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By: Juan Esteban Carranza
Stefany Moreno-Burbano

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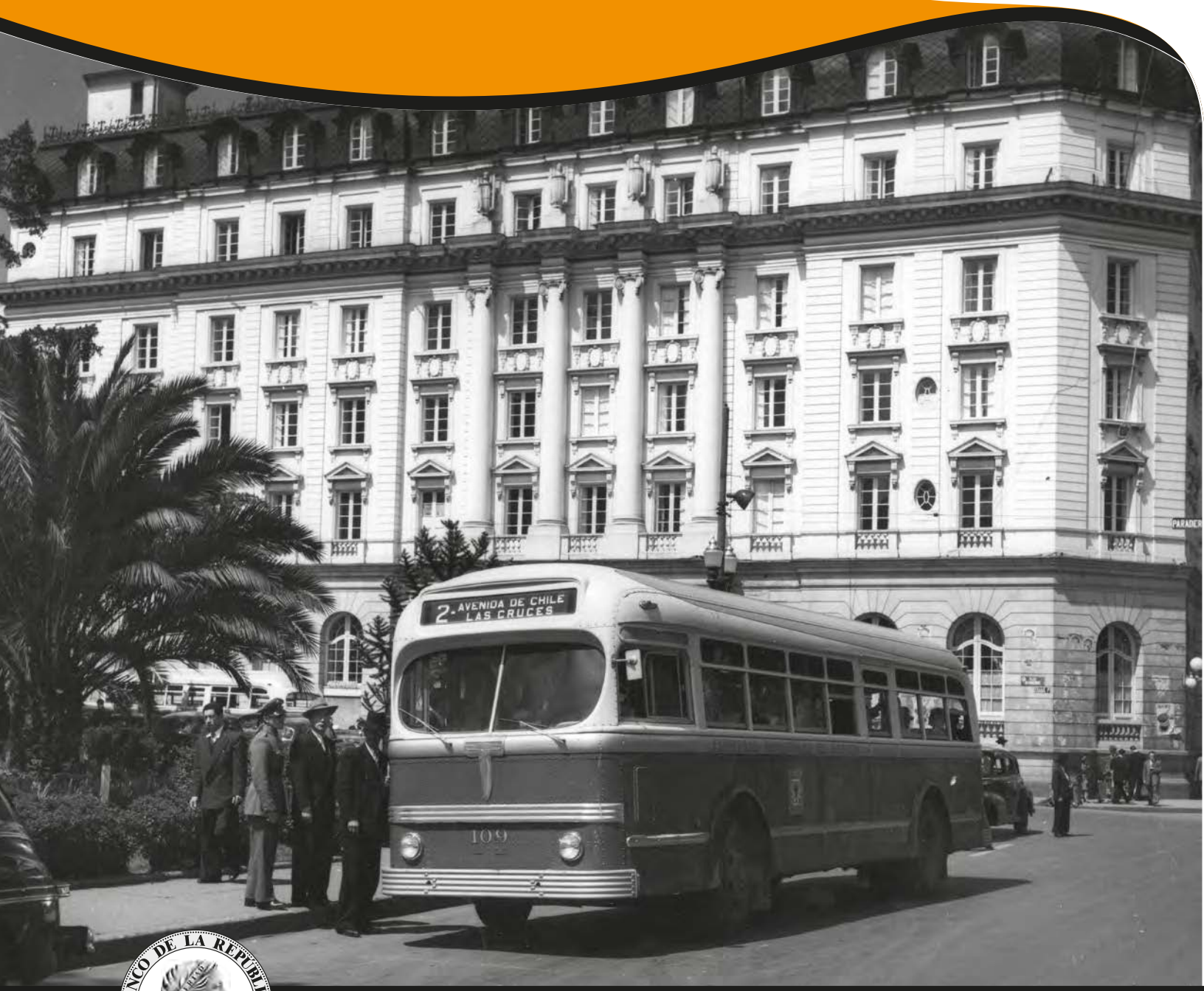

The effect of a bank liquidity shock on the performance of firms

Juan Esteban Carranza* Stefany Moreno-Burbano

Abstract

We study the effect of a credit supply shock on the performance of Colombian firms, induced by an unexpected increase in the liquidity of banks. The increased liquidity was the result of sudden sell-off of Colombian government bonds by banks in response to an unexpected increase in their demand. The shift in demand for these government bonds followed the unexpected increase of its share in the composition of a prominent JP Morgan index. We exploit the variation in liquidity across banks and their preexisting relationships with firms at the time of the shock to extract from the data the variation in loans that was driven by the exogenous shock. We then connect this variation in loans to the performance of firms. We find that the positive credit shock led to increased sales by firms, based mainly on increases of capital investment.

Keywords: Lending channel, supply shock, firm' performance
JEL: G21, G11, L25

*Centro de Estudios sobre Economía Industrial e Internacional - CEEII, Banco de la República - Cali.

El efecto de un choque a la liquidez de los bancos sobre el desempeño de las firmas

Juan Esteban Carranza* Stefany Moreno-Burbano

Abstract

En este documento estudiamos el efecto de un choque a la oferta de crédito en el desempeño de las firmas colombianas, como consecuencia de un incremento inesperado en la liquidez de los bancos. El aumento en la liquidez fue resultado de un aumento súbito en las ventas por parte de los bancos de bonos gubernamentales en respuesta a un incremento inesperado en su demanda. El cambio en la demanda por estos activos fue resultado de un incremento en la participación de estos activos en dos índices de mercados emergentes de J.P.Morgan. Explotamos la heterogeneidad en la tenencia de bonos entre bancos y las relaciones pre-existentes con las firmas en el momento del choque para extraer de los datos la variación en los créditos inducida por el choque exógeno. Luego conectamos esta variación de los créditos con el desempeño de las firmas. Encontramos que el aumento inesperado de la liquidez de los bancos condujo a un aumento en las ventas de las firmas, con base principalmente en aumentos en la inversión en capital fijo.

Keywords: Canal de crédito, choque de oferta, desempeño de las firmas
JEL: G21, G11, L25

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1 Introduction

In March 2014 JPMorgan unexpectedly increased the share of Colombian government bonds in an emerging market index, widely followed by mutual funds and ETFs. This change induced an abrupt increase in the demand for these bonds, which at the time were mostly held by Colombian commercial banks. The subsequent price increase induced banks to liquidate their bond holdings, which generated a substantial increase in their liquidity. The banks could then use these funds to lend to their costumers, who in turn could also use to increase their productive activity.

In this paper we exploit this exogenous shock to bank liquidity to estimate the effect of the credit shock on the performance of individual firms. We exploit the fact that banks had different holdings of government bonds before the announcement by JPMorgan, and then disproportionally increased their lending to firms with which they already had business with, to identify similar firms that were exposed to different credit shocks. Then we correlate these shocks with the firms' performance afterwards to identify the causal effect of the shock on real firm-level economic activity.

More specifically, we use an instrumental variables estimator to obtain the variation in firm-level loans that was caused by the shock. Since loans are affected by firm-level unobserved shocks, we use the pre-existing exposure of banks to government bonds and the pre-existing relationship of firms with specific banks to instrument the observed change in loans after the exogenous shock to bond demand.

The projected increase in loans, which is arguably exogenous, is used to infer the causal effect of the credit shock on firm-level performance measures. We find that the credit shock had a significant effect on the sales and exports of firms, through increased investment in fixed capital. We found no evidence that the credit shock had any effect on hiring or labor hiring.

As we point out in our review of the literature, we are not aware of any other paper that connects an exogenous credit shock with bank lending, and then with firm-level performance, including exports. The understanding of this connection is crucial for the construction of models of firm behaviour and the design of public policies, including the aggregate credit management policies of central banks.

The paper is organized as follows. In the next section, we provide a description of problem that we study and a brief literature review. In section 3, we describe the data. In section 4 we describe our empirical approach and results. The fifth section concludes.

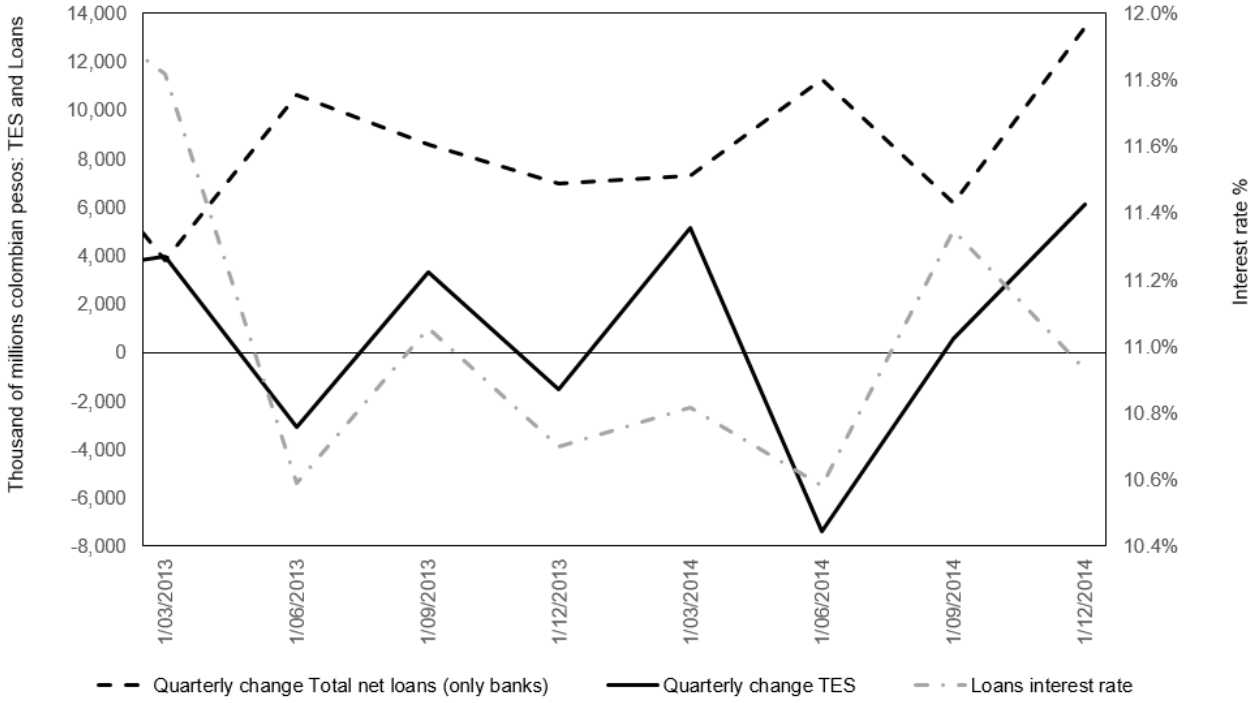
2 Description of the problem and related literature

On 19th March 2014, J.P. Morgan announced an increase in the share of Colombian treasury bonds (henceforth, TES) in a set of widely followed indices. Specifically, it added five Colombian types of TES to the Government Bond-Emerging Markets Indices (GBI-EM) with maturities in 2016, 2018, 2022,2024 and 2028. The inclusion phased in at the end of May 2014 and was completed on 30th September 2014. This was an unexpected and unanticipated shock that lead to an immediate increase in the demand for these bonds by investors aiming to replicate the performance of the indices.

At the time, the main holders of TES were the Colombian commercial banks. The sudden increase in the demand for TES and its price induced banks to rebalance their portfolio away from TES. As a result, banks accumulated substantial liquidity that they had to invest in new assets, including loans to firms in the real sector. In other words, the announcement induced a sudden liquidity shock that was transmitted to the economy via new credit to firms.

To provide a first look to the shock that we study, in Figure 1 we show the quarterly change in total TES holdings by commercial banks, and the quarterly change in total bank loans between the first quarter of 2013 and the fourth quarter of 2014. On the right axis, we show the average yields of TES. As shown, in the second quarter of 2014, the holdings of TES by banks fell around COP$7 billion, coinciding with an increase of around COP$11 billion in loans. Even though loans increased throughout all the shown periods, it is reasonable to assume that at least part of the increase in loans observed during the second quarter of 2014 was funded by the sales of bonds, which was in turn triggered by JP Morgan's announcement. Notice that there is an increase in the average interest rate of loans during the third quarter of 2014, which was a result of an increase in the Central Bank´s rate 3.25% to 4.75% in September 2014.

Figure 1: Average interest rate of loans, and quarterly change in TES holdings and total loans.



Note: TES balances correspond to TES holdings by the 17 banks in our sample, as reported in their quarterly reports. The value of loans corresponds to all types of loans, not only to firms. The interest rate of loans is the average interest rate across all types of loans, excluding overnight loans, weighted by the value of each loan. The quarterly change of each variable is measured by the end date of each quarter. Source: Superfinanciera.

In our econometric analysis below, we exploit the correlation between loans and TES at the level of individual firms and banks. Specifically, we assume that the variation in the liquidity shock across banks

is exogenous, and use the pre-existing relationships between individual firms and banks as instrument to extract the exogenous firm-level credit shocks from the observed variation in new loans across firms. We then correlate this exogenous variation in loans with measures of firm performance to infer their causal effect.

Our instrumenting approach to extract the exogenous variation in loans is similar to the one in Khwaja and Mian [2008], Chava and Purnanandam [2011], Schnabl [2012] and Paravisini *et al.* [2015]. In Khwaja and Mian [2008], a large unexpected political shock is used to infer firm-level credit shocks in a sample of Pakistani firms, but they cannot link these shocks to measures of firm performance, due to lack of data. A similar approach is taken in Schnabl [2012] to estimate the effect of an international credit shock on bank-level loans in Peru. In Chava and Purnanandam [2011], an exogenous shock to the U.S. banking system is also connected to firm performance measures depending on their reliance on bank lending.

Our paper is closer to Paravisini *et al.* [2015], in which an estimated exogenous credit shock is connected with firm-level loan and trade data in a sample of Peruvian firms, with a focus on the effect of exports. In our case, we connect the exogenous shock with financial data of banks and firms, and with performance data of firms. We can therefore estimate the effect of credit shocks on a broad range of firm-level performance data including sales, investment, payroll and exports. We are not aware of any other paper that can trace the effects of a credit shock across such a range of firm-level variables.

Our paper is also related to a large body of literature that studies the effect of credit shocks on real activity at a macroeconomic level through what is called the banking channel, as in Bernanke [1983], Blinder and Stiglitz [1983], and Bernanke and Blinder [1992]. This literature studies the connection of monetary policy with bank liquidity and with the real economy, accounting for credit market imperfections. For example, recent papers by Becker and Ivashina [2018] and Altavilla *et al.* [2017]) study the effects of crowding-out and liquidity shocks on bank lending. Finally, there is also a broad trade literature that studies the determinants of firms' exports, including access to financing (see, for example, Paravisini *et al.* [2017]).

2.1 Data

Our firm-level data set has four components: First, we have the quarterly reports of banks containing the information about the banks' TES holdings and its change over time. Second, we have the confidential reports of banks to the financial regulator about each single loan they have. Third, we have the yearly financial reports and additional information reported by the universe of mid-size and big firms to the regulator of corporations. Fourth, we match these data to detailed firm-level information of exports, collected by the customs agency.

The first part of the data is public. All regulated financial institutions disclose publicly their TES holdings in their monthly financial reports. We focus on JPMorgan's announcement, which took place on March 2014, and focus on these holdings before and after the shock. Specifically, we will assume that the changes in these holdings between the first and second quarter of 2014 were an exogenous shock that provided the banks with an exogenous increase in liquidity.

The second part of the microdata set connects the liquidity shock with the lending activity of banks to firms. The Colombian financial regulator (called Superintendencia Financiera, henceforth Superfinanciera) collects quarterly information about every single loan issued by all regulated financial institutions using a standard format called *Formato 341*. Banks and other financial institutions report the balance of each loan, its interest rate, its start- and end-date, the identity of the debtor, its credit rating, among others. They also report the status of each ongoing loan. Again, we focus only on the loan data of the first two quarters of 2014, right around the time when the announcement of JP Morgan took place. We use the subsample of bank loans with positive balances and interest rate (i.e. we ignore loans by smaller specialized financial firms and credit cooperatives), and end up with 422.000 loans that correspond to 337.000 unique bank-firm relationships. Each of these bank-firm relationships contains a total balance and an average interest.

In order to trace the effects of loans on real activity, we match the banks' loans data with a third component of the data set, obtained from the regulator of corporations (called Superintedencia de Sociedades, henceforth Supersociedades), with yearly public financial information and additional confidential data of all the country's relatively big firms. We keep from this sample the set of firms that have active relationships with more than one bank in the second quarter of 2014 and for which all the income, payroll and investment data are available. The reason why we use only the firms with more than one bank relationship will become apparent when we explain our econometric approach.

We end up with a sample of 29.626 firm-bank observations corresponding to 8.640 firms and 17 banks. In Table 2 we show how the data set was put together starting from Superfinanciera data set in panel 1 with a total of 102.000 firms. Once we use only banks, as panel 2 shows, the number of firms reduces to 99.000. The merge between the Superfinanciera and Supersociedades data sets yields a total of 20.000 firms (panel 3), which reduces to almost 15.000 firms for which all the relevant information is available (panel 4). The data set reduces to the 8.640 firms in panel 5 with all relevant information and having relationships with at least two banks.

We have additional detailed export data obtained separately from the Colombian customs agency, which is the fourth component of our microdata set. These data links individual firms with the volume (in kg) and value (in USD) of their monthly exports. If we match this data set to the main data set and use only the firms with positive exports, we end up with a smaller sample of 2.245 firms, which is our most refined data sample. Notice that the firms in this reduced data set are much larger than average, as shown in panel 6 of Table 2.

When exploring the effects of the liquidity shock on exports, we will also consider alternative samples in which we only match the financial data of individual firms with their exports. When we use the sample of firms with positive exports, for which the financial data are available, the sample collapses to 3.700 firms with average loan balances that are substantially larger than average, as shown in panel 7 of Table 2. We also use a broader sample of more than 30.000 firms in exporting sectors, as shown in panel 8, when we use firms that belong to sectors with positive exports and for which their financial information is available in the Superfinanciera data set.

Table 1: Descriptive Statistics

	Debt (L)	*Revenue*	*Investment Property, Plant, and Equipment*	*Stock Property, Plant, and Equipment*	*Cost Direct Employees*	*Total Cost and Expenditures of Employees*	*Exports FOB (cop)*	*Number firms - banks*	*Number firms*
1. All loans : Banks and other financial institutions									
$L_{t=0}, Y^k_{t=0}$	1,369							186,443	102,599
$\Delta L, \Delta Y^k$	124								
2. Only Banks									
$L_{t=0}, Y^k_{t=0}$	1,286							167,140	99,786
$\Delta L, \Delta Y^k$	42								
3. Only banks, without outliers, firms with revenue information									
$L_{t=0}, Y^k_{t=0}$	3,876	25,127						49,353	20,094
$\Delta L, \Delta Y^k$	152	2,842							
4. Only banks, without outliers, firms with information for all performance variables									
$L_{t=0}, Y^k_{t=0}$	4,362	29,221	11,895	11,895	1,118	3,423		38,953	14,973
$\Delta L, \Delta Y^k$	180	2,057	5,613	1,122	46	164			
5. Only banks, with two or more loans at second quarter, firms with information for all performance variables									
$L_{t=0}, Y^k_{t=0}$	6,628	35,636	12,337	12,337	1,372	4,159		29,626	8,640
$\Delta L, \Delta Y^k$	279	3,082	3,309	691	51	193			
6. Only banks, with two or more loans at second quarter, firms with information for all performance variables and exports									
$L_{t=0}, Y^k_{t=0}$	12,547	78,862	31,433	31,433	2,219	7,918	2,403	8,548	2,245
$\Delta L, \Delta Y^k$	421	5,311	6,910	992	-55	199	697		
7. Only banks, with two or more loans at second quarter, firms with information of exports									
$L_{t=0}, Y^k_{t=0}$	11,441						1,995	13,074	3,738
$\Delta L, \Delta Y^k$	617						399		
8. Only banks, with two or more loans at second quarter, all firms at sectors with exports									
$L_{t=0}, Y^k_{t=0}$	3,572						243	88,466	30,662
$\Delta L, \Delta Y^k$	149						49		

Note: *Debt (L)* corresponds to the value of total outstanding debt of each firm with all banks; *Revenue* correspond to sales of firms, as reported annually at the end of the year; *Investment Property, Plant, and Equipment* corresponds to each firm's purchases and production of property, plant and equipment, as reported annually; *Stock of Property, Plant, and Equipment* is the book value of property, plant and equipment of each firm, as reported annually; *Cost Direct Employees* correspond to each firm's wages and salaries paid to direct employees; *Total Cost and Expenditures of Employees* correspond to each firm's total cost of direct and indirect labor; *Exports FOB* correspond to each firm's total exports in Colombian pesos. The last two columns of each panel show the number of loans, and firm-bank relationships for each subsample of data. All variables are in millions of Colombian pesos. Source: Superfinanciera and Supersociedades.

As indicated above, we will focus on the liquidity shock induced by the JPMorgan announcement described in Figure 1. This shock was spread differentially across banks, as shown in table 1. The table shows TES holdings by bank, before and after JPMorgan announcement. As shown, not all banks liquidated their TES holdings. In particular two big banks (Banco de Bogotá and Occidente) that belong

to the same bank holding increased their TES holdings. The other bank that increased substantially its TES holdings is Banagrario, which is the only government-owned bank that lends directly to the public and operates less as a profit maximizing entity than an instrument of public policy. As shown, there is a substantial heterogeneity in the changes of TES holdings across banks. This heterogeneity, which will be assumed to be exogenous, is an important source of variation that will allow the identification of causal effects of liquidity on the activity of firms that borrow from these banks.

We now turn to the econometric analysis in which we connect the liquidity shock to banks with both the credit activity of firms and their real performance.

Table 2. Distribution of Bank TES holdings

Bank	Feb-28	Jun-30	ΔTES
Av Villas	2.050	1.910	-0.140
BBVA	3.649	2.735	-0.913
Agrario	0.889	1.362	0.473
Caja Social	0.506	0.311	-0.195
Coomeva	0.008	0.012	0.004
Bogotá	3.578	3.819	0.241
Pichincha	0.094	0.106	0.012
Popular	2.015	1.772	-0.244
WWB	0.005	0.005	0.000
Bancolombia	6.800	3.689	-3.111
Citibank	1.908	2.008	0.100
Corpbanca	3.234	1.698	-1.536
Davivienda	3.444	2.862	-0.583
Colpatria	0.711	0.734	0.024
Occidente	2.141	2.698	0.557
Sudameris	2.762	2.530	-0.232
GNB Colombia	0.181	0.171	-0.009
Mean	1.998	1.672	-0.327
Sum	33.974	28.422	-5.552
Sum (March vs June)	35.826	28.422	-7.404

Note: TES holdings were obtained from banks' reports. Data in millions of Colombian pesos. Source: Superfinanciera

3 Econometric analysis

3.1 The econometric problem

We will focus for the estimation of the effects of the shock only before and after its occurrence and will therefore disregard time subscripts, except when needed. We will assume that the announcement by JPMorgan induced an exogenous change in bank-level holdings of TES by each bank b between the first and the second quarter of 2014, denoted as ΔTES_b. We are interested in estimating the effect of this shock on the evolution of firm-level loans between the first and second quarter of 2014 ΔL_i. Then we want to estimate the effect of this change on changes of firm-level activity between 2015 and 2014 ΔY_i.

We assume that the change in equilibrium economic activity ΔY_i of firm i depends on the endogenous change in the firm-level level of loans ΔL_i and other factors as follows:

$$\Delta Y_i = \Delta Y(\Delta L_i, X_i, \epsilon_i). \tag{1}$$

where X_i andϵ_i denote other relevant observed and unobserved factors, respectively.

The equilibrium change in firm-level loans $\Delta L_i = \sum_b \Delta L_{ib}$ is the sum of the change of each firm's loans across all banks. Each change depends on the firm's characteristics and each bank's exposure to the shock, ΔTES_b, which affects the loan level, but does not affect directly the activity of the firm. Let $\Delta L_i = \sum_b \Delta L_{ib}$ be the sum of changes in loans of each firm i with each bank b between the first and second quarter of 2014. The change in loans with each firm i with each bank b depends on firm-level factors and each bank's shock as follows:

$$\Delta L_{ib} = L(X_i, \epsilon_{ib}, \Delta TES_b), \tag{2}$$

where it is assumed that ΔTES_b is uncorrelated with ϵ_i.

The controls X_i and ϵ_i in (2) are the same as in (1). The presence of the unobserved variable in both equations, imply that the effect of loans on the firms' activity cannot be estimated directly from the correlation between ΔL_i and ΔY_i. Notice, though, that ΔTES_b serves as an exogenous shifter of the equilibrium change in loans, and in practice will be the basis of instruments used for estimating the causal effects of loans on firm activity.

In general, it is difficult to find in standard data sets instruments for the change in loans in order to estimate its effect on firm performance. In similar setups, Paravisini *et al.* [2015] and Khwaja and Mian [2008] use two different external financing crisis in Peru and Pakistan to extract from the data exogenous variation in firm-level debt. They assume that the ex-ante exposure of each bank to external financing and the bank's relationships with individual firms are exogenous. Therefore, the variation in loans across firms that was due to these ex-ante conditions is also exogenous and can be estimated from the data.

In the case of Khwaja and Mian [2008], these exogenous shocks to firm-level loans cannot be connected to measures of firm-level activity, since they don't have access to firm-level performance data. On the other hand, Paravisini *et al.* [2015] connect these exogenous changes in the loans of individual firms to

detailed export data. They can then estimate the causal effect of liquidity shocks on the exporting activity of firms.

In our case, we adopt similar assumptions, in the sense that we assume that the change in TES experienced by each bank and its relationships with individual firms are exogenous, conditional on the observed characteristics of firms. Moreover, we can connect the exogenous liquidity shock to a broad set of firm-level performance measures, including exports. Our estimation proceeds in two stages, in which we first obtain an estimate of the exogenous credit shock experienced by individual firms, and then estimate its effect on each firm's activity. As we explain below, it is not a standard IV estimation, because the instruments vary at the bank-firm level, whereas economic activity varies at the firm-level.

3.2 The econometric model

We want to estimate the effect of the exogenous change in bank liquidity given by the change in TES bond holdings ΔTES_b on the performance of firms. In the first stage, we estimate the effect of the shock on each firm's relationship with each bank as follows:

$$\Delta L_{ib} = g(\Delta TES_b * X_i) + h(X_i, \epsilon_{ib}), \tag{3}$$

where ΔL_{ib} is the change between the first and the second quarter of 2014 in the loans of each firm$i$ with each bank b. As we explain below, we can also add firm-level fixed effects that will absorb firm-specific unobserved attributes that do not depend on their relationships with specific banks.

The components $g(.)$ and $h(.)$ in (3) correspond to the portion of the variation in loans to firm i from bank b that are correlated with the exogenous shock ΔTES_b and with other variables, respectively. Estimation of (3) yields an estimated $\hat{g}_{bi} = \hat{g}(\Delta TES_b * X_i)$ which under the given assumptions is an exogenous change in loans and can be used to estimate the causal effect on economic activity.

To estimate this causal effect of loans on economic activity, we aggregate the predicted changes in firm-bank loans $\hat{g}_{bi}$ at each firm's level to obtain the predicted change in loans for each firm that was caused by the exogenous shock:

$$\hat{\Delta} L_i = \sum_b \hat{g}_{bi}. \tag{4}$$

This predicted change in firm-level loans depends only on the exogenous shocks ΔTES and does not depend on the unobserved variables ϵ that create the endogenous problem that we described above.

In the second stage of the estimation, we use the predicted change in loans (4) to estimate the causal effect of the shock on firm performance using (1):

$$E[\Delta Y_i^k] = f(\hat{\Delta} L_i), \tag{5}$$

where ΔY_i^k denotes the change in specific k measures of firm i economic activity reported in their financial reports in the end of 2013 and the end of 2014, which is the frequency of the available data. The use of this yearly also allows for the estimation to pick up effects of the shock on the performance of firms that take months to become effective.

The estimation framework that we have described is analogous to a standard two stage IV estimation. In the first stage, we obtain the exogenous variation in the loans, using the TES shock as an instrument. In the second stage, we use this exogenous variation to infer the causal effect of loans on firm activity. The non-standard feature of the problem, is that the data for the first stage is at the firm-bank level, whereas the data for the second stage is a the firm level.

In the following section we describe the details of the estimation of (3) and (5). We show the specification of the equations and the results.

3.3 Estimation and results

First stage: the effect of the shock on firm-level loans

In the first stage of our econometric analysis, we estimate the effect of the bank-level liquidity shock ΔTES_b on the loans of firms and other firm-level factors. We specify equation (3) as follows:

$$\Delta L_{ib} = [\gamma_1 \Delta TES_b + \gamma_2 \Delta TES_b * L_{it=0} + \gamma_3 \Delta TES_b * L_{ibt=0}] + [\rho_0 + \rho_1 L_{it=0} + \rho_2 L_{ibt=0} + \epsilon_i + \epsilon_{ib}], \quad (6)$$

where we condition the estimates on the initial level of loans of each firm with each bank $L_{ibt=0}$ and all banks $L_{it=0}$.

It is assumed that the initial loan levels of firms with the given bank and with all banks are predetermined, and are therefore also valid instruments when interacted with the change in each bank's TES holdings for estimating the effect of the shock on each firm's loans. The use of the predetermined specific relationship of firm i with bank b recognizes the fact that firms face different financial restrictions depending on their levels of debt with each bank and the whole banking system.

Notice that we have split the unobserved component of the regression in two parts, ϵ_i and ϵ_{ib}. In order to estimate the first firm-specific component as a fixed effect using the subsample of firms with relationship with more than one bank, described in panel 5 of Table 2. Even though this is a a first-differences regression that discounts firm-specific differences in demand for loans, the inclusion of fixed effects controls for firm-specific demand shocks that could bias our results, as discussed in Khwaja and Mian (2008). It should be noted that these fixed effects also controls for changes in any firm-level variable that may affect the demand for loans.

Using only firms that have relationships with more than one bank mitigates the potential problem that firms cluster by types in specific banks. If , for example,"good" firms are costumers of one bank, while "bad" firms are costumers of another bank, then our estimates would not necessarily reflect the causal effect of liquidity on firm performance, but some feature of the bank-firm relationship that is not part of our model.

The results of this estimation are shown in Table 3. We show four sets of results. The variable of interest is ΔTES_b which is the measure of the liquidity shock experienced by each bank. Column (1) shows the result for the OLS regression with no controls. For the models with controls and interactions in columns (2)-(4) we also show the marginal effect of ΔTES_b. The results in column (4) include all controls

and fixed-firm effects. Standard errors were computed via bootstrap iterations that were also used in the second stage of the estimation.

As shown in column (1), a decrease of COP$1000 million in the TES holdings of a bank is correlated with an average increase of COP$30 million in each firm's loans with the given bank. Once we add controls in columns (2)-(4), the estimated effect, shown as a marginal effect in the lower part of the table, becomes sharper and bigger in absolute terms. A decrease of COP$1000 million in the TES holdings of a bank is correlated with an average increase of COP$57-COP$90 million in each firm's loans with the given bank, conditional on controls.

Table 3. First stage: Effect of exogenous bank liquidity shock on firms' debt

	$\Delta L_{j,b}$	$\Delta L_{j,b}$	$\Delta L_{j,b}$	$\Delta L_{j,b}$
	(1)	(2)	(3)	(4)
ΔTES_b	-33.735**	22.423***	-2.919**	-0.837
	(17.734)	(1.532)	(1.248)	(0.923)
$\Delta TES_b \times L_{j,b,t=0}$		0.048***	0.071***	0.043***
		(0.0019)	(0.003)	(0.002)
$L_{j,b,t=0}$			0.082***	0.028***
			(0.004)	(0.003)
$\Delta TES_b \times L_{j,t=0}$		-0.019***	-0.021***	-0.013***
		(0.0007)	(0.0008)	(0.0005)
$L_{j,t=0}$			-0.007***	
			(0.0004)	
c	53.665**	38.879***	-40.188***	3.566
	(27.409)	(0.484)	(2.814)	(4.836)
Marginal effect		-92.821***	-87.454***	-57.91***
		(2.357)	(2.182)	(1.267)
Firm fixed effects	No	No	No	Si
N	29,626	29,626	29,626	29,626

Note: The table shows the results of regressions of firm-bank debt changes on instruments and controls as shown in each comumn. $\Delta L_{j,b}$ is the debt change of firm j with bank b between the first and second quarter of 2014; ΔTES_b is the change in TES holdings by bank b between the first and second quarter of 2014; $L_{j,b,t=0}$ is the debt of firm j with bank b at the end of the first quarter of 2014 ($t = 0$); $L_{j,t=0}$ is the the total debt of firm j with all banks at the end of the first quarter of 2014 ($t = 0$); $\Delta TES_b \times L_{j,b,t=0}$ is the interaction between the change of TES holdings by bank b and the debt of firm j with bank b at the end of the first quarter of 2014 ($t = 0$); $\Delta TES_b \times L_{j,t=0}$ is the interaction between the change of TES holdings by bank b and total debt of firm j at the end of the first quarter of 2014 ($t = 0$). Standard errors were computed via bootstrap iterations that were also used in the second stage of the estimation. $***p < 0,01$; $**p < 0,05$; $*p < 0,1$. Source: Superfinanciera an Supersociedades

As shown in columns (3) and (4), the predetermined relationship of each firm with each bank measured through the variable L_{ib} the growth of the firm's loans with the bank after the shock but attenuates the effect of the shock ΔTES_b on the firm's debt as indicated by the positive coefficient of the interaction $\Delta TES_b L_{ibt=0}$. On the other hand, as shown in column (3), the total debt of the firms with all banks

$L_{it=0}$ is associated with lower growth of loans, which might be a consequence of the higher credit risk of more indebted firms.

The effect of loans on firm activity

The first stage regression described above yields estimates of the portion of the observed variation in firm-level loans that is correlated with the exogenous shocks ΔTES_b, and therefore can be used to estimate the causal effect of the shock on firm level activity. In order to estimate this effect, we need to aggregate the predicted exogenous variation in firm-bank-level loans $\hat{g}_{bi}$ obtained from (6) to the firm level:

$$\hat{\Delta} L_i = \sum_b \hat{g}_{bi} = \sum_b \left[\hat{\gamma_1} \Delta TES_b + \hat{\gamma_2} \Delta TES_b * L_{it=0} + \hat{\gamma_3} \Delta TES_b * L_{ibt=0} \right]. \tag{7}$$

In other words, we subtract from the observed variation, the part that is explained by the initial characteristics of firms and keep only the part that is explained by the variation in bank-level TES holdings.

In the second stage of the estimation we regress the changes in several measures of firm-level changes in economic activity on the exogenous shock $\hat{\Delta} L_i$ obtained in (7) as described in (5). We focus on six variables: gross revenue, two measures of capital investment, two measures of labor input, and a measure of exports. We use the available yearly data that we described above and measure changes in these variables between the 2013 and 2014 year-end reports. Given our model and our econometric specification with controls for both the levels and the changes of unobserved firm-level factors, we interpret the covariation of $\hat{\Delta} L_i$ and these year-long measures of firm-performance as a causal effect of the exogenous change in loans on firm performance.

The estimated equation is a linear version of (5):

$$E[\Delta Y_i^k] = \beta_0 + \beta_1 \hat{\Delta} L_i, \tag{8}$$

where the superscript k in Y_i^k corresponds to each of the six activity measures. The regressor $\hat{\Delta} L_i$ is the predicted change in loans estimated in the first stage. In other words, we estimate the correlation of the change in firm-performance with the change in loans that was caused by the change in TES holdings across banks.

The results of the estimation are shown on Table 4. We show in columns (1)-(6) the results for each performance measure. For each one, we show three results, corresponding to the three different alternative estimates of $\hat{\Delta} L_i$ descibed in (2)-(4) of Table 3. Since the regressor in (8) is itself an estimate, we compute the standard errors bootstraping the sample through both stages of the estimation.

Column (1) shows the results for the change in Revenue; the results for measures of investment in columns (2) and (3) correspond, respectively, to total purchases of property and equipment (*Investment Property, Plant and Equipment*) and the net change in property and equipment (Δ *Stock Property, Plant and Equipment*); results in columns (4) and (5) correspond to the change in total payroll (Δ *Cost*

Direct Employees) and the change in total labor costs (Δ *Total Cost and Expenditures of Employees*), respectively. Column (6) shows the results for the change in Exports (FOB), measured in Colombian pesos.

Tabla 4. Second stage: Effect of firms debt change, related to banks' liquidity shock, over firm performance variables

	ΔRevenue	*Investment Property, Plant, and Equipment*	*Δ Stock Property, Plant, and Equipment*	*Δ Cost Direct Employees*	*Δ Total Cost and Expenditures of Employees*	*Δ Exports FOB (cop)*
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: First stage, column 2						
$\hat{\Delta}L_j$	2.083***	4.940***	1.997***	-0.026**	0.037***	764,026.4***
Std. Err.	(0.257)	(0.463)	(0.211)	(0.009)	(0.008)	(178,979)
Panel B: First stage, column 3						
$\hat{\Delta}L_j$	2.581***	5.461***	2.398***	-0.043**	0.029***	363,815.7**
Std. Err.	(0.229)	(0.473)	(0.218)	(0.008)	(0.007)	(95,302)
Panel C: First stage, column 4						
$\hat{\Delta}L_j$	2.657***	4.714***	2.233***	-0.044**	0.037***	-86,785.4
Std. Err.	(0.172)	(0.350)	(0.162)	(0.007)	(0.008)	(121,280)

Note: This table shows the results of regressions of measures of firm yearly performance during 2014 on the exogenous change in their debt $\Delta\hat{L}_j$, estimated in the first stage. $\Delta Revenue$ is the yearly sales change of firm j during 2014; $InvestmentProperty, Plant, andEquipment$ is firm's purchases and production of property, plant and equipment during 2014; $\Delta StockProperty, PlantandEquipment$ is the change in the book value of property, plant and equipment of firm j during 2014; $\Delta CostDirectEmployees$ is the change in the cost of wages and salaries of direct employees of firm j during 2014; $\Delta TotalCostandExpendituresofEmployees$ is the change during 2014 of the total cost of direct and indirect labor of firm j; $\Delta ExportsFOB$ is the change of total exports of firm j in Colombian pesos during 2014. Panel A shows the results of the estimation using $\Delta\hat{L}_j$ obtained from column (2) of table 3, Panel B uses $\Delta\hat{L}_j$ obtained from column (3) of table 3, and Panel C uses $\Delta\hat{L}_j$ obtained from column (4) of table 3. Standard errors were computed via bootstrap iterations that were also used in the second stage of the estimation. $***p < 0,01$; $**p < 0,05$; $*p < 0,1$. Source: Superfinanciera and Supersociedades

The results for exports in column (6) deserve an additional discussion. The first stage of the estimation is the same as in columns (1)-(5). For the second stage, we use the more refined subsample of firms shown in panel 6 of Table 2, containing the subset of firms with positive export data. We should add that we tried several alternative subsamples and the results were similar. In particular, we tried broader samples for firms and/or sectors in both the first and second stage of the estimation. To be consistent with the other results that we show, the results for exports are measured in Colombian pesos, but we also tried the available measures in US dollars and kg. The results of all these alternative estimations were consistent with the results that we show, and in many instances were even stronger. [1]

As shown, there is a significant effect of the exogenous shifts in loans on all considered measures of firm

[1] not shown, but available upon request

performance, almost across all specifications. There is a clear positive effect on revenue and investment, while the impact on labor and exports is less clear, as we discuss below. The result implies that firms that were relatively exposed to banks that experienced bigger increases in liquidity due to changes in their TES holdings during the second quarter of 2014, had a statistically different change in their performance between 2014 and 2013. This results is very important, because it shows that loans *per se* have an effect on firm performance.

We now turn to the actual effect of the observed aggregate liquidity shock associated with JPMorgan's announcement. To do so, we assess the impact of each bank's change in its TES holdings on their lending and the corresponding effect the additional loans on each firm's performance. This calculation yields the estimate of the causal effect of the exogenous liquidity shock on the economic activity of the firms in our sample. It will also clarify the magnitude and the economic significance of the estimates shown in Table 4.

We show the results of this calculations in Table 5. The table has two panels: the upper panel shows the mean (upper row) and the change (lower row) of the variables that we are interested in. The lower panel shows the predicted changes of these variables, using three different first-stage estimates from Table 3. The lower panel shows the variation en each variable that we estimate was caused by the exogenous shock.

Each column in the table corresponds to one variable. Column (1) show the mean and the change between the first and second quarter of 2014 of loans across the firms in the sample. As shown, the mean loan level of firms in the sample at the end of the first quarter of 2014 was COP$6.6 billion, and its change over the following quarter was COP$279 million. Notice that these number correspond to the sample described in Panel 5 of Table 2.

As shown in the same column (1) of the table in the lower panel, we estimate that the variation in the firm-level change in loans that was due to the exogenous shock ranges from COP$74 million to COP$140. In other words, between 26% and 62% of the observed variation in firm-level loans we estimate to be caused by the bank-level liquidity shock. The higher estimate corresponds to the first-stage regression in which we do not control for the initial loan levels of firms and we do not control for firm-level fixed effects (Table 3, column 2). The lower estimate, which is still economically significant, uses all available controls (Table 3, column 4).

Columns (2)-(7) correspond to the measures Y^k of firm performance that we used to obtain the results in Table 4. The upper panel shows the yearly mean and yearly mean 2014-2013 change for each measure of performance of the firms in the sample, which as indicated corresponds to the descriptive statistics of the sample in Panel 5 in Table 2.

As shown, we estimate that the liquidity shock had a positive effect on the revenue of firms. During the year, the firms in the sample had an increase of COP$3 billion, which is around 8% of their average revenue in 2013. We estimate that between COP$195 million and COP$292 of this yearly increase was caused by the exogenous shock that took place during the second quarter of the year. In other words, the liquidity shock caused an increase of around 0.5% and 0.8% in the firms' revenue.

Table 5. Observed and predicted changes in debt and measures of firm performance.

	Debt (L)	*Revenue*	*Investment Property, Plant, and Equipment*	*Stock Property, Plant, and Equipment*	*Cost Direct Employees*	*Total Cost and Expenditures of Employees*	*Exports FOB (cop)*
Panel A: Debt and firm performance variables (average) before shock							
$L_{t=0}, Y^k_{t=0}$	6,628	35,636	12,337	12,337	1,372	4,159	2,403
Panel B: Average change (levels) of debt and firm performance variables between before and after the shock							
$\Delta L, \Delta Y^k$	279	3,082	3,309	691	51	193	697
Panel C: Average shock effect, first stage column 2							
$\hat{\Delta} L, \hat{\Delta} Y^k$	140	292	693	280	-3.8	5.3	240
Panel D: Average shock effect, first stage column 3							
$\hat{\Delta} L, \hat{\Delta} Y^k$	103	266	563	247	-4.5	3.0	63
Panel E: Average shock effect, first stage column 4							
$\hat{\Delta} L, \hat{\Delta} Y^k$	74	195	347	164	-3.3	2.8	-11

Note: Panel A and B show the initial observed level and the observed change in in the included variables. Panel C, D and E show the change in the variables predicted by different specifications of the model. $L_{t=0}$ is average debt of firms at the end of the first quarter of 2014; $Y^k_{t=0}$ is average level of each firm' performance variable in the end of 2013; ΔL is the average change in firm debt between first and second quarter of 2014; ΔY^k is average change of each firm's performance variable between 2013 and 2014, as reported in their annual reports. $\hat{\Delta L}$ and $\Delta \hat{Y}^k$ correspond to the predicted change in debt and the performance variables as predicted by the model. Variables are in millions Colombian pesos. Source: Superfinanciera

We estimate that the more sizeable effect of the shock occurred on the firms' measures of capital investment. Table 5, columns (3) and (4) show the initial level and the gross and net change in the measure of capital, respectively. The data in column (3) indicate that the average gross purchases of physical capital were COP$3.3 billion or around 25% of its initial level. Our estimates, shown in the lower panel of the table, show that the exogenous shock caused between COP$347 million and COP$693 millions of this increase, so that the shock explains between 10% and 20% of the observed increase.

Similarly, as shown in column (4), the data show that the mean net increase in physical capital reported by the firms in the sample was COP$691 million, of which between COP$164 million and COP$280 million were explained by the shock, which correspond to 23%-40% of the observed change. In other words, the exogenous shock explains a substantial part of the observed investment of firms in the sample.

The estimated effects of the shock on measures of labor hiring are not significant in economic terms, as shown in columns (5) and (6). As indicated in the upper panel, the yearly increase for the firms in the sample during 2014 in total payroll (column 5) and total labor costs (column 6) were 3.7% and 4.6%, respectively. This increase is low when compared with the changes in the measures of capital, even without accounting for the effect of the shock. According to our estimates, the effect of the shock on these measures of labor hiring, shown in the lower panel, are virtually zero.

The effects of the shock on exports are very much in line with the revenue results. In the smaller

sample of firms with positive exports during the year, the average value of exports increased COP$697 million or around 30%. Of this average increase, the shock generated a *decrease* of COP$11 million or an increase of up to COP$240 million. We have indicated, that the estimated effect of the shock on exports is sensitive to the specification of samples, but a deeper analysis is beyond the scope of this paper. Suffice it to say, that whatever effect the shock had on exports is small compared to the effect it had on investment in physical capital.

To summarize, we find strong effects of the exogenous liquidity shock on the investment of firms on physical capital. The estimated causal effect is at least 10% and up to 20% of observed gross investment, or at least 23% and up to 40% of observed net investment. Since we find a positive effect of the shock on firms' revenue but not on firms' labor, we conclude that increased sales were achieved through increases in capital, but not in labor.

4 Concluding remarks

We have estimated the effects on the performance of firms of an unexpected shock that increased the liquidity of Colombian banks in 2014. We took advantage of the fact that the shock affected banks differentially and that these banks had business with different firms.

We find first that the shock explains a substantial part of the quarterly increase in firm-level loans. This increase in firm level loans, in turn, had a significant positive effect on firms' revenue throughout the year 2014. We find that this increase in revenue, is mostly explained by increases in capital investment. We find no evidence that the shock had any effect on labor hiring.

In other words, we estimated a statistically and economically significant causal effect of an aggregate liquidity shock on the performance of firms. In the given context, increased liquidity increased the investment and the revenue of firms. This finding is a significant contribution to the literature that connects financing and economic activity, which is crucial for the design of policies by governments and central banks.

References

Carlo Altavilla, Marco Pagano, and Saverio Simonelli. Bank exposures and sovereign stress transmission. *Review of Finance*, 21(6):2103–2139, 2017.

Bo Becker and Victoria Ivashina. Financial repression in the european sovereign debt crisis. *Review of Finance*, 22(1):83–115, 2018.

Ben Bernanke and Alan Blinder. The federal funds rate and the channels of monetary transmission. *The American Economic Review*, 82(4):901–921, 1992.

Ben S Bernanke. Non-monetary effects of the financial crisis in the propagation of the great depression. Technical report, National Bureau of Economic Research, 1983.

Alan S Blinder and Joseph E Stiglitz. Money, credit constraints, and economic activity. *The American Economic Review*, 73(2):297–302, 1983.

Sudheer Chava and Amiyatosh Purnanandam. The effect of banking crisis on bank-dependent borrowers. *Journal of financial economics*, 99(1):116–135, 2011.

Rajkamal Iyer and Jose-Luis Peydro. Interbank contagion at work: Evidence from a natural experiment. *The Review of Financial Studies*, 24(4):1337–1377, 2011.

Anil K Kashyap, Jeremy C Stein, and David W Wilcox. Monetary policy and credit conditions: Evidence from the composition of external finance: Reply. *The American Economic Review*, 86(1):310–314, 1996.

Asim Ijaz Khwaja and Atif Mian. Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review*, 98(4):1413–1442, 2008.

Daniel Paravisini, Veronica Rappoport, Philipp Schnabl, and Daniel Wolfenzon. Dissecting the effect of credit supply on trade: Evidence from matched credit-export data. *The Review of Economic Studies*, 82(1):333–359, 2015.

Daniel Paravisini, Veronica Rappoport, and Philipp Schnabl. Specialization in bank lending: Evidence from exporting firms. Technical Report 1492, Centre for Economic Performance, LSE, 2017.

Joe Peek and Eric S Rosengren. The international transmission of financial shocks: The case of japan. *The American Economic Review*, pages 495–505, 1997.

Philipp Schnabl. The international transmission of bank liquidity shocks: Evidence from an emerging market. *The Journal of Finance*, 67(3):897–932, 2012.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