries (1987-2014)

This table presents summary statistics on bank-level liquidity creation (in $ million). The liquidity creation measures classify all bank activities by category and include (or exclude) off-balance sheet activities. We refer to Appendix A for details on the categories and weights. Panel A is for the whole sample comprising 100 countries from 1987 to 2014. Panel B splits the sample by bank size, total assets (TA): Large (TA > $3 billion), Medium (TA $1 billion - $3 billion), Small (TA < $1 billion). Panel C presents the mean value for some years.

Panel A: Liquidity creation for the whole sample						
	Mean	S.D. (overall)	S.D. (between)	S.D. (within)	N	n
On- and off-balance sheet liquidity creation	985.299	12,245.720	9,996.203	8,764.668	199,812	18,217
On-balance sheet liquidity creation	602.982	9,224.037	7,243.388	6,907.769	199,812	18,217
Panel B: Liquidity creation by bank size						
	Mean	25th pc	Median	75th pc	S.D.	N
On- and off-balance sheet liquidity creation						
Large	4,629.637	29.523	267.904	1,828.094	27,091.480	30,500
Medium	907.838	22.329	186.896	587.773	11,465.810	19,284
Small	254.213	9.500	34.500	104.000	5,512.183	150,002
On-balance sheet liquidity creation						
Large	2,761.718	16.655	184.972	1,287.051	20,023.080	30,500
Medium	564.407	13.362	144.308	483.500	9,397.375	19,284
Small	169.021	7.000	28.000	87.000	4,396.204	150,002
Panel C: Mean liquidity creation by year						
	1989	1994	1999	2004	2009	2014
On- and off-balance sheet liquidity creation	674.228	470.219	536.973	780.035	1,165.040	1,786.657
On-balance sheet liquidity creation	562.101	321.078	337.438	443.018	757.066	1,083.281

Table 2: Summary statistics for the main variables used in the country-level analysis

This table presents summary statistics for the variables used in the country-level analysis. We refer to Appendix B for a full description of the variables and their corresponding sources.

Variable	Mean	Median	S.D.	N
Dependent variables				
GDP per capita	15,212.780	5,982.855	18,512.040	1,404
Fixed investment	3,413.477	1,408.680	4,131.169	1,385
Inventory investment	178.263	62.780	415.305	1,349
Patents	22,375.250	1,734.500	84,768.470	1,110
Net tangible investment rate	0.022	0.019	0.016	306
Net intangible investment rate	0.098	0.061	0.124	306
Liquidity creation				
Liquidity creation in $ million (on-balance sheet)	87,472.625	6,923.137	262,165.026	1,410
Liquidity creation in $ million (off-balance sheet)	52,463.367	1,717.588	267,918.955	1,410
Liquidity creation per capita (on-balance sheet)	3,299.337	566.368	6,365.865	1,410
Liquidity creation per capita (off-balance sheet)	1,866.455	155.768	5,406.549	1,410
Controls				
Democracy	5.738	8.000	5.729	1,311
Inflation (S.D.)	5.587	3.612	5.612	1,352
Private credit	61.258	47.175	47.125	1,376

Table 3: Effect of liquidity creation on (log) GDP per capita

This table presents estimates of the effect of liquidity creation on log GDP per capita based on the dynamic panel model in equation (1). Columns 1-4 present results using the within estimator. Columns 5-8 present results using Arellano and Bond's GMM estimator. The AR(2) row reports the p-value for a test of serial correlation in the residuals. The Hansen row reports the p-value for a test of over-identifying restrictions. We refer to Appendix B for a full description of the variables and their corresponding sources. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Within estimates				Arellano and Bond estimates			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidity creation								
Liquidity creation per capita (on-balance sheet)	0.017***	0.023***	0.025***	0.022***	0.044**	0.015*	0.035***	0.029***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.021)	(0.009)	(0.013)	(0.011)
Liquidity creation per capita (off-balance sheet)				0.008**				0.006
				(0.004)				(0.013)
Controls								
GDP per capita first lag	0.836***	0.805***	0.933***	0.924***	0.449***	0.552***	0.645***	0.616***
	(0.024)	(0.027)	(0.054)	(0.055)	(0.067)	(0.096)	(0.164)	(0.124)
GDP per capita second lag			-0.149***	-0.149***			-0.353*	-0.228
			(0.040)	(0.041)			(0.185)	(0.156)
Democracy		0.002	0.003*	0.003		0.035**	0.034*	0.030**
		(0.002)	(0.002)	(0.002)		(0.015)	(0.020)	(0.014)
Inflation (S.D.)		-0.005***	-0.005**	-0.005**		-0.001	0.002	-0.000
		(0.002)	(0.002)	(0.002)		(0.004)	(0.005)	(0.004)
Private credit		0.119	0.150*	0.140*		0.623**	0.950***	0.788***
		(0.085)	(0.082)	(0.080)		(0.274)	(0.363)	(0.297)
Private credit squared		-0.019*	-0.022**	-0.021*		-0.063	-0.078	-0.077*
		(0.011)	(0.011)	(0.011)		(0.040)	(0.050)	(0.040)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) test p-value	-	-	-	-	0.022	0.018	0.502	0.975
Hansen test p-value	-	-	-	-	0.139	0.111	0.244	0.566
Countries	100	92	92	92	100	92	92	92
Observations	1,397	1,242	1,228	1,228	1,357	1,192	1,175	1,175
Within R-squared	0.951	0.953	0.954	0.954	-	-	-	-

Table 4: Effect of liquidity creation on (log) GDP per capita adding additional controls

This table presents estimates of the effect of liquidity creation on log GDP per capita. All columns present results using the within estimator. All specifications include the full set of country and year fixed effects, two lags of GDP per capita, and democracy, inflation (S.D.), private credit, private credit squared as controls. Additionally, the covariates specified in each column label are included. We refer to Appendix B for a full description of the variables and their corresponding sources. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Financial reforms			Financial systems			Other traditional factors		
	Creditor rights	Macroprudential policies	Equity market liberalization	Bank concentration	Financial structure	Stock market liquidity	Law and order	Globalization	School enrollment
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Liquidity creation									
Liquidity creation per capita (on-balance sheet)	0.066***	0.015**	0.042***	0.023***	0.020***	0.021***	0.051***	0.018***	0.022**
	(0.017)	(0.006)	(0.013)	(0.007)	(0.007)	(0.007)	(0.014)	(0.006)	(0.009)
Liquidity creation per capita (off-balance sheet)	0.002	0.014**	0.007*	0.012**	0.008	0.010**	0.012	0.006*	0.013
	(0.006)	(0.011)	(0.014)	(0.005)	(0.006)	(0.004)	(0.008)	(0.004)	(0.008)
Additional controls									
Covariate specified in column label	0.157***	0.008	0.076***	-0.001**	-0.062***	0.007	0.042**	0.008	0.004***
	(0.055)	(0.006)	(0.024)	(0.000)	(0.012)	(0.008)	(0.019)	(0.020)	(0.001)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Countries	48	78	45	91	66	81	47	81	74
Observations	344	758	566	1,120	736	984	332	928	563
Within R-squared	0.723	0.957	0.923	0.954	0.952	0.956	0.673	0.954	0.949

Table 5: Effect of liquidity creation on output: STAN industry-level data

This table presents estimates of the effect of liquidity creation on output at the industry-country level. Columns 1-2 focus on log value added and columns 3-4 on log gross output. We refer to Appendix B for a full description of the variables and their corresponding sources and Table C.1 for the list of industries included. The 33 countries included are: Australia, Austria, Belgium, Canada, Chile, Costa Rica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. The United States is excluded because it is the benchmark. Standard errors (in parentheses) are clustered at the country-year level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Value added		Gross output	
	(1)	(2)	(3)	(4)
Liquidity creation				
Liquidity creation per capita (on-balance sheet) x Debt dependence	0.017**	0.019**	0.018***	0.021**
	(0.007)	(0.009)	(0.007)	(0.008)
Liquidity creation per capita (off-balance sheet) x Debt dependence		-0.002		-0.003
		(0.006)		(0.005)
Controls				
Democracy x Debt dependence	0.003	0.003	0.003	0.003
	(0.004)	(0.004)	(0.005)	(0.005)
Inflation (S.D.) x Debt dependence	-0.016*	-0.015*	-0.011	-0.010
	(0.009)	(0.009)	(0.008)	(0.008)
Private credit x Debt dependence	-0.088	-0.085	-0.360	-0.355
	(0.269)	(0.267)	(0.313)	(0.311)
Private credit squared x Debt dependence	0.006	0.006	0.038	0.037
	(0.032)	(0.032)	(0.037)	(0.037)
Country x Year FE	Yes	Yes	Yes	Yes
Country x Industry FE	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes
Countries	33	33	33	33
Industries	25	25	25	25
Observations	8,636	8,636	8,361	8,361
Within R-squared	0.987	0.987	0.986	0.986

Table 6: Effect of liquidity creation on investment types

This table presents estimates of the effect of liquidity creation on investment. The types of investment are fixed investment, inventory investment, and patents. All columns present results using the within estimator. We refer to Appendix B for a full description of the variables and their corresponding sources. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Investment				Patents	
	Fixed investment		Inventory investment			
	(1)	(2)	(3)	(4)	(5)	(6)
Liquidity creation						
Liquidity creation per capita (on-balance sheet)	0.036***	0.031***	0.014	-0.031	0.004	0.011
	(0.009)	(0.009)	(0.068)	(0.069)	(0.012)	(0.012)
Liquidity creation per capita (off-balance sheet)		0.012**		0.109***		-0.018*
		(0.005)		(0.037)		(0.009)
Controls						
Investment component first lag	0.916***	0.909***	0.558***	0.549***	0.729***	0.726***
	(0.054)	(0.055)	(0.095)	(0.095)	(0.073)	(0.072)
Investment component second lag	-0.132**	-0.130**	0.143***	0.140***	0.085	0.084
	(0.051)	(0.051)	(0.041)	(0.039)	(0.056)	(0.055)
Democracy	0.006***	0.005**	0.006	0.002	0.008*	0.008*
	(0.002)	(0.002)	(0.019)	(0.019)	(0.005)	(0.004)
Inflation (S.D.)	-0.006**	-0.006***	0.015	0.014	-0.001	-0.001
	(0.002)	(0.002)	(0.011)	(0.011)	(0.003)	(0.003)
Private credit	0.258*	0.237*	-0.257	-0.532	0.009	0.062
	(0.138)	(0.136)	(0.853)	(0.880)	(0.151)	(0.149)
Private credit squared	-0.044**	-0.041**	-0.013	0.022	-0.004	-0.011
	(0.019)	(0.019)	(0.097)	(0.102)	(0.020)	(0.020)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Countries	92	92	90	90	80	80
Observations	1,215	1,215	1,178	1,178	945	945
Within R-squared	0.913	0.914	0.523	0.527	0.700	0.702

Table 7: Effect of liquidity creation on net investment rate: Klems country-level data

This table presents estimates of the effect of liquidity creation on net investment rate at the country level. Columns 1-2 focus on tangible assets and columns 3-4 on intangible assets. We refer to Appendix B for a full description of the variables and their corresponding sources. The countries included are: Austria, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, and the United States. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Net tangible investment rate		Net intangible investment rate	
	(1)	(2)	(3)	(4)
Liquidity creation				
Liquidity creation per capita (on-balance sheet)	0.007***	0.007***	0.006	0.010
	(0.002)	(0.002)	(0.011)	(0.009)
Liquidity creation per capita (off-balance sheet)		-0.001		-0.008
		(0.001)		(0.011)
Controls				
Democracy	0.000	-0.001	-0.020	-0.024
	(0.001)	(0.001)	(0.017)	(0.017)
Inflation (S.D.)	0.001***	0.001***	0.002	0.002
	(0.000)	(0.000)	(0.003)	(0.003)
Private credit	0.054***	0.060***	-0.073	-0.033
	(0.014)	(0.015)	(0.125)	(0.173)
Private credit squared	-0.007***	-0.007***	0.003	-0.002
	(0.002)	(0.002)	(0.017)	(0.023)
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Countries	22	22	22	22
Observations	286	286	286	286
Within R-squared	0.662	0.664	0.261	0.267

Table 8: Effect of liquidity creation on the net investment rate: Klems industry-level data

This table presents estimates of the effect of liquidity creation on the net investment rate at the industry level. Columns 1-2 focus on tangible assets and columns 3-4 on intangible assets. We refer to Appendix B for a full description of the variables and their corresponding sources and Table C.1 for the list of industries included. The 14 countries included are: Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. The US is excluded because it is the benchmark. Standard errors (in parentheses) are clustered at the country-year level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Net tangible investment rate		Net intangible investment rate	
	(1)	(2)	(3)	(4)
Liquidity creation				
Liquidity creation per capita (on-balance sheet) x Debt dependence	0.004*	0.005***	0.014	0.019
	(0.002)	(0.002)	(0.011)	(0.012)
Liquidity creation per capita (off-balance sheet) x Debt dependence		-0.001		-0.007
		(0.002)		(0.008)
Controls				
Democracy x Debt dependence	-0.002	-0.002	-0.004	-0.005
	(0.003)	(0.003)	(0.013)	(0.014)
Inflation (S.D.) x Debt dependence	-0.002**	-0.003**	0.016***	0.015***
	(0.001)	(0.001)	(0.004)	(0.004)
Private credit x Debt dependence	-0.015	-0.032	0.423**	0.335
	(0.049)	(0.056)	(0.201)	(0.258)
Private credit squared x Debt dependence	0.002	0.004	-0.041*	-0.031
	(0.006)	(0.007)	(0.024)	(0.030)
Country x Year FE	(0.006)	(0.007)	(0.024)	(0.030)
Country x Industry FE	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes
Countries	14	14	14	14
Industries	25	25	25	25
Observations	4,363	4,363	4,337	4,337
Within R-squared	0.744	0.744	0.622	0.622

Table 9: Differential effect of liquidity creation on (log) GDP per capita across countries' intangible intensity

This table presents estimates of the effect of liquidity creation on log GDP per capita across countries' intangible ratio. Columns 1-2 present results using the within estimator. Columns 3-4 present results using Arellano and Bond's GMM estimator. The AR(2) row reports the p-value for a test of serial correlation in the residuals. The Hansen row reports the p-value for a test of over-identifying restrictions. We refer to Appendix B for a full description of the variables and their corresponding sources. Standard errors (in parentheses) are clustered at the country level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Within estimates		Arellano and Bond estimates	
	(1)	(2)	(3)	(4)
Liquidity creation				
Liquidity creation per capita (on-balance sheet)	0.043***	0.045***	0.056***	0.051***
	(0.011)	(0.011)	(0.017)	(0.016)
Liquidity creation per capita (off-balance sheet)		-0.005		0.008
		(0.009)		(0.010)
Liquidity creation per capita (on-balance sheet) x Intangible ratio	-0.350**	-0.408**	-0.462***	-0.409***
	(0.135)	(0.153)	(0.145)	(0.154)
Liquidity creation per capita (off-balance sheet) x Intangible ratio		0.086		-0.079
		(0.122)		(0.143)
Intangible ratio	2.895**	2.658**	3.685***	3.879***
	(1.225)	(1.260)	(1.336)	(1.501)
Controls				
GDP per capita first lag	1.005***	1.004***	1.005***	1.001***
	(0.049)	(0.049)	(0.058)	(0.060)
GDP per capita second lag	-0.196***	-0.196***	-0.231***	-0.233***
	(0.037)	(0.037)	(0.036)	(0.036)
Democracy	0.000	-0.000	-0.014***	-0.014***
	(0.006)	(0.006)	(0.003)	(0.003)
Inflation (S.D.)	-0.001	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Private credit	0.177**	0.181**	0.191***	0.183***
	(0.077)	(0.076)	(0.071)	(0.071)
Private credit squared	-0.022**	-0.023**	-0.024***	-0.023***
	(0.009)	(0.009)	(0.008)	(0.008)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
AR(2) test p-value	-	-	0.182	0.181
Hansen test p-value	-	-	1.000	1.000
Countries	34	34	34	34
Observations	474	474	454	454
Within R-squared	0.973	0.973	-	-

A Liquidity Classification of Bank Activities

In this appendix, we provide an overview of the weights assigned to each bank balance sheet item (as retrieved from BvD/Fitch Bankscope) to construct the liquidity creation measures. As explained in the main text, we follow as much as we can Berger and Bouwman (2009)'s methodology of both *catnonfat* and *catfat* measures. The weights assigned are also in line with Silva (2019), with the exception of "Other Mortgage Loans" (weight = 1/2), "Customer Deposits - Savings" (weight = 0), "Deposits from Banks" (weight = 1/2), and "Other Deposits and Short-Term Borrowings" (weight = 1/2), which has no material impact on our estimates.

A.1 Bank Assets

Illiquid assets (weight = 1/2)	Semiliquid assets (weight = 0)	Liquid assets (weight = -1/2)
Corporate & Commercial Loans	Residential Mortgage Loans	Reverse Repos and Cash Collateral
Other Loans	Other Mortgage Loans	Trading Securities and at FV through Income
At-Equity Investments in Associates	Other Consumer/Retail Loans	Derivatives
Investments in Property	Loans and Advances to Banks	Available for Sale Securities
Insurance Assets		Held to Maturity Securities
Other Earning Assets		Other Securities
Total Earning Assets		
Fixed Assets		Cash and Due from Banks
Foreclosed Real Estate		
Goodwill		
Other Intangibles		
Current Tax Assets		
Deferred Tax Assets		
Discontinued Operations		
Other Assets		
Total Non-Earning Assets		

A.2 Bank Liabilities and Equity

Liquid liabilities (weight = 1/2)	Semiliquid liabilities (weight = 0)	Illiquid liabilities and equity (weight = -1/2)
Customer Deposits - Current Customer Deposits - Savings Repos and Cash Collateral Derivatives Trading Liabilities	Customer Deposits - Term Deposits from Banks Other Deposits and Short-Term Borrowings	Senior Debt Maturing after 1 Year Subordinated Borrowing Other Funding
Total Interest-Bearing Liabilities		
		Fair Value Portion of Debt Credit Impairment Reserves Reserves for Pensions and Other Current Tax Liabilities Deferred Tax Liabilities Other Deferred Liabilities Discontinued Operations Insurance Liabilities Other Liabilities
Total Non-Interest Bearing Liabilities		
		Pref. Shares and Hybrid Capital accounted for as Debt Pref. Shares and Hybrid Capital accounted for as Equity
Hybrid Capital		
		Common Equity Other Equity
Equity		

A.3 Off-Balance Sheet Activities

Illiquid activities (weight = 1/2)	Semiliquid activities (weight = 0)	Liquid activities (weight = -1/2)
Acceptances and Documentary Credits Reported Off-Balance Sheet	Managed Securitized Assets Reported Off-Balance Sheet	
Committed Credit Lines	Other Off-Balance Sheet Exposure to Securitizations	
Other Contingent Liabilities	Guarantees	

B Variable Definitions and Data Sources

In this appendix, we provide detailed definitions for all variables used in our analysis as well as their corresponding data sources.

B.1 Dependent variables

GDP per capita: Gross domestic product divided by midyear population. Data are in current \$. For brevity, we use the label GDP per capita in referring to the logarithm of GDP per capita in the text. *Source:* World Bank Development Indicators.

Investment: Gross capital formation divided by midyear population. It consists of outlays on additions to the fixed assets of the economy (the variable *Fixed investment* as defined below) plus net changes in the level of inventories (the variable *Inventory investment* as defined below). Data are in current \$. For brevity, we use the label *Investment* in referring to the logarithm of *Investment* in the text. *Source:* World Bank Development Indicators.

Fixed investment: Gross fixed capital formation divided by midyear population. It includes land improvements; plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Data are in current \$. For brevity, we use the label *Fixed investment* in referring to the logarithm of *Fixed investment* in the text. *Source:* World Bank Development Indicators.

Inventory investment: Changes in inventories divided by midyear population. These are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." Data are in current \$. For brevity, we use the label *Investment* in referring to the logarithm of *Investment* in the text. *Source:* World Bank Development Indicators.

Patents: Total patent applications by both residents and non-residents filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights (generally for 20 years) for an invention. For brevity, we use the label *Patents* in referring to the logarithm of *Patents* in the text. *Source:* World Bank Development Indicators.

Net tangible and intangible investment rates: Net investment rates are calculated as the gross investment minus depreciation, divided by the previous year's capital stock. Klems groups investment into different categories. We define as intangible capital investments into Intellectual Property Products (IPP), which are the sum of (1) research and development (*I_RD*); (2) other IPP assets (*I_OIPP*); and (3) computer software and databases (*I_Soft_DB*). We set intangible investment to missing if one of the components is missing. Tangible investment is defined as the residual of total gross fixed capital formation (*I_GFCF*) minus intangible investment and consists of the following items: (1) Computing equipment (*I_IT*); (2) communications equipment (*I_CT*); (3) transport equipment (*I_TraEq*); (4) other machinery and equipment (*I_OMach*); (5) residential structures (*I_RStruc*); (6) total non-residential investment (*I_OCon*); (7) cultivated assets (*I_Cult*); (8) Research and development (*I_RD*); (9) other IPP assets (*I_OIPP*); and (10) computer software and databases (*I_Soft_DB*). *Sources:* Klems EU and World.

B.2 Liquidity Creation

Liquidity creation per capita (on-balance sheet): Total on-balance sheet liquidity creation of all banks in the country, divided by the country's midyear population. Appendix A provides details on the weights and classifications of each bank balance-sheet item. For brevity, we use the label *Liquidity creation per capita (on-balance sheet)* in referring to the logarithm of *Liquidity creation per capita (on-balance sheet)* in the text. *Source:* BvD/Fitch Bankscope.

Liquidity creation per capita (off-balance sheet): Total off-balance sheet liquidity creation of all banks in the country, divided by the country's midyear population. Appendix A provides details on the weights and classifications of each bank balance-sheet item. For brevity, we use the label *Liquidity creation per capita (off-balance sheet)* in referring to the logarithm of *Liquidity creation per capita (off-balance sheet)* in the text. *Source:* BvD/Fitch Bankscope.

B.3 Controls

Democracy: Revised combined *Polity2* score, which is computed by subtracting the autocracy score from the democracy score; the resulting unified polity scale ranges from +10 (strongly democratic) to −10 (strongly autocratic). For brevity, we use the label *Democracy* in referring to lagged *Democracy* in the text. *Source:* Polity IV.

Inflation (S.D.): Standard deviation of inflation, measured over the previous 15 years. Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspereyes formula is generally used. *Source:* World Bank Development Indicators.

Private credit: Private credit by deposit money banks and other financial institutions to GDP. For brevity, we use the label *Private credit* in referring to the logarithm of lagged *Private credit* in the text. *Source:* Financial Development and Structure Database.

Creditor rights: Index aggregating different creditor rights, following La Porta et al. (1998). The index if formed by adding 1 when (1) the country imposes restrictions, such as creditor consent or minimum dividends, for a debtor to file for reorganization; (2) secured creditors are able to seize their collateral after the reorganization petition is approved, i.e., there is no automatic stay or asset freeze; (3) secured creditors are paid first out of the proceeds of liquidating a bankrupt firm, as opposed to other creditors such as government or workers; and (4) the debtor does not retain administration of its property pending the resolution of the reorganization. The index ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. *Source:* Djankov et al. (2007).

Macroprudential policies: Index aggregating different macroprudential policies. The index if formed by summing the scores on all following policy instruments: (1) Loan-to-value ratio; (2) debt-to-income ratio; (3) time-varying/dynamic Loan-Loss provisioning; (4) general countercyclical capital buffer/requirement; (5) leverage ratio; (6) capital surcharges on SIFIs; (7) limits on interbank exposures; (8) concentration limits; (9) limits on foreign currency loans; (10) reserve requirement ratios; (11) limits on domestic currency loan; and (12) levy/tax on financial institution. The index ranges from 0 (no usage of macroprudential policies) to 12 (intensive usage of all macroprudential policies) and is constructed for every year from 2000 to 2013. *Source:* Cerutti et al. (2017).

Equity market liberalization: Date of formal regulatory change after which foreign investors officially have the opportunity to invest in domestic equity securities. This chronology is based on over 50 different source materials. *Source:* Bekaert et al. (2005).

Bank concentration: Assets of three largest banks as a share of assets of all commercial banks. *Source:* Financial Development and Structure Database.

Financial structure: Ratio of private credit by deposit money banks and other financial institutions (i.e., *Private credit*) to market capitalization of listed domestic companies. For brevity, we use the label *Financial structure* in referring to the logarithm of lagged *Financial structure* in the text. *Sources:* World Bank Development Indicators and Financial Development and Structure Database.

Stock market liquidity: Total value of shares traded during the period divided by the average market capitalization for the period. Average market capitalization is calculated as the average of the end-of-period values for the current period and the previous period. For brevity, we use the label *Stock market liquidity* in referring to the logarithm of lagged *Stock market liquidity* in the text. *Source:* World Bank Development Indicators.

Law and order: Index comprising the following two elements, separately scored from 0 to 3: (1) The "Law" element is the strength and impartiality of the legal system; and (2) the "Order" element is an assessment of popular observance of the law. Thus, a country can enjoy a high rating (3) in terms of its judicial system, but a low rating (1) if it suffers from a very high crime rate if the law is routinely ignored without effective sanction (e.g., widespread illegal strikes). *Source:* International Country Risk Guide.

Globalization: Composite index, known as KOF Index of Globalization, measuring the economic, social and political aspects of globalization distinguishing between de facto and de jure aspects. For brevity, we use the label *Globalization* in referring to the logarithm of *Globalization* in the text.*Source:* Gygli et al. (2019).

School enrollment: Ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the secondary level of education. *Source:* World Bank Development .

Investor protection index: Index, known as the strength of investor protection index, is the sum of the extent of disclosure index, extent of director liability index and ease of shareholder suits index. The index is computed based on the methodology in the DB06-14 studies. We take the average of this index over the sample period and normalize it to range it between 0 and 1. *Source:* World Bank Doing Business.

Recovery rate: Cents on the dollar recovered by secured creditors through judicial reorganization, liquidation or debt enforcement (foreclosure or receivership) proceedings. The calculation takes into account the outcome: whether the business emerges from the proceedings as a going concern or the assets are sold piecemeal. We take the average of this index over the sample period and normalize it to range it between 0 and 1.*Source:* World Bank Doing Business.

B.4 Industry-Level Variables

Net tangible and intangible investment rates: Net investment rates are calculated as the gross investment minus depreciation, divided by the previous year's capital stock. Industry-level investment rates are constructed in the same way as the country-level investment rates (see above for details) but using capital data fields for the 25 (ISIC Rev. 4) industries (see Table C.1 for details on sample industries). Industry-level investment rates are also winsorized at the 1-percent and 99-

percent levels because of a few outliers. Intangible investment is defined as the Klems asset types software and databases, R&D and other IPP. The remaining asset types are defined as tangible investment and include computing equipment, communications equipment, transport equipment, other machinery and equipment, dwellings, other buildings and structures, and cultivated assets. *Sources:* Klems EU and World.

Intangible ratio: The ratio of intangible to total (tangible plus intangible) capital, with intangible and tangible asset types classified as described in the previous paragraph. We measure an industry's intangible ratio based on US data, and define a country's intangible ratio as the weighted average intangible ratio using the country's industry value added. *Sources:* Klems EU and World, and OECD STAN.

Debt dependence: Ratio of net debt issuance to capital expenditures. Net debt issuance is the industry aggregate of long-term debt issuance (*dltis*) minus long-term debt reduction (*dltr*). Capital expenditures (*capx*) are also aggregated at the industry level. *Source:* Compustat.

Value added: Gross output net of intermediate inputs. All values are converted to current \$. For brevity, we use the label *Value added* in referring to the logarithm of *Value added* in the text. *Source:* OECD STAN.

Gross output: Gross output as taken from STAN. All values are converted to current \$. For brevity, we use the label *Gross output* in referring to the logarithm of *Gross output* in the text. *Source:* OECD STAN.

Fixed investment: Gross fixed capital formation in national currencies, converted to current \$. For brevity, we use the label *Fixed Investment* in referring to the logarithm of *Fixed Investment* in the text. *Source:* OECD STAN.

R&D expenditures: R&D expenditures as taken from ANBERD, converted to current \$. For brevity, we use the label *R&D expenditures* in referring to the logarithm of *R&D expenditures* in the text. *Source:* OECD ANBERD.

C Additional Tables

Table C.1: Summary statistics for key variables used in the industry-level analysis

This table presents the statistics for the debt dependence, value added, gross output, and net investment (tangible and intangible) rate variables used in the industry-level analysis. Data is available at the industry level (19 groups) following the ISIC Rev. 4 hierarchy. Data for some industries is further broken out (e.g., C "TOTAL MANUFACTURING" is split into 11 groups). In principle, this leads to 34 categories. But Klems capital data are not available for some of these granular segments (e.g., capital data for Klems segments D45, D46 and D47 is missing for several countries, so we combine D45T47 into one segment). In the end, we use the most granular segmentation for which data is available, which corresponds to 31 Klems categories. Six industries are also excluded as discussed in the main text (i.e., D-E "UTILITIES", K ""FINANCIAL AND INSURANCE ACTIVITIES", L "REAL ESTATE ACTIVITIES", O "Public administration and defence; compulsory social security", T "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use", U "Activities of extraterritorial organizations and bodies"). We refer to Appendix B for a full description of the variables and their corresponding sources.

Industry (ISIC Rev. 4)	Debt dependence		Value added		Gross output		Net tangible investment rate		Net intangible investment rate	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
A. AGRICULTURE, FORESTRY AND FISHING	0.313	0.152	13,090.71	15,734.89	28,366.01	31,300.46	0.017	0.035	0.110	0.159
B. MINING AND QUARRYING	0.125	0.047	13,820.96	28,058.87	20,903.84	41,505.84	0.031	0.052	0.023	0.129
C. MANUFACTURING										
10-12. Food products, beverages, and tobacco	0.334	0.195	17,899.92	25,298.04	62,921.55	76,384.23	0.020	0.031	0.077	0.147
13-15. Textiles, wearing apparel, leather, and related products	0.225	0.105	4,514.14	6,720.64	13,275.22	21,123.34	-0.011	0.033	0.038	0.096
16-18. Wood and paper products; printing and reproduction of recorded media	0.102	0.082	9,131.19	13,130.40	27,014.68	36,087.42	0.005	0.037	0.074	0.147
19. Coke and refined petroleum products	0.006	0.024	3,840.54	9,321.73	30,376.84	42,480.71	0.012	0.055	0.060	0.148
20-21. Chemicals and chemical products	0.288	0.106	15,285.55	21,991.68	47,283.15	64,558.46	0.018	0.035	0.040	0.117
22-23. Rubber and plastics products, and other non-metallic mineral products	0.228	0.154	-	-	-	-	0.011	0.034	0.052	0.089
24-25. Basic metals and fabricated metal products, except machinery and equipment	0.273	0.078	17,211.21	27,352.31	58,448.48	97,856.03	0.013	0.032	0.034	0.059
26-27. Electrical and optical equipment	0.245	0.084	-	-	-	-	0.027	0.055	0.029	0.071
28. Machinery and equipment	0.442	0.094	15,317.15	30,771.69	41,396.65	77,028.30	0.023	0.029	0.050	0.090
29-30. Transport equipment	0.383	0.182	-	-	-	-	0.025	0.048	0.041	0.112
31-33. Other manufacturing; repair and installation of machinery and equipment	0.299	0.120	8,406.73	10,817.67	20,688.47	26,320.26	0.016	0.031	0.028	0.080
F. CONSTRUCTION	0.996	0.954	42,843.33	60,179.04	108,780.00	143,704.50	0.032	0.041	0.080	0.130
G. WHOLESALE AND RETAIL TRADE	0.217	0.051	90,002.41	135,771.80	158,625.20	223,490.60	0.027	0.033	0.123	0.129
H. TRANSPORTATION AND STORAGE	0.211	0.040	37,270.00	51,958.42	81,256.12	100,868.80	0.028	0.033	0.126	0.147
I. ACCOMMODATION AND FOOD SERVICE ACTIVITIES	0.328	0.073	19,523.43	29,874.30	39,981.10	64,244.73	0.026	0.037	0.135	0.170
J. INFORMATION AND COMMUNICATION										
58-60. Publishing, audiovisual and broadcasting activities	0.367	0.118	8,214.84	11,516.03	18,580.02	25,490.89	0.029	0.047	0.196	0.131
61. Telecommunications	0.148	0.095	13,432.41	20,089.70	26,164.10	39,490.12	0.040	0.051	0.169	0.205
62-63. IT and other information services	0.247	0.185	15,077.98	25,432.70	25,777.07	40,492.92	0.065	0.065	0.153	0.149
M-N. PROFESSIONAL, SCIENTIFIC, TECHNICAL, AND SUPPORT SERVICE ACTIVITIES	0.240	0.082	67,368.87	94,927.11	120,896.90	162,867.80	0.058	0.047	0.071	0.152
P. EDUCATION	0.139	0.080	35,658.07	46,591.90	44,067.06	57,777.68	0.024	0.029	0.024	0.029
Q. HEALTH AND SOCIAL WORK	0.549	0.202	49,386.80	71,366.29	74,332.87	111,296.70	0.034	0.031	0.066	0.147
R. ARTS, ENTERTAINMENT, AND RECREATION	0.554	0.195	10,150.33	19,010.11	18,489.40	33,151.56	0.010	0.028	0.132	0.167
S. OTHER SERVICE ACTIVITIES	0.475	0.685	-	-	-	-	0.004	0.036	0.132	0.188
Total	0.309	0.325	24,753.72	53,257.16	51,367.64	96,941.10	0.023	0.043	0.084	0.146

Table C.2: Effect of liquidity creation on investment types: STAN industry-level data

This table presents estimates of the effect of liquidity creation on investment types at the industry-country level. Columns 1-2 focus on log fixed investment and columns 3-4 on log R&D expenditures. We refer to Appendix B for a full description of the variables and their corresponding sources and Table C.1 for the list of industries included. The 33 countries included are: Australia, Austria, Belgium, Canada, Chile, Costa Rica, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom. The United States is excluded because it is the benchmark. Standard errors (in parentheses) are clustered at the country-year level. ***, **, and * indicate statistical significance at 1-percent, 5-percent, and 10-percent levels, respectively.

	Fixed investment		R&D expenditures	
	(1)	(2)	(3)	(4)
Liquidity creation				
Liquidity creation per capita (on-balance sheet) x Debt dependence	0.022**	0.039***	-0.070***	-0.084
	(0.010)	(0.014)	(0.026)	(0.056)
Liquidity creation per capita (off-balance sheet) x Debt dependence		-0.018*		0.016
		(0.009)		(0.053)
Controls				
Democracy x Debt dependence	0.016***	0.016***	0.028*	0.028*
	(0.006)	(0.006)	(0.016)	(0.016)
Inflation (S.D.) x Debt dependence	0.000	0.003	0.036***	0.037**
	(0.013)	(0.013)	(0.013)	(0.015)
Private credit x Debt dependence	0.782***	0.814***	1.253	1.246
	(0.233)	(0.230)	(0.887)	(0.870)
Private credit squared x Debt dependence	-0.096***	-0.101***	-0.144	-0.143
	(0.029)	(0.028)	(0.100)	(0.097)
Country x Year FE	Yes	Yes	Yes	Yes
Country x Industry FE	Yes	Yes	Yes	Yes
Industry x Year FE	Yes	Yes	Yes	Yes
Countries	33	33	33	33
Industries	25	25	25	25
Observations	7,777	7,777	4,891	4,891
Within R-squared	0.982	0.982	0.974	0.974

D Model Details

This appendix presents details on the solution to the model in Section 5. The following subsections solve the investor problem and derive the allocations under autarky and and in the first-best allocation in Section 5.2.

D.1 Autarky

Under autarky, an investor who invests I in the long-term project and $s = e - I$ into storage, needs to liquidate the entire investment if he or she is an early type. Thus, early investors consume an amount

$$c_E = s + (1 - \mu)I = e - \mu I.$$

In contrast, late investors optimally do not liquidate any investment at $t = 1$. If the investment project of late investors fails (prob. $1 - p$), they also consume c_E. If the project succeeds (prob. p), the project earns a return $1 + r$ and late investors consume

$$c_L = s + (1 + r)I - c_0 = e + rI.$$

Investors solve the following problem:

$$\max_{c_E, c_L, I} E[U] = \tilde{\lambda} u(c_E) + (1 - \tilde{\lambda}) u(c_L)$$

where $\tilde{\lambda} \equiv [\lambda + (1-\lambda)(1-p)]$ is the probability of consuming c_E (i.e. the joint probability of being early and being late while owning a project that fails). The first-order conditions with respect to I are given by

$$\tilde{\lambda} u'(c_E)\mu = (1 - \tilde{\lambda}) u'(c_L) r. \tag{6}$$

This optimality condition trades off the risk of the potential liquidation loss μ against the gain r if the project succeeds. Together with the two budget constraints, these first-order conditions define the optimal choices $(I^{aut}, c_E^{aut}, c_L^{aut})$ under autarky:

$$\begin{aligned} I^{aut} &= \frac{(1 - \tilde{\lambda})r - \tilde{\lambda}\mu}{\mu r} e, \\ c_E^{aut} &= \frac{\tilde{\lambda}(r + \mu)e}{r}, \\ c_L^{aut} &= \frac{(1 - \tilde{\lambda})(r + \mu)e}{\mu}. \end{aligned}$$

D.2 First Best and the Role of Banks

A bank can improve upon autarky as it can facilitate risk sharing and avoid inefficient liquidation of the long-term investment. In fact, Diamond and Dybvig (1983) show that banks can implement the first-best allocation by offering demand deposits contracts. This subsection derives the first-best allocation by solving the problem of a social planner. We show below under what conditions the first-best allocation can be implemented by a bank.

By the law of large numbers, the planner can perfectly forecast the aggregate number of early and late investors. Consequently, there is no need to inefficiently liquidate long-term assets and the planner invests just enough in storage to service all early investors,

$$s = \lambda c_E,$$

where c_E denotes consumption by early types. The returns from the long-term investment are entirely left for late investors who in aggregate consume

$$(1-\lambda)c_L = RI,$$

where $R \equiv p(1+r)+(1-p)(1-\mu)$ is the aggregate (=average) return on the long-term investment. The social planner solves the following problem:

$$\max_{c_E, c_L, I} E[U] = \lambda u(c_E) + (1-\lambda)u(c_L). \tag{7}$$

The first-order condition is given by

$$u'(c_E) = Ru'(c_L). \tag{8}$$

Together with the two budget constraints, these first-order conditions define the optimal first-best values (I^*, c_E^*, c_L^*):

$$\begin{aligned} I^* &= (1-\lambda)e, \\ c_E^* &= e, \\ c_L^* &= Re \end{aligned}$$