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Slowdown of credit flows in Jordan in the wake of the global financial crisis: Supply or demand driven?

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ABSTRACT

This paper estimates a disequilibrium model of credit supply and demand to evaluate the relative role of these factors in the slowdown of credit flows in the Jordanian economy in the wake of the global financial crisis. The empirical analysis suggests that the credit stagnation is mainly driven by the restricted credit supply amid tighter monetary policy conditions in Jordan relative to the United States, as evidenced by the widened interest differential between the Central Bank of Jordan (CBJ) re-discount and the U.S. Federal Reserve funds rates. Although it appears that demand side factors related to the slowdown of economic activity have also had an impact, their role has been relatively modest. The estimation results imply that economic policies targeted towards stimulating the supply of credit are likely to be a more effective tool for expanding credit flows relative to demand stimulating policies.

1. Introduction

The global financial crisis has resulted in a worldwide slowdown of credit flows, which triggered a discussion about the factors driving sluggish lending activity. Unlike previous prominent crises (e.g., in East Asia and Latin America in the 1990s), the current slowdown in lending is taking place in the absence of rising cost of credit and amid record-low policy rates and monetary stimulus (Dabrowski, 2010; Kenc and Dibooglu, 2010). Although the decline in credit flows can be rationalized in view of the overall decline in economic activity (e.g., Daras and Tyrowicz, 2011), some critics have argued that the slowdown of lending (despite generally low interest rates) can be attributed to credit rationing by banks. According to this "credit crunch" hypothesis, in the presence of asymmetric information, interest rates do not equilibrate supply of

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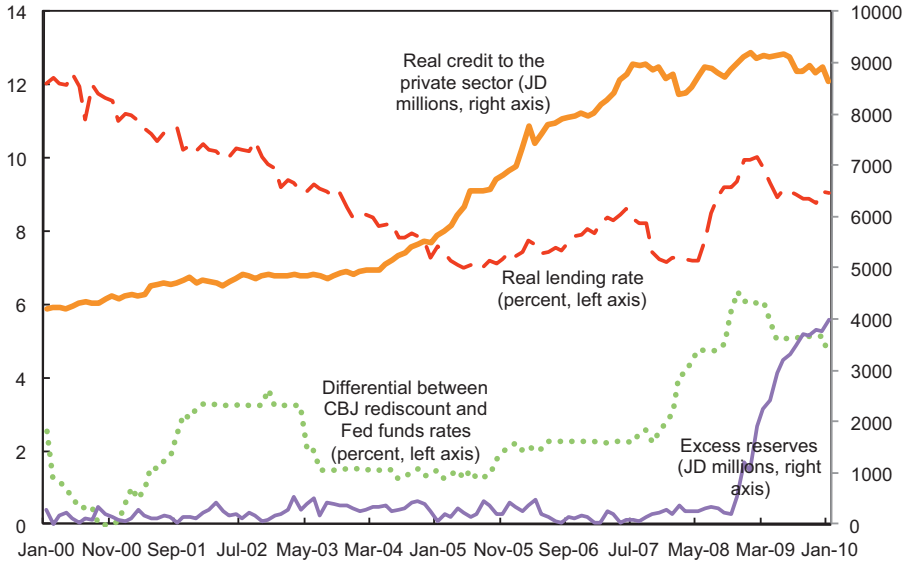


Fig. 1. Jordan: interest rates, credit to the private sector and excess reserves.

and demand for credit, and rational profit-maximizing lenders deliberately constrain the outflow of liquidity in an attempt to avoid the accumulation of risky assets.

Understanding whether sluggish credit activity is related to constrained supply or weak demand for credit is important from a policy perspective. If the reduction of credit flows is mainly a response to tightened credit standards by banks, then targeted monetary easing coupled with regulatory measures aimed at relaxing prudential norms may be needed to remove the obstacles for credit growth.[1] Alternatively, if the reduction of credit flows is mostly driven by the decline in credit demand amid slower business activity, then economic policies aimed at expanding aggregate demand might be more effective in stimulating credit growth.

In an attempt to identify the relative role of credit supply and demand factors, we estimate a disequilibrium credit market model pioneered by Laffont and Garcia (1977) using Jordanian data. Similar to the other countries in the Middle East, Jordan has experienced a slowdown in credit activity following the global financial crisis, which corresponded with a widening gap between the Central Bank of Jordan (CBJ) and the U.S. Federal Reserve's (Fed) funds policy rates, an increase in the real lending rate, and mounting excess reserves of banks (see Fig. 1). Our estimations suggest that even though there is some evidence of decline in credit demand from the private sector, the observed slowdown in bank lending has been mainly in reaction to a tightened supply of credit following the global financial crisis. In a nutshell, these results support the "credit crunch" hypothesis in Jordan and suggest that policies aimed at expanding the supply of credit are key for accelerating lending activity in the wake of the global financial crisis.

The remainder of the paper is structured as follows. Section 2 sets the stage by describing the monetary policy framework and credit markets in Jordan. Section 3 provides a brief review of the disequilibrium model and its applications. Section 4 describes the empirical methodology and discusses the estimation strategy. Section 5 presents estimation results, while Section 6 checks their robustness. The final section concludes.

[1] Among others, this view has been advocated by experts favoring countercyclical regulation of banks, according to which capital requirements imposed on banks should be relaxed in times of economic slowdown and strengthened in times of economic boom.

2. Overview of the monetary policy framework and credit markets in Jordan

The main pillar of the Jordanian monetary system is the fixed exchange rate regime. The Jordanian dinar (JD) has been pegged to the U.S. dollar (at 0.71 JD/USD rate) since 1997.[2] The primary objective of the CBJ is to maintain the peg and ensure monetary stability and sustained growth by employing a standard set of monetary policy instruments. The CBJ sets its policy rate in line with the Fed funds target to provide a floor for the interest rate term structure in the economy that would be consistent with the peg. Temporary deviations of the CBJ policy rate from the Fed funds rate target indicate a relative tightening or easing of the monetary policy stance in Jordan. In particular, in periods of financial turbulence, the CBJ typically imposes a positive spread over the Fed funds target to mitigate the possible pressures on capital outflows and to protect the peg.

An important component of the CBJ monetary operations is the management of excess liquidity (Vandenbussche et al., 2009[3]). For this purpose, the CBJ uses both direct (reserve requirements ratio[4]) and indirect (issuance of repurchase agreements and CDs, open market operations) monetary policy instruments. In addition, in 1998 the CBJ has introduced a standalone overnight deposit facility at which banks can deposit their excess liquidity at the CBJ policy rate. This facility allows CBJ to manage liquidity on a daily basis and provides a floor for interbank rates. The overnight deposit facility has been very actively used by banks in the aftermath of the global financial crisis, when excess reserves of banks reached an unprecedented level and interbank markets dried out in view of increased risk aversion.

The financial deepening in Jordan is relatively high compared to other countries in the region: the share of total bank assets in GDP exceeds 200 percent and the share of bank credit in GDP is about 80 percent. The banking system is composed of about twenty banks. Most of them are private commercial banks involved in traditional financial intermediation activities. Concentration in the banking system is quite high, with the share of the three largest banks exceeding 50 percent of total assets, loans, and deposits. The high level of market concentration suggests an oligopolistic structure of competition.

The banking system has high average capital adequacy, and nonperforming loans have fallen substantially since the early 2000s. The major source of bank funding is customer deposits, which compose about 90 percent of total non-equity funding. Some 85 percent of total deposits come from residents and are predominantly in JDs. Dollarization has declined over the last decade and currently only 30 percent of bank deposits are foreign currency denominated. Foreign exchange loans comprise only 12 percent of total loans, and, by CBJ regulation, are limited to hedged borrowers, mainly in the export industries. Banks also have limited direct foreign exchange exposure.

The loan portfolio of the Jordanian banks is concentrated in dominant industries. For example, loans for trade, construction, and industry together comprise about 50 percent of the total loan portfolio. Some banks' portfolios are highly concentrated in individual borrowers within industries, reflecting the overall structure of the economy with large business groups dominating certain industries (especially the export-oriented ones). In addition, the banking sector is effectively integrated into the global financial system. For instance, the largest bank holds 80 percent of its assets outside Jordan.

Due to its high international exposure, the Jordanian banking sector is highly vulnerable to international shocks (Lucke, 2004). Two channels have proven key in transmitting international shocks to the Jordanian banking sector during the global financial crisis. First, regional economic slowdown affected the real sector activity in Jordan through lower exports and reduction in remittances from abroad. The consequent negative effect on domestic incomes has resulted in a deterioration of loan quality and put upward pressure on the share of non-performing loans, especially in the real estate sector. Second, large Jordanian banks with a regional presence were exposed to the contraction in the economies where they are active. These banks have responded to the deterioration of their lending portfolios by restricting their activities across the board, including in Jordan. Overall, the slowdown in credit flows following the global financial crisis was a combination of demand and

[2] The Jordanian dinar (JD) is pegged to the U.S. dollar at a rate of 0.71 JD/USD.
[3] See Poddar et al. (2006) for a discussion of the monetary policy transmission mechanism in Jordan.
[4] Both required and excess reserves of banks held at the CBJ are not remunerated.

supply-driven factors. The aim of this paper is to analyze which of these two sets of factors was dominant in explaining the observed credit contraction.

3. Disequilibrium models: a brief survey of the literature

In a seminal credit rationing paper, Stiglitz and Weiss (1981) show that loan markets can frequently be characterized by a disequilibrium status. In the presence of asymmetric information, loan rates are not presumed to adjust in each period to clear the market (i.e., there is loan rate stickiness) and banks can ration the volume of credit on the basis of non-price terms of the credit contract (Neyer, 2004). From an econometric point of view, the main challenge associated with estimating the market model in disequilibrium is that one has to obtain estimators for the parameters of loan supply and demand functions using only the observed volume of transactions in the loan market.

Laffont and Garcia (1977) offer a solution to this problem by employing the assumption of the "short side" principle in which the observed credit quantity is constrained to be the smallest of the unobserved demanded and supplied volumes. According to this framework, at a given point in time the credit market can exhibit temporary disequilibrium (excess supply or excess demand) owing to imperfect flexibility in the interest rate. Hence, the observed decline in real credit can either be due to falling supply of credit, or falling demand for credit, or both. The identification problem is solved by using exclusion restrictions on the supply and demand functions (e.g., banks' lending capacity affects the supply of credit, but not the demand for credit). Maddala and Nelson (1974) discuss the appropriate maximum likelihood method for this class of disequilibrium models, which has been used for empirical analysis of credit markets in different countries.

Pazarbasioglu (1997) estimates a disequilibrium model of credit demand and supply for Finland for the period 1981–1995. Credit demand is modeled as a function of the cost of credit and state of the overall economic environment, while credit supply is linked to the return on credit and resources available to the banks. The author finds that the sharp decline of lending in the Finnish economy following the banking crisis of 1991–1992 was not a reflection of a credit crunch but was mainly caused by a cyclical decline in credit demand. Ghosh and Ghosh (1999) build on the work of Pazarbasioglu and differentiate between two components of possible decline in credit supply: banks' lending capacity (ability to lend) and risk aversion (willingness to lend). Using data on Indonesia, Korea, and Thailand in the aftermath of the 1997–1998 East Asian crisis, they show that both credit supply and demand have shown signs of stagnation, but the decline in demand was more pronounced. Barajas and Steiner (2002) adopt the disequilibrium approach to investigate the causes of credit slowdown in three Latin American countries (Colombia, Mexico, and Peru). They augment the model by incorporating regulatory variables in the supply equation and conclude that while supply expansion was primarily driven by lending capacity regulatory variables became key during the slowdown.

Kim (1999) applies the disequilibrium approach for analyzing the impact of the Asian crisis on Korea. In contrast to Ghosh and Ghosh (1999), the author includes a dummy variable for the post-crisis period in the supply equation and reports a significant negative coefficient. Kim concludes that severe credit contraction in Korea in the aftermath of the crisis was mainly driven by a sharp decline in credit supply, supporting the credit crunch hypothesis. Hurlin and Kierzenkowski (2007) apply the disequilibrium approach to highlight the importance of restricted supply for the credit slowdown in Poland during 1999–2002, partly blaming contractionary monetary policy for amplifying the consequences of the credit crunch. Using a slightly different approach, Agénor et al. (2000) also find indirect support for the credit crunch hypothesis in Thailand. They develop a model of optimal excess reserves held by banks and show that these were modest in Thailand. If the slowdown in credit was caused by a reduction in the demand for loans, there would have been an involuntary accumulation of excess reserves by banks, which was proven not to be the case in Thailand.

The above discussion suggests that the evidence on credit crunch from previous crisis episodes is mixed. One important difference between the recent global financial crisis and the crises analyzed in previous work is the behavior of interest rates: while nominal interest rates have been on the rise

during previous crises, they have not gone up during the recent financial crisis owing to an unprecedented fiscal and monetary stimulus exercised by governments around the world. This was also the case in Jordan, where nominal lending rates were flat during the crisis, while real lending rates peaked amid a decelerating rate of inflation. A comparison of disequilibrium estimations in Jordan with the results in previous studies would therefore provide an illustration on how interest rate behavior can affect credit markets in crisis.

4. Methodology

We adopt the disequilibrium framework of Laffont and Garcia (1977), used in previous studies to analyze credit demand and supply in other countries. According to this framework, at a given point in time the credit market can exhibit temporary disequilibrium (excess supply or excess demand) owing to imperfect flexibility in interest rates. Hence, the observed decline in real credit can either be due to a falling supply of credit, a falling demand for credit, or both. The identification problem is solved by using exclusion restrictions on the supply and demand functions (e.g., banks' lending capacity affects the supply of credit, but not the demand for credit). Below, we present the demand and supply equations for the real credit to the private sector, followed by a description of the estimation strategy.

4.1. The credit supply equation

Following the previous literature and taking into account the Jordan-specific economic environment, the following variables are used as determinants of credit supply:

Return on credit (i^l). This variable, approximated by the real lending rate (nominal loan rate minus smoothed inflation[5]), indicates the rate of return raised by banks from credit provision. A higher real lending rate is expected to make lending more attractive to banks and expand their credit supply.

Differential between CBJ re-discount rate and the U.S. Federal Reserve's (Fed) funds rate (im). Given the peg of the Jordanian dinar against the U.S. dollar, monetary policy in Jordan is closely linked to monetary policy in the U.S. Hence, the interest differential between policy rates in Jordan and the U.S. indicates the relative stance of monetary policies in these two countries. A wider differential implies a relatively stricter monetary policy in Jordan, and is expected to have a negative impact on credit supply. Therefore, the coefficient of this variable is expected to be negative.

Future economic prospects (IP^e). Banks are expected to expand credit supply when expecting brighter economic prospects for the economy. We proxy economic prospects smoothed industrial production index (taken with a lag).

Lending capacity (LC). Given expected returns on lending, banks should take into account the amount of available resources in deciding the amount of their credit portfolio. We proxy the real lending capacity of banks by the difference between total deposits and required reserves in the CBJ overnight facility deflated by the CPI (in logs). A higher lending capacity is expected to expand potential credit supply by banks.

Economic uncertainty (UNC). We proxy economic uncertainty by a rolling standard deviation of the log difference between the monthly Amman stock exchange index and its smoothed value (taken with a lag). We expect a negative coefficient on this variable, since banks' willingness to lend is likely to diminish in times of economic uncertainty (Rhoades and Guner, 2003).

Using these determinants, the credit supply equation takes the following form:

$$C_t^S = \alpha_0 + \alpha_1 i_t^l + \alpha_2 im_t + \alpha_3 IP_{t-1}^e + \alpha_4 LC_t + \alpha_5 UNC_{t-1} + \varepsilon_t^S \quad (1)$$

where ε^S is the homoscedastic i.i.d. error term.

[5] Inflation is smoothed using MA (4,1,4) representation using the following formula: $1/9^*(x_{t-4}+x_{t-3}+x_{t-2}+x_{t-1}+x_t+x_{t+1}+x_{t+2}+x_{t+3}+x_{t+4})$, where x_t is monthly CPI inflation. This approach was also applied for smoothing the growth of industrial production and stock market indices.

4.2. The credit demand equation

Credit demand is modeled as a function of the following variables:

Cost of credit (i^l). The demand for bank credit is expected to depend negatively on its cost as proxied by the real lending rate. Thus, unlike the supply equation, this coefficient is expected to be negative.

Future economic prospects (IP^e). Developments in the macroeconomic and business environment influence the decision of firms to expand or contract their business, which is crucial for credit applications. Similar to the supply equation, we expect a positive coefficient for this variable.

Lagged growth of real Amman Stock Exchange index (*ASE*). The impact of stock market activity on demand for bank credit is unclear a priori. On the one hand, expansion in stock market activity may increase demand for credit due to improved economic prospects. On the other hand, a rising value of stocks might improve the ability of businesses to acquire external funding from the financial market and reduce their demand for bank credit. Which of these two effects dominates is an empirical question.

Iraq war effect (*T and Tsq*). The demand equation also features a linear trend and its square, beginning in 2004 (in logs). These variables enter to capture the impact of the Iraq War on credit flows in Jordan. Specifically, the inflow of Iraqi refugees to Jordan appears to have placed additional pressure on credit demand, as evidenced by a rapid acceleration of observed credit volumes since the beginning of the war (see Fig. 1). The inclusion of the quadratic term ensures that the marginal effect of the trend is diminishing over time, as refugees are expected to return to Iraq after stabilization of its economic situation, or to move to other countries outside the region.

Using these determinants, the credit demand equation takes the following form:

$$C_t^D = \beta_0 + \beta_1 i_t^l + \beta_2 IP_{t-1}^e + \beta_3 ASE_{t-1} + \beta_4 T + \beta_5 Tsq + \varepsilon_t^D \tag{2}$$

where ε^D is the homoscedastic i.i.d. error term.

4.3. The empirical estimation strategy

The disequilibrium hypothesis suggests that actual observed credit at time period t, C_t, lies either on the supply curve (excess demand), or on the demand curve (excess supply), or on both (equilibrium). Algebraically, this assumption can be expressed as:

$$C_t = \min(C_t^S, C_t^D) \tag{3}$$

where C^S and C^D are credit supply and demand functions defined in Eqs. (1) and (2), respectively. As shown in Maddala and Nelson (1974), in the absence of any information regarding the price adjustment process and assuming that the error terms ε^S and ε^D are normally distributed and homoscedastic random variables, the above model can be solved using the maximum likelihood method. The log-likelihood function is defined as follows (see Appendix A for the derivations):

$$LL = \sum_{t=1}^{T} \log[f^D(C_t)F^S(C_t) + f^S(C_t)F^D(C_t)] \tag{4}$$

where $f(\cdot)$ and $F(\cdot)$ are probability density and cumulative density functions, respectively. We optimize the log-likelihood function (4) using the BHHH (Berndt et al., 1974) iterative procedure.

5. Results

Table 1 displays the estimation results of the disequilibrium model of credit for Jordan, using data for the period December 1999 to January 2010. Most of the coefficients are significant and all have the expected signs. Standard deviation errors in both supply and demand equations are significantly different from zero, providing support for the chosen model specification.

The estimations suggest that both supply and demand for credit in the Jordanian banking system are positively affected by expected economic prospects. Similarly, the real lending rate has a positive impact on credit supply, while its impact on credit demand is negative. However, the interest rate

Table 1
Maximum likelihood estimation of disequilibrium model.

Credit supply	
Real lending rate	0.04** [3.01]
Differential between CBJ rediscount and Fed funds rates	−0.03* [−2.17]
Industrial production index (lagged)	2.94*** [7.69]
Standard deviation of ASE index growth (lagged)	−0.02 [−1.37]
Lending capacity	0.47* [2.19]
Constant	−9.15*** [−7.32]
Credit demand	
Real lending rate	−0.02*** [−7.19]
Industrial production index (lagged)	0.51*** [8.97]
Lagged real ASE index growth (smoothed)	−0.01*** [−3.53]
Time trend (logs)	−0.09*** [−9.98]
Time trend^2 (logs)	0.05*** [20.10]
Constant	6.42*** [23.15]
Number of obs.	134
Log-likelihood	306.0
Akaike information criterion	−584.0
Bayes–Schwartz information criterion	−544.0
St. Dev. of supply equation error	0.04*** [6.39]
St. Dev. of demand equation error	0.02*** [12.86]

Notes: The dependent variable is real credit to the private sector (in logs). Estimations are performed using the BHHH iterative procedure. *t*-Statistics are reported in brackets.
* Significance at 10 percent level.
** Significance at 5 percent level.
*** Significance at 1 percent level.

elasticity of credit demand is somewhat lower than the interest rate elasticity of credit supply, suggesting that the demand curve is steeper than the supply curve. This finding does not come as a surprise given the developing nature of the Jordanian economy, where the monetary policy transmission mechanism works largely through the monetary aggregates rather than the interest rate (see Poddar et al., 2006).

In addition to the lending rate, the supply of credit is also affected by the differential between the CBJ rediscount and the U.S. Federal Reserve's (Fed) funds rate, which proxies the tightness of CBJ monetary policy relative to the Fed's monetary policy. The negative sign of this coefficient suggests that a tighter monetary policy in Jordan relative to that of the U.S. reduces the supply of credit. Related to this, a higher CBJ policy rate increases bank returns on excess reserves, further discouraging lending to the real sector.

In addition to the price effects, we single out two possible motives governing the supply of bank credit: availability of lendable resources (ability to lend) and risk aversion (willingness to lend in uncertain times). The coefficient of lending capacity (proxied by the difference between total deposits and required reserves) is strongly significant and positive, suggesting that higher lending capacity expands banks' potential to lend. Similarly, economic uncertainty (proxied by a rolling standard deviation of the monthly Amman Stock Exchange index ratio relative to its smoothed value, in logs) has a negative impact on banks' willingness to lend. The magnitude of the latter coefficient is small (and statistically insignificant) relative to the former (0.47), suggesting that while banks slightly reduce credit supply in times of financial market volatility, the main factor driving credit supply is the availability of funds.

Finally, we find a negative association between stock market activity and demand for credit. This implies that sluggish stock market developments put additional pressure on the ability of firms to acquire external funding, generating additional demand for bank credit. Credit demand has also been affected by the war in Iraq, as shown by the significant coefficients of trend variables.

Figs. 2 and 3 display estimates of demand for and supply of credit obtained from the disequilibrium model, and their deviations from observed volumes of lending. The plotted credit supply and demand series suggest that the recent slowdown in credit flows is mainly driven by sluggish credit supply, affected by the widening differential between the CBJ rediscount and Fed funds rates. The demand for credit has also been affected in the wake of the global financial crisis. Credit demand flattened in 2008 amid the slowdown in Jordanian economic activity, but has rebounded since the beginning of 2009 as declining stock prices have dried up alternative sources of external funding for businesses.

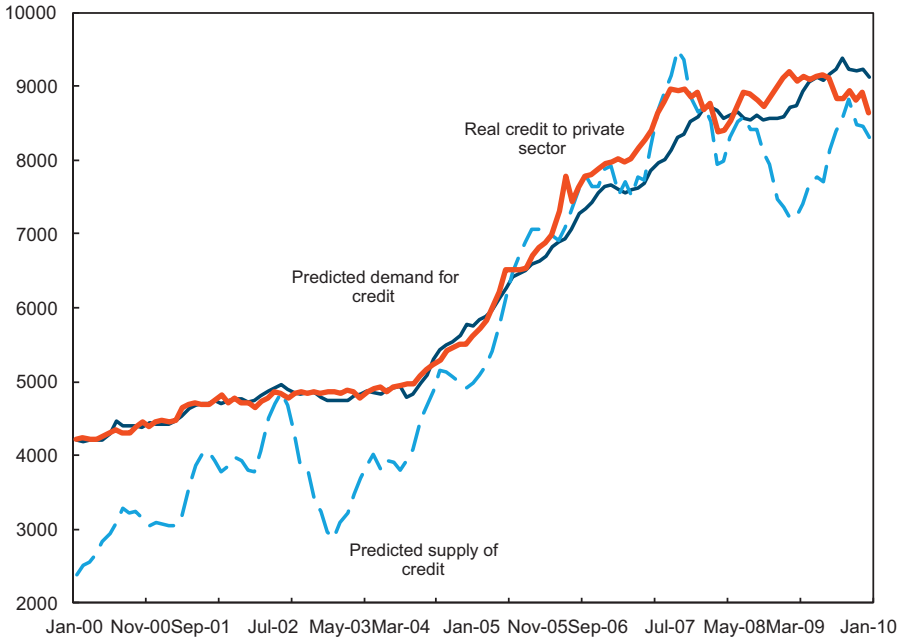


Fig. 2. Jordan: dynamics of predicted credit demand and supply (JD millions).

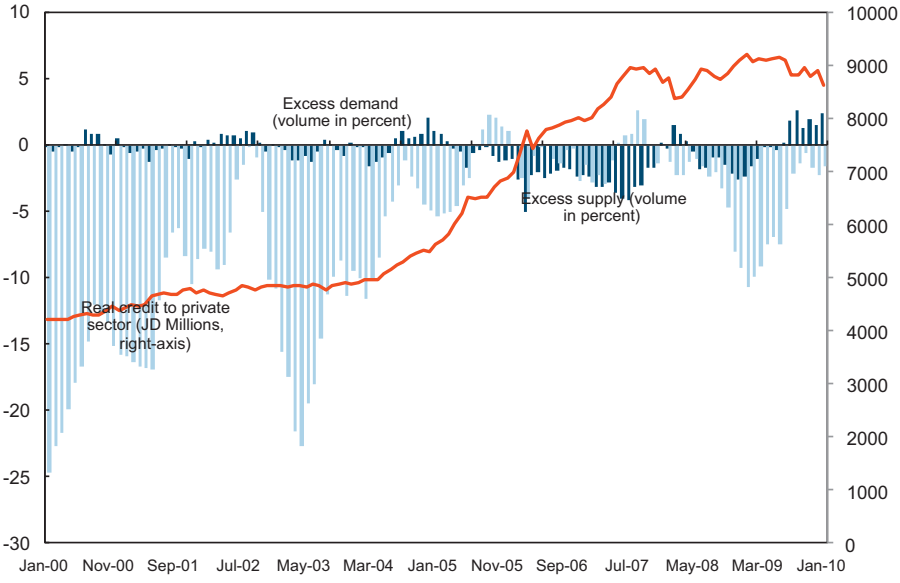
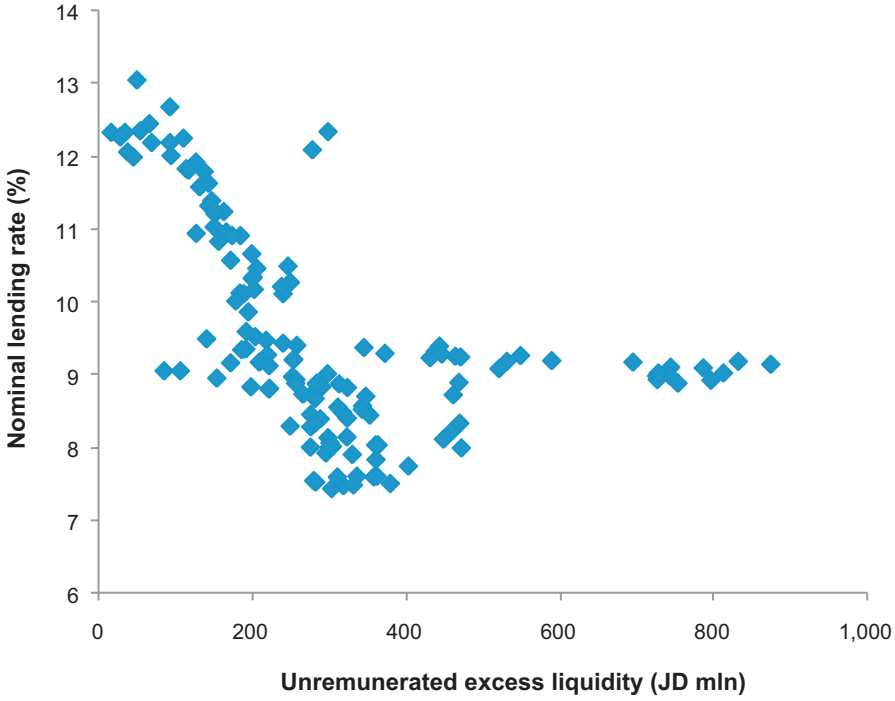


Fig. 3. Jordan: deviation of demand and supply from observed credit volume.

Starting in mid-2009, the ability of banks to potentially expand the supply of credit has risen due to a combination of the following factors: (i) reduction of the CBJ policy rate and its differential with the Fed funds rate; (ii) elimination of the issuance of CBJ certificates of deposit and consequent accumulation of excess reserves by commercial banks; and (iii) the potential increase in deposit inflows (including unrecorded financial flows from abroad). Nevertheless, the predicted supply of



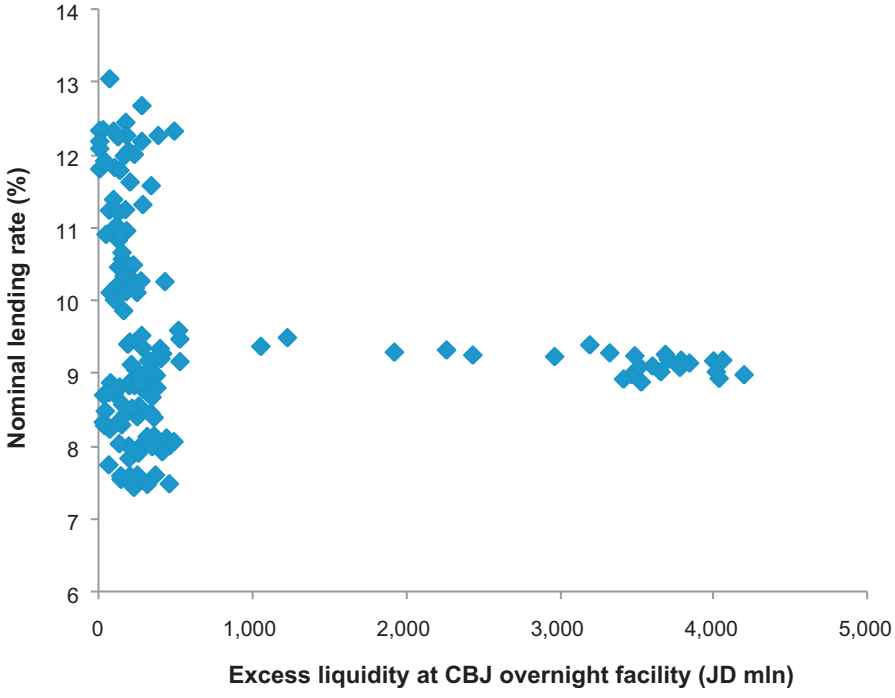


Fig. 4. Jordan: the liquidity preference curve.

credit by the end of the sample (January 2010) is still about 7 percent lower than the predicted demand, suggesting that credit supply still has a large potential for further expansion (see also International Monetary Fund, 2010).

6. Robustness check

This section checks for the robustness of the supply driven credit contraction finding reported in the previous section using an alternative methodology. For this purpose, we draw on the liquidity preferences curve approach proposed by Khemraj (2010). The author develops a banking model of oligopolistic competition in which loans and excess reserves of banks become perfect substitutes at a positive lending rate.[6] This model provides a fairly realistic description of the banking environment in emerging markets, where banks tend to mark up their lending rate over exogenous foreign benchmark rate, transaction costs, and credit risks. The main outcome of the model is that it provides a theoretical rationale for banks to stop lending and start hoarding excess liquidity when the market lending rate declines below the break-even positive rate required to compensate for the above mentioned benchmark costs. This may lead to a credit crunch, when even injection of additional liquidity by the central bank would not be sufficient to contribute to the expansion of loanable funds.

The main prediction of the model can be tested by plotting the average nominal lending rate against excess liquidity of banks in the form of the liquidity preference curve. The model predicts that the liquidity preference curve should be downward sloping because the excess liquidity is expected to decline with a higher lending rate due to larger alternative costs of holding cash. It also predicts that the liquidity preference curve should flatten (i.e., should become perfectly elastic) at the break-even lending rate, since banks restrict their lending when the market rate declines beyond this rate. Khemraj (2010) uses a sample of emerging markets to show that the shapes of the liquidity preference curves in many of them satisfy this pattern, providing support for the credit crunch hypothesis.

Fig. 4 presents the liquidity preference curve in Jordan. The upper figure plots the average nominal lending rate against the unremunerated excess liquidity held by commercial banks at the CBJ. The lower panel plots the average lending rate against the excess liquidity held by commercial banks in the overnight facility at the CBJ for which banks receive remuneration equivalent to the CBJ policy rate (currently 2 percent). Both plots display a downward sloping shape and flatten when the lending rate crosses the 8–9 percent break-even point. It is notable that the flat part of the liquidity preference curve is mostly composed of data points observed in the aftermath of the global financial crisis (see also Fig. 1). This provides further support to our main finding that the credit contraction in the aftermath of the crisis has largely been a supply-driven phenomenon.

7. Conclusion

This paper estimates a disequilibrium model of credit supply and demand in Jordan. The main objective is to evaluate the relative role of demand and supply factors in the slowdown of credit flows in the Jordanian economy in the wake of the global financial crisis.

The estimation results support the credit crunch hypothesis, according to which the slowdown of credit activity in Jordan is a supply phenomenon owing to the tighter lending standards exercised by banks following the global financial crisis. Another factor that has contributed to restricted credit supply has been a widening of the interest differential between monetary policy rates in Jordan and the United States, which reflects the relatively tighter monetary policy exercised by the Jordanian monetary authorities in the wake of the global financial crisis. A higher policy rate in Jordan also increases bank returns from holding excess reserves at the CBJ, and further discourages lending to the real sector.

In addition, we distinguish between banks' ability (lending capacity) and willingness (risk aversion) to lend and show that the former has a relatively stronger impact on the supply of bank credit. Estimations also suggest that the elasticity of credit demand with respect to the lending rate is also relatively smaller than the elasticity of credit supply. Taken together, these findings suggest that

[6] Under perfect competition, loans and excess reserves of banks become perfect substitutes at zero lending rate.

the equilibrium interest rate in Jordan is largely affected by shifts in credit supply. The liquidity preference curve approach of Khemraj (2010) provides further support to the credit supply shift hypothesis.

In a nutshell, the results of this study suggest that economic policies targeted towards stimulating credit supply are likely to be a more effective tool for expanding credit flows in Jordan relative to demand-stimulating policies. In particular, the monetary easing which occurred between November 2008 and February 2010, by narrowing the gap between policy rates in Jordan and the United States, looks to have assisted in expanding the supply of bank credit.

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Appendix A.

The disequilibrium approach is based on the notion that the observed volume of loans (C_t) is the minimum of demand (C^D) and supply (C^S), as indicated in Eq. (3). Let $\boldsymbol{\theta}_t$ denotes the probability that the observation C_t belongs to the demand equation:

$$\theta_t = Pr(C_t^D < C_t^S) = Pr(\beta' X_t^D + \varepsilon_t^D < \alpha' X_t^S + \varepsilon_t^S) = Pr(\varepsilon_t^D - \varepsilon_t^S < \alpha' X_t^S - \beta' X_t^D) \tag{5}$$

where X^S and X^D are vectors of credit supply and demand determinants, respectively, and $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are corresponding coefficients. Assuming that $\boldsymbol{\varepsilon}^D$ and $\boldsymbol{\varepsilon}^S$ are normally and independently distributed with variances $\boldsymbol{\sigma}^{2D}$ and $\boldsymbol{\sigma}^{2S}$, their difference $\boldsymbol{\varepsilon}^D - \boldsymbol{\varepsilon}^S$ is normally distributed with variance $\boldsymbol{\sigma}^2 = \boldsymbol{\sigma}^{2D} + \boldsymbol{\sigma}^{2S}$. Using this parameterization, Eq. (5) can be rewritten as:

$$\theta_t = \int_{-\infty}^{(\alpha' X_t^S - \beta' X_t^D)/\sigma} \frac{1}{\sqrt{2\pi}} e^{-\varepsilon^2/2} d\varepsilon \tag{6}$$

Now let's define the probability density functions of credit supply (f^S) and demand (f^D) as:

$$f^D(C_t) = \frac{1}{\sqrt{2\pi\sigma^D}} e^{-1/(2\sigma^{2D})(C_t - \beta' X_t^D)^2} \tag{7}$$

$$f^S(C_t) = \frac{1}{\sqrt{2\pi\sigma^S}} e^{-1/(2\sigma^{2S})(C_t - \alpha' X_t^S)^2} \tag{8}$$

The corresponding cumulative density functions for credit supply (F^S) and demand (F^D) are given by:

$$F^D(C_t) = \frac{1}{\sqrt{2\pi\sigma^D}} \int_{C_t}^{\infty} e^{-1/(2\sigma^{2D})(C_t^D - \beta' X_t^D)^2} dC_t^D \tag{9}$$

$$F^S(C_t) = \frac{1}{\sqrt{2\pi\sigma^S}} \int_{C_t}^{\infty} e^{-1/(2\sigma^{2S})(C_t^S - \alpha' X_t^S)^2} dC_t^S \tag{10}$$

Using this notation, the density function of credit conditional on excess supply (or conditional on credit laying on the demand curve) can be written as:

$$f(C_t | C_t^D < C_t^S) = \frac{f^D(C_t) F^S(C_t)}{\theta_t} \tag{11}$$

Similarly, the density function of credit conditional on excess demand (or conditional on credit laying on the supply curve) is:

$$f(C_t|C_t^S < C_t^D) = \frac{f^S(C_t)F^D(C_t)}{1-\theta_t} \tag{12}$$

Since C_t lies on the demand equation with probability $\boldsymbol{\theta}_t$ and on the supply equation with probability $(1-\boldsymbol{\theta}_t)$, the unconditional density of C_t given the observed values of determinants of credit demand (X^D) and supply (X^S) can be written as follows:

$$f(C_t|X_t^S, X_t^D) = \theta_t \frac{f^D(C_t)F^S(C_t)}{\theta_t} + (1-\theta_t)\frac{f^S(C_t)F^D(C_t)}{1-\theta_t} = f^D(C_t)F^S(C_t) + f^S(C_t)F^D(C_t) \tag{13}$$

Hence, the log-likelihood function takes the form of Eq. (4).

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