Real Effects of Credit Supply Disruptions: The Case of 2011 Embezzlement Scandal in Iran

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Abstract

In this paper we study the effect of credit market disruptions on real decisions in a firm. We use firm-level data on employment for a sample of Iranian public firms. We construct a new hand-collected dataset on bank-firm relationship. As for the source of credit supply disruption, we use the 2011 Iranian banking fraud that impacted the credit access for connected firms. Using a difference in difference approach, we compare how employment is affected by credit supply for the impacted firms (connected to a troubled bank) vs. non-impacted ones (connected to a non-troubled bank). Our findings show that a sudden dry up in the credit supply channel is followed by a drop in employment, especially in smaller and more financially constrained firms. Our results signify the hidden costs of financial scandals and the importance of the credit supply channel on the real side of the economy.

Keywords: credit supply channel, embezzlement, bank fraud, bank-firm relationship, employment

JEL Classification: E24, E44, G20

1 Introduction

Do negative shocks to the banking sector impact the real side of the economy? How do credit market frictions play a role in transmitting credit supply shocks to employment? And if so, what types of firms suffer more job losses as a result of disruptions in credit supply channel? In this paper, we answer these questions using firm-level employment and financial data for companies listed on the Tehran Stock Exchange. In the case of Iran, these are particularly timely questions given the new initiatives on banking reform by the Central Bank of Iran.

The structure of the credit market in the Iranian economy provides an ideal setting to study the impact of credit disruptions on the real side of the economy. Iranian firms are highly dependent on the banking system as their source of credit supply. Other sources of financing, such as the stock and bond markets are relatively underdeveloped and therefore relatively small. Based on the estimates by an Iranian investment bank, Sepehr, in 2011, the banking system provided 85 percent of the total financing while the stock and bond markets collectively had a 15 percent share. Similarly, according to World Development Indicators database in 2011 the ratio of domestic credit to private sector provided by banks as a percentage of GDP in Iran was 53 percent, while the ratio of domestic credit provided by the financial sector also as a percentage of GDP was 55 percent. Moreover, the majority of Iranian public companies are small and medium size enterprises that are highly levered with an average debt-to-asset ratio of 59 percent.

Inspired by Chodorow-Reich (2014), our identification strategy exploits a plausibly exogenous shock to credit availability to Iranian public firms as a result of the 2011 Iranian embezzlement scandal. We show that following the 2011 scandal, there has been a significant drop in credit supply by the six banks that were hit by the embezzlement crisis. To the extent that their client firms depend on the credit supplied by those banks, this shock can potentially impact the real outcomes such as production, investment and employment in those firms. Therefore, we compare employment in firms that had borrowed from those six banks before the crisis with firms that had borrowed from other banks.

The validity of our identification strategy hinges on two implicit assumptions. First, the borrower-lender relationship is a sticky relationship that makes substituting financing sources costly during the crisis time. Therefore, we expect to observe a more severe impact on employment for the firms that rely more on this relationship. The second assumption is that there

is no selection in receiving the embezzlement shock. That is, the six banks that were involved with the embezzlement scandal were similar to the rest of the banks that were not.

To establish that the embezzlement crisis resulted in lending contraction in the six impacted banks, we first show a decline in measures of credit supply for those banks versus other banks. Using a difference in difference approach, we show that the share of the credit provided by each of the six banks of the total credit provided by all banks drops by 1.3% to 1.8% after the crisis. Similarly, when we measure credit supply by credit-to-asset ratio, again we observe a credit dry up of 5.7% to 7.9% for the impacted banks versus others. This confirms the significance (both economically and statistically) of the credit disruption following the 2011 embezzlement scandal.

Next, we investigate if the credit supply disruption in those banks resulted in job losses in their client firms. Again, using a difference in difference approach, we show a 6.5% to 8.4% gap in employment growth in firms connected to the troubled banks compared to the firms that were connected to non-troubled banks. Given that the time window of six years from 2008 to 2014 around the crisis event, this translates into an average annual gap of 2.2% to 2.8%. These figures are highly significant when compared to the average annual employment growth rate of 1.2% in our sample.

Finally, to identify which companies were hit harder by the crisis, we re-estimate our empirical model in subsamples formed based on firm characteristics. Economic theory suggests that firms that depend more on banks' credit channel or equivalently have more limited access to other financing sources would suffer more at the crisis time. Thus, we first split our sample into financially constrained and unconstrained based on a financial constraint measure developed by Whited & Wu (2006). Our results show that the impact among financially constrained firms is at least 5 times as large as the uncontained sample. Second, we split our sample into small and large firms because as pointed out by Gertler and Gilchrist (1994) smaller firms are more vulnerable to credit disruptions. Likewise, our estimation results indicate that the impact on smaller firms is at least 4 times greater than larger firms. More importantly, in both cases the impact is highly statistically significant in the subsamples predicted by economic theory, smaller and financially constrained firms, but not statistically significant in other subsamples.

While we are not the first to establish the link between the real side of the economy and credit supply shocks[1], to the best of our knowledge, we are the first to use bank fraud as a source of credit supply disruptions. Moreover, our paper is the first to study the link between the credit supply channel and the real side of the economy for the MENA region. Other studies on the banking sector in the MENA region tend to focus on efficiency and banking performance (Olson and Zoubi (2011)), competition in banking industry (Turk-Ariss, R. (2009) and Abuzayed et al (2012)), the impact of different types of ownership (Farazi et al., 2011), and the effects of the global financial crisis on the banking system (Caporale et al (2017)). In addition, our paper documents the indirect social costs of fraud in the banking industry and identifies where those costs are the highest.

The rest of the paper is organized as follows. In Section 2, we provide a survey of related paper. In section 3 we outlay the 2011 Iranian embezzle scandal. Section 4 describes the data we use. Section 5 lays out our empirical model and in Section 6 we present our estimation results. Section 7 concludes.

2 Background

This paper is closely related to the bank lending channel literature. This literature has expanded considerably since the financial crisis of 2008, as both policy makers and academic scholars felt the need to understand the effect of financial crisis and credit crunch on firms' decisions and their behavior during the subsequent recovery. Several studies employ the bank-firm matched loan data to identify the bank lending channel and examine the impact of a credit shock on corporate policies, most notably investment.

Prior to the 2008 financial crisis, Peek and Rosengren (1997) exploited the sharp decline in Japanese stock prices in the 1990s and its impact on the lending behavior of Japanese banks in the U.S. Their purpose was to identify a loan supply shock in the U.S. that is independent of the U.S. loan demand. They found that the U.S. branches of Japanese banks significantly reduced their lending to the U.S. firms in response to the decline in Japanese stock values and the subsequent declines in their parents' capital positions. Sloving et al (1993) studied the near failure of the Continental Illinois Bank and its rescue by the FDIC in 1984 to analyze share price

[1] See section 2 for a list of papers studied the real effects of credit supply shocks.

effects on the borrowing firms. They found that firms with lending relationships with Continental Illinois experienced an excess return of – 4.2% during the bank's impending insolvency.

Outside the U.S., Khwaja and Mian (2008) identified the effect of credit supply shocks on firms by exploiting the cross-bank liquidity variation caused by unanticipated nuclear tests in Pakistan during the political tensions with India in 1998. Using firm fixed effects, they compare the same firm's loan growth from different banks with varying exposure to the liquidity shocks. They found that small firms face large drops in borrowing and increased financial distress, while large firms with strong business or political ties are able to compensate for the loss by additional borrowing from alternative financing channels. More recently, Amiti and Weinstein (2018) study Japanese bank-firm relationships over a twenty-year sample period (1990 - 2010) and propose a new method to decompose demand and supply shocks to credit. They find that bank supply shocks explain 30 - 40 percent of aggregate loan and investment fluctuations.

We now have an extensive literature that has focused on the 2008 financial crisis and subsequent recovery to study the effect of bank health on lending and corporate policies. Ivashina and Scharfstein (2010) document a sharp decline in bank lending following the failure of Lehman Brothers in 2008, in particular among banks with more short-term financing and higher exposure to Lehman through co-syndicated credit lines. Chodorow-Reich (2014) uses the Lehman bankruptcy as a source of exogenous shock to lender health, and reviewing a large sample of nonfinancial firms finds that between one-third and one-half of the employment decline at small and medium firms in the year following the Lehman bankruptcy can be explained by decline in credit. His results are consistent with Duygan-Bump, Levkov and Montoriol-Garriga (2015) who find that small firms in industries with more external finance dependence, and hence more credit constraints, were one of the main drivers of the high rate of unemployment that followed the financial crisis (See also Greenstone et al 2014).

Finally, several studies examine credit supply shocks and economic outcomes during the sovereign debt crisis in Europe. Acharya et al (2018) explore the value impairment in European banks' assets caused by their exposure to sovereign debt during that crisis. They find that crisis-induced losses in their sovereign bond holdings forced banks to significantly reduce their loan supply, which in turn affected investment, employment, and sales growth of firms affiliated with affected banks. Similarly, Balduzzi, Brancati, and Schiantarelli (2018) use banks' financial

market valuations as measures of bank funding costs for Italian banks during the financial and sovereign debt crises and find that lower equity valuations and higher bank CDS spreads resulted in lower investment, employment and bank debt among borrowing firms. Cingano, Manaresi, and Sette (2016) provide similar evidence by studying Italian firms that borrowed from banks affected by the sharp liquidity drought in the interbank market. They document negative impact on firm investment, value added, employment and input purchases. Similar evidence has been documented for Spain, (Bentolila et al, 2018), Germany (Popov and Rocholl, 2018 and Dwenger et al, 2018) and Belgium (Cornille et al, 2018).

Our paper is also broadly related to the papers that exploit natural experiments to study the role of access to finance on economic outcomes, including employment. Gilje (2017) exploits exogenous shocks to local credit supply caused by shale recoveries at the county level in the U.S. He finds that the number of business establishments increases in industries that are more dependent on external finance. The effect is found to be stronger in counties dominated by small banks with limited access to the deep internal capital markets available to large banks. Mayordomo and Rodríguez-Moreno (2018) study the introduction of SME Supporting Factor in capital requirement regulations in the EU in 2014. Using bank-firm matched data in Spain, they provide evidence that banks granted more loans to medium-sized firms to optimize their regulatory capital, but did not increase lending to smaller firms to control their credit exposure. Boustanifar (2014) examines different episodes of banking reforms in the U.S. to analyze the impact of access to credit on employment growth (See also Benmelech, Bergman and Seru, 2015).

3 2011 Embezzlement Scandal

In this paper we estimate the effect of credit supply on employment by exploiting the natural experiment created by the 2011 embezzlement scandal that involved six Iranian banks[2]. Of the six banks, two (Parsian and Saderat) were listed on the Tehran Stock Exchange (TSE) and the other four were non-listed. In terms of ownership structure, three banks (Meli, Sepah and Refah) were state-owned banks, one (Saderat) was partially owned by the government, and the other two were privately owned. The Iranian financial system is characterized by high dependence on bank finance and a relatively underdeveloped capital market. In 2011, the banking system provided 85 percent of the total financing, and the stock and

[2] The major banks involved with embezzlement scandal are Saderat and Melli. Other smaller banks are Sepah, Refah, Parsian and Saman.

bond markets collectively had a 15 percent share[3]. The government exerts significant control on the banking system both by full or partial ownership in (primarily larger) banks and by extensive intervention in the banking system, including interest rate ceilings and imposing quotas on bank credit supply to different sectors. Until 1999, only state-owned banks were granted license by the central bank, but since then, several privately owned banks have also obtained license. The government started to partially privatize some of the state-owned banks (including Saderat Bank) in 2009 by listing them on the TSE, but retained a stake of at least 20 percent.

The embezzlement occurred through a scheme devised by a businessman, Mahafarid Aria, to exploit the lax regulation and supervision of domestic Letters of Credit (LC) in the banking system. Through the scheme, the buyer, a company owned (indirectly) by Mr. Aria, would approach Saderat Bank, one of the major banks involved in the embezzlement, to open an LC to make payment for a product purchased from a seller, another company also owned (indirectly) by Mr. Aria. The buyer would be required to pay its obligations to the bank a few months later. The buyer would in turn sell the buyer's obligation to other banks (hereafter, "discount banks") at a discount reflecting the time value of the LC funds. The discount banks would pay the seller, for the purchase amount. At the payment due date, the buyer opened a new LC using forged documents to finance a fake purchase from the seller, only to repay its obligations to Saderat Bank and be able to continue the scheme. Figure 1 illustrates the scheme behind the embezzlement.

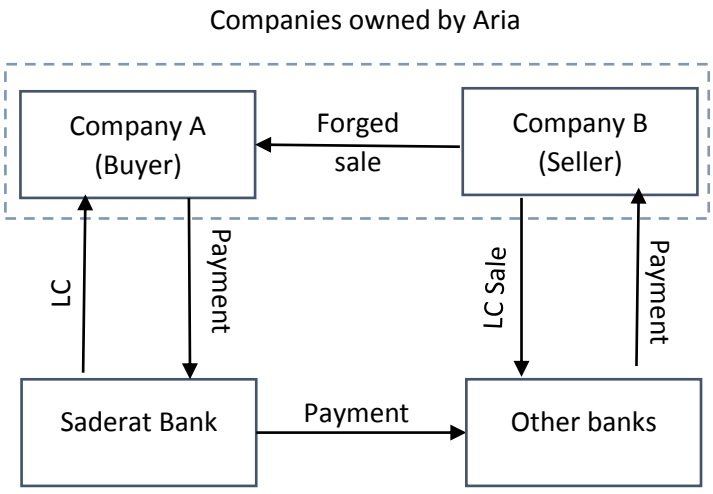

Figure 1: Embezzlement scheme

[3] Zareh, B., Investment Banking Challenges in Capital Market, Sepeher Investment Banking, 2013

The lack of proper internal controls within the involved banks and the weak supervision by the Central Bank of Iran allowed Aria to tunnel approximately 30 trillion Rials through this scheme over a four-year period. To put this into context, the amount was equivalent to approximately $943.5 million (using 2011 Rial to USD exchange rate), which is equivalent to 24% of the six banks' capital at the time. The scheme was eventually discovered in September 2011 and was called by the head of the General Inspection Office of Iran as "the most unprecedented financial corruption case in the history" of Iran. In response to the scandal, the CEO of Saderat Bank stepped down and the CEO of Melli Bank, the largest Iranian bank, fled the country. Mr. Aria was also convicted and finally executed. In response to the scandal, the banks involved in the scheme were under intense scrutiny, and anecdotal evidence suggests they significantly curtailed lending. We exploit this plausibly exogenous shock to credit supply to study employment in companies with borrowing relationships with these banks.

4 Data

We construct a matched bank-firm data set linking 160 Iranian public companies to virtually all Iranian banks between 2007 and 2014. Financial data for Iranian public firms are obtained from Rahavard. Rahavard collects firm-level financial information on companies listed on the Tehran Stock Exchange (TSE) from their filings with the Securities and Exchange Organization (SEO), the Iranian equivalent to the SEC in the US. Data on financial statements of Iranian private and public banks are obtained from the Iran banking Institute database. Employment data at firm-level and bank-firm loan data are hand collected from financial statement footnotes filed with SEO and available on Codal website[4]. Finally, CPI data comes from the Economic Statistics database on the Iranian Central Bank website[5].

We start constructing our sample with 260 Iranian non-financial public companies for which financial data is available between 2007 and 2014. **Error! Reference source not found.** provides a descriptive statistics for this sample.

[4] https://www.codal.ir/
[5] https://www.cbi.ir/section/1372.aspx

Variables	N	Mean	Std. Dev.	Min	Max
Debt/Assets	1,073	0.589	0.175	0.11	0.98
Interest Expense/Debt	1,009	0.150	0.075	0.00	0.49
Payable/Assets	1,073	0.178	0.121	0.01	0.92
Receivable/Asset	1,073	0.248	0.160	0.00	0.80
Log(Employment)	1,067	5.970	1.109	1.39	10.13
Employment Growth	968	0.012	0.26	-0.78	586
Log(Real Sales)	1,064	7.548	1.466	2.31	13.01
ROA	1,071	0.130	0.119	-0.24	0.63
Age	1,059	21.91	8.50	7	51

Table 1. Descriptive Statistics of 260 Iranian Public Firms from 2007 to 2014. For variable definitions, see the Appendix table. Real sales are calculated by deflating nominal sales by the CPI deflator with the 2004 base year.

Next, we merge this sample with the hand collected firm-bank dataset. As a result, the sample size shrinks to 160 because of data availability on firm-bank relationships. It is important to note that for each of the 160 firms, what we learn from matching a borrower (firm) to a lender (bank) is information on the firm's remaining loan balances with each bank at the end of the fiscal year. Therefore, this data set only provides a snapshot of the loans and not the whole flow. For example, in 2010 the top three lenders to Isfahan Steel Company were Pasargard Bank with 2,377 billion Rials, Export Development (Tose-e-Saderat) Bank with 1,150 billion Rials, and the Bank of Nation (Mellat) with 1,090 billion Rials. Other major lenders include Parsian Bank, Meli Bank, Bank of Industry and Mine, and Export Bank (Saderat), which together had a balance of 1,365 billion Rials at the end of the year.

Error! Reference source not found. compares the same characteristics as in **Error! Reference source not found.** for firms whose primary lender before the 2011 embezzlement was one of the banks impacted by the scandal vs. firms that were linked to non-impacted (non-troubled) banks. A t-test for mean comparison reveals that the firms in the first group are larger in terms of both number of employees and sales, have higher leverage ratios, and are less profitable. We control for these differences by using those characteristics as control in our regression analysis.

	Linked to a Troubled Bank			Linked to a Non-Troubled Bank				
Variables	N	Mean	Std.	N	Mean	Std.	Diff.	t-stat
Debt/Assets	429	0.621	0.16	102	0.512	0.163	0.109	6.131***
Interest Expense/Debt	414	0.135	0.066	93	0.14	0.091	-0.01	-0.51
Payable/Assets	429	0.173	0.111	102	0.172	0.105	0.001	0.095
Receivable/Asset	429	0.255	0.158	102	0.229	0.143	0.026	1.622
Log(Employment)	425	6.103	0.971	101	5.454	1.271	0.649	4.808***
Log(Real Sales)	428	7.754	1.34	98	7.121	1.676	0.633	3.492***
ROA	429	0.115	0.109	101	0.146	0.111	-0.03	-2.51***
Age	429	22.671	8.971	96	18.458	4.374	4.213	6.773***

Table 2. Comparison of Firm Characteristics for Firms Connected to a Troubled vs. Non-Troubled Bank. The table report the results of a mean comparison t-test for the two samples of firms that are connected to troubled and non-troubled banks. The sample covers 2007 to 2014. For variable definitions, see the Appendix table. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively

To verify the magnitude of the credit shock due to embezzlement, we also collect data from the balance sheets of lenders. **Error! Reference source not found.** provides a summary statistics for virtually all Iranian banks between 2007 and 2014.

Variable	N	Mean	Std. Dev.	Min	Max
Credit/Credit by All Banks	188	0.037	0.044	0.00	0.190
Credit/Assets	188	0.599	0.170	0.01	0.879
ROA	188	0.016	0.019	-0.035	0.096
Liquid Asset Ratio	188	0.190	0.099	0.026	0.840
Capital /Asset	188	0.139	0.159	0.00	0.886
Loan/Deposit	187	1.050	0.761	0.022	4.805
Non-Performing Loans Ratio	188	0.128	0.095	0.00	0.47
Ln(Real Assets)	188	5.82	1.35	2.53	8.09

Table 3. Descriptive Statistics of Iranian Banks from 2007 to 2014. For variable definitions, see the Appendix table.

The first two variables are our measures when evaluating the impact of embezzlement on credit supply in the next section.

5 Empirical Strategy

Our identification strategy includes two steps. The first step consists of establishing the existence of a dry up of the credit supply associated with embezzlement-troubled banks. The second step consists of estimating the impact on employment of credit dry up in firms connected to troubled banks and comparing it to employment in firms associated with non-troubled banks.

5.1 Identification of the Credit Dry up

We begin by estimating the following credit change equation for each bank using a difference in difference approach:

$$Credit_{bt} = \beta_0 + \beta_1 Post_t + \beta_2 Emb_b + \beta_3 Post_t \times Emb_b + \beta_4 Controls_{bt} + \gamma_t + \epsilon_{bt} \quad (1)$$

where $Credit_{bt}$ is a measure of total credit provided by bank *b* in period *t*, proxied by either bank *b* share of total credit supplied by all banks in period *t* or the credit-to-asset ratio for bank *b* in period *t*. Emb_b is a dummy (treatment) variable that takes the value 1 if bank b is a troubled bank due to embezzlement, $Post_t$ is also a dummy variable that switches on in periods after embezzlement, namely after 2011, $Controls_{bt}$ is a vector of bank controls including lags of *ROA, Liquid Asset Ratio, Capital Ratio, Loan-to-Deposit Ratio, Non-Performing Loans (NLP) Ratio,* and *Bank Size (logarithm of real value of total assets),* $\gamma_t$is the year fixed effect, and ϵ_{bt} is the error term.

Equation (1) captures any shocks to the credit supply for troubled versus non-troubled banks. If there is a dry up as a result of the 2011 embezzlement, we expect to observe a negative and significant coefficient for the interaction term, β_3. The sample includes all 30 Iranian banks between 2008 and 2014.

5.2 The Employment Impact of Credit Dry up

Next, we proceed to estimate the impact of credit supply dry up on employment. Our difference in difference identification strategy is based on a comparison of two firms in the same industry and in same year for which the credit supply differs because of embezzlement. This ensures that our estimates are not driven by observable firm characteristics. Specifically, we estimate the following equation:

$$Emp_{it} = \beta_0 + \beta_1 Post_t + \beta_2 LTB_i + \beta_3 Post_t \times LTB_i + \beta_4 Controls_{it} + \gamma_t + \delta_I + \epsilon_{it} \quad (2)$$

where Emp_{it} is the natural logarithm of number of employees in firm i in period t. LTB_i (Linked to a Troubled Bank) is a dummy (treatment) variable that takes the value 1 if firm i is a borrower of a troubled bank in 2010 (pre-treatment), $Post_t$ is also a dummy variable that switches on in periods after embezzlement, namely after 2011, $Controls_{it}$ is a vector of firm controls including lags of *Emp, Size (logarithm of real value of sales), Profitability Ratio, Age, Average Emp in industry*, $\gamma_t$is the year fixed effect, δ_I is the industry fixed effect, and ϵ_{bt} is the error term.

Equation (2) measures the impact of credit supply shock on employment by comparing the employment growth rate[6] before and after embezzlement between firms that had established a link prior to 2011 to troubled banks and the firms that did not. If the credit dry up in a troubled bank lowers the employment in connected firms, we expect a negative and significant coefficient for the interaction term, β_3. The sample here includes all 160 public Iranian firms between 2008 and 2014 for which we can observe a lender-borrower relationship.

6 Results

In this section we present the estimation results for both the credit dry up, equation (1), and its impact on employment, equation (2). Overall, our results confirm that the credit dry up resulting from the 2011 embezzlement, resulted in employment loss in firms connected to those banks. To identify where the results are stronger, we also re-estimate the employment model in subsamples.

6.1 Credit Dry up Results

In this subsection we investigate whether the 2011 embezzlement scandal resulted in a credit dry up in impacted banks or not. To do this, as illustrated in equation (1), we compare the lending pattern for banks that are involved with the embezzlement versus those that are not before and after 2011.

Error! Reference source not found. reports the estimation results for equation (1). Year fixed effects are included in all specifications to control for macro events that potentially impact the banking industry. Bank fixed effects are also included in all specifications to control for unobservable bank characteristics that may impact its lending behavior (e.g., public versus private banks). In columns 1 and 2, the dependent variable, bank credit, is measured by the share of the credit provided by bank b of total credit provided by the banking sector in each year.

[6] Note, change in logarithm of employment is approximately equal to the employment growth rate.

Results in columns 1 and 2 of **Error! Reference source not found.** confirm a significant credit dry up in impacted banks. In column 1, the estimated value for the coefficient for the interaction term, β_3, shows that after the scandal the credit share of impacted banks dropped by 1.8% more than other banks, which is statistically significant with a p-value less than 0.01. This result is robust to adding controls in column 2, although the estimated impact drops from 1.8% to 1.3%. Similarly, the result is robust to alternative measures of bank credit. In columns 3 and 4, in which bank credit is measured by the credit to asset ratio for each bank, again the estimated coefficient for the interaction term ranges from 5.7% to 7.9% with and without control variables, both statistically significant with p-values less than 0.01.

Dependent Variable:	Credit Share of Bank		Credit-to-Assets Ratio	
	(1)	(2)	(3)	(4)
$Post_t$	0.0012	-0.0019	0.026*	0.0039
	(0.0020)	(0.0021)	(0.0130)	(0.0120)
Emb_b	0.058***	0.036***	-0.071*	-0.065*
	(0.0058)	(0.0067)	(0.0400)	(0.0370)
$Post_t \times Emb_b$	-0.018***	-0.013***	-0.079***	-0.057***
	(0.0038)	(0.0036)	(0.0260)	(0.0200)
ROA_{bt-1}		0.00023		0.0047
		(0.0009)		(0.0051)
Liquid Asset Ratio$_{bt-1}$		-0.000002		0.00019
		(0.0001)		(0.0006)
Capital Ratio$_{bt-1}$		0.00013		-0.0040***
		(0.0001)		(0.0007)
Loan-to-Deposit Ratio$_{bt-1}$		0.000070***		0.00042***
		(0.0000)		(0.0001)
Non-Performing Loans$_{bt-1}$		-0.034***		-0.20***
		(0.0130)		(0.0730)
Bank Size$_{bt-1}$		0.017***		-0.0071
		(0.0032)		(0.0180)
Constant	0.030***	-0.073***	0.69***	0.76***
	(0.004)	(0.02)	(0.028)	(0.11)
R^2	0.945	0.961	0.801	0.896
Observations	225	192	225	192
Year FE	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes

Table 4. Impact of Embezzlement on Bank Credit Supply. Dependent variable in columns 1 and 2 is bank credit, measured by the share of the credit provided by bank b of total credit provided by the banking sector in each year t, and in columns 3 and 4 is also bank credit, measured by the credit to asset ratio for each bank. For variable definitions, see the Appendix table. Standard error in parentheses .The sample covers 2008 to 2014. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively

Overall, our results in this section confirm a significant credit dry up in impacted banks following the embezzlement. Our finding is robust to the measure of bank credit, and non-tabulated results show that our finding is also robust to inclusion or exclusion of the major impacted banks (Saderat and Melli). Moreover, variation in the choice of time window shows that the credit dry up lasted throughout 2012 and 2013.

6.2 Main Employment Results

In the previous section we provided empirical evidence confirming a credit dry up following the 2011 embezzlement scandal in impacted banks. Next, we investigate if the credit dry up had any impact on the real side of the economy. Specifically, we ask: what is the effect on employment of the scandal? To answer this question, as illustrated in equation (2), we compare the employment growth between firms connected to impacted banks and other non-connected firms.

reports the estimation results for equation (2). LTB in this table is the treatment variable that switches on for firms that are connected to a troubled bank. The average treatment effect is captured by the coefficient of the interaction term, β_3, in equation (2). The dependent variable in this table is the natural logarithm of number of firm employees. Therefore, the interaction coefficient, which compares the change in logarithm of employment, has the interpretation of difference in employment growth rates between connected and non-connected firms. The impact of company size on employment level is controlled by including the logarithm of company's total sales in all specifications in

. Year fixed effects are included in all specifications to control for macro events that potentially impact the labor market and therefore employment in Iranian public companies. Industry fixed effects are also included to control for unobservable industry differences that may impact its employment picture (e.g., labor intensive versus capital intensive industries).

Results in column 1 of

confirm a significant difference in employment growth rates between connected versus non-connected firms. In column 1, the estimated value for the coefficient for the interaction term, β_3, shows a 7.8% difference in employment growth rate, which is statistically significant at the 5% level. Adding controls in column 2 does not alter this finding. Instead, it suggests that the

treatment effect may actually be even larger, 8.4%. Our finding is also robust to the way we control for industry unobservable factors. The interaction coefficient remains negative and both economically and statistically significant when we use average industry employment instead of industry fixed effects in column 3.

	Dependent Variable: Log(Employment$_{it}$)		
	(1)	(2)	(3)
$Post_t$	0.12***	0.16***	0.14***
	(0.0400)	(0.0430)	(0.0400)
LTB_i	0.24**	0.2	0.29**
	(0.1200)	(0.1200)	(0.1200)
$Post_t \times LTB_i$	-0.078**	-0.084**	-0.065*
	(0.0370)	(0.0390)	(0.0370)
$Size_{it-1}$	0.28***	0.32***	0.29***
	-0.019	(0.0210)	(0.0200)
Profitability Ratio$_{it-1}$		-0.37***	-0.33***
		(0.1000)	(0.0950)
Age_{it-1}		0.0023	0.00021
		(0.0061)	(0.0053)
Log(Employment)$_{it-1}$			
Average Industry Log(Emp)$_{it}$			0.71***
			(0.0610)
Constant	3.93***	3.68***	-0.67*
	(0.53)	(0.52)	(0.38)
R^2	0.71	0.733	0.687
Observations	964	941	941
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	No

Table 5. Overall Impact of Credit Supply Shock on Employment. Dependent variable is the natural logarithm of number of employees in firm i in year t. For variable definitions, see the Appendix table. Standard error in parentheses .The sample covers 2008 to 2014. *, **, and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Overall, our findings indicate that there is a link between the financial side and the real side of the economy. Negative credit shocks in the loan market do have a significant impact on the employment outcome among firms. Firms with established relationships with lenders suffer employment losses when the credit provided by those lenders dries up. This is because lender-borrower frictions make it more costly for a borrower to switch to an alternative lender at the time of crisis.

6.3 Subsample Employment Results

Next, we ask: what types of companies are more likely to suffer greater employment losses as a result of credit dry up? Economic theory predicts that firms without access to alternative financing, *financially constrained* firms, are more sensitive to disruptions in the credit channel. Also, as pointed out by Gertler and Gilchrist (1994), smaller firms are more vulnerable to those credit disruptions because of non-convex monitoring costs, fewer pledgable assets, or lower transparency. Therefore, we hypothesize that the employment loss due to credit dry up must be more severe among financially constrained and smaller firms. To test this hypothesis, we split our sample in two ways. First, we sort our sample based on Whited & Wu (2006)'s measure of financial constraint. We label the top 40% of the companies as companies with "high" financial constraint and the bottom 40% as "low" financial constraint. Similarly, we sort our sample based on asset size and label the top 40% as "large" and the bottom 40% as "small." Then, to compare the employment outcomes, we re-estimate equation (1) for each of the subsamples. The results are reported in **Error! Reference source not found.**.

	Dependent Variable: Log(Employment$_{it}$)			
	Financial Constraint		Firm Size	
	Low	High	Large	Small
	(1)	(2)	(3)	(4)
$Post_t$	0.027	0.52***	0.029	0.45***
	(0.4900)	(4.5100)	(0.5500)	(4.4700)
LTB_i	0.077	0.12	0.17	0.037
	(0.5900)	(0.6500)	(1.2400)	(0.1500)
$Post_t \times LTB_i$	-0.069	-0.37***	-0.066	-0.30***
	(-1.41)	(-3.20)	(-1.41)	(-3.00)
$Size_{it-1}$	0.23***	0.57***	0.19***	0.56***
	(6.9)	(17.00)	(5.7600)	(11.30)
$Profitability\ Ratio_{it-1}$	-0.042	-0.95***	-0.011	-0.70***
	(-0.33)	(-3.54)	(-0.085)	(-2.73)
Age_{it-1}	0.0084	-0.0014	0.0085	0.01
	(1.1500)	(-0.18)	(1.0600)	(1.1000)
Constant	4.33***	1.95***	4.57***	1.91***
	(7.87)	(3.73)	(8.03)	(2.79)
R^2	*0.62*	0.86	0.62	0.85
Observations	404	311	417	291
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	No

Table 6. Impact of Credit Supply Shock on Employment in Subsamples. Dependent variable is the natural logarithm of number of employees in firm i in year t. For variable definitions, see the Appendix table. Standard error in parentheses .The sample covers 2008 to 2014. *, **, and *** indicate significance at the 10%, 5%

and 1% levels, respectively.

Columns 1 and 2 in **Error! Reference source not found.** report the estimation results for equation (2) for the subsample of firms with high and low financial constraint. Focusing on the coefficient of the interaction term, we observe in column 1 that while firms with low financial constraint do not suffer significant employment losses (with an insignificant estimated coefficient of -0.069), employment growth is 37% slower in financially constrained firms when compared to the control group (non-connected firms). Similarly, in columns 3 and 4 where the estimation result for equation (2) is reported for the small and large subsamples, significant employment losses are only observed among small firms and not large firms. While the coefficient of the interaction term is insignificant for large firms, it is estimated as -30% for the small firms, which is highly significant with a p-value of less than 0.01. Consistent with our hypothesis, these results indicate that credit shocks are indeed more impactful for smaller and more financially constrained firms.

7 Conclusion

We provided empirical evidence confirming the existence of a link between credit supply channel and the real side of the Iranian economy. We used credit disruptions resulting from the 2011 Iranian embezzlement scandal as a plausibly exogenous shock to credit availability of public firms. Using a difference in difference approach, we first confirmed a sizable credit supply contraction among bank involved with the scandal compared to other banks. Second, by comparing firms that were client of the impacted banks prior to scandal versus other firms, we documented a slower employment growth rate of up to 2.8 percent for those firms. Finally, our sub-sample analysis showed that smaller and more financially constrained firms were actually those that suffered more significant job losses as a result of credit contraction caused by the scandal.

Our findings have important policy implications. First, the existence of a link between the credit supply and the real side of the economy suggests that policy makers must be aware of the economic and social costs of any shocks to the banking industry that can create credit contractions. Second, given that smaller and more financially constrained firms are more vulnerable to credit supply disruptions, any government interventions in the credit markets should be focused on supporting those types of firms. This may include providing direct support by making alternative sources of financing available to such firms or indirectly by prioritizing protecting banks that serve such clients. This is the key to reducing the impact of a banking

crisis. As pointed out by Ben Bernanke in 2010 "making credit accessible to sound small businesses is crucial to our economic recovery and so should be front and center among our current policy challenges." Third, in the case of bank embezzlement scandals, policy makers can consider pre-crisis and post-crisis polices that can minimize the economic and social costs of the crisis. As for the former, regulators can minimize the likelihood of similar crisis by putting an integrated internal monitoring and control systems in place especially in banks which serve more vulnerable clients. Creating a centralized customer database in which all banks share their customer transaction data with the regulator provides the opportunity to design a fraud detection system using recent advancement in data science. And for the latter, in case of a new scandal, regulators should focus on minimizing the length of the credit disruption period. They can do so by facilitating information sharing among banks which lowers the costs of credit risk assessment of a client firms. For example, this can be done by establishing a centralized credit scoring system similar to credit bureaus in the US. Such policies can lower credit market frictions by making the borrower-lender relationship less sticky. Doing so will make it easier for the impacted firms to find alternative sources of financing at the time of crisis.

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Appendix: Variables Definitions

	Variable	*Definition*
Bank –related variable	Credit Share$_{bt}$	share of bank b's credit out of total banking system's credit
	Credit-to-Assets$_{bt}$	value of credits by bank to its total assets
	Emb$_b$	for the banks involved with the embezzlement equals 1, otherwise equals 0
	ROA$_{bt}$	net income to total assets ratio
	Liquid Asset Ratio$_{bt}$	share of liquid assets (cash, balance with banks and balance with central bank) of total assets for a bank
	Capital Ratio$_{bt}$	capital value to total assets
	Loan-to-Deposit Ratio$_{bt}$	values of loan to value of deposits
	Non-Performing Loans$_{bt}$	value of non-performing loans to total loans value
	Bank Size$_{bt}$	natural logarithm of real value of total assets
overall	*Post$_t$*	after 2011(embezzlement year) equals 1, otherwise equals 0
Firm –related variables	*Log(Employment)$_{it}$*	natural logarithm of number of firm employees
	LTB$_i$	If prior to embezzlement (in 2010) firm i is connected to a bank involved with 2011 embezzlement equals 1, otherwise 0
	Size$_{it}$	natural logarithm of real value of firm's total sales
	Profitability Ratio$_{it}$	net income to total assets ratio
	Age$_i$	number of years since firm's IPO
	Average Industry Log(Emp)$_{it}$	average of *Log(Employment)$_{it}$* in firm's in year t
	Financial Constraint $_{it}$	Whited & Wu (2006)'s measure of

		financial constraint