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PREFACE OF THE CHAIRMAN OF THE EDITORIAL BOARD

Dear readers,

The articles in this journal issue address the topics of liquidity risk and exchange rate variability. The authors explore the benefits and drawbacks of firm-bank relationships for corporate liquidity management, examine bank exposure to liquidity risk, and study the effects of a depreciation of the hryvnia in Ukraine.

The first article in the issue, *Do Firm-Bank Relationships Affect Corporate Cash Holdings*? by Andriy Tsapin, shows that firm-bank relationships can affect corporate cash holdings and liquidity management. Specifically, an increase in the length of a bank's relationship with a main bank initially reduces corporate cash holdings, but the effect turns positive due to the hold-up problem when the relationship matures. Additionally, companies with a greater number of bank relationships hold more cash reserves, whereas tight competition among banks allows firms to hold lower amounts of cash. The study also provides evidence that firm-bank relationships are important in helping firms resolve agency conflicts and reduce financial constraints.

The next article, *How Does Credit Risk Influence Liquidity Risk? Evidence from Ukrainian Banks* by Ruoyu Cai and Mao Zhang, investigates the link between liquidity risk and credit risk in the Ukrainian banking sector. The authors argue that banks with high level of non-performing loans did not meet depositors' withdrawal demands, which lowered cash flow and consequently increased liquidity risk. Moreover, the positive relationship between credit risk and liquidity risk is found to be more pronounced in foreign banks and large banks.

In the article *The Impact of Anticipated and Unanticipated Exchange Rate Variability in Ukraine*, Viktor Shevchuk examines the impact of the anticipated and unanticipated components of the nominal effective exchange rate changes on key macroeconomic indicators in Ukraine. The research shows that a depreciation of the hryvnia accelerated wholesale price inflation and negatively affected the performance of GDP and industrial output – these effects were clearly visible after the financial crisis of 2008–2009. The results are justified by means of a modified AD–AS model with rational expectations that accounts for the main mechanisms of the influence of the exchange rate on aggregate demand and supply amid a high level of dollarization in the economy.

We hope the findings of the research contained in this journal issue will be valuable to experts, scholars, and policymakers alike. The Editorial Board invites researchers working in the fields of economics, finance, and banking to submit original fundamental and applied studies for publication in the *Visnyk of the National Bank of Ukraine*.

Best regards,
Dmytro Sologub

CONTENTS

DO FIRM-BANK RELATIONSHIPS AFFECT CORPORATE CASH HOLDINGS?

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ABSTRACT

This paper explores the impact of firm-bank relationships on corporate cash holdings using a sample of more than 4,000 Ukrainian companies over the period from 2008 to 2015. The empirical evidence suggests that the duration of the relationship and the presence of multiple bank relationships affect corporate cash holdings. Specifically, an increase in the length of a bank's relationship with a main bank initially reduces corporate cash holdings but the effect turns positive due to the hold-up problem when the relationship matures. We also observe that companies with a greater number of bank relationships tend to hold more cash reserves, whereas more competition among banks allows firms to hold less cash. Additionally, we document that firm-bank relationships are important in helping firms resolve agency conflicts and facilitate reducing a firm's financial constraints.

JEL Codes: G32, G21, D22

Keywords: cash holdings, firm-bank relationships, financial constraints, managerial discretion

I. INTRODUCTION

After the 2008 crisis, financial and economic literature began scrutinizing corporate liquidity management decision to explain a significant increase in corporate cash reserves. The literature documents an accumulation of excess cash by firms that were expecting uncertainty about future cash flows (Almeida, Campello & Weisbach, 2004; Han & Qiu, 2007), expecting financial constraints (Opler, Pinkowitz & Williamson, 1999; Bigelli & Sanchez-Vidal, 2012), or facing agency-type conflicts (Yafeh & Yosha, 2003; Yu, Sopranzetti & Lee, 2015). At least theoretically, a bank's influence can weaken the effect of those issues that lead to excess cash holdings. Specifically, a close relationship between a company and a bank can ease a company's financial constraints (Ioannidou & Ongena, 2006). Banks also can assist firms in resolving agency conflicts (Yafeh & Yosha, 2003).

Redundant liquidity is especially a concern in emerging markets where firms rely more on internally generated funds because of the cost of external financing (Al-Najjar, 2013). In emerging markets, (i) firms typically do not have long-term credit histories and established market reputations (Singh, 2003); (ii) firms are susceptible to shocks in the banking sector because underdeveloped capital markets restrict firms from raising external capital and do not offer acceptable substitutes for bank loans (Shen & Huang, 2003). Furthermore, emerging markets typically have weak corporate governance standards and limited information disclosure requirements, which yields an information gap between a firm's managers and investors (Uyar & Kuzey, 2014). Thus, firms may be inclined to hoard more cash to finance operations than developed market peers. In addition, since emerging market financial systems are bank-oriented, corporate decisions on cash holdings are expected to be sensitive to firm-bank relationships.

Research on a bank's influence on corporate cash holdings is rarely conducted even in developed countries because of data limitations (Ozkan & Ozkan, 2004). Recently, Yu, Sopranzetti & Lee (2015) and Uyar & Kuzey (2014) studied the determinants of corporate cash holdings in emerging markets. Yu, Sopranzetti & Lee (2015) focused on the role of banking relationships as a governance device in corporate decisions on the cash ratio. However, to our knowledge, no research has been conducted on the nonlinearity in a bank's impact on corporate cash holdings.

This paper explores whether firm-bank relationships influence corporate cash holdings in an emerging market. In this study, we examine the role of the duration of the relationship with a main bank and ties to multiple banks in decisions relating to corporate cash holdings. Specifically, we test whether the effect of the duration on corporate cash holdings is nonlinear and if it turns from negative to positive in a mature relationship because of the hold-up problem. We also examine whether numerous banking relationships can increase corporate cash holdings because of free-rider monitoring problems or if they enable a reduction of cash by a bank's clients thanks to competition among banks.

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Our study explores the specific drivers of cash holdings for a comprehensive sample of Ukrainian exporter companies over the period from 2008 to 2015. Ukraine is an excellent market for researching the link between corporate cash flows and banking relationships for several equally important reasons. First, Ukraine is an emerging market where constrained firms have no acceptable substitutes for bank financing. Second, since Ukrainian exports accounted for almost 50% of GDP in 2015, unpredictable external conditions and export price volatility make the Ukrainian economy vulnerable to external shocks. Sensitivity to external shocks can be an important determinant of cash holdings, which explains our choice of a sample of large Ukrainian exporters. Finally, the National Bank of Ukraine (NBU) reports that economic agents keep a large share of assets in liquid instruments to ensure a proper liquidity buffer against possible shocks (NBU, 2016). At the same time, the excess liquidity does not notably affect bank lending (does not encourage a credit recovery) due to the poor creditworthiness of borrowers or inappropriate firm-bank links. We believe this study can help identify the specific determinants of cash holdings and reveal the role banking relationships play in corporate liquidity management.

The next section reviews relevant theories and introduces hypotheses on the link between corporate cash holdings and bank relationships. Section 3 describes the empirical methodology used; section 4 discusses the data sets and provides description statistics; section 5 presents the empirical results; and section 6 concludes.

II. THEORY AND EMPIRICAL HYPOTHESES

The financial literature on the topic traditionally use trade-off and pecking order theories to explain corporate cash levels. The trade-off approach argues that firms optimize the level of cash by weighing the marginal costs and benefits of cash (Miller & Orr, 1966). According to Keynes (1936), the benefits of those holdings stem from transactional and precautionary motives. Cash allows firms to avoid liquidating assets and to invest when financial constraints are met. Additionally, cash reduces the cost of external funds.

The pecking order model rejects the notion of a target level for liquid assets and says that firms finance themselves in a hierarchical fashion based on the relative costs of different sources of funds: firms first rely on internal financial funds and then external financing (Myers & Majluf, 1984). In this model, cash is considered as a buffer between retained earnings and investments.

Agency cost can also explain variations in cash reserves. The interests of a firm's managers and its shareholders are not perfectly aligned, and conflicts of interest over payout policies can arise (Jensen, 1986). Managers tend to increase the amount of assets under their control (i.e. cash or equivalents), thereby increasing their own power. Entrenched managers can even be inclined to invest free cash flows at below the cost of capital or spend funds inefficiently. Their behavior (managerial discretion) causes overinvestment and should be relevant for firms without substantial investment opportunities.

Companies can hoard cash in response to adverse shocks and in the face of financial constraints (Almeida, Campello & Weisbach, 2004) or as a result of managerial moral hazard (Yafeh & Yosha, 2003). Notably, firm-bank relationships can affect both of those issues (Degryse & de Jong, 2006).

When firms form new banking relationships, they secure higher loan amounts and expand their access to capital market services (Gopalan, Udell & Yerramilli, 2011). Moreover, Petersen & Rajan (1994) and Berger & Udell (1995) offer evidence that firms with longer relationships have easier access to bank credit and pay lower interest rates. Long-term bank relationships are most beneficial for firms that are sensitive to hold-up problems and suffer from large information asymmetries.[1] Luo & Hachiya (2005) find that cash is less important for firms with closer bank relations. It is plausible that a firm could be interested in building a long-term relationship with a bank and then holding less cash once it secures a good credit standing.[2]

However, firm-bank relationships can also impose costs and become costly over time. In establishing a relationship with a firm, banks can acquire access to information not otherwise publicly available (Fama, 1985). A bank that collects private corporate information gains bargaining power over the client (Rajan, 1992). In such a case, the firm faces a hold-up cost and can be forced by the bank to pay higher financing costs or to maintain additional cash holdings. Pinkowitz & Williamson (2001) find that firms tend to hold more cash during periods of high bank power (when banks abuse their monopolistic power). We thus offer our first hypothesis:

Hypothesis 1: *An increase in the duration of a relationship between a firm and its main bank initially has a negative effect on corporate cash holdings, but the effect turns positive at a certain level.*

A firm can easily be captured by its main bank owing to hold-up cost if the firm does business with a single bank (Rajan, 1992). The firm-bank relationship with a bank becomes less valuable if a bank's borrowing constraints outweigh the information benefits

[1] Von Thadden (2004) discusses the "hold-up problem" in detail.
[2] Here we focus on the key role of a main bank because the main bank is typically responsible for screening and monitoring the firm (Sufi, 2007).

(Gopalan, Udell & Yerramilli, 2011). Working with multiple banks and spurring competition among creditors can eliminate the hold-up risk inherent in a single-bank relationship (Detragiache, Garella & Guiso, 2000).

This can lead a firm to switch its main bank. The length of a banking relationship actually depends on determinants of switching costs, but firms are restrained from breaking existing relationships because switching may entail (i) additional transaction costs when opening new accounts, (ii) uncertainty about the quality of the new bank, and (iii) unobserved costs related to the loss of the capitalized value of the previously established relationship (Klemperer, 1995; Sharpe, 1990; Kim, Kliger, & Vale, 2003). Moreover, after changing banks, a firm does gain additional access to bank financing from the new bank, but they pay a higher interest rate that deteriorates the firm's performance (Stephan, Tsapin & Talavera, 2012). Therefore, a firm can better mitigate its dependence on its main bank by attracting a new niche bank or other financial institution (creditor) that can compete with the main bank.

However, there is no consensus in the literature regarding the link between the number of banks servicing a firm and a client's cash holdings. Firms can use new niche banks or banks that are prepared to finance a higher-risk firm's growth when an existing main bank has a resource limitation and declines to lend. Gopalan, Udell & Yerramilli (2011) explain firms' desire to attract a new bank by the life cycle of the firms and their need for growth, which cannot be financed by their main bank. In this case, we should observe an increase in transaction costs and cash holdings for firms that work with several banks. Furthermore, Degryse & Ongena (2001) argue that firms that work with many banks signal their low creditworthiness and are restricted in their access to external financing and thus should accumulate more cash. Finally, Chan, Lin, Chang & Liao (2013) show that numerous bank relationships can drive firms to take higher risks under conditions of information asymmetry between banks and firms. Risky activities in turn are likely to be secured by an additional cash buffer.

The positive association between the number of banks and corporate cash holdings can also be explained by bank behavior. Specifically, multiple creditors can suffer from a mutual free-riding problem (Holmstrom, 1982; Bris & Welch, 2005). The free-rider problem arises when the moral hazard in banking deteriorates the quality of a bank's screening and monitoring activities, which results in costly financing for clients. Banks lose their motivation to lend because profits from mutually financed projects are shared with other creditors.

By contrast, Diamond (1991) argues that multiple bank relationships may decrease a firm's liquidity risk. Yu, Sopranzetti & Lee (2015) document a negative association between a greater number of bank relationships and the level of cash holdings. They attribute this relationship to the lower needs of firms with multiple relationships to hold cash because they are likely to be less constrained in their access to external financing. Carletti, Cerasi & Daltung (2007) point out that multiple bank relationships can positively influence overall monitoring and increase a firm's performance. They argue that sharing the burden of lending allows banks to diversify risk despite the free-riding that reduces the cost of financing.

Thus, if a greater number of bank relationships lead to increased transaction costs or force firms into riskier behavior, then firms are expected to hold more cash reserves as a contingency. However, if competition among banks facilitates access to capital, then firms tend to hold less cash. We thus offer our second hypothesis:

Hypothesis 2: *The number of bank relationships has a positive effect on corporate cash holdings, but the effect turns negative at a certain level.*

To summarize, this study tests the impact of firm-bank relationships on corporate cash holdings. Specifically, we focus on the non-linear effects of the length of firm-bank ties and multiple bank relationships. In particular, corporate cash reserves are hypothesized to decrease with the duration of a relationship with a main bank, while the hold-up problem derived from the main bank's information monopoly may push firms to accumulate cash. We also examine whether multiple bank relationships lead to a higher cash ratio and whether competition among banks or the possible diversification from multiple bank relationships are likely to reduce corporate cash holdings.

III. REGRESSION MODEL

We extend the empirical model established by Opler, Pinkowitz & Williamson (1999) that includes fundamental determinants of cash holdings and build a regression model with the key characteristics of firm-bank relationships.

$$Cash_{it}=\beta_1 Duration_{it}+\beta_2 Duration_{it}^2+\beta_3 NB_{it}+\beta_4 NB_{it}^2+\sum_{j=5}^{13}\beta_j Controls_{it}+\mu_i+\lambda_i+\tau_t+\varepsilon_{it},$$

where *i* refers to firms and t to periods, μ_i, λ_i and τ_t are firm, industry, and time effects, respectively, ε_{it} denotes the error term. *Cash* is the ratio of cash to net assets.[3] $Duration_{it}$ is the duration of a relationship with a main bank. NB denotes the number of bank relationships.

[3] Net assets are defined as total assets excluding cash.

The model (1) allows us to test the non-linear impact of firm-bank relationships on corporate cash holdings. In contrast to the linear framework where a constant effect can be detected, the nonlinearity in the regressions – the inclusion of higher ordered terms ($Duration_{it}^2$ and NB_{it}^2) – allow the effects for duration and multiple bank relationships to vary with the value of the respective variables.

In our regression analysis, we control for other determinants of corporate cash holdings: the control variables are Cash Flow (*CF*), Net Working Capital (*NWC*), Size (*Size*), Leverage (*Leverage*), Debt Maturity (*DM*), and a proxy for the type of monetary policy (MP).

Cash Flow

The trade-off theory posits that cash is inversely related to cash flow because cash flow reduces the need for cash reserves (Kim, Mauer & Sherman, 1998). The alternative view posits that firms that generate cash flow can conserve an amount of cash to fund investment in the event of financial constraints (Opler, Pinkowitz & Williamson, 1999). The latter view, based on the pecking order theory, has more supporting empirical evidence.

Net Working Capital

Non-cash liquid assets or net working capital can substitute cash relatively easily (Opler, Pinkowitz & Williamson, 1999). Firms should therefore hold less cash if they hold more net working capital.

Size

Larger firms are more transparent and diversified, have better credit history, and more collateral. Moreover, borrowing costs are not proportional to loan size, which allows larger firms to save transaction costs by using economies of scale (Miller & Orr, 1966). Therefore, larger companies can more easily secure lower-cost external financing and should thus maintain lower cash holdings.

Growth Opportunities

Firms with growth opportunities suffer more from information asymmetry when applying for external capital. Therefore, they should hold more cash to avoid missing investment opportunities (Dittmar, Mahrt-Smith & Servaes, 2003).

Leverage

Highly leveraged firms are more likely to experience financial distress and firms keep more cash as a reserve for this (Ferreira & Vilela, 2003). However, leverage can also exert a negative influence on cash as it reduces the free cash flow problem (Harford, Klasa & Maxwell, 2014).

Debt Maturity

Firms with a larger proportion of short-term debt should hold more cash as they have a greater need to renegotiate their debt and are more exposed to refinancing risk (Wu, Rui & Wu, 2012).

Bank Loans

Dell'Ariccia & Marquez (2004) argue that banks may insure borrowers against credit rationing. Bank loans and the related monitoring activity allow firms to mitigate asymmetric information between potential borrowers and their creditors, which eases a firm's financial constraints. Additionally, bank debt is an important tool for external corporate governance; it reduces managerial discretion as monitoring activity informs banks and helps mitigate moral hazard (Degryse & de Jong, 2006). Moreover, borrowing from banks can signal to outside investors a firm's good financial standing (Koo & Maeng, 2008; Ozkan & Ozkan, 2004). This implies that bank-dependent firms are seen as creditworthy borrowers, which facilitates capital market financing. Finally, bank loans are a substitute for cash. Taking these arguments together, if a firm borrows from banks, it should hold less cash. We predict that firms with more bank debt hold less cash.

We also expect exporters to be more exposed to currency risk. Thus, we add to the model (1) the turnover ratio (*EXTurn*): the ratio of export sales to net assets.

The regression also includes a proxy for monetary policy (*MP*) to control for monetary liquidity conditions and the effect of monetary policy changes. We use a measure of the policy type that accounts for the relationship between money demand and money supply (Dai & Yang, 2015). The variable *MP* is defined as the M3 growth rate divided by the nominal GDP growth rate.[4] A loose monetary policy should result in excess monetary liquidity (money supply is greater than demand), whereas tight monetary policy leads to a shortage in monetary liquidity.

IV. DATA

To examine the link between firm-bank relationships and cash holdings, we use data from two sources. We use the SMIDA database from the National Securities and Stock Market Commission for balance sheet and income statement data for Ukrainian companies and the National Bank of Ukraine (NBU) for data on export activities of the firms serviced by banks. Our sample

[4] Alternatively, we can use the difference between these two rates.

includes only non-financial firms with positive sales and we discard the top and bottom 1% values for all firm-level continuous variables on an annual distribution to mitigate the potential influence of outliers on the parameter estimates in our analysis. After that, the year-end Consumer Price Index (CPI) for Ukraine is used to deflate the variables to 2008 hryvnia (UAH). After applying the filters, we obtain a sample of about 15,500 annual firm observations (for more than 4,000 firms) for the period of 2008-2015. The companies in our sample represent approximately 70% of large corporate exporters and more than 15% of all large active corporations in Ukraine.

Table 1 shows the descriptive statistics for the variables used in this study. In our sample, the cash holdings of firms range from almost 0% to 72.3% of net assets. Large exporters hold on average about 5% of net assets as cash reserves, while non-exporters (firms not included in our sample) hold only 4.1% of net assets as cash. The sample mean of cash flow, defined as the ratio of pre-tax profit plus depreciation and amortization to net assets, is about 9.8%. On average, bank loans represent 12.3% of total debt; short-term bank financing accounts for 8.6% of total debt.

About 45% of firms in the sample work with two or more banks. These firms have a shorter duration of relationship (two years) with their main banks than do firms that work with a single bank (almost three years). This is a preliminary sign that competition among banks/creditors may mitigate the hold-up problem that stems from a main bank's information monopoly.

Firms with multiple bank relationships are larger on average (UAH 21.882 billion in net assets vs. UAH 11.141 million for companies with a single bank), have a greater proportion of long-term debt, and borrow more from banks (13.6% vs. 10.3% of total debt), but they also have more short-term loans (6.4% vs. 5.0% of total debt). The latter underlines the importance of bank monitoring, as it suggests that the presence of more banks may be associated with short-term bank financing and accompanying stronger control from the creditors.

Theory suggests a strong relationship between a firm and a bank can ease financial constraints and smooth out cash flow volatility. To examine how a bank's ability to ease a client's financial constraints affects corporate cash holdings, we first split our full sample into sub-samples of bank-dependent and bank-independent firms. Firms with a low liquidity ratio and those who borrow from banks are treated as bank-dependent firms. We take an annual sample mean of the net working capital ratio to separate firms with different levels of liquidity. Bank-dependent firms face considerable internal constraints (lower cash flow relative to peers). They are highly leveraged and borrow more short-term funds, which entails stricter screening and monitoring from their banks (see Tables 2 and 3).

The descriptive statistics for firms with different levels of sales and cash flow volatility are reported in Tables 4 and 5, respectively. Volatility in sales (cash flow) is defined as the standard deviation of sales (cash flow) divided by the mean of the variable. Firms with more volatile sales and cash flow use more debt financing than do peers. At the same time, firms with high volatility of sales use more short-term bank loans, while firms with high volatility of cash flow use more short-term informal financing like trade credit. The data also show that firms with less bank debt hold more cash.

We will also examine whether firm-bank relationships can attenuate the overinvestment incentives that originate from the managerial discretion problem. We use the cash ratio and a proxy for investment opportunities to identify firms exposed to material agency conflicts between managers and shareholders. Firms with a cash ratio higher than the mean are likely to experience managerial moral hazard as managers accumulate cash to increase their power (Yafeh & Yosha, 2003). In addition, firms with poor prospects and below-mean sales growth may experience overinvestment issues as managers are incentivized to overspend (Degryse & de Jong, 2006). Tables 6 and 7 show the descriptive statistics for firms prone to agency conflicts and their peers.

V. RESULTS

This section reports our key findings. We begin our analysis by estimating the impact of the length of and number of bank relationships on corporate cash holdings. Our study also tests these links on the sub-samples to estimate the capacity of each channel to alleviate financial constraints and agency conflicts of bank clients.

Table 8 documents the estimation outcomes of the model (1) for the full sample. Here and further we present the results of the regressions with fixed effects (within-group transformations) robust to heteroscedasticity, since the null hypothesis of the Hausman Test (appropriateness of the random effects estimator) is rejected at the 1% level of significance in all specifications and the model with fixed effects is concluded to be preferable.[5] In all specifications we also control for industry effects and the business cycle.

The coefficients for all fundamental variables have predicted signs and almost all of them (except debt maturity) are highly significant (at the 1% level).[6] Adding key variables that measure different aspects of firm-bank relationships to the base model

[5] The Hausman statistics (χ^2) are reported in tables 8–11.

[6] The lower significance level for debt maturity can be explained to a certain extent by a level of collinearity between the debt maturity and the share of bank loans in total debt. The Pearson correlation coefficient for these two variables is 0.12, which is not critical and does not distort our main findings.

increases the model's explanatory power. Both F and t-tests support the relevance of a bank's influence on corporate cash holdings. Notably, the signs and significance levels of the control variables remain unchanged after the inclusion of key variables into the model.

Our findings confirm our key hypotheses about the impact of banks on corporate cash holdings. We also corroborate the findings of Ozkan & Ozkan (2004): bank financing serves as a substitute for cash reserves.

The results in Table 8 provide strong supporting evidence of the U-shaped relationship between the length of a bank relationship and corporate cash holdings as the estimated coefficients on Duration and Duration^2 have the expected signs and are significant at the 1% level in all specifications where they appear (Hypothesis 1). This suggests that firms initially benefit from starting to work with a bank as it allows them to reduce additional cash needs. However, once the relationship matures (after 3 years on average), firms start to increase cash reserves. That tendency is consistent with the notion that lasting relationships give rise to the hold-up problem when a bank acquires private client information not available to other financial institutions and thus gain a measure of control over the client (Fama, 1985; Rajan, 1992).

Our results also confirm the nonlinear relationship (inverted U-shaped) of the number of banks and corporate cash holdings at least at the 5% level (Hypothesis 2). Engagement of a new bank appears justified if a firm engages a niche bank and increases its cash to cover transaction costs. Otherwise, the positive association between corporate cash and numerous banking relationships indicates free-rider monitoring problem. On average, only competition among five or more banks can reduce financial constraints and corporate cash holdings. The latter evidence is in line with Yu, Sopranzetti & Lee (2015) and Carletti, Cerasi & Daltung (2007).

We next analyze the results for the sub-samples. Firms are first separated by their dependence on their main bank (see Table 9). The cash holdings of both bank-dependent groups are not sensitive to bank financing. A plausible explanation for this outcome is that these firms are highly leveraged (see Tables 2 and 3) and may be viewed by lenders as borrowers with low creditworthiness. Thus, firms with a low liquidity ratio and high bank debt can be considered financially constrained. Unlike constrained firms, their high-liquidity peers can substitute cash with bank loans relatively easily. The duration of firm-bank relationships is important for firms with varying levels of net working capital to form liquidity reserves, but the influence of the bank is more pronounced for the unconstrained firms.

The number of bank relationships significantly affects the cash holdings of financially constrained firms. This is the case when a firm with financial constraints applies to a new bank to finance high-risk projects. In this situation, the presence of multiple bank relationships is a sign of a firm's questionable creditworthiness (as shown by Degryse & Ongena, 2001). The negative and significant coefficients for the non-linear terms mean that an increase in the number of banks results in relaxed financial constraints.

Table 10 provides regression results for the sub-samples of firms with different levels of sales and cash flow volatility. Regardless of volatility, the length of a firm-bank relationship is a significant determinant of cash holdings for all types of firms. Bank debt has a significant and negative effect on cash holdings, but only for firms with a low volatility ratio. Our results show that, unlike their peers, riskier firms tend to work with multiple banks, which helps them curtail sales and cash flow volatility.

Finally, firms effectively use banking relations to resolve agency conflicts between owners and managers (Table 11). At the same time, neither the duration nor number of relationships affect the cash ratio in firms without any agency conflicts. Our key hypotheses about the impact of firm-bank relationships on corporate cash holdings are confirmed in firms with severe agency costs. Similar to the findings of Degryse & de Jong (2006), bank debt is found to be an efficient tool to address managers' overinvestment incentives. At the outset of a relationship, banks are ready to lend and monitor, which decreases cash levels and attenuates the agency issue. Competition among lenders have a similar effect. Nevertheless, a long-term relationship enables the hold-up problem, while multiple bank relationships may result in the free-rider problem. The latter effects can weaken the benefits from banking relationships for firms with agency conflicts. This means that matured relationships with a main bank and the moral hazard in banking reduce a bank's capacity to resolve agency conflicts.

V. CONCLUSIONS

In this paper, we examined the impact of firm-bank relationships on corporate cash holdings using a sample of more than 4,000 Ukrainian companies from 2008 to 2015. We test a bank's capacity to weaken financial constraints and managerial discretion problems by focusing on the effects of the duration and number of bank relationships.

Our findings show that banks play a significant role in monitoring firms by restricting the use of cash that could otherwise be misused by managers. Notably, firms use a bank's influence (duration and number of bank relationships) to resolve agency conflicts and eliminate overinvestment incentives at underperforming firms.

This paper also provides convincing evidence of the non-linear relationship (U-shaped) between the length of a banking relationship and corporate cash holdings. At the onset of a banking relationship, firms benefit from a reduction in the need

for additional liquidity. However, once the relationship matures (after 3 years on average), firms increase cash because of the hold-up problem that stems from a bank's control over a firm's private information.

We also find a non-linear relationship (inverted U-shaped) between the number of banks and corporate cash holdings. Multiple bank relationships are relevant for financially constrained firms with a significant debt ratio and low creditworthiness. Although the negative and significant coefficients for the non-linear terms show that the competition among banks that service a firm reduces the firm's financial constraints, the positive relationship between corporate cash reserves and the number of banks at low levels of competition may be a signal of a firm's poor creditworthiness (Degryse & Ongena, 2001) or a risk of the free-rider problem among the banks (Rajan, 1992).

That situation is concerning in the case of a bank that does not sufficiently screen potential borrowers. This institutional problem caused by information asymmetry can be partially addressed through the introduction of a credit registry. A lender may also choose to deliberately take on that risk, which could spur a propagation of risk through firm-bank links (Chan, Lin, Chang & Liao, 2013). However, any deeper analysis of those related issues is a topic for future research.

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APPENDIX

Table 1. Descriptive Statistics: All Firms

Variable	μ	σ	*Min*	*Max*
Cash	0.050	0.088	0.000	0.723
NWC	0.102	0.334	-2.249	0.889
Size	11.841	1.592	7.143	16.219
Growth	1.031	0.387	0.063	3.319
EXTurn	0.034	0.061	0.000	2.295
CF	0.098	0.217	-1.332	1.809
Leverage	0.596	0.387	0.017	2.858
DM	0.178	0.255	0.000	0.946
BC	0.123	0.192	0.000	0.997
STBC	0.086	0.169	0.000	0.834
Duration	2.505	1.713	1	8
NB	1.415	0.741	1	11
MP	1.151	0.052	1.087	1.273
N	15,482			

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. Growth is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 2. Descriptive Statistics for Firms with Low and High Liquidity

Variable	*Low Liquidity*		*High Liquidity*	
	μ	σ	μ	σ
Cash	0.042	0.083	0.058	0.092
NWC	-0.167	0.252	0.338	0.180
Size	11.849	1.672	11.826	1.521
Growth	1.032	0.398	1.030	0.377
EXTurn	0.035	0.072	0.032	0.049
CF	0.075	0.234	0.119	0.197
Leverage	0.756	0.395	0.456	0.320
DM	0.137	0.214	0.216	0.282
BC	0.119	0.184	0.112	0.170
STBC	0.097	0.178	0.076	0.159
Duration	2.455	1.698	2.548	1.726
NB	1.402	0.744	1.428	0.740
N	7,093		8,236	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. BC is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 3. Descriptive Statistics for Firms with and without Bank Debt

Variable	*Bank Loans > 0*		*Bank Loans = 0*	
	μ	σ	μ	σ
Cash	0.028	0.054	0.073	0.108
NWC	0.083	0.317	0.125	0.346
Size	12.292	1.529	11.372	1.521
Growth	1.026	0.382	1.036	0.392
EXTurn	0.027	0.057	0.040	0.064
CF	0.065	0.194	0.133	0.232
Leverage	0.683	0.362	0.506	0.390
DM	0.248	0.273	0.110	0.216
BC	0.228	0.190	0.000	0.000
STBC	0.170	0.205	0.000	0.000
Duration	2.354	1.619	2.659	1.792
NB	1.511	0.847	1.319	0.600
N	7,738		7,591	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. Size is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 4. Descriptive Statistics for Firms with Low and High Volatility of Sales

Variable	*Low Volatility of Sales*		*High Volatility of Sales*	
	μ	σ	μ	σ
Cash	0.054	0.090	0.045	0.084
NWC	0.113	0.324	0.082	0.350
Size	11.722	1.601	12.050	1.553
Growth	1.018	0.303	1.054	0.502
EXTurn	0.036	0.061	0.029	0.060
CF	0.115	0.214	0.068	0.217
Leverage	0.559	0.372	0.661	0.404
DM	0.172	0.250	0.189	0.263
BC	0.121	0.191	0.127	0.192
STBC	0.084	0.168	0.088	0.170
Duration	2.571	1.746	2.388	1.646
NB	1.441	0.745	1.371	0.734
N	9,871		5,611	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 5. Descriptive Statistics for Firms with Low and High Volatility of Cash Flow

Variable	*Low Volatility of Cash Flow*		*High Volatility of Cash Flow*	
	μ	σ	μ	σ
Cash	0.047	0.082	0.055	0.096
NWC	0.100	0.336	0.106	0.332
Size	11.850	1.582	11.825	1.607
Growth	1.021	0.374	1.047	0.407
EXTurn	0.034	0.064	0.033	0.056
CF	0.093	0.214	0.106	0.220
Leverage	0.588	0.400	0.610	0.365
DM	0.180	0.257	0.175	0.253
BC	0.127	0.194	0.115	0.187
STBC	0.089	0.171	0.080	0.164
Duration	2.412	1.648	2.656	1.804
NB	1.414	0.743	1.418	0.740
N	9,593		5,889	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 6. Descriptive Statistics for Firms with Low and High Cash Ratios

Variable	*Low Cash Ratio*		*High Cash Ratio*	
	μ	σ	μ	σ
Cash	0.004	0.004	0.093	0.105
NWC	0.052	0.331	0.149	0.330
Size	12.000	1.600	11.693	1.570
Growth	1.004	0.401	1.056	0.373
EXTurn	0.024	0.048	0.043	0.070
CF	0.063	0.201	0.130	0.225
Leverage	0.636	0.379	0.558	0.391
DM	0.197	0.262	0.160	0.247
BC	0.147	0.198	0.100	0.183
STBC	0.102	0.178	0.070	0.158
Duration	2.399	1.635	2.603	1.778
NB	1.388	0.715	1.441	0.765
N	7,465		8,015	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. Size is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 7. Descriptive Statistics for Firms with Low and High Growth

Variable	*Low Growth*		*High Growth*	
	μ	σ	μ	σ
Cash	0.045	0.084	0.057	0.093
NWC	0.103	0.336	0.101	0.331
Size	11.818	1.597	11.872	1.584
Growth	0.808	0.223	1.331	0.359
EXTurn	0.029	0.054	0.040	0.068
CF	0.080	0.219	0.122	0.211
Leverage	0.589	0.393	0.606	0.379
DM	0.182	0.258	0.172	0.251
BC	0.127	0.194	0.117	0.188
STBC	0.088	0.171	0.083	0.165
Duration	2.503	1.693	2.508	1.740
NB	1.408	0.733	1.426	0.753
N	8,887		6,595	

Note: *Cash* is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 8. Corporate Cash Holdings and Bank Relationships: Results for All Firms

Cash	(1)	(2)	(3)	(4)	(5)
NWC	-0.0202*** (0.0065)	-0.0206*** (0.0065)	-0.0198*** (0.0064)	-0.0201*** (0.0064)	-0.0201*** (0.0064)
Size	-0.0229*** (0.0030)	-0.0226*** (0.0030)	-0.022*** (0.0030)	-0.0230*** (0.0030)	-0.0230*** (0.0030)
Growth	0.0106*** (0.0018)	0.0105*** (0.0018)	0.0101*** (0.0018)	0.0100*** (0.0018)	0.0100*** (0.0018)
EXTurn	0.1830*** (0.0407)	0.1828*** (0.0408)	0.1859*** (0.0409)	0.1862*** (0.0408)	0.1862*** (0.0408)
CF	0.0439*** (0.0046)	0.0437*** (0.0046)	0.0433*** (0.0045)	0.0431*** (0.0045)	0.0431*** (0.0045)
Leverage	0.0303*** (0.0064)	0.0305*** (0.0064)	0.0313*** (0.0064)	0.0314*** (0.0064)	0.0314*** (0.0064)
DM	0.0123** (0.0060)	0.0119** (0.0060)	0.0115* (0.0060)	0.0122** (0.0060)	0.0122** (0.0060)
BC		-0.0137** (0.0066)	-0.0137** (0.0065)	-0.0140** (0.0065)	-0.0140** (0.0065)
Duration			-0.0078*** (0.0018)	-0.0068*** (0.0018)	-0.0068*** (0.0018)
$Duration^2$			0.0012*** (0.0003)	0.0011*** (0.0003)	0.0011*** (0.0003)
NB				0.0078*** (0.0020)	0.0078*** (0.0020)
NB^2				-0.0008** (0.0003)	-0.0008** (0.0003)
MP					0.3601*** (0.0941)
R^2	0.1131	0.1137	0.1172	0.1188	0.1188
F	17.445	16.909	15.928	15.294	15.294
χ^2	501.99***	507.48***	528.14***	533.43***	533.43***
N	15,482	15,482	15,482	15,482	15,482

Note: *i* refers to a firm, *t* refers to time. Each equation includes year and industry dummy variables. Robust standard errors are reported in parentheses. *$^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

Cash is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. Size is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 9. Corporate Cash Holdings and Bank Relationships: Do Banks Affect Financial Constraints?

Cash	*Bank–Dependent*		*Bank–Independent*	
	Low Liquidity	*Bank Loans > 0*	*High Liquidity*	*Bank Loans = 0*
	(1)	(2)	(3)	(4)
NWC	-0.0283** (0.0122)	-0.0122 (0.0070)	-0.0191 (0.0128)	-0.0305** (0.0122)
Size	-0.0130*** (0.0045)	-0.0164*** (0.0034)	-0.0335*** (0.0053)	-0.0350*** (0.0051)
Growth	0.0110*** (0.0025)	0.0084*** (0.0018)	0.0086** (0.0028)	0.0118*** (0.0035)
EXTurn	0.1130** (0.0510)	0.0976** (0.0409)	0.2517*** (0.0475)	0.2177*** (0.0577)
CF	0.0448*** (0.0063)	0.0235*** (0.0052)	0.0424*** (0.0070)	0.0551*** (0.0069)
Leverage	0.0302*** (0.0091)	0.0238*** (0.0069)	0.0266** (0.0119)	0.0496*** (0.0122)
DM	0.0121 (0.0112)	0.0036 (0.0059)	0.0030 (0.0086)	0.0205 (0.0124)
BC	0.0012 (0.0092)	-0.0038 (0.0058)	-0.0399*** (0.0090)	
Duration	-0.0059** (0.0025)	-0.0015 (0.0016)	-0.0072** (0.0025)	-0.0077** (0.0031)
$Duration^2$	0.0008** (0.0004)	0.0003 (0.0002)	0.0013*** (0.0004)	0.0013*** (0.0004)
NB	0.0068** (0.0027)	0.0039** (0.0016)	0.0078** (0.0034)	0.0131 (0.0085)
NB^2	-0.0007* (0.0004)	-0.0004* (0.0002)	-0.0007 (0.0006)	-0.0013 (0.0021)
MP	0.4871*** (0.1457)	-0.1165 (0.0869)	0.2722* (0.1341)	0.6588*** (0.1623)
R^2	0.134	0.075	0.118	0.162
χ^2	191.29***	178.34***	290.72***	392.75***
N	7,093	7,738	8,236	7,591

Note: *i* refers to a firm, *t* refers to time. Each equation includes year and industry dummy variables. Robust standard errors are reported in parentheses. *$p<0.10$, **$p<0.05$, ***$p<0.01$.

Cash is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 10. Corporate Cash Holdings and Bank Relationships: Do Banks Assist Firms in Curbing Volatility?

Cash	*Low Volatility*		*High Volatility*	
	Sales	*Cash Flow*	*Sales*	*Cash Flow*
	(1)	(2)	(3)	(4)
NWC	-0.0290*** (0.0085)	-0.0183** (0.0068)	-0.0064 (0.0098)	-0.0071 (0.0121)
Size	-0.0288*** (0.0041)	-0.0241*** (0.0038)	-0.0191*** (0.0042)	-0.0191*** (0.0046)
Growth	0.0131*** (0.0029)	0.0089*** (0.0022)	0.0074*** (0.0023)	0.0066*** (0.0031)
EXTurn	0.1474*** (0.0506)	0.1605*** (0.0470)	0.2563*** (0.0494)	0.2787*** (0.0549)
CF	0.0530*** (0.0056)	0.0325*** (0.0049)	0.0267*** (0.0073)	0.0299*** (0.0074)
Leverage	0.0355*** (0.0089)	0.0295*** (0.0072)	0.0281*** (0.0087)	0.0435*** (0.0118)
DM	0.0198*** (0.0073)	0.0104 (0.0072)	-0.0005 (0.0100)	0.0052 (0.0095)
BC	-0.0166** (0.0082)	-0.0147** (0.0066)	-0.0099 (0.0112)	-0.0187 (0.0137)
Duration	-0.0071*** (0.0022)	-0.0044** (0.0022)	-0.0064** (0.0031)	-0.0073** (0.0027)
$Duration^2$	0.0011*** (0.0003)	0.0009*** (0.0003)	0.0013** (0.0005)	0.0010*** (0.0004)
NB	0.0060** (0.0025)	0.0068** (0.0029)	0.0092*** (0.0033)	0.0098*** (0.0031)
NB^2	-0.0003 (0.0004)	-0.0006 (0.0005)	-0.0012** (0.0005)	-0.0011*** (0.0003)
MP	0.4052*** (0.1199)	-1.0388*** (0.1720)	0.1890 (0.1516)	0.5670*** (0.1675)
R^2	0.147	0.095	0.087	0.154
χ^2	424.29***	339.08***	159.10***	313.01***
N	9,871	9,593	5,611	5,889

Note: *i* refers to a firm, *t* refers to time. Each equation includes year and industry dummy variables. Robust standard errors are reported in parentheses. *$^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

Cash is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

Table 11. Corporate Cash Holdings and Bank Relationships: Do Banks Restrict Agency Conflicts?

Cash	*Agency Conflicts*		*No Agency Conflicts*	
	High Cash	*Low Growth*	*Low Cash*	*High Growth*
	(1)	(2)	(3)	(4)
NWC	-0.0382*** (0.0126)	-0.0107 (0.0087)	-0.0000 (0.0005)	-0.0261** (0.0112)
Size	-0.0481*** (0.0051)	-0.0200*** (0.0037)	-0.0002 (0.0002)	-0.0316*** (0.0049)
Growth	0.0072** (0.0035)	0.0222*** (0.0052)	0.0007*** (0.0002)	-0.0006 (0.0043)
EXTurn	0.1904*** (0.0553)	0.2455*** (0.0409)	0.0049** (0.0024)	0.1626** (0.0684)
CF	0.0555*** (0.0073)	0.0325*** (0.0056)	0.0007** (0.0003)	0.0589*** (0.0099)
Leverage	0.0638*** (0.0128)	0.0262*** (0.0081)	-0.0005 (0.0005)	0.0458*** (0.0116)
DM	0.0084 (0.0101)	0.0031 (0.0067)	-0.0004 (0.0005)	0.0245** (0.0111)
BC	-0.0271** (0.0120)	-0.0132* (0.0073)	-0.0011** (0.0005)	-0.0066 (0.0127)
Duration	-0.0063** (0.0031)	-0.0075*** (0.0022)	-0.0002 (0.0002)	-0.0051 (0.0030)
$Duration^2$	0.0011*** (0.0004)	0.0011*** (0.0003)	0.0000 (0.0000)	0.0010** (0.0004)
NB	0.0113*** (0.0034)	0.0092*** (0.0033)	0.0000 (0.0003)	0.0029 (0.0036)
NB^2	-0.0009** (0.0004)	-0.0010* (0.0006)	0.0000 (0.0000)	-0.0000 (0.0006)
MP	0.7641*** (0.1698)	0.3428** (0.1339)	0.0831*** (0.0109)	0.5807*** (0.1739)
R^2	0.192	0.096	0.143	0.166
χ^2	436.77***	277.86***	95.20***	262.42***
N	8,015	8,887	7,465	6,595

Note: *i* refers to a firm, *t* refers to time. Each equation includes year and industry dummy variables. Robust standard errors are reported in parentheses. *$^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

Cash is the ratio of cash to net assets, where net assets are defined as total assets excluding cash. Net assets are defined as total assets minus cash. *NWC* is constructed as the ratio of net working capital minus cash to net assets. *Size* is the natural logarithm of net assets. *Growth* is defined as the growth of a company's sales. *CF* is constructed as cash flow divided by net assets. *EXTurn* is the ratio of export sales to net assets. *Leverage* is total debt over net assets. *DM* is the share of long-term debt in a company's total debt. *BC* is the share of bank loans in a company's total debt. *STBC* is the share of short-term bank debt in a company's total debt. *Duration* is the length of a firm's relationship with its main bank in years. *NB* is the number of banks with which a firm works.

HOW DOES CREDIT RISK INFLUENCE LIQUIDITY RISK? EVIDENCE FROM UKRAINIAN BANKS

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ABSTRACT

This study investigates the link between two major risks in the banking sector: liquidity risk and credit risk. Utilizing a novel sample of Ukrainian banks for the period from Q1 2009 to Q4 2015, we document credit risk as having a positive relationship with liquidity risk. Our findings suggest banks with high level of non-performing loans might not meet depositors' withdrawal demands, which could lower cash flow and trigger depreciations in loan assets, and consequently increase liquidity risk. Furthermore, we find this positive relationship between credit risk and liquidity risk is more pronounced in foreign banks and large banks. Our results are robust with respect to alternative measures of bank risks.

JEL Codes: G21, G31, G33

Keywords: liquidity risk, credit risk, bank size, bank ownership

I. INTRODUCTION

The collapse in 2008 of Lehman Brothers, a global bank, brought down the global financial system, triggering numerous bank failures. In the wake of the crisis, substantial bailouts were required to shore up the financial sector. Anecdotal evidence suggests most bank failures are partly caused by liquidity problems and by the credit crunch. For example, the Material Loss Reports from the Federal Deposit Insurance Corporation (FDIC) state that liquidity risk and credit risk together contributed to most commercial bank failures during the recent crisis.[1]

In the banking sector, *liquidity risk* and *credit risk* are considered the major sources of default risk. Liquidity is viewed as a fundamental part of banking operations (Cornett et al., 2011) and the Basel Committee on Banking Supervision defines *liquidity risk* as the risk of being unable to meet the obligations of depositors or to fund increases in assets, which stems from a shortage of liquid assets (2008). Credit is another important element in banking. *Credit risk* materializes when a bank borrower or counterparty fails to meet obligations per agreed terms (Casu et al., 2006). Additionally, since banks accept deposits from savers and lend those funds to borrowers, a bank's asset and liability structures are closely connected, especially in terms of borrower defaults and deposit outflows (Bryant, 1980). Thus: are *liquidity risk* and *credit risk* closely related in banks?

A large amount of literature has investigated *liquidity risk* and *credit risk* in banks (e.g., Berger and Bouwman, 2009; Castro, 2013; Diamond and Rajan, 2001). The literature contains two main views on the link between the two risks. The first, the classic financial intermediation theory (Bryant, 1980) and the Diamond and Dybvig (1983) model, suggests *liquidity risk* and *credit risk* are positively related in banks, which is supported by empirical studies (e.g., Acharya and Viswanathan, 2011; Gorton and Metrick, 2011; He and Xiong, 2012). More specifically, a loan default can increase *liquidity risk* by leading to a decrease in cash flow and depreciations in loan assets (Dermine, 1986). For example, if a bank lends to distressed projects, it may then struggle to meet depositors' demands for funds. Then, if asset values deteriorate, depositors may demand their funds. On the other hand, some empirical studies also document a negative relation or no relation at all between *liquidity risk* and *credit risk* (e.g., Cai and Thakor, 2008; Wagner, 2007). These studies share a common trait – they focus on specific features of credit risk or liquidity risk, or on/ narrow economic circumstances. Given the contradictory viewpoints presented in the literature, the relationship between *credit risk* and *liquidity risk* remains an open question.

[1] The FDIC publishes Material Loss Reports for all bank defaults that result in a "material loss" to the FDIC insurance fund.

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Ukraine, an emerging market, offers an interesting framework in which to study the relationship between *credit risk* and *liquidity risk*. In the face of the political and economic challenges in recent years, Ukraine is viewed as a struggling economy and its banking sector has been named as one of the least efficient and highest cost emerging markets (Fries and Taci, 2005). Based on the *Banking Industry Country Risk Assessment* (2017) released by S&P Global, the risk in the Ukrainian banking system remains one of the highest in a global comparison due to the country's unstable political and economic environments. During the global financial crisis in 2008, Ukrainian banks experienced a sharp downturn and regional and sectoral imbalances (Liubkina and Borovikova, 2013), with outflows of deposits, a decreased liquidity position, and the threat of default risk. Rising non-performing loans (NPLs) also forced banks' profitability into losses. To relieve the pressure in the banking sector, the National Bank of Ukraine (NBU) introduced a large package of liquidity support.

In 2010, the economy began to recover from the serious recession; confidence in the banking sector returned and deposits returned to growth. After a short recovery, Ukrainian banks began to again accumulate the large imbalances until 2014-2015 when conditions deteriorated. Total deposits decreased 15% in 2014 and returned to growth only in the middle of 2015 as confidence in banks returned. Meanwhile, bad loans surged from 4.6% of all loans at the start of 2014 to 24.3% in late 2014 (Barisitz et al., 2012; Barisitz and Fungáčová, 2015). More recently, as reported in the Financial Stability Report (NBU, 2016), NPLs remain at record highs, while the late recognition of regulation contributes to the minor increase in the bad loans. Furthermore, liquidity risk has not abated because the distribution of high-quality liquid assets in Ukrainian banks is uneven. Overall, Ukrainian banks continue to face high levels of *credit risk* and *liquidity risk*.

To study the relationship between *liquidity risk* and *credit risk* in the Ukrainian banking sector, we use a novel sample of 176 Ukrainian banks from Q1 2009 to Q4 2015. The data were collected from Ukrainian banks' quarterly reports from the NBU website. In terms of the methodology, we use the fixed-effects estimator, justified using the Hausman Test. Using the fixed-effects model enables us to control for unobserved heterogeneity. With respect to the results, we find a positive and significant impact of *credit risk* on *liquidity risk* in Ukrainian banks. The results show that when credit risk increases by 1 percentage point (pp), liquidity drops by 0.061 pp.[2] A lower value of *liquidity* indicates a higher *liquidity risk*, meaning our results suggest that higher *credit risk* leads to higher *liquidity risk* in Ukrainian banks. In other words, a default in loans could easily increase the liquidity problem. Our main results are in-line with the classic financial intermediary theory (Bryant, 1980) and the Diamond and Dybvig (1983) model, as well as available empirical literature (e.g., Bryant, 1980; Dermine, 1986; Nikomaram et al., 2013).

Furthermore, since banks with different characteristics behave differently in terms of risk, we divide the banks into different sub-groups based on *size* and *ownership*. Our further estimation shows the positive relationship between *credit risk* and *liquidity risk* varies across different bank *sizes* and *ownership types*. We observe that the positive effect of *credit risk* is likely to exist only in larger, foreign owned banks. For foreign-owned banks, when *credit risk* increases 1 pp, *liquidity* falls 0.11.8 pp. For large banks, a 1 pp increase in *credit risk* results in an 0.084 pp decrease in *liquidity*. Our results are robust with respect to alternative measures of bank risks.

Our study contributes to the existing literature on bank *liquidity risk* and *credit risk*. Most of the existing literature focuses on investigating these two major bank risks separately, while limited studies estimate the link between the two together (e.g., Berger and Bouwman, 2009; Foos et al., 2010; Houston et al., 2010; Imbierowicz, 2014; Laeven and Levine, 2009). Furthermore, most empirical studies on the relationship between *liquidity risk* and *credit risk* only focus on developed countries. To bridge the gap, we extend the literature to an emerging economy, Ukraine. To the best of our knowledge, this is the first study that estimates the relationship between *liquidity risk* and *credit risk* in Ukrainian banks.

The rest of the paper is organized as follows: section 2 presents a critical review of literature on *liquidity risk* and *credit risk*; section 3 describes the data collection and methodology; section 4 provides the empirical analysis; section 5 contains a series of robustness tests; section 6 contains the summary and conclusion.

II. LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESIS

2.1. Bank liquidity risk

The financial crisis proved that liquidity, an important factor in the banking sector, has the potential to influence banks' survival (DeYoung et al., 2016). Financial intermediation theories posit liquidity production as a key to banking operations (Cornett et al., 2011). In banks, liquid assets refer to cash and assets that can be converted to cash quickly with limited or no losses (Casu et al., 2006). *Liquidity risk* refers to the risk of being unable to meet the obligations of depositors or to fund increases in assets as they fall due without incurring unacceptable costs or losses (BCBS, 2008).

The opaque nature of banks, with high information asymmetry, may increase *liquidity risk*. If external stakeholders were to receive the same information on the quality of the portfolio as insiders, banks would provide an appropriate price to take in deposits and take portfolio risks (Greenbaum and Thakor, 1995). When depositors are in greater need of withdrawals

[2] In our study, we follow Cornett et al. (2011) to use liquidity (the change in the liquidity position) as a proxy for liquidity risk. Thus, a higher value of liquidity indicates a lower level of liquidity risk.

than normal, *liquidity risks* can occur. To reduce the risk, banks can borrow funds from other banks or from the central bank. However, banks then pay a higher interest rate than the rate at which other banks borrow, which may increase the bank's costs. Banks can also reduce *liquidity risk* by increasing cash or other liquid assets, such as Treasury bills. This improves the bank's ability to sell assets, which can increase its resilience to liquidity shocks and diversify balance sheet risk (Cornett et al., 2011). Banks are therefore required to meet minimum liquidity standards according to the Basel III Accord (2010). However, holding more liquid assets carries associated costs. Holding too much cash can reduce profit because of the low returns of liquid assets (Casu et al., 2006).

Banks' asset and liability structures are closely connected, especially in terms of borrower defaults and deposit outflows (Bryant, 1980). Thus, a bank needs to identify and manage imbalances between assets and liabilities. Loans become illiquid assets when a bank provides liquid assets to borrowers (Diamond and Rajan, 2001), while loans can be used as collateral when banks need liquidity (Bhattacharya and Thakor, 1993). If demand for liquidity is high, banks can limit the supply of credit and change illiquid assets to liquid liabilities (Berger and Bouwman, 2009). However, banks can also create the liquidity by changing the funding on their liability side (Gorton and Winton, 2000). In addition, when borrowers choose to withdraw commitments, an off-balance sheet loan comes onto the balance sheet. In this case, half of commercial banks' liquidity creation occurs through off-balance sheet commitments (Berger and Bouwman, 2013).

2.2. Bank credit risk

Credit risk is another major element of bank default risk. The Basel Committee on Banking Supervision (2000) defines *credit risk* as the potential that a bank borrower or counterparty fails to meet its obligations in accordance with agreed terms. In other words, *credit risk* materializes when a loan is not paid in part or in full to a lender (Castro, 2013). *Credit risk* management is essential in identifying warning signs of a bank's vulnerability. Typically, banks provide credit to clients in one of two ways: banks can originate new loans (on the balance sheet) and provide lines of credit (off the balance sheet) (Allen, 2012).

The agency problem is another major concern that can create bank *credit risk*. Owing to the information asymmetry between a bank and a borrower, a borrower can fail to fulfill their commitment to a bank, which creates moral hazard. To minimize the *credit risk*, banks should adhere to strict underwriting standards and diversify exposures (Casu et al., 2006). In addition, in terms of the problem of adverse selection, banks can screen borrowers by assessing their ability to repay loans before issuing the credit.

2.3. The relationship between liquidity and credit risk in banks

A large amount of literature has been written about *credit risk*, starting with Merton (1974), whereas *liquidity risk* was a largely unexplored topic until 1998 (Imbierowicz and Rauch, 2014). Most authors explore *liquidity risk* and *credit risk* separately, but the link between the two has received only limited attention (e.g., Hertrich, 2015; Imbierowicz and Rauch, 2014). In general, these limited studies provide two arguments regarding the relationship between *credit risk* and *liquidity risk* in banks.

The first, grounded in the classic financial intermediation theory (Bryant, 1980) and the Diamond and Dybvig (1983) model, posits a positive relationship between *liquidity risk* and *credit risk*. In particular, a loan default can trigger a decrease in cash flow and depreciation in loan assets, thus increasing *liquidity risk* (Dermine, 1986). A new body of empirical study also supports this positive relationship. Diamond and Rajan (2001) state that if a bank provides loans to many distressed projects, it is more likely to fail to meet depositors' demands. Furthermore, if the values of those assets deteriorate, many depositors will demand a return of their funds, which will result in cash outflows. In-line with Diamond and Rajan (2001), Nikomaram et al. (2013) document a positive relationship between *credit risk* and *liquidity risk* in the Islamic banking sector. Gorton and Metrick (2011) show a different perspective on how perceived *credit risk* can lead to *liquidity risk*. Perceived *credit risk* (subprime loans) caused a substantial increase in refinancing rates and funding haircuts in the interbank market during the most recent financial crisis. Acharya and Viswanathan (2011) suggest that when asset prices deteriorate, it is more difficult to roll over debt because a liquidity problem exists. Based on the Diamond and Dybvig (1983) model, He and Xiong (2012) also focused on the debt rollover risk and found that lenders will not roll over debt contracts if the value of the underlying asset is below a certain threshold. In addition, Boss and Scheicher (2002) suggest a positive relationship between *credit risk* and *liquidity risk* in the European corporate bond market. Similarly, Ericsson and Renault (2006) established a bond valuation model and found that *credit risk* has a positive relationship with illiquidity.

However, there are other papers that provide negative or null evidence regarding the relationship between *liquidity risk* and *credit risk* (e.g., Cai and Thakor, 2008; Wagner, 2007). In general, these studies only focus on specific features of *credit risk* or *liquidity risk*, such as assets, deposits, and loan commitments, or on narrow economic circumstances. In particular, Nikomaram et al. (2013) use different proxies of *liquidity risk* and *credit risk* in their study and obtain different results regarding the relationship between the two risks, either positive or negative. Imbierowicz and Rauch (2014) failed to find a meaningful impact of *credit risk* on *liquidity risk* in US banks.

Studies with a negative or null relationship between *liquidity risk* and *credit risk* mostly focus on specific aspects of the risks given certain assumptions and economic environments. However, most recent empirical studies support the positive

relationship between *credit risk* and *liquidity risk*, which is consistent with the classic financial intermediation theory (Bryant, 1980) and the Diamond and Dybvig (1983) model. Thus, from a broad perspective, we address the following hypothesis, *H1: Credit risk is positively correlated with liquidity risk*.

III. DATA AND METHODOLOGY

3.1. Data and sample selection

We build a novel sample of Ukrainian banks for the period from Q1 2009 to Q4 2015. All bank-specific information is extracted from the quarterly reports of Ukrainian banks from the website of the National Bank of Ukraine (NBU). We start with the universe of available Ukrainian banks from the NBU and remove the banks that have had their license revoked or have been liquidated during the banking sector clean-up since 2014 (banks are removed from the dataset as of their date of removal from the market). Next, only banks with financial information available for at least two consecutive quarters are retained. Finally, we drop observations with extreme and questionable values. After the filtering process, our final estimation sample consists of 176 Ukrainian banks.

3.2. Liquidity risk and credit risk variables

In this study, we use two main variables to measure *liquidity* and *credit risk*. *Liquidity risk* reflects banks' ability to deal with unexpected liquid demand. Per Cornett et al. (2011), we use liquidity position as a proxy for *liquidity risk*, which is calculated as the change in total liquid assets during a quarter compared with total assets at the start of a quarter.[3] Total liquid assets include cash and other assets a bank can quickly convert to cash.[4] In our study, the value of the *liquidity risk* variable can either be positive or negative. A negative value of *liquidity risk* means a bank has a shortage of *liquidity*. A lower value indicates a higher *liquidity risk*. On the other hand, a positive value is a sign of low *liquidity risk* and is a sign a bank can cover some short-term withdrawals using liquid assets.

Table 1. Definition of variables

Variable name	Definition
Liquidity risk	$\Delta Liquid\ assets_{i,t}$ /Total $assets_{t-1}$
Credit risk	Non-performing loans/Total loans
Capital ratio	Total equity/Total assets
Illiquidity	Illiquid assets/Total assets
Efficiency ratio	Operating expenses/Total income
Deposit ratio	Total deposit/Total assets
Loans ratio	Loans/Total assets
Size	Log(Total assets)
ROA	Pre-tax profit/Total assets
Ownership	Dummy variable: 1 for a foreign-owned bank and 0 for a domestically owned bank

Furthermore, credit risk shows the potential a bank borrower or a counterparty fails to meet obligations in accordance with agreed terms. We follow previous studies (Gonzalez, 2005; Liang et al., 2013) and as a proxy for *credit risk* use the non-performing loans (NPL) ratio – impaired loans divided by total loans. This measure captures the current risk level of a bank's loan portfolio. A higher value of the *credit risk* variable indicates a higher level of *credit risk* at a bank.

3.3. Model specification and descriptive statistics

To estimate the effect of *credit risk* on *liquidity risk*, we use the following model:

$$Liquidity\ risk_{i,t} = \alpha + \beta Credit\ risk_{i,t-1} + X_{i,t-1}\delta + \theta_t + \mu_i + \varepsilon_{i,t}, \quad (1)$$

where *i* is the bank identifier and *t* is the year. Model (1) is estimated using a fixed-effects estimator, justified using the Hausman Test. Using the fixed-effects model enables us to control for unobserved heterogeneity. In this model, *liquidity risk* is the

[3] $Liquidity\ risk = \Delta Liquid\ assets_{i,t}/total\ assets_{i,t-1}$

[4] Due to the availability of data, liquid assets in this study include cash balances, held-to-maturity securities, available-for-sale securities, and financial assets designated at fair value through profit or loss.

dependent variable and α is constant. All independent variables are estimated with a one-quarter lag. The coefficient of key interest, β, captures the impact of *credit risk* on *liquidity risk*. A positive value of β indicates a positive relationship between *credit risk* and *liquidity risk* in Ukrainian banks, while a negative value denotes a negative relationship. μ is an individual-specific effect, which varies across banks, and ε denotes the error term, which varies among banks and across time periods. Additionally, the reported standard errors are adjusted for potential heteroscedasticity. However, our model (1) also has limitations. For example, it fails to address the endogeneity problem even though we use the one-quarter lagged independent variables.

Based on existing studies of bank risk (e.g., Imbierowicz and Rauch, 2014; Nikomaram et al., 2013), we include a set of control variables $X_{i,t}$ that can influence bank *liquidity risk*, namely the *illiquidity ratio*, the *capital ratio*, the *efficiency ratio, deposit ratio, loan ratio, size, return on assets (ROA)*, and *ownership*. The *illiquidity ratio* is the ratio of illiquid assets (assets not easily convertible to cash) to total assets. The *efficiency ratio* is calculated as operating expenses divided by total income, which indicates a bank's ability to turn expenses into revenue. The *capital ratio*, the proportion of total equity to total assets, reflects how well a bank operates and develops. In our study, *deposit ratio* and *loan ratio* are normalized by total assets to normalize differences in bank size. *Size* is defined as the natural logarithm of total assets. *Return on assets (ROA)* is measured as after-tax profit over total assets, which measures a bank's ability to generate profit with its assets. A dummy variable for foreign banks (*ownership*) is also included to account for ownership type; this variable equals 1 if a bank has foreign ownership and 0 if a bank is owned solely by domestic entities.

Table 2 reports the descriptive statistics for each variable in model (1). On average, *credit risk* is 0.123, which implies a low quality of loans in Ukrainian banks, with a slightly elevated NPL ratio. *Liquidity risk* averages 0.027 and ranges from -0.402 to 0.552. This suggests Ukrainian banks in our sample have relatively low liquidity risk. The average *capital ratio* in Ukrainian banks is around 21% and the average *illiquidity ratio* is 15.8%. The average *efficiency ratio* of 0.407 suggests Ukrainian banks are inefficient in converting assets into revenue. On average, the value of normalized *deposit ratio* is 32.6%, while for *loan ratio* it is slightly higher at 56.6%. In terms of operating performance, Ukrainian banks generate an average *ROA* of around -0.003. Approximately 16.9% of banks have foreign *ownership*.

Table 2. Descriptive statistics

Variables	Mean	Std	Min	P25	P50	P75	Max	N
Liquidity risk	0.027	0.122	-0.402	-0.033	0.016	0.075	0.552	3.553
Credit risk	0.123	0.142	0.000	0.033	0.080	0.154	0.971	3.827
Illiquid ratio	0.158	0.132	0.004	0.056	0.118	0.224	0.684	3.773
Efficiency ratio	0.407	0.248	0.050	0.249	0.346	0.507	2.009	3.707
Deposit ratio	0.326	0.161	0.000	0.206	0.335	0.444	0.727	3.784
Loan ratio	0.566	0.176	0.055	0.452	0.583	0.697	0.923	3.786
Size	14.358	1.571	11.501	13.132	14.165	15.308	18.982	3.752
Capital ratio	0.210	0.157	0.000	0.104	0.156	0.259	0.834	3.797
ROA	-0.003	0.022	-0.313	-0.000	0.000	0.001	0.035	3.782
Ownership	0.169	0.375	0.000	0.000	0.000	0.000	1.000	3.505

Note. This table provides summary statistics for the main variable in our study.

Multicollinearity is an important issue in regression models; it occurs when two or more variables are highly correlated. When variable ranges are narrow, a model's specifications can cause multicollinearity. Multicollinearity can also be the result of an over-determined model, which includes models with small numbers of observations but significant numbers of variables. The correlation matrix between the main variables is shown in Table 3. The results show there is no multicollinearity in our main model.

Table 3. Correlation matrix between variables

	Liquidity risk	Credit risk	Illiquid ratio	Efficiency ratio	Deposit ratio	Loan ratio	Size	Capital ratio	ROA	Owner-ship
Liquidity risk	1.000									
Credit risk	-0.110***	1.000								
Illiquid ratio	-0.036***	0.140***	1.000							
Efficiency ratio	-0.079***	0.215***	0.088***	1.000						
Deposit ratio	0.063***	-0.086***	-0.105***	-0.148***	1.000					
Loan ratio	-0.035**	-0.210***	-0.507***	-0.258***	0.201***	1.000				
Size	-0.003	0.202***	0.196***	-0.192***	0.015	0.037**	1.000			
Capital ratio	-0.074***	-0.113***	-0.143***	0.235***	-0.410***	0.010	-0.613***	1.000		
ROA	0.145***	-0.190***	-0.013	-0.049***	-0.022	-0.030*	-0.057***	0.070***	1.000	
Ownership	-0.042**	0.120***	-0.056***	0.090***	-0.187***	0.081***	0.435***	-0.215***	-0.018	1.000

Note: This table shows the correlation between each variable.

IV. EMPIRICAL RESULTS

4.1. The relationship between liquidity risk and credit risk

Table 4 reports the basic results of the relationship between *credit risk* and *liquidity risk* in Ukrainian banks. The coefficient of *credit risk* is negative and significant at 10%, which supports our hypothesis (H1). Since a lower value of *liquidity* indicates a higher *liquidity risk*, our results suggest that higher *credit risk* leads to higher *liquidity risk* in Ukrainian banks. More specifically, when credit risk increases by 1 pp, *liquidity* drops by 0.072 pp.

Similar to Cornett et al. (2001) and Imbierowicz and Rauch (2014), our results provide additional evidence to support the classic financial intermediation theory (Bryant, 1980) and the Diamond and Dybvig (1983) model. As a financial channel between depositors and borrowers, banks allocate deposits and provide loans. Typically, banks maximize profits by increasing the interest spread between deposits and loans. Since liquidity risk is the cost of profit-lowering, a loan default is more likely to lower cash flow and trigger depreciations in loan assets, which can ultimately result in an increase in liquidity risk (Dermine, 1986). Additionally, if a bank issues loans to many distressed projects, depositors can lose confidence in the bank and demand the return of their funds. In the event the bank is unable to meet those depositors' needs, liquidity shortages occur.

With respect to other bank-specific characteristics, the *illiquidity* ratio has a positive effect on *liquidity* at a significance level of 1%. This is consistent with Cornett et al. (2011), who studied the US banking sector. This indicates that banks with a higher fraction of illiquid assets in the investment portfolio tend to increase the holding of liquid assets. The *efficiency ratio* shows a negative relationship with liquidity risk, but it is not statistically significant. *Deposit ratio* and *loan* ratio both have a negative relationship with liquidity risk. More specifically, a 1 pp increase in *deposit ratio* and *loan ratio* results in a increase of 0.083 pp and 0.070 pp in liquidity risk, respectively. Similarly, the *capital ratio* coefficient is also positive, which suggests a negative relationship with *liquidity risk*. By contrast, the *size* coefficient is negative, which indicates a positive impact on *liquidity risk*. Specifically, a 1pp increase in bank size decreases *liquidity* by 0.068 pp.

Table 4. Relationship between liquidity risk and credit risk

	Liquidity risk
Credit risk	-0.072**
	(0.028)
Illiquid ratio	0.154***
	(0.040)
Efficiency ratio	-0.022
	(0.015)
Deposit ratio	0.083**
	(0.037)
Loan ratio	0.070**
	(0.035)
Size	-0.068***
	(0.010)
Capital ratio	0.117**
	(0.048)
ROA	0.387**
	(0.183)
Quarter dummy	Yes
N	3,306
R^2	0.180

Note: This table shows the relationship between credit risk and liquidity risk. Liquidity risk is calculated as the change in liquid assets divided by total assets in the previous quarter. Credit risk is measured as non-performing loans divided by total loans. The capital ratio is total equity divided by total assets. The illiquidity ratio is defined as the ratio of illiquid assets to total assets. The efficiency ratio is calculated as operating expenses divided by total income. Deposit ratio and Loan ratio are both normalized by total assets. ROA is measured as pre-tax profit divided by total assets. Size is the log of total assets. Ownership is a dummy variable that is equal to 1 for a foreign-owned bank and 0 for a domestic-owned bank. The analysis uses the panel fixed-effect estimator with lagged independent variables. A constant is included in the estimation but not reported. The robust error of each coefficient is shown in parentheses. *, **, *** indicate the statistical significance level at 10%, 5%, and 1%, respectively.

4.2. Results for foreign and domestic banks

From the previous study, we see that *credit risk* is positively correlated with *liquidity risk*. To further investigate the link, we explore whether banks of different characteristics behave differently in terms of risk. In Ukraine, nearly 20% of banks have foreign *ownership*. To differentiate the difference between domestic and foreign banks in terms of the behavior on risk, we categorize all Ukrainian banks into two groups: foreign-owned banks and domestically owned banks. Table 5 shows the results of the relationship between *credit risk* and *liquidity risk* by ownership group. The *credit risk* coefficient is negative and significant in columns (1) and (2), which suggests *credit risk* is positively correlated with *liquidity risk* in foreign- and domestic-owned banks. However, the positive correlation is more pronounced in foreign banks. In foreign-owned banks, when *credit risk* rises by 1 pp, *liquidity* falls by 0.116 pp. In domestically owned banks, a 1 pp increase in *credit risk* leads to a 0.061 pp decrease in *liquidity*. Based on the global advantage hypothesis, foreign banks benefit from competitive advantages relative to domestic banks, such as better risk management and advanced information technologies. Accordingly, foreign banks could have lower level of risk than domestic banks. Our results, however, suggest that the positive relationship between credit risk and liquidity risk is more pronounced in foreign banks, which is counterintuitive. Therefore, it might be because domestically owned banks typically underestimate risks in Ukrainian banks. Additionally, in-line with our baseline results, the *illiquidity ratio* is negatively correlated with *liquidity risk* at a 10% significance level in domestically owned banks. By contrast, *size* has a positive relationship with *liquidity risk* in both foreign- and domestic-owned banks. The influence is more pronounced in domestic banks. Fur-

thermore, for foreign banks, *deposit ratio have* a negative effect on *liquidity risk*, while *ROA* is negatively correlated with bank *liquidity risk* only in domestic banks.

Table 5. The relationship between credit risk and liquidity risk by bank ownership

	Foreign banks	Domestic banks
	(1)	(2)
Credit risk	-0.116**	-0.061*
	(0.044)	(0.036)
Illiquid ratio	0.093	0.174***
	(0.072)	(0.050)
Efficiency ratio	-0.022	-0.019
	(0.022)	(0.019)
Deposit ratio	0.165**	0.064
	(0.062)	(0.044)
Loan ratio	0.064	0.062
	(0.065)	(0.043)
Size	-0.055**	-0.077***
	(0.024)	(0.012)
Capital ratio	0.235	0.081
	(0.143)	(0.054)
ROA	-0.040	0.373*
	(0.287)	(0.208)
Quarter dummy	Yes	Yes
N	530	2,494
R^2	0.393	0.171

Note: This table shows the relationship between credit risk and liquidity risk. Column (1) reports the results for foreign-owned banks and column (2) for domestic banks. Liquidity risk is calculated as the change in liquid assets divided by total assets in the previous quarter. Credit risk is measured as non-performing loans divided by total loans. The capital ratio is total equity divided by total assets. The illiquidity ratio is defined as the ratio of illiquid assets to total assets. The efficiency ratio is calculated as operating expenses divided by total income. Deposit ratio and Loan ratio are both normalized by total assets. ROA is measured as pre-tax profit divided by total assets. Size is the log of total assets. Ownership is a dummy variable that is equal to 1 for a foreign-owned bank and 0 for a domestic-owned bank. The analysis uses the panel fixed-effect estimator with lagged independent variables. A constant is included in the estimation but not reported. The robust error of each coefficient is shown in parentheses. *, **, *** indicate the statistical significance level at 10%, 5%, and 1%, respectively.

4.3. Results for large and small banks

Ukraine's banking sector has a lower concentration and is more fragmented than other transition countries, with the prevalence of small "pocket banks" that often lend to related parties. In this section, to distinguish the effect of *credit risk* on *liquidity risk* in different sizes of banks, banks are divided into large and small sub-groups based on total assets. The median total asset size across the sector (UAH 1,166,286,000) is the threshold: large banks have above-median total assets and small banks have below-median total assets. In Table 6, we find that in large banks, credit risk shows a positive relationship with *liquidity risk*, with a 1% significance level. A 1 pp increase in *credit risk* results in an 0.085 pp decrease in *liquidity*. At small banks, *credit risk* has no effect on *liquidity risk*.

In terms of other variables, the *illiquidity ratio* and *loan ratio* in both small and large Ukrainian banks are negatively correlated with *liquidity risk* at a 1% significance level. Similar to previous baseline results, *size* has a positive influence on *liquidity*

risk in both small and large banks, but the impact is greater in small banks. *ROA* is negatively correlated with *liquidity risk* in small banks, while the *efficiency ratio* has a positive relationship with *liquidity risk* in large banks.

Table 6. The relationship between credit risk and liquidity risk by bank size

	Small banks	Large banks
	(1)	(2)
Credit risk	0.005	-0.085***
	(0.059)	(0.029)
Illiquid ratio	0.183**	0.166***
	(0.072)	(0.060)
Efficiency ratio	0.025	-0.061***
	(0.024)	(0.018)
Deposit ratio	0.090	0.070
	(0.063)	(0.057)
Loan ratio	0.091*	0.095*
	(0.052)	(0.054)
Size	-0.122***	-0.083***
	(0.023)	(0.016)
Capital ratio	0.040	0.129
	(0.072)	(0.102)
ROA	1.082***	0.121
	(0.327)	(0.170)
Quarter dummy	Yes	Yes
N	1,605	1,701
R^2	0.148	0.291

Note: This table shows the relationship between credit risk and liquidity risk. Column (1) reports the results for small banks and column (2) for large banks. Liquidity risk is calculated as the change in liquid assets divided by total assets in the previous quarter. Credit risk is measured as non-performing loans divided by total loans. The capital ratio is total equity divided by total assets. The illiquidity ratio is defined as the ratio of illiquid assets to total assets. The efficiency ratio is calculated as operating expenses divided by total income. Deposit ratio and Loan ratio are both normalized by total assets. ROA is measured as pre-tax profit divided by total assets. Size is the log of total assets. Ownership is a dummy variable that is equal to 1 for a foreign-owned bank and 0 for a domestic-owned bank. The analysis uses the panel fixed-effect estimator with lagged independent variables. A constant is included in the estimation but not reported. The robust error of each coefficient is shown in parentheses. *, **, *** indicate the statistical significance level at 10%, 5%, and 1%, respectively.

5. ROBUSTNESS TEST

5.1. Alternative measures

In addition to our previous analysis, we estimate the relationship between *liquidity risk* and *credit risk* using an alternative measure of *credit risk*. In this section, following Liang et al. (2013), we recalculate *credit risk* as the ratio of non-performing loans (NPLs) to total assets. As shown in Table 7, the alternative measure of *credit risk* still has a positive relationship with *liquidity risk*. Specifically, if *credit risk* increases by 1 pp, *liquidity* reduces by 0.160 pp. This result is consistent with our previous analysis and provides additional evidence for our hypothesis (H1): higher *credit risk* at banks leads to higher *liquidity risk*.

As in Table 4 (main model), most of the control variables have a significant influence on *liquidity risk*. Overall, *size* is negatively correlated to *liquidity risk*. By contrast, the *illiquidity ratio*, the *capital ratio, loan ratio,* and *deposit ratio* are positively related to *liquidity risk* in Ukrainian banks.

Table 7. The relationship between credit risk and liquidity risk (robust)

	Liquidity risk
Credit risk	-0.160***
	(0.060)
Illiquid ratio	0.154***
	(0.040)
Efficiency ratio	-0.021
	(0.015)
Deposit ratio	0.084**
	(0.037)
Loan ratio	0.090***
	(0.034)
Size	-0.069***
	(0.010)
Capital ratio	0.119**
	(0.047)
ROA	0.357*
	(0.183)
Quarter dummy	Yes
N	3,306
R^2	0.181

Note: This table shows the relationship between credit risk and liquidity risk. Liquidity risk is calculated as the change in liquid assets divided by total assets in the previous quarter. Credit risk is measured as non-performing loans divided by total loans. The capital ratio is total equity divided by total assets. The illiquidity ratio is defined as the ratio of illiquid assets to total assets. The efficiency ratio is calculated as operating expenses divided by total income. Deposit ratio and Loan ratio are both normalized by total assets. ROA is measured as pre-tax profit divided by total assets. Size is the log of total assets. Ownership is a dummy variable that is equal to 1 for a foreign-owned bank and 0 for a domestic-owned bank. The analysis uses the panel fixed-effect estimator with lagged independent variables. A constant is included in the estimation but not reported. The robust error of each coefficient is shown in parentheses. *, **, *** indicate the statistical significance level at 10%, 5%, and 1%, respectively.

5.2. Potential endogeneity concern

Endogeneity is one area of concern in our analysis. The relationship between *credit risk* and *liquidity risk* may be biased because of a possible correlation between the independent variables and the error term. On one hand, banks with high level of non-performing loans may carry *liquidity risk*. On the other, banks with liquidity shortages may also face *credit risk*. In the previous analysis, we partially address this reverse causality by employing a one-quarter lagged *credit risk*.

As a possible solution, our empirical analysis is extended to use the Arellano-Bond (1991) dynamic Generalized Method of Moments (GMM) estimator, which accounts for unobserved heterogeneity as well as the dynamic relation between *credit risk* and previous *liquidity risk*. We report the GMM regressions in Table 8.

Table 8. The relationship between credit risk and liquidity risk (GMM)

	Liquidity risk
L. Liquidity	-0.065**
	(0.033)
Credit risk	0.171
	(0.108)
Illiquid ratio	-0.022
	(0.119)
Efficiency ratio	-0.240***
	(0.078)
Deposit ratio	0.183**
	(0.078)
Loan ratio	-0.024
	(0.086)
Size	-0.057***
	(0.021)
Capital ratio	0.049
	(0.132)
ROA	1.581***
	(0.497)
Quarter dummies	Yes
N	3,001
AR(2) P-value	0.740
Hansen Test P-value	0.184

Note: This table shows the results of the GMM regression of the relationship between credit risk and liquidity risk. Liquidity risk is calculated as the change in liquid assets divided by total assets in the previous quarter. Credit risk is measured as non-performing loans divided by total loans. The capital ratio is total equity divided by total assets. The illiquidity ratio is defined as the ratio of illiquid assets to total assets. The efficiency ratio is calculated as operating expenses divided by total income. Deposit ratio and Loan ratio are both normalized by total assets. ROA is measured as pre-tax profit divided by total assets. Size is the log of total assets. Ownership is a dummy variable that is equal to 1 for a foreign-owned bank and 0 for a domestic-owned bank. The analysis uses the panel fixed-effect estimator with lagged independent variables. A constant is included in the estimation but not reported. The robust error of each coefficient is shown in parentheses. *, **, *** indicate the statistical significance level at 10%, 5%, and 1%, respectively.

All the independent variables are assumed to be endogenous variables, except the quarter dummies. The lags (t-2 and t-3) of *liquidity* and lags (t-2, t-3, and t-4) of the endogenous variables, together with all the lags of the exogenous variables, are instrument variables. In Table 8, our instruments satisfy the second order serial correlation test and the Hansen Test of over-identification. However, we fail to find a negative and significant impact of *credit risk* on *liquidity risk*.

VI. CONCLUSION

Credit risk and *liquidity risk* are major sources of bank default risk. The existing literature focuses largely on the effect of *credit risk* or *liquidity risk* in the banking sector separately, while limited studies consider the link between the two. We expand the literature by investigating the relationship between *credit risk* and *liquidity risk*, as well as the effect of banks' character-

istics on the link between *credit risk* and *liquidity risk* in an emerging economy, Ukraine. This paper utilizes a novel sample of Ukrainian banks, covering 176 banks over the period from Q1 2009 to Q4 2015. We find that the credit and liquidity risk in Ukraine's banking sector is relatively high compared to other developed economy banking sectors.

Our results provide empirical evidence to support the classic financial intermediation theory (Bryant, 1980) and the Diamond and Dybvig (1983) model. In particular, higher *credit risk* leads to higher *liquidity risk*. Banks maximize profit by increasing the interest spread between deposits and loans. Then, a loan default leads to lower cash flow and triggers depreciations in loan assets, which ultimately increases *liquidity risk* in banks.

Since banks with different characteristics behave differently in terms of risk, we then further estimate the effect of bank *size* and *ownership* on the positive link between *credit risk* and *liquidity risk*. Our findings suggest that the positive relationship is slightly stronger in larger banks and foreign-owned banks. We conduct a robustness check by replacing *credit risk* with an alternative measure, which yields consistent results.

Our empirical findings carry some implications for regulators and policy makers. Managing *credit risk* and *liquidity risk* is important in the banking sector, and risk management practices can affect banking sector stability. Given Ukraine's unstable financial system, more efforts should be placed on the management of *liquidity risk* and *credit risk* in conjunction with asset quality.

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THE IMPACT OF ANTICIPATED AND UNANTICIPATED EXCHANGE RATE VARIABILITY IN UKRAINE

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ABSTRACT

This article studies the impact of the anticipated and unanticipated components of the nominal effective exchange rate on Ukraine's main macroeconomic indicators. The study uses quarterly data from 1999 to 2016 and considers the relationship with the budget balance, incomes of trading partner countries, global interest rates, and global raw material prices. Using the time-varying coefficient model (the Kalman filter), the research shows that a depreciation of the hryvnia accelerates wholesale price inflation and negatively affects the performance of GDP and industrial output – these effects were clearly visible after the financial crisis of 2008–2009). However, the research found that only unanticipated changes in the exchange rate have an impact on agricultural production. The results are justified by means of a modified AD–AS model with rational expectations that accounts for the main mechanisms of the influence of the exchange rate on aggregate demand and supply amid a high level of dollarization in the economy.

JEL Codes: E31, E51, F37, F41

Keywords: exchange rate, income, wholesale price inflation, Kalman filter, Ukraine

I. INTRODUCTION

In an inflation targeting regime, analyzing anticipated and unanticipated changes to an exchange rate is important for assessing the signal effect from foreign exchange (FX) interventions, which are justifiably viewed as an essential element of the National Bank of Ukraine's (NBU) policy (Grui and Lepushynskyi, 2016). The macroeconomic consequences of a signaled change in an exchange rate may depend on agents' perception of whether disturbances are permanent (anticipated) or temporary (unanticipated). The nature of those expectations is especially significant under conditions of a stabilization policy in economies that lack FX risk hedging tools. Using Mexico as an example, Mendoza and Uribe (2000) show that depreciation expectations can lead to difficulties related to an increase in the interest rate premium, which reduces demand for money, savings, investment, and labor supply. Sanchez (2005) provides theoretical proof that fear of a floating exchange rate can be explained by the central bank raising interest rates in response to the restrictive effect of currency depreciation, which is accompanied by an acceleration of inflation. This only serves to worsen the decline in output and provokes criticism against anti-inflation monetary policy.

Although cases of reduced incomes seem to be more a product of currency depreciation than an anti-inflation interest rate increase (Frankel, 2005), the depreciation shock as the main reason for a drop in output is often explained by pre-crisis imbalances – especially in the case of an FX crisis. Therefore, depreciation actually has a stimulus effect when taking the circumstances into consideration (Bussière et al., 2012). This approach has been and remains popular in Ukraine. For example, the economic recovery of 1999–2000 was related to a substantial depreciation of the hryvnia (Stelmakh, 2001), while any measures to strengthen the currency were considered harmful. The idea of a clear benefit from an undervalued exchange rate and being doomed to a weak hryvnia still has its proponents in the current post-crisis economic environment – against the backdrop of a sharp depreciation from UAH 8/USD to UAH 26-27/USD. For example, Yurchyshyn (2016) believes the administrative measures to restrain a further depreciation of the hryvnia adversely affected the manufacturing sector and the household's welfare, accelerated the economy's dollarization, and provoked greater panic among the public.

This article aims to assess the impact of anticipated and unanticipated changes to the nominal effective exchange rate (NEER) upon the main macroeconomic indicators of the Ukrainian economy: GDP, industrial and agricultural production growth, and

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wholesale price inflation. The empirical estimates utilize the time-varying coefficient model (Kalman filter), which accounts for possible structural changes and complies overall with the concept of rational expectations. The author's own modification of the standard AD–AS model is used to provide theoretically consistent explanations for the functional relationships. The theoretical analysis offers a better understanding of the exchange rate impact, while the empirical results are important in assessing the effectiveness of FX interventions as an auxiliary element of inflation targeting policy.

The article starts by providing an overview of the main studies on the topic of the macroeconomic effects of the exchange rate. The paper then outlines the potential differences between the consequences of anticipated and unanticipated changes in the exchange rate (using the standard AD–AS model with rational expectations), describes the source data and the research method, and explains the findings. The final section provides concise conclusions and recommendations to summarize the study.

II. LITERATURE REVIEW

In the model, which accounts for aggregate demand and supply mechanisms, Agenor (1991) showed that an anticipated devaluation under a fixed exchange rate regime had a negative effect on income, while unanticipated devaluation is of a favorable impact. That marks a difference from the earlier models of the 1970s and 1980s, which found that the effect of an anticipated change in the exchange rate depended on the relative strength of the mainly expansionary factors of aggregate demand and the restrictive factors of aggregate supply. Agenor's conclusions had been empirically supported using data from 23 developing countries.

Kandil and Mirzaie (2003) proposed a modified AD–AS model, in which unanticipated devaluation increases aggregate demand through improvements in the trade balance, but it also increases demand for money thus restricting the supply of goods and services at the expense of higher import prices. Since unanticipated depreciation leads to a favorable price "surprise" (prices rise by more than expected), there is higher demand for labor, which translates into an increase in wages. Consequently, the employment level and output also rise. The impact of a devaluation on the aggregate supply depends on which effect prevails: whether it is an expansionary price "surprise" factor or a restrictive factor of higher prices for imported raw materials. For 33 developing countries, research shows that an unanticipated increase of the real exchange rate (RER) has a restrictive effect in two countries and an expansionary effect in three countries only. In the remaining countries, the regression coefficients were not statistically different from zero. Consumer prices grew in four countries and fell in two countries. The impact of the anticipated component of the RER on income levels and prices was not determined (except in one country that experienced price hikes).

Later, Kandil (2015) found that in Latin American countries, a devaluation – both anticipated and unanticipated – tends to have a restrictive effect and accelerate inflation (unpredictable changes in an exchange rate are stronger in a system of floating exchange rates). As for Australia, Kohler et al. (2014) found that an unanticipated decrease of the RER by 10% prompts GDP to temporarily increase by 0.25-0.5 pp over two years and to increase permanently by 1 pp over three years (with inflation growing 0.25-0.5 pp).

Additional theoretical arguments stem from the distribution of demand for and supply of goods of domestic and foreign trade – Q^N and Q^T, respectively (Lizondo and Montiel, 1988). Price increases for imports becomes restrictive if the size of the wage increase is lower than the currency devaluation. Since the impact of an anticipated devaluation on the RER is lower than in the case of an unanticipated change in the exchange rate, the macroeconomic effects should also be lower. An increase in the costs of working capital due to an increase in interest rates is practically the only factor that restricts the supply of goods QT directly because of devaluation. This mechanism used to be called the "Cavallo effect".

Leaving aside the decomposition into the anticipated and unanticipated components, empirical studies mostly find a standard expansionary effect from a devaluation in industrial countries, mainly due to increased exports and reduced imports, while restrictive effects prevail in developing countries (Bahmani-Oskooee and Miteza, 2006; Hutchison and Noy, 2002). At the same time, a decline in production is seen, both in the case of a devaluation under a fixed exchange rate and depreciation under a floating exchange rate (Ahmed et al., 2002). Restrictive devaluation is found to prevail in Latin American countries (Bebczuk et al., 2006; Pineres and Cantavella-Jorda, 2010), but it is also not uncommon in Asian countries either (Chou and Chao 2001; Moreno, 1999). Since an improvement in the trade balance is combined with a decline in the government revenues in Latin American countries (An et al., 2014), the aggregate supply is concluded to be the dominant factor.

Earlier studies on the Central and Eastern European (CEE) countries mainly showed a restrictive devaluation effect (Miteza, 2006), while later studies demonstrated rather ambiguous results across different countries (Bahmani-Oskooee and Kutan, 2008). The results are more favorable for excgange rate depreciation effects when using the RER (Mirdala, 2013), which can be interpreted in favor of a 'weaker' currency. However, in a number of studies, the strengthening of the RER is a factor behind an increase in output in Bulgaria (Hsing and Krenn, 2016), Slovakia (Hsing, 2016a), the Czech Republic (Hsing, 2016b), and Croatia (Hsing, 2016c). In Macedonia, a weakening of the exchange rate drives up inflation but does not affect output (Fetai and Zeqiri, 2010). Poland is practically the only country where empirical studies have shown a sustained expansionary effect from an exchange rate depreciation (Haug et al., 2013; Twarowska, 2015; Mills and Pentecost, 2001).

Notably, an expansionary effect from a declining RER does not mean that a currency devaluation will produce a similar effect, as it may be hindered by a pass-through effect in domestic prices. Freund and Pierola (2012) found that a moderate decline in the RER (by 20%) creates a favorable precondition for an increase in exports of industrial goods, as long as the nominal exchange rate remains stable. However, in the CEE countries, research shows that each percent of devaluation increases the RER by 0.5% to 0.6%, while the pass-through effect is slightly higher for countries with a fixed exchange rate (Beirne and Bijsterbosch, 2009).

Particular difficulties for an analysis of exchange rate effects used to be found in the case of large devaluations of a currency (by more than 20%) resulted from the currency crisis. Based on a study of 195 currency crises in 91 developing countries from 1970 to 1998, IMF experts found that both expansionary and restrictive effects can be obtained (with a higher probability of the latter in large and more developed economies, with a significant inflow of capital on the eve of the currency crisis) (Gupta et al., 2003). Efforts to restore production levels are hampered by policies aimed at curbing the money supply, which are coupled with an increase in the budget deficit. However, a more recent study for 108 developing countries over 1960 to 2006 is more categorical: currency crises serve to restore GDP growth, which was slowed by destructive pre-crisis factors (Bussière et al., 2012). At the same time, no any impact of currency crises on the macroeconomic effects of the exchange rate has been found for the Southeast Asia countries (Moreno, 1999).

In addition to the above mentioned context of the crisis or "normal" conditions, the varied impact of the exchange rate can also be attributed to heterogeneous factors such as the business cycle, the specifics of capital flows, economic dollarization, openness to foreign trade, critical overstatement of the RER, and related external conditions (Bebczuk et al., 2006; Bussière et al., 2012). The mechanisms of a restrictive exchange rate impact are no less diverse: low price elasticity of exports and imports, wage cuts, capital flight (Kamin and Rogers, 2000; Lizondo and Montiel, 1988), redistribution of income in favor of richer strata of the population with a higher propensity for saving, improvements in the budget balance because of higher tax revenues from exporter companies (Krugman and Taylor, 1978), a decrease in the value of financial assets of local companies (Delli Gatti et al., 2007), the balance effect when the post-devaluation costs of external debt servicing increase significantly (Blanchard et al., 2010). The Marshall Lerner Condition used to be held in modern economies, mainly due to the high import price elasticity (IMF, 2006). In general, devaluation can be both expansionary and restrictive. However, in large economies, the effect of relative prices prevails in foreign trade (exports grow and imports decrease), while in small economies – imports fall due to lower incomes (Acevedo et al., 2015).

The probability of a restrictive exchange rate effect is enhanced by:
a) a high proportion of imported goods in the determination of the overall price level;
b) inflationary pass-through;
c) the predominance of money supply in the total value of private sector assets.

Recently, a weaker pass-through effect to inflation can be explained in various ways (a decrease in the long-term inflation rate, a change in the export-import structure), but the most relevant explanation is based on the liberalization of trade (lower duties), the reduction of transport costs, and the cost of labor-intensive wholesale and retail services (Frankel, 2005). However, this may not be applicable to economies that are used to prices in the dollar equivalent. On the aggregate supply side, the dependence of output on imported components and the increase of capital value in economies with capital-intensive technologies exerts a negative effect (Forbes, 2002).

Although many studies reject the largely restrictive effect of currency devaluations, primarily over the long run, and relate heterogeneity of exchange rate effects to differences per capita income (e.g., Kamin and Klau, (1998)), most papers suggest just the opposite. At the same time, it is true that the macroeconomic impact of the exchange rate differs in different countries and depends on many mechanisms that work in opposite directions. Another problem stems from a possible instability of the functional relationships over time. The empirical studies for Ukraine based on pre-crisis data showed an expansionary effect on industrial output from the depreciation of the RER, but a restrictive effect from the depreciation of the hryvnia exchange rate against the US dollar. Post-crisis empirical estimates show a stimulating effect on industrial production growth, but a simultaneous deterioration of the agricultural production growth (Shevchuk, 2016a). If we use estimates with flexible coefficients and account for the effect of the currency crisis using corresponding dummy variables, the depreciation of the hryvnia improved the industrial production trend up to 2009; after 2014 a weak restraining effect is observed. A reduction of imports is mainly responsible for the improvement in the trade balance. However, the direct effect of a currency crisis is restrictive for industrial production, as well as for export and import volumes.

III. THEORETICAL MODEL

This study uses the AD–AS model with rational expectations to illustrate the main influence mechanisms of anticipated and unanticipated changes in the exchange rate[1]:

[1] The chosen variant of the AD–AS model takes into account most important functional relationships of aggregate supply and demand as it is elaborated in several studies (Agenor, 1991; Kandil and Mirzaie, 2003; McCallum, 1996; Rojas-Suarez, 1992). The main novelty is accounting for the dollarization of the money supply and for the exchange rate surprise of the aggregate supply.

$$y = a_1(m_t - E_{t-1}p_t) - a_2E_{t-1}(e_t + p_t^* - p_t) - a_3(e_t - E_{t-1}e_t) + u_t, \quad (1)$$

$$y = b_1(m_t - E_t i_{t+1}) + b_2E_t(e_{t+1} + p_{t+1}^* - p_{t+1}) - b_3r_t + b_4g_t + b_5y_t^* + v_t, \quad (2)$$

$$m_t = \varphi h_t + (1-\varphi)(e_t + f_{t-1}), \quad (3)$$

$$i_t = \gamma p_t + (1-\gamma)(e_t + p_t^*), \quad (4)$$

$$r_t = r_t^* + E_t e_{t+1} - e_t - (E_t i_{t+1} - i_t), \quad (5)$$

$$e_t = \rho e_{t-1} + \varepsilon_t, \quad (6)$$

where y_t and y_t^*, p_t and p_t^*, r_t and r_t^* respectively represent GDP (income), domestic prices, and the real interest rate in the domestic country and abroad; m_t is the aggregate money supply; h_t is the internal component of the money supply; f_t is FX assets; e_t is the exchange rate (the value of foreign currency defined in the domestic currency), ε_t is the unanticipated exchange rate component; i_t is the general price level; u_t and v_t are stochastic aggregate supply and demand shocks, respectively. Except for r and r^*, all series are in logarithms. E_t and E_{t-1} imply the expectation operators formed at the beginning of periods t and $t-1$, respectively.

Model (1)–(6) outlines the main impact mechanisms of the exchange rate to be of interest. Equations (1) and (2) define the factors of aggregate supply and demand, respectively. The central bank controls only a part of money supply h_t (equation (3)), while the rest are FX assets of the private sector f_{t-1} (in domestic currency, with the exchange rate taken into account). The overall price level includes both domestic and imported goods and services, while coefficient 1-γ can be viewed as a measure of the pass-through effect (equation (4)). The real interest rate depends on the world interest rate as well as expectations of exchange rate depreciation and inflation (equation (5)). Finally, two components of equation (6) – anticipated ρe_{t-1} and unanticipated ε_t – determine the exchange rate. If the exchange rate changes are unanticipated (temporary), ρ=0; if they are completely anticipated (permanent), ρ=1.

Our specification of the aggregate supply corresponds to the microeconomic explanation of the production function for a dollarized economy with financial constraints (Rojas-Suarez, 1992), but takes into account the possible currency surprise (Sanchez, 2005). The inverse relationship between the aggregate supply and the exchange rate makes it similar to the model of Agenor (1991), although it does not limit the price surprise to domestic price expectations (like the Friedman-Phelps hypothesis).

Output depend on real lending (financial effect a_1) and a stochastic shock u_t, whereas a depreciation of the real exchange rate (RER) (price effect a_2) and the exchange rate surprise (a_3) have an opposite restrictive effect (equation (1)). Businesses make decisions on the production of goods and services based on expectations formed at the beginning of the current period. Therefore, in the current period, the impact of an anticipated hryvnia depreciation is materialized only through an increase in the value of financial assets f_{t-1} (in the domestic currency) and the exchange rate surprise. A depreciation of the hryvnia above its expected value ($e_t > E_{t-1}e_t$) hampers output growth due to higher cost of short-term lending to meet current production needs, or for several other reasons. For example, an excessive depreciation may be seen as a sign of further difficulties in the manufacturing sector or may increase incentives for FX savings, which are unrelated to current production activity.

Equation (2) relates the aggregate demand to money supply (the wealth effect b_1), RER expectations (the price effect b_2), the real interest rate, government spending, foreign income, and stochastic shocks. This specification corresponds to the specification of aggregate demand by Agenor (1991), but takes into account the dependence of demand on the interest rate as in the IS–LM framework, in line with proposals by Kandil and Mirzaie (2003). The respective relationships for the specification with rational expectations can be found in the studies of Rojas-Suarez (1992) or McCallum (1996). The wealth effect is limited to monetary assets, although, in general, it can also account for the value of real estate, securities, etc. Depreciation can stimulate demand by improving relative prices in foreign trade and reducing the real interest rate. The wealth effect has a stimulating impact in a dollarized economy (low value of φ) with a weak dependence of the general price level on imports (high value of γ). The stochastic shock v_t can be viewed as a sign of greater preference for current consumption.

The formal solution of the equation system (1)-(6) for income and domestic prices is as follows:

$$\begin{aligned} y = {} & \bar{y} + \left(1/\Delta\right)\{[(b_2 - (1-\gamma)b_1)a_1 + a_2b_2](\varphi h_t + (1-\varphi)f_{t-1}) + \\ & + [((1-\gamma)b_1 - b_2)a_1 - a_2b_1]p_t^* + (a_2 - a_1)(b_4g_t + b_5y_t^* - b_3r_t^*)\} - \\ & - \left(1/\Delta_1\right)[\rho a_1((1-(1-\varphi)\rho)b_2 - \varphi(1-\gamma)b_1 - (1-\varphi)(1-\rho)\gamma b_3) + \\ & + a_2((\gamma + (\varphi - \gamma)\rho))b_1 + (1-\rho)\gamma b_3) - (1-\rho)a_3(\gamma b_1 + \rho b_2 + (1-\rho)\gamma b_3))]e_{t-1} \\ & + [((1-\varphi)a_1 - a_3)]\varepsilon_t + u_t, \end{aligned} \quad (7)$$

$$p = \vec{p} + \left(1/\Delta\right)\{(b_1 - a_1)(\varphi h_t + (1-\varphi) f_{t-1}) + \left[a_2 + b_2 - (1-\gamma)b_1\right]p_t^* +$$
$$+ b_4 g_t + b_5 y_t^* - b_3 r_t^*\} + \left(1/\Delta_1\right)\left[a_2 + \rho b_2 - \rho(\varphi-\gamma)b_1 - (1-\varphi)\rho a_1 - (1-\rho)a_3\right]e_{t-1}$$
$$+ \left(1/\Delta_2\right)\left[(b_2 - \gamma b_3)\frac{a_2 + \rho b_2 - \rho(\varphi-\gamma)b_1 - (1-\varphi)\rho a_1 - (1-\rho)a_3}{\Delta_1} -\right.$$
$$\left. -(1-\varphi)a_1 + a_3 + \gamma b_3 + (\varphi-\gamma)b_1\right]\varepsilon_t + \left(1/\Delta_2\right)(v_t - u_t), \qquad (8)$$

where $\bar{y}$ and $\bar{p}$ are the equilibrium values of income and domestic prices, respectively

$$\Delta = \gamma b_1 + b_2 + a_2 - a_1,$$
$$\Delta_1 = \gamma b_1 + (1-\rho)\gamma b_3 + \rho b_2 + a_2 - a_1,$$
$$\Delta_2 = \gamma b_1 + \gamma b_3.$$

An unanticipated depreciation has an expansionary effect on income through the financial effect a_1. At the same time, there is a negative impact of an increase in the costs of working capital. It is clear that the impact of ε_t becomes restrictive if there is no dollarization (ϕ=1). The impact of unanticipated depreciation on domestic prices is complex and depends on the structural features of an economy. Anticipated depreciation would most likely have a restrictive effect and would drive prices upwards (obviously, these relationships become unambiguous if ρ=1 and γ=1). In any case, the impact of the exchange rate on income and domestic prices is intricate, and it is further complicated by the dollarization of the economy.

Interpretation of other independent factors is simpler. The money supply stimulates income if the price effect exceeds the welfare effect ($b_2 > b_1$); the less prices depend on imports, the better. At the same time, both the structural features have no impact on the link between money supply and domestic prices, which is determined by the relative strength of financial and wealth effects. If these effects are equal ($a_1 = b_1$) and the same condition does hold for the respective price effects ($a_2 = b_2$), the impact of money supply becomes clearly restrictive.

The strong price effect prompts a decline in income and growth in domestic prices in response to a global price hike. If the financial effect is weaker than the price effect ($a_1 > a_2$), one can expect that the intuitively expected growth in income will materialize as a result of higher government spending and income of trading partner countries, as well as due to a decline in the world interest rate. In all three cases, the expansionary effect is accompanied by a rise in domestic prices. A stochastic aggregate supply shock ($u_t > 0$) is expansionary and has an anti-inflation effect, whereas a shock on the side of aggregate demand ($v_t > 0$) has no influence on effect on income and drives domestic prices upwards.

IV. SOURCE DATA AND STATISTICAL METHOD

The empirical estimates used quarterly data for 1999–2016 from the databases of the State Statistics Service of Ukraine (www.ukrstat.gov.ua) and the IMF's *International Financial Statistics* (www.imf.org). The research is focused on the relationship between GDP (y_t), as well as industrial and agricultural production as its individual components (index, 1999=100), and wholesale prices (p_t) and a number of independent variables as envisaged in model (1)–(6). The approximate value of FX assets (ft) is proxied with the indicator of FX deposits in the banking system (in million US dollars). Such a choice is not perfect (FX deposits may be negatively correlated with assets outside banks, for example during crises), but other data on the FX assets of private Ukrainian individuals and companies is not available. The domestic component of the money supply (h_t) was obtained by subtracting the value of FX bank deposits from the monetary aggregate M2 (expressed in million hryvnias). The budget balance (% of GDP) was taken as the approximate value of net government spending (g_t), the LIBOR rate as the world global interest rate (r_t^*), and as income of trading partner countries (y_t^*) we used industrial production in the euro area ($indeuro_t$) and both GDP and industrial production in Russia ($yrus_t$ and $indrus_t$ respectively). Dependent on the specification of the statistical model, world prices (p_t^*) are proxied with commodity price indexes for metal ($metal_t$), crude oil ($brent_t$), and agricultural raw materials ($praw_t$).

Indicators of GDP, industrial and agricultural production (in real terms), and money supply components were seasonally adjusted using the Census X-11 method. All variables were used in logarithms, except LIBOR and the budget balance.

The Beveridge–Nelson decomposition (Beveridge and Nelson, 1981) was applied to extract permanent (anticipated) and temporary (unanticipated) components of the nominal effective exchange rate (index, 2010=100):

$$\varphi(L)\left[\Delta e_t - \eta\right] = \theta(L)\xi_t, \tag{9}$$

where the permanent (anticipated) component is equal to:

$$\Delta e_t = \eta + \psi(1)\xi_t, \quad \psi(L) = \theta(L)\varphi(L)^{-1}, \tag{10}$$

and the temporary (unanticipated) component is defined as:

$$\varepsilon_t = \tilde{\psi}(L)\xi_t, \quad \tilde{\psi}(L) = -\sum_{k=j+1}^{\infty}\psi_k. \tag{11}$$

Essentially, it is about dragging of the current NEER values through the autoregressive filter. The NEER behavior is found to be compliant with the ARIMA process (3, 1, 2). In-sample one-step ahead forecasts constitute the permanent (anticipated) components for the NEER, while the respective forecast errors constitute the temporary (unanticipated) parts of the NEER. Such an interpretation of the Beveridge–Nelson decomposition seems to be relevant for the logic of the model with rational expectations, while not without being open to criticism.[2]

Figure 1 shows the results of the NEER decomposition into the anticipated and unanticipated components. The trajectory of the permanent (anticipated) NEER component is quite predictable: a lasting period of currency stability follows every sudden crisis-driven transition to a much lower value. A slight anticipated strengthening of the NEER was observed only in 2002–2004 and 2011–2013. The most unexpected development was the depreciation of the hryvnia in 2015–2016. Surprisingly, the fall of the exchange rate in 2014 seems rather predictable. The hryvnia depreciation of 2008–2009 did not surprise the market. At the same time, 1999, 2002, and 2010 were full of exchange rate surprises. The NEER strengthened unpredictably in 2003 and 2011. Notably, the two official hryvnia revaluations (April 2005 and May 2008) do not seem unanticipated.

Figure 1. NEER decomposition using the Beveridge–Nelson method (in logarithms, 2010=100), 1999–2016

a) Permanent (anticipated) component

b) Temporary (unanticipated) component

Source: Author's estimates according to the IMF International Financial Statistics data.

[2] As explained by Morley (2011, pp. 419-439), the Beveridge–Nelson decomposition is subject to two very distinct interpretations. One interpretation is such that the optimal long-run forecast (minus any deterministic drift) corresponds to an estimate of an unobserved permanent component, while the alternative interpretation is that the optimal long-run forecast defines an observable permanent component. It is demonstrated that both interpretations are empirically distinguishable in a multivariate setting, but it is not the case in a univariate setting. Contrary to quite a popular view that the Beveridge–Nelson decomposition defines trend, on the basis of U.S. macroeconomic data it is found support for interpreting the Beveridge–Nelson decomposition as indeed providing estimates of trend and cycle.

The choice of the NEER as exchange rate variable is convenient from both a technical and a methodological point of view. First, the NEER indicator is sufficiently volatile while retaining a high correlation with the UAH/USD exchange rate (0.94). Second, a substantial share of Ukraine's export and import operations are conducted in euro, which provides the necessary unpredictability to the behavior of the exchange rate. Third, maintaining the fixed UAH/USD exchange rate de facto does not mean that there are no exchange rate expectations that are significantly different from the value of informal currency peg parity. Forming exchange rate expectations based on the money supply may be one of the explanations (Rojas-Suarez, 1992; Shevchuk, 2008). In this case, the nominal exchange rate may remain unchanged but expectations will change depending on the monetary policy stance. However, this study does not cover that possibility; it remains a subject for future research.

The statistical model with time-varying coefficients (TVP) comprises two equations:

$$x_t = \beta_{1,t} neera_{t-1} + \beta_{2,t} neers_t + \beta_{3,t}\mathbf{K}_t + \xi_t, \quad (12)$$

$$\beta_{j,t} = \beta_{j,t-1} + \zeta_{j,t}, \quad j = 1,2,3, \quad (12a)$$

where x_t is a dependent variable, $neera_t$ and $neers_t$ are the anticipated and unanticipated NEER components, $\mathbf{K}_t$ is the vector of independent variables, and ξ_t is the stochastic factor.

Equations (12) and (12a) show the functional structure of the statistical model and the nature of the time-varying coefficients, respectively. Stochastic factors ξ_t and ζ_t are assumed to have a normal distribution and not to be correlated with each other. Practically all the time-varying coefficients are modeled as recursive ones ($\zeta_{j,t} = 0$). However, the $neers_t$ coefficients in GDP and industrial output equations turned out to be compliant with the assumption of random walk without drift. In addition, the time-varying coefficients $\beta_{3,t}$ relate to the vector of the independent variables $\mathbf{K}_t$.

The main advantage of the TVP method lies in the possibility to account for the structural instability of functional relations, for example, those caused by an FX crisis. In a wider context, time-varying coefficients allow the model to abstract away from factors such as the business cycle or openness to foreign trade. To control for the critical overvaluation of the RER or the scale of an abrupt exchange rate realignment (moderate or substantial), relevant dummy variables should be used, as in our previous study with the monthly data (Shevchuk, 2016b). As for quarterly data, there is simply not enough historical data available. In addition, the use of the time-varying estimates significantly neutralizes the dependence of the results on the specifications of the statistical model. For example, there were no significant changes in findings for both exchange rate components after taking into consideration variables for external debt and both direct and portfolio investments, which account for the capital flows and thus being responsible for real sector developments.

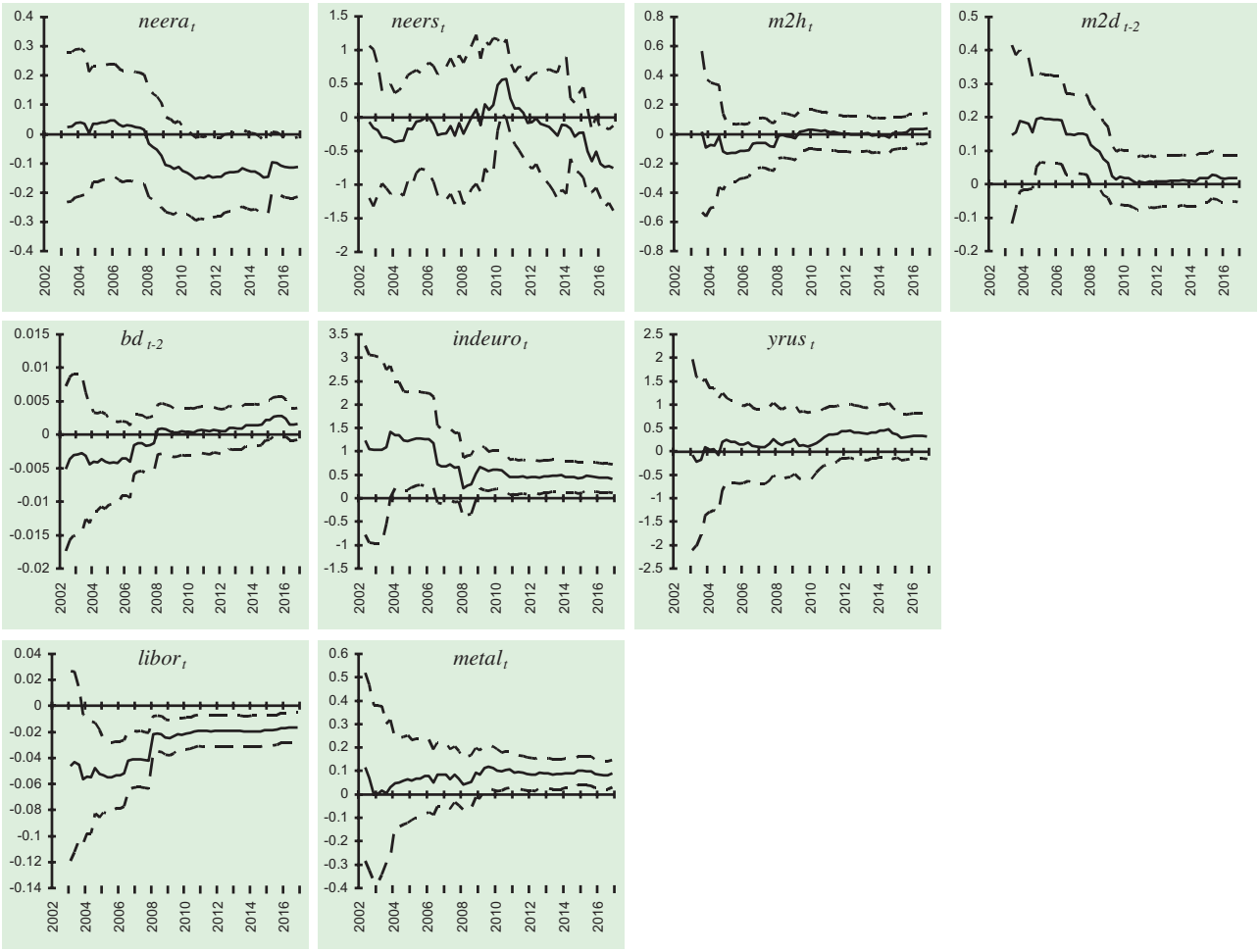
V. EMPIRICAL FINDINGS

The estimates of the GDP dynamic functional relations show a vivid change in the impact of an anticipated decline in the NEER depreciation – from neutral to restrictive stance – in 2008, after the start of the global financial crisis (see Figure 2).[3] The unanticipated decline in the NEER was neutral up to 2009 and turned expansionary for a short time in the mid-2010, but then a downward trend followed. According to model (1)–(6), the occurrence of the restrictive impact indicates that the adverse exchange rate surprise in the aggregate supply exceeds the favorable financial effect when an unanticipated currency depreciation worsens current business opportunities. The local weakness of this mechanism explains the expansionary effect observed in 2010.

An increase in the domestic component of the money supply has no influence on GDP dynamics. On the other hand, the FX component had a stimulating impact until 2008, but has since become neutral. The improvement in the budget balance showed weak signs of a restrictive impact in 2002–2005, but afterwards the link between the two components disappeared and then a stimulating effect emerged in 2015–2016. A pick-up in industrial production in the euro area is an important factor in the acceleration of GDP growth, although in recent years, its impact has been halved compared to the middle of the previous decade. In 2004–2006, a one percent growth in industrial production in Europe added up to 1.2 pp to Ukraine's GDP growth rate. That effect weakened to 0.4 as at the end of 2016. Curiously, Ukraine's reliance on the Russian GDP emerged only in 2008–2009, but as expected, it has weakened starting in 2014: the time-varying coefficient declined to 0.32 from 0.44 for the respective periods.

[3] The time-varying coefficients shown in Figures 2–5 reflect the statistical model's specifications used in each of the cases, i.e., they refer to the list of independent variables. It is worth noting that this list differs for individual dependent variables, and the choice is based on the best statistical properties of the estimated model. For this reason, the world crude oil price index ($brent_t$) was not included into the models for the GDP and agricultural production. It is obvious why the indicator for world prices for agricultural raw materials ($praw_t$) is not included into the GDP and industrial production models and why the world metal price index ($metal_t$) is not used in the agricultural production model.

Figure 2. Determinants of GDP dynamics (in first differences)



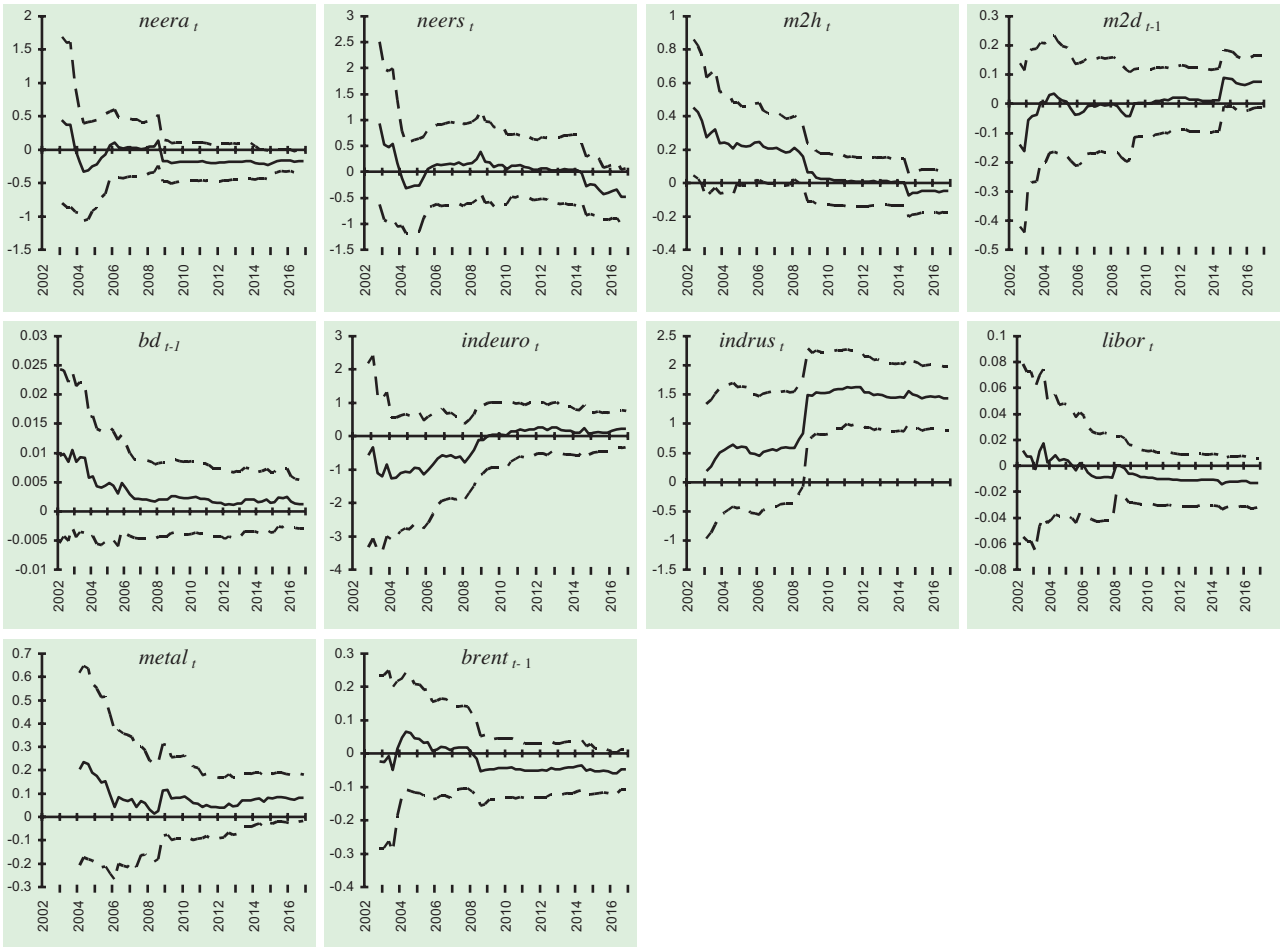
Note: hereinafter the confidence interval for the estimated time-varying coefficients is ±2 standard deviations.

An increase in the foreign interest rate has a clear restrictive effect, which is fully compliant with model (1)–(6). An increase in metal prices started stimulating Ukraine's GDP only as late as in 2008, which contradicts one of the popular explanations for the economic growth determinants during the boom years in 2002–2007. There is substantial evidence that industry in Europe was the real driver of the Ukrainian economy over those years. The dependence on world metal prices was quite stable over 2010–2016.

The estimates for industrial production do not rule out that an anticipated NEER depreciation may have a restrictive effect (see Figure 3). The restrictive impact of an unanticipated NEER depreciation was also observed in 2014–2016. As of the end of 2016, the anticipated 1 percent decline in the NEER caused the industrial production growth to slow by 0.17 pp and GDP by 0.11 pp. The restrictive effect is much stronger in the case of an unanticipated NEER decline: each percent depreciation in the hryvnia reduces the growth rates of industrial production by 0.5 pp (as of the start of 2014, the coefficient was −0.02) and GDP growth by 0.75 pp (−0.12).

Unlike the estimates for the GDP growth, an increase in the domestic component of the money supply stimulated industrial growth in 2002–2008. Afterwards, this favorable effect disappeared and gave way to a weak restrictive effect since the start of 2014 (each percent increase in $m2h_t$ reduced the industrial growth rate by 0.05 pp). On the other hand, an increase in the FX component of the money supply became expansionary in 2014–2016, while previously it had no influence on industrial production (each percent of growth in $m2d_{t-1}$ accelerated industrial growth by 0.07 pp). Clearly, these findings contradict the popular belief that it was an acute money shortage that slowed Ukraine's economic growth. More recently, the budget balance has had practically no effect on industrial production, although an improvement in this indicator had created an expansionary effect in the early 2000s.

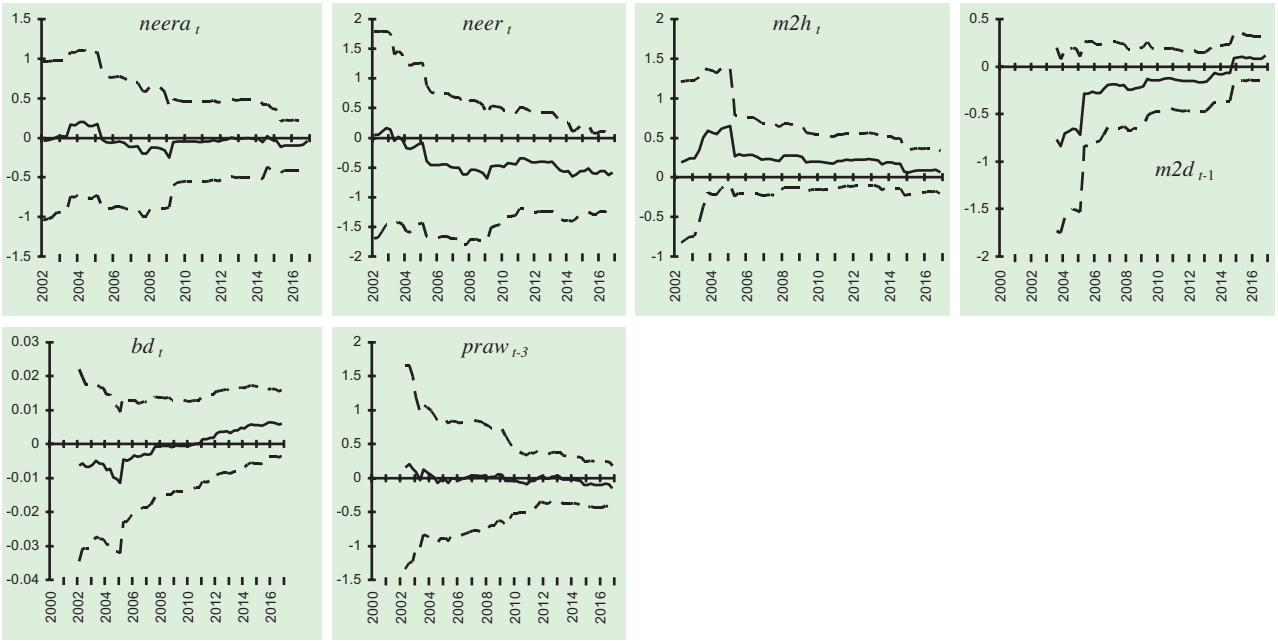
Figure 3. Determinants of industrial production dynamics (in first differences)



Ukraine's economy still does not depend on industrial production in the euro area, whereas Ukraine's dependence on Russian industrial production remains high despite the recent intense conflict between the two countries (the coefficient on $indrus_t$ decreased slightly to 1.43 as of the end of 2016 from 1.54 at the end of 2013). Remarkably, the dependence of Ukraine's economy on Russia more than doubled in 2010–2013. A weak reliance on the world metal prices emerged as late as in 2014–2016. In addition, the inverse relationship with the world crude oil prices strengthened over this period. LIBOR had a negative effect on industrial production, but the respective coefficients lacked statistical significance. That result is not surprising since Ukraine's industrial sector remains more isolated from foreign financial markets than other sectors.

Estimates for agricultural production do not reveal any effects of an anticipated NEER depreciation (see Figure 4). However, the results confirm that an unanticipated decline in the NEER has a restrictive effect, which seems more stable over time (this is partially explained by the use of a recursive model for time-varying coefficients). This effect also became more pronounced in 2014–2016 (the coefficient was −0.6 as of the end of the period). Similar to the estimates for GDP and industrial production, this conclusion provides an extra proof of the importance of the functional relationship between the real sector and exchange rate instability.

Figure 4. Determinants of agricultural production dynamics (in first differences)



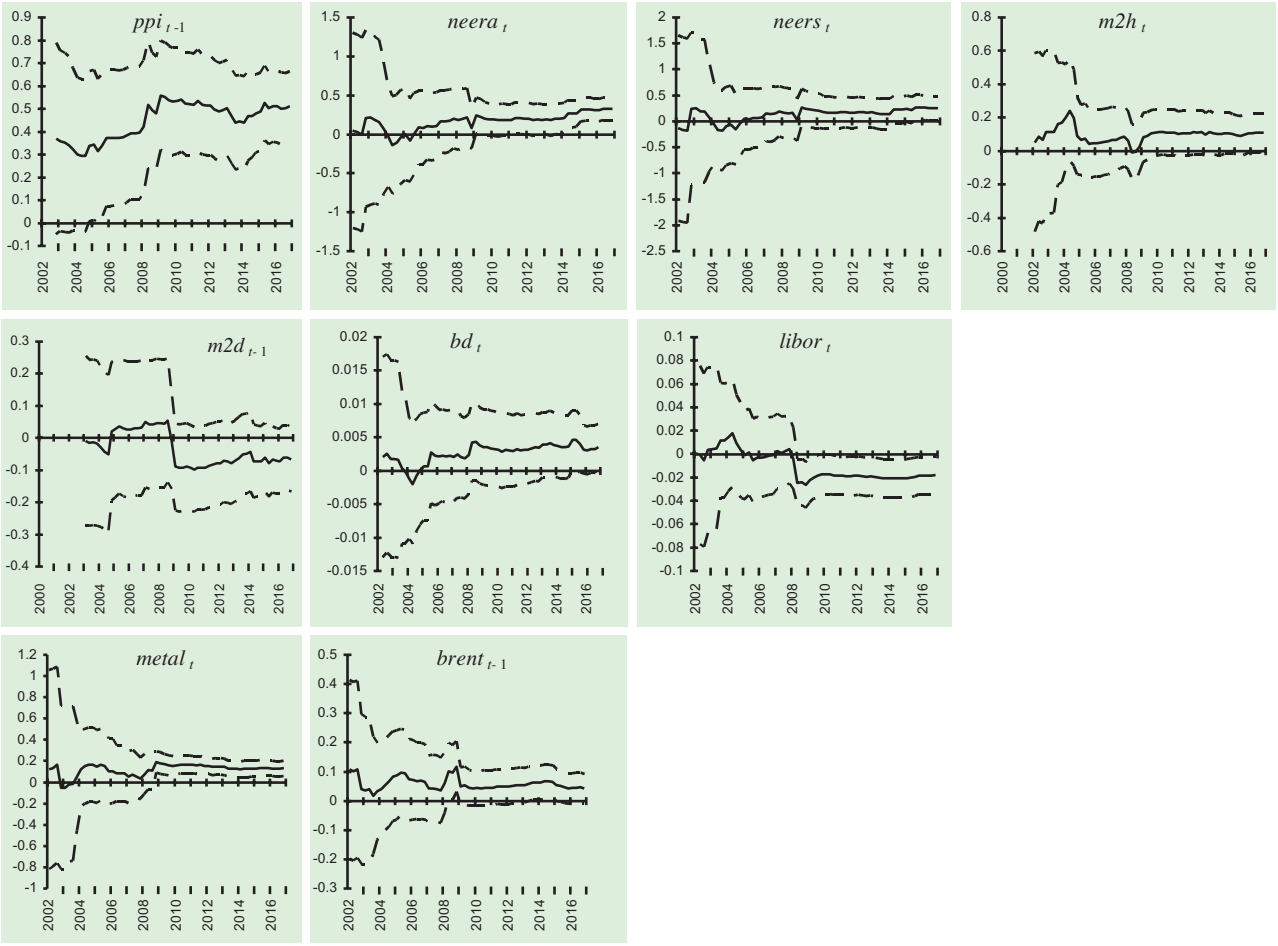
Similar to industry, the agricultural sector benefited from a favorable effect of the domestic component of the money supply in 2002–2005. Afterwards, however, that favourable effect disappeared. The accumulation of FX bank deposits had a negative impact until 2006 and then its effect on agricultural production turned neutral. The budget balance was also neutral for a long time, but its stimulating effect has grown gradually since 2012. The fact that agricultural production did not react to changes in the world agricultural raw material prices seems unusual. There was also no connections to the world crude oil prices.

The findings could mean that unanticipated changes in the exchange rate become stronger if the currency is floating, as found by Kandil (2015). The results also show that both anticipated and unanticipated currency depreciations can be restrictive. This feature marks a difference from results for industrial countries, e.g., Australia (Kohler et al., 2014), and from studies that find a restrictive effect only in the case of anticipated depreciation (Agenor, 1991).

Our estimates seems to support a significant link between wholesale prices and both NEER components, starting in 2008 (see Figure 5). As of the beginning of the global financial crisis (autumn 2008), the inflation pass-through for the anticipated and unanticipated decline in the NEER was 0.18 and 0.16, respectively, or almost the same. However, in the following years, the inflation impact of anticipated NEER depreciation became more significant. As of the end of 2016, the coefficients for inflation pass-through from $neera_t$ and $neers_t$ increased to 0.32 and 0.25, respectively. The results generally comply with the quantitative estimates and the conclusion about a greater pass-through effect for substantial depreciations of NEER obtained for consumer prices (Faryna, 2016). However, there is little evidence that minor depreciations have the same effect on prices and that moderate depreciations do not influence prices at all.

The inflationary effect of the domestic component of the money supply is less significant: each percent of $m2h_t$ growth accelerates wholesale price inflation by 0.1 pp. Notably, an increase in FX deposits can produce an anti-inflation effect (that kind of virtuous relationship emerged after 2008).

Figure 5. Determinants of wholesale price inflation (in first differences)



The functional relationships found in this study are in support that FX interventions to strengthen the hryvnia are an efficient measure for a simultaneous non-contradictory decline in inflation combined with output gains, which is relevant for the current economic conditions. Since these FX interventions will most probably limit the domestic money supply, it will provide an additional anti-inflation effect without any output losses. At the same time, any attempts to maintain an undervalued exchange rate of the hryvnia cannot but weaken economic recovery.

In general, the FX crisis of 2008 had a major impact on functional relations for wholesale price inflation. Along with a stronger inflationary pass-through and an emergence of asymmetric effects on the wholesale prices by domestic and FX components of the money supply, the inflationary effects of the budget balance, world metal prices, and world interest rate have strengthened. The inflationary impact of world crude oil prices remained almost unchanged but the respective time-varying coefficients became statistically significant. Finally, the autoregressive inertia with a quarter lag, which had been increasing over the pre-crisis period, stabilized at the highest level (the respective coefficient grew to 0.52 in 2008 from 0.35 in 2004). During the crisis years of 2014–2015, the wholesale price inertia increased again, but not much.

VI. CONCLUSIONS

This study's main finding is that Ukraine can expect a clear signal effect (through exchange rate expectations) from FX interventions as an additional tool of the inflation targeting regime. For example, a strengthening of the hryvnia by a reduction in the money supply can bring about a deceleration in inflation without any output losses. This complies with the current realities of a recovery in economic growth with a substantially undervalued hryvnia exchange rate. Owing to the economy's dollarization, both types of currency appreciation – anticipated and unanticipated – can yield a stimulating effect. An increase in the money supply seems to be neutral in respect to GDP in general and industrial and agricultural production in particular.

Among other findings, the inverse relationship between GDP (industrial production) and the world interest rate is worth of extra attention. Euro area output does stimulate only GDP of Ukraine, with no impact on industrial and agricultural production. At the same time, both indicators – GDP and industrial production – remain dependent on the Russian economy, despite the economic sanctions currently in place. Since volumes of direct trade between Ukraine and Russia have decreased, this means that bilateral trade has been conducted with intermediation of other countries. Contrary to a popular belief, a statistically significant effect of world metal prices on the Ukraine's economy emerged only after 2008.

The specifics of wholesale price inflation in Ukraine lies in the asymmetric dependence on the domestic and FX components of the money supply, which also established in 2008, as well as it is the case for an inflationary effect from improvements in the budget balance. As expected, an increase in the price of crude oil has an inflationary impact. Meanwhile, a similar relationship emerged in 2008 for the world metal prices. Since the financial crisis of 2008–2009 had substantially affected many functional relationships in the Ukraine's economy, statistical methods with time-varying coefficients (the Kalman filter) prove most efficient. If other methods are used, e.g., 2SLS or vector autoregression, the effect of the structural changes driven by the crisis of 2008–2009 should be accounted for.

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