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FACULTY OF ECONOMICS
11000 Belgrade, Kamenička 6, Serbia
Tel: (381)(11) 3021-210
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*Özcan Karahan**
*Olcay Çolak***

# AN EXAMINATION OF THE CAUSALITY RELATIONSHIP BETWEEN CURRENT AND FINANCIAL ACCOUNTS IN TURKEY

**ABSTRACT:** *In today's economies, where commerce and the economy are strongly interrelated, the relationship between current account and financial account has become crucial. However, economists have not reached a consensus regarding the direction of the causality relationship between capital and current accounts. Our study aims to contribute to the literature by determining the direction of the causality relationship between current and financial accounts in Turkey, applying the Johansen Cointegration Test and the Vector Error Correction (VEC) model to quarterly data for 2002–2018. The empirical results show that the causality relationship in Turkey runs from the financial account to the current account. This means that capital inflows to Turkey have the potential to deteriorate the current account balance. Therefore, it is of crucial importance that Turkey implement policies to manage the financial account in order to provide a current account balance.*

**KEY WORDS:** *current account, financial account, Turkish economy.*

**JEL CLASSIFICATION:** F32, F40, C22.

* Corresponding author, Faculty of Economics and Administrative Sciences, Department of Economics, Bandirma Onyedi Eylul University, Turkey, e-mail: okarahan@bandirma.edu.tr.
** Co-author, Faculty of Economics and Administrative Sciences, Department of Economics, Usak University, Turkey, e-mail: olcay.colak@usak.edu.tr.

## 1. INTRODUCTION

With today's rapid globalisation, international trade and especially financial relations have expanded exponentially. Therefore, keeping a record of the commercial and financial relations between nations has become increasingly important, so much so that the balance of payments sheet in which a country's commercial and financial relations with other countries are recorded has become a significant tool for measuring macroeconomic performance. In general, the balance of payments sheet consists of the current, financial, and reserve sub-accounts and net errors and omissions. The current and financial accounts are the two most important sub-accounts on the balance of payments sheet. An excess in the financial account or a decrease in reserves can be used to finance a current account deficit. However, excess in the financial account is generally used to meet the current account deficit. Accordingly, even though it is possible to finance the current account deficit from reserves, this is a temporary and secondary method. Thus, the interaction between capital and current account is the basic dynamic in the balance of payments sheet. Therefore, a country's economic situation can be analysed via developments in the relationship between current and financial accounts – so much so that an economy's stability and performance are closely related to the interaction between financial and current transactions.

In the literature the reason for a deteriorating current account balance is indicated by an increase in the components of total demand such as consumption, investment, and government expenditure. However, there is no consensus among economists regarding the source of the increase in total demand that causes a current account imbalance. Nevertheless, determining the source of the increase in total demand is a crucial issue in identifying the direction of the causality relationship between capital and current account. One group of economists claims that foreign capital is required to finance a growing current account deficit based on expanding domestic demand, which results in changes in the financial account (Higgins and Klitgaard 1998; Lau and Fu 2011; Oeking and Zwick 2015; Urbanovsky 2017). Thus, any increase in domestic demand, whether from the private or the public sector, causes a deficit in the current account, whereupon foreign capital is needed to finance this deficit in the current account. This means that the causality relationship runs from the current account to the financial account. Another group of economists argues that financial capital inflows to a

country lead to the expansion of domestic demand and growth of the current account deficit (Calvo et al. 1996; Yan 2005; "Mastroyiannis 2012; Garg and Prabheesh 2015; Yalta and Sağlam 2016). The surge in capital inflows tends to be channelled into enlarging basic components of total demand in the host countries. This means that the basic source of total demand increase triggering the current account deficit is capital inflow to the host country. Thus, the direction of causality in the balance of payments operates from the financial account to the current account.

As can be seen from the discussion above, the direction of the causality relationship between the current and financial accounts is determined by whether or not the source of the increase in total demand is capital inflow. Within the framework of this discussion, our study aims to analyse the direction of the causal relationship between the current and the financial accounts in Turkey's economy. In other words, we try to determine whether the causal relationship is from current account to financial account or from financial account to current account. By determining the direction of the causal relationship between current and financial accounts we also identify whether or not the source of the increase in total demand is capital inflow to Turkey. With the introduction in 2002 of the Inflation Targeted Stability Program under a free exchange rate system, Turkey's economy became completely open to the impact of foreign capital inflows. Thus, determining the direction of causality between current and financial accounts contributes not only to the literature but also to the design of the inflation-targeting policies to be implemented in Turkey.

The following section reviews the studies in the literature on this subject. The third section gives information on the data and methodology. Next, the empirical results are presented. The last chapter concludes and makes some some policy recommendations for Turkey's economy.

## 2. LITERATURE REVIEW

Numerous studies in the literature examine the causality relationship between current account and financial account. Nevertheless, there is still no agreement on the transmission mechanism between these accounts. Two different transmission mechanisms are posited as the framework in which the current and financial accounts affect each other. In the first transmission mechanism, an

increase in the current account deficit stimulates capital inflows and thus triggers developments in the financial account. Accordingly, an increase in total demand arising from factors other than capital inflows to the home country leads to a current account deficit, which later is financed by capital inflows. In the second transmission mechanism, movements in the financial account cause developments in the current account. According to this mechanism, foreign capital inflows deteriorate the current account by stimulating total demand. Thus, there is significant disagreement about the direction of the causality relationship between current and financial accounts. This disagreement actually arises from whether or not the source of the increase in total demand is capital inflow. If capital inflow first stimulates total demand and thus deteriorates the current account balance, the direction of the causality relationship is from a financial account to the current account. However, if the current account deficit arising from the expansion of total demand increases first and thus causes capital inflows to the home country later, this implies that the direction of the causality relationship is from the current account to financial account (IMF 2009: 222–223).

Those claiming that the direction of the causality relationship is from the current account to the financial account argue that other reasons are causing the expansion of total demand, not foreign capital inflows. For example, both consumption and investments may increase due to a decline in interest rates because the central bank implements expansionary monetary policy and therefore expands the current account deficit. Thus, foreign capital is needed to finance deficits in the current account arising from expansionary monetary policy and the direction of the causal relationship runs from current account to financial account. The same process may also occur if the increase in total domestic demand is due to the public sector. A budget deficit resulting from the state implementing expansionary fiscal policies may lead to a current account deficit by increasing domestic demand. In that case, expressed as twin deficits, foreign capital will be needed to finance the deficit in the current account. Thus, an increase in domestic demand arising from the private or public sector results in a causality relationship from the current to the financial account (Higgins and Klitgaard 1998: 3).

On the other hand, foreign exchange rate policies implemented by the central bank may result in a causal relationship from capital account to financial account. For example, a devaluation policy under the fixed exchange rate regime may reduce domestic demand by restricting imports and promoting exports. Therefore, the economy needs less external capital resources due to a decreased current account deficit. Thus, maintaining a balance in the current account by implementing a devaluation policy also provides financial account stability in the next stage.

In the literature there are empirical studies which indicate that the direction of the causality relationship is from current account to financial account. Lau and Fu (2011) empirically investigate the interrelationships between financial account and current account for the Asian countries Indonesia, Korea, the Philippines, and Thailand. Johansen Cointegration and Granger Causality Tests are used to examine quarterly data series of variables for 1987–2006. The empirical results show that the current account Granger-causes the financial account. Thus, it is suggested that in Asian countries management of the current account can be used as the control policy variable. Gürsoy and Yılancı (2013) analyse the causal relationship between current account and financial account in Central, Eastern, and South-Eastern European countries using Emirmahmutoğlu and Kose's panel causality test with the panel selection method for quarterly data covering the period 2002–2010. The findings show the current account mostly Granger-causes the financial account.

More recent research has also clearly indicated a causal relationship from capital account to financial account. Oeking and Zwick (2015) analyse the relationship between current account balance and capital movements for 23 selected OECD countries, examining quarterly data between 1990 and 2013 using the Granger causality test. The empirical results show that in the OECD countries current account developments generally determine movement in the financial account. The results of more detailed analysis also indicate that the causality relationship is obscured in circumstances of extreme fluctuation in the economy. Urbanovsky (2017) examines the interaction between current account and financial account in the Czech Republic. Quarterly data for 1995–2015 is used in a causality analysis conducted within the framework of the Johansen Cointegration and Error Correction model. The empirical results show that the direction of the causality

relationship is from current account to financial account. It is also found that there is a potential risk of economic crisis in the current account during large capital inflows.

Contrary to the empirical indications above, some economists argue that the transmission mechanism operates from the financial account to the current account. In other words, developments in domestic demand, which lead to a change in the current account balance, mainly arise from changes in financial accounts resulting from foreign capital inflows. This process has been increasingly present in developing countries since they started to receive large capital inflows from developed countries – so much so that developing countries, where there are scarce funds and high profits, offer high returns to capital owners in developed countries. Capital owners in developed countries, where there are abundant funds and less profit, also naturally prefer investing in developing countries (Alp 2000: 115).

Movement of financial capital to developing countries, especially in the form of portfolio and other investments, has created significant economic effects. Undoubtedly, these inflows that cause a surplus in the financial account have expanded total demand in developing countries and thus have resulted in current account imbalances. Consumption and investment expenditure in developing countries used to be under a significant financial constraint due to the limited supply of funds, but with foreign capital inflows these kinds of expenditure rapidly increased. Moreover, the financial capital inflows provided the state with new financing opportunities through public loans and considerably increased its public expenditure. The expansion in public expenditure due to increased capital inflow raised total demand and consequently the current account deficit. Capital inflows to developing economies also deteriorated the current account via exchange rates: capital inflows led to a decline in nominal exchange rates by revaluating domestic currencies in developing countries. As a result, imports became more attractive while exports became more difficult and the current account deficit grew (Calvo et al. 1996: 128–131). Thus, with increased international capital movement and its effect on both domestic demand and exchange rates, especially in developing countries, the direction of the causality relationship has been from financial account to current account.

Many empirical studies in the literature determine the causality relationship direction as being from the financial account to the current account. Yan (2005) analyses the interaction between current and financial accounts in Argentina, Mexico, Indonesia, South Korea, and Thailand. Quarterly data for 1989–2004 is examined using the Granger causality test. The empirical findings determine that in these countries the financial account is responsible for the current account. Mastroyiannis (2012) examines the relationship between current account and financial account in the Portuguese economy. Granger causality test results show that capital inflows between 1980 and 2009 affected the current account balance, indicating that foreign capital flows 'pushed' Portugal's economy into current account imbalances. In terms of policy implications, to sustain the current account deficit, policies focusing on the effective management of capital inflows are preferable. Akbaş et al. (2014) analyse the relationship between capital inflows and current account deficit in the case of emerging markets for the years 1990–2011. A panel causality test covering the data of 20 emerging countries shows that there is a one-way relationship from short-term capital inflows to current account deficit. Therefore, to reduce the risk caused by high current account deficits, policies aiming for financial balance should be prioritised. Garg and Prabheesh (2015) empirically investigate the causal relationship between current and financial accounts in the Indian economy. They utilise quarterly data from 1990 to 2011 and apply the Modified Wald Granger causality test proposed by Toda and Yamamoto. The findings suggest that there is a causal relationship from capital flows to current account. They emphasize that the soundness of the financial sector should be improved, since capital flows have the potential to deteriorate the current account balance. Yalta and Saglam (2016) examine the causal relationship between current account and different types of capital inflow, applying a dynamic panel causality approach for 19 emerging market economies between 1980 and 2009. The empirical results indicate that foreign capital inflows Granger-cause current account deficits. Thus, they raise questions regarding the sustainability of current account deficits based on foreign capital inflows to emerging market economies.

In studies focusing on Turkey there is also no consensus on the direction of the causality relationship between capital and current accounts. Some studies indicate that the causality runs from current account to financial account. Karagöz and Karagöz (2006) investigate whether causality runs from current

account to financial account for the period 1980–2002 in Turkey. In a recent study, Kesgingöz and Karataş (2016) show that there is a causal relationship from current account deficit to foreign capital movements for the periods 1992–2001 and 2002–2005. However, most of the research on Turkey indicates a causality from capital to current account, similar to the experience of other developing countries. Erden and Çağatay (2011) examine the causal relationship between current account and financial account using monthly data for the years 1992–2009. The findings show that the relationship between variables is unidirectional and that the causality direction is from financial account to current account. Turan and Karakas (2016) investigate the causal relationship between current balance and financial account in Turkey using quarterly data for the period 1998–2014 and using Toda-Yamamoto and Hatemi-J causality tests. The empirical findings show that there is a unidirectional causality relationship from the financial account to the current balance. Tüzemen and Tüzemen (2018) analyse the causal nexus between financial account and current account balance using Toda-Yamamoto causality and Hatemi-J asymmetric causality tests on data covering the period 2002–2017. The empirical findings show that capital flows to Turkey cause positive and negative shocks to the current account balance. Finally, Gümüşoğlu and Alçın (2019) analyse the interaction between current and financial accounts in Turkey by employing the vector autoregression (VAR) model and ımpulse responses to examine quarterly data for the period 1998–2015. The empirical findings indicate a positive causality relationship from capital flows to current account deficit.

In the literature the financial crises in developing countries are discussed and explained within the framework of the causality relationship between current and financial accounts. Capital inflows caused the current account deficit to rise to a very high level, which after a while created significant risks for foreign investors. When foreign capital inflows to developing countries were suddenly abandoned a major liquidity crisis resulted and the real sector faced major problems (Alp 2000: 233–247). Thus, the arguments raised in studies of the financial crises caused by financial liberalisation in developing countries have been developed within the framework of a causality relationship that moves from financial account to current account. Calvo et al. (1992) find that the financial capital that entered Latin American countries during the 1990s caused significant deficits in the current account by appreciating domestic currencies. Thus, a deteriorating

current account balance led to devaluation expectations and consequently, with the deterioration of the financial balances, to the banking crises. Similarly, Fernandez-Arias & Montiel (1996) determine that even if capital inflows to developing countries create economic expansion and prosperity, consequently the risks caused by the rise in the current account deficit cause the foreign capital to escape, resulting in economic crisis and shrinkage. Yentürk (1999) draws attention to the large number of capital inflows to Turkey during the 1990s and points out that these led to current account deficits due to public deficits and caused great economic instability. Yeldan (2008) also emphasizes that the main cause of the 1994 and 2001 crises in Turkey was the high amount of foreign capital inflows experienced after 1989. Accordingly, exchange rate fluctuations caused by capital inflows during the crisis periods caused unsustainable deficits in the current account.

As can be seen from the literature, many studies have been conducted on the causality between current and financial accounts. The link has even been analysed within the framework of determining the dynamics of the economic crisis. Pure cross-country evidence on the causal relationship between capital account and financial account is summarized in Table 1.

**Table 1:** Pure Cross-Country Evidence on the Causal Relationship between Capital Account (CA) and Financial Account (FC)

| Study | Sample | Method | Key Finding |
|---|---|---|---|
| Yan (2005) | Quarterly data for Argentina, Mexico, Indonesia, & Thailand for the period 1989–2004 | Granger causality test | FA→CA |
| Lau and Fu (2011) | Quarterly data for 4 Asian countries over the period 1987–2006 | Johansen Coint. and Granger Causality Test | CA→FA |
| Mastroyiannis (2012) | Quarterly data for Portugal covering the period 1980–2009. | Granger causality test | FA→CA |

| | | | |
|---|---|---|---|
| Gürsoy and Yılancı (2013) | Quarterly data for Central Eastern European countries for the period 2002–2010 | Panel causality test of Emirmahmutoğlu and Köse | CA→FA |
| Akbaş et. al (2014) | Quarterly data for 40 emerging countries for the period 1990–2011 | Granger panel causality test | FA→CA |
| Oeking and Zwick (2015) | Quarterly data for 23 OECD countries during the period 1990–2013 | Granger panel causality test | CA→FA |
| Garg and Prabheesh (2015) | Quarterly data for India covering the period 1990–2011. | Modified Wald Granger Causality Test | FA→CA |
| Yalta and Sağlam (2016) | Quarterly data for 19 emerging countries for the period 1980–2009 | Dynamic panel causality test | FA→CA |
| Turan and Karakaş (2016) | Quarterly data for Turkey over the period 1998–2014 | Toda-Yamamato and Hatemi-J causality test | FA→CA |
| Urbanovsky (2017) | Quarterly data for Czech Repub. for the period 1995–2015. | Johansen Cointeg. and ECM | CA→FA |
| Tüzemen and Tüzemen (2018) | Quarterly data for Turkey over the period 2002–2017 | Toda-Yamamato and Hatemi-J causality test | FA→CA |
| Gümüşoğlu and Alçın (2019) | Quarterly data for Turkey over the period 1998–2015 | VAR Model | FA→CA |

## 3. DATA SET AND METHODOLOGY

Within the framework of the discussion indicated above, our study aims to determine the direction of the causal relationship between current and financial accounts in Turkey's economy, whether from capital account to financial account or from financial account to capital account.

By utilizing quarterly data for the period 2002–2018, we investigate the linkage between financial account and current account for the Turkish economy. The financial account data consists of Foreign Direct Investment (FDI), Portfolio Investment (PI), and Other Investment (OI). The financial account and current account data used for the detailed analysis of the balance of payments is from the Electronic Data Distribution System of the Central Bank of the Republic of Turkey. Both series are adjusted for seasonal and calendar effects using the X-12 methodology and are expressed in US$.

Table 2 briefly introduces the descriptive statistics. It is striking that the standard deviations of both series display high variance due to the considerable difference between corresponding maximum and minimum values.

**Table 2**: Descriptive Statistics

| Variable | CA | FA |
|---|---|---|
| Number of Observations | 68 | 68 |
| Mean | –8475.73 | 9758.63 |
| Maximum | 2174.00 | 27582.00 |
| Minimum | –22681.00 | 148.00 |
| Standard Deviation | 5822.27 | 7194.86 |

**Note:** CA: Current Account, FA: Financial Account.

To investigate the interplay between the current and financial account in Turkey we conduct the cointegration test developed by Johansen (1988), Johansen and Juselius (1990), and Johansen (1995). The Johansen cointegration test suggests that there are multi-cointegrated vectors between the variables, assuming all variables to be determined endogenously. The model is constructed with the matrix notation in the following form:

$$M_t = A_1 M_{t-1} + A_2 M_{t-2} + \ldots + A_p M_{t-p} + \varepsilon_t \quad (1)$$

where $M_t$ is the vector matrix of the independent variables and $\varepsilon_t$ denotes the disturbance term with zero mean and constant variance. From Equation 1, the vector error correction (VEC) model can be written in the following form:

$$\Delta M_t = \sum_{i=2}^{p} \gamma_{i-1} \Delta M_{t-i+1} + \Pi M_{t-1} + \varepsilon_t \quad (2)$$

where $i$=1,2,…, $p$ denotes the lag length, $\gamma_i = -(I - A_1 - A_2 - \ldots - A_i)$ and $\Pi = -(I - \Pi_1 - \Pi_2 - \ldots - \Pi_i)$ denote the short-run and long-run parameters respectively. The parameter $\Pi$ can be expressed by decomposing it into two parts as $\Pi = \alpha\beta'$ where $\beta'$ denotes the long-run coefficient and $\alpha$ denotes the adjustment coefficient of the long-run parameter. If rank $(\Pi) = p$, then the process of the vector matrix is stationary. However, if rank $(\Pi) = r < p$, then there is $r$ stationarity and linear combinations do exist in the long run.

Before employing the Johansen cointegration test we check the stationarity status of the vector $M_t$ that requires that the variables should be integrated at I (1). We employ the augmented Dickey-Fuller unit root (ADF) test developed by Dickey-Fuller (1981) to check for the stationarity of the variables. In the next step we estimate the Vector Autoregression (VAR) model to figure out the appropriate lag order when employing the cointegration test. By incorporating Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hanna-Quinn (HQ), the optimal lag length is selected under which there are no serial correlation and heteroskedasticity problems besides the normal distribution of standard errors. Johansen's approach may also require making assumptions regarding the trend. Hence, the appropriate test method under AIC and SIC is selected by making assumptions regarding the trend in five cases. As suggested by Johansen (1995), cases 1 and 2 do not include deterministic trends in the level data, while case 2 includes an intercept in the cointegrating equations. Cases 3 and 4 have linear trends and intercepts in the level data, whereas case 4 has a linear trend and intercept in the cointegrating equations while case 3 has only an intercept in cointegrating equations. Finally, case 5 includes quadratic trends in the level data,

whereas cointegrating equations include linear trends. The decision is made by selecting any case that satisfies the minimum value of the AIC or SIC.

To discover the long-run interplay between the variables we conduct the Johansen cointegration test in which cointegrated vectors of the matrix $\Pi$ are also identified. Two types of test are used to estimate the cointegrated vector numbers, namely trace statistics and maximum Eigenvalue statistics, which are estimated in the following form (Johansen and Juselius 1990: 177_178):

$$\lambda_{trace(r)} = -n \sum_{i=r+1}^{n} ln\left(1-\hat{\lambda}_i\right) \tag{3}$$

$$\lambda_{max(r,r+1)} = -n \sum_{i=r+1}^{n} ln\left(1-\hat{\lambda}_{r+1}\right) \tag{4}$$

Both statistics are used to test the null hypothesis of no cointegrating equations over the alternative, which is that there exists at least one cointegrating equation. If the calculated test statistics exceed the critical values, then the null hypotheses are rejected. Thus, a long-run relationship between the variables exists, i.e., the variables are cointegrated.

After deciding the cointegration relationship between the variables, the short-run dynamics are investigated by estimating the VEC model using Equation 2 in the following form:

$$\Delta M_t = \sum_{i=2}^{p} \gamma_{i-1} \Delta M_{t-i+1} + \alpha(\beta' M_{t-1}) + \varepsilon_t \tag{5}$$

where $\beta' M_{t-1}$ is the vector error correction term that includes (*m-1*) vectors by which the deviations tangle in the vector matrix. In the context of the VEC model we also check for the exogeneity/endogeneity of the variables by performing the block Wald weak exogeneity test. The test is employed on the α parameter and the hypothesis testing is performed by restraining the relevant coefficients of the α parameter. If the null hypothesis cannot be accepted, then the variables are regarded as endogenously determined.

## 4. EMPIRICAL RESULTS

Our empirical analysis commences by checking the stationarity status of the variables used to investigate the nexus between financial account and current account by employing the ADF-type unit root test developed by Dickey and Fuller (1981). Table 3 reports the results, which confirm that both series become stationary by taking the first-differenced form, i.e., I (1). Hence, the null hypothesis of the presence of a unit root is rejected for both series after taking the first differences at the 1% significance level. This result leads us to identify the long-run patterns of both series by employing the cointegration test proposed by Johansen (1988) in which the series are necessarily integrated at the same order, i.e., at I (1).

**Table 3:** ADF Unit Root Test

| Variable | ADF test | ADF test (Trend) | Decision |
|---|---|---|---|
| $FA_t$ | –2.098 [0.245] | –2.495 [0.329] | Non-stationary |
| $CA_t$ | –2.019 [0.248] | –1.090 [0.921] | Non-stationary |
| $\Delta FA_t$ | –11.813[0.000]* | –11.718 [0.000]* | I(1) |
| $\Delta CA_t$ | –3.538 [0.010]** | –3.952 [0.015]** | I(1) |

**Notes:** * and ** denote 1% and 5% significance levels respectively. Δ denotes the first difference. AIC is used for selecting the optimal lag length. Probability values are shown in brackets.

Based on the vector autoregression (VAR) technique, Johansen's (1988) methodology requires that all the variables are endogenously determined. In this context we initiate the VAR model to decide the optimal lag length by employing Johansen's (1988) test and Table 4 reports the results for the optimal lag order. Since we incorporate the quarterly data, the maximum lag length is selected to be 4. Three criteria out of five show that the optimal lag order should be four when employing Johansen's (1988) cointegration test.

**Table 4:** Lag Order Selection

| Lag | Log likelihood | LR | FPE | AIC | SIC | HQ |
|---|---|---|---|---|---|---|
| 1 | −872.796 | NA | 0.027 | 27.399 | 27.534* | 27.453* |
| 2 | −872.410 | 0.722 | 0.035 | 27.512 | 27.782 | 27.619 |
| 3 | −869.284 | 5.667 | 0.031 | 27.540 | 27.944 | 27.699 |
| 4 | −856.367 | 22.604* | 0.023* | 27.261* | 27.801 | 27.474 |

**Notes:** * denotes the selected appropriate criterion that ensures no autocorrelation or heteroskedasticity problems. LR: Likelihood Ratio; FPE: Final Prediction Error; AIC: Akaike Information Criterion; SIC: Schwarz Information Criterion; HQ: Hanna-Quinn.

After detecting the optimal lag order for the cointegration test we tailor the appropriate trend assumption to carry out the analysis rigorously. By using the AIC and SIC, the selection of the correct form is based on five cases in which there exist various assumptions regarding the deterministic trend and intercept. Table 5 displays the corresponding results. The results reveal that case 2, in which the cointegrating equations have only a restricted constant and no deterministic trend, is selected for bearing the minimum value of each criterion according to rank number.

**Table 5:** Selection of Cointegration Model

| AIC by Rank and Case | | | | | |
|---|---|---|---|---|---|
| Rank | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
| 0 | 27.004 | 27.004 | 27.056 | 27.056 | 27.098 |
| 1 | 26.963 | 26.925* | 26.952 | 26.983 | 27.007 |
| 2 | 27.080 | 27.028 | 27.028 | 27.086 | 27.086 |
| SIC by Rank and Case | | | | | |
| Rank | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 |
| 0 | 27.643 | 27.640 | 27.668 | 27.668 | 27.779 |
| 1 | 27.548* | 27.548* | 27.701 | 27.766 | 27.823 |
| 2 | 27.896 | 27.912 | 27.912 | 28.038 | 28.038 |

**Notes:** * denotes the selection of appropriate model.

Having decided on the correct form, we proceed to the Johansen (1988) cointegration test to determine the long-run interaction between the variables. The upper segment of Table 6 is devoted to the trace statistics and the lower segment to the maximum eigenvalue statistics. The null hypothesis of no

cointegration between the variables is tested over its alternative and the results of both statistics reveal that there is one cointegrating equation at the 5% significance level. This means that there is at least one long-run relationship between these variables.

**Table 6:** Johansen Cointegration Test

| Trace Statistics | | | |
|---|---|---|---|
| # of Co-integrations | $\lambda_{trace}$ | % 5 Critical Value | p-value[a] |
| None* | 17.775 | 15.494 | 0.022 |
| At most 1 | 3.259 | 3.841 | 0.071 |
| Maximum Eigen Value Statistics | | | |
| # of Co-integrations | $\lambda_{maximum}$ | % 5 Critical Value | p-value[a] |
| None* | 14.516 | 14.264 | 0.045 |
| At most 1 | 3.259 | 3.841 | 0.071 |

**Notes:** * denotes rejection of the null hypothesis at the 5% level. [a] denotes MacKinnon-Haug-Michelis (1999) p-values.

After confirming the cointegration, the long-run relationship is assessed by estimating normalised cointegrating vectors. The estimated vector is normalised by multiplying the relevant endogenous variable by its reverse value. Table 7 shows the long-run parameter estimates of the normalised coefficients and unrestricted coefficients of each variable. Since both variables are endogenously determined, we report the normalised cointegrating coefficients by considering each variable as the dependent variable individually. Model 1 denotes that normalisation is conducted on the current account, whereas Model 2 denotes normalisation on the financial account. In Model 1 the coefficient of the financial account is –1.307, indicating that a 1% rise in capital flows results in a 1.5 % fall in the current account deficit. Model 2 shows the normalisation on financial accounts, in which the coefficient of the current account is –0.764 and statistically significant at the 5% level. Hence, a 1% rise in current account deficit leads to a rise in capital inflows of less than 1%.

**Table 7:** Long-Run Coefficient Estimates

| | $CA_t$ | $FA_t$ |
|---|---|---|
| Model 1 | 1.000 | –1.307*(0.020) |
| Model 2 | –0.764*(0.137) | 1.000 |

**Notes:** * denotes a 1% significance level. Standard errors are shown in parenthesis.

In the next step we investigate the short-run dynamics between the variables using the VEC model. However, before investigating the short-run dynamics we need to investigate whether the variables included in the empirical analysis are exogenously or endogenously determined. To do this we perform a block exogeneity test, and the results are reported in Table 8. They show that the null hypotheses regarding the exogeneity of each variable is not accepted since the corresponding test statistics are statistically significant at the 5% and 10% levels. Thus, there is an interplay between these variables in the long run and both variables are endogenously determined.

**Table 8:** Block Exogeneity Test

| Variable | $\chi^2$-statistic | p-value |
|---|---|---|
| $FA_t$ | 12.432 | 0.014** |
| $CA_t$ | 8.283 | 0.081*** |

**Notes:** ** and *** denote 5% and 10% significance levels respectively.

In order to capture the short-run dynamics of the variables we perform the VEC model. As both variables are endogenously determined and cointegrated in the long run, the VEC model is estimated individually by considering each variable as a dependent variable. Table 9 displays the results of the VEC (4) model.

**Table 9:** Vector Error Correction Model

| | Dependent Variable: $\Delta CA_t$ | Dependent Variable: $\Delta FA_t$ |
|---|---|---|
| $ECT_t$ | –0.461(0.180)* | –0.326(0.103)* |
| $\Delta CA_{t-1}$ | 0.223(0.051)* | –0.118(0.334) |
| $\Delta CA_{t-2}$ | –0.068(0.158) | 0.422(0.327) |
| $\Delta CA_{t-3}$ | –0.417(0.427) | 0.585(0.305) |
| $\Delta CA_{t-4}$ | –0.468(0.463) | –0.163(0.295) |
| $\Delta FA_{t-1}$ | 0.227(0.037)* | 0.699(0.199)* |
| $\Delta FA_{t-2}$ | 0.135(0.013)* | 0.513(0.177)* |
| $\Delta FA_{t-3}$ | 0.012(0.084) | 0.313(0.206) |
| $\Delta FA_{t-4}$ | –0.068(0.158) | –0.024(0.273) |
| Diagnostic Check | | |
| $R^2$ | 0.61 | 0.47 |
| Adjusted $R^2$ | 0.55 | 0.39 |
| AIC | 19.03 | 20.49 |
| SIC | 19.34 | 20.80 |
| F-Statistics | 10.81 | 6.03 |
| Log Likelihood | –590.67 | –636.60 |

**Notes:** * denotes 1% significance level.

In the estimation of the VEC model where the current account (CA) is a dependent variable, the coefficients of the first and second lags of the first-differentiated series of the financial account (FA) are statistically significant at the 1% significance level. These results show that the financial account (FA) has a positive impact on the current account (CA). However, in the estimation of the VEC model where the current account (FA) is a dependent variable, all lags of the first differentiated series of the current account (CA) are statistically insignificant. Thus, the estimation results do not yield any significant effect of the current account (CA) on the financial account (FA) in the short run.

To sum up, the empirical findings show a causal relationship from financial account (FA) to current account (CA) in Turkey. This result is similar to other research on developing countries. However, in our study – unlike in most other research – the causality relationship is determined separately for the short term and the long term. Thus, through a dynamic analysis it demonstrates that the

causality relationship from capital account to current account is valid in both the short and the long term.

## 5. CONCLUSION AND POLICY RECOMMENDATIONS

In today's increasingly globalised economies the interaction between current account and financial account has increased in importance. In particular, the direction of the causality relationship between capital and current account deficit is very important in determining whether or not the current account deficit arises from enlarged aggregate demand financed by capital inflows. This is of great importance when designing policies to prevent current account imbalances that result in economic crises. However, in the literature there is no consensus among economists regarding the direction of causality between current and financial accounts. One group of economists argues that the direction of causality is from the current account to the financial account, while another group of economists asserts that the causality direction is from the financial account to the current account.

In order to contribute to the above discussion, this study uses quarterly data for 2002–2018 in Turkey to analyse the direction of the causal relationship between current and financial accounts. The results of the Johansen Cointegration test show that there is a long-term relationship between the variables. In order to obtain the short-run relationship between capital and current accounts we employ the Vector Error Correction (VEC) model. The results indicate that the financial account has an impact on the current account but the current account does not have an impact on the financial account. Thus, the results of our study confirm the existence of a unidirectional causality relationship from the financial account to the current account in Turkey.

The findings of the study show that the basis of the current account imbalances experienced in Turkey arise from changes in financial capital flows. This means that financial capital inflows to Turkey create extra liquidity that stimulates domestic aggregate demand and deteriorates the current account balance. Therefore, the management of capital movement in Turkey and consequently regulation of financial capital flows is of vital importance in terms of providing a current account balance and thus macroeconomic stability. If capital flows are successfully managed, economic growth can be achieved consistently by the

opportunities provided by additional foreign financial resources. If control of capital inflows is lost, the country will inevitably face serious economic crises due to current account imbalances. Therefore, policymakers in Turkey should prioritise financial account management with the ultimate purpose of reducing the high current account deficit.

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*Anh Tho To**
*Quoc Tuan Tran***
*Thi Siem Tran****
*Kim Phong Thai*****
*Thi Thu Hong Ho******

# THE MONITORING ROLE OF NON-EXECUTIVE DIRECTORS IN VIETNAM FROM A RETURN-VOLATILITY PERSPECTIVE

**ABSTRACT:** *This study examines the relevance of board independence to stock return volatility for a sample of 160 companies listed on the Vietnamese stock market over ten years (2008–2017). After controlling for potential endogeneity, we find that the presence of non-executive directors on the board tends to increase firm risk. The results indicate that non-executive directors do not play a supervisory role under the agency theory. Our findings remain robust when we apply alternative measures of the dependent variable.*

**KEY WORDS:** *Corporate governance, non-executive director, firm risk*

**JEL CLASSIFICATION:** G34, M10

* University of Finance and Marketing, Vietnam, anhtho27@gmail.com
** University of Finance and Marketing, Vietnam
*** University of Finance and Marketing, Vietnam
**** University of Finance and Marketing, Vietnam
***** University of Finance and Marketing, Vietnam

## 1. INTRODUCTION

Building and maintaining a sound corporate governance system to reduce firm risk and prevent financial crises has become essential. Efficient corporate governance is considered a critical mechanism for reducing information asymmetries between managers and non-executive shareholders, and between minority and majority shareholders. Also, "better corporate governance can add value by improving firm performance, through more efficient management, better asset allocation, better labor policies, and other efficient improvements" (Claessens & Yurtoglu 2013). On the contrary, more synchronous stock price movements are related to worse transparency and weaker corporate governance, especially in emerging markets (Morck et al. 2000). For instance, the financial crisis of 2007–2009 was the result of weakness in the corporate governance mechanisms in many countries (Akbar et al. 2017). Johnson et al. (2000) also emphasize that the weakness of legal institutions regulating corporate governance in most emerging markets caused stock market declines during the 1997 Asian financial crisis.

Therefore, the Vietnamese government has paid more attention to corporate governance in recent years, especially regarding listed companies. Legal documents regulating corporate governance were issued, but the Circular 121/2012/TT-BTC dated 26 July 2012 provided further regulation of corporate governance applicable to public companies. This law represents a step forward in identifying internal controls as an essential risk management process. It is also the first official legal document in Vietnam to define the concept of non-executive directors. While most of the available empirical papers on the relationship between board independence and firm risk come from developed countries such as the US and UK, little attention has been paid to emerging markets, especially in Vietnam. Hence, this paper is designed to fill the gap.

However, the institutional environment in Vietnam differs from that in many developed economies in several important respects, including weak legal protection, more concentrated ownership, and significant government ownership. Because the nature of corporate governance problems depends significantly on ownership structure, the results of studies on corporate governance in developed markets might not apply to emerging markets.

Specifically, Southeast Asian firms tend to exhibit concentrated ownership, while firms in developed countries such as the US and the UK prefer dispersed ownership (Claessens et al. 2000). In Southeast Asia listed firms are usually controlled by family shareholders or state shareholders who have a strong tie with the management team, and the protection of minority stockholders' rights is weak (La Porta et al. 1996). In Vietnam, state ownership still accounts for a significant proportion of the stock market, although a state-owned enterprise (SOE) equitisation process has taken place since the 1990s. Consequently, the role of non-executive directors in Vietnam is dominated by the state as the controlling shareholder. The primary contribution of this paper is to add to the existing stock of knowledge on how non-executive directors influence firm risk in the context of an emerging market – Vietnam.

After controlling for ownership concentration characteristics, we find a positive relationship between non-executive ratio and firm risk for a sample of 160 companies listed on the Vietnamese stock market from 2008 to 2017. This result does not support the agency theory view that maintaining a high proportion of non-executive directors on the board helps to reduce firm risk.

The remainder of the paper is organised as follows. Section 2 provides the literature review. The data and variables are explained in Section 3. Section 4 discusses the results of the empirical analysis. The conclusions are summarized in the last section.

## 2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

### 2.1. Non-executive directors and information transparency

A good board structure is usually established to reduce agency costs (Hutchinson & Gul 2003). The presence of non-executive directors on the board is generally expected to be effective in monitoring firm strategy and decision-making (Fama 1980). However, many empirical studies have shown that increasing the number of non-executive directors is unlikely to bring proper supervision (Raheja 2005; Kim et al. 2014; Baysinger & Hoskinsson 1990). Thus, there are two conflicting views on the role of non-executive directors in corporate risk management.

Many studies argue that agency problems can be alleviated by increasing the number of non-executive directors on the board (Cotter et al. 1997; McConnell & Servaes 1990; Jensen & Meckling 1976). Thanks to their expertise, prestige, and contacts, non-executive directors can influence managerial decisions, provide strategic direction, and improve firm performance (Pearce & Zahra 1992; Kesner & Johnson 1990; Grace et al. 1995). Non-executive directors also tend to support less risky projects or pursue risk-reducing corporate diversification strategies in order to prevent losses and protect the image of the firm (Hill & Snell 1988; Baysinger et al. 1991; Pathan 2009). Uzun et al. (2004) show that the incidence of corporate fraud decreases as the number of outside directors on the board increases. Furthermore, according to the reputation hypothesis, non-executive directors also want to maintain their reputation in the directorship market (Fama & Jensen 1983).

However, a high non-executive ratio may also reduce firm performance and thus lead to more risk due to over-supervision (Baysinger & Butler 1985), lack of specific investment knowledge and experience (Raheja 2005), or a lack of real independence (Demb & Neubauer 1992). Baysinger and Butler (1985) report that it is not necessary to have a majority of independent directors because too much monitoring can cause low performance. Executive directors are an essential source of firm-specific information for the board and may be better monitors because they have more and better information about firm operations (Baysinger & Hoskinsson 1990). Therefore, they provide valuable information to outsiders regarding the criteria necessary for evaluating the performance of senior managers (Fama & Jensen 1983). Maug (1997) also finds that it is not optimal for firms with high information asymmetry to invite monitoring from independent directors because it is costly to transfer firm-specific information to outsiders. In line with that study, Kim et al. (2014) state that outside directors face higher costs when accumulating knowledge about a firm when those firms have higher information asymmetry. Dahya et al. (1996) and Rechner & Dalton (1991) suggest that reinforcing executive managers' responsibility and authority may achieve effective performance. Finally, in firms with highly concentrated ownership non-executive directors may not perform their duties adequately because they are usually proposed by majority shareholders who control the business.

### 2.2. The monitoring role of non-executive directors in Vietnam

In Vietnam the corporate governance code on board independence as an internal control has been weak. The differentiation between executive directors, non-executive directors, and independent directors is not mentioned in general law or the 2005 Enterprise Law (Minh & Walker 2008). The Finance Minister's Decision 15/2007/QD-BTC on the Model Charter of listed companies (Model Charter 2007) and Decision 12/2007/QD-BTC on the Code of Corporate Governance for Listed Companies on Stock Exchange/Securities Trading Centers of March 2007 mention, very ambiguously, two categories: (1) executive directors, and (2) non-executive and independent directors, which are not defined. Since 2012 the 26th July Circular 121/2012/TT-BTC, providing further regulation of corporate governance applicable to public companies, has been considered as the first official legal document to define non-executive directors as members of the supervisory board and not as the general manager, deputy general manager, chief accountant, or any other managers appointed by the supervisory board (the board structure of companies listed on Vietnamese stock markets consists of two tiers, a management board and a supervisory board).

In the companies listed on the Vietnamese stock market, the supervisory role of non-executive directors is not recognised. There are three reasons for the ineffective monitoring role of non-executive directors: first, non-executive directors do not have enough specific knowledge and experience regarding processes such as sector analysis, internal benchmarks, and guidelines (Raheja 2005). Using a sample of 217 non-financial Vietnam-listed companies during the period 2010–2014, Nguyen et al. (2017) show that more than 50% of independent directors have extensive financial expertise but may not understand the nature of the business. Second, non-executive directors typically do not engage in the day-to-day management of the organisation, and the information asymmetry between executives and non-executives in Vietnamese companies is a concern. One reason is that they are usually non-executive directors of many listed companies at the same time, so they represent large shareholders or portfolio managers rather than having a supervisory role. Third, the supervisory role of non-executive directors is less critical in Vietnam because shareholder–manager conflict in emerging markets can be addressed by ownership concentration (Demsetz & Lehn 1985; Grossman & Hart 1986). Family companies are still present on the Vietnamese stock market, but they are not long-controlled family-owned groups of

companies (World Bank 2013). Meanwhile, state ownership also accounts for a significant proportion of the listed companies in Vietnam. Therefore, non-executive positions are sometimes nominated or appointed by majority shareholders who do not want to lose control of the business. Nguyen et al. (2017) also report that ownership concentration in Vietnamese companies may limit the supervisory role of non-executive directors. Hence, the hypothesis of this paper is that a higher proportion of non-executive directors leads to higher firm risk.

### 2.3 The historical background of the Vietnamese economic transition and stock market

In 1986, Vietnam began to transition from a centralised economy to a socialist-oriented market economy. The "Equitisation Programme" in Vietnam started in 1992 as a part of the State-owned Company Reform Programme due to the poor performance of state-owned enterprises (SOEs). The weak financial performance of the SOEs was caused by many different factors, such as unclear objectives, poor management, and budget constraints. Equitisation was implemented by selling part of an SOE's equity to the public or strategic investors to increase competitiveness and utilise external resources, but the government did not lose its ultimate control over these companies.

In the 1990s the Vietnamese stock market had not yet been developed, so restructuring was implemented by focusing on the small and medium-sized SOEs and by integrating plural SOEs into groups. The government was very cautious at first. For example, in 1994, 18 general corporations and 64 specialised corporations were founded by combining state-owned enterprises operating in industries considered specific strategic sectors.

Since 2000 the securities market has played an essential supporting role in the SOE equitisation process because SOE equitisation in Vietnam has mostly taken place through Initial Public Offerings (IPO) on the stock exchanges (Mishra 2011). In 1998 it was decided to establish stock exchanges in Hanoi City and Ho Chi Minh City under Degree 75/1996/ND-CP on the organisation and functioning of the Vietnam State Securities Commission and Degree 48/1998/ND-CP on the securities and Vietnam stock market. Degree 48 was then replaced by Degree 144/2003/ND-CP on securities and the Vietnamese Stock market. The Ho Chi Minh Securities Trading Center (HoSTC) was opened in

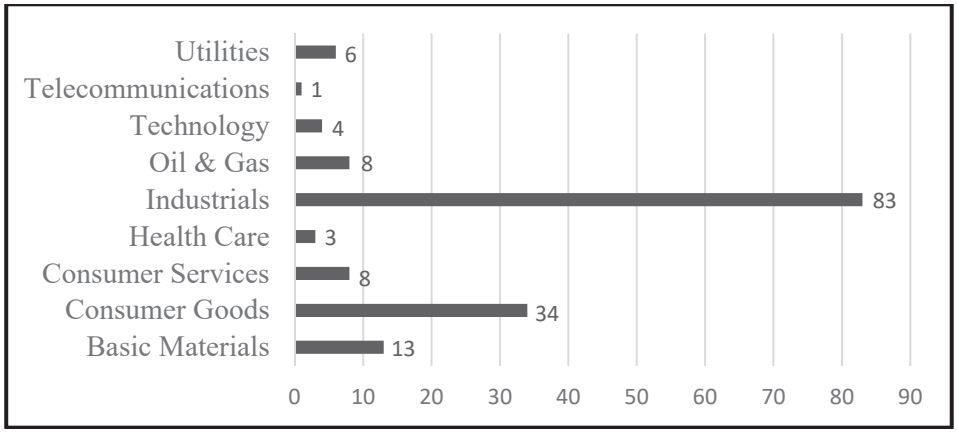
2000 and renamed Ho Chi Minh Stock Exchange in 2007. The Hanoi Stock Exchange opened in 2005.

At the end of 2005 all the listed companies were former state-owned companies. In 2000–2007 many laws were issued concerning the alignment of SOE equitisation with the development of the Vietnamese Stock Exchanges. Decision No. 238/2005/QD-TT established a foreign investor participation of up to 49% in all listed companies in Vietnam, replacing Decision No. 146/2003/QD-TT that limited foreign ownership of listed Vietnamese companies to up to 30% (raised from 20% in 2000). The divestment of state-owned companies and the new regulations increased the presence of large external investors, including foreign investors. The Vietnamese Securities Law that was issued in June 2006 and took effect on 1 January 2007 provided additional rules for listing stocks, transparency, and the disclosure of information by public companies, and further increased the inflow of foreign investment. Then, in June 2007, the international community officially recognised Vietnam as the 150th WTO member. These trends forced SOEs to bring their corporate governance and financial accounting up to international standards.

## 3. DATA, VARIABLES, AND ECONOMETRIC METHODS

### 3.1 Sample and data

**Figure 1:** Industry distribution according to the Industry Classification Benchmark (ICB)




**Source:** Datastream industry classification

Our research sample comprises 160 non-financial companies listed on the Vietnamese stock markets (HNX – Hanoi Stock Exchange and HOSE – Ho Chi Minh Stock Exchange) from 2008 to 2017. We use the one-year lag of some variables to check the causal effects, so their values in 2007 are essential. The total number of companies listed on the two security trading centres HNX and HOSE in 2007 was 112 and 138, respectively. Hence, the selected sample is highly representative. The publicly listed companies on the two stock exchanges HOSE and HNX are classified into ten industry sectors according to the Industry Classification Benchmark (ICB) 2008: (1) Oil & Gas; (2) Basic materials; (3) Industrials; (4) Consumer goods; (5) Healthcare; (6) Consumer services; (7) Telecommunications; (8) Utilities; (9) Financials (including banks, securities companies, insurance companies, real estate, and financial service companies); (10) Technology. Financial companies are excluded because they act as market makers, and, more specifically, the board structure of these companies must comply with state bank regulations. As shown in Figure 1, industrials account for a significant proportion in our sample. The ICB industrials group includes construction and material, aerospace and defence, general industrials, electronic and electrical equipment, industrial engineering, industrial transportation, and support services (Mokoaleli-Mokoteli & Ojah 2010). This group plays a significant role in the Vietnamese economy and the proportion of state ownership is high. Hence, the model has to control for ownership concentration.

The data used in this paper was collected from various sources. Governance-related variables such as non-executive directors, CEO duality, board size, and gender were collected manually by reviewing annual reports available on the official websites of the two stock exchanges, HOSE and HNX. The other financial variables were collected from DataStream. Any additional data or information was directly gathered from companies' websites or www.vietstock.vn (a leading website providing financial information, market data, and investing tools for institutional and individual investors in Vietnam).

### 3.2 Measurement of variables

#### Dependent variable

The paper uses two measures of firm risk: (1) Total risk (TRISK) equals the standard deviation of daily stock returns on a fiscal-year basis. (2) Idiosyncratic risk (IRISK) is the residuals' standard deviation from the model on a fiscal-year

basis: $R_{it} = \beta_0 + \beta_i RM_t + \varepsilon_{it}$ (where $R_{it}$ is the daily stock returns, $RM_t$ is the daily market returns based on the VN-index[6], and $\varepsilon_{it}$ is the residuals). Many previous studies related to governance structure and firm risk have used these measures (Cheng 2008; Nakano & Nguyen 2012; Wang 2012; Brick & Chidambaran 2008).

#### Independent and control variables

The non-executive director ratio (NON_EX) is the number of non-executive directors to total supervisory board members. This calculation is different from the measure used in most previous papers (e.g., Florackis & Ozkan 2009; De Andres & Vallelado 2008) that investigate a one-tier board structure and divide the number of non-executive directors by the total members in a one-tier board. The board structure of companies listed on the Vietnamese stock markets is a dual system, separated into two tiers: supervising board and managing board. Our measure evaluates the impact of non-executive director ratio on stock return volatility by controlling for the dual board system.

*GOR_OWN* is the number of shares held by the state to the total number of shares outstanding. State ownership tends to offer policy and resource benefits (Zhou et al. 2017) that allow SOEs to reduce firm risk. Losses and bad debts, which are pervasive in the majority of SOEs, are usually ignored or erased in the state banking system (Nguyen & Van Dijk 2012). Also, the government uses state-owned enterprises to pursue social objectives, such as optimal levels of employment or the provision of social services to the community, rather than profit maximisation (Shleifer & Vishny 1997), so a high level of state ownership is maintained to stabilise key business groups. From a different perspective, state ownership is associated with poor monitoring, while executives tend to have a conservative attitude toward risk-taking in order to safeguard their jobs (Boubakri et al. 2013). It is necessary to control for state ownership concentration in the model because historically Vietnam's centralised economy has been characterised by state ownership. Vo (2018) supports this argument by studying the relationship between state ownership and risk-taking behaviour for a sample of listed companies on the Ho Chi Minh stock market in the period 2007–2015. The results show that firms with substantial state ownership tend to enjoy

[6] The VN-index is the Vietnam Ho Chi Minh stock index

political and financial privileges and do not have a strong incentive to take more strategic risks.

Firm size (FSIZE) is calculated as the natural logarithm of total assets. It is selected as a control variable because both the literature and empirical results recognize that stock return volatility is driven by firm characteristics, particularly firm size (Vo 2015). Malkiel and Xu (1997) also find a negative relationship between idiosyncratic risk and firm size.

Leverage (LEV) is measured by the ratio of total debt to total assets. High debt leverage may put pressure on a firm to fulfil its interest and other obligations, which then leads to variability in the firm's future performance (Huang & Wang 2015). Adams et al. (2005) and Nakano and Nguyen (2012) suggest that higher leverage significantly increases the volatility of stock returns and the risk of bankruptcy.

Dividend payment (DIV) is the ratio of dividend payout to total assets (Jiraporn et al. 2011). The negative correlation between dividend payment and corporate risk is demonstrated experimentally in many studies (Pastor & Veronesi 2003; Bartram et al. 2015). One of the explanations for this is the use of dividend policy as a mechanism to mitigate agency problems by reducing the cash in place and consequently avoiding overinvestment (Lewellen & Emery 1981).

Price to book value (PB) is the ratio of the market value of equity to the book value of equity, which is a proxy for growth opportunity. Fama and French (1992) find a strong univariate relationship between average returns and both firm size and P/B ratio, while firm-specific risks are directly related to corporate performance (Nguyen 2011).

Cash ratio (CASH) is cash and equivalent cash divided by total assets. Tufano (1998) shows that firms can implement risk management programmes by managing internal cash surpluses and shortages, in turn reducing investment distortion costs.

The study also uses other control variables such as ROA (ratio of net income to total assets), LIQ (proportion of trading days in one year in which the return is zero), lnBSIZE (natural logarithm of the total number of directors), FEMALE

(proportion of female directors to the total number of directors), CEO_DUAL (a dummy variable with a value of 1 if the firm has CEO–chairman duality status and 0 otherwise), and LARGE (the proportion of shares held by the three largest shareholders to the number of shares outstanding).

### 3.3 Empirical models

To better capture the effect of board independence on stock return volatility we control for ownership concentration characteristics by including variables such as state ownership and the proportion of shares held by the three largest shareholders into the model, because ownership concentration is a concern in studies of corporate governance in emerging markets. Our regression model is developed as follows:

$$RISK_{it} = \beta_0 + \beta_1 NON\_EX_{it} + \beta_2 LnBSIZE_{it} + \beta_3 CEO\_DUAL_{it} + \beta_4 FEMALE_{it} + \beta_5 GOR\_OWN_{it} + \beta_6 LARGE_{it} + \beta_7 LIQ_{it} + \beta_8 FSIZE_{it} + \beta_9 CASH_{it} + \beta_{10} DIV_{it} + \beta_{11} LEV_{it} + \beta_{12} PB_{it} + \beta_{13} ROA_{it} + \varepsilon_{it}$$

Controlling for unobserved heterogeneity, we use the fixed effects approach to gain an insight into the relationship between volatility and non-executive directors. As appropriate, we include firm fixed-effects to control for omitted time-invariant firm characteristics, and time fixed-effects to control for any unobserved time-variant effect that affects all firms in the sample. The standard errors are clustered by firm-level to control for heteroskedasticity and within-firm correlation in the residuals.

However, the potential endogeneity problem has to be considered because it is recognised as a problem that undermines causal inference in corporate governance studies (Roberts & Whited 2012; Wintoki et al. 2012). Although unobservable heterogeneity can be eliminated by applying fixed effects models, the reported coefficient estimates may still be biased if simultaneity exists in the relationship between non-executive director ratio and volatility. Notably, the non-executive ratio in a certain period may lead to a change in stock return volatility in that period, while the reverse is also true – high volatility may motivate firms to adjust their board structure and change their non-executive ratio. In that case, the two variables are simultaneously determined.

Therefore, to check the robustness of our estimates we re-estimate with two alternative model specifications. First, following Hermalin and Weisbach (1991) and Wang (2012), we replace the contemporary values of the corporate governance variables with the one-year lagged values, reflecting the board characteristics at the beginning of the year. This approach might help to remove endogeneity due to reverse causality and thereby mitigate the estimation bias. Second, an instrumental variable fixed-effects approach is implemented to further address the reverse causality issue. In Stata, this approach is implemented by the *ivreghdfe* command, which is essentially the *ivreg2* command with an additional "absorb" option to capture fixed effects (Correia 2018). This method requires instrumental variables to be highly correlated with the non-executive ratio but not correlated with the error term or unexplained variations in volatility. Following Haider and Fang (2016), we use the one-year lag of non-executive ratio and the one-year lag of board size as instruments. According to Li (1994) and Mak and Li (2001), board size has a negative impact on the composition of outside board members. Linck et al. (2008) even show that the contemporary value of board independence is significantly related to the lagged board size.

## 4. RESULTS AND DISCUSSION

Table 1 presents descriptive statistics of the research variables. The average total risk (idiosyncratic risk) of companies listed on the Vietnamese stock markets is 3.03% (2.75%). The average proportion of non-executive directors is around 57.4%. This means that on average there are between three and seven non-executive directors serving on a supervisory board, because the total number of members on the board for listed companies must comprise between five and eleven members (Article 30 of Circular 121/2012/TT-BTC).

**Table 1:** Descriptive statistics

| | N | Mean | SD | Min | p25 | p50 | p75 | Max |
|---|---|---|---|---|---|---|---|---|
| **TRISK (%)** | 1,600 | 3.03 | 1.14 | 1.06 | 2.35 | 2.98 | 3.58 | 32.99 |
| **IRISK (%)** | 1,600 | 2.75 | 1.12 | 0.93 | 2.14 | 2.62 | 3.27 | 33.05 |
| **NON_EX** | 1,760 | 0.57 | 0.21 | 0.00 | 0.40 | 0.60 | 0.75 | 1.00 |
| **BSIZE** | 1,760 | 5.53 | 1.20 | 2 | 5 | 5 | 6 | 13 |
| **CEO_DUAL** | 1,760 | 0.30 | 0.46 | 0 | 0 | 0 | 1 | 1 |
| **FEMALE** | 1,760 | 0.14 | 0.16 | 0.00 | 0.00 | 0.11 | 0.20 | 0.80 |
| **GOR_OWN (%)** | 1,748 | 32.08 | 22.81 | 0.00 | 9.25 | 35.24 | 51.00 | 84.44 |
| **LARGE (%)** | 1,734 | 48.12 | 19.66 | 0.00 | 34.93 | 51.00 | 60.65 | 99.25 |
| **LIQ** | 1,600 | 0.27 | 0.19 | 0.01 | 0.12 | 0.22 | 0.35 | 0.98 |
| **FSIZE** | 1,760 | 20.24 | 1.44 | 16.31 | 19.23 | 20.10 | 21.17 | 24.69 |
| **CASH** | 1,760 | 0.11 | 0.11 | 0.00 | 0.03 | 0.07 | 0.15 | 0.70 |
| **DIV** | 1,760 | 0.03 | 0.04 | 0.00 | 0.01 | 0.02 | 0.04 | 0.74 |
| **LEV** | 1,760 | 0.48 | 0.22 | 0.02 | 0.30 | 0.50 | 0.66 | 0.95 |
| **PB** | 1,743 | 1.42 | 1.50 | 0.13 | 0.62 | 0.98 | 1.63 | 24.96 |
| **ROA** | 1,760 | 0.07 | 0.08 | –0.65 | 0.03 | 0.06 | 0.10 | 1.11 |

**Notes:** The table presents descriptive statistics for the variables in this study, where TRISK is total risk, IRISK is idiosyncratic risk, NON_EX is the percentage of non-executives on the supervisory board, BSIZE is the total number of directors, CEO_DUAL has a value of 1 if the firm has CEO–chairman duality status and 0 otherwise, FEMALE is the proportion of female directors to the total number of directors, GOR_OWN is the proportion of shares held by the state to the number of shares outstanding, LARGE is the proportion of shares held by the three largest shareholders to the number of shares outstanding, LIQ is the proportion of trading days in one year in which the return is zero, FSIZE is the natural logarithm of total assets, CASH is calculated as cash and equivalent cash divided by total assets, DIV is the ratio of dividend payout to total assets, LEV is the ratio of total debt to total assets, PB is the market value to book value of equity, and ROA is net income divided by total assets.

Table 2 presents the correlation matrix. There are no particularly high bivariate correlations among the independent variables (the highest being 0.575 between GOR_OWN and LARGE). Because all the correlation coefficients are lower than 0.8, the model is not at risk of violating multicollinearity (Gujarati & Porter 2003). We also run the variance inflation factor (VIF) after regressions to check again for any multicollinearity issue, but all VIFs are low, with a mean of 1.46 (not reported in the tables).

Table 3 mainly investigates whether the non-executive ratio is related to stock return volatility by using the fixed effects method. The results of the Hausman tests (P-values <5%) suggest that the fixed-effect models are preferable to the random-effects model. As hypothesized, the overall results show that stock return volatility is higher in firms with more non-executive directors, as the coefficients on NON_EX have a positive sign and are statistically significant. The positive impact rejects the monitoring role of non-executive directors under the agency theory. Remarkably, the significance of the lagged NON_EX in panel B is higher than the significance of the contemporary NON_EX in panel A. The evidence shows that past board independence also has an impact on volatility. It also means that a higher ratio of non-executive directors in the current period is likely to cause more stock return volatility in the next period. These results are in contrast to studies by Nakano and Nguyen (2012) that show a negative relationship between board independence and corporate risk for a sample of 1,324 Japanese firms over the period 2003–2007. The finding implies that in Vietnamese listed firms the presence of non-executive directors has not been understood as a potential risk-controlling measure. There are two reasons for this. First, non-executive directors do not take part in the routine management of the organisation and so do not have enough specific knowledge to solve the company's problems. Second, majority shareholders – who control the company – usually interfere with the appointment of non-executive directors, so in some cases, non-executive directors are not going to implement monitoring activities to address owner–manager conflicts .

The coefficients on the firm characteristic variables also provide an essential insight. As expected, the negative and significant coefficient on FSIZE indicates that large firms have many advantages when controlling risk. In line with Pastor and Veronesi (2003) and Bartram et al. (2015), the coefficient on DIV is negative and significant at the 5% level, which implies that paying more dividends can help reduce firm risk. By contrast, leverage has a positive effect on firm risk, which is consistent with Adams et al. (2005) and Nakano and Nguyen (2012).

**Table 2:** Correlation matrix

| | TRISK | IRISK | NON_EX | LnBSIZE | CEO_DUAL | FEMALE | GOR_OWN | LARGE | LIQ | FSIZE | CASH | DIV | LEV | PB | VIF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NON_EX | –0.049* | –0.007 | | | | | | | | | | | | | 1.22 |
| LnBSIZE | –0.164*** | –0.192*** | 0.027 | | | | | | | | | | | | 1.19 |
| CEO_DUAL | 0.039 | 0.007 | –0.355*** | 0.015 | | | | | | | | | | | 1.22 |
| FEMALE | –0.103*** | –0.076*** | –0.107*** | 0.047* | 0.110*** | | | | | | | | | | 1.16 |
| GOR_OWN | –0.003 | –0.033 | 0.043* | –0.172*** | –0.220*** | –0.256*** | | | | | | | | | 1.69 |
| LARGE | –0.098*** | –0.036 | 0.153*** | –0.124*** | –0.196*** | –0.104*** | 0.575*** | | | | | | | | 1.77 |
| LIQ | –0.010 | 0.205*** | 0.052** | –0.148*** | –0.060** | 0.068*** | 0.040 | 0.192*** | | | | | | | 1.30 |
| FSIZE | –0.351*** | –0.387*** | 0.108*** | 0.316*** | –0.133*** | –0.069*** | 0.058** | 0.147*** | –0.343*** | | | | | | 1.58 |
| CASH | –0.086*** | –0.082*** | 0.080*** | 0.060** | 0.001 | 0.066*** | 0.019 | 0.051** | 0.009 | –0.038 | | | | | 1.16 |
| DIV | –0.161*** | –0.179*** | 0.027 | 0.026 | 0.033 | 0.106*** | 0.077*** | 0.117*** | –0.062** | –0.052** | 0.239*** | | | | 1.72 |
| LEV | 0.091*** | 0.078*** | –0.081*** | –0.026 | –0.049* | –0.175*** | 0.100*** | 0.084*** | –0.032 | 0.307*** | –0.309*** | –0.424*** | | | 1.60 |
| PB | –0.118*** | –0.139*** | 0.123*** | 0.111*** | –0.035 | 0.166*** | 0.022 | 0.187*** | –0.082*** | 0.201*** | 0.166*** | 0.333*** | –0.133*** | | 1.42 |
| ROA | –0.137*** | –0.170*** | 0.014 | 0.066*** | 0.036 | 0.140*** | 0.061** | 0.101*** | –0.147*** | 0.004 | 0.287*** | 0.610*** | –0.425*** | 0.453*** | 2.00 |

**Note:** Variables are defined as in Table 1

**Table 3:** Fixed effects results

| **Panel A** | | | **Panel B** | | |
|---|---|---|---|---|---|
| | **Total risk** | **Idiosyncratic risk** | | **Total risk** | **Idiosyncratic risk** |
| NON_EX | 0.394* | 0.360* | $NON\_EX_{t-1}$ | 0.580*** | 0.524** |
| | (1.97) | (1.80) | | (2.66) | (2.44) |
| LnBSIZE | –0.371* | –0.302* | $LnBSIZE_{t-1}$ | –0.412* | –0.414* |
| | (–1.91) | (–1.68) | | (–1.83) | (–1.90) |
| CEO_DUAL | –0.123** | –0.108* | $CEO\_DUAL_{t-1}$ | –0.0282 | –0.0298 |
| | (–1.99) | (–1.86) | | (–0.42) | (–0.46) |
| FEMALE | –0.145 | –0.0102 | $FEMALE_{t-1}$ | –0.394 | –0.208 |
| | (–0.57) | (–0.04) | | (–1.65) | (–0.95) |
| GOR_OWN | –0.000275 | –0.00123 | $GOR\_OWN_{t-1}$ | 0.00192 | 0.00183 |
| | (–0.09) | (–0.47) | | (0.65) | (0.69) |
| LARGE | 0.00240 | 0.00226 | $LARGE_{t-1}$ | 0.00481* | 0.00409* |
| | (0.74) | (0.72) | | (1.80) | (1.69) |
| LIQ | –0.634 | –0.351 | LIQ | –0.647 | –0.356 |
| | (–1.14) | (–0.61) | | (–1.17) | (–0.62) |
| FSIZE | –0.262*** | –0.268*** | FSIZE | –0.247*** | –0.244*** |
| | (–3.08) | (–3.61) | | (–2.86) | (–3.20) |
| CASH | 0.313 | 0.342 | CASH | 0.239 | 0.286 |
| | (1.22) | (1.46) | | (0.92) | (1.18) |
| DIV | –1.444** | –1.515** | DIV | –1.550** | –1.569** |
| | (–1.99) | (–2.21) | | (–2.15) | (–2.33) |
| LEV | 0.863*** | 0.868*** | LEV | 0.760*** | 0.758*** |
| | (3.37) | (3.63) | | (2.76) | (2.92) |
| PB | –0.0163 | –0.0552 | PB | –0.0137 | –0.0525 |
| | (–0.31) | (–1.06) | | (–0.26) | (–1.02) |
| ROA | 0.331 | 0.431 | ROA | 0.243 | 0.330 |
| | (0.98) | (1.29) | | (0.74) | (1.03) |
| Constant | 8.458*** | 8.185*** | Constant | 8.001*** | 7.686*** |
| | (4.92) | (5.50) | | (4.77) | (5.31) |
| **Observations** | 1,572 | 1,572 | **Observations** | 1,563 | 1,563 |
| **Year fixed** | Yes | Yes | **Year fixed** | Yes | Yes |
| **Firm fixed** | Yes | Yes | **Firm fixed** | Yes | Yes |
| **F-statistics** | 4.35 | 4.36 | **F-statistics** | 5.18 | 4.60 |
| **P-value** | 0.000 | 0.000 | **P-value** | 0.000 | 0.000 |
| **R-squared** | 0.4196 | 0.4113 | **R-squared** | 0.4243 | 0.4134 |
| **Hausman test** | 0.0018 | 0.0032 | **Hausman test** | 0.0010 | 0.0028 |

**Note:** This table presents fixed effects regressions to examine the relationship between non-executive ratio and firm risk. The variables are defined as in Table 1. Robust t-statistics adjusted for firm-level clustering are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

**Table 4:** Instrumental variables fixed-effects regressions

| | First-stage regression | Second-stage regressions | |
|---|---|---|---|
| | NON_EX | Total risk | Idiosyncratic risk |
| LnBSIZE $_{t-1}$ | −0.0820** | | |
| | (−2.08) | | |
| NON_EX $_{t-1}$ | 0.507*** | | |
| | (18.16) | | |
| NON_EX | | 1.068** | 0.965** |
| | | (2.39) | (2.18) |
| LnBSIZE | 0.122*** | −0.419** | −0.345* |
| | (3.01) | (−2.15) | (−1.94) |
| CEO_DUAL | −0.0797*** | −0.0371 | −0.0315 |
| | (−5.93) | (−0.54) | (−0.47) |
| FEMALE | 0.0725 | −0.194 | −0.0538 |
| | (1.59) | (−0.74) | (−0.21) |
| GOR_OWN | −0.000579 | 0.000370 | −0.000652 |
| | (−1.24) | (0.12) | (−0.24) |
| LARGE | 0.000816** | 0.00163 | 0.00157 |
| | (2.21) | (0.46) | (0.46) |
| LIQ | 0.0312 | −0.652 | −0.367 |
| | (1.17) | (−1.19) | (−0.65) |
| FSIZE | 0.00469 | −0.274*** | −0.279*** |
| | (0.41) | (−3.16) | (−3.68) |
| CASH | 0.0395 | 0.271 | 0.305 |
| | (0.94) | (1.06) | (1.30) |
| DIV | 0.0394 | −1.459* | −1.529** |
| | (0.54) | (−1.96) | (−2.17) |
| LEV | 0.0309 | 0.846*** | 0.852*** |
| | (0.86) | (3.22) | (3.51) |
| PB | 0.000994 | −0.0171 | −0.0559 |
| | (0.22) | (−0.31) | (−1.04) |
| ROA | −0.0313 | 0.303 | 0.405 |
| | (−0.55) | (0.86) | (1.16) |
| Observations | 1,572 | 1,572 | 1,572 |
| Year fixed | Yes | Yes | Yes |
| Firm fixed | Yes | Yes | Yes |
| *F test of excluded instruments:* | | | |

| | | | |
|---|---|---|---|
| F-statistics | 183.89 | | |
| P-value | 0.000 | | |
| *Overidentification test of all instruments* | | | |
| Hansen test (P-value) | | 0.5513 | 0.4213 |
| Endogeneity test (P-value) | | 0.0338 | 0.0465 |

**Note:** This table presents instrumental variable fixed-effects regressions to examine the relationship between non-executive ratio and firm risk. NON_EX is treated as a potentially endogenous variable. $LnBSIZE_{t-1}$ and $NON\_EX_{t-1}$ are instrumental variables. The other variables are defined as in Table 1. The first-stage F-test is used to test for the joint significance of the instruments. The null hypothesis of the Hansen test for overidentifying restrictions is that the excluded instruments are not correlated to the error term. The null hypothesis for the endogenous test is that NON_EX is exogenous. Robust t-statistics adjusted for firm-level clustering are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

To mitigate the endogeneity bias, we use instrumental variable fixed-effects provided by Correia (2018) and report the results in Table 4. All the coefficients on NON_EX are significant at the 5% level, confirming that the risk management role of non-executive directors is ineffective. The first-stage regression shows that the coefficients on the lagged board independence and board size are highly significant, indicating that the past values of board independence and board size strongly explain the current board independence. The validity of our instrument can be justified by obtained F-statistics of more than 10 in the first-stage regression, and Hansen tests for over-identifying restrictions indicate that the instruments are not correlated with the error term. All the diagnostic tests support the conclusion that the instruments used are reasonable, and the regression results are consistent. In brief, after addressing the endogeneity bias the results remain unaffected and show that firms with more non-executive directors tend to have more stock return volatility. This finding is consistent with Haider and Fang (2016), who also use two-stage least squares regression analyses to solve the endogeneity problem and find a positive impact of independent directors on corporate risk in Chinese SOEs.

## 5. CONCLUSION

Although the role of non-executive directors in controlling corporate risk has been studied extensively in developed markets, the investigation of this issue is lacking in emerging markets such as Vietnam. By investigating a sample of 160 companies listed on the Vietnamese stock markets in the period 2008–2017, we

find a higher stock return volatility in firms with more non-executive directors. This positive relationship is proved to be consistent with instrumental variable fixed-effect regressions and alternative measures of volatility. The result rejects the monitoring role of non-executive directors under the agency theory.

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*Sanja Popović-Pantić**
*Dušica Semenčenko***
*Nikola Vasilić****

# DIGITAL TECHNOLOGIES AND THE FINANCIAL PERFORMANCE OF FEMALE SMES IN SERBIA: THE MEDIATING ROLE OF INNOVATION

**ABSTRACT:** *Digital technologies that create innovation have the capacity to leverage economic development. The integration of digital technologies in daily operations has become a key success factor in sustainable development, market positioning, and advancement. This is particulary challenging for female companies in developing countries, which face numerous biases on their entrepreneurial path, including in innovation. This specific group of entrepreneurs faces additional barriers in implementing digital technologies and digital transformation, which are considered part of their innovation capacity. However, some companies perform well according to financial parameters, regardless of the level of digitization and innovation potential. This research paper explores the correlation between financial performance and the innovative implementation of digital technologies. The main assumption in this research is that companies that do not use digital technologies to innovate can not expect to improve their financial performance. We focus on the impact of digital technology on the financial performance of female companies. We also consider the indirect impact of digital technology use on financial performance, with product innovation as the mediator variable. The sample consists of 46 female companies. The results of the analysis confirm the hypotheses that digital technology has no direct influence on financial performance, and that product innovation mediates the relationship between digital technology and financial performance.*

**KEY WORDS:** *digital technology, innovation, product innovation, female companies, SME, financial performance, mediation*

**JEL CLASSIFICATION:** M15, M21, O33, J16

* University of Belgrade, Institute Mihajlo Pupin – Science and Technology Policy Research Center, Belgrade, Serbia, sanjap.pantic@pupin.rs
** University of Belgrade, Institute Mihajlo Pupin – Science and Technology Policy Research Center, Belgrade, Serbia, dusica.semencenko@pupin.rs
*** University of Belgrade, Institute Mihajlo Pupin – Science and Technology Policy Research Center, Belgrade, Serbia, nikola.vasilic@pupin.rs

## 1. INTRODUCTION

Female entrepreneurship has been recognized as one of the main factors behind business growth and venture creation in the 21st century, boosting economic development in general.

The role of female entrepreneurship in economic prosperity and poverty reduction is apparent in both less-developed and developed countries. Apart from contributing to the growth of employment, female entrepreneurship improves diversification in the work place through introducing different innovation processes and management and marketing practices. The share of female businesses in the total number of SMEs in Serbia is 31.7% (Babović 2014), which is similar to the EU average. The main characteristics of female businesses are their location in the traditional low-income and low-growth sectors and their small size. Female companies face issues regarding access to and use of digital technologies (DT), which is often seen as the main reason for the development gap between female and male companies, since prosperity is conditioned by the overall use of DT. Information and communication technologies (ICT) – social media, mobile telecommunication, the Internet of Things (IoT), big data, 3D printing – and digital transformation in general enable women to cope with gender bias in their path to development and growth. Adoption of ICT and the digital transformation of businesses are important factors in developing business strategies, encouraging creativity and innovation, and enhancing competitiveness (Ongori & Migiro 2010), leading to a more competitive position in the globalised market and better financial performance. As DT is affordabale and user-friendly it can enable women, who mostly run and own micro and small-sized businesses located in traditional sectors, to level-up relatively easily.

This paper expands previous research on the innovation capacity of female companies, with the aim of identifying the impact of DT on the financial performance of female companies, using product/service innovation as the mediator variable.

Various studies have reported a positive effect of DT on productivity, innovation, financial performance, and the labour market. Companies that recognize the importance of DT and are able to incorporate it in their regular operations benefit in the short term and improve their market position. This is very important for

female companies in particular, as they are considered a vulnerable category in relation to the access, adoption, and use of DT. Entrepreneurship based on extensive use of DT and the internet is a great equaliser and leveller (Andjelković et al. 2019) that provides equal opportunities and access to business opportunites for everyone irrespective of gender, ethnicity, and race, abolishing the inequalities that exist in the offline business environment.

However, it is important to note that the precondition for benefiting from DT is the company's capacity to implement it in an innovative way. DT will only be the source of progress if it changes the regular way of doing business and adds value by contributing to innovation.

This research explores whether female companies use DT to create innovation and analyses the impact of DT in female companies on financial performance. The next section presents the concept of innovation from a gender perspective, as gender diversity is perceived as an innovation booster. The third section presents the results of previous research on innovation in female companies in Serbia, including that based on the IMP³rove methodology, consisting of five dimensions of innovation management and enabling factors. The 'House of Innovation' core of the IMP³rove[1] methodology was created in 2006, and DT can be considered as a new, additional innovation-enabling factor. The third section focuses on the benefits and limits of DT use in female companies. The fourth part presents the research methodology and the fifth part presents the research results. The sixth part presents a robustness analysis of the obtained results.

[1] Designed by A.T Kearney in 2006, IMP³rove methodology is a holistic approach to innovation management that has five basic dimensions, called the "House of Innovation". It includes a benchmarking process which produces a comprehensive report on how to improve and leverage innovation management for profitable growth, which a) identifies the gaps in championing growth and b) directs where and how the company should be developed and grown (Popović-Pantić 2014). The five dimensions of the House of Innovation are innovation strategy, innovation organization and culture, innovation process (life cycle management), and enabling factors that support the development of a company's innovation management (Kearney 2006.)

## 2. INNOVATION – A GENDER-BASED APPROACH

The impact of gender diversity on the adoption and use of technology is stronger than ever, which builds the case for gender diversity in both business and innovation. Gender diversity in business brings a range of benefits: enhanced employee recruitment and retention from a wider pool of skilled workers, improved corporate image and reputation, greater innovation, and enhanced marketing opportunities. The case for gender diversity and innovation is based on six areas: 1) Competition for well-educated employees, 2) Competition through better decision-making, 3) Gender diversity as a driver of creativity and innovation, 4) Competition with user-driven innovation, 5) Gender as a means of design innovation, and 6) Competition by image shaping (Danilda & Thorslund 2011).

#### Competition for well-educated employees.

Today, companies look for technology personnel with experience and developed skill sets. Competition among companies and specific head hunting is increasing, given the drop in science graduates and lack of this profile among the older generation. Therefore, companies have to compete to offer the best working conditions in order to attract the best high-tech employees. If Europe is to achieve its goal of becoming a dynamic and competitive knowledge-based economy in a globalised world, then women's talents and skills should be put to better use, especially in highly innovative sectors (European Commission 2010).

#### Competition through better decision-making.

Gender diversity is especially important in and beneficial to problem-solving. Studies by international development and financial organisations show that companies with a balance of women and men make better decisions than companies with more monolithic structures (EBRD 2017). More women in decision-making positions also implies less corruption and results in effective good governance.

#### Gender diversity as driver of creativity and innovation.

A study of research and development teams at more than 4,000 companies finds that gender diversity "generates dynamics that lend themselves to radical innovation" (Díaz-García et al. 2013). Moreover, research suggests that women

score as well or higher than men in key innovation capacities, such as championing change (Zenger & Folkman 2015) However, creativity is an intangible phenomenon; it is almost impossible to directly measure creativity and to determine whether a gender gap exists. Foss et al. (2013) emphasize that there is no difference between men and women in creativity or in their ability to generate innovative ideas, although many authors agree that diversity, including gender diversity, leads to innovative thinking. Human capital resources have different dimensions such as education, training, and experience. Demographic dimensions such as gender, age, and cultural background also affect the application and combination of existing knowledge and the communication and interaction between employees. Employee diversity is often considered positive since it can create a broader search base and make a business more creative and more open to new ideas. It is assumed that women, either as business owners or in top management, receive less support for implementing their ideas within organisations (Foss et al. 2013). The prevailing organisational culture is a key factor in enabling women's involvement in the innovation process.

There is a positive relationship between gender diversity in the firm's knowledge base and the firm's innovative capability. Gender diversity increases both the firm's knowledge base and the interaction between different types of competency and knowledge (Østergaard et al. 2009). Businesses with a balanced workforce (50%–60% of the same gender) are almost twice as likely to innovate than those with a very segregated workforce (90%–100% of the same gender). Thus, a balanced gender distribution has a strong effect on the innovative performance of a business.

**Competition and user-driven innovation.**

Women influence 80% of consumer spending decisions, and yet 90% of technological products and services are designed by men (Danilda & Thorslund 2011). Including women in the technological design process would result in more competitive products in the marketplace. The most innovative companies design products through user-driven innovation by integrating lead users in the design process. Involving more women can bring new markets and new technological applications to the design process. Furthermore, the purchasing power of women is increasing. Marketing strategies directed towards women as spenders, which

do not rely on gender stereotypes and prejudice, will create new business opportunities (Danilda & Thorslund 2011).

#### Gender as a means of design innovation

Consumers are interested in the individualisation of products and products that break with traditional gender stereotypes. There is a positive and a negative side to companies' focus on the ways women differ from men. On the one hand, a focus on what women want strengthens and gives value to feminine-connoted skills and preferences. On the other hand, by developing a product based on 'typical women's interests', designers run the risk of reinforcing and re-inscribing gender stereotypes rather than "transforming gender" (Danilda & Thorslund 2011). Gendered design could reproduce stereotypes and the view that women and men are different. Moreover, designers' beliefs about women often do not conform to most women's skills, preferences, and experiences (Rommes 2007). Increased innovative capacity improves competitiveness. Respecting the diversity of the consumer's needs according to their gender and their inclusion in the design of innovations represents a new source of innovation. For example, it is important to include non-traditional product developers working in a sector that is normally perceived to be predominantly male or female.

Women owners and managers emphasise the importance of a relaxed and flexible working atmosphere and informal communication in order to stimulate the generation of innovative ideas and knowledge (Sandberg 2003). The focus on open communication is clear in the leadership style of female managers, who apply a transformational leadership style more often than men (Eagly & Carli 2003).

#### Competition by image shaping.

Gender diversity enhances a company's image and makes it more attractive to society in general. In the context of sustainable development, organisations are taking a different approach to doing business: financial performance is no longer regarded as the exclusive driver. Instead, economic, environmental, and social factors, including gender equality, are increasingly being recognised as important.

The sectors in which women operate are another crucial factor that influences women's businesses. Traditionally, women-owned companies are most present in the service sector and retail, which are not demanding regarding technological innovation compared to traditionally 'male' sectors such as construction, high-tech, and the processing industry. Nevertheless, DeTienne and Chandler (2007) find that women-owned companies in male-dominated industries are not less innovative. Furthermore, Kushnirovich and Heilbrunn (2013) show that gender does not have a significant influence on the innovativeness of high-tech companies. Rather, culture is the dominant influence on innovation (Schøtt & Cheraghi 2015).

Social capital and access to a business network also affect the capacity of women to innovate (Roomi 2009). Women often have less access to business networks than men, mostly because of family duties. Recently, the access of women entrepreneurs to female networks has been increasing, but their involvement in more-developed business networks is still modest (Watkins et al. 2015). In general, women owners spend less time on networking than men owners (Verheul & Thurik 2001).

The gap in innovation between female and male companies also depends on the development level of the economy and institutions. In highly developed countries, women-owned companies are as successful in technological innovation as male-owned companies, if not more successful (Vanderbrug 2013). In less-developed countries of Africa and Asia there is a significant gender gap in technological innovation because women have limited access to education and financial resources (Ighomereho et al. 2013). In transition economies the gender gap in this area is due to a lack of financial resources

Strohmeyer et al. (2017) point out that although female companies in general are less innovative than male companies, their is no significant difference in non-technological innovation. Women are more inclined toward social innovation than men, thus benefitting the whole society (UNCTAD 2014).

## 3. REVIEW OF RESEARCH ON INNOVATION IN WOMEN-OWNED AND MANAGED SMES IN SERBIA

Previous research on innovation activities in Serbian SMEs that are owned and managed by women includes surveys carried out in 2005 by Semenčenko (2009) and in 2006-2007 by Popović-Pantić and Petrović (2007) using the OECD methodology (OECD 2005). Research on the innovation capacity of women's enterprises in Serbia was carried out in 2010 using the IMP$^3$rove methodology (Popović-Pantić 2014)

The results of the 2005 survey conducted on a sample of 31 women-owned and managed firms show that 96% of respondents used ICT, and 82% had developed their own information systems. ICTs were mostly used for contacts with other companies, business relations with suppliers and customers, and administration and accounting (around 81% for all three categories), followed by company presentations on the Internet (71%), business system management (66%), and technical preparation and management/monitoring of production processes (at least 53%).

Forty-eight per cent of the enterprises had produced new innovations (physical products, services, and software), sixty per cent of which were technological. Forty-six per cent of the innovators cooperated with R&D institutions. It should be noted that the survey participants had previously been educated on the importance to small businesses of innovation and technological competitiveness. Consequently, the participants understood the subject of the survey and the answers relating to innovation and R&D are reliable (Semenčenko 2009).

A second piece of research on innovation and female entrepreneurship in Serbia was conducted in 2006–2007 on a sample of 52 small women-owned companies with up to 10 employees, also using OECD methodology (Popović-Pantić & Petrović 2007). The findings show innovation acitivity in 45% of the companies, mostly for purchasing equipment and software, training employees, and internal R&D.

The following conclusions can be drawn from this research. First, women are active in equally diverse sectors as men, defying gender stereotypes about the sectors in which women set up and develop their businesses. Almost 40% of

companies in the sample are technical. The stereotype is that women-run and owned businesses are mostly in handicrafts with a modest share in advanced sectors. The data on ICT innovation shows that 32% of employees in the technical sector were women, of which 19% were owners and 28% were in management positions. Considering the total number of employees and the number of employed women graduates in the ICT sector, these figures show a lack of gender equality at top-level management positions.

Second, the owners of the companies are mostly women graduates with BA or BSc diplomas who are commited to furthering and upgrading their knowledge, and third, there is a high level of awareness of the importance of DT for the competitivness of products and services.

In general, there is a huge creative potential among women entrepreneurs. All the women entrepreneurs in the sample planned to develop their companies. Apart from gender-related bias, women entrepreneurs faced the same business problems as men. There is huge potential among women entrepreneurs to learn and upgrade their knowledge and the skills of their employess, which is one of the main indicators of an innovation culture. However, in most of the sampled companies the innovation culture is not encouraged as the result of a systematic approach but is rather an ad hoc activity.

The 2010 research was based on the IMP$^3$rove methodology (Popović-Pantić 2014), adjusted and simplified according to assessments of the innovation capacity of the companies without benchmarking. The sample consists of 22 women-run and owned companies, the majority of which had more than 10 employees. Only six employed less than 3 people. The research finds that innovation in female companies is mainly focused on new product development. Female companies also prioritize marketing and sales, which is in line with the finding that the preferred form of commercializing innovation in Serbian companies is the sale of final products rather than the sale of concepts and patents, which is very rare. The prevalent external source from which they receive ideas and information relevant to innovation development is their direct customers/clients. The internal sources female entrepreneurs rely on most are the procurement/sales and marketing departments. In most cases (18 companies) it takes 1 month to 1 year from the beginning of product/service development to

enter the market. In the majority (16) of companies the same period is required for the product to become profitable. Serbian female companies prefer fast-track innovations, which means that they opt for a fast go-to-market approach rather than investing in long-term R&D. They have limited innovation development budgets and therefore their interest is getting the product into the market as soon as possible to get a return on their investment. It is difficult to get exact data on the profit share generated by innovation in Serbian SMEs in general, but for more than 50% of the companies it is in the range of 1%–60%, suggesting that the innovations were successful in the market and/or that the companies prepared their entrance to the market well, despite the relatively short development period. In general, a limited number of the female companies are able to report on their innovativeness because female companies are mostly micro-sized firms in low-income sectors, including personal services like hairdressers, cosmetics, and small shops. Therefore, the share of female companies in innovation support programmes and funding schemes that support competitiveness and innovativeness is very small. However, digital entrepreneurship has changed the way female businesses innovate by opening up new opportunities to collaborate with platforms and partners and new sources of innovative ideas, risk, and competitive advantage.

Women entrepreneurs tend to use DT to innovate by creating new markets, new product lines, and new customers, and expanding their services vertically (Still & Walker 2006). Nählinder et al. (2015) find no significant difference between the innovation of male and female entrepreneurs, as there are a number of factors that moderate the relationship between gender and innovation, such as level of education, interfirm network, regional location of the firm (Marvel et al. 2015) confidence level, personal wealth, etc.

The research shows that DT is an innovation-driver in companies regardless of gender. A recently published European study, Women in the Digital Age (European Union 2018), emphasizes the role of digital transformation in boosting female entrepreneurs, particularly among younger generations that have grown up with DT.

## 4. DIGITAL TECHNOLOGY AND FEMALE COMPANIES – OPPORTUNITIES AND BARRIERS

The comprehensive use of DT in business is one of the most important factors in the advancement of female entrepreneurship (Weeks 2012). Modern DT – software, social media, IoT, Big Data, 3D printing – provides women entrepreneurs with new ways to overcome a range of problems and challenges. Women's companies can use DT to radically change the way they do business, and, most importantly, to make relationships with consumers more efficient and intensive. UNCTAD (2011) lists four benefits that DT bring to women-owned businesses:

- Reducing transaction costs
- Increased availability of market information
- Improved communication in the value chain
- Diversifying customer collaboration modalities.

Apart from the many benefits of using DT, the digital gender divide is recognized globally as a significant problem in both everyday life and the business sphere. There are significant gender differences in terms of accessing and using DT, with men using it more. Numerous studies address the causes of this gender difference; an UNCTAD (2014) publication (based on research in Tanzania, Nigeria, Uganda, and some Central Asian countries) identifies a number of factors that determine the position of women in the business world and their use of modern DT:

- Social status of women compared to men
- Gender-based power relations
- Traditional roles of women and men in a particular community
- Ability to own property and other legal rights
- Access to business support services and support programmes for female entrepreneurship
- Societal attitude
- The existence of women's social services infrastructure.

The OECD booklet Bridging the Digital Gender Divide (OECD 2018) lists difficult DT access, poor inclusion of women in the education system, especially

in disciplines that facilitate functioning in the digital world, and socio-cultural norms that place women in a subordinate position with respect to men as just some of the reasons for the existence of the digital gender gap. In addition, the difficulty of accessing finance for innovative projects and socially unrecognized barriers to women's professional advancement, especially in the IT sphere, further complicate the digital gender divide and its potential mitigation.

A report by Startup Canada (2017) shows that 93% of women's businesses perceive new DT as key to success in the business world. However, the actual picture is slightly different. The number of female businesses using DT in the start-up phase, running a business, or in business growth is 20% lower than in male-owned businesses (Conference Board of Canada 2014). The main reason given for this gap is a lack of knowledge and skills relevant to mastering and using DT.

Our analysis uses research and data obtained over the last twenty years, during which time ICT and the innovation infrastructure have rapidly developed. Table 1 provides a gender-disaggregated summary of statistics for the European Union, Croatia, and Serbia regarding internet use and the knowledge and skills of internet users as individuals and/or professionals (some data for Serbia is not available). The overall conclusion is that much more effort is needed to overcome inequality in ICT use.

**Table 1:** Internet use in the, EU, Croatia, and Serbia, %

| | **Serbia (2019)** | | **EU (2018)** | | **Croatia (2018)** | |
|---|---|---|---|---|---|---|
| | Women | Men | Women | Men | Women | Men |
| **Use of internet** | | | | | | |
| Use internet regularly | 76.6 | 82.16 | 82 | 84 | 71 | 75 |
| Have never used the internet | 23.3 | 16.3 | 12 | 11 | 24 | 19 |
| Online banking | 22.2 | 23.9 | 63 | 64 | 52 | 57 |
| Professional social networks | n/a | n/a | 13 | 18 | 7 | 10 |
| Doing an online course | 7.7 | 5.9 | 8.1 | 9.5 | 3.3 | 3.9 |
| Online consultation or voting | 2.5 | 3.8 | 9.9 | 10.6 | 8.4 | 13.1 |
| eGovernment users | 11.5 | 14.4 | 64 | 65 | 74 | 76 |
| **Internet user skills** | | | | | | |
| At least basic digital skills | 52.3 | 57.5 | 55 | 60 | 50 | 59 |
| Above basic digital skills | 39.7 | 50.2 | 28 | 34 | 30 | 37 |
| At least basic software skills | 34.2 | 43.9 | 58 | 62 | 54 | 63 |
| **Specialist skills and employment** | | | | | | |
| STEM graduates Per 1000 individuals aged 20–29, 2016 | 11.8 | 16.5 | 13.1 | 24.9 | 13.2 | 20.8 |
| ICT specialists % total employment, 2017 | n/a | n/a | 1.4 | 5.7 | 0.9 | 5.3 |
| Unadjusted gender pay gap % difference in pay, 2017 | n/a | | 19 | | 14 | |

**Note:** n/a – not available.

**Sources:** EC, Women in Digital Scoreboard 2019, Eurostat SORS, Use of Information and Communication Technology in the Republic of Serbia 2019, households/individual enterprises

In Serbia there is little available data on the readiness of female companies to invest in innovation. In the survey of innovativeness in women's businesses in Serbia (Popović-Pantić 2014), 45% of the sampled women entrepreneurs said they budgeted funds for the company's development. Since these were small and micro businesses and slightly less than 50% had not had profit growth in the previous four years, there was no point in raising the question of research investment. On the other hand, the majority planned to invest in new products and services, for which R&D is necessary, demonstrating that women entrepreneurs in Serbia are aware of the necessity to invest in innovation as a precondition for competitiveness.

However, limited financial and human resources mean that only modest investment in IT development is feasible, and even that at a basic level. The situation changes somewhat when the company exceeds 20 employees: its economic potential grows, and therefore its capacity for innovation development.

Although insufficient funds is a possible explanation for the limited use of DT in women-owned firms, certain types of DT are practically free, do not require a high level of ICT proficiency, and could be of great use to women-owned companies. Various digital platforms in the fields of law, intellectual property management, creativity, leadership, etc. offer free information and the possibility to advance education using DT, such as distance education, webinairs, virtual entrepreneurship communities, online programmes, etc. (Thomas & Moisey 2006). Additionally, new digital solutions reduce the issues that women face, especially in developing countries. Cloud services and crowdfunding platforms offer information on different options for securing needed resources for the realisation of new projects and ideas. However, some studies have shown that there is little possibility that women will opt to use any sort of service with the help of DT, especially financial services (Hunt & Samman 2016), which still shows a high resistance towards new technology and a lack of knowledge. Social media has increased the possibility of communication, cooperation, and access to information, at relatively low cost. The different types of 'free' social media platforms, for instance, social networking (e.g., Facebook), microblogging (e.g., Twitter), and media-sharing (e.g., Youtube) (Jagongo & Kinyua 2013) have different functions in business. According to Ukpere et al. (2014), the wide availability of social media to users with different profiles and its ease of use offer

the possibility of mutual cooperation and communication between different stakeholders. Access to a variety of information through social media serves as a source of new ideas for women (Alsop & Heinsohn 2005) making serious business decisions, strengthening their entrepreneurial capacity. Social media is significant when starting a business and during business-related activities, especially for promoting activities, increasing visibility, starting new marketing projects, and maintaining business relationships. Social networks can mitigate the negative effects of limited financial resources and equalise the business conditions between men and women (Gibbs, Sequeira, & White 2007). Women are more inclined than men to communicate and realise marketing activities via social media such as Facebook and Twitter (UNCTAD 2014).

## 5. RESEARCH METHODOLOGY

### 5.1. The sample and questionnaire

The sample comprises 46 companies where women have at least 50% ownership. In 42 companies women are the sole owner, while in 4 companies over 50% of the ownership is female. Sixty per cent of the companies are in the service sector and 40% in the manufacturing sector. Seventy-four per cent are micro and small companies and 26% are medium-sized. Turnover in 2018 was between 20,000 and 14,000,000 euros. Most of the companies are located in Belgrade (63%), followed by Loznica (7%), Novi-Sad (7%), Kragujevac (7%), Šabac (7%), Jazak (2%), Subotica (2%), Vršac (2%), Brus (2%), and Badovinci (2%). Sixty-three per cent of the companies have been comprehensively and intensively using DT for over two years, while 37% have been using it for less than 2 years.

The statements in the questionnaire regarding the use of DT were selected based on questionnaires in papers by Cuevas-Vergase et al. (2016), Naidoo and Hoque (2018), and Chege et al. (2020), and a questionnaire developed by the The Digital Transformation Centre of the Serbian Chamber of Commerce, whose main task is to support SMEs in the digital transformation process. Eighteen statements for evaluating DT were assessed using a 3-point scale: 1 – Never; 2 – Sometimes; 3 – Always. Three statements to evaluate financial performance were adapted from Tajvidi and Karami (2017), Naidoo and Hoque (2018), and Chege et al. (2020). Innovation was evaluated using four statements following Palacios-Marqués et al. (2015) and Naidoo and Hoque (2018). Financial performance and innovation

were evaluated using a 5-point-Likert scale, from 1 – strongly disagree, to 5 – strongly agree. All the statements in the questionnaire were modified according to the characteristics of the sample and the research needs. The questionnaire was completed by women business owners/co-owners who are also directors/managers.

### 5.2. Hypotheses development

The rapid development of existing DT, the emergence of new DT, and their increasing use in the business world has led to various studies investigating the impact of DT on business success. These studies vary according to the type of DT investigated and the intensity of DT use. Some authors show that DT use improves financial performance (Piget & Kossaï 2013; Ainin et al. 2015; Tajvidi & Karami 2017), while others find that DT implementation worsens (Esselaar et al. 2007) or does not significantly change financial performance (Hitt & Brynjolfsson 1996; Velcu 2005; Aral & Weill 2007; Koski 2010; Benavente et al. 2011), while Hendricks et al. (2007) report mixed results. Most papers focus on the direct influence of digital technology and find it to be insignificant, while other studies find the indirect influence of DT on financial performance significant. The implementation of Customer Relations Management (CRM) is part of the process of digital transformation. Similar to the use of social media for business purposes, whether CRM implementation will influence the growth of financial performance depends on multiple factors; for example, the firm's ability to use the software to its fullest capacity to add value.

This paper uses a mediation variable in order to discover the indirect effects of DT on financial performance, so it is necessary to select the mediation variable that will reflect improved financial performance from DT use. The variable should represent a new value for consumers, since satisfied and loyal consumers are the main precondition for sustainable profit growth. A basic assumption is that innovation, primarily product innovation, could be the invisible thread that ties DT and financial performance together. Several studies find innovation to be a mediator between DT and financial performance (Yu et al. 2013; Palacios-Marqués et al. 2015; Arvanitis & Loukis 2015; Tajvidi & Karami 2017). Yu et al. (2013) find that ICT contributes to organisational performance by enhancing efficiency and innovation. Palacios-Marqués et al. (2015), in a hospitality firm in Spain, show that the relationship between online social networks and firm

performance is fully mediated by innovation capacity. Arvanitis and Loukis (2015) find that innovation reinforces the impact of ICT on performance. They analyse 743 hospitals in 18 European countries and come to the conclusion that via product/process innovation, ICT has both direct and indirect positive effects on revenue growth. They also find that the connection between DT and performance is partially mediated by innovation. In an analysis of 384 hotels in the UK, Tajvidi and Karami (2017) conclude that innovation positively and significantly mediates the association between social media use and firm performance.

Based on the above empirical studies, the following hypotheses will be tested:

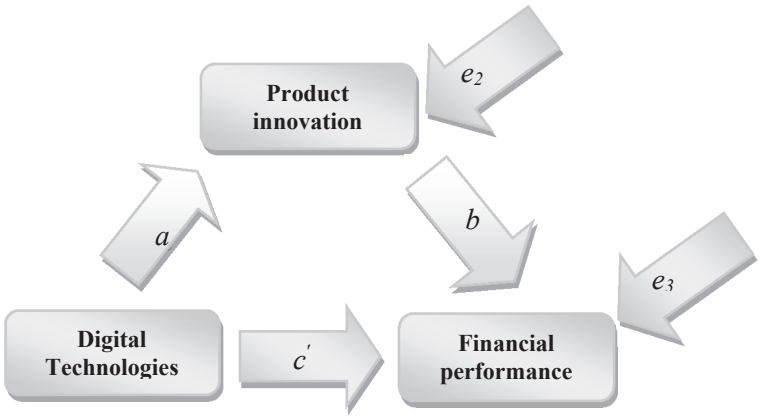
**$H_1$:** *Digital technology has no significant direct effect on financial performance.*

**$H_2$:** *Product innovation significantly mediates the relationship between digital technology and financial performance.*

### 5.3. Mediation procedure

The analysis of the role of innovation as mediator uses a procedure developed by Baron and Kenny (1986). The steps in the implementation of that procedure are shown graphically in Figure 1.

**Figure 1:** Research framework



This diagram (Figure 1) can be expressed by the following regression equations:

$$Perf = i_1 + cDT + e_1 \quad (1)$$

$$Innov = i_2 + aDT + e_2 \quad (2)$$

$$Perf = i_3 + c'DT + bInnov + e_3 \quad (3)$$

where $i_1$, $i_2$, $i_3$ are intercepts, *Perf* (financial performance) is the dependent variable, *DT* (digital technologies) is the independent variable, *Innov* (Product innovation) is the mediator, *c* is the coefficient relating *DT* and *Perf*, *c′* is the coefficient relating *DT* to *Perf* adjusted for *Innov*, *b* is the coefficient relating *Innov* to the *Perf* variable adjusted for the *DT* variable, *a* is the coefficient relating the *DT* variable to *Innov*, and $e_1$, $e_2$, $e_3$ are residuals. The first model is used to describe the influence of *DT* on *Perf*. The second model describes the influence of *DT* on *Innov*. The third model shows the connection between *Innov* and *Perf* when *DT* and *Innov* are explanatory variables.

Before considering the mediation effect, three conditions must be satisfied: 1) path a must be significant; 2) path b must be significant; 3) path c must be significant. The fourth step is to analyse path c′, which can either be significant or insignificant. A simple OLS regression method is used to evaluate the first three conditions and a multiple OLS regression analysis is used for the final step.

To determine the significance of the mediation effect, the most commonly used and highly recommended method of computing the z-value is that proposed by Sobel (1982). The z equation is:

$$z = \frac{a * b}{\sqrt{b^2 s_a^2 + a^2 s_b^2}} \quad (4)$$

where $a*b$ is the size of the indirect effect; $b^2$ signifies the unstandardised coefficient for path *b* (Figure 1), $a^2$ is the square of the unstandardised error for the coefficient for path *a* (Figure 1), and $s_a^2$ is the square of standard error for path *b*; *z-value* indicates whether the mediation effect is statistically significant using probabilities corresponding to the standard normal distribution. Successively, the significance of the z-test is determined by a value larger than 1.96 in the absolute value, which is significant at the 0.05 level (Handayani & Rashid 2016).

## 6. RESULTS

The first step towards analysing the collected data is to determine the reliability of the variables by calculating the Cronbach Alpha (CA) for the *DT*, *Perf*, and *Innov* values and for the questionnaire as a whole. The recommended CA is over 0.7. The CA value for the entire questionnaire is 0.860. Individually observed, all variables have a CA value over 0.7, ranging between 0.804 and 0.962. The obtained results confirm the internal consistency of the tested variables.

The next step is to carry out a correlation analysis. There is a significant correlation between all the variables ($p<0.01$). There is a strong correlation between *Perf* and *Innov* (r=0.682) and a moderate correlation between *DT* and *Perf* (r=0.393) and *DT* and *Innov* (r=0.392).

**Table 2:** Reliability test and correlation analysis

| Variable | CA | DT | Perf | Innov |
|---|---|---|---|---|
| **DT** | 0.804 | 1 | **0.393**** | **0.392**** |
| **Perf** | 0.962 | **0.393**** | 1 | **0.682**** |
| **Innov** | 0.835 | **0.392**** | **0.682**** | 1 |

**Note:** **p<0.01.

a. CA for the questionnaire as a whole=0.860

The results of the simple OLS regression analysis are shown in Table 3. Fourteen per cent of the variance in *Innov* is explained by Model 1. *DT* has a significant and positive effect on *Innov* ($\beta$=0.392; sig=0.007; Durbin-Watson=2.264). Model 2 analyses the influence of *DT* on *Perf*. *DT* has a significant and positive influence on *Perf* ($\beta$=0.393; sig=0.007). The obtained value $R^2$=0.14 implies that *DT* explains 14% of *Perf* variability. In Model 2 there is no autocorrelation issue (Durbin-Watson=2.255).

**Table 3:** Simple OLS regression analysis

| | Unstandardized coefficients | | Standardized coefficients | Sig | Durbin-Watson | Adj. $R^2$ |
|---|---|---|---|---|---|---|
| Model | ***β*** | ***Std. error*** | ***β*** | | | |
| 1 **DT→Innov** | 0.894 | 0.316 | 0.392 | 0.007 | 2.264 | 0.14 |
| 2 **DT→Perf** | 0.945 | 0.333 | 0.393 | 0.007 | 2.255 | 0.14 |

In both cases the tested variables have a significant influence. It is necessary to conduct a multiple OLS regression analysis to identify the direct influence of the independent variable on the dependent variable, and the indirect (mediation) effect the independent variable has on the dependent variable via the mediator variable. The multiple OLS regression observes the behaviour of the independent variable *DT* in terms of the influence on the dependent variable *Perf* when the mediatory variable *Innov* is included as an explanatory variable in the regression model.

The results of the multiple OLS regression analysis are presented in Table 4. Model 3 shows the simultaneous impact of *DT* and *Innov* on *Perf*. The coefficient of determination for this model is 0.46 and it indicates that Model 3 explains 46% of *Perf* variability with *DT* and *Innov* as the explanatory variables. *DT* has an insignificant influence on *Perf* (sig=0.225), while *Innov* has a significant and positive influence on *Perf* ($\beta$=0.624; sig=0.000). Model 3 does not have a multicollinearity issue VIF<10 (in both cases VIF=1.182), nor autocorrelation (Durbin-Watson=2.163).

**Table 4:** Multiple OLS regression analysis

| Model 3 | $\beta$ | Sig | VIF | Adjusted $R^2$ | Durbin-Watson |
|---|---|---|---|---|---|
| **DT** | 0.148 | 0.221 | 1.182 | 0.46 | 2.163 |
| **Innov** | 0.624 | 0.000 | 1.182 | | |

**Note:** Dependent variable: *Perf*

Unlike Model 2, where *DT* has a significant and positive influence on *Perf*, when *Innov* is included with *DT* as an explanatory variable in the analysis of the influence on *Perf* (Model 3), it is noticeable that *DT* ceases to have a significant influence on variable *Perf*. This implies that the direct influence of *DT* on *Perf* is insignificant (sig=0.221), confirming hypothesis $\mathbf{H_1}$ and in accordance with the research of Hitt and Brynjolfsson (1996), Velcu (2005), Aral and Weill (2007), Koski (2010), and Benavente et al. (2011).

Since the results in the first two steps (Model 1 and Model 2) are significant, and the third step confirms that the independent variable *DT* does not have a direct influence on the dependent variable *Perf*, it is necessary to carry out additional tests to determine the size and significance of the mediation effect. The Sobel,

Aroian, and Goodman tests were used for this purpose. The obtained results were Sobel test=2.488392**, Aroian test=2.453933**, and Goodman test=2.524344**; implying that *Innov* has a significant mediation effect on the *DT* and *Perf* relationship (e.s.=0.245; sig=0.01). The type of mediation is full, because *DT* does not have a significant direct effect on financial performance, confirming hypothesis $\mathbf{H_2}$ and the findings of other studies (Yu et al. 2013; Palacios-Marqués et al. 2015; Arvanitis & Loukis 2015; Cuevas-Vargas et al. 2016; Tajvidi & Karami 2017).

**Table 5:** Mediation test

| *Path* | Effect size | Sobel test | Type of mediation |
|---|---|---|---|
| **DT→Innov→Perf** | 0.245 | 2.488392** | *Full* |

**Note:** **Result is significant at the 1% level. Aroian test=2.453933**; Goodman test=2.524344**.

## 7. ROBUSTNESS CHECK

A robustness analysis is conducted to evaluate the stability of the obtained results using an alternative method for determining the presence of a mediation effect called the bootstrap method,[2] recommended by Hayes (2009). Some authors consider the use of the Sobel test to verify the existence of mediation to be relevant only for large samples, since this test is based on the assumption of normal data distribution. On the other hand, the bootstrap method can be applied regardless of the assumption of data normality, which makes it suitable for small samples (Hair et al. 2014; Pardo & Roman 2013) such as the sample used in this paper. The bootstrap method is suitable for samples of 20 to 80 observation units (Shrout

[2] According to Hayes (2009), "Bootstrapping generates an empirical representation of the sampling distribution of the indirect effect by treating the obtained sample of size n as a representation of the population in miniature, one that is repeatedly resampled during analysis as a means of mimicking the original sampling process. The resampling of the sample is conducted with replacement, so that a new sample of size n is built by sampling cases from the original sample but allowing any case once drawn to be thrown back to be redrawn as the resample of size n is constructed. Once a resample is constructed, a and b are estimated this resampled data set and the product of the path coefficients recorded. This process is repeated for a total of k times, where k is some large number (typically at least 1000, although I recommend at least 5000)."

& Bolger 2002) and tends to have the highest power and the best Type I error control (Hayes 2009).

Table 6 shows the results of the calculation of 1,000 subsamples. The results obtained with the bootstrap method confirm the findings of the Sobel test. Insignificant discrepancies were observed. The direct impact of *DT* on *Perf* is not statistically different from zero, meaning that the direct effect contains zero with a 95% Bootstrap Confidence Interval (BCI) between –0.2680 and 0.9475. There is a difference of 0.003 units in favour of the original sample when it comes to the direct effect. The difference between the original sample and the bootstrap sample regarding the mediation effect is only 0.006 units in favour of the bootstrap sample. The mediation effect is statistically different from zero; i.e., the value of the mediation effect is somewhere between 0.078 and 0.437 with a 95% BCI, so that the bootstrap method confirms that the relationship between *DT* and *Perf* is mediated by *Innov*.

**Table 6:** Mediation based on bootstrap method

| | Original sample | Bias | Bootstrap sample | Bootstrap Confidence Interval of 95% | |
|---|---|---|---|---|---|
| | | | | LL | UL |
| Direct effect | 0.148 | –0.003 | 0.145 | –0.268 | 0.948 |
| Mediation | 0.245 | 0.006 | 0.251 | 0.078 | 0.437 |

**Note:** The number of bootstrap samples for percentile bootstrap confidence intervals is 1,000. We used 5,000 bootstrap replications of the original samples and there were no significant changes in the results. Dependent variable: Performance. All coefficients were transformed from unstandardized to standardized according to the following procedure: unstandardized·(independent variable$_{standard_deviation}$/dependent variable$_{standard_deviation}$).

## 8. CONCLUSION

Digital technology can be considered the latest innovation enabling innovation capacity in SMEs. From a gender perspective it is often perceived as a great equaliser and leveller, enabling equal access to business opportunites and reducing the evident gender gap in 'offline' businesses and entrepreneurship. As is the case with all small and medium-sized firms, including women-owned businesses, DT contributes to business development only if it is used to innovate.

Adequate use of DT will reduce transaction costs, provide easier access to necessary information and knowledge transfer, improve the quality of the buyer–seller relationship, and strengthen market position, thus improving overall business performance. Digital technology represents an opportunity for women-owned businesses to catch up with men-owned businesses in the marketplace.

The results of the research show that DT does not have a direct influence on the financial performance of the observed companies, confirming hypothesis $\mathbf{H_1}$. Hypothesis $\mathbf{H_2}$ is also confirmed, since if DT is used in an innovative way, i.e., if it results in product innovation, then business performance is unquestionably improved.

This research contributes to the literature on the relationship between DT, innovation, and business performance in women-owned firms. The confirmed hypotheses and obtained results show that innovation is the missing link in the relationship between DT and financial performance. What makes this research distinct is that the sample involves only women-owned firms, which is of great importance as women's access to DT and innovation development is an important issue, especially regarding transition economies. In the literature an insignificant number of papers test similar hypotheses

The theoretical findings and results of this study can be useful to both economic policymakers and decision-makers at the micro-level. They can familiarize governing structures with the potential barriers women-owned businesses face in the process of adopting and using DT, and with the possibilities offered by innovation development. By actualizing and making this subject present in the media and by developing financial assistance and consultancy programmes to develop and support the process of digital transformation and innovation in female-run companies, policymakers can help women-owned businesses to develop in the same conditions as men-owned businesses.

Management structures in female companies can also use the findings to learn about the potential benefits of DT and how its innovative use can improve financial performance. Digital technology such as CRM software will not have any significant effect on financial performance unless it is used for innovation development, whether by introducing a completely new product/service or modifying existing ones. Similarly, the use of social media alone as a promotional

tool will not result in significant progress. The potential of social media is great and enables the identification and analysis of positive and negative comments, communication with consumers, identifying consumer types and the behaviour of competitors, and recognizing and removing consumers' dissatisfaction with products and service. The digital transformation of a business through the comprehensive, complementary, and versatile use of digital technology to promote innovation will produce a synergic effect and boost financial performance. Thus, a base is created for investing in both existing and new digital technology.

The paper has certain limitations. First, the sample is fairly small. Second, process innovation, organisational innovation, and marketing innovation can all influence financial performance, so future research should examine whether these are influenced by the use of DT and their influence on financial performance. Third, in order to additionally check the robustness of the results the following variables should be taken into consideration: age of female owner/manager, education, company age, company size, industry type, etc. These could be included as either control or moderator variables. Additionally, a comparative analysis with male-owned businesses would identify potential gender-based differences between companies involved in the process of digital transformation.

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*Bojan Baškot**
*Stanko Stanić***

# PARAMETRIC CROP INSURANCE AGAINST FLOODS: THE CASE OF BOSNIA AND HERZEGOVINA

**ABSTRACT:** *The importance of risk management in agriculture is unquestionable. Farmers in Bosnia and Herzegovina face weather, product, and price and market risk. Index-based insurance products for agriculture present alternatives for managing weather risk. They differ from classical insurance products in that they do not remunerate actual loss and to purchase a weather index insurance policy the insured does not actually have to have an insurable interest. In this research, two flood parametric insurance products are presented, one with fixed compensation and the other with compensation proportional to flood intensity.*

**KEY WORDS:** *catastrophic insurance, weather-index-based insurance, insurance premium.*

**JEL CLASSIFICATION:** C58, G22

* Assistant Professor, Faculty of Economics, University of Banja Luka, bojan.baskot@ef.unibl.org
** Full Professor, Faculty of Economics, University of Banja Luka, stanko.stanic@ef.unibl.org

## 1. INTRODUCTION

Risk, defined as the uncertainty surrounding the outcome of an event, is an integral and inevitable part of agriculture. Risk can be broadly classified as financial risk and operating risk, or as pure risk or speculative risk. However, classifying risk by frequency and severity is crucial when dealing with weather-related risk.

Risk management is the process of determining how to handle the pure risks to which an individual, family, or entity is exposed. Surviving the loss event and having peace of mind through total risk management will result in higher profits and stabilize earnings. With little or no interruption to operations, growth will be stable and an overall positive image will be maintained by demonstrating social responsibility (Casualty Actuarial Society 2001).

Natural catastrophes are disasters that originate in nature or from natural forces. They have low frequency but a huge impact on agricultural production: the direct impact on an agricultural sector can be devastating and the supply chain disruption can result in severe long-run consequences. Protecting crops protects the food supply that is essential for the survival of both people and animals.

Crop insurance contributes to self-reliance and self-respect among farmers: it mitigates the shock of crop loss by protecting farmers against natural hazards that are beyond their control (Kumar et al., 2011).

Private insurance companies in Bosnia and Herzegovina (B&H) are currently experiencing difficulty providing coverage for catastrophe and weather-related risks. This could be because the insurance market is still developing, but the problem is not only found in developing countries. Jaffee and Russell (1997) recommend two specific reforms regarding catastrophe insurance in the United States:

1. A way must be found to permit an insurer to retain their premium income against expected catastrophe losses in such a way that these funds cannot be used for other purposes.
2. The capital market must be willing to provide capital in advance of catastrophes for the right price. Breaking down the barrier between banking

and insurance would enable more such contracts to be developed, and many attempts are being made to find other ways to link capital sources to the uses of capital required by catastrophe insurers.

Alternatively, if private markets cannot do the work, then implementing a government plan is a reasonable option. Another appealing option is to adopt a national risk management strategy through an NGO (Scheyvens et al., 2015).

Many small farmers in B&H have no risk management strategy. For instance, in Republika Srpska, the part of Bosnia & Herzegovina where more than half of country's cultivated field are located, only 6% of farmers have some kind of insurance.[1] Given the importance of agricultural output for the population's survival, when the sector lacks a clear risk management strategy, society as a whole has a problem. An effective strategy is hard to achieve even for wealthy and well organized states, but the need for some risk management strategy in agriculture is essential.

This research presents the actuarial background of parametric insurance products. Like for classic insurance products in B&H, the data is available and the product can be accurately and precisely calculated. The procedure is identical to the option pricing procedure. In essence, we apply the econometric technique to the parameters that stand behind the product. We show that the classical Box-Jenkins procedure provides the same result as the Black-Scholes model. An innovative premium modelling approach can implement an encompassing public agricultural insurance plan against flood-related risks in B&H. Index-based insurance is adequate for the agricultural sector in B&H, which has high agricultural potential and low insurance infrastructure development. A key feature of index-based insurance is its immediacy.

The goal of the goal is to answer the following questions:

- What is an adequate crop insurance instrument to transfer flood risk in B&H?
- Can flood risk in B&H be covered with weather-index-based insurance?
- Is there a crop insurance instrument against flood risk that meets the needs of both small farmers and large agricultural enterprises in B&H?

[1] https://www.agromedia.rs/vesti/iskustva-ratara-u-bih-sa-osiguranjem-poljoprivrede

- Which premium model is optimal for pricing insurance instruments against flood risk in growing agricultural insurance markets like that in B&H?

The rest of this paper is organized as follows. The next section reviews the relevant literature. Section 3 describes and discusses the data and the theoretical background of the methods used in the analysis. The results of the empirical analysis are presented in Section 4. Finally, Section 5 discusses the results of the research.

## 2. LITERATURE REVIEW

Index insurance products do not remunerate actual loss and the insured does not have to have an insurable interest as a condition for purchasing a weather index insurance policy. On the one hand there are index-based agricultural insurance products, while on the other there are insurance products based on Actual Production History (APH). In addition, there are weather-index-based products and area-yield-index-based products.

Assume a situation where the insurer sells weather-indexed crop insurance against flooding. If the flood occurs in a certain area during a certain predefined time interval, the farmer has the right to receive compensation (indemnity) from the insurer, as defined by the insurance policy. If the flood insurance is index-related, when the water level reaches a certain point (and/or exceeds that point) the insurer has to pay a certain amount of money to the insured.

Adverse selection is a well-known insurance issue (Cohen & Siegelman, 2010). A feature of adverse selection is that it reduces asymmetric information, which is a huge problem in the insurance industry. When farmers have more information than those setting the rates (asymmetric information), moral hazard (the farmer may work less) and adverse selection (hidden information may misguide the insurer) may occur (Makki & Somwaru, 2001). This is a reason to consider parametric insurance, which reduces the moral hazard and adverse selection that are especially problematic in the conventional approach when dealing with small farmers.

Conventional insurance products sometimes does not look adequate from the perspective of farmers, who cannot count on the altruism of insurance companies

(Born & Klimaszewski-Blettner, 2013). On the other side, reinsurance costs of these products also raises questions from the perspective of individual insurers (Gürtler et.al., 2016).

Catastrophic events have high financial costs for insurers. Governments can get involved, but it is hard to find a unified approach in the regulation in developed countries. Klein and Wang (2009) give a good comparison of catastrophe risk financing in the EU and the US (Klein & Wang, 2009)

### 2.1 Some concerns about weather-index-based insurance implementation

A general problem regarding agricultural insurance is how to provide uniform insurance coverage for subsistence farmers on the one hand, and large commercial agricultural enterprises on the other. It is hard to have a systematic approach when insuring small farmers, because they are all different and there is a lack of data. Conventional insurance and index-based insurance suffer from the same issues, but the latter is far more robust .

From the utility point of view, weather insurance offers the greatest benefit to small farmers who have limited coping mechanisms to deal with the weather. The problem is whether their risks can be properly covered with a premium that is acceptable from the financial point of view. The government supports large farmers by providing premium subsidies, and this should be extended to small farmers based on parameters that are known to work efficiently (Nair, 2011).

Data is crucial for pricing any insurance product and parametric insurance is no exception. Nair,lists the key drivers of the effectiveness of weather-based crop insurance:

- The most important thing about any meteorological observation is the exposure conditions of the sensors.
- Sensors must be serviced on a regular basis.
- Quality observational data is assured by applying effective near-real-time Quality Control (QC) procedures.
- QC is carried out at manned observatories by comparing the observed data with the long term normal. (Nair, 2011).

The observations are checked for proper World Meteorological Organization (WMO) format at communication centres before being forwarded to users.Insurance is a relatively expensive financial instrument because it carries significant transaction costs and is designed to protect against low-probability extreme losses. As self-insurance instruments, savings and credit can appear to be more efficient mechanisms for managing small losses. On the other hand, the occurrence of a single catastrophic event affects yields, assets, and income on a long-run basis. Weather insurance for catastrophic events covers the losses that result from the initial destruction.

The base risk for such products is much lower than for products that cover moderate risk. Administration costs are reduced and the insurance premium is more acceptable than premiums for traditional (conventional) crop insurance. Insurance can thus be provided for almost all important assets, which in turn can lead to increased demand and a high level of insurance penetration (Rao & Nair, 2011).

Although some effort is needed regarding infrastructure in B&H (Nair, 2011), there is a solid infrastructure for implementing successful index-based insurance, in the form of a significant number of hydrological stations. Data inputs for this insurance product are generated to high metrological standards, and thus pricing precision would be higher than for conventional insurance products.

One of the biggest disputes concerning agricultural insurance is government intervention and the long-run consequences of state policy, which are beyond the scope of this work. However, agriculture insurance is recognized worldwide as an instrument that supports economic development by making the rural sector less subject to weather conditions. Insurance is becoming deeper and wider in order to manage the unforeseen risks that affect crops. The climate has changed radically during the past few decades, which inevitably increases agriculture risk. Crops have a non-random and semi-systemic (correlated) pattern of loss. Therefore, governments and government agencies have focused on propagating improved models of crop insurance to protect farmers and enable them to manage risks, in order to achieve the final goal of increasing yields and productivity. To achieve this goal a package of financing and insurance/risk management tools is needed (Nair, 2011).

Various governments use premium subsidies as instruments for different issues. In the U.S. the Agricultural Risk Protection Act (ARPA) of 2000 increased subsidies for crop insurance premiums. Premium subsidies at coverage levels above 65% were changed from a fixed per-acre dollar amount to a percentage of the premium. During the 1980s the U.S. Federal Crop Insurance Program did not have good actuarial performance, partly because the Federal Program over-emphasized its intention to adapt the coverage to individual farmer yield losses. Yield losses are related to yield risks, which Miranda divides into systemic and non-systemic risk (Miranda, 1991).

Globally, government attempts at delivering farm-level, multiple-peril crop insurance have been deficient. The total public cost of these programmes has far exceeded their public benefits (Skees, Hazell, & Miranda, 1999). Traditional products based on actual product history (all-risk, multi-peril, and particular risk) have failed to play a sustainable role in public crop insurance plans. However, the need to apply some sort of risk management strategy is in direct proportion to the need to produce enough food for the population. A nation's basic food needs should be a high policy priority (Chantarat et. al., 2007).

## 3. DATA AND METHODOLOGY

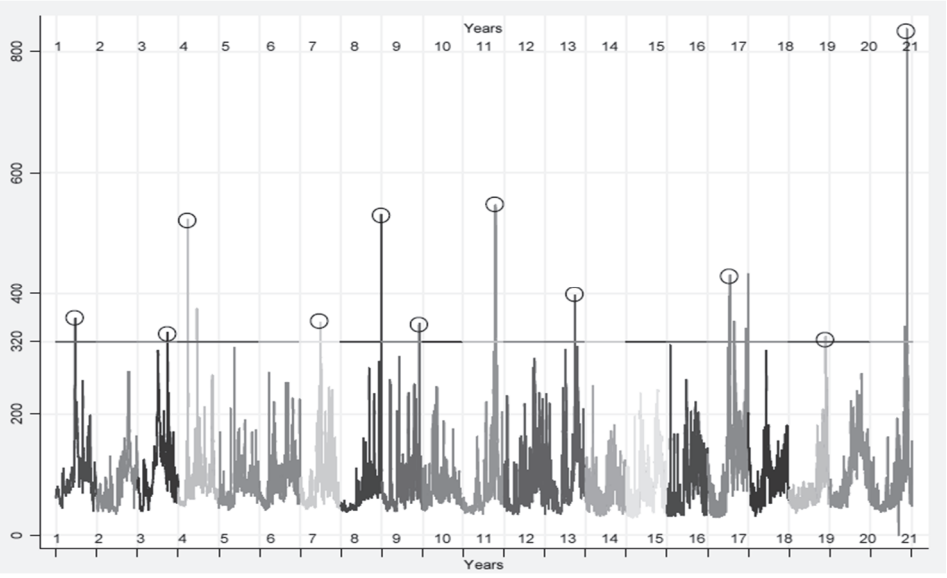
For every insurance product the pricing method is crucial: the cost and price of the insurance and its method of calculation must be defined. Traditionally, there is an understanding that the insurance market can exist if there is free choice and significant risk aversion. Considering crop insurance as mandatory is one possibility, but let us consider the basic logic of crop insurance products as market-oriented. In this context, the premium rate is a critical parameter of any insurance contract.

The first step is to examine the relationship between agricultural production and flood occurrence. We start by observing the relation between wheat-producing regions in B&H and flood occurrence. The wheat-producing regions are associated with three rivers, the Vrbas, Drina, and Trebišnjica, each of which has a hydrological station. In the Vrbas river basin the main agricultural province is Lijevče polje, in the Trebišnjica basin it is Popovo polje, Bilećko polje, and Gatačko polje and in the Drina basin it is Semberija.

Wheat production data is collected for these three basins, expressed in tons. We use a simple regression model that shows that wheat production dropped in years of flooding. The slope coefficient is –71.71 (SE 16.21) and the p-value of 0.04 indicates that it is statistically significant. In addition, the 95% confidence interval (between –111.78 and –32.1) leaves no ground for any possibility that this coefficient could equal zero.

To define parametric insurance products we focus on the Vrbas River. The previous exercise showed a clear link between floods and crops; next we continue with the pricing procedure.

**Figure 1:** Water level at Delibašino selo hydrological station, Vrbas River 01.07.1993–30.06.2014




**Source:** Author

The data used in the pricing procedure are the daily water levels recorded at the Delibašino selo hydrological station on the Vrbas River, located 70 km from the mouth of the Vrbas. The Republic's Hydrometeorological Service provided data

for the 1st July 1993 to 30th June 2014. [2] This observation period covers 7,671 days when the average water level was 87.72 cm (Table 1). The water level that marks flooding is 320 cm.

**Table 1:** Water level at Delibašino selo, 1st July 1993 – 30th June 2014

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Water level** | 7,671 | 87.71503 | 51.73224 | 0 | 837 |

**Source:** Author

Figure 1 represents flood occurrences over a 21-year period. Collecting such data is challenging from a financial point of view, especially when older records of daily water levels are involved. Accordingly, expanding this kind of approach to all 11 hydrological stations in B&H is a financial challenge.

The following exercise presents a pricing model. It is important to emphasize that a risk-free world is assumed. The focus is on defining the technical premium – the part of the gross premium that is related to the pure risk that is the object of insurance.

We have:

$O$ – the fixed amount of money that becomes payable if the water level reaches a predefined level at a certain hydrology station;

$P_F$ – the insurance premium;

$W$ – the water level at a certain hydrology station that triggers the insurer's obligation to pay $O$ ;

$r$ – the risk-free rate;

$w$ – variable that stands for the water level at a certain hydrology station.

There are two possible approaches, both of which could be part of a broader pillar-design risk management strategy.

[2] Republic Hydrometeorological Service of Republika Srpska - meteorological activities in Bosnia and Herzegovina are carried out by institutions from the two entities.

## 4. RESULTS

Here we present the pricing models for two parametric flood insurance products.

### a. Product with fixed compensation

The first approach requires the following assumptions:

- the interest is compounded continuously
- the insurance contract is closed at the beginning of the year and the insurance coverage is valid throughout the year
- the sum $O$ is payable at the end of a year in which flooding occurs (the water level exceeds the predetermined point). We can use random variable $X$ as a Bernoulli random variable with parameter $p$.

Let us set $X$ as the number of successful results in a Bernoulli trial. A Bernoulli trial is an experiment in which only two outcomes are possible: success, with probability $p$, and failure, with probability $1-p$.

In our case:

- success is when the water level at a certain hydrology station exceeds $W$ at least once during the year;
- failure is when the water level at a certain hydrology station stays below $W$ during the year.

In our case, if the water level at the $i^{\text{th}}$ hydrology station is equal to or greater than $W$, then $X=1$, and if otherwise $X=0$.

The insurance premium that provides a payout of fixed sum $O$ if the water level exceeds the predetermined point at a certain hydrology station is:

$$P_F = OE(X)e^{-r} \tag{1}$$

This pricing approach could be used for coverage in the first pillar of a public agricultural insurance plan. A minimum of data is required and indemnity in this case would have a minimal compensation effect. The main goal is to maintain a

minimal standard of living level for small farmers. Therefore, if the Bernoulli trials are repeated more than once we are dealing with a binomial distribution, and if some time period is defined as the sum of $n$ days we will have $n$ successful Bernoulli trials defined by probability $p$.

For daily water levels taken at the Delibašino selo hydrological station we have $p = 0.0045626$, $W = 320$, and let us assume $O = 1$ (one unit of money). Success is if $w \geq W$ and failure if otherwise. Hence, we can write:

$$P_F = \left[ \left( 1 - \left( \binom{n}{0} (1-p)\, p \right) \right) \right] e^{-r\frac{n}{365}}$$

where $n$ represents the number of days covered by insurance. Therefore, every day is a new trial, and if flooding occurs just once (the water exceeds a certain level) the product is triggered and every policyholder is entitled to a certain amount of money. In this case, there is no relationship between the flood intensity and the sum paid by the insurance.

If we analyse the possibility of implementing the first pillar of an agricultural insurance plan, then calculating a premium that has pure actuarial meaning is pointless. Hypothetically, the first pillar provides a sum that bears no relationship to the flood damage. The main task is to provide disbursements that are sufficient to maintain a certain standard of living. Therefore, the first pillar should provide benefits that are calculated in proportion to the minimal needs of the farmer and his family, and not to the actual flood damage.

#### b. Product with compensation proportional to flood intensity

The next step considers an insurance product that covers every time flooding occurs. The insurance product should provide a certain relationship between indemnity and flood intensity. Hypothetically, this approach would result in a product embodied in the second pillar.

Let us define a premium for the parametric flood insurance period, where that period is the sum of $n$ days (successive dates). Suppose we set the water level as the asset price, and a premium that provides $o^i$ payout as daily compensation

(compensation pay-out is triggered on the $i^{\text{th}}$ day if $w_i \geq W$) as a cash-or-nothing call option.

In the Black-Scholes model (Black & Scholes 1973) the price of a cash-or-nothing call option can be calculated explicitly, like the European call options. Thus, the premium for $i^{\text{th}}$ day insurance against the situation where the water level at a certain hydrology station exceeds the predetermined point is given by:

$$P_{Fi}^{1} = e^{-r(T-t)} N(d_2) \tag{2}$$

where function $N(x)$ is the cumulative probability distribution function for a standardized normal distribution and $d_2 = \dfrac{ln(w_0 / W) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$. In other words, it is probable that the variable with a standard normal distribution $\Phi(0,1)$ will be less than $x$. Therefore, we have assumed that the water level fits log-normal distribution.

The premium for the whole year's insurance is defined as follows:

$$P_T^1 = \sum_{i=1}^{n} P_{Fi}^1 \tag{3}$$

where $n$ stands for all days covered by insurance and $P_{Fi}^1$ is defined by the relation in Equation (2).

In the relation in Equation (3) the total compensation will equal the daily, established compensation multiplied by the number of days for which the water index (level) has satisfied the condition defined in the insurance agreement. Note that everything needs to be discounted to the present date (when the insurance agreement is signed and the premium needs to be paid). It is obvious that now, as opposed to Equation (1), we have established a relation between flood intensity and total indemnity.

Let us apply this approach to data taken at the Delibašino selo hydrological station.

We have daily data and therefore an estimate of historical volatility is given by:

$$\hat{\sigma} = \sqrt{\frac{\frac{1}{n-1}\sum_{i=1}^{n}\left(u_i - \overline{u}\right)}{1/d}}$$

where $d$ is the number of days covered by a certain insurance product and $u_i = ln\left(\frac{w_i}{w_{i-1}}\right)$

If we use values from Table 3 we can write $\hat{\sigma} = 4.4037173$ .[3]

Let us assume $w_0$=190, and we have stated before that $W$=320. Also, let us set $r$=0.04 and now we can calculate $d_2$ and $N(d_2)$ for each of the 365 days. Discounting can be done with $e^{-r}$ for each value defined in the previous step – we want our indemnity to be payable at the end of the year. Therefore, discounting is done for the whole year. That is because the relation given by Black and Scholes assumes that discounting needs to be made for a period defined by the expiration date, and in our case indemnity is paid at the end of the year in which the expiration is realized. In our case, expiration is actually realized every day in the year covered by the insurance.

Table 3 presents three potential types of insurance coverage, where one unit of money indemnity per day is assumed. The sum of actuarial present values for each of these indemnities gives a corresponding net premium for the different coverage. Thus, a net premium equal to 20.35 provides coverage for 365 days. Therefore, the total sum paid by the insurer is conditioned by how long the water level stays above the predefined level. This is the opposite of the first approach,

[3] $4.4037173 = \sqrt{365} \times 0.2305011$

where the indemnity is uniquely defined with no relationship to the total number of days the water stays above the predefined level.

**Table 2:** Volatility estimation

| *u* | | |
|---|---|---|
| **Std. Dev.** | Min | Max |
| **0.2305011** | –1.244795 | 2.040074 |

**Source:** Author

Hence, if we want to design a product that provides one unit of money payable at the end of the year to the farmer for each day in which $w \geq W = 320$ knowing that $w_0$=190, then that product requires 20.35 units of money to be paid at the beginning of the year as a premium.

**Table 3:** Premium system for water level equal to 190cm at moment of signing insurance agreement – Black-Scholes model

| ***Time interval*** | ***Premium at the beginning of insurance*** | ***The indemnity payable at the end of the time interval is equal to one unit of money for each day in which the water level at the Delibašino selo hydrological station was recorded as equalling 320 cm or higher*** |
|---|---|---|
| **30 days** | 3.96 | |
| **182 days** | 16.68 | |
| **365 days** | 20.35 | |

**Source:** Author

## 5. DISCUSSION

The implementation of parametric flood insurance products should be evaluated at different levels of agriculture activity. Small farmers and larger agriculture enterprises should be observed in the same framework. This research presents two basic products and examines their role in broad agriculture risk management regarding the concept of flood-related risk.

Whether or not an agency is established at the state level, some kind of government intervention is needed. The nature of agriculture is that it provides

food, and therefore agriculture production is hugely important for each individual at every level of social organization.

For some categories of farmers, business continuity plans can provide useful guidelines during the process of defining subsidies. The number of categories in which farmers are categorized can be determined by separate research on that specific topic. Here, we make some assumptions regarding the number of categories. Also, when defining the level of subsidies expressed as an amount of money (not as a percentage), the expected future revenue/yield can provide useful information.[4]

Finding the funds for subsidies is a real challenge. Can the energy sector provide some funding, considering that hydropower facilities can produce more electrical power during the years in which floods occur? Is it possible that input-output analysis is a tool that can be exploited to find a solution? Policymakers should also consider adverse selection in insurance markets (Azevedo & Gottlieb 2017). Parametric insurance products are robust against these issues and this feature should be exploited.

Before presenting the final design for an agricultural insurance plan, the issue of whether certain insurance instruments have only a social function has to be resolved. If the design of a product has to preserve a minimal standard of living for farmers affected by natural disasters, then the instrument has a social function. If that is the case, a simple model needs to be considered. This approach assumes indemnity that is payable at the end of the period in which flooding has occurred. All farmers located in the area affected by the flood will receive some compensation, but probably not enough for total recovery; i.e., not enough to meet the production level of the period prior to the natural disaster. However, this kind of compensation should be sufficient for production to survive, with the high levels of production achieved in the past remaining goals to be achieved again in future. The main task is to ensure the future of the agricultural sector.

It is known that there is more state intervention in the agricultural sector than in most other sectors. This is traditionally justified by the huge importance of the agricultural sector: the agricultural sector produces food and food is essential.

[4] This refers to insurance provided mostly by the first pillar.

Parametric insurance schemes in India, Canada, the USA, Brazil, etc. assume some kind of state intervention. Can we design instruments that provide compensation that not only ensure future agricultural production but also increase production? If agriculture is strongly affected by weather-related risk, is that risk systematic or not? These considerations lead to philosophical questions about our needs and how much food we actually need as a human race, and are beyond the scope of this paper.

A second approach would be to construct a product that provides sufficient compensation for more than just the bare survival of farmers in certain areas. This approach assumes maintaining the agricultural sector at the same level as before the natural disaster.

Lack of data is a problem when considering any insurance product in the context of the financial markets in B&H. Parametric insurance products are a solid solution in this situation. We have solid statistics for certain agricultural regions and hydrological data is available that covers long periods. We successfully collected data for the Vrbas river basin. The same approach could be replicated in other regions with hydrological stations.

A clear policy implication is that one unique financial instrument that provides adequate risk transfer for both small and large farmers is not possible. Small farmers can be introduced to a basic insurance product as the main feature of a first pillar. The second pillar should consist of products that are subsidized by the state but offered by private insurance companies.

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*Sajad Ahmad Bhat**
*Javed Ahmad Bhat***
*Taufeeq Ajaz****

# THE PUBLIC–PRIVATE INVESTMENT NEXUS IN INDIA: EVIDENCE FROM A POLICY SIMULATION APPROACH

**ABSTRACT:** *This study investigates the influence of public investment on private investment in India, at both the aggregate and Sectoral levels and under two different modes of deficit financing – monetisation and commercial borrowing – in an eclectic macroeconometric modelling framework. Using Generalised Method of Moments (GMM), the two simulation exercises conducted in the study highlight the crowding-in effect of public investment on aggregate private investment, irrespective of the mode of financing. The favourable accelerator effect and the complementary effect are found to outweigh the deleterious interest effect in both simulation exercises. At the Sectoral level, public investment is found to most strongly and positively affect private investment in manufacturing, followed by agriculture, the service sector, and finally infrastructure. The impact of public investment on the other sectors included in the model accords well with theoretical expectations.*

**KEY WORDS:** *Public investment, Private investment, crowding in, crowding out, India.*

**JEL CLASSIFICATION:** C15, C51, E22.

* School of Economics, University of Hyderabad-500046; Email: sajadeco@gmail.com.
** School of Economics, University of Hyderabad-500046; Email: apjavaid.jn@gmail.com.
*** Corresponding Author, School of Economics, SVKM's NMIMS, Bangalore-560083; Email: tajazgeight@gmail.com.

## 1. INTRODUCTION

The importance of investment in enhancing and sustaining an economy's growth performance cannot be disputed. Economists agree on its positive role in expanding the capital base and other resources essential for developing an economy's growth, employment level, and competitiveness. To increase the investment structure, economies turn to the government or private sector (both domestic and external), or to a combination of both, depending on the nature of the economy.[1] The research community has observed the behaviour of private investment in various economies across the globe when certain alterations are attempted in the public investment component.[2]

The existing literature provides three theories of the possible linkage between public and private investment. Neo-classical theory advocates the substitutability hypothesis, according to which an increase in public investment will lead to a crowding out of private investment. Any increase in public sector expenditure will need to be financed out of the given stock of funds available in the economy and hence competition between the private and public sectors for the available funds causes the interest rate to rise. The higher interest rate ultimately adversely affects the interest-sensitive components of private investment. Keynesian economics advocates a complementarity hypothesis in which there is a direct association between public and private investment; i.e.. any increase in public investment creates a favourable environment for private investment by providing better infrastructure, enhancing productivity, and increasing profitability.[3] The public sector's crowding-in effect can also be explained by public sector contracts with the private sector. Finally, the Ricardian Equivalence Hypothesis (Barro, 1989) posits that the relationship between the two investment choices is neutral.

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1 In capitalist countries most investment comes from the private sector, with a very limited contribution by the public sector. On the contrary, in developing and communist countries (India, China, Russia) the public sector is the major investor in the economy

2 Scholars have been interested in examining the relative impact of public and private investment on an economy's growth performance (Khan and Reinhart 1990). If they have a different effect on growth it is important to elucidate the linkages between them so that proper policy stances can be devised (Cavallo and Daude 2010).

3 Any increase in public investment in infrastructure projects like roads, sewage systems, harbours, energy, etc. improves the productivity of private investment and reduces production costs in the private sector, thereby enhancing its profitability. Thus, public investment 'crowds in' private investment.

Due to infinite horizons, perfect foresight, and absence of liquidity constraints, rational economic agents will consider present increases in government expenditure or tax cuts (increased fiscal deficit) as future liabilities. Any dissaving by the government is offset by a rise in the savings of rational economic agents, leaving the total national savings unchanged. Their wealth position is unaltered and hence there is no effect on consumer purchases. Since there is no effect on the interest rate, private investment is not affected.

There have been many empirical studies, but the evidence is largely inconclusive and the studies have been primarily conducted in a single equation framework and do not consider the sources of public spending financing. The present paper examines the nature of the relationship between public and private investment in the case of India, which is an interesting candidate owing to its frequent policy changes, occasional public sector stimulation packages, and efforts to increase private participation in the economy through economic liberalisation. The study analyses the public–private investment linkages in a macroeconometric modelling framework by taking into account the other endogenously determined sectors of the economy. It highlights the possible influence of public investment on private investment at both the aggregate and sectoral level and under two different financing modes, monetisation and commercial borrowing. The Generalized Method of Moments (GMM) is applied to estimate the structural model.

Using data for the period 1981–82 to 2015–16, the two simulation exercises report public investment's crowding-in effect on India's aggregate private investment, financed by either monetisation or borrowing from commercial banks. In both cases the favourable accelerator effect and the complementary effect on private investment outweigh the deleterious interest effect in a macro-modelling framework. At the sectoral level, public investment is found to affect private investment in manufacturing most strongly and positively, followed by investment in agriculture, the service sector, and finally infrastructure. The impact of public investment under the two different financing modes on the other sectors included in the macro model accords well with theoretical expectations.

The rest of the paper is organised as follows. Section 2 provides a heuristic overview of the existing literature. Section 3 outlines the analytical framework of

the developed macro model along with its characteristic features. Section 4 discusses the data, the model estimation, and its predictive accuracy. The results of policy simulations are presented in section 5 and section 6 concludes.

## 2. LITERATURE REVIEW

The impact of public investment on the private investment in an economy has been the topic of recurrent discussions, along both theoretical and empirical lines. Not only is there a lack of theoretical unanimity but the research fraternity has also failed to find any conclusive empirical evidence. Scholars started by examining the influence of public investment on private sector productivity generally and economic growth particularly. Some studies (Ram and Ramsey, 1989; Aschauer, 1989a; Munnel, 1990; Khan and Kumar, 1997; Heintz, 2010) found that public investment had a substantial productive role in the production technology of the private sector, whereas others, while doing away with the methodological issues of earlier studies (Tatom, 1991; Evans & Karras, 1994; Sturm & de Haan, 1995; Pereira & de Frutos, 1999), found that public investment had a neutral effect on private sector productivity.

In another growing strand of the literature, researchers have attempted to examine the association between private and public investment indirectly by estimating an investment model. These studies can be categorized in two sub-groups depending on whether they adhere to the complementarity or substitutability hypothesis.[4] Studies arguing for a positive association (complementarity or crowding in) between public and private investment include the following: Aschauer (1989a); Greene and Villanueva (1991); Erenburg and Wohar (1995); Bahmani-Oskooee (1999); Ahmed and Miller (1999); Ramirez (2000); Pereira (2001); Voss (2002); Narayanan (2005); Erden and Holcombe (2005); Alani (2006); Dreger and Reimers (2016); Abaid and Furceri (2016). By contrast, a number of studies favour substitutability between the two variables (Baily, 1971; Barro, 1981; Knot & de Haan, 1999; Looney, 1995; Apergis, 2000; Dong, 2006; Afonso & St Aubyn, 2009; Hussain et al., 2009; Cavallo & Daude, 2011; Xu & Yan, 2014). However, the results are sensitive to the type of economy investigated, the analytical framework and econometric method adopted, the

[4] A number of studies have also reported evidence of neutrality between the two (Liu & Ma 2001; Raju & Mukherjee 2010; Hur et al. 2014).

transmission channel, the level of segregation used for analysis, the time period, the source and kind of public expenditure, and the development level and institutional quality of the examined country.

In the Indian context, researchers have also shown an increasing interest in uncovering the impact of public investment on private investment. Initially, scholars (Sundararajan & Thakur 1980; Krishnamurty 1985; Serven 1996) examined the nature of the nexus between the two variables and found that private investment was crowded out by public investment, which later was considered a growth-retarding factor. An interesting study by Pradhan et al. (1990) examines the impact of public investment on private investment in India taking into account the sources of public investment financing and its allocation under various scenarios. Using a computational general equilibrium model (CGE) and assuming the non-neutrality of money, the authors find that private investment is crowded out as a result of public investment hikes. However, the authors support the desirability of initial crowding out owing to its favourable effect on total investment and income distribution. Applying the SVAR method, Mitra (2006) finds substitutability in the short run & complementarity in the long run. Using an asymmetric VAR method, Chakraborty (2007) reports the absence of any real crowding out between the two variables: instead the two are found to be positively correlated. In another case, Raju and Mukherjee (2010) document evidence for the neutrality hypothesis. Sahu and Panda (2012) find evidence in favour of the crowding-out hypothesis in the long run, although GDP has a positive effect on private investment. Using the autoregressive distributed lag model (ARDL), Mohanty (2016) finds the crowding out of private investment as a result of increasing fiscal deficits in both the short and long run. Muthu (2017) reports the crowding in of private investment due to an increase in total public investment in both the short and the long run. After segregating public investment into its infrastructural and non-infrastructural investment components, the former is not found to have any impact on private investment whereas the latter affects it favourably.

Though a plethora of studies have been conducted in both developed and developing countries with both uniform and mixed panels, the results are largely divergent and the adopted methodologies mostly lack the desirable features. This study examines the impact of public investment on private investment in India.

The paper contributes to the existing literature in the following ways. Firstly, we develop an eclectic macroeconomic model to examine the nexus between the two variables in a framework that includes both the supply and demand sides of various sectors of the economy. Secondly, the study examines the likely response of private investment to public investment under two different modes of public investment financing. In addition to the aggregate analysis, the study evaluates the nature of the relationship at the sectoral level and analyses the response of private agricultural, manufacturing, infrastructure, and service sector investment to changes in public investment. Finally, the study highlights the impact of public investment on the model's other endogenous variables.

## 3. ANALYTICAL FRAMEWORK

The model adopted to conduct the empirical exercise is theoretically eclectic in nature and primarily belongs to Tinbergen–Klein–Goldberger tradition. The causal structure of the model is simultaneous in nature, developed particularly for policy simulation. While most of the early models tend to rely on either the Keynesian or the classical paradigm, in many developing countries like India, supply side constraints are a major problem (Khan & ud Din, 2011). We specify the production functions, investment functions, and price functions for the agriculture, manufacturing, services, and infrastructure sectors separately (Bhattacharya and Kar, 2005) in order to gain a comprehensive insight into supply side factors and heterogeneous dynamics in terms of production, price, and investment behaviour.

Our model strives to balance classical and Keynesian approaches regarding the effectiveness of money supply on prices and output. It considers both price and income transmission channels of fiscal impulses to the external sector, which are comprehensively discussed in the theoretical literature (Rangarajan & Mohanty, 1997). Fiscal deficit is assumed to increase the aggregate absorption level in the economy immediately, relative to output, as capital stock responds with some lag. Thus, imports may grow as a consequence of both. The price channel, on the other hand, depends on how the fiscal deficit is financed.

The simplicity of the model is a deliberate attempt to make black box causal effect relationships transparent – as happens in large-scale macro models – in order to more easily show policymakers how policy shocks/exogenous variables affect the

outcome variables in the economy. The model's flexible and adaptable nature provides an interesting way to change instruments and target variables in order to answer different policy questions. If necessary, the sub-components of the model can easily be expanded, and thus the basic nature of the model is a 'work in progress'. The model is applied to track the overall macro-economic ramifications of fiscal deficit. Finally, the specific equations are a sub-set of those from several tested regression specifications that have higher goodness of fit, the appropriate theoretical sign, and significance of parameters.[5]

## 4. MODEL ESTIMATION AND PERFORMANCE

The complete model consists of four major blocks: real sector, fiscal sector, monetary sector, and external sector. It contains 56 equations (31 behavioural equations and 25 identities) and 82 variables, including dummy variables. A description of the variables used in the analysis is provided in Appendix 2. The model is estimated using annual data for the period 1981–82 to 2015–16. The model is estimated equation-by-equation using the Generalized Method of Moments (GMM).[6] All equations are estimated in conformity with the underlying economic theories. The dummy variables take care of structural shifts and unusual fluctuations in the data for certain variables. AR terms are used to correct for autocorrelation. Appendix 1 provides the estimates of the behavioural equations along with the regression statistics.

To test the empirical accuracy of the full model when describing the historical data and policy analysis, we carry out two sets of simulation exercises using the EViews software package. The first validates the predictive accuracy of the model and the second delineates the model's policy simulation potential.

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5 The complete structure of the model related to various blocks, equations, & identities has not been reported here to save space. However, the same can be provided on request.

6 All the variables except the various rates used are transformed into natural logarithms. GMM is considered to be superior to the alternatives in handling many econometric problems, including endogeneity, heteroskedasticity, and serial correlation. The number of instruments in each equation is greater than the number of parameters to be estimated; hence, all the equations are over-identified and GMM gives unique estimates of parameters in the over-identified equations (Akbar and Jamil 2012).

The model is assessed for both within-sample and out-of-sample predictive performance. Conventional simulation error statistics such as root mean square percentage error (RMSPE), mean percentage error (MAP), and Theil's inequality coefficient (U) are used to evaluate the within-sample performance of the model, while stochastic simulations are used to test the out-of-sample performance. The model is solved by running the deterministic simulations in both static and dynamic frameworks for the period 1981–82 to 2015–16. The fundamental difference between the two solution options is that in the case of a static framework, actual lagged values are used in place of lagged forecast values (Pierse, 2001). The root mean square percentage error (RMSPE), mean percentage error (MPE), and Theil's inequality coefficient (U) of both solution exercises for key variables are reported in Table 1. For almost all variables, under both the static and dynamic solutions, simulation error statistics are within a reasonable range. The trajectories of the static and dynamic simulations along with the actual values of the key variables capture most of the turning points reasonably well. To assess the out-of-sample predictive performance we apply the stochastic simulations that add random shocks to each equation during the forecast simulation.[7]

**Table 1:** Simulation error statistics for key variables

| | Static Simulations | | | Dynamic Simulations | | |
|---|---|---|---|---|---|---|
| Variable | MPE | RMPSE | U | MPE | RMPSE | U |
| YAR | 0.00 | 0.024 | 0.014 | 0.00 | 0.03 | 0.02 |
| YMNR | –0.06 | 0.072 | 0.026 | –0.07 | 0.08 | 0.04 |
| YSRR | –0.07 | 0.099 | 0.113 | –0.02 | 0.09 | 0.12 |
| YINFR | 0.00 | 0.043 | 0.039 | 0.13 | 0.17 | 0.07 |
| YR | –0.03 | 0.050 | 0.034 | 0.02 | 0.05 | 0.03 |
| PIAGR | –0.01 | 0.092 | 0.048 | –0.03 | 0.10 | 0.05 |
| PIMNR | –0.02 | 0.166 | 0.086 | –0.11 | 0.21 | 0.12 |
| PISRR | 0.00 | 0.111 | 0.041 | 0.61 | 0.69 | 0.22 |
| PIINFR | –0.01 | 0.170 | 0.067 | 0.72 | 1.05 | 0.10 |
| PITOTR | –0.02 | 0.092 | 0.047 | 0.25 | 0.31 | 0.09 |
| PRAG | –0.03 | 0.061 | 0.026 | –0.04 | 0.07 | 0.04 |

[7] The figures portraying the model's forecasting performance are not reported here to save space.

| | | | | | | |
|---|---|---|---|---|---|---|
| PRMN | 0.00 | 0.023 | 0.012 | –0.03 | 0.05 | 0.03 |
| PRSR | 0.00 | 0.018 | 0.012 | –0.01 | 0.05 | 0.02 |
| PRINF | 0.00 | 0.070 | 0.063 | –0.04 | 0.10 | 0.07 |
| PGDP | –0.01 | 0.028 | 0.017 | –0.03 | 0.05 | 0.02 |
| P | 0.00 | 0.028 | 0.020 | –0.02 | 0.05 | 0.02 |
| DOILP | 0.03 | 0.141 | 0.037 | 0.03 | 0.14 | 0.04 |
| DT | –0.02 | 0.077 | 0.034 | –0.04 | 0.10 | 0.05 |
| INDT | 0.01 | 0.051 | 0.023 | 0.03 | 0.08 | 0.03 |
| NTR | 0.00 | 0.099 | 0.078 | 0.00 | 0.10 | 0.08 |
| TR | 0.00 | 0.047 | 0.023 | 0.00 | 0.06 | 0.02 |
| GXP | 0.00 | 0.014 | 0.007 | 0.00 | 0.02 | 0.01 |
| CONS | 0.00 | 0.032 | 0.017 | –0.01 | 0.05 | 0.03 |
| PCR | –0.02 | 0.049 | 0.018 | –0.03 | 0.06 | 0.02 |
| GFD | 0.12 | 0.220 | 0.087 | 0.11 | 0.26 | 0.09 |
| M3 | 0.00 | 0.040 | 0.015 | 0.01 | 0.05 | 0.02 |
| PLR | 0.01 | 0.100 | 0.047 | 0.00 | 0.11 | 0.06 |
| EXT | –0.03 | 0.133 | 0.073 | –0.31 | 0.36 | 0.21 |
| IMP | –0.09 | 0.111 | 0.038 | –0.20 | 0.23 | 0.13 |
| NOIMP | –0.11 | 0.140 | 0.051 | –0.25 | 0.28 | 0.17 |
| OIMP | 0.01 | 0.121 | 0.055 | 0.01 | 0.22 | 0.06 |
| UVEXP | 0.01 | 0.070 | 0.040 | 0.01 | 0.11 | 0.05 |
| TB | –0.15 | 0.482 | 0.216 | 0.19 | 0.66 | 0.11 |
| CAB | –0.71 | 1.934 | 0.613 | 0.16 | 1.93 | 0.35 |
| EXR | 0.04 | 0.114 | 0.031 | 0.03 | 0.14 | 0.05 |
| KAGR | 0.00 | 0.013 | 0.011 | –0.02 | 0.03 | 0.02 |
| KMNR | 0.00 | 0.023 | 0.020 | –0.08 | 0.11 | 0.08 |
| KSRR | 0.00 | 0.023 | 0.022 | 0.33 | 0.38 | 0.19 |
| KINFR | 0.00 | 0.020 | 0.021 | 0.13 | 0.16 | 0.07 |

## 5. RESULTS AND DISCUSSION

The prime concern of the study is to explore the impact of public investment on private investment in India by taking into consideration the modes of public investment financing. The study also highlights the potential effect of public investment on the system's other endogenously determined macroeconomic sectors. To this end, by incorporating the above designed model we conducted the following policy simulations:

Simulation 1: Sustained 40% increase in real public investment (10% increase in agriculture, 10% increase in manufacturing, 10% increase in services, and 10% increase in infrastructure) financed by money creation.

Simulation 2: Sustained 40% increase in real public investment (10% increase in agriculture, 10% increase in manufacturing, 10% increase in services, and 10% increase in infrastructure) financed through borrowing from commercial banks.

### 1.1. Public investment financed through money supply

We start with a dynamic deterministic solution of the model in order to obtain the coefficients of the endogenous variables, popularly called in the literature 'control' or 'base-line' solutions. Subsequently, policy solutions are obtained through a persistent (exogenous) shock to policy variables by running a dynamic deterministic path under the assumption of ceteris paribus. The divergence so obtained between the base line and policy solutions is ascribed to the policy changes under examination.

**Table 2:** Simulation Scheme 1

| Percentage Deviation of Policy Simulation from Base Line Simulation (#) through RCG | | | |
|---|---|---|---|
| **Variable** | **Impact (1991–92)** | **Short-run (1991–92 to 1992–93)** | **Long-run (1991–92 to 2015–16)** |
| YAR | 0.15 | 0.17 | 0.53 |
| YMNR | 1.76 | 1.81 | 4.09 |
| YSRR | 1.46 | 1.47 | 3.94 |
| YINFR | 4.32 | 5.24 | 8.65 |
| YR | 1.58 | 1.67 | 6.18 |

| | | | |
|---|---|---|---|
| Y | 6.10 | 6.20 | 5.52 |
| PIAGR | 2.59 | 3.04 | 13.20 |
| PIMNR | 8.19 | 8.39 | 20.50 |
| PISRR | 2.30 | 2.26 | 7.21 |
| PIINFR | 4.65 | 4.73 | 4.96 |
| PITOTR | 4.47 | 4.57 | 14.95 |
| PRAG | –3.40 | –3.51 | –4.25 |
| PRMN | 3.74 | 3.97 | 4.02 |
| PRSR | 10.86 | 11.10 | 11.41 |
| PRINF | 4.65 | 4.73 | 4.96 |
| PGDP | 5.61 | 5.75 | 5.79 |
| P | 5.71 | 5.80 | 5.85 |
| GXP | 4.62 | 4.48 | 10.70 |
| GFD | 10.33 | 9.53 | 12.95 |
| M3 | 26.06 | 29.98 | 93.57 |
| PLR | –0.35 | –0.44 | –0.52 |
| EXT | 0.53 | 0.67 | 8.47 |
| IMP | 1.44 | 1.54 | 9.67 |
| UVEXP | 6.87 | 7.03 | 8.10 |
| TB* | 2.74 | 2.78 | 11.39 |
| CAB* | 7.04 | 7.14 | 29.30 |
| EXR** | 2.16 | 2.19 | 2.25 |
| KAGR | 1.23 | 1.33 | 4.62 |
| KMNR | 3.75 | 4.45 | 6.57 |
| KSRR | 1.05 | 1.14 | 7.72 |
| KINFR | 3.89 | 4.52 | 6.99 |

**NOTE:** # = {(PS-BS)/BS}*100. Where PS is defined as policy-simulated data and BS as base-line-simulated data. *(+) indicates deficit and (–) indicates surplus. ** (+) means depreciation of domestic currency and (–) denotes appreciation.

Table 2 reports the effects of increased public investment financed through the monetary route on the various endogenous variables in Simulation 1. At the outset it should be noted that public investment, treated as an exogenous variable

in the model specification, is supposed to have twin effects. First, according to multiplier principle, increased public investment leads to a lagged output expansion by enhancing the capital base of the economy. Second, competition between public and private investment is supposed to exist. Following a rise in public investment, fiscal deficit and money supply responded positively in the year of shock itself with respective magnitudes of 10.33% and 26.06%. As a result of enhanced aggregate demand, the price level and real aggregate output initially increased by 5.61% and 1.58% respectively. Due to the direct association between money supply and non-agricultural price deflators, the latter is found to increase as a result of an increase in the former. The general price level in the economy as measured by WPI also showed an increasing tendency of about 5.71% following the rising trends of the aggregate deflators. The increased price level in the economy resulted in currency depreciation and a hike in the unit value of the export index of 2.16 and 6.87 percentage points respectively. Owing to the increased money supply the interest rate responded as per the theoretical relationship between the two and declined by about 0.35%.

Taking into account the direct impact of public investment on private investment, it can be observed from Table 2 that the two variables are positively related (complementary) and therefore the former crowds in the latter in the first year of the policy change. Table 2 reveals that public investment increases private investment in the immediate period by about 4.47% with a public investment multiplier equal to 1.30 (shown in Table 4 below). However, according to the macroeconomic model adopted in the study it is appropriate to entertain the influence of other variables supposed to influence the level of private investment in the economy.[8] Thus, to provide a more lucid evaluation of the public–private investment nexus in India the study examines both the complementarity channel and the interest rate channel. On the whole, it can be observed that public investment has a favourable impact on private investment when the former is financed through monetisation because all the effects – complementary,

[8] Increased public investment through monetisation increases the money stock in the economy, and therefore the interest rate changes accordingly. It is imperative to take cognizance of the interest effect on private investment as well, since the former is supposed to be an important determinant of the latter.

accelerator, and interest rate – move in the desired direction of enhancing private investment in the immediate period.

On the external side of the economy, Table 2 reveals the problem of trade and current account deficits of 2.74% and 7.04% respectively. This result is a clear reflection of the fact that relative currency depreciation and the hike in the unit value of the export index leads to a 1.44% increase in imports and a meagre 0.53% increase in exports. The reason is that part of the expansionary effect of currency depreciation is offset by a rise in the unit value of the export index, and therefore exports rise by a lower magnitude than imports.

In the short run the variables' response remains more or less similar to that of the immediate period, except that some change in trends is observed due to the persistent nature of the shock. The movement of fiscal deficits and money supply is the same, but the magnitude of the fiscal deficit response decreases to 9.53% and that of money supply increases to 29.98%, relative to their response in the immediate period. Following the transmission analogy observed in the first period, real output continues to increase by a higher magnitude of 1.67% due to continuous additions to the capital stock through consistent doses of public investment. Public investment crowds in private investment at both the sectoral (agriculture, manufacturing, infrastructure, services) and aggregate levels. The price levels follow the upward trajectory, along with exchange rate and the unit value of the export index, whereas the interest rate falls due to the increased money supply in the economy. Imports consistently rise by about 1.54% due to increased import demand following an output expansion, and increase in domestic absorption and exports also rises – but only marginally, by about 0.67%. The existence of a gap between imports and exports leads to continuous trade and current account imbalances.

In the long run a persistent increase in public investment leads to a continuous aggregate output expansion of around 6.18%, and at the sectoral level the infrastructure sector witnesses the maximum hike relative to the other sectors included in the analysis. The value of the long-run output multiplier is 3.78 (Table 4). Fiscal deficits, money supply, price level, exchange rate, and interest rate follow a similar pattern to that observed in the immediate and short-run periods. Total private investment rises consistently by about 14.95% with a cumulative

long-run multiplier equal to 1.94. Thus, the study reveals that if public investment is financed by monetisation a case of strong crowding in is inevitable, since the three effects mentioned earlier are operative during the immediate, short-run, and long-run periods. A similar pattern is observed at the sectoral level, with the manufacturing sector registering the maximum crowding in. Exports rise by about 8.47% and imports by 9.67% due to the already mentioned reasons of increased output, domestic absorption of imports, and currency depreciation for exports. Finally, both trade and current accounts are continuously plagued with undesirable deficit increases of about 11.39% and 29.30% respectively.

### 5.2. Public investment financed through borrowing from commercial banks

To conduct this simulation exercise, some adjustments in the model specifications are necessary. Reserve bank credit to the government, earlier treated as purely exogenous, now needs to be transformed into an endogenous variable. In this policy scenario, reserve bank credit to the government is expressed as the residual capital needed to balance the gap between fiscal deficit and borrowing from all sources, inclusive of commercial bank credit to the government. In this framework both the exogenous variables like public investment and commercial bank credit to the government are enhanced by the same percentage, and therefore reserve bank credit to the government decreases, leading to a fall in reserve money, and finally in money supply. The reduced money supply in the second simulation initiates various other changes in the economy, as reported in Table 3.

Like in the case of the first simulation, fiscal deficit increases by about 14.40% following an increase in public investment in the first year. But unlike the first case, here the money supply decreases by about 12.66%, leading to an interest rate rise of about 0.47%, a fall in the overall price level of 2.25%, a fall in the exchange rate of about 3.77%, and a fall in the unit value of the export index of 2.67%. Real aggregate output increases by around 0.92% due to the increase in aggregate demand following increased public investment. At the sectoral level a similar response is observed; however, the maximum response is in the infrastructure sector. The variable of prime concern, private investment, responds positively to the increase in public investment, validating the complementarity between the two variables. With a view to incorporating the influence of the accelerator and the interest rate effects, it is observed that the complementary and accelerator

effect of private investment outweighs the adverse impact of increased interest rate on private investment. Therefore, private investment increases even when public investment is financed through commercial bank borrowing in the immediate period.

**Table 3:** Simulation Scheme 2

| % Deviation of Policy Simulation from Base Line Simulation (#) through BCG | | | |
|---|---|---|---|
| **Variable** | **Impact (1991–92)** | **Short-Run (1991–92 to 1992–93)** | **Long-run (1991–92 to 2015–16)** |
| YAR | 0.07 | 0.09 | 0.47 |
| YMNR | 1.58 | 1.59 | 3.90 |
| YSRR | 0.21 | 0.24 | 3.30 |
| YINFR | 4.73 | 5.59 | 8.59 |
| YR | 0.92 | 0.99 | 5.48 |
| Y | 0.54 | 0.22 | 1.36 |
| PIAGR | 2.56 | 2.96 | 12.82 |
| PIMNR | 5.40 | 5.54 | 17.62 |
| PISRR | 0.54 | 0.52 | 5.16 |
| PIINFR | 5.47 | 5.85 | 7.70 |
| PITOTR | 2.52 | 2.59 | 12.52 |
| PRAG | 0.14 | –0.05 | 1.87 |
| PRMN | –1.72 | –1.56 | –4.93 |
| PRSR | –1.92 | –1.30 | –7.56 |
| PRINF | –2.72 | –2.55 | –5.88 |
| PGDP | –1.62 | –1.32 | –4.93 |
| P | –2.25 | –1.95 | –4.80 |
| GXP | 4.95 | 4.78 | 10.81 |
| GFD | 14.40 | 13.78 | 20.53 |
| M3 | –12.66 | –12.43 | –43.44 |
| PLR | 0.47 | 0.51 | 0.71 |
| EXT | 9.51 | 10.84 | 40.96 |
| IMP | 5.93 | 4.99 | 27.37 |

| | | | |
|---|---|---|---|
| UVEXP | –2.67 | –2.32 | –6.94 |
| TB* | –2.53 | –7.69 | –15.89 |
| CAB* | –6.22 | –18.91 | –39.08 |
| EXR** | –3.77 | –3.31 | –2.69 |
| KAGR | 0.67 | 0.78 | 4.17 |
| KMNR | 3.58 | 4.00 | 5.75 |
| KSRR | 0.36 | 0.63 | 1.67 |
| KINFR | 4.32 | 4.86 | 6.94 |

**NOTE:** # = {(PS-BS)/BS}*100. PS is defined as policy-simulated data and BS as base-line-simulated data. *(+) indicates the deficit and (–) indicates surplus. ** (+) means depreciation of domestic currency and (–) denotes appreciation.

The increased domestic absorption and output growth increases the demand for imports by 5.93%, and exports register a hike of around 9.51%, mostly due to a decrease in the unit value of the export index. This leads to a surplus in the current and trade accounts of 2.53% and 6.22% respectively. In the short run an almost similar behaviour of endogenous variables is reported.

In the long run the fiscal deficit progressively increases by 20.53% and the money supply decreases by 43.44%. The interest rate also follows the upward trajectory and the price level decreases by –4.80%. Domestic currency appreciates by 2.69% and the unit value of the export index declines by 6.94%. The trade and current account balances continue to improve by 15.89% and 39.08% respectively, due to the relatively more pronounced increase in exports than imports because of a stronger price effect than exchange rate effect.[9] Due to increased aggregate demand and real net capital stock following sustained non-agricultural public investment, real aggregate output registers a continuous hike of 5.48% with a long-run cumulative multiplier of 3.02 (Table 4). At the sectoral level the infrastructure sector output appreciated most, followed by manufacturing and services. Aggregate private investment responded positively by a magnitude of 12.52% with a cumulative multiplier equal to 1.60 (Table 4). Here again, of the

[9] A fall in the unit value of exports outweighs the currency appreciation, and therefore exports rise by a greater magnitude.

various private investment components the manufacturing sector registered the largest increase, followed by agriculture.

The two simulation exercises highlight the crowding-in effect of public investment financed either through monetisation or borrowing from commercial banks. In a macro-modelling framework, the favourable accelerator effect and complementary effect on private investment outweigh the deleterious interest effect in both cases. It is important to mention that although the crowding-in effect is reported under both financing modes the response is greater in the case of monetisation, as is reflected by the relative higher values of impact and cumulative multipliers in the case of monetisation than in the case of borrowing.

**Table 4:** Impact and cumulative multipliers

| | Simulation 1 | | Simulation 2 | |
|---|---|---|---|---|
| Variable | Impact effect | Cumulative Multiplier | Impact Effect | Cumulative Multiplier |
| PIAGR | 0.45 | 1.61 | 0.44 | 1.56 |
| PIMNR | 2.69 | 4.73 | 1.82 | 4.15 |
| PISRR | 1.90 | 2.33 | 0.93 | 0.96 |
| PIINFR | 0.16 | 1.10 | 0.15 | 1.02 |
| PITOTR | 1.30 | 1.94 | 0.74 | 1.60 |
| YAR | 0.63 | 1.50 | 0.30 | 1.34 |
| YMNR | 1.33 | 2.16 | 1.19 | 2.07 |
| YSRR | 0.37 | 2.17 | 0.23 | 1.39 |
| YINFR | 1.62 | 5.50 | 1.76 | 5.39 |
| YR | 2.00 | 3.78 | 1.17 | 3.02 |

## 6. CONCLUSION

The paper scrutinizes the possible interactions between public and private investment at both the aggregate and sectoral level and under two different financing modes; i.e., monetisation and commercial borrowing. A structural macro-econometric modelling framework is developed to comprehensively investigate India's open and highly deregulated economy. The empirical exercise

documents the evidence for complementarity between the two investment options, irrespective of whether the public investment is financed through monetisation or commercial borrowing. However, the association is more pronounced in the former financing mode than in the latter. From the results it can be observed that the favourable accelerator effect and the complementary effect on private investment outweigh the deleterious interest effect in both simulation exercises.

At the sectoral level, private investment in the manufacturing sector is most responsive to public investment, followed by agricultural investment, service sector investment, and infrastructure investment. Finally, the impact of public investment under alternative financing modes on the other variables included in the model accords well with existing theoretical expectations. In terms of policy implications the study recommends a robust expansion of public investment, particularly in the areas where the response of private investment is substantial. However, a mixture of the two sources of public investment financing would be an appropriate policy due to the negatives associated with both modes, like interest rate, inflation, and external account imbalance.

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## APPENDIX 1.

$$LOG(YAR) = \underset{(0.001)}{6.99} + \underset{(0.09)}{0.51} * LOG(AREA) + \underset{(0.005)}{0.0016} * (RFI) + \underset{(0.05)}{\text{LOG(KAGR(-1))}} + \underset{(0.00)}{0.26} * LOG(MSP) + [AR(1) = \underset{0.004}{0.4}]$$

$$LOG(YMNR) = \underset{(0.00)}{2.62} + \underset{(0.00)}{.58} * LOG(ADD) + \underset{(0.002)}{.15} * LOG(KMNR(-1)) - \underset{(0.00)}{.11} * \text{LOG(DOILP)} + [AR(1) = .3]_{(0.00)}$$

$$LOG(YSRR) = \underset{(0.00)}{2.01} + \underset{(0.002)}{.22} * LOG(KSRR(-1)) + \underset{(0.00)}{.58}\, LOG(ADD) - \underset{(.0023)}{.02}\, DYSRR + [AR(1) = .58]_{(0.00)}$$

$$LOG(YINFR) = \underset{(0.00)}{-4.94} + \underset{(0.00)}{1.26} * LOG(KINFR(-1)) + [AR(1) = .8]_{(0.00)}$$

$$LOG(\text{PIAGR}) = \underset{(0.00)}{-8.66} + \underset{(0.002)}{.91} * LOG(\text{YA}\,R(-1)) + \underset{(0.05)}{0.1}\, LOG(\text{PCFAGR}) - \underset{(.000)}{0.34} * D02 + \underset{(.01)}{0.45} * D03 + \underset{0.00}{0.6} * LOG(PIAGR(-1)) + [AR(1) = -.25]_{(0.01)}$$

$$LOG(\text{PIMNR}) = \underset{(0.03)}{0.46} * LOG(\text{YMNR}) + \underset{(0.000)}{0.71} * LOG(\text{PCFMNR}) - \underset{(.10)}{0.05} * \text{PLR} + \underset{(.14)}{0.042} * \text{LOG(OTEXP)} + \underset{(0.1)}{0.06} * \text{D04} + [AR(1) = -.89]_{(0.00)}$$

$$LOG(\text{PISRR}) = \underset{(.14)}{.077} + \underset{(0.00)}{0.86} * LOG(\text{YSRR}) + \underset{(0.1)}{0.09} * LOG(\text{PCFSRR}) - \underset{(.10)}{0.02} * \text{PLR}$$

$$LOG(\text{PIINFR}) = \underset{(.15)}{-0.6} + \underset{(0.1)}{0.5} * LOG(\text{YINFR}) + \underset{(0.1)}{0.36} * LOG(\text{PCFINFR}) - \underset{(0.00)}{0.069} * \text{PLR} + \underset{(0.00)}{0.07} @TREND$$

$$PLR = \underset{(0.00)}{0.39} + \underset{(0.02)}{0.19} * \text{RP} - \underset{(0.06)}{0.12} * \text{LOG(M3)} + \underset{(.05)}{0.66} * \text{PLR}(-1) + \underset{(0.5)}{0.05} * \text{INFL}$$

$$LOG(\text{PRAG}) = \underset{(0.15)}{0.46} - \underset{(0.03)}{0.27} * LOG(YAR) + \underset{(0.00)}{0.58} * LOG(PYDR) + \underset{(0.00)}{0.30} * LOG(MSP) + [AR(1) = .94]_{0.00}$$

$$LOG(\text{PRMN}) = \underset{(0.1)}{1.44} + \underset{(0.05)}{0.16}^{*}\, LOG(\text{M3}) + \underset{(0.05)}{0.06}^{*}\, LOG(PRAG) + \underset{(0.06)}{0.037}^{*}\, LOG(\text{DOILP}) + \underset{(0.08)}{0.11}^{*}\, LOG(UVIMP) + [\underset{0.00}{AR(1) = .96}]$$

$$LOG(\text{PRSR}) = \underset{(0.07)}{-0.54} + \underset{(0.00)}{0.23}^{*}\, LOG(\text{M3}) + \underset{(0.01)}{0.48}^{*}\, LOG(\text{PRSR}(-1)) + [\underset{0.00}{AR(1) = .86}]$$

$$LOG(\text{PRINF}) = \underset{(0.15)}{-0.09} + \underset{(0.06)}{0.43}^{*}\, LOG(\text{PRMN}) + \underset{(0.003)}{0.59}^{*}\, LOG(\text{PRINF}(-1))$$

$$LOG(\text{DT}) = \underset{(0.00)}{-5.06} + \underset{(0.00)}{0.54}^{*}\, LOG(\text{YNAR}) + \underset{(0.57)}{0.03}^{*}\, \text{D06} + \underset{(0.00)}{1.94}\, LOG(P) + [\underset{0.00}{AR(1) = 0.85}]$$

$$LOG(\text{INDT}) = \underset{(0.03)}{-1.25} + \underset{(0.00)}{0.93}^{*}\, LOG(\text{YM}) + \underset{(0.2)}{0.11}^{*}\, \text{D07} + [\underset{(0.01)}{AR(1) = 0.75}]$$

$$LOG(\text{NTR}) = \underset{(0.00)}{-3.11} + \underset{(0.00)}{0.98}^{*}\, LOG(\text{YM}) - \underset{(0.15)}{0.033}^{*}\, \text{DNTR}$$

$$LOG(\text{CONS}) = \underset{(0.05)}{-0.4} + \underset{(0.001)}{0.28}^{*}\, LOG(\text{YM}) - \underset{(0.00)}{0.7}^{*}\, \text{LOG}(\text{CONS}(-1))$$

$$LOG(\text{PCR}) = \underset{(0.00)}{-0.99} + \underset{(0.00)}{0.47}^{*}\, LOG(\text{PYDR}) - \underset{(0.00)}{0.2}^{*}\, \text{LOG}(\text{CONS}) + \underset{(0.00)}{0.49}^{*}\, LOG(\text{P}) + \underset{(0.00)}{0.25}^{*}\, LOG(PCR(-1))$$

$$LOG(\text{M3}) = \underset{(0.1)}{0.64} + \underset{(0.00)}{1.07}^{*}\, LOG(\text{RM}) - \underset{(0.001)}{0.036}^{*}\, \text{CRR} + [\underset{0.00}{AR(1)=0.47}]$$

$$P = \underset{(0.00)}{1.19} + \underset{(0.00)}{.051}^{*}\, \text{PGDP} + \underset{(0.00)}{0.49}^{*}\, \text{P}(-1)$$

$$LOG(DOILP) = \underset{(0.00)}{-1.61} + \underset{(0.00)}{1.36}^{*}\, \text{OILPRATIO} + \underset{(0.00)}{1.05}^{*}\, \text{LOG}(\text{WIOLP})$$

$$LOG(DEPAG) = \underset{(0.00)}{-7.6} + \underset{(0.00)}{1.32}^{*}\, \text{LOG}(\text{KAGR}(-1))$$

$$LOG(DEPMN) = \underset{(0.00)}{-4.66} + \underset{(0.00)}{1.09}^{*}\, \text{LOG}(\text{KMNR}(-1))$$

$$LOG(DEPSR) = \underset{(0.00)}{-5.23} + \underset{(0.00)}{1.09}^{*}\, \text{LOG}(\text{KSRR}(-1))$$

$$LOG(DEPINFR) = \underset{(0.00)}{-5.23} + \underset{(0.00)}{1.15}^{*}\,\mathrm{LOG}(\mathrm{KINFR}(-1))$$

$$LOG(EXT) = \underset{(0.00)}{-1.09} + \underset{(0.00)}{0.09}^{*}\,WGDP - \underset{(0.00)}{0.17}^{*}\,(UVEXP / EXR) + \underset{(0.00)}{1.1}^{*}\,LOG(NOIMP(-1)) + \underset{(0.01)}{0.28}^{*}\,DEXP + [\underset{(0.00)}{AR(1) = 0.45}]$$

$$LOG(\mathrm{NOIMP}) = \underset{(0.00)}{-6.62} + \underset{(0.00)}{1.02}^{*}\,\mathrm{LOG}(\mathrm{ADD}) - \underset{(0.15)}{0.006}^{*}\,(EXR) + \underset{(0.01)}{0.35}^{*}\,LOG(\mathrm{EXT}(-1)) - \underset{(0.1)}{0.023}^{*}\,\mathrm{LOG}(\mathrm{UVIMP}) + \underset{(0.00)}{0.23}^{*}\,D05 + [\underset{(0.00)}{AR(1) = 0.82}]$$

$$LOG(\mathrm{OIMP}) = \underset{(0.00)}{-5.6} + \underset{(0.01)}{0.88}^{*}\,LOG(\mathrm{YM}) - \underset{(0.00)}{0.87}^{*}\,\mathrm{LOG}(\mathrm{WIOLP}) + [\underset{(0.00)}{AR(1) = 0.84}]$$

$$EXR = \underset{(0.02)}{16.54} + \underset{(0.00)}{0.23}^{*}\,\mathrm{P} - \underset{(0.04)}{2.03}^{*}\,(\mathrm{CAB}/\mathrm{RBFA}) + \underset{(0.08)}{4.9}^{*}\,\mathrm{D08} - \underset{(0.2)}{1.1}^{*}\,DEXR + [\underset{(0.00)}{AR(1) = 0.85}]$$

$$LOG(NCIAB) = \underset{(0.00)}{-6.72} + \underset{(0.00)}{1.19}^{*}\,\mathrm{LOG}(\mathrm{Y}) + \underset{(0.04)}{0.13}^{*}\,\mathrm{WGDP} - \underset{(0.04)}{0.75}^{*}\,DNCIAB$$

$$LOG(\mathrm{UVEXP}) = \underset{(0.00)}{-0.75} + \underset{(0.00)}{1.19}^{*}\,\mathrm{LOG}(\mathrm{P}) + [\underset{(0.00)}{AR(1) = 0.73}]$$

---

$$ABSP = PCR + PIAGR + PIMNR + PIINFR$$

$$ADD = ABSP + CONS + PCFTOTR + REXP - RIMP$$

$$AD = ADD + RIMP$$

$$PYD = YM - TR + TP$$

$$PYDR = PYD / PGDP$$

$$INFL = ((P - P(-1) / \mathrm{P}) * 100$$

$$KAGR = KAGR(-1) + PIAGR + PCFAGR - DEPAG$$

$$KMNR = KMNR\,(-1) + PIMNR + PCFMNR - DEPMN$$

$$KINFR = KINFR(-1) + PIINFR + PCFINFR - DEPINFR$$

$$KSRR = KSRR(-1) + PISRR + PCFSRR - DEPSR$$

$$PITOTR = PIAGR + PIMNR + PIINFR + PISRR$$

$$PCFTOTR = PCFAGR + PCFMNR + PCFINFR + PCFSRR$$

$$GXP = CONS + PCFTOTR + TP$$

$$TR = DT + INDT + NTR$$

$$GFD = GXP - TR$$

$$RM = RCG + RBCS + RBFA + GCL + RGCB - RNML$$

$$IMP = NOIMP + OIMP$$

$$TB = EXT - IMP$$

$$PGDP = 0.19 * PRAG + 0.18 * PRMN + 0.44 * PRSR + 0.18 * PRINF$$

$$REXP = EXT / UVEXP$$

$$RIMP = IMP / UVIMP$$

$$YR = YAR + YMNR + YINFR + YSRR$$

$$CAB = EXT - IMP + INVSB$$

$$Y = PRAG * YAR + PRMN * YMNR + PRSR * YSRR + PRINF * YINFR$$

$$YNAR = YMNR + YINFR + YSRR$$

$$RCG = GFD - \Delta(\mathrm{BCG}) - \mathrm{DNB} - \mathrm{EB} - \mathrm{MISCR} + \mathrm{RCG}(-1)$$

$$BCG = \Delta BCG + BCG(-1)$$

## APPENDIX 2: LIST OF ACRONYMS USED

| | |
|---|---|
| ABSP: | Real private absorption |
| DEPAG: | Real depreciation in agriculture, forestry and fishing (Industry group 1 of NAS), called 'agriculture' for simplicity. |
| DEPINF: | Real depreciation in infrastructure including electricity, gas, and water supply, construction, transport, storage and communication (Industry groups 4, 5, and 7 of NAS), called 'infrastructure' for simplicity. |
| DEPMN: | Real depreciation in manufacturing including mining and quarrying (Industry Groups 2 and 3 of NAS), called 'manufacturing' for simplicity; DEPSR, Real depreciation in services including all others (Industry groups 6, 8, and 9 of NAS), called 'services' for simplicity. |
| DT: | Direct tax revenue. |
| GXE: | Government total expenditure centre and state combined. |
| CONS: | Government final consumption expenditure. |
| IDT: | Indirect tax revenues. |
| KAGR: | Real net capital stock in agriculture. |
| KINFR: | Real net capital stock in infrastructure. |
| KMNR: | Real net capital stock in manufacturing. |
| KSRR: | Real net capital stock in services. |
| NTX: | Non-tax revenue (incl. income from entrepreneurship, property, and miscellaneous current receipts). |
| PCFTOTR: | Real aggregate public investment. |
| PCFTOTR: | Aggregate public investment. |
| PCR: | Real private consumption. |
| PGDP: | GDP deflator (2004–05 = 100). |
| PGKE: | Implicit price deflator for public sector investment. |
| PIAGR: | Real gross private investment in agriculture. |
| PIINFR: | Real gross private investment in infrastructure. |
| PIMNR: | Real gross private investment in manufacturing. |
| PISRR: | Real gross private investment in services. |
| PITOTR: | Real aggregate private investment. |
| PNA: | Price deflator for non-agriculture sector. |
| PPIE: | Implicit price deflator for public sector investment. |
| PRAG: | Price deflator for agriculture. |
| PRINF: | Price deflator for infrastructure. |
| PRMN: | Price deflator for manufacturing. |

| | |
|---|---|
| PRSR: | Price deflator for services. |
| PYD: | Personal disposable income. |
| PYDR: | Real personal disposable income. |
| TR: | Government current revenues combined. |
| Y: | Aggregate output at factor cost. |
| YAR: | Real output in agriculture. |
| YINFR: | Real output in infrastructure. |
| YM: | Gross domestic product at market prices. |
| YMNR: | Real output in manufacturing. |
| YNAR: | Real output in non-agriculture sector. |
| YSRR: | Real output in services. |
| YR: | Real output at factor cost |
| TP: | Other transfer payments. |
| PCFAGR: | Real gross public investment in agriculture. |
| PCFINFR: | Real gross public investment in infrastructure. |
| PCFMNR: | Real gross public investment in manufacturing. |
| PCFSRR: | Real gross public investment in services. |
| RFI: | Percentage deviation between actual and normal rainfall. |
| AD: | Real aggregate absorption. |
| ADD: | Real aggregate demand for domestically produced goods. |
| BCP: | Bank credit to commercial sector. |
| CAB: | Current account balance. |
| EXT: | Exports (Merchandise). |
| EXTR: | Real exports. |
| GFD: | Gross fiscal deficit of both central and state government. |
| IMP: | Imports (Merchandise). |
| IMPR: | Real imports. |
| NOIMP: | Non-oil Imports. |
| OIMP: | Oil imports. |
| DOILP: | Domestic oil price index (index of mineral oil in WPI basket (2004-05=100). |
| OILPRATIO: | Domestic oil price index upon world oil price index. |
| M3: | Money supply. |
| RP: | Policy rate, bank rate up to 2000–01 and repo rate after that. |
| P: | Wholesale price index (2004–05 =100). |
| INFL: | Rate of inflation. |
| PLR: | Prime lending rate. |
| RBFA: | Net foreign exchange assets of RBI. |
| RCG: | Reserve bank credit to the government. |

| | |
|---|---|
| RM: | Reserve money. |
| TB: | Trade balance. |
| CAB: | Current account balance. |
| UVEXP: | Unit value of exports. |
| AREA: | Index of gross cropped area. |
| BCG: | Commercial bank credit to government. |
| CRR: | Cash reserve ratio. |
| DNB: | Non-market borrowings of both central and state government. |
| EXR: | Exchange rate of Indian rupee against US$ (Nominal, Rs. /$). |
| EB: | External borrowings by the govt. |
| GCL: | Government's currency liabilities to public. |
| INVSB: | Invisibles in current account balance. |
| MSP: | Average of minimum support price of fair average quality. |
| MISCR: | Other capital receipts of the govt. |
| NCIAB: | Net capital inflows including net capital account in the balance of payments and errors and omissions. |
| RBCS: | RBI credit to the commercial sector. |
| UVIMP: | Unit value of imports. |
| WGDP: | Index number of world's GDP (2004–05=100). |
| WOILP: | World oil price index (price of Indian basket of oil imports rupees per ton). |
| D01: | Dummy for post-reform period. |
| D02: | Unusual increase in agriculture investment. |
| D03: | Unusual decrease in agriculture investment. |
| D04: | Irregular dummy for manufacturing (2007–08) for sharp increase. |
| D05: | Dummy crisis, 1 for 2008–09 and 0 for others. |
| D06: | Dummy for 1991–92 for change in structure of direct tax. |
| D07: | Dummy for 1992–93 and 1993–94 for sharp change in indirect tax rates. |
| D08: | Dummy representing a large depreciation of rupee exchange rate in 1992–93, 1 for that and 0 for others. |

***Sources:*** *National Accounts Statistics, CSO, GOI; Agriculture Statistics at a Glance; Handbook of Statistics on Indian Economy, RBI; Office of the Economic Advisor, Ministry of Commerce & Industry, GOI and authors' calculated Indices and Dummies.*

# CORRIGENDUM

https://doi.org/10.2298/EKA2024129E

## CORRECTION TO ŽARKOVIĆ RAKIĆ ET AL. (2019)

Some terminological inaccuracies have been identified in the article "Income inequality in transition economies: a comparative analysis of Croatia, Serbia and Slovenia" by Jelena Žarković Rakić, Gorana Krstić, Nermin Oruč and Will Bartlett which appeared in ***Economic Annals*, 2019, LXIV(223): 39-60**. https://doi.org/10.2298/EKA1923039Z. On pp. 43-45 of the article, the term "market income" should read "post-tax income" and the term "tax and benefit" on p. 44-45 should read "benefit". The Legend for Figure 1 on p 44 "Redistributive effects of social transfers" in place of "Redistributive effects reducing market inequality". The Note should read "… the post-tax Gini coefficient for total equivalised income before social transfers (including pensions) [ilc_di12b] "in place of "...the market-generated Gini coefficient for total equivalised income". The authors are grateful to Nikola Altiparmakov for bringing their attention to these details.

# ERRATUM

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## CORRECTION TO STUBBS (2019)

A correction has been made to the article "Towards a political economy of social welfare in Croatia" by Paul Stubbs in ***Economic Annals*, 2019, LXIV(223): 105-136** (https://doi.org/10.2298/EKA1923105S). On page 117 line 9, there was an error: "… the crisis of shipbuilding in Croatia - dating back to the civil war or even before…" should read: "…the crisis of shipbuilding in Croatia - dating back to wartime or even before…". The latter formulation appeared in the final revised version of the submitted paper and was inadvertently changed during the editing process.

# INSTRUCTIONS TO AUTHORS

**Economic Annals** is an international professional journal published quarterly by the Faculty of Economics, University of Belgrade. It publishes research in all areas of economics and business administration, particularly for transition and emerging economies. The journal encourages the submission of original unpublished works, not under consideration by other journals or publications. Contributions written in English and in electronic form should be forwarded to: ea@ekof.bg.ac.rs.

The journal maintains high scientific standards. Papers submitted for publication should be original, relevant and scientifically accurate. Authors are expected to provide new information or analysis and should present a summary of the conclusions they draw, maintaining coherence and compactness of their reasoning. The originality of the work is subject to test by iThenticate crosscheck. The texts should also follow appropriate technical standards and stylistic criteria. UK spelling (specialisation, labour, etc.) should be used, while both UK and US abbreviations are acceptable.

All submitted papers will undergo a double-blind refereeing process. An anonymous version of the paper should be submitted along with a separate cover page, containing the article's title, author's name and affiliation, e-mail address, and a suggested running head (an abbreviated form of the title of no more than 50 characters with spaces). The cover page should also should contain a short abstract of between 100 to 200 words, summarising the major points and conclusions of the paper, a list of up to five keywords and up to five two-digit codes in accordance with the Journal of Economic Literature (JEL) classification (https://www.aeaweb.org/econlit/jelCodes.php).

Papers should be prepared as a single file (including text, notes, references, figures, and tables) in MS-Word. Papers should be submitted in A4 page format (21×29.7 cm), left and right margins cm, top and bottom 4.5 cm, in font Times New Roman 12, single line spacing. There should be no tabs in paragraphs and a single line spacing should separate paragraphs and titles. Tables, figures and footnotes should be included as they are intended to appear in the final version. Footnotes (in font 10) should be kept to a minimum and numbered as superscripts. Papers which do not conform with the above instructions will not be taken into consideration.

As a rule, submitted articles should not exceed 8,000 words. All pages apart from the first one should be numbered. Subtitles should be concise, clearly marked in bold, and numbered (up to two levels of numbering). No other entries should be bolded. Formulae should be numbered on the right-hand side of the page. In case of long proofs, these should be inserted in a separate Appendix, following the References. Tables and Figures must not use colour, and should be in a format easy to edit, for instance they should take half a page (or a full page) within the indicated margins. They should be clearly labelled at the top, with a legend at the bottom, and should be logically ordered, using Arabic numerals. Sources of the data should be given below tables and figures.

Papers should follow APA style guideless: https://apastyle.apa.org/style-grammar-guidelines/references/examples#textual-works. Some key points watch out for are as follows. Parenthetic references in the text and in footnotes should be listed by the author surname, with the year of publication in parentheses; in case of more than one author use an ampersand, for instance: (Atkinson, Picketty & Emmanuel, 2011). Narrative citations within the text should use "and" rather than ampersand, for instance: Djankov, Glaeser and La Porta (2003). Use an ampersand in the list of references. When citing works with one or two authors, include the author name(s) in every citation. For works with three or more authors, include the name of only the first author plus "et al." in every citation (even the first citation). Include all author names in the list of references. If the author is unknown, the first few words of the reference should be used; this is usually the title of the source. For example: (*A guide for economy*, 2019). Multiple works by the same author are sorted by date in ascending order; if the works are in the same year they should be ordered alphabetically by title and allocated a letter (a, b, c, ...) after the date. Cite only the works you have read and incorporated into your writing; readers may find long strings of citations difficult to understand. Before submitting your paper, check that all references cited in the paper are included in the reference list at the end of the paper, and that all papers included in the reference list have been cited in the text.

References should be left aligned in alphabetical order in the reference list, according to the following formats:

#### Article in journals

Author surname(s), initial(s). (Year). Article title. Journal, Volume number (issue or part number, optional), page numbers. DOI.

Rodrik, R., Subramanian, D., & Trebbi, F. (2004). Institutions rule: the primacy of institutions over geography and integration in economic development. *Journal of Economic Growth*, 9(2), 131-165.

https://DOI: 10.1023/B:JOEG.0000031425.72248.85.

#### Book

Author surname, initial(s). (Year). *Title*. Publisher location: Publisher

De Grauwe, P. (2020) *Economics of Monetary Union* (13th ed.). Oxford: Oxford University Press.

#### Edited book

Author surname, initial(s). (Ed(s).). (Year). *Title*. Publisher location: Publisher

Baltagi, B.H. (Ed.). (2003). *A Companion to Theoretical Econometrics*. Oxford: Blackwell

#### Book with several authors

When there are multiple authors, list them all, with the addition of ampersand (&) before the last surname. If there are more than seven authors, list the first six, then write three full stops (…), and at the end write the last author.

Acemoglu, D. & Robinson, J.A. (2006). *Economic Origins of Dictatorship and Democracy*. Cambridge: Cambridge University Press.

Baumol, W. J., Panzar, J. C. & Willig, R.W. (1982). *Contestable Markets and the Theory of Industry Structure*. New York: Harcourt, Brace, Jovanovich, Inc.

#### Chapter in book

Last name of the chapter author, initial(s). (Year). Chapter title. In editor initial(s), surname (Ed.). *Title* (ed., pp.). Publisher location: Publisher

McMillan J., & Woodruff C. (2003) The central role of entrepreneurs in transition economies. In G. S. Fields, & G. Pfefferman (Eds.). *Pathways Out of Poverty* (pp. 105-121). Dordrecht: Springer. https://doi.org/10.1007/978-94-010-0009-3_6.

**E-Book**

Author surname, initial(s). (Year). *Title*. URL

Perry, R.B. (1909). *The Moral Economy.*

https://manybooks.net/book/137844/read#epubcfi(/6/2[id00000]!/4/2[id00000]/1:0)

**Technical Reports or Working Papers**

Individual authors

Author surname, initial(s) or corporate name. (Year). Title. (Report or Working Paper No.). URL.

Cătuți, M., Kustova, I. and Egenhofer, C. (2020) *Delivering the European Green Deal for Southeast Europe: Do we need a regional approach?* (CEPS Research Report No. 2020/1). https://www.ceps.eu/wp-content/uploads/2020/06/RR_2020-01_European-Green-Deal-for-South-Eastern-Europe.pdf.

Corporate authors

American Psychological Association, Task Force on the Interface Between Psychology and Global Climate Change. (2009). *Report of the APA Task Force on the Interface Between Psychology and Global Climate Change*.

http://www.apa.org/science/about/publications/climate-change.aspx

**Newspaper Articles**

Author surname, initial(s). (Year, Month Day). Title. *Title of Newspaper*, p. or pp. URL*

*only include if the article is online.

Note: the date includes the year, month and date.

Smialek, J. (2020, May 2). Hotel Group Will Return Tens of Millions in Small Business Loans. *The New York Times*, pp. 10.

https://www.nytimes.com/2020/05/02/business/economy/ashford-hotels-virus-monty- bennett.html

**Website**

Author surname, initial(s). (Year, month day). *Title*. URL

Mitchell, J.A. (2017, May 21). *How and when to reference*.

https://www.howandwhentoreference.com